APPOLO STUDY CENTRE CHENNAI

APPOLO STUDY CENTRE

Geography - TEST - 4

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11th standard

Unit 1. Fundamentals of Geography

Introduction

- "The study of Geography is about more than just memorising places on a map. It is about understanding the complexity of our world, appreciating the diversity of cultures that exists across continents. And in the end it is about using all that knowledge to help bridge divides and bring people together" - Barak Obama, Former President of USA.The subject 'Geography' was considered as 'The Mother of all Sciences' as most streams of sciences took rootfrom geography.

- It is a subject much needed in everyday life .Unfortunately, in the recent past it has been demoted to the back seat in most parts of the world, while certain other sciences hold prominent places in the society. Just as an intellectual understands the value of a library, a financier understands the value of money, a parent understands the value of their child a geographer understands the value of our planet earth and the wealth of resources it offers to us.

- A societythatlacks sufficient geographic knowledge cannot be expected to exhibit its strength of resource potentials and empowerment to make decisions in real-world context.Therefore, the knowledge of geography is very much vital for the care and concern of the earth, growth and development of every country and for minimising the issues related to human activity. In this context, the National Geographic Society, USA defines geographic literacy as being equipped to understand the complexity of the world, how our decisions affect others (and vice versa), and the interconnectedness of this rich, diverse, and not-so-large world.

- This unit introduces the student to the foundations over which the subject had developed in the past, the content it offers now and the changes that it had undergone. It also opens the door to the world of physical geography and the practical skills to be acquired to understand geography which are explained in the units following this.

Defining Geography

- Geography is one of the oldest earth sciences and its roots date back to the works of the early Greek scholars. The term 'Geography' was coined by the Greek scholar Eratosthenes who combined two Greek words 'Geo' (The Earth) and 'Graphing' (to describe). Therefore, in the literary sense, geography is the description of the Earth. Over the ages, geography has become the art and science of studying the physical characteristics of the earth and man's role in adapting to and modifying the environment.

- Geography was born through explorations and discoveries. Earlier, the aim of geography was to discovernew lands, sea routes, prepare maps and describe them.

Later, its emphasis had shifted to scientific investigation of earth's landforms, oceans and atmosphere, as well as the interactions with human beings and the environment.

- In essence, geography can be defined as a multifaceted discipline studying intra and inter relationships of various spheres of the earth, collects and analyses relevant data, applies the latest tools and methods to prepare maps and visuals and provides sustainable solutions to human and environmental issues of the earth.

Evolution of Geography

- Geography had evolved over a long period of time. Some of the earliest geographical studies go back about four thousand years ago through explorations. The early explorers travelled and tried to map the new places.The evidences of such explorations come from the archaeological discovery of a Babylonian clay tablet map that dates back to 600 BCE. During this time, Phoenician, Chinese and Egyptian civilisations were in the beginning to explore places outside their homelands. It was the ancient Greek scholars who laid the foundations and gave a solid form to geographic studies and on these foundations, the pillars of modern geography were erected by others in the subsequent ages. The Romans, the Arabs, the Indians, the Chinese, the Germans, the French, the British and the American geographers have contributed to the development and enrichment of the subject.

- The Greek philosophers and scientist focused on the spatial nature of human and physical features of the Earth. The first Greek geographer was Herodotus (484 - 425 BCE) who wrote a numberof volumes on the human and physical geography of the Persian Empire. The other early Greek contributors to geography are, Thales, Aristotle and Eratosthenes (276 - 194 BCE).

- The earlier geographers were descriptive geographers concerned with answering questions like 'what is where' on the earth and the question like 'why it is there' came later. Geographers study the location of the activities, carefully identify patterns using maps and find out the reasons for these patterns. The areas are then described based on the distribution of land forms, population, housing and agriculture. They discover the linkages and movements between places and are able to infer the spatial processes that are working in these areas.

- The development of geography can be summarised in three phases namely (1) The age of discovery (1400-1800), (2) The period between 1800 and 1950 and (3) The period after 1950.

The age of discovery between 1400 - 1800

- The period between 1400 and 1800 was when the subject matter and the methodology of geography were not fully developed. The discipline was in an embryonic stage. Tis period was characterized by exploration, discovery and conquest through the voyages of Vasco da Gama and Christopher Columbus. Numerous journeys

of geographical exploration were commissioned by a number of Nations in Europe (Figure. 1.1, 1.2, 1.3 and 1.4). Most of these voyages were financed because of the potential commercial returns from resource exploitation. The voyages also provided an opportunity for scientific investigation anddiscovery. Making of maps (cartography) was important in the discipline of geography due to the emphasis on location of phenomena on the earth surface, e.g. location of trade routes, relief features and settlements.

The period between 1800 -1950

- The period between 1800 and 1950 was characterized by the work of various individual philosophers who helped to expand the scope of geography. The discipline of geography became more distinct as a subject matter. Geographic knowledge saw strong growth in Europe and the United States in the 1800s. Tis period also saw the emergence of a number of societies interested in geographic issues. In Germany, Alexander Von Humboldt, Carl Ritter and Friedrich Ratzel made substantial contributions to human and physical geography. Humboldt's publication 'Kosmos' in 1844, examines the geology and physical geography of the earth. Tis work is still considered by many academics as a milestone contribution to geography.

- There are two schools of thought that emerged during this period as an attempt to explain the relationship between human beings and their environment. These were environmental determinismand possibilism.Proponents of environmental deterministic school of thought such as Mackinder, Ellen Semple and Huntington believed that human actions and activities were moulded by the physical (natural) conditions. In several developing countries, human beings are susceptible to natural disasters such as drought, famine, floods and earthquakes. Human beings under such natural conditions usually surrender to nature. A good example of environmental determinism is the influence of the natural environment on human activities such as nomadic pastoralism. Nomadic pastoralism is so much dependent on the natural environment. Pastoralists do very little to modify their environment.

- The proponents of possibilistic school of thought, such as Vidal de la Blache saw the environment as a limiting factor rather than as a deterministic force. According to the possibilism school of thought, human beings have several alternatives in their environment and their actions are influenced by the decisions they make in the environment. For instance, humans can survive in hot or extremely cold conditions due to their ability to modify the environment to suit them. A good example is that in many arid countries such as Israel, humans have overcome the constraints set by the natural environment such as low rainfall, high temperatures and poor soils.

The period after 1950

- Until 1950s, geography was more of an art subject where facts were established by casual observation in the field rather than by careful measurement and hypothesis testing. In the 1950s there was a new development in the discipline and several laws were established to explain geographical phenomena. Using the laws, it is possible to

predict what willhappen in the future. If we can predict successfully, we can plan and limit the extreme possibilities.

- One of the important developments in this period was the use of quantitative techniques in physical and human geography. These techniques refer to various statistical tools that are used to synthesise the data from maps, field, laboratories and questionnaires. Quantification came about as a result of the expanding scope of the discipline as well the need to understand the processes that were becoming more diversified and complicated.

- This quantitative revolution was referred to as a revolution because it marked a new beginning in the way the subject matter of geography was to be studied. The quantitative revolution involves the use of statistics, mathematical equations and the use of deterministic models. Many geographers believed that numbers are more precise, and therefore perceived as more scientific compared to words. The map, both as graphic language and visual representation, continues to be used as a geographical tool and at present with the valuable assistance of remote sensing and Geographical Information Systems, map making has become digital and easier especially due to advances in computer and software technologies.

Themes of Geography

- In any subject there will be certain themes, around which the scholars work and contribute. In this way, geography subject also has certain traditional themes. Let us look at them carefully. In 1963, William D. Pattison identified the core themes of geographic studies as 'The Four Traditionsof Geography'. These distinct, but related, traditions, of the discipline are: Spatial tradition (areal distributions and spatialpatterns. Examples: Population movement) Area studies tradition, (hierarchy of areas, small to large) Man-land tradition(relationship between man and his physical environment) and Earth science tradition (processes of the earth).

- Like the major traditions identifed in geography, the signifcant themes of the subject are also identifed. Te Association of American Geographers put forward the 'Five themes of Geography' and it has been widely accepted by geographers worldwide (Figure1.5). Te themes are location, place, human – environment interaction, movement and regions.

Five Themes in Geography

Themes of Geography are the educational tools for understanding the geography subject in detail. It was adopted in the year 1984 by the Association of American Geographers and these five themes were publishedin the National Council for Geographic Education/Association of American Geographers' publication Guidelines for Geographic Education.

Location

Every point on earth has a location. The location can be described in two different ways:

- Absolute location is a location as described by its latitude and longitude on the earth. For example, the coordinates of Chennai Central Railway station are 13°04'56" N latitude and 80°16'32" E longitude.
- Relative location is the position of a place in relation to another well-known landmark. For example, Kallanai Dam or Grand Anicut is located roughly 350 km south –southwest of Chennai City. The absolute and relative location related surveys and studies fall under this category.

Place

- A place is an area that is defined by everything in it. All places have features that give them personality to distinguish them from other places. A number of place names in Tamil Nadu, like Redhills, Fort St. George, Mint, and George Town are examples to this theme.
  - Toponym: A place name, especially one derived from topographical feature.
  - Site: An area of ground on which a town, building, or monument is constructed.
  - Situation: The location and surroundings of a place.

Human-Environment Interaction

The theme describes how people interact with the environment and how the environment responds. These are studied with reference to the following three key concepts:

- Dependency: How humans depend on the environment (Example: For water, fresh air, sunlight etc.)
- Adaptation: How humans adapt to the environment (Example: Life in polar or desert regions)
- Modifcation: How humans modify the environment (Example: Construction of Underground Metro rail, Agriculture in Israel).

Movement

- Movement is the network of travel of people, goods and ideas from one location to another. Examples: Rural-urban migration and metro train commuting in Chennai. Air transport which carries people and goods and the internet that allows access to ideas and knowledge across the world are also examples of this kind.

Region

- Regions are areas with distinct homogenous characteristics such as climate (Monsoon regions), natural vegetation (Tropical rain forests), crops (Corn Belt of USA), major landforms (Himalayan region), industries (Chota-Nagpur plateau) etc.

Geography's Relation with Physical and Social Science Disciplines

- While defining geography, we have seen that some branches of geography have strongest affiliations with subjects like mathematics and environmental sciences, while others have very close connection with history and sociology. Some subjects deal with distinctive type of phenomena while geography examines several kinds of phenomena together. Te diagram (Figure 1.6) gives clear idea about the relationship of geography with other disciplines.

Relations with Physical Sciences

Astronomy, Mathematics, Computer Science and Geography:

- Astronomy basically deals with the celestial bodies including stars, planets, satellites, their motions, constellations, as well as different kinds of phenomena occurring in the outer space. The precise location, nature of movements, form and size of celestial bodies, including those of the solar system, have been accurately measured with the help of mathematics. The interaction of astronomy, mathematics and computer science with geography has paved way for the development of modern cartography and GIS.

Geology and Geography:

- Geology is the study of rocks, their types, distribution, mineral content, petroleum, etc. The subject investigates all these phenomena, classify them and put them in a sequence. Geography interacts with the subject in studying the distribution of exposed rocks, interaction with climate and human activities, economic prospects of the minerals and so on. Interaction between geology and geography leads toformation of the new branch of study called geomorphology, the study of landforms.

Physics, Chemistry and Geography:

- As geography is the study of variable phenomena on the earth's surface, the dynamic mechanism of the phenomena requires to be studied within the framework of physics. The physics of atmosphere is studied under climatology and the physics of hydrosphere through oceanography, and both the subjects investigate, interpret and explain the atmospheric and hydrological processes. The chemical contents of rocks,soil, surface and groundwater, atmosphere are the interests of the geographers. They study how the physical and chemical contents are disturbed by human activities and vice versa.

Botany, Zoology and Geography:

- The systematic branches of botany and zoology have traditionally been confined to the classification and description of various kinds of species on the earth's surface.

Geography, being the study of the spatial section of earth's surface, attempts to study the distributional aspects of fora and faunaespecially with reference to climate and relief. The integration among these subjects has given birth to biogeography.

> The study of 'apartheid' (a system of institutionalised racial segregation as existed in South Africa) is an example of anthropo-geographic study.

Relationship with Social Sciences

Economics and Geography:

- Economics is concerned with how human needs and wants are satisfied with the available resources. Economic geography is concerned with the study of resources endowment and patterns of utilisation. The economic activities of the human beings including agriculture, fishing, forestry, industries, trade and transport are studied in this branch. The economic activities are highly influenced by the relief and climatic factors of the region or the country. Therefore, economics and geography have close links with each other, especially for integrated resources development.

Sociology and Geography:

- Sociology is mainly concerned with the institutional aspects of the society. A number of investigations including social behaviour, movement of people between rural-urban areas, spatial interactions between social groups, the relations between innovation and tradition in rural and urban areas etc., have been jointly undertaken by sociologists and geographers in different countries of the world. Social geography is the logical expression of the interaction betweensociology and geography as it studies social phenomena in spatial context.

Anthropology and Geography:

- Anthropology attempts to study human races and their classification. Both anthropology and geography seek to identify and classify the human races on the basis of their habitat and cultural traits and attempt to study the variable racial phenomena on the spatial context of the earth's surface. The relationship between anthropology and geography has resulted in the development of 'anthropogeography' or geography of humans.

History and Geography:

- History is a framework of events as per time and place. Geography attempts to study these events with reference to the physical earth and depict the places of historical events using thematic maps. Anyone who attempts to study any historical events of India should always integrate the temporal and the spatial phenomena of that period together to arrive at a conclusion.

Tamil Rulers and Geographic Knowledge

History reveals to us that how the Great rulers like Raja Raja Chola or

RajendraChola had trade relations with other countries of the world, especially South Asian countries by understanding the relief, seasons, ocean current movements etc., The sailors would have been experts in every aspect of geography to move their troops, sail overseas and trade with all known nations of that time. They also utilised the ocean currents to transport teak and other valuable timbers from Indonesia, Myanmar, and other countries to South India.

Approaches to the Study of Geography

- Geography has undergone several changes in its approach. Te earlier geographers were descriptive geographers. Later, geography came to be developed as an analytical science. Today the discipline is not only concerned with descriptions but also with analysis as well as prediction. There are two distinct approaches or methods to study geography. They are:1. Systematic approach and 2. Regional approach

Systematic Approach:

- Systematic or nomothetic approach was introduced by Alexander Von Humbolt, a German geographer (1769-1859). In this approach a particular phenomenon is considered for detailed understanding. Te study of specifc natural or human phenomenon that gives rise to certain spatial patterns and structures on the earth surface is called systematic study. Generally, systematic geography is divided into four main branches.

i. Physical Geography: Study of various elements of earth systems like atmosphere (air), hydrosphere (water), lithosphere (rock) and biosphere (life) and their distributions.
ii. Biogeography, including environmental geography: It focuses on various kinds of forests, grasslands, distribution of flora and fauna, human-nature relationships, quality of the living environment and its implications for human welfare.
iii. Human Geography: It describes the human culture, population, dynamic socio economic and political aspects.
iv. Geographical methods and techniques: Itisconcernedwith methods andtechniques for field studies, qualitative, quantitative and cartographic analysis.

Regional Approach:

- It isotherwisecalled as ideographical approach. It was developed by Carl Ritter(1779 – 1859), a contemporary of Humboldt. The regions could be classified based on a single factor like relief, rainfall, vegetation, percapita income or there could also be

multi-factor regions formed by the association of two or more factors. Administrative units like states, districts and taluks can also be treated as regions. The main sub branches of regional geography are : i) Regional studies ii) Regional analysis iii) Regional development and iv) Regional planning.

Born on 14 September 1769 Alexander Von Humboldt was a Prussian polymath, geographer, naturalist, explorer. Humboldt's quantitative work on botanical geography laid the foundation for the field of biogeography Humboldt resurrected the use of the word cosmos from the ancient Greek and assigned it to his multi-volume treatise, Kosmos. He was the first person to describe the phenomenon and cause of human-induced climate change, in 1800. He described the Guanoco asphalt lake as "The spring of the good priest". Humboldt and Bonpland discovered dangerous electric eels, whose shock could kill a man. His stay in Ecuador was marked by the ascent of Pichincha and their climb of Chimborazo, where Humboldt and his party reached an altitude of 19,286 feet (5,878 m). This was a world record at the time. U.S President, Jefferson later referred to Humboldt as the most scientific man of the age.

Geographical Data Matrix:

- The matrixis a simple method of arranging information in rows and columns for better understanding of complex spatial problems. Brian J.L. Berry adopted this method from anthropology for studying geography more effectively.Geographic data can be arranged in a rectangular array or matrix. Row-wise group of variables represent the systematic or topical branches of geography while, regions are represented by columns. Berry has explained that regional synthesis could be derived with the help of a series of geographic matrices in correct temporal sequence. Each time period has been taken to be equivalent to a 'slice' of the three-dimensional cake. The diagram of 'Third Dimension' makes it possible to examine rows and columns, cutting across time.

Branches of Geography

- Based on content and the available techniques, the discipline can be divided into three major domains. Each one has many sub divisions which deal with specific objectives (Figure 1.7).
  a. Physical Geography
  b. Human Geography and
  c. Geographic Techniques.

Physical Geography

- It is the study of natural features of the earth such as land, water, air and living organisms. The changes taking place within and among these natural features and their

resultant features are studied under its various branches. The branches of physical geography are:

i. **Geomorphology** deals with the distribution of land forms, their origin and the forces causing changes over these landforms. Geology provides basic information to the study of geomorphology.
ii. Soil Geography is a study related to soil formation, soil profile, soil types, their fertility level and distribution. Soil erosion and conservation measures are also dealt in this branch.
iii. Climatology deals with the study of global and regional weather and climatic conditions by analysing relevant statistical data. Meteorology provides basic information on the composition, structure and the changes in the atmosphere.
iv. Hydrology encompasses the study of earth's realm of water such as oceans and surface water bodies like rivers, reservoirs and ponds. It also makes a study of underground water and its recharge and also pollution of water bodies.
v. Oceanography is the study of seas and oceans. The shape, size, depth and bottom relief of ocean, distribution of oceans, ocean currents and variouslife forms existing in ocean are also studied under oceanography.
vi. Biogeography is a study of ecosystems over geographical space. It also analyses the changes in the ecosystems. Phytogeography or plant Geography, Zoo Geography or animal geography and Ecology are the branches of biogeography.
vii. Environmental Geography is the study of environmental issues arising out of misuse of various spheres of the earth and their implications. The ozone layer depletion, global warming, melting of polar ice caps, rising sea level and other related aspects are also givendue importance. It also tries to give sustainable solutions to these problems.

Human Geography

- Human Geography is concerned with the changes made by the humans over the natural or physical landscape. The ethnic and political aspects are taken into consideration. The issues like climatic change, natural and anthropogenic disasters are also the major concerns.

i. Population Geography is the study of distribution and density of population, the changing patterns in age and sex composition, birth and death rates, life expectancy, literacy level and dependency ratio, migrationsat national and international level and the causes and consequences of migration.
ii. Settlement Geography deals with the characteristics of rural and urban settlements and transportation network. It seeks better understanding of the present landscape and plans for the future. The study is more important for town and country planning.
iii. Historical Geography tries to picturise the geography of an area or region as it was in the past and studies how it has evolved over time. The forces involved in transforming region such as colonisation by the Europeans or a natural disaster are also included in the study.
iv. Anthropo Geography deals with the distribution of human communities on the earth in relation to their geographical environment.

v. Cultural Geography gives emphasis on the location and diffusion of customs and cultural traits such as food habits, skills, clothing and beliefs and social organisations and their developments in different parts of the earth.
vi. Social Geography is closely related to cultural geography. It examines the relationships among the social groups and their social relationships in the places of their living.
vii. Political Geography tries to understand the countries and their neighbours, problems of resources sharing, boundaries and territorial limits.Thisbranchis also concerned with understandingthepoliticalbehaviour of the population, relations between independent states, and patterns of voting and delimitation of electoral constituencies.
viii. Economic Geography deals with the distribution of economic activities such as, primary, secondary and tertiary. The primary activities include food gathering, hunting, animal rearing, agriculture, and mining. The secondary activities include manufacturing and the tertiary activities include the service sectors such as trade, transport, communication and other related areas.
ix. Medical Geography mainly deals with study of geographical aspects of origin, diffusion and distribution of various communicable diseases and health care planning.

Geographic Techniques

- Geography has developed a number of methods and tools to investigate and identify the spatial structures and patterns. Besides, it also lends or borrows some methods and tools to measure and investigate precise understanding of the spatial locations and patterns.

i. Mathematical Geography deals with the study of earth's size and shape, motions of the earth, concept of time and the time zones.
ii. Statistical Geography is concerned with the practice of collecting, analysing and presenting data that has a geographic or areal dimension, such as census data.
iii. Cartography is the study of making maps of various scales using authentic information.
iv. Remote Sensing is the art, science and technique of capturing the earth surface features using sensors or cameras in airplanes or satellites, processing and presenting the spatial information tousers.
v. Geographic Information System (GIS) is a computer-based tool of the recent decades for geographical studies. It is used for storing, retrieving, transforming, analysing, and displaying data to prepare useful thematic maps.
vi. Global Navigation Satellite System (GNSS) is used to pinpoint the geographic location of a user anywhere in the world. Airlines, shipping, travel agencies and automobile drivers use the system to track the vehicles and follow the best routes to reach the destination in the shortest possible time.

Global Navigation Satellites System

GNSS is the standard generic term forsatellite navigation systems that provide geo-spatial positioning with global or regional coverage. This term

includes the GPS (USA), GLONASS (Russia), Galileo (Europe), Beidou (China), IRNSS (India) and other systems. The GPS was the first GNSS system of the United States and originally used for military applications. Today it is commonly used in mobiles, vehicles, agriculture and other areas that allow us to use it in all fields of mapping.

- Geography is undergoing frequent changes to tackle the challenges of the dynamic world. The subject is more flexible and accommodates many principles of related subjects. At the same time, it lends concepts and knowledge to many related disciplines. Owing to these changes, the subject is attaining more refinement, accuracy, precision, depth and scientific rationale.

Geographical Tools and Skills

- Every day the news media report several geographically significant events of near-by or faraway places. Such reports include the occurrence of earthquakes, floods, forest fire, landslides etc., which trigger the interests of everyone to recollect their geographic knowledge they had acquired earlier.The essential tools of geography are maps and globes and now the digital versions of aerial photographs, satellite images, Geographical Information Systems (GIS) and Global Navigation Satellite System (GNSS).These tools have become an integral part of geography and these products help us to visualise the spatial patterns over the surface of the earth.

- The GIS technique has enhanced the skills and capabilities to compare and overlay the digital layers to create maps quickly and efficiently. It helps us to study the areas affected by floods or cyclones or forest fire and the damages can be assessed accurately and losses be estimated within a very short span of time. The navigation satellites provide accurate location of these occurrences.

- In recent years, geography aims to develop a set of marketable skills to the students rather than preparing the students only for the teaching in educational institutions.

- The job market is changing frequently. Therefore, the teaching methodology of the subject is to be adapted to the changing trends of the society and provides a couple of specialisations to the students so that they could be acquainted with the global market and get suitable employment. The maps still remains an important visual medium for geographers although the microchip revolution is expanding exponentially to address a number of societal issues.

Cartography:

- Geographers who specialise in this branch make traditional maps, digital maps, atlases, charts, globes and models. Quantification and cartography are considered as two sides of the 'geography coin'. Owing to quantitative and computer revolutions, handling of spatial data become easier, not only for the preparation of 'instant maps' but also for

statistical graphs, graphic images and models. Preparation of the computer-aided-maps and updating the existing ones become easier and faster. Creation of three dimensional models, changing the viewing angle of these models and plotting the images are made possible due to the introduction of computer expertise in cartography.

Land use Studies:

- For studies of quickly changing phenomena on the earth surface, such as foods, drought, forest fires, etc, remote sensing data provide accurate information in different scales. The remote sensing organisations employ geographers who have the knowledge to process the frequently changing earth's surface features. Even before the introduction of satellites in remote sensing, aerial photographs were widely used by geographers for natural resources surveysand urban and regional planning. The satellite data from Landsat, SPOT, IRS and other satellites made it possible to repeatedly view each part of the earth surface at frequent intervals and thereby geographers' 'data thirst' is considerably quenched.

Geospatial Analysis:

- A geospatial analyst designs databases, analyses geographical data, uses appropriate GIS software to a wide range of applications including defence, real estate, pollution and government administrations. The skill helps to identify optimum size and ideal location, establish new or relocate existing facilities like hospitals, police station, banks, shopping centres etc.,

Environmental Impact Assessment:

- This investigation requires voluminous data related to physical, social, economic and other aspects of the area under study. The data are collected from maps, satellites and field and synthesised to provide meaningful visual results. Such complex thematic visual results allow the decision makers to take appropriate steps to tackle the day to day and long term environmental issues.

Regional Planning:

- A planner who is responsible for planning an urban or a regional unit needs to have an overall view of the area. They should be able to synthesise the issues from multiple perspectives. The problems are increasingly concerned with balancing different, sometimes contradictory, interests into functional and sustainable suggestions and proposals. Tis specialisation is concerned with planning, housing, and smart city development projects. The regional land use maps are to be preparedto locate facilities and optimise the existing land for various uses.

Weather Forecasting / Now casting:

- At present the meteorologists are using ground data and satellite data to forecast the wind direction, rainfall possibilities and cyclone movement. However, with the advancement of satellite sensors, navigation satellites and GIS technology it is possible to nowcast the weather conditions and provide live cyclone movement tracts, otherwise known as weather nowcasting.Geographers are utilising spatial and non–spatial data to analyse weather and climate parameters and conduct research concerning climate and climate changes and forecast the earth's future climate and weather conditions and their implications.

Surveying, Utilising Large Scale Maps/Sketches:

- Surveying with instruments, starting from chain survey to differential GPS (DGPS), are an integral partof geography curriculum. The students survey and prepare sketches of various features in an area. They also survey the campuses with advanced survey instruments and prepare large scale maps. The geographical knowledge and training enable the students to interpret large scale maps of India and other countries of the world. Ground Penetrating Radar (GPR), one of the emerging field survey instruments, is gaining importance not only in earthsciences discipline but also in archaeology, civil engineering, city planning and other related fields.

- The students of geography undergo special trainings in their college level studies and seek employment in the areas of their specialisation. Depending upon their area of specialization; geographers are employed as scientists in national and state planning commissions, water resources organizations, and land use planning units, agricultural or economic institutes or as demographers in government and research organizations.

- The geographers are also employed as climatologists, geomorphologists, GIS specialists and hydrologists. Geography background is an asset for careers in travel and tourism, particularly for 'Travel Journalism'. Besides these, the geography graduates apply for civil services examinations conducted by various States of India and also the UPSC. Recent developments in geography are technological in nature and mostly computer oriented. The average geography graduate is therefore well versed in the use of computers, and as they are trained in understanding patterns and relationships over space.

Geography in Tamil Nadu

- A number of institutions of higher learning in Tamil Nadu have been offering graduate and post graduate programmes in geography for several decades. Some of the Departments are recognized asresearch centers and these are engaged in undertaking national and international research projects besides conducting research programmes in geography. The departments are also engaged in organizing short term and long term training programmes and workshops to disseminate the latest geographic knowledge and technology for the benefit of students, researchers and teachers of geography.

Annual Geography Talent Tests for College / University Students and School Students of Tamil Nadu

The Indian Geographical Society is conducting talent test examination to final year UG and PG geography students across the State and present awards and cash prizes to a tune of Rs. 15,000 (top three M.Sc. students) and Rs. 10,000 (top three B.Sc. students) in the names of the IGS Founder Prof N.Subrahmanyam and the former Head of the Department of Geography of University of Madras Prof. A.Ramesh, respectively.

The Association of Geography Teachers of India conducts Annual Geography Talent Tests to the school students. The talent test is conducted at two levels: Students of classes 7 and 8 take Junior Level test while the students of classes 9 and 10 take it at the Senior Level. Prizes and certificates are awarded to top ranking candidates.

- Two geographical Associations are functioning in Tamil Nadu to disseminate geographic knowledge to the students and teachers of schools, colleges and universities through publishing journals, organizing workshops and conduct talent tests to the geography students.

Databases for Geography Teaching and Learning

- Geographers are concerned about certain global and local issues like disasters, environmental problems, natural resources and other related aspects. Often these issues are discussed in the classrooms. Data relating to the issues are necessary for better understanding of the same and for seeking real world solutions. A number of organizations in India are engaged in disseminating such valuable information through special publications, especially to the student community. The schools, colleges, universities and research institutions can write to the following organizations and enroll themselves to receive the published materials like booklets, pamphlets, satellite images, manuals etc. They can also enroll for short term trainings / field visits / workshops arranged by these organizations.

Awards to Geography Teachers and Scientists

The Indian Geographical Society has instituted Awardsin the names of renowned Geographers Prof. B. M. Thirunaranan, Prof. A.R. Irawathy and Prof. V. L. S. PrakasaRao to the leading geographers who work in the areas of

geomorphology, remote sensing and regional planning respectively.

- The students can make use of the free software available from these organizations to visualize the earth's surfaces from space and map the existing and changing land cover details, traffic density, pollution levels etc., A number of spatial information, including satellite images can be downloaded freely for educational purposes such as classroom teaching, preparation of maps, for project work, field work and other activities.

Glossary

1. **Absolute Location:** The exact position of an object or place stated in spatial coordinates of a grid system designed for the location purposes. In geography, the reference system is the global grid of parallels of latitudes north or south of equator and of meridians of longitude east or west of the Prime meridian.

2. **Cartography:**The art, science and technology of making maps.

3. **Field Measurement Book (F.M.B):** The FMB depicts the dimensions of each field boundaries and the sub divisions. In FMB the individual survey number maps are maintained at a scale of 1:1000 or 1:2000. Each survey number is divided into several sub divisions. Each sub division is owned by a owner. The FMB's also depicts the dimensions of each field boundaries and the sub divisions.

4. **GlobalPositioning System (GPS):** A method of using satellite observations for the determination of extremely accurate location information.

5. **Greenhouse Effect:** The heating of the earth's surface as shortwave solar energy passes through the atmosphere, which is transparent to it but opaque to reradiated long wave terrestrial energy. It also refers to increasing the opacity of the atmosphere through the addition of increased amounts of carbon dioxide, nitrous oxide, methane and chlorofluorocarbons.

6. **Greenwich Mean Time (GMT):** Local time at the prime meridian (Zero degree longitude), which passes through the observatory at Greenwich, England.

7. **Map Projection:** A method by which the curved surface of the Earth is shown on a flat surface map. As it is not possible to show all the Earth's features accurately on a flat surface, some projections aim to show direction accurately at the expense of area, some the shape of the land and oceans, while others show correct area at the expense of accurate shape.

a. One of the projections most commonly used is the Mercator projection, devised in 1569, in which all lines of latitude are the same length as the equator. This results in increased distortion of area, moving from the equator towards the poles. This projection is suitable for navigation charts.

b. The Mollweide projection shows the land masses the correct size in relation to each other but there is distortion of shape. As the Mollweide projection has no area distortion it is useful for showing distributions such as population distribution. The only true representation of the Earth's surface is a globe.

8. **Nation:** A culturally distinctive group of people occupying a particular region and bond together by a sense of unity arising from shared ethnicity, beliefs and customs.

9. **Natural Resource:** A physically occurring item that a populationperceives to the necessary and useful to its maintenance and well-being.

10. **Ozone Layer:** A gas molecule consisting of three atoms of oxygen (O3) formed when diatomic oxygen (O2) is exposed to ultraviolet radiation. In the lower atmosphere, it constitutes a damaging component of photochemical smog; in the upper atmosphere, it forms a normally continuous, thin layer that blocks ultraviolet light. A layer of ozone in the atmosphere (stratosphere) protects life on earth by absorbing ultraviolet radiation from the sun.

11. **Prime Meridian:** An imaginary line passing through the Royal Observatory at Greenwich, England, serving by agreement as the zero degree line of longitude.

12. **Region:** In geography, the term applied to an area of the earth that displays a distinctive grouping of physical or cultural phenomena or is functionally united as a single organisational unit.

13. **Relative Location:** The position of a place in relation to a well-known place.

14. **Site:** The place where something is located; the immediate surroundings and their attributes.

15. **Situation:** The location of something in relation to physical and human characteristics of a larger region.

16. **Toponym:** A place name with reference to topography.

Unit II The Solar System and the Earth

2.1 Introduction

Have you ever relaxed lying on the terrace of a building or in the front yard at a cloudless night? If yes, could you watch the night sky filled with glittering stars which appear to be growing in numbers?These glittering stars, which we see, are a part of the universe. Let us now discuss in detail about the Universe, stars, planets and other objects. The universe is a vast endless space which includes galaxies, stars, planets and other forms of matter and energy in it.

2.2 Theories of the Earth's origin

There are many theories supporting the origin of the earth. One of the earlier and popular arguments of the earth's origin was by a German professor Immanuel Kant. Mathematician Laplace revised it in 1796. It was known as Nebular Hypothesis. It considered that planets were formed out of a cloud of materialassociated with a youthful sun, which was slowly rotating. Lyttleton propounded the accretion theory of the earth's formation. According to this theory, approximately 4.6 billion years ago, the solar system was a cloud of dust and gas known as a solar nebula. As the solar nebula began to spin, the gravity collapsed the materials on itself and it formed the sun in the centre of the solar system. When the sun formed, the remaining materials began to clump up. Small particles drew together, bound by the force of gravity, into larger particles. The solar wind swept away lighter elements, such as hydrogen and helium, from the closer regions. It left only heavy rocky materials to create planets like the Earth. But farther away, the solar winds had less impact on lighter elements, allowing them to coalesce into gas giants. In this way, planets, moons, asteroids, comets, etc., were created.

Voyager 2 travelling at the speed of more than 62,764.416 km/h will still take morethan 296,000 years to pass Sirius, the brightest star in our night sky.

Earth's rocky core formed first when heavy elements collided and bound together. Dense materials sank to the center, while the lighter material created the crust. The planet's magnetic field probably formed around this time. Gravity captured some of the gases that made up the planet's early atmosphere.

2.3 Modern theories of the origin of the Universe

The most popular argument regarding the origin of the universe is the Big Bang Theory. It is also called expanding universe hypothesis. In 1927, Abbe Georges Lemaitre, a Belgian astronomer was the first to propose, a theory on the origin of the universe. It was Edwin Hubble who provided the evidence that the universe is expanding. It was called, 'the Big Bang Theory'. According to it, the universe was formed during a period of inflation that began about 13.75 billion years ago.

Like a rapidly expanding balloon, it swelled from a size smaller than an electron to nearly its current size within a fraction of a second. Matter from the universe was thrown out with great force in all directions and started expanding outwards. From this matter, many groups of stars were formed which we call 'galaxies'. A galaxy is a system of billions of stars, stellar remnants, interstellar gas, dust, and dark matter. The word galaxy is derived from the Greek word Galaxias, literally "milky", a reference to the Milky Way (Figure 2.1). The Milky Way is the galaxy that contains our Solar System.

Galaxies are in three major forms:

1. Spiral Galaxies: It consists of a fat and rotating disk of stars, gases and dust. It has a central concentration of stars known as the 'bulge'. The Milky Way and the Andromeda are spiral galaxies.
2. Elliptical Galaxies: It contains older stars with fewer gases. Messier89 galaxy is an elliptical galaxy.
3. Irregular Galaxies: They are youthful galaxies with more dust and gases. This can make them very bright. Large Magellanic Cloud is an example of irregular galaxy.

Initially, the universe was saturated only by energy. Some of this energy set into particles, which assembled into light atoms like hydrogen and helium. These atoms grouped first into galaxies, then stars and all the other elements. This is generally agreed-upon concept of our universe's origin as estimated by scientists.

In fact, the stars, planets and galaxies that can be detected make up only 4 percent of the universe, according to astronomers. The other 96 percent of the substances in the universe cannot be seen or easily understandable.

The new measurement technique called gravitational lensing confirmed the age of the universe and the strength of dark energy. Dark energy is responsible for the accelerating expansion of the universe. Scientists used gravitational lensing to measure the distances light travelled from a bright, active galaxy to the earth and some details of its expansion.

Three scientists, Saul Perlmutter, Brian Schmidt and Adam Riess won the Nobel Prize in Physics (2011) for their discovery that the universe is just expanding and picking up speed.

2.4 Star and Constellations

A star is type of astronomical object which has its own light and heat. The nearest star to earth is the Sun. Sirius is brighter star than the sun. 'Proxima Centaur? is the closest star to the sun. Star is formed when enough dust and gas clump together because of the gravitational forces. Star changes its formsduring its lifetime such as-red giant, white dwarf, neutron star and black hole.

Constellation (Figure 2.2) is a group of stars that forms a particular shape in the sky. In 1929, the International Astronomical Union (1AU) adopted official constellation

boundaries that defined 88 official constellations thatexist today. Earlier Ptolemy, in his book Almagest, listed 48 constellations.

Ursa Major (Figure 2.3) is a constellation that can be seen in the northern hemisphere and part of the southern hemisphere. Ursa Major means Great Bear in Latin.

2.5 The Solar system

A solar system consists of a star (Figure 2.4) at the centre and the eight planets, moons, asteroids, comets and meteoroids that revolve it. The eight planets, namely the Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune, revolvearound the sun in fixed elliptical paths known as 'orbits'. Most stars host their own planets. So there are billions of other solar systems in the Milky Way galaxy alone.
Solar systems can also have more than one star. These are called binary star systems if there are two stars or multi-star systems if there are three or more stars. Our solar system is located in an outer spiral arm of the vast Milky Way galaxy. Our solar system orbits the centre of the Milky Way Galaxy at about 828,000 km/h. Our solar system takes about 230 million years to complete one orbit around the galactic centre.

The solar system is believed to have been formed about 4.6 billion years ago. The solar system also includes the Kuiper Belt that lies past Neptune's orbit. This is a sparsely occupied ring of icy bodies. This is almost all smaller than the dwarf planet Pluto. Beyond the fringes of the Kuiper belt (Figure 2.5) is the Oort cloud. This giant spherical shell surrounds our solar system. It has never been directly observed,by gravitational attraction, producing immense pressure and temperature at its core. There are three main layers in the Sun's interior: the core, the radioactive zone, and the convective zone (Figure 2.6). The core is at the centre. It is the hottest region, where the nuclear fusion reaction to give the sun power. Moving outward next come the radioactive (or radiation) zone. Its name is derived from the way energy is carried outward through this layer, carried by photons as thermal radiation. The third and final region of the solar interior is named the convective (or convection) zone. It is also named after the dominant mode of energy flow in this layer. The boundary between the Sun's interior and the solar atmosphere is called the photosphere. It is what we see as the visible 'surface' of the Sun.

Did you know that the Sun has an atmosphere? Te lower region of the solar atmosphere is called the chromosphere. Its name is derived from the Greek word chroma (meaning colour), for it appears bright red when viewed during a solar eclipse. A thin transition region, where temperature rises sharply, separates the chromospheres from the vast corona above. The uppermost portion of the Sun's atmosphere is called the corona, and is surprisingly much hotter than the Sun's surface (photosphere) The upper corona gradually turns into the solar wind. Solar wind is a flow of plasma that moves outward through our solar system into interstellar space.

Therefore, the Sun has six regions: the core, the radioactive zone, and the convective zone in the interior; the photosphere; the chromospheres; and the corona. The temperature of the sun'ssurface is about 5,500 to 6,000 degrees Celsius.

At the core, the temperature is about 15 million degrees Celsius, which is sufficient to sustain thermonuclear fusion. This is a process in which atoms combine to form larger atoms and in this process, released, staggering amounts of energy. Specifically, in the Sun's core, hydrogen atoms fuse to make helium.

Size and Distance

The sun has a radius of 695,508 kilometres. It is far more massive than earth and 3,32,946 Earths equal to the mass of the Sun. The Sun's volume would need 1.3 million Earths to fill it.

Venus is hotter than Mercury because Venus has an atmosphere which is thicker and made almost entirely of carbon dioxide

Orbit and Rotation

The Milky Way has four main spiral arms: the Norma and Cygnus arm, Sagittarius, Scutum-Crux, and Perseus. The Sun is located in a minor arm, the Sagittarius arm. From there, the Sun orbits the centre of the Milky Way Galaxy, bringing the planets, asteroids, comets and other objects along with it. Our solar system is moving with an average velocity of 828,000 kilometres per hour. It takes about 230 million years to make one complete orbit around the Milky Way. The Sun's spin has an axial tilt of 7.25 degrees with respect to the plane of the planets' orbits. Since the Sun is not a solid body, different parts of the Sun rotate at different rates. At the equator, the Sunspins around once about every 25 days, but at its poles the Sun rotates once on its axis every 36 Earth days. Most of the materials are pulled toward the centre to form our Sun. The Sun alone accounts for 99.8% of the mass of the entire solar system.

Like all stars, the Sun will someday run out of energy. When the Sun starts to die, it will swell so big that it will engulf Mercury y and Venus and maybe even Earth. Scientists predict that the Sun is a little less than halfway through its lifetime and will last another 6.5 billion years before it shrinks down to be a white dwarf.

2.7 The Planets

The word planet in Greek means 'wanderer'. Planet is the celestial body which does not have light or heat of its own. A planet should possess the following qualities:

a. It should orbit around the sun.
b. It should not be a satellite of any planet
c. Due to its own mass and self-gravity, it should get a spherical shape and
d. Any other celestial body should not cross in its orbit.

The planets are classified in order of their distance from the sun and based on their characteristics. They are:

1. The inner planets or terrestrial planets or rocky planets. Mercury, Venus, Earth and Mars are called inner or terrestrial planets.
2. The outer planets or gaseous planets or giant planets. Jupiter, Saturn, Uranus and Neptune are called outer or gaseous planets.
3. Each planet spins on its own axis. Tis movement is called rotation. One rotation makes one 'planet day'. The planets moving around the sun is called revolution or a 'planet-year'.

Planets in the Solar System

Name of the Planet	**Mercury**	**Venus**	**Earth**	**Mars**	**Jupiter**	**Saturn**	**Uranus**	**Neptune**
Diameter (KM)	4,879	12,104	12,756	6,794	1,42,984	1,20,536	51,118	49,528
Density (kg/m3)	5,427	5,427	5,514	3,933	1,326	687	1,271	1,638
Rotation Period (hours)	1,407.6	-5,832.5	23.9	24.6	9.9	10.7	17.2	16.1
Length of Day (hours)	4,222.6	2,802	24	24.7	9.9	10.7	17.2	16.1
The Average distance from the sun(10^6 km)	57.9	108.2	149.6	227.9	778.6	1,433.5	2,872.5	4,495.1
Orbital Period (days)	88	224.7	365.3	687	4331	10,747	30,589	59,800
Number of Satellites	0	0	1	2	67	53	27	13

The Mercury

Mercury is the nearest planet to the sun and it is the smallest planet in the solar system. It does not have any satellite. It rotates on its own axis in 58.65 earth days while it takes 88 Earth days to complete one revolution around the sun. Mercury is 0.4 astronomical units away from the Sun. The sunlight takes 3.2 minutes to travel from the Sun to Mercury. Mercury is the second hottest planet though it is nearest to the sun.

The Venus

'Venus' is the second nearest planet to the sun. It is also called as 'Earth's Sister' planet due to its similar size and mass as that of our Earth. It is the hottest planet in the solar system and experiences a mean surface temperature of 462°C. It is popularly known as "Morning star and Evening star" It is seen in the east sky before sunrise (dawn) in the morning and in the west sky after the sunset (twilight). It rotates clockwise i.e. east to west direction on its own axis. The rotation and orbit of the Venus are unusual in several ways. Venus is one of just two planets that rotate from east to west. Only Venus and Uranus have this 'backwards' rotation. It completes one rotation in 243 Earth days which is the longest day of any planet in our solar system. The Venus takes 224.7 Earth days to complete one revolution around the sun, and it has no natural satellites. Venus is 0.7 astronomical units away from the sun. The sunlight takes 6 minutes to travel from the sun to Venus.

The Earth

Earth is the third nearest planet to the sun. It is the fifth largest planet in the solar system. The Earth's orbit lies between the orbits of Venus and Mars. It takes 23 hours 56 minutes and 4 seconds for the earth to complete one rotation on its own axis. The Earth takes 365.25 days (Table 2.1) to complete one revolution around the Sun. Earth's surface temperature varies from - 88° to 58°C and it is the densest planet in the solar system.

The Earth is a unique planet because of its distance from the sun, its motions, atmosphere with oxygen, presence of water and moderate temperature. The earth is neither too close nor too far from the sun. It is the only known planet to support life. It is also known as the 'Blue Planet' because of the presence of water. Earth has only one natural satellite called the Moon. The sun light takes about 8.3 minutes to reach the earth.

The Mars

Mars is the fourth nearest planet to the sun and it is the second smallest planet in the Solar system. It is also described as the "Red planet". It is reddish in colour due to the presence of iron oxide on its surface. The landmass of Mars and Earth are very similar. It takes 24 hours and 37 minutesto complete one rotation on its axis and its takes 687 days to complete one revolution around the Sun. The surface temperature of the Mars is ranging from -153° to 20°C. With the exception of the Earth, Mars probably is the most hospitable to life. This planet has seasons, polar ice caps, volcanoes, canyons and weather. Mars has two satellites namely Phobos and Deimos.

The Jupiter

Jupiter is the largest planet in the solar system. It is made primarily of gases and is therefore known as 'Giant Gas planet'. It takes 9 hours 55 minutes to complete one rotation on its axis and it takes 11.86 years to complete one revolution. Jupiter has the shortest day

in the solar system. Jupiter has a faint ring system around it. They are mostly comprised of dust particles. Jupiter has 67 confirmed satellites orbiting the planet. Ganymede, the satellite of Jupiter, is the largest natural satellite in the solar system (even bigger than the planet Mercury).

The Saturn

Saturn is the sixth planet from the sun and the second largest planet in the solar system. Saturn is called as the Ringed Planet. It is because of large, beautiful and extensive ring systems that encircles the planet. These rings are mostly made from the chunksof ice and carbonaceous dust. Saturn is the only planet in our solar system whose average density is less than water.

The Saturn has 30 rings and 53confrmed natural satellites. The Saturn takes 10 hours 34 minutes to complete one rotation on its axis and it takes 29.4 years to complete one revolution around the sun.

The Uranus

Uranus is the seventh planet from the sun and it is not visible to the naked eye. Like Venus, Uranus also rotates on its axis from east to west. Uranus is inclined on its axis at an angle of 98 degrees. The planet is almost lying on its side as it goes around the sun. The sunlight, thus, is received mostly in the polar areas. Hydrogen, helium and methane are the major gases of its atmosphere. It is very cold due to its great distance from the sun. Uranus is named after the ancient Greek god of the sky. It has a dense atmosphere primarily consisting of methane, which lends it a bluish-green appearance. Uranus also has rings and twenty-seven satellites.

The Neptune

Neptune is the eighth planet from the sun. It takes 16 hours to complete one rotation on its own axis and it takes nearly 165 years to revolve around the sun. It has 13 natural satellites and 5 rings. It is the coldest planet in the Solar System because it is the farthest planet from the Sun. Neptune was the first planet located through mathematical calculations. Neptune is our solar system's windiest planet.

2.8 Dwarf Planets

Dwarf planets are tiny planets in our solar system. Any celestial body orbiting around the sun, weighing for the self-gravity and nearly be round in shape is called 'Dwarf Planet'. It should not be a satellite of any planet. They are five in number Ceres, Pluto, Heumea, Makemake and Eris. As Pluto has not cleared the neighbourhood around its orbit, it is officially demoted in 2006 from its ninth position as a planet.

North Pole of the Uranus experiences 21 years of night time in winter, 21 years of daytime in summer and 42 years of day and night in the spring and fall.

2.9 Satellites

The word 'Satellite' means companion. The moon was the only known satellite in the Solar System until 1610. Today, there are 163 known satellites in the Solar System. The satellites move around a planet from West to East. They do not have own light, but reflect the light of the Sun. They have no atmosphere and water.

Moon: the Earth's Satellite

The moon is located at a distance of 8, 84,401 km from the earth (Figure 2.7). The moon revolves around the earth. The moon takes 27 days and 7 hours and 43 minutes for both its rotation and revolution around the earth.

Hence, the observers on the earth could see only one side of the moon.The moon is the fifth largest natural satellite in the solar system. The moon was likely to be formed after a Mars-sized body collided with Earth. There are many craters, high and steep mountains of different sizes which cast shadows on the Moon's surface. The light which is reflected by the Moon will reach the Earth in just one and a quarter seconds.

Apollo 11 was the first manned mission to land on the Moon sent by NASA. Two American Astronauts Neil Armstrong and Edwin Aldrin set foot on the moon's surface on the waterless Sea of Tranquillity on 20th July, 1969. They stayed there for 21 hours 38 minutes and 21 seconds on the moon. Michael Collins piloted Apollo 11.

Since the moon is smaller than the earth, it has 1/6 of the gravitational pull of the earth. So, man weighs 6 times less on the moon than the earth.

2.10 Asteroids

Asteroids are small rocky celestial bodies that revolve around the Sun, like other planets. They are also called 'Minor Planets'. Tere are lots of asteroids in the solar system. Larger asteroids are called Planetoids. Theseare found in between the planets Mars and Jupiter. Tis belt is known as 'Asteroid belt'. The diameter of the asteroids varies from 100 km to a size of a pebble. The asteroids may be the fragments of a planet exploded in the past or some parts of comets. The new asteroids are being discovered continuously.

2.11 Comets

Comets are the most exciting heavenly bodies and have ever been the objects of man's curiosity as well as fear. The word Comet (Figure 2.8) is derived from the Greek word Aster Kometes meaning 'Long Haired Star'. They are made up of small ice particles and meteoric fragments. They revolve around the Sun. But their orbits are irregular. Sometimes they get very close (Perihelion) to the sun and in other times they go far away (Aphelion) from the sun.

The best known Comet, Halley s Comet, appears once in every 76 years. The Halley s Comet was seen last in 1986 and it will be seen again on 28th July 2061.

Titan – only moon with clouds and atmosphere

Titan is Saturn's largest moon and the second largest (after Ganymede of Jupiter) in the solar system. It is the only moon in the solar system with clouds and a dense, planet-like atmosphere.

Scientists believe that conditions on Titan are similar to Earth's early years (the main difference is that, because of is closer to the sun, Earth has always been warmer). According to NASA, "In many respects, Titan, is one of the most Earth-like worlds we have found to date".
Titan was discovered by Dutch astronomer Christiaan Huygens in 1655. The Huygens lander probe sent to the moon aborad NASA's Cassini spacecraft by the European Space Agency is named in his honour. Huygens was the first human-built object to land on Titan's surface. Diameter:5,150 kilometres, about half the size of Earth and almost as large as Mars. Surface temperature:-179 degrees Celsius, which makes water as hard as rocks and allows methane to be found in its liquid form. Surface pressure. Earth's pressure at sea level is 1 bar while Titan's is 1.6 bars. Orbital period: 15;945 days. Titan's mass is composed mainly of water in the form of ice and rocky material. Titan has no magnetic field.

2.12 Meteors

There is a bright streak of light flashing seen often in the sky during night for a few seconds. They are called as 'shooting stars'. They are the removed pieces of rocks mainly from the Asteroid belt. Tey are called Meteoroids before they enter into our atmosphere. Tey enter into the atmosphere with great speed. But most of them are burnt when they enter into the atmosphere.

After entering into our atmosphere they are called as Meteors. Some pieces do not burn fully and they fall on the earth and make craters. The large unburned pieces of rocks that fall on the earth are called Meteorites.

Examples for Meteorite Fall: Meteor crater in Northern Arizona and Lake Lonar in Buldhana District of Maharastra in India were created by meteor impacts.

2.13 Shape and size of the Earth

It once was believed that the Earth was flat and that ships could sail over the edge. This view persisted even in the middle ages and was an issue in recruitment of Columbus.

Early Greek view was that the world was surrounded by the ocean (Oceanus), origin of all rivers. Anaximander (600 B.C) proposed that cylindrical earth was

surrounded by celestial sphere. Pythagoras (582-507 B.C.) believed that the Earth was a sphere, which was considered the most harmonious geometric shape. Aristotle (384-322 B.C.) described observations that supported the theory that the Earth was a sphere. These included the fact that the shadow of the moon is circular in lunar eclipses and constellations were higher in the sky as one travelled south. Eratosthenes

(275-195 BCE) estimated size of earth from observations that the elevation of the sun varied with position on the Earth's surface in Egypt. Observations of the following suggested that the Earth is a sphere.

1. Mountain peaks lit by the Sun after sunset.
2. Ships disappear below the horizon as they sail across ocean.
3. The moon looks like a disc.
4. The Earth casts a circular shadow during lunar eclipses.

The Earth is an oblate spheroid, bulged at the equator and fattened at the poles. It is called 'Geoid' (Figure 2.9) meaning the earth is earth-shaped. The bulge at the equator is caused by the centrifugal force of the Earth's rotation. The gravitational pull of the earth is the strongest at the fattened poles and it is weaker towards the equator.

The Sun's gravitational pull differs in force at the poles. The North Pole points in the same direction to the North Star when it revolves about the Sun. If the Earth would not have been tilted on its axis, the days and nights would have been of same duration always.

2.14 Motions of the earth

The earth has two basic movements: 1) Rotation and 2) Revolution.

Galactic movement:
This is the movement of the earth with the sun and the rest of the solar system in an orbit around the centre of the MilkyWay Galaxy. This, however, has little effect upon the changing environment of the earth.

1. Rotation:

The spinning of the earth around its axis is called the rotation of the earth. The axis is the imaginary line passing through the centre of the earth. The earth completes one rotation in 23 hours, 56 minutes and 4.09 seconds. It rotates in an eastward directionopposite to the apparent movement of the sun. The earth's axis is inclined at an angle of 66½0 to the orbital plane as it moves around the sun. We can say, the earths axis is tilted at an angle of 23½° (Figure 2.10) from a perpendicular to the elliptic plane. The velocity of earth's rotation varies depending on the distance of a given place from the equator.The rotational velocity at the poles is nearly zero. The greatest velocity of the rotation is found at the equator. The velocity of rotation at the equator is 1,670 km per hour.

Effects of earth's rotation: The rotation of the earth causes the following effects:

1. The apparent rising and setting of the sun is actually caused by the earth's rotation which results in the alternate occurrence of day and night everywhere on the earth's surface.
2. Rotation of the earth is also responsible for the difference in time between different places on the earth. A 24 hour period divided by 360 degreesgives a difference of 4 minutes for every degree of longitude that passes the sun. The hour (60 minutes) is thus 1/24 of a day.
3. When you observe through a moving train, trees, houses and fields on the other side of the track appear to move in the direction opposite to that of the speeding train. The apparent movement of the sun and the other heavenly bodies in relation to the rotating earth is similar. As the earth rotates from west to east, the sun, moon, planets and stars appear to rise in the east and set in the west.
4. Rotation causes the working of the Coriolis force which results in the deflection of the winds and the ocean currents from their normal path.
5. Tide is caused by the rotation of the earth apart from the gravitational pull of the sun and the moon.

Rotation causes a flattening of Earth at the two poles and bulging at the Equator. Hence, there is a difference in diameter at the poles and equator.

Circle of Illumination: The line around the earth separating the light and dark is known as the circle of illumination (Figure 2.11).

It passes through the poles and allows the entire earth to have an equal amount of time during the daylight and night time hours. This line can be seen from space, and the exact location of the line is dependent on the various seasons.

Revolution of the Earth

The movement of the earth in its orbit around the sun in an anti-clockwise direction, that is, from west to east is called revolution of the earth. The earth revolvesin an orbit at an average distance of 150 million km. The distance of the earth from sun varies time to time due to the elliptical shape of the orbit. About January 3rd the earth is closest to the sun and it is said to be at Perihelion ('peri' means close to and Helios means sun). At Perihelion, the distance is 147 million km.

Around July 4th the earth is farthest from the sun and it is said to be at Aphelion (Ap means away and Helios means sun). At Aphelion the distance of the earth is 152 million km away from the sun.

The period taken by the earth to complete one revolution around the sun is 365 days and 6 hours (5 hours, 48 minutes and 45 seconds) or 365¼ days. The speedof the revolution is 1,07,000 km per hour. The speed is 30 km per second. The bullet from a gun travels with a speed of 9 km per second.

Period of Revolution and Leap year

The period of time the earth takes to make one revolution around the sun determines the length of one year. The earth takes 365 days and 6 hours to complete one revolution. Earth takes 365.25 days to complete one trip around the Sun .That extra quarter of a day presents a challenge to our calendar system, which has one year as 365 days. To keep our yearly calendars consistent with our orbit around the Sun once in, every four years we add one day.

The extra day added to is called a leap day, and the year the extra day is added to is called a leap year. The extra day is added to the month of February which has 29 days in a leap year.

Effects of revolution of the earth

The revolution of the earth around the sun results in the following

- Cycle of seasons,
- Variation in length of days and nights,
- Variation in distribution of solar energy over the earth and the temperature zones.

2.15 Seasons

The seasons are caused due to the combined effect of the earth's revolution and the tilt of its axis in the same direction throughout the year. In general, spring, summer, autumn and winter are the four seasons (Figure 2.12). The latitude atwhich the sun appears directly overhead changes as the earth orbits the sun. The sun appears to follow a yearly pattern of northward and southward motion in the sky, known as the 'apparent movement of the sun'. It gives an impression that the sun is continuously swinging north and south of the equator. Actually it is the earth that is moving around the sun on its tilted axis. It varies when observed on a daily and monthly basis, at different times of the year. On 21 March and 23 September the sun rises precisely in the east and sets exactly in the west.

Equinoxes and solstices

You already knew that the sunrays are vertical at noon. The vertical rays fall on a small area, giving more heat.

Equinoxes

Equinoxes occur when the earth reaches the points in its orbits where the equatorial and the orbital planes intersect, causing the sun to appear directly overhead at the equator. During the equinoxes the periods of day light and darkness are equal all over the world. On 21 March the sun is directly overhead at the equator. Throughout the world, on this day all the places experience almost equal hours of day and night. This position of the sun is called spring equinox. Again on 23 September the sun is directly overhead on the equator and it is called autumn equinox.

Position of the earth on 21 March

Neither pole is inclined towards the sun. The rays of the sun fall vertically on the equator. All the places have equal days and nights as both the poles receive therays of the sun. It is spring in the northern hemisphere and autumn in the southern hemisphere. This day (21 March) is known as spring equinox.

Position of the earth on 23 September.

Neither pole of the earth is inclined towards the sun. The rays of the sun fall vertically on the equator. All the places have equal days and nights. It is autumn in the northern hemisphere and spring in the southern hemisphere. Tis day (23 September) when sun's rays for fall vertically on the equator, is known as autumnal equinox (Figure 2.13).
Position of the earth on 21 June
The North Pole is inclined or tilted towards the sun. It, therefore, experiences complete light for 24 hours. The South Pole is tilted away from the sun so it is in complete darkness for 24 hours. The rays of the sun fall vertically at the tropic of cancer (23½° N). In the Northern hemisphere, the days are longer than the nights (Table 2.2). It is summer in the northern hemisphere and winter in the southern hemisphere. The day 21 June is known as summer solstice.

Position of the earth on 22 December

Latitude	Summer Solstice	Winter Solstice	Equinoxes
0°	12hrs	12hrs	12hrs
10°	12hrs 35 min	11hrs 25 min	12hrs
20°	13hrs 12 min	10hrs 48 min	12hrs
30°	13hrs 56min	10hrs 4 min	12hrs
40°	14hrs52min	9hrs 8 min	12hrs
50°	16hrs18min	7hrs 8 min	12hrs
60°	18hrs27min	5hrs 42 min	12hrs
70°	24hrs (for 2 months)	0hrs00 min	12hrs
80°	24hrs (for 4 months)	0hrs00 min	12hrs
90°	24hrs (for 6 months)	0hrs00 min	12hrs

The South Pole is inclined towards the sun and the North Pole is away from it. The rays of the sun fall vertically at the tropic of Capricorn (23½° S). The greater part of the southern hemisphere gets the direct rays of the sun so the days are long and the nights are short here. In the northern hemisphere the nights are longer than the days at this time. The southern hemisphere has summer. The northern hemisphere has winter. This day (22 December), when the sun's rays fall vertically on the Tropic of Capricorn, is known as winter solstice.

Eclipses

Let us understand the effect of the revolution of the earth on the length of the days and the nights. The duration of the daylight varies with latitude and seasons.

An eclipse is a complete or partial obscuration of light from a celestial body and it passes through the shadow of another celestial body. The eclipses are of two types. They are:

a) Solar Eclipse

It occurs on New Moon days, when the moon is between the Sun and the Earth. Thus it obscures a part of the Sun viewed from the Earth, but only from a small area of the world. It lasts only for a few minutes. A partial solar eclipse (Figure 2.14) happens when the moon partially covers the disc of the sun. An annular solar eclipse occurs when themoon passes centrally across the solar disc. During a total solar eclipse, the moon's shadow is short enough to cover the whole sun. The outer regions still glow and look bright as a ring. Such a phenomenon is called Diamond Ring

Geo connects History

Secret to Great Pyramid's Near Perfect Alignment Possibly Found!

The Great Pyramid of Giza, 4,500 years ago, is an ancient feat of engineering. Now an archaeologist has figured out how the Egyptians may have aligned the pyramid almost perfectly along the cardinal points, north-south-east-west. Egyptians may have used the autumn
equinox. Methods used by the ancient Egyptians to align the pyramids along the cardinal points are accurate.

On the day of the fall equinox, a surveyor placed a rod into the ground and tracked its shadow throughout the day. The result was a line running almost perfectly east-west. Te Egyptians could have determined the day of the fall equinox by counting forward 91 days after the summer solstice.

Rotation	Revolution
Spinning of the earth from west to east on its axis	Movement of the earth around the sun in its elliptical orbit.
It takes 24 hours to complete a rotation (or a day)	It takes 365 ¼ days to complete on revolution (Or a year)
It is known as the daily or diurnal movement.	It is known as the annual movement of the earth.
Rotation causes days and nights to alternate, tides, deflection of winds and ocean currents and also gives the earth	Revolution results in the varying lengths of day and night,, changes in the altitude of the midday sun and change of

its shape.	seasons.

b) Lunar Eclipse

It occurs on a Full Moon position when the earth is between the sun and the moon. The earth's shadow obscures themoon as viewed from the earth. A partial lunar eclipse can be observed when only a part of the moon's surface is obscured by earth's umbra (Figure 2.15). A penumbral lunar eclipse happens when the moon travels through the faint penumbral portion of the earth's shadow. A total lunar eclipse occurs when the earth umbra obscures the entire the moon's surface. Lunar eclipse can be seen from anywhere on the night side of the Earth. It lasts for a few hours due to the smaller size of the moon.

The changing angles between the earth, the sun and the moon determine the phases of the moon. Phases of the moon (Figure 2.16) start from the 'New Moon' every month. Then, only a part of the Moon is seen bright called 'Crescent', which develops into the 'first quarter'. With the increasing brightness it turns into three quarters known as 'Gibbous' and then it becomes a 'Full Moon'. These stages are the waxing moon. After the full moon, the moon starts waning or receding through the stages of Gibbous, last quarter, crescent, andfinally becomes invisible as dark New Moon.

The varying lengths of daylight in different latitudes

It is evident from the table that the duration of daylight is 12 hours throughout the year at the equator only. As one moves away from the equator, the seasonal variations in the duration of daylight increase. The seasonal variations in the duration of daylight are maximum at the polar region.

Effects of the spherical shape of the earth

Variation in the amount of solar radiation received:

If the earth were a flat surface, oriented at right angle to the sun, all the places on the earth would have received the same amount of radiation. But the earth is spherical/ geoid. Hence the sunrays do not heat the higher latitudes of the earth as much as the tropics. On any given day only the places located atparticular latitude receive vertical rays from the sun. As we move north or south of this location, the sun's rays strike at decreasing angles. The yearly fluctuations in the angle of the sun's rays and the length of the days change with the continual change of the earth's position in its orbit around the sun at an inclination of 66½ to the orbital plane.

Difference in the angle of the sun's rays striking diferent parts of the earth.

Away from the equator, the sun's rays strike the earth's surface at particular angle. The slanting rays are spread over a large area and do not heat with the same intensity as the direct rays. As we go pole wards, the rays spread over the regions beyond the Arctic and the Antarctic circles in an extremely slanting manner. This is how we get the various temperature zones.

Lower the degree of latitude; higher the temperature. Not only that, the rays striking at a low angle must travel through a greaterthickness of the atmosphere than the rays striking at a higher angle. The rays striking at a lower angle are subject to greater depletion by refection and absorption by the atmosphere.

Temperature zones

The spherical shape of the earth along with its movement around the sun causes differences in the angles at which the sun's rays fall on the earth's surface. This causes a difference in the distribution of heat on the earth's surface.

As a result, the world has been divided into three distinct heat zones or temperature zones. They are the Torrid zone, Temperate zone and Frigid zone. You will learn more about it under the unit atmosphere.

2.16 Time Zones of the World

People during the medieval period were using sundials and water clocks to observe the Sun's meridian passing at noon. In 17th century, the people started using pendulum clock which did not show accurate time while travelling in the sea. Later chronometer was invented in 1764. Chronometer measures time accurately and the mariners widely used this during the 19th century. But in many towns and cities clocks were set based on sunset and sunrise. The use of local solar time hindered the development of railways and telecommunications. A time zone is a region on the earth where uniform standard time should be maintained for transport, commercial and social purposes. For example, if different time zones were followed, the trains coming from different regions, sharing single track may meet with accidents.

The world time zone (Figure 2.17) was formed, relating longitude and the rotation of the earth. The Prime Meridian is the centre of time zone extending from 7½°W and 7½ ° E longitudes. The 24 hours time zone system had been developed so that all the time zones should be referred with respect to Greenwich Mean Time. Earth was divided into 24 time zones, each one zone for one hour of the day. It is because earth rotates 15° of longitude in one hour (360° divided by 24 hours). The time when solar noon occurs at the Prime Meridian is fixed as noon for all places between 7½° E and 7½° W.

Daylight Saving Time

In the mid latitude countries of Europe, North America, Australia and South America, the day time are longer in summer than the night. In spite of employing

daylight duration, the clocks are adjusted 1 hour forward in spring and 1 hour backward in autumn. This time is generally known as 'the Daylight Saving Time' (DST).

Time Zones

On its axis, the earth rotates 360 degrees every 24 hours. You can look at it as it takes one day to complete a full circle. Divided up into an hourly rate, the earth rotates 15 degrees every hour (360/24). This number plays an important role in determining time zones. You have already learned about the latitudes and longitudes and their importance in the lower classes.

An important factor in determining time zones is the lines of latitude and longitude, imaginary lines known as latitudes and longitudes dividing theearth. Latitude lines are drawn east - west and they measure the location in northern and southern hemisphere. The line starts at the equator and measure distance from 0 degrees to 90 degrees north and also 0 degrees to 90 degrees south. They also become shorter farther away from the equator. On the other hand, longitude lines are drawn north - south and they measure eastern and western hemisphere. They start at the Prime Meridian (or 0 degree) and measure from 0 degrees to 180 degrees east and 180 degrees west. Unlike lines of latitude, these lines are fairly equal in length. The origin of this spherical coordinate system is at 0 degree latitude and 0 degree longitude. This spot can be found in the Atlantic Ocean just south west of Africa. Also, the two lines connect at 180 degrees or at the International Date Line (Figure 2.18). This too helps to determining different time zones of the world.

Together all of the above information can be used to calculate the difference of time between two locations.

1. First, we need to know what longitudes the two places are located.
2. Next, you would need to find the differences in longitude (in degrees) between the two places. If both places are located on the same side of the Prime Meridian, then the numbers are just simply subtracted to find the difference. If they are on the opposite side of the Prime Meridian then the two numbers should be added together to find the difference.
3. Third, we need to divide the difference (measured in degrees) by 15 since there are 15 degrees in every hour. This will give us the difference in time between the two locations. So if you know what time it is in one location, and the longitude of another location, then just simple addition or subtraction problem will give us the time in a different time zone. Let's look at another way we may have to calculate the difference between times of two locations.

Another calculation you may have to make is over the International Date Line. This line is strategically placed in the Pacific Ocean so that no two neighbouring cities are one day apart in time. It can be difficult to calculate though the International Date Line when trying to determine the amount of time difference between locations on either side. This

calculation is very similar to the situation with the Prime Meridian. We must start by finding the difference in longitude (or degrees) of the two places. We do this by adding the two numbers. Then, divide by the 15 degrees that occurs in one hour and this will give you the time difference between two locations throughthe International Date Line. And again, just add or subtract that difference from the time that we already know to come up with the new time in the new time zone.

Example of Time Calculations

To review, to find the difference between the two longitudes and divide by 15, this gives you the difference in hours between the two locations. Second, add or subtract the number of hours from the time of day that was already known, we will need to add the numbers if we are going east, and subtract if we are going west. Here are some examples of how we may need to calculate the difference of time zones.

If you are in London at 12:00, and want to know what time it is in Japan, you would need to first figure out that London is 0 degrees (right on the prime meridian), and Japan is 135 degrees East. So the difference is 135 degrees (135-0), divided by 15 which equals 9. It means there is a 9-hour difference between London and Japan. Since Japan is further east than London is, you would add 9 hours to 12:00. The answer is at 12:00 noon London time, it is 9:00pm in Japan.

Now we suppose imagine that we are going through the International Date Line. Pretend you are in Japan, which is 135 degrees east and you wanted to know what time it is in Hawaii, which is 150 West. Well, there is 45 (180-135) degrees difference between Japan and the IDL. Also there is 30 (180-150) degrees difference between the IDL and Hawaii. Therefore the difference in time is (45 + 30/15 = 5) 5 hours. Now the tricky part is that Japan and Hawaii are on different days. It is one day ahead on the left side of the IDL compared to the right side. If it is3:00pm in Japan on Thursday that means it is 3:00 + 5 hours = 8:00pm in Hawaii. However notice that when crossing the IDL we subtract a day going east. So, in Hawaii it is 8:00pm on Wednesday.

Now note that Latitudinal lines are imaginary horizontal lines over the Earth's globe. 0° longitudinal line is Equator. Earth completes one rotation on its axis in 24 hours and in the process turns a complete circle of 360°. This means Earth rotates 360°/24 = 15° in one hour. Every gain or loss of 1° longitude stands for 4 minutes.

360° = 24 hours = 1440 min
Difference of time for 15° longitude = one hour.
Difference of time for 1° longitude = 4 minutes.

Longitude Calculations Procedures

a. First locate the two places involved
b. find the longitude difference
c. Convert the longitude difference to time and,

d. Adjust the time according to the direction of movement, (west or east).

Example 1

Ponni starts her journey at longitude 0° at 12 noon and she's moving towards eastward of longitude 10°. Calculate the time that Ponni will arrive at her destination.

Solution

Initial time = 12 noon
Destination = 10°E
Conversion of degree to time 1 hour =15°
and 4 minutes =1°
Hence 10° = (4 x 10) minutes
= 40 minutes
Destination time = Initial time + calculated time
= 12 noon + 40minutes
= 12:40pm

Example 2

If the time at village A (long 75° W) is 5:00 pm on Friday. Calculate the time and day at village B (long 120°E)

Solution

360° = 24hrs
15° = 1 hour
1° = 4 minutes
Village A = 75°W
Village B = 120°E
We will add (west and east)
(75 + 120)° = 195°
195 divided by 15°= 13hrs
Destination time = initial + calculatedtime
= 5:00 + 13hrs
= 18:00
18:00 = 6:00

Answer = 6:00am on Saturday

Example 3

Calculate the local time in New York (USA) longitude 75°W, when it is 10am in Nigeria of longitude 15°E

Solution

Initial time = 10:00am
New York = 75°W
Nigeria = 15° E We will add (west and east)
(75 + 15)° = 90°
90° divided by 15° = 6 hrs
Destination time = initial + calculated time
= 10:00am + 6hrs
= 14:00pm
14:00pm = 4:00pm

Answer = 4:00pm

Unit III Lithosphere Endogenic Processes

Introduction

- Do you know that the Russians tried to dig through the centre of the Earth? It indeed is a daring attempt.

- While the famous Voyager 1 satellite took 26 years to exit our Solar System (16.5 billion km away), almost the same amount of time (24 years) was taken for man to dig out a mere 12.3 km into the earth's surface.

- Russia drilled Kola Super Deep bore hole between 1970 and 1994. The deepestpart of it, named 'SG-3 (Star Gate), extends 12.3 km into the Earth. Look at figure 3.2 and amaze the highest and deepest points of the earth.

- The earth's surface is being continuously reshaped by both the internal (Endogenic forces) and external forces (Exogenic forces). The changes that the endogenic and exogenic forces bring about in the appearance of the surface of the earth are collectively known as geomorphic processes. (figure. 3.3)

- The process by which the earth's surface is reshaped through rock movements and displacement is termed as diastrophism. Diastrophism includes both orogenic and epeirogenic processes.

- Our knowledge of the earth is mostly limited to its surface. But the earth has a complicated interior. The earth is composed of lithosphere, atmosphere, hydrosphere, and biosphere.

- The lithosphere is the outermost rigid rocky shell of the earth. It comprises the crust and the upper portion of the mantle. The word lithosphere is derived from the Greek words lithos meaning rocky and sphaira meaning sphere. The term lithosphere was introduced by Joseph Barrel, an American Geologist.

Interior of the Earth

- The interior of the earth is composed of many minerals both in the solid and liquid state. The temperature in general increases at the rate of 1° C for every 32 metres towards the earth's interior.Look at the figure.3.4 the layers of the earth. Earth's interior can be divided into the crust, upper mantle, lower mantle, outer core, and inner core.

The Crust

- The crust is further divided into upper crust (continental crust), composed of silica and aluminium (sial) and the lower crust (oceanic crust) made up of silica and magnesium (sima). The boundary between the upper crust and the lower crust is termed

as 'Conorod boundary'. The thickness of the crust varies from oceanic areas to continental areas. Oceanic crust is thinner when compared to the continental crust. The mean thickness of oceanic crust is 5 km while the continental crust is around 30 km. The continental crust is thicker in the areas of major mountain systems. It is as much as70 km thick in the Himalayan region. The density of the crust is less than 2.7 g/cm3.

The mantle

- The mantle is composed of silica, magnesium and iron. It lies between the lower crust and the outer core. It extends for about 2,900 km. It is divided into upper mantle and lower mantle. The mantle generally is in a solid state. The upper part of the mantle is called asthenosphere. The word Asthen in Greek means weak. It extends up to 400 km and it is the main source of magma. The Mohorovicic is the boundary which divides the lower crust and the upper mantle. The density of the mantle is 3.9 g/cm3.

The core

- The core forms the centre of the earth. Its density is 13.0 g/cm3. Its temperature is about 5500° C to 6000° C. The core has two parts namely the outer core and the inner core. The boundary between the lower mantle and the outer core is called Guttenberg margin.

- The outer core and inner core are separated by Lehmann boundary. Theouter core is in the liquid state while the inner core is in the solid state. Generally, the core is composed of Nickel and Ferrous (Iron) which is called NiFe (Barysphere). The core is extended from 2,900 km to 6,370 km from the surface of the earth.

Continental Drift Theory

- In 1912 Alfred Wegener (1880-1930) postulated that all the continents once were together forming a single continent. According to him, about 250 million yearsago, the earth was made up of a single landmass called Pangaea (meaning "all lands"), and a single ocean surrounding it called as Panthalassa. Over a long period of time, probably 220 million years ago, they drifted apart and gradually moved to form their present position. First, Pangaea broke into two landmasses namely Laurasia in the north and Gondwana in the south.

- Laurasia further split into Eurasia and North America. Gondwana land split into Africa, South America, Antarctica, Australia, and India.

Wegener put forward certain evidences to support the continental drift theory. Let us deal with it in detail.

Evidences to support continental drift theory

- The continental drift theory is supported by the following evidences

1. Certain identical rare fossils have been found in different continents.
   The fossils of Mesosaurus (a small Permian reptile), for example, have been found only in Africa and South America.
2. The fossil of a Fern tree, about 360 million year old, has been found only in India and Antarctica.
3. Rocks of similar type, formation, and age have been found in Africa and Brazil.
4. Geological structure in Newfoundland matches with that of Ireland, Scotland and Scandinavia. Geological Structure of Appalachian Mountains matches with Morocco and Algeria in North Africa.
5. The corresponding edges of the continents fit together. For example,the western side of Africa and the eastern side of South America fit together.

Enchanted rock in the Texas Hill Country is about a billion years old. TheHawaiianIslands are the youngest lava forms of the Hawaiian hotspot.

Plate Tectonics

- Have you heard about diving between two continents? It is possible in the Silfra rift of Iceland. Look at Figure.3.7. It is located in the Tingvellir National Park. It is in the boundary between the North American plate and the Eurasian plate. It is the visible boundary between these two plates.

Plate boundaries

- Plate boundaries are the zones where two or more plates move about. Plate tectonics describes the distribution and motion of the plates. The earth's surface is composed of rigid lithospheric slabs technically called "plates". The word Tectonic is derived from the Greek word tekton meaning builders.

GNSS (Global navigation satellite System) measures the speed of plate movement. Rate of seafloor spreading ranges from 1 to 2 centimetres per year along the oceanic ridge in the northern Atlantic Ocean to more than 15 cm per year along the East Pacific Rise.

- Lithospheric plates are sometimes called as crustal plates or tectonic plates. Earth's lithosphere is divided into a series of major and minor mobile plates. Eurasian plate, Into-Australian platen North, American plate, Pacific plate, African plate and Antarctic plate are the major plates. Arabian plate, Caribbean plate, Cocas plate and Scotia plate are the examples of minor plates. Plates move at the rate of 2 to 3 centimetres per year.

- Plates are composed of the continental or oceanic landmass. The subduction of the oceanic plates results in the occurrence of earthquakes and volcanoes adjacent to trenches.

- Plate margins mark the occurrence of the most significant landforms, including volcanoes, fold mountains, island arcs and deep-sea trenches. There are three principal types of plate boundaries. They are divergent, convergent, and transform boundaries.

Divergent plate boundaries

- Divergent plate boundary is the margin where two plates move apart. For instance, the African plate and South American plate move apart and form a divergent plate boundary. Narrow oceans represent young divergent boundaries and wide oceans are indications of old ocean basins. Ocean ridges are the boundaries between plates of the lithosphere.

Atlantic Oceanis widening at an estimated rate of 1 to 10 cm a year

- A fissure is created when oceanic lithosphere separates along the oceanic plate boundary. The gap is filled by magma that rises from the asthenosphere. The magma cools and solidifies to create a new oceanic crust. Hence, the divergent plate boundary is termed as the constructive plate boundary. It is also called as accreting plate margin.

- Let us see what happens in the divergent plate boundary. Firstly, submarine mountain ridge is formed through the fissures in the oceanic crust when the plates move apart. The Mid-Atlantic Ridge is an ideal example of a submarine mountain ridge in the Atlantic Ocean. It is the longest mountain ridge in the world.

- It extends for about 16,000 km, in a 'S' shaped path, between Iceland in the north and Bouvet Island in the south. It is about 80 to 120 km wide. It reaches above the sea level in some places thus forming theislands such as the Azores, Ascension, St. Helena and Tristan da Cunha.

Secondly, rift valley is formed when two plates move apart. If a divergent boundary runs through the continent, the continent splits apart and rift valley is formed. The African Rift Valley of East Africa is an example.

Convergent plate boundary

- Convergent plate boundary is the margin where two plates collide with one another. For instance, the South American plate and Nazca plate collide with each other. There are two kinds of surface features associated with the convergent margin. The first is the ocean trench that forms a line between the two colliding plates.

Wadati-Benioff zones are nothing but Subduction zone

- A trench is a narrow and deep depression of the ocean floor. It is formed when the oceanic plate slides down underneath continental plate as the oceanic plate is denser than the continental plate. For instance, Mariana Trench in the Pacific Ocean, is the

deepest trench in the world. It is formed when the Pacific plate sinks down the Eurasian plate. It is about 10,994 metres (10.99 km) deep. Mariana Trench stretches for more than 2,540 km with a width of 69 km.

- You could take Mount Everest and sink it in the Mariana Trench, the deepest point in the ocean, and still you have a km of depth to reach the surface of the ocean.When a continental plate and an oceanic plate collide with each other, denser oceanic plate sinks below the lighter continental plate, subduction zone is formed.

- A subduction zone is a boundary where one plate sinks under the other plate. It was first identified by KiyooWadati and Benioff.Secondly fold mountain is formed when two plates collide each other. For instance, the Himalayas were formed when the Indian plate collided with the Eurasian plate. The zone marking the boundary of the two colliding plates is known as suture line.

- As the crust is less dense than the mantle, the newly formed magma will tend to rise to the Earth's surface, where it may form volcanoes. The area in the subduction zone where most earthquakes occur is known as the Benioff zone.

Transform plate boundaries

- Transform plate boundary is the margin where two plates move side by side. The lithosphere is neither destroyed nor created by the transform plate boundary. Hence it is called as the Conservative or passive plate boundary. The San Andreas Fault, California, is a transform boundary that separates the North American plate and Pacific Plates.

Convection Cell

- Now you may think why plates keep moving. The plate movements are caused by the convection cells. Convection cell is the circulation of the molten materials caused by the heat derived from the core. When looking at the figure.3.13 you will understand how and why plates move in different directions.

- When the molten materials(magma) circulate in different directions, they push or pull the plates in different directions. Thus, the plates move towards each other, move away from one another and move side by side. The plate movements cause the formation of fold, fault, earthquake, and volcano to occur. Let us see the cause, effects, and distribution of the internal forces.

Internal forces

- The internal forces are also called as the tectonic forces. They generally occur in the plate boundaries. They are caused by convection cell and plate movement. They form fold, fault, earthquake and volcano.

Fold

- Horizontal movements are produced by forces of compression and tension. Folding is the bending of rock strata due to compression. Folding on a large scale results in mountain building generally referred to as orogeny.

Parts of a Fold

- Up thrown part of a fold is called anticline. Down thrown part of a fold is syncline. The side of the fold is a limb. The top of the fold is the crest. The plane which bisects the angle between two limbs is called the axis of fold or axial plane. The fold is formed by the plate movements.

Types of Folds

- The type of fold depends on the nature of the rock, the intensity of compression forces, etc. The types of the fold can be many but we will deal with five of the following.

1. When compressional force is equal from both sides, the angle of the limb is same on both sides. Such a fold is called symmetrical fold.
2. When compressional force is more from one end, one limb is steeper than the other. Such a fold is called asymmetrical fold.
3. Isoclinal folds are similar to symmetrical folds, but these folds both have the same angle and are parallel to each other. 'iso' means 'the same' (symmetrical), and 'cline' means 'angle,' so this name literally means 'the same angle.'So isoclinal folds are symmetrical and aligned in a parallel fashion.
4. When one limb of the fold is pushed over the other limb of the fold, it is called as over turned fold. Limbs are seldom horizontal.
5. When one side of the fold is pushed so much that it lies positioned over the other, such a fold is called recumbent fold.

- When plates converge, the weak rocks and sediments lying between two plates get squeezed and folded. Parallel folds form long chains of fold mountain ranges with high peaks. The fold mountains are characterised by peaks and valleys. The tops of anticlines become the peaks and synclines become the valleys. Intermontane plateaus (plateau surrounded by the mountain ranges all sides) may be found between the high ranges. Example, Tibet.

Fault

- A fault is a break in earth's crust where blocks of rock crust slide past each other.Usually it occurs along plate boundaries, where the forces of plate motion compress, pull or shear the crust that breaks the crust. Energy release associated with rapid movement on active faults is the cause of most earthquakes.

- The fault plane is the flat surface along which broken blocks of rock slide past one another. A fault dip is an angle between the fault plane and horizontal plane. Up thrown side represents the uppermost block of a fault. Down thrown side represents the

lowermost block of a fault. Sometimes it becomes difficult to find out, which block has really moved along the fault plane. Hanging wall is the upper wall of a fault. Foot wall represents the lower wall of a fault.

- A fault scarp is the steep wall like slope caused by faulting of the crustal rocks. Sometimes the fault scrap is so steep that it resembles a cliff.

Types of Faults

- Based on how plates move about, the fault can be divided into as follow:

Normal Fault

- Vertical displacement of the crust is called a normal fault. The normal fault is caused by tensional forces where plates diverge. One block lies above the other (hanging wall). The other block lies below the fault (footwall).When movement occurs along a normal fault, the hanging wall slips downward.

Landforms made by Normal fault are:

1. Rift Valley or Graben

- When a narrow block of land drops or subsides between two parallel normal faults, rift valley (Graben) is formed. Graben originates from the German word meaning 'trough'. A Rift Valley may subsequently get filled by water and a river may flow through it. Normally, a rift valley is long, narrow and very deep. For example,

i. Rhine rift Valley is flanked by two Block Mountains namely the Vosges and the Black Forest.
ii. The rift of River Narmada in India lies between the Vindhyas and Satpura block mountains.
iii. The great rift valley of Africa.

- The Great Rift Valley of Africa is the longest rift valley in the world. It stretches for 6,400 km from Mozambique in the south to Syria in the north. The depressions have become lakes. The lakesof Africa, Dead Sea of Israel and the Red Sea form the parts of the Great Rift Valley.

2. Horst

- When a block of land between two faults is pushed up, block mountainor horst is formed. In this case, the central block is not only up thrown but the side blocks are also relatively downthrown so that the whole central mass appears like a dome.

- In India, specifically the mountain ranges of Vindhya and Satpura found in the central western part of the India are block mountains.

Reverse Fault

- A reverse fault is a horizontal displacement of the crust. It is formed where two fractured blocks move towards each other. It is caused by compressional forces alongconvergent plate boundaries. One side of the fault lies at an angle above the other.

Shear Fault / Transform Fault/ Strike – Slip Fault

- It is created by shearing along transform boundaries. Rocks on either side of fault slip past each other sideways with little up or down motion. It mostly occurs in the ocean basin and connects offsets in the mid ocean ridge.

Earthquake

- Earthquake is a sudden shaking of the earth's surface. **Focus** is the location inside the earth where the earthquake originates. **Epicenter** is the point on the earth's surface vertically above the focus of an earthquake. Earthquake results from the sudden release of pressure which has slowly built up within the earth's crust. Energy is released in the form of shockwaves known as seismic waves. The seismic waves can broadly be classified into two types namely Body waves and surface waves.

I. **Body Waves**are the waves that travel through the interior of the earth. They are further divided into the following.

a. P or Primary or Compressional waves are the fastest seismic waves (6 km/ sec. in the upper crust). They cause the matter to oscillate forward and backward, parallel to the motion of the seismic wave front. P waves push (compress) and pull (dilate) the rock that they pass through. They pass through all medium.
b. S or Secondary or Shear waves are slower than the primary waves (3.5 km/sec. in the upper crust). They cause matter to oscillate side to side, perpendicular to the motion of the wave front. S waves shear the rock that they pass through. They pass through only solid medium.

II. Surface Waves are the waves that travel along the earth's surface. They are slower than body waves. They cause damage during earthquakes.

Love waves shake the ground side to side like S wave.

Rayleigh waves displace the ground like rolling ocean waves. The ground rolls forward and up and then down and backwards. This is similar to a p wave but with the extra up-down motion.

Measuring the earthquake

- It is estimated that about 100,000 earthquakes occur but all cannot be felt. A few earthquakes may be severe causing huge damage to property. Earthquake magnitude is measured on the Richter scale (named after the seismologist who devised it), which rates them on a scale of 1 to 10. Earthquake intensity is measured on the modified Mercalli scale, which ranges from 1 to 12, depending upon the intensity. The seismograph is an instrument used to detect and record seismic waves created by the earthquakes.

Causes of Earthquakes

- There are many factors controlling the occurrence of the earthquake. Some of the major factors include:

1. Plate Tectonic Movements
2. Volcanic Eruptions.
3. Construction of large dams results in earthquake. Example. Koyna dam, Maharashtra.
4. Other Reasons: The nuclear explosions also release massive energy to cause tremors in the earth crust. When underground cave collapses, earthquake may occur.

Effects of the Earthquakes

1. Damage to buildings, roads, rails, factories, dams, bridges etc.

2. Landslides caused by earthquakes damage infrastructure.

3. Fires in the forest and urban areas.

4. Flash floods.

5. Tsunami - The high amplitude oceanic waves caused by submarine earthquake (measuring more than 7 on Richter scale). The seismic waves travel through seawater generates high sea waves. They cause severe loss of life and property. For instance, on 26th December 2004, a tsunami originating from a magnitude 8.9 earthquake in northern Sumatra killed over 1,50,000 people in countries surrounding the Indian Ocean.

Distribution of earthquakes

1. Circum-Pacific region: This region includes all the coastal areas around the Pacific Ocean. It extends through the coasts of Alaska, Aleutian Islands, Japan, Philippines, New Zealand, west coast of North and South America. This zone accounts for 68% of all earthquakes on the surface of the earth.

2. Mediterranean-Himalayan region: This region extends from Alps mountain to the Himalayan Mountains and Tibet to China. About 31% of world's earthquakes occur in this region.

3. Other Areas: These include Northern Africa and Rift Valley areas of the Red Sea and the Dead Sea.

Volcano

- A volcano is an opening in the earth's crust through which magma, gases and ash are released to the earth's surface. The molten rock material found in the interior of the earth is called magma. It can be noted that when magma reaches the earth's surface, it is known as lava (Figure. 3.25). Vent is an opening or mouth of a volcano. Fumaroles are the gushing fumes through the gap in the volcano. Crater is a saucer shaped depression in the mouth of a volcano. When the crater is widened, it is called asCaldera. Volcanic ash consists of fragments of pulverized rock, minerals and volcanic glass, created during volcanic eruptions. Volcano generally erupts either through the vent (E.g. Mt. Fujiyama, Japan) or fissure (The Deccan Plateau, India). Pumice is a volcanic rock produced when lava with a very high content of water and gases is discharged from a volcano.

Causes of Volcanic Eruptions

The following are the causes of volcanic eruptions:

- Weak Zones in the Earth Crust: The parts of the earth where two tectonic plates collide against or drift apart from each other are considered very weak. Volcanoes may erupt in such zones, for example, African and Eurasian plates.

- Magma Saturated with Gases: The magma, in the interior of the earth, is often found saturated with gases like carbon dioxide, and hydrogen sulfide. These gases together with water vapour make the magma highly explosive. Magma is forced out as lava on the surface of the earth due to the pressure exerted by these gases.

Mt. Krakatau

- The greatest volcanic explosion known to humans is perhaps Mt. Krakatau in August 1883.
- Krakatau is a small volcanic island in the Sunda Straits, between Java and Sumatra.
- The explosion could be heard in Australia, almost 4,000 km away.
- The vibration set up enormous waves over 30 m high which drowned 36,000 people in the coastal districts of Indonesia.

Cotopaxi in Ecuador is the world's highest active volcano

.

Types of Volcanoes

Based on the frequency of eruption, there are three types of volcanoes:

1. **Active Volcanoes:** Volcanoes which erupt frequently are called active volcanoes. Generally, their vent remains open. Mount Etna of Italy, Cotopaxi in Ecuador are some examples.

2. **Dormant Volcanoes:** These volcanoes may not have erupted in the recent past but there is a possibility of eruption at any time. In other words, they may lie dormant awaiting active eruption anytime. Sometimes gases and steam come out of them. They cause great destruction to life and property once they become active again. Mt. Vesuvius of Italy and Mt. Fujiyama of Japan are examples.

3. **Extinct Volcanoes**: These volcanoes have exhausted their energy and havenot erupted during the known geological period. The vent of these volcanoes remains closed with solidified lava. The formations such as craters may be filled with water and crater lakes may be formed. The slopes of these landforms may be covered with vegetation. Popa in Myanmar and Mt. Kenya in eastern Africa are the examples of extinct volcano.

- On the basis of nature of eruption and form developed on the surface, they are classified into following types:

1. **Shield Volcanoes**: These are made up of basalt, a type of lava that is very fluid when erupted. They become explosive when water gets into the vent. They develop into a cinder cone. Hawaiian volcano is an example of this category.

2. **Composite cone volcanoes**: They are also called 'strato volcanoes'. They are cone-shaped volcanoes composed of layers of lava, ash and rock debris. Mount Vesuvius and Mount St. Helens are examples of composite volcanoes.

3. **Cinder Cone Volcano** : It forms when magma is thrown out to the surface, cooled in to ash and cinders and settled around the mouth of volcano. It is less dangerous than other volcanoes.

4. **Lava Dome**: Unlike composite and shield volcanoes, lava domes are of significantly smaller structure. They are formed when the lava is too viscous to flow to a great distance. As the lava dome slowly grows, the outer surface cools and hardens as the lava continues to pile within. Eventually, the internal pressure can shatter the outer surface, causing loose fragments to spill down its sides.

Effects of Volcanic Activities Destructive effects of volcano

- Showers of cinders and bombs can cause damage to life and properties. Sometimes ash can precipitate under the influence of rain and completely cover large areas.

- The volcanic gases pose potential hazard to people, animals; agriculture, while sulfur dioxide gas can lead to acid rain and air pollution.

Positive Effects of Volcanoes

- Volcanism creates new landforms. Volcanic rocks yield very fertile soil upon weathering and decomposition.The Kimberlite rock of South Africa, the source of diamonds, is the pipe of an ancient volcano.

- In the vicinity of active volcanoes, waters in the depth are heated from contact with hot magma giving rise to springs and geysers. The Puga valley in Ladakh region and Manikaran (Himachal Pradesh) are promising spots in India for the generation of geothermal electricity.

Distribution of Volcanoes across the World

- Most known volcanic activity and the earthquakes occur along converging plate margins and mid-oceanic ridges. The major regions of volcanic distributions are as follows.

1. Pacific Ring of Fire

- Circum-Pacific region, popularly termed the 'Pacific Ring of Fire', has the greatest concentration of active volcanoes. Volcanic belt and earthquake belt closely overlap along the 'Pacific Ring of Fire'. It is estimated to include two-thirds of the world's volcanoes.

2. Mid-Atlantic Region

- The Mid-Atlantic Region coasts has comparatively fewer active volcanoes but many dormant or extinct volcanoes, example. St. Helena, Cape Verde Islands and the Canary Islands. But the volcanoes of Iceland and the Azores are active.

3. The Great Rift valley of Africa

- In Africa some volcanoes are found along the East African Rift Valley. Kilimanjaro and Mt. Kenya are extinct volcanoes. The only active volcano in West Africa is Mt. Cameroon.

4. Mediterranean Region

- Volcanoes of the Mediterranean region are mainly associated with the Alpine folds. Example, Mt. Vesuvius, Mt. Stromboli (known as the Light House of the Mediterranean Sea).

5. Other Regions

- Elsewhere in the interiors of continents of Asia, North America and Europe active volcanoes are rare. There are no volcanoes in Australia.

Volcanoes in India

- There are no volcanoes in the Himalayan region of India. However, Barren Island, lying 135 km north-east of Port Blair became active in 1991 and 1995.

- However, the other volcanic island in Indian Territory is Narcondam (Andaman and Nicobar Islands) It is probably extinct. Its crater wall has been completely destroyed.

Rocks

- Rock is the solid mineral material forming the surface of the earth. Petrology is the science of rocks. The age of the rock is determined based on Carbon-14 dating.

Rock Types

- Based on their origin, the rocks are classified as follows:

1. Igneous Rocks

- Igneous rocks are formed out of magma and lava and they are known as primary rocks. If the magma cools slowly at great depths, mineral grains increase in their size. Sudden cooling (at the surface) results in small and smooth grains. The igneous rocks are the oldest of all the rocks. Granite, pegmatite, basalt, etc are some of the examples of igneous rocks. There are two types of igneous rocks: intrusive rocks (Granite) and extrusive rocks (Basalt-Deccan Traps).

Granite is less dense and is lighter in colour than basalt rocks.

1. Intrusive Igneous rocks

- Intrusive Igneous rocks are formed when magma rises and cools within the crust. The intrusive activity of volcanoes gives rise to various forms. We see them one by one as follow.

i.Batholiths

Batholiths are large rock masses formed due to cooling and solidification of hot magma inside the earth. It is granitic in origin.

ii. Laccoliths

Laccoliths are large dome-shaped intrusive rock connected by a pipe-like conduit from below. These are basically intrusive counterparts of an exposed domelike batholiths. The Karnataka plateau is spotted with dome hills of granite rocks. Most of these, now exfoliated, are examples of laccoliths.

iii. Lapoliths

When the magma moves upwards, a saucer shape, concave shaped body called Lapolith is formed.

iv. Sill

Sill is a solidified sheet-like horizontal lava layer inside the earth. The near horizontal bodies of the intrusive igneous rocks are called sill or sheet, depending on the thickness of the material. The thinner ones are called sheets while the thick horizontal deposits are called sills.

v. Dyke

When the magma makes its way through cracks and the fissures developed in the land, it solidifies almost perpendicular to the ground. It gets cooled in the same position to develop a wall-like structure. Such structures are called dikes.

These are the most commonly found intrusive forms in the western Maharashtra area. These are considered the feeders for the eruptions that led to the development of the Deccan traps.

2. Sedimentary Rocks

- Sedimentary rocks are also called as detrital rocks. They are formed as a result of denudation. These deposits throughcompaction turn into sedimentary rocks. They occupy only 5 percent of the earth. They are layered or stratified of varying thickness. Example: sandstone, shale etc. Ice deposited sedimentary rocks is called Till. Wind-deposited sediments are called Loess. Depending upon the mode of formation, sedimentary rocks are classified into

1. Mechanically formed sedimentary rocks: sandstone, conglomerate, limestone, shale, loess, etc.
2. Organically formed sedimentary rocks: geyserite's, chalk, limestone, coal etc.
3. Chemically formed: halite, potash, etc.

3. Metamorphic Rocks

- The word metamorphic means 'change of form'. The metamorphic rocks form under the action of pressure, volume and temperature (PVT) change.

- Metamorphism is a process by which the already consolidated rocks undergo recrystallisation and reorganization of materials within original rocks. Gneiss, slate, schist, diamond, marble, quartziteetc. are some examples of metamorphic rocks. The igneous and metamorphic rocks together account for 95 percent of the earth.

Rock Cycle

- Rock cycle is a continuous process through which old rocks are transformed into new ones. Igneous rocks can be changed into sedimentary or metamorphic rocks. The fragments derived out of igneous and metamorphic rocks form into sedimentary rocks.

- Igneous and sedimentary rocks can change into metamorphic rocks. The crustal rocks (igneous, sedimentary and metamorphic) may be carried down into the mantle (interior of the earth) through subduction process and the same melt and turn into magma, the original source for igneous rocks. In this way the rock cycle is a continuous process.

Glossary

1. **Orogeny:** structural deformation of lithosphere due to interaction between tectonic plates.
2. **Conorod boundary:**Margin between the upper crust and the lower crust.
3. **Shearing fault:** the fault is created by shearing along the plate boundary.
4. **Laccoliths:** are large dome-shaped intrusive rock connected by a pipe.
5. **Lapolith:** When the magma moves upwards, a saucer shape, concave shaped body called lapolith.
6. **Syncline:** down slope of a fold
7. **Crest:** the top of the fold.
8. **Catasrophism:** sudden movements of the earth caused by plate movements.
9. **Metamorphism:** the process by which both igneous and sedimentary rocks get changed into metamorphic rocks.
10. **Rock cycle:** a continuous process through which old rocks are transformed into new ones.

Unit -5
Lithosphere Exogenic Processes

Introduction

- Let's recall that you have learned in the previous chapter about geomorphic processes - Endogenic processes in detail. Now we deal with the exogenic processes. The forces which act on the earth's exterior are called as exogenic forces or externalforces. The action of exogenic forces results in wearing down the rock and hence, they are considered as land wearing forces.

Exogenic Processes

- The processes which occur on earth's surface due to the influence of external forces are called as exogenic processes. Weathering, mass wasting and denudation are the major exogenic processes. The elements of nature capable of doing these exogenic processes are termed as gradational agents. For instance, the wind, river, glacier, waves and ground water.

Weathering

- Weathering is the process of disintegration and decomposition of rocks. It is due to the action of climate, plants, animals and other living organisms which cause the rocks to break down physically, chemically and biologically.

- There are three types of weathering. They are physical weathering, chemical weathering and biological weathering.

Physical weathering

- Physical Weathering is the disintegration of rock mainly induced by elements of weather. It produces smaller, angular fragments of the same rock. It is caused by the change in temperature, pressure, water and wind. Physical weathering is further divided into different categories. They are thermal weathering, frost wedging and exfoliation.

Thermal weathering

- In arid and semi-arid areas, the temperature increases, heat up and expand the rocks during the day and contract the rock materials when cooling at night. Under extreme temperature conditions, due to alternate expansion and contraction, the rocks crack and eventually split. The thermal weathering's are of two types. They are;

  (a) Granular disintegration and
  (b) Block disintegration

- Alternate expansion and contraction of minerals of varying properties in the rocks due to temperature changes, makesthe rocks break down into small pieces (Figure 4.2). Due to this, the breakup of rocks occurs, grain by grain. This is known as granular disintegration.

- Block disintegration occurs in rocks such as granite rock. So in the areas of jointed igneous or layered sedimentary rocks due to the great diurnal range of temperature, the rocks may break up along the joints and cracks into a large rectangular shaped blocks.

Frost Wedging

- Almost all liquids contract when frozen, but when water freezes it becomes larger in size or takes up more space. As water expands it puts great pressure on rocks. When water enters into the cracks ofrocks and freezes, the pressure exerted on the rock is enough to wedge the walls of the crack farther apart, thus expanding and deepening the crack. Thus, frost wedging results in weathering of rock.

Exfoliation

- Rocks generally heat or cool more on the surface layers. The alternate changes in temperature could cause their outer layers to peel off from the main mass of the rock in concentric layers just as the skin of an onion. The process by which curved layers of rock breakaway from the rock beneath them leaving behind dome shaped monoliths is called exfoliation (Figure 4.2). It is also called as 'onion weathering'. Exfoliation occurs commonly in the arid areas.

Chemical Weathering

- Chemical weathering is the decomposition of rock. For example it creates altered rock substances, such as kaolinite (china clay) from granite. The types of chemical weathering are as follows:

1. **Solution:** Some soluble minerals in the rock get dissolved when come in contact with water. Over a long period minerals get washed away from rock and sometimes leading to the formation of caves.

2. **Oxidation:** When oxygen combines with water and iron, it weakens the rock and breaks it. Example, rusting of iron.

3. **Hydrolysis:** It is the chemical breakdown of a rock substance when combined with water and forms an insoluble precipitate like clay mineral. The most common example of hydrolysis is feldspar found in granite changing to clay.

4. **Carbonation:** Carbonation is the mixing of water with carbon dioxide to make carbonic acid. This acid reacts with minerals in the rocks. This type of weathering is important in the formation of caves.

5. **Hydration:** It is the absorption of water into the mineral structure of the rock. Hydration expands volume and also results in rock deformation. A good example of hydration is the absorption of water by anhydrite, resulting in the formation of gypsum.

Biological Weathering

- Biological weathering is the alteration of rock by the action of plants, animals, and man. Burrowing and wedging by organisms like earthworms, termites, rodents, etc., helpin exposing the rock surfaces to chemical changes with the penetration of moisture and air. Human beings by removing vegetation for agriculture and other activities also help in mixing and creating new contacts between air, water, and minerals in the rock materials. Plant roots make a great pressure on the rock materials mechanically breaking them apart.

Mass wasting

- Mass wasting is the movement of a large mass of rock, soil and debris downward by the pull of gravity. It is also called a mass movement or slope movement. It may happen suddenly or slowly. Generally, mass wasting is classified by the type of material involved (mud, soil, and rock) and type of motion (fall-free-falling pieces, slide-material moves along the rock slope and flow–material mixed with water).

Types of Mass Wasting

Following are the types of mass wasting:

Rock falls

- Rock falls occur when pieces of rock break from a cliff. Frost wedging may also eventually loosen large blocks causing them to fall. Te accumulation of rock debris at the base of a steep slope is called talus.

Rockslides

- Rockslides usually follow a zone of weakness. Presence of water increases slippage. Collisions down the slope generally break the rock mass into rubble that eventually results in rockslides.

Landslides

- Landslides occur when a large piece of rock breaks off and slides down -hill. It is often initiated by earthquakes and very heavy rain.

Slump

- Great mass of bed rock moves downward by rotational slip from a high cliff is known as slump. Most common reason for slumping is erosion at the base of the slope which reduces the support for overlying sediments.

Debris Slide

- Debris slide is more extensive and occurs on a larger scale than slump but there is a little amount of water. The materials involved in debris slide are a mixture of soils and rock fragments.

Debris flows

- Debris flow is defined as mass wasting event in which turbulence occurs throughout the mass. Debris flow includes earth flows, mudflows, and debris avalanches. Debris flow occurs when the rock or soil mass loses coherency when lots of water is involved. Debris becomes mixed up completely and flows as liquid mud. It often carries large boulders which can bevery destructive. When earth material moves down a hillside as a fluid-like mass, it is called an earth flow. These flows typically occur in humid areas on steep slopes with thick, clay-rich soil that becomes saturated with water during storms.

A mudflow

- Mudflow is a liquid mass of soil, rock debris and water that moves quickly down a well-defined channel. They occur most often in mountainous semiarid environments. A mudflow originating on a volcanic slope is called a lahar.

Debris avalanche

- The deadliest type of debris flow is the debris avalanche. It is a rapidly churning mass of rock debris, soil, water, and air that moves down steep slopes. The trapped air may increase the speed of an avalanche by acting as a cushion between the debris and the underlying surface

Creep

- Creep is a slow and gradual movement of soil downhill. Its velocity is typically less than a centimetre per year. Freezing and thawing contribute the soil creep by progressively moving soil particles down the hill. Creep is manifested at the surface by things like tilted utility poles, fences and trees Vegetation helps reduce the rate of soil creep.

Gradational Processes

- Gradation is the process by which the earth's surface gets levelled. It can be further divided into degradation, the process of eroding the earth's elevated surface and aggradations, the process of filling up the earth's depressions.

Gradational Agents

- The forces which act on the surface of the earth are termed as Gradational agents. Water, wave, wind, ice are the important gradational agents. Let us now discuss the gradational agents one by one.

The River

- The streams have a huge capacity to erode the rock over which they flow. In fact, the formation of the river channel is the result of the erosional capacity of the stream. The erosional capacity of the stream depends on its volume of water and velocity of flow. The river performs three types of work. They are erosion, transportation and deposition.

1. **Erosion:** The breaking of rocks by the river in along its course is called erosion. Erosional work of a river is performed mechanically and chemically. River erosion is carried out in the following ways:

    i. **Hydraulic action:** It refers to the physical force of the moving water which breaks the rocks in its course.
    ii. **Corrasion (abrasion):** It refers to the breaking of rock in the bed and on the bank by fragments carried by the stream.
    iii. **Corrosion(solution):** It refers to the dissolving process of soluble minerals by the splashing of stream water.
    iv. **Attrition:** It refers to the eroded materials carried by the stream strike against each other.

2. **Transportation:** Stream carrying the fragmented materials broken by the stream is called transportation. After erosion, the eroded materials get transported alont with the running water. This transportation of eroded materials is carried in four ways:

    i. Traction: The heavier and larger rock fragments like gravels, pebbles etc are forced by the flow of the river to roll along its bed. These fragments can be seen rolling, slipping, bumping and being dragged. This process is called as traction and the load transported in this way are called traction load.

    ii. Saltation: Some of the fragments of the rocks move along the bed of a stream by bouncing continuously. This process is called as saltation.

iii. Suspension: The holding up of small particles of sand, silt, and mud by the water as the stream flows is called suspension.

iv. Solution: Some parts of the rock fragments dissolve in the river water and transported. This type of transportation is called solution transportation.

3. **Deposition:** When the velocity of the stream decreases, the stream deposits sand, silt and other fragments. It iscalled as the deposition. When a river moves in a gentle slope, its speed reduces and river begins to deposit its load. The river starts depositing larger materials first and smaller and finer materials are carried further down to the mouth of the river.

Stages of the River

- The course of a river includes the upper stage, the middle stage, and the final stage. Each stage of the river is dominated by a kind of work. Let's discuss the stages of a river, the main work and the landforms made in each stage.

1. The Upper Stage

- The upper stage of a river is also called the youthful stage or mountain stage. The velocity and speed of the stream are very high because the slope here is steep. The vertical erosion is the most dominant work here. The valley is formed here. The place where a river starts is called a **source**. In the mountain stage, the number of small streams originates from different locations. They are called **Tributaries**. The placewhere two rivers join is called as the confuence. The mountain which has two river systems draining on either side of the slope is termed as the water divide.

2. The Middle Stage

- Middle stage is the matured stage of a river. Vertical erosion or deepening of the valley is significantly reduced. Lateral erosion is the dominant work. Due to the lateral erosion of this stage, the widening of the valley occurs. The volume of the river water increases and the slope of river is moderate. The depth of the river is deep here.

3. The Lower Sage

- This is the final stage of a river where the valleys are extremely broad and it has generally gentle slope. The valley becomes almost fat which is called a pen plain. Most of the pen plain forms low residual hills with steep slopes which are called as Monadnocks. T e main work of the river in this stage is the deposition. The depth of the river is shallow here. When the main river splits into many small rivers, they are called as the distributaries. The place where the river ends is called mouth of the river. (for example: Sea coast, Lake.)

4. Landforms by the Erosional Work of River

- The significant landforms resulting from erosion by rivers include gorge, canyon, V-Shaped Valley, waterfall, pothole, structural bench, river terrace, river meander, ox-bow lake, peneplain, etc.

Gorges are formed due to active down cutting of the valleys. So, a Gorge is a narrow and deep river valley which has steep slopes.

Canyons are extended form of gorges. Canyons represent very deep, narrow but long valleys. The steepness of the valley sides depends on the nature of the rocks. The Grand Canyon of the Colorado River in the state of Arizona, USA having a length of 482.8 kilometers and depth of 2088.3 meter is the largest canyon in the world. The Canyon of Gandikota is situated on the Pennar River in Andhra Pradesh is known as the Grand Canyon of India.

V-Shaped Valley The valleys made by the rivers are erosional landforms. The valley is formed in the youthful stage of the river erosion. Due to the steep slope and large volume of water, the river cuts its bed vertically forming narrow and deep river valley. This is called as V-shaped valley.

Rapids and waterfalls Rapids are stream sections with extremely strong currents, numerous obstacles, and steps in their streambeds. A waterfall is a vertical drop in a streambed. Both water fall and rapids are formed by vigorous erosion. Series of a waterfall in a river is called as Cascade.

Plunge poolA plunge pool is a deep depression in a stream bed at the base of a waterfall. It is created by the erosional forces of falling water at the base of a waterfall.

Angel Falls, in Venezuela, is Earth's highest waterfall (979 m). Hogenakal falls, Dharmapuri, Tamil Nadu some times is called as the Niagara of India.

Grooves

- Long and narrow depression at the base of a waterfall made by river runoff is called a groove. The grooves are created by water eroding soil from a hill or mountain in a short period of time.

- The swirling movement of the water falling into the plunge pool is called eddying.

Interlocking spurs

- An interlocking spur, also known as an overlapping spur, is a projectingridge that extends alternately from the opposite sides of a V-shaped valley. A river with a winding course flows down the interlocking spur.

Pot Holes

- The kettle-like small depressions in the rocky beds of the river valleys are called potholes. They are always cylindrical in shape. Potholes are generally formed in coarse-grained rocks such as sandstones and granites.

River Terraces

- The narrow step like flat surfaces on either side of the valley floor are called river terraces. They represent the level of former valley floors.

Landforms by the deposition of river

1. Alluvial fan

- Alluvial fans are often found at the foot of arid or semiarid mountain ranges where intermittent streams flow. An alluvial fan is a fan shaped deposit of gravel, sand and other smaller particles of sediment.Alluvial fans are found in Kosiriver, Himalayan region, Death Valley National Park and along the sides of the Colorado River at Grand Canyon National Park, U.S.

2. Penplains

- Pen plains represent low featureless plain having undulating surface and remnants of convex-concave residual hills.

3. Meander

- A meander is a winding curve or bend in a river. Meanders are the result of both erosional and depositional processes. They are typical landform of the middle and lower course of a river. This is formed by vertical erosion, lateral erosion, and deposition within the floodplain.

4. Oxbow lake

- Oxbow lake is a free standing body of water formed when the meander is cutoff from the main river. This landform is so named because it resembles horse shoe

5. Levees:

- Raised bed and a bank of the river due to frequent flooding and deposition of the sediments is called levees.

6. Flood Plain

- A flood plain is a flat area of land adjacent to a river. It stretches from the bank of its channel to the base of the enclosing valley walls which experiences flooding during the period of high discharge.

7. Estuary

- The word "estuary" is derived from the Latin word aestuarium meaning tidal inlet of the sea, which is derived from the term aestus, meaning tide. An estuary is a partially enclosed coastal body of brackish water with one or more rivers flowing into it, and with a free connection to the open sea.The inflow of both sea water and fresh water provide high levels of nutrients both in the water column and in sediment. Hence, it makes estuaries among the most productive natural habitats in the world. Narmada river estuary is located in Gujarat.

8.Delta

- Delta is found in the old stage of a river. It is the triangular shaped landform made up of alluvial deposition in the mouth of the river. It is named after the fourth Greek alphabet called delta. Example, The Ganges Brahmaputra delta is the largest delta in the world.Types of Delta: Delta is classified into the following based on the shape and kind of the load deposited by the river.

1. **Arcuate Delta:** A bowed or curved delta with the convex margin facing the body of water. It is also known as fan-shaped delta. Example, River Nile Delta in Egypt and Ganga Delta in India.

2. **Estuarine Delta** : it is formed at the mouth of submerged rivers depositing down the sides of the estuary. Example, Seine River of France.

3. **Birds foot Delta:** They are formed due to deposition of finer materials by river water. Deposited alluvial material divides the river into smaller distributaries. Such delta is also called as finger delta. Example, Mississippi river delta, the USA.

4. **Lacustrine Delta:** It is formed when a river flows into a lake. Example, Lough Leanne river delta, Ireland.

5. **Truncated Delta:** Sea waves and ocean currents modify and even destroy deltas deposited by the river through their erosional work. Thus, eroded and dissected deltas are called truncated deltas.

6. **Abandoned Delta:** when the river shifts its mouth, the delta already made is left abandoned. Such a delta is called abandoned delta. Example, Yellow river delta, China and the Western part of Ganga delta made by Hooglyriver, India.

7. Cuspate delta is a tooth shaped delta formed when a single distributaryflows through and deposits its load on its either side. Example, Tiber River of Italy

Glacier

- A glacier is a huge mass of ice that moves slowly along the mountain slope. The term "glacier" comes from the French word glace which means ice. Glaciers are often called "rivers of ice". It forms where the accumulation of snow exceeds its ablation over many years.

- The places where the snow lies for the whole year are called snowfields. The imaginary line above which there is a permanent snowfield is known as the snow line. The snowfields are always situated above the snow line. The snow line differs according to latitude, amount of snowfall, the direction of the wind and the physical features of the region. Snow starts melting below the snow line. Under the pressure of the upper layers, the lower layers of the snow field begin to melt causing the mass of snow to move down slope as glacier. Glacier moves at an average speed of 1meter per day. Over 96 percent of the glaciers occur in Antarctica and Greenland.

The worlds largest glacier is the Lambert Glacier in Antarctica, more than 96 km wideand 435 km long and 2,500 metres deep.

Types of Glaciers

The Glaciers are of three types. They are;

1. Continental Glaciers
2. Ice Caps
3. Mountain and Valley Glaciers

1. Continental Glaciers

- The continental glaciers are found in polar regions. In these areas, all the precipitation is in the form of snow. The snow that falls from year to year gradually gets accumulated. As a result, these regions are covered by an extensive ice mass. This is known as ice sheet or continental glacier. It is estimated that the maximum thickness of the ice sheets of Greenland is 3,400 meter, while the maximum thickness of the ice sheet of Antarctica is 4776 meter. Sometimes, the ends of the ice sheet projects outwards over the sea. The waves of the sea strike against them and break the ice sheets into blocks of floating ice known as Icebergs.

2. Ice Caps

- It is the covering of snow and ice on the oceans of poles. The ice caps can cover vast areas with the extensive accumulation of snow and ice. Example, Svartissen ice cap in Northern Norway.

3. **Mountain and Valley Glaciers**

- These are also known as Alpine glaciers. They flow like tongues of ice down through the mountain valleys from the ice caps. The piedmont glaciers form continuous ice sheets at the base of mountains. The valley glaciers or Alpine glaciers are found in higher regions of the Himalayas and on all such high mountain ranges of the world.

Characteristics of Glaciers

- A moving ice mass or glacier possesses certain characteristics of movement, speed, and surface structure. The rate of movement of the glacier is very slow.

- Terate of movement or the speed of a glacier depends upon the size of the glacierand the slope of the valley. Sometimes, the surface of the glacier forms cracks known as **Crevasses**. Crevasses are the deep fissure of variable width in the surface of a glacier. These crevasses are dangerous to the Mountaineers.

Action of glaciers

- The glacier performs three actions namely erosion, transportation and deposition.A glacier erodes its bedrock by the action of 1. Plucking and 2. Abrasion

1. **Plucking**

- The glacier plucks big pieces of rocks from the valley floor and creates large grooves or hollows. These pieces are dragged along the valley floor as the glacier moves. The boulders and rocky floor are grounded by mutual contact.

2. **Abrasion**

- Pure ice is capable of wearing down massive rocks when equipped with angular rock fragments. The glacier can groove, scratch, and chisel the rock surface. It has a powerful abrasive effect.As a result, a glacier during its lifetime creates various landforms which may be classified into erosional and depositional landforms.

Erosional landforms of Glaciers

- The landforms created by glaciers are mainly found in the mountainous regions.The chief erosional landforms by the glaciers are as follow:

1. **U-Shaped Valley**

- U-Shaped Valley is a typical glacial feature. Since glacial mass is heavy and slow moving, erosional activity is uniform in all directions. A steep-sided curved bottom valley has a U shaped profile.

2. Hanging Valley

- Hanging valley is formed when tributary glaciers are unable to cut as deeply as main ones and remain "hanging" at higher levels than the main valley as discordant tributaries. These tributary valleys appear hanging over the main valley and enter the main valley at some height.

3. Cirque and Tarn

- A Cirque or Corrie is an amphitheater-shaped hollow basin cut into a mountain ridge. It has a steep-sided slope on three sides, an open end on one side and a flat bottom. When the ice melts, the Cirque may develop into a Tarn Lake and the whole thing appears like a big armchair.

4. Aretes

- It is a steep-sided, sharp-tipped saw toothed ridges which have undergone glacial erosion from two sides. These comb like ridges are called as arete.

5. Horn

- If the summit of the Arete is roughly inclined, it gives rise to pyramidal peaks which are known as horns. Example, Matterhornof Alps-Switzerland.

6. Roche Moutonnees or Sheep Rock

- Roche Moutonnees or sheep rock is a glaciated bedrock surface, usually in the form of rounded knobs. The upstream side of a rochemoutonnee has been subjected to glacial scouring that has produced a gentle, polished, and striated slope and the downstream side has been subjected to glacial plucking that has resulted in a steep, irregular and jagged slope.

7. Nunataks

- A rock mass surrounded by ice is called Nunatak. It stands out as an island in the ice.

8. Fjord

- The fjord is formed as a steep-sided narrow entrance like feature at the coast of a glaciated region where the stream meets the coast. Fjords are common in Norway, Greenland and New Zealand.

Depositional landforms of glaciers

- When the glaciers melt or recede they deposit the rock material, brought by them, forming hillocks of various shapes

and sizes. The depositional landforms of the glaciers are;

1. **Moraines:** Moraines are the piles of dirt and rock that are deposited by a glacier as it moves across the landscape. These debris fields exist in places where glaciers have moved through in the past. There are many kinds of glacial moraines that form. Moraines are generally classified based on their location.

   a. Lateral Moraines

   Lateral moraines are ridges of debris that run parallel to the sides of a glacier. This is often accompanied by scraping of the valley sides which means the debris from the moraine creates high ridges above the glacier.

   b. Ground Moraines

   Ground moraines are glacial depositions formed on the floor of glacial valley. Ground moraines can be deposited in between lateral moraines in the case of many alpine glaciers.

   c. Medial Moraines

   Medial moraines are ridges of debris that are left down a valley floor at the middle of two glaciers. Both glaciers merge together and their debris combine to form a consistent moraine field along their borders. They are actually the merging of two lateral moraines which continue as medial moraines.

   d. Terminal or End Moraines

   Terminal or end moraines are left by the end of a glacier. The slower a glacier moves the bigger the moraine will be as the glacier has more time to accumulate outside debris.

   e. Recessional Moraines

   This recessional moraine runs across the landscape behind a terminal moraine. They are caused by times when the glacier slows or stops in its movement. It is formed because the receding glacier pauses in certain places for a long time before continuing its movement.

2. **Outwash Plain;**

When the glacier reaches its lowest point and melts, it leaves behind a layered deposition of rock debris, clay, sand, gravel, etc. This layered surface is called as an Outwash Plain.

3. **Esker :**

It is a winding ridge of depositions of rock, gravel, clay, etc, running along a glacier in an outwash plain. The Eskers resemble the feature of an embankment and are often used for laying roads.

4. **Drumlins:**

It is an inverted boat-shaped deposition in an outwash plain caused by deposition.

5. **Kames:**

Kamesare the number of ridges formed along the ice front.

Ground water (Karst Topography)

- The word "karst" literally means "rocky mountain" comes from a region in former Yugoslavia that includes Croatia and Slovenia. The word is derived from the Slavic word Kras.

What does Groundwater do?

- Any limestone, dolomite or gypsum region showing typical landforms produced by the action of groundwater through the process of solution and deposition is called as Karst Topography (Karst region in the Balkans).

Erosional Landforms due to Groundwater

- Following are the erosional landforms formed due to the action of groundwater

1. **Sinkholes**

A sinkhole is an opening more or less circular at the top and funnel-shaped towards the bottom. When as sinkhole is formed solely through the process of solution, it is called as a solution sink.

2. **Doline**

A doline is a closed depression draining underground in karst areas. It can be cylindrical, conical, bowl or dish shaped. The diameter ranges from a few meters

to many hundreds of meters. The name doline comes from doline, the Slovenian word meaning valley.

3. **Lappies**

Lappies are the irregular grooves and ridges formed when most of the surfaces of limestone are removed by solution process.

4. **Uvala**

Series of smaller sinkholes coalesce into a compound sinkhole is called uvala.

5. **Polje**

Polje is an elongated basin having a fat floor and steep walls. It is formed by the coalescence of several sinkholes. The basins often cover 250 square km and may expose "disappearing streams." Most of these basins have steep enclosing walls that range from 50 to 100 meter in height, giving rise to the name "blind valley."

6. **Caves**

Caves normally have an opening through which cave streams are discharged. Caveshaving an opening at both the ends are called tunnels.

Depositional Landforms due to Ground water

The following depositional features are formed within caves.

1. **Curtains**

Rain water drips from long crack in a cave roof forms a continuous strip of calcites. It is called as curtains.

2. **Stalactite**

Drops of water containing dissolved limestone seep down through cracks in the cave roof. Drops of water lose carbon dioxide and deposit calcite. Overtime deposition of calcite forms pillars hanging down from the roof of the cave. It is called as stalactite and where the stalactite stretches towards the sides are known as Helactites.

3. **Stalagmite**

Deposition of calcite forming icicles growing upward from the cave floor is called as stalagmite.Stalactites are calcium carbonate deposits hanging as icicles while Stalagmites are calcium carbonate deposits which rise up from the floor.

4. **Pillar**

When both the stalagmite and stalactite join together, it is known as pillar.

Wind

- The wind is the main geomorphic agent in the arid region. Wind in arid region has greater speed which causes erosional and depositional activities in the desert. The landforms which are created by erosional and depositional activities of wind are called as Aeolian Landforms.

Action of the wind

The action of the wind is carried in the following ways;

1. **Deflation:** Removal of sand and dust particles by wind. It forms depression in the desert. When depression is filled with water, it is called as Oasis

2. **Abrasion:** Action of wind in which sand particles carried by the wind strike against the rock.

3. **Attrition:** Sand particles carried by the wind striking each other is known as attrition.

Erosional Landforms of Wind

1. **Deflation Hollows**

- When deflation causes a shallow depression by persistent movements of wind, they are called as deflation hollows.

2. **Mushroom Rock**

- A mushroom rock, also called rock pedestal, or a pedestal rock, is a naturally occurring rock whose shape, as its name implies, resembles a mushroom.

- In deserts, a greater amount of sand and rock particles are transported close to the ground by the winds which cause more erosion in the lower part of the rock than the top. These result in the formation of rock pillars shaped like a mushroom with narrow pillars with broad top surfaces.

3. **Yardang**

- Yardangs areextensively grooved, fluted, pitted and irregular rock ridges or reliefs of about 1 to 10 meters high running parallel to the prevailing winds. They are caused by differential erosion. When the sand-laden wind corrades zones of softer or weaker rock between harder vertical ridges from old lake sediment where soft, consolidated rock and bedrock surfaces are eroded into alternating ridges and furrows. Large-scale yardangs are found in Egypt (near KomOmbo, north of Lake Aswan).

Zeugen

- Zeugen is a landscape of alternate horizontal ridges and furrows made by the action of wind abrasion. It may be as high as 30 m height.

Depositional Landforms of Wind

1. **Sand dunes**

Dry hot deserts are good places for sand dune formation. According to the shape of a sand dune, there are varieties of sand dune forms like Barchans, Seif dune, etc. The barchan is one of the classic desert landforms. It is a crescent-shaped dune with the horns of the crescent stretching out in the leeward direction. Barchan dunes may reach more than 27 meter in height. Seif dunes are long ridges of sand. In general they are aligned in the direction of the prevailing wind. The slip face of seif dunes are probably formed by eddies. The depressions between seif dune ridges are swept clear of sand by the winds. The ridgesrun for long distances, sometimes several kilometres.

2. **Loess**

- In several large areas of the world, the surface is covered by deposits of wind transported silt that has settled out from dust storms over many thousands of years. These depositions are called as Loess.

3. **Pedi plains**

- When the high relief structures in deserts are reduced to low featureless plains by the activities of wind, they are called as Pediplains.

Waves (Coast)

Horizontal movement of sea water caused by the wind, rotation of the earth, etc., are called waves.

How do Waves Erode?

Waves carry out the erosive work in the following ways.

1. **Abrasion:** The waves striking against the coast witheroded materials iscalled abrasion. Abrasion is also called as the corrasion.

2. **Hydraulic action:** The waves force water and air into the cracks in the rock. The parcel of air can be compressed by the surging water and the waves retreat, air expands explosively, weakening the joints and cracks and causing the rock to break. This is called the Hydraulic action.

3. **Corrosion:** The action of dissolving soluble rocks by waves is termed as the corrosion or solution.

4. **Attrition:** Eroded materials like boulders and rocks knock together to wear out into smaller particles. This is called attrition.

Landforms by the Erosion of Waves

- Erosional landforms dominate rocky coasts but are also found in association with predominantly depositional landforms.

1. Sea cliff is steep rocky coast rising almost vertically above seawater is called sea cliff.

2. Wave Cut Platform: Rock cut flat surfaces in front of a cliff are called wave-cut platform. They are slightly concave upward. It is also formed when blowhole is collapsed.

3. A sea cave is a hollow excavated by waves in a zone of weakness on a cliff. The cave depth is greater than the entrance width.

4. Sea caves usually form at points of geological weakness, such as bedding planes, joints, and faults. A 90 meter long sea cave is found in the Loliem beach in Canacona in Goa. The world's most extensive cave is 1.5 km long Matainaka cave in New Zealand.

5. A blowhole may form in the roof of a sea cave by the hydraulic and pneumatic action of waves, with fountains of spray

6. emerging from the top. If blowholes become enlarged, they may collapse.

5. Arch is formed when the sea cave is cut right through by wave action. The arch is termed as sea tunnel if it is comparatively longer.

6. The stack is a steep and often vertical column of rock in the sea near a coast, formed by wave erosion.

7. It is formed when the natural arch is collapsed. It is also called chimney rock, needles, columns, pillars, skerries, etc,

7. Stump is the worn out stack. 4.10.3 Transportation Work of Waves

8. The eroded materials are transported by the waves in different ways. The materials involved in the transportation by sea waves include silt, sand, gravel, cobble, pebble and boulder.

Landforms by the deposition of waves

Depositional landforms developed by the sea waves include the beach, bar, lagoon, spit, tombolo, barrier island, etc. Let us see one by one in detail

1. Beach is an elongated stretch of sands, pebbles, gravels, etc deposited along the coast. It can be a sandy beach or pebble beach. Praia da Cassino beach in Brazil is the world's longest beach stretching for 200 km from the Rio Grande to the border with Uruguay. Marina beach, Chennai is the second longest beach in the world.
2. The Bar is a stretch of sand deposition off the shoreline. The larger form of a bar is called barrier.
3. The Lagoon is enclosed seawater between the bar and the coast. For example,Pulicatlake, located in the Tamil Nadu and Andhra Pradesh is a lagoon.
4. Spit is a long, narrow ridge of sand or pebble with one end connected to the coast and the other end running into the sea. For example, Rameshwaram, Tamil Nadu.
5. A Tombolo is a bar connecting an island with the coast.

Glossary

1. **Streambed:** A chanel in which a stream flow or formerly flowed
2. **Cataracts**: water fall with volume of water.
3. **The Ice Caps**:It is the covering of Snow and Ice on the oceans of poles.
4. **Offshore** is the zone shallow bottom of the continental shelf.
5. **Source of a river:** place where river starts.
6. **Water Divide:** relief having two river systems.
7. **Oasis:** depression in the desert filled with rain water.
8. **Desert:** waste land unfit for human use at the moment.
9. **Snow line**: an imaginary line below which snow starts melting.
10. **Delta**: A triangular shaped fertile land built by river at the mouth.

Unit V Hydrosphere

Introduction

"World cannot survive without water and morality cannot exist without rain"

- As thirukkural quotes, water is the most important resource in the world. Over 90% of the world's supply of fresh water is in Antarctica. You must know that 85% of the world population lives in the driest

half of the planet. Now we shall learn about the hydrosphere in detail.

70% of human brain is water.

- Water is the most common substance found on earth. It is an important constituent of all life forms on the earth. Hydrosphere is one among the four spheres of the earth. The hydrosphere includes the water on the surface of the earth, the water below the surface called ground water and the water in the atmosphere above earth's surface. Oceans, rivers, lakes and glaciers form part of surface water. There is substantialamount of water under the surface of the earth. The atmosphere has water in all the three forms. The total amount of water on the earth does not change over time. Water is constantly in motion within the spheres of the earth which is being transformed and reused all over the earth. The earth's hydrosphere, thus, acts as a closed system.

Distribution of Land and Water in the Earth

- Earth is covered by land and water. About 70.8% of its area (361millionsq km) is covered by water and 29.2% (148 million sq km) of its area by land. About 96.5% of water is salty found in seas and oceans. Fresh water occupies only 2.5%. Saline ground water and saline lakes together form 1%.

Fresh water

Fresh water is defined as water with a salinity of less than1% compared to that of the oceans (i.e. below 0.35%). Water with salinity between 0.35‰ and 1‰ is typically referred to as marginal water because it is marginal for many uses by humans and animals.

- Considering the distribution of fresh water 68.6% of it is locked in Glaciers and icecaps. About 30.1% is stored as ground water and the remaining 1.5% is available as surface water.

- Surface water includes ice and snow on the land and sea, water in the lakes, rivers, swamps and marshes, moisture in soil, atmosphere and biosphere. Rivers and lakes are the major sources of fresh water around the world, and are vital to the communities they serve.

- **Rivers:** Rivers generally have a source on a mountain either from a glacier, a spring or a lake. River Ganga has its source from Gangotri glacier in the Himalayas. River Cauvery has its source from a spring in Talacauvery located in Kodagu district of Karnataka. River Nile has its source near Lake Victoria in Uganda. The river flows through confined channel between two banks and ends up at the mouth which is either on a sea or lake. When rivers drain their water into a lake or an inland sea, it is said to be an inland drainage.

- The Nile River in Africa is the longest river in the world. The Nile River flows through Egypt, Uganda, Ethiopia, Kenya, Tanzania, Democratic Republic of the Congo, Rwanda, Burundi, Sudan and Eritrea drains and into the Mediterranean Sea forming a delta to the north of Cairo city.

- The river Amazon in South America, is the second longest river, and has the largest drainage basin of any river. The Amazon River flows through Peru, Colombia, and Brazil and drains into the Atlantic Ocean forming an estuarine delta.

- The Yangtze River, which flows in China, is the longest river in Asia, and the third longest river in the world. The longest river system in the United States, the Mississippi-Missouri system is considered the fourth longest river in the world.

263 rivers either cross or demarcate international political boundaries.

- The total volume of water in rivers in the world is estimated at 2,120 km3. Asiaexcluding Middle East, has the largest run off of 13,300 km3/year followed by North America with 12,000 km3 per year.

A nationwide water resources information system, "Generation of Database and Implementation of Web Enabled Water Resources Information System (India-WRIS) in the country" contain all aspects of water resources and related data provide data and information in public domain through India-WRIS Web GIS portal.

Lakes:

- Lakes are larger bodies of water with outlet through a river or stream. Lake may have their origin through tectonic activity, volcanic activity, river, glacier and wave action or sometimes meteoric origin. Caspian Sea, Lake Baikal and Wular Lake have been formed by earth movements. Lake Baikal is the deepest freshwater lake in the world. Caspian Sea is the largest salt water lake in the world.

Tmcft, is the abbreviation for one thousand million cubic feet (1,000,000,000 = 1 billion), commonly used in India with reference to volume of water in a reservoir or river flow.

- Lagoon lakes are formed by wave deposition. Chilika Lake is the largest lagoon lake in India. Lonar Lake in Maharashtra is believed to be formed by depression created by meteor impact which hit during Pleistocene Epoch.

- Lake Toba on the island of Sumatra is the largest resurgent caldera on Earth.
- Sambhar Lake in Rajasthan is the largest salt water lake in India.
- Finland is known as land of thousand lakes.

Wetlands:

- Wetlands are areas of marsh, fen, peat land or water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. Marshes are shallow wetlandsaround lakes, streams, or the ocean where grasses and reeds are common, without trees. Rann of Kutch in India is a salt marsh. A swamp is a wetland with lush trees and vines found in a low-lying area beside slow-moving rivers. Pallikaranai wetland is a fresh water swamp adjacent to the Bay of Bengal situated in the southern part of Chennai.

Groundwater

- Groundwater is the most valuable resource for any country. The rain water that falls on the earth cither runs off as surface water or percolates into the ground to recharge the groundwater. The permeable rocks that can hold water and allow water to

pass through them are called aquifers. The upper part of the saturated zone of the aquifer is called the water table. The level of water table fluctuates according to seasons (Figure 5.1).

Saltwater intrusion

If excessive water is taken from the aquifers along the coast, the sea water enters the coastal aquifer. This process is termed as saltwater intrusion.

Cryosphere

- Cryosphere includes the water in frozen state. Glaciers, ice sheets, ice caps, lake and river ice, permafrost, seasonal snow and ice crystals in the atmosphere together form cryosphere. Earth's climate is highly influenced by the extent of cryosphere as it controls the energy budget of the earth (Figure 5.2).

- Perennial ice cover is found in Greenland and Antarctica as ice sheets, as mountain glaciers and as permafrost in higher latitudes. Permafrost is the condition prevailing when water freezes above and below the ground, (including rock or soil) for more than two consecutive years. Most permafrost regions are located in high latitudes, but alpine permafrost may exist at high mountains in much lower latitudes.

Mount Kilimanjaro (5895m) in Tanzania, Africa, located closer to the equator has permafrost.

- Seasonal snow and ice crystals are confined to middle latitudes and high mountains in lower latitude. Sea ice is frozen ocean water. Its formation, growth and melting are all confined to the ocean. An ice shelf is a thick, floating slab of ice that forms where a glacier or ice flowsdown a coastline. The world's largest ice shelves are the Ross Ice Shelf and the Filchner-Ronne ice shelf in Antarctica. An iceberg is ice floating in open water that has broken off from glaciers or ice shelf.

Interaction of cryosphere with other spheres

- Cryosphere is a climate indicator. Cryosphere with its high albedo influences the energy balance of the whole planet. Changes in cryosphere will alter land cover, surface temperature, soil moisture, air temperature, radiation, air circulation, clouds, precipitation, sea level, sea surface temperature, salinity, ocean current, fauna, flora and microbes. There is a complex interaction and balance among the spheres of the earth which makes life to flourish in the earth. If there is a change in one sphere it affects the other spheres as well. Nature maintains this balance. Understanding this complex

interactions and living in harmony with nature will help to mitigate the environmental problems faced by the earth.

Carbon is removed from the atmospheric cycle by cryosphere during the formationof ice and is released when the ice melts.

Oceans and Seas

- The water in the oceans and seas is termed as marine water. Continuous water body that surrounds the continents, created by earth's internal force is known as Ocean. The term ocean takes its origin from the Greek word 'Oceaonus' meaning enormous river encircling the earth. Thearea of the World Ocean is 361 million square kilometre. The earth has at present five major oceans: The Pacific Ocean, the Atlantic Ocean, the Indian Ocean, the Arctic Ocean, and the Southern ocean (Figure 5.3). All these oceans are interconnected to form one Global Ocean or World Ocean. This nature of water to level up quickly has made it as a reference point to measure the height of the land features and the depth of the sea features.

Mean Sea Level (MSL) is the average height of the surface of the sea for all stages of the tide. MSL is reference point to measure the height of land features and depth of the sea features.

- **Sea** is a body of saline water (generally a division of the world ocean) partly or fully enclosed by land. Marginal sea is a sea partially enclosed by islands, archipelagos, or peninsulas and extension of oceans towards land. They are generally shallow. Andaman Sea, Arabian Sea, Bay of Bengal, Java Sea, Persian Gulf and Red Sea are marginal seas of the Indian Ocean.

- **Bay** is a water body surrounded on three sides by land and the fourth side (mouth) wide open towards an ocean. Gulf is a large body of water, **with** a narrow mouth, that is almost completely surrounded by land. The world's largest gulf is the Gulf of Mexico. Sound, creek, bight and cove are bays which vary in size and depth.

- Strait is a narrow channel of water, connecting two larger bodies of water. Palk Strait connects Gulf of Mannar and Bay of Bengal. Isthmus is a narrowstrip of land connecting two larger land masses. Isthmus of Suez connects Africa and Asia.

- Enclosed **seas** are seas that reach very deep into the continent stay connected with one or the other ocean of the world through straits. Mediterranean Sea is the best example for enclosed sea. Partly Enclosed Seas are those types of seas that are connected to the oceans by a very wide opening and have similar characters

of the adjacent ocean. A series of islands may also occur between a partly enclosed sea and the ocean to which it is connected. Caribbean Sea is a perfect example.

- **Landlocked Seas** are completely surrounded by landmass on all sides without any natural outlet. They are actually hyper saline lakes. Dead Sea and Caspian Sea are good examples of landlocked seas. Jordon River and Volga River flow into Dead Sea and Caspian Sea respectively.Fjord is a long indented bay with steep slope that has been created by the submergence of U shaped glacial valley. Example: sogne Fjord in Nor way (203 km).

- **Ria** is an indented bay with gradual slope formed by the submergence of V shaped river valley. George River in Sydney is the best example for Ria.

Oceans of the world

1. The Pacific Ocean

- Pacific Ocean is the largest ocean in the world. It is bigger than all continents put together. Portuguese explorer Ferdinand Magellan in 1521 named the ocean Pacific Ocean meaning 'peaceful' because he felt the ocean to be calm after sailing from the Atlantic Ocean through the stormy and dangerous Strait of Magellan. Average depth of this ocean is 4,280 meters.

There is life cycle for oceans too! It is known as Wilson cycle.

2. The Atlantic Ocean

- Atlantic Ocean is the second largest ocean of the world. The Atlantic Ocean's name refers to Atlas of Greek mythology. The North Atlantic Ocean was formed by the break-up of the supercontinent Pangaea and the south Atlantic was formed when the Gondwanaland broke in thegeological past.

The Suez Canal, an artificial sea-level waterway in Egypt, connecting the Mediterranean Sea to the Red Sea through the Isthmus of Suez was officially opened on November 17, 1869.

3. The Indian Ocean

- The Indian Ocean is the third-largest in the world. It is named after India. Its calm open water has encouraged the sea trade earlier than the Atlantic or the Pacific Ocean.

4. The Southern Ocean

- The Southern Ocean is the worlds fourth largest ocean. The Southern Ocean is the youngest ocean and was formed 30 million years ago when South America moved away from Antarctica, opening the Drake Passage (Figure 5.4). This ocean has the boundary where cold, northward flowing water from the Antarctic mixes with warmer sub Antarctic water. During summer in southern hemisphere over half of the Southern Ocean is covered with ice and icebergs.

5. The Arctic ocean

- The Arctic Ocean is shallower and smaller than the other four oceans. Itis completely surrounded by Eurasia and North America. It is covered by ice completely in winter. The Arctic Oceans surface temperature and salinity vary seasonally as the ice cover melts and freezes alternatively. Its salinity is the lowest on an average of the five major oceans. Bering Strait connects the Arctic Ocean with the Pacific Ocean while the Greenland Sea and the Labrador Sea connects it with the Atlantic. The deepest point is Litke Deep in the Eurasian Basin, at 5,450 m.

The International Hydrographic Organization (IHO) is the inter-governmental organisation that surveys and produces charts for the world's seas, oceans and navigable waters.

Maritime zones

- The low-tide line forms the base line for marking maritime zones. Water landward of the baseline in defined as internal waters over which the state has complete sovereignty. A country's territorial sea extends up to 12 nautical miles(22.2 km) from its baseline (Figure 5.5). The contiguous zone is a zone of water extending from the outer edge of the territorial sea up to 24 nautical miles (44.4 km) from the baseline.

- An Exclusive Economic Zone (EEZ) extends from the base line to a maximumA nautical mile is based on the circumference of the earth, and is equal to one minute of latitude which is equivalent to one sixtieth of a degree of latitude. A nautical mile is a unit of measurement defined as 1,852 metres. Nautical miles are used in Navigational charts.

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Relief of ocean

- The bottom of the ocean has a variety of landforms just as it is seen on the earth's surface. There are large mountain ridges, deep depressions, flat plains, basins and volcanoes. The configuration of an ocean floor is shown with the help of aIndian National Centre for Ocean Information Services (INCOIS) with its Marine Satellite Information Services uses the remotely sensed sea surface temperature (SST) to identify the locations of fish aggregation. The details of the Potential Fishing Zones (PFZ) are then disseminated to the fishermen once in every three days along the Indian Coast by displaying the details in the Lighthouse in their respective regional language (Figure 5.6).

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'Hypsometric curve' or 'Hypsographic curve'. It is a graph denoting the proportion of a landmass standing above or below the sea level (Figure 5.7).

Continental shelf

- Continental shelf is the seaward extension of land that lies under the sea water. It occupies 7% of the sea floor. The continental shelf slopes gently away from the land and is covered with shallow seas with an average depth of 200fathoms. The width of the continental shelf varies according to the nature of the rock beneath the crust. If the crust is dynamic then the shelf would be narrow and vice versa. Continental shelves are formed due to either any one or combination of the factors like fluvial deposits, marine erosion, tectonic forces, and the fluctuations in sea level in the past. Continental shelves are well known for oil, natural gas, mineral deposits and coral reefs. World famous fishing grounds like Grand Bank are situated here. The world's widest continental shelf (1210 km long) is located along the coast of Siberia, in Russia.

- Continental shelf on the east coast of India is formed by deltas of the Ganga, the Godavari, the Krishna and the Cauvery. On the West coast of India the continental shelves are formed due to faulting and consequent submergence.

Continental Slope

- The zone of steep slope extending from the continental shelf to the deep sea plain or abyssal plain is called continental slope. The slope angle varies from 5° to 60°. It occupies 9% of sea floor. This is the region in oceans where landslides, turbid currents, large sediment slumps, under water canyons, gorges cut by the currents and rivers occur. The deposit from the continental shelves immediately falls down here. The origin of continental slope is believed to be due to erosional, tectonic and aggradational processes.

Continental rise

- The area between the continental slope and the sea floor is known as the continental rise. This part is noted for the accumulation of sediments similar to the alluvial fans near the foot hills in the land. It represents the boundary between continents and abyssal plain. It constitutes about 5% of the oceanic area.

Abyssal plain

- The Abyssal plain is the vast area of flat terrain in the bottom of the oceans. It isthe largest part of ocean relief covering more than 50% of the total area. There is an accumulation of very fine sediments on the floor. The sediments are combinations of fine particles of clay and microorganisms. As in the case of sedimentary rocks of earth's surface these sediments are in layers and are used to trace geological events in the past.

Mid oceanic ridges

- The mid-ocean ridges are submarine mountains. They are continuous and are connected to form a single global mid-oceanic ridge system. They are formed by the tectonic forces acting from within the earth. Mid oceanic ridges are located on the divergent plate boundaries where magma flows through the fissure to form new oceanic crust. They form the longest mountain range in the world extending for more than 56,000 km long and has a maximum width of 800–1,500 km.

Ocean trench

- The long, narrow, steep-sided depressions formed by tectonic forces beneath the abyssal plain are called Ocean trenches. Oceanic trenches actually extend 3 to 4 km below the level of the abyssal plain. There are 26 oceanic trenches in the world: 22 in the Pacific Ocean, 3 in the Atlantic Ocean and only one in the Indian Ocean. The Challenger Deep in the Mariana Trench, (10,994 m) in the Pacific Ocean is the deepest part of the earth. A trench forms along the convergent boundary where one plate subducts below the other (Figure 5.9).

Island

- An island is a landmass surrounded by water on all sides. Islands may be formed on the continental shelf or as oceanic islands. Most of the oceanic islands are volcanic in origin. Groupof islandsOcean deepis grouped into two categories based on their size.

- Very deep but less extensive depression are called deeps. Long narrow linear and more extensive depressions are called 'trenches'.formed by subduction of ocean plate are known as archipelago. Islands of Japan form an archipelago.

- Marine organisms, the coral polyps colonize the tropical warm water and form islands known as coral islands. Lakshadweep Island in Indian Territory is made of corals. Andaman Nicobar islands are of volcanic origin.

Guyots

- Flat topped volcanic hills submerged under the sea water are called guyots. It is a part of an underwater chain of volcanic mountains produced by slow plate movement.

Seamounts

- Seamounts are conical, volcanic hills submerged under ocean water. It does not reach to the water's surface. It is an isolated rise with an elevation of thousand metres or more from the surrounding sea floor and with a limited summit area. It occupies 4.39 percent of ocean region. Seamounts and guyots are most abundant in the North Pacific Ocean.

Bottom relief of Pacific Ocean

- Continental shelf of the Eastern Pacific Ocean is very narrow due to the presence of trenches while those on the western coast are wide. Continental shelf adjoining coasts of Australia and Indonesia varies in width from 160 to 1,600 km. In the Pacific Ocean, the abyssal plains are very vast. Absence of mid oceanic ridges is the main reason for deep sea plains. Prominent submarine ridges of the Pacific Ocean are Albatross plateau, Cocas ridge and Aleutian ridge. Tasmania basin (New Zealand) and east pacific basin are major basins of Pacific Ocean. Pacific Ocean has about 25,000 islands. There are number of archipelagos both in north and south Pacific Ocean. The Hawaii islands were formed by hotspot. The challenger deep in Mariana trench is the deepest part of Pacific Ocean (10994m).

Bottom relief of Atlantic Ocean

- In the North Atlantic Ocean, extensive continental shelves are found around the
- shores of Newfoundland (Grand bank) and British islands (Dogger Bank). In the South Atlantic Ocean, a very extensive continental shelf is found between Bahia Blanca and Antarctica (Figure 5.10).

- The most striking relief feature which is the 'S' shaped Mid–Atlantic ridge which extends for 16,000 km from Iceland in the north to Bouvet Island in the south. The ridge separates the Eurasian Plate and North American Plate in the North Atlantic, and the African Plate from the South American Plate in the South Atlantic. Iceland and Faroe are the few peaks of the Mid-Atlantic ridge.

- The mid-Atlantic ridge divides the Atlantic Ocean into two major basins, i.e., East and West Atlantic basins. Other basins are Spanish basin, north and south Canary basin, Guinea basin, Brazilian basin and Labrador basin. Puerto Rico Deep (8,380 m) is the

deepest of all deeps in the Atlantic Ocean. Other deeps are Romanche Deep and South Sandwich Trench.

- The West Indies is an island archipelago near the main land of North America. British Isles and Newfoundland are famous islands, formed on the continental shelf in the North Atlantic Ocean. Sandwich island, Georgia Island, Falkland and Shetland islands are islands in the South Atlantic Ocean.

Bottom Relief of the Indian Ocean

- The Indian Ocean has continental shelf of varying width. Continental shelf along the coast of Arabian Sea, the Bay of Bengal and Andaman varies in width from 192km to 280km. A variety of coral reefs thrive in the warm tropical water of the Indian Ocean.

- Indian Ocean has a continuous central ridge called the Arabic Indian ridge. Other important ridges include the East Indian ridge, West Australian ridge, SouthMadagascar ridge. Basins of Indian Ocean include Comoro basin, North Australian basin, South Indian basin and the Arab basin (Figure 5.11).

- The average depth of the Indian Ocean is 3890m. Sunda deep near Java is the deepest part of this ocean (7450m). Madagascar and SriLanka are the most prominent islands present in Indian Ocean. Andaman and Nicobar islands in the Bay of Bengal are the raised part of mountains that are the extension of ArakanYoma which forms a part of Himalayas. Reunion Island is located on a Hot spot.

Ocean Temperature

- The measurement of degree of hotness or coldness of ocean water is referred to asocean temperature. Temperature isnormally measured in the unit of degree Celsius by thermometers. The major source of heat energy for ocean water is the radiation from sun. The heating and cooling capacity of water differs significantly from that of land.

Factors affecting horizontal distribution of ocean temperature

The factors affecting distribution of ocean temperature are latitude, prevailing winds, ocean currents and local weather.

1. Latitude: The temperature of surface water decreases from equator towards the poles because of the slanting rays of the Sun pole ward.
2. Prevailing wind: Direction of the wind affects the distribution of temperature of ocean water. The off shore winds blowing from the land towards ocean or sea raise the temperature of ocean water. Winds blowing from snow covered regions in winter lower the surface temperature. In trade wind belt, the off shore winds initiate upwelling of cooler water from beneath and on shore winds pile up warm water to increase the temperature to certain extent.

3. Ocean currents: Warm currents raise the temperature of the oceans where they flow whereas cold currents lower down the temperature. Gulf Stream (warm current) increases the temperature of the eastern part of North America and the west coast ofEurope. Labrador cold current reduces the temperature near north eastern coast of North America.
4. Apart from these, some minor factors like submarine ridges, local weather conditions like storms, cyclones, hurricanes, fog, cloudiness, evaporation and condensation also affect the surface temperature of ocean water.

- These images show the sea surface temperature in Celsius. The Figure 5.12 shows the sea surface temperature in July and the Figure 5.13 in January. Cold temperatures are shown in purple, moderate temperatures in aquatic green and warm temperatures in yellow to red. Landmass is shown by black colour. The diurnal range and annual range oftemperature of ocean is much less than that of the land. The temperature of the sea surface is highest (27°C to 30°C) not near Equator but few degrees north of the Equator. The lowest temperature recorded is -1.9°C near the poles. The maximum and minimum annual temperatures of ocean water are recorded in August and February in the Northern hemisphere and reverse in case of the southern hemisphere.

Vertical distribution of temperature in oceans

- The uppermost layer of ocean water is warm and well mixed surface layer with average temperature between 20° and 25°C. The depth of this layer varies according to seasons. On an average this layer extends up to 200 m in tropical region. Beneath this layerlies the thermocline layer. This layer varies in depth between 200 metre to 1000 metre. This layer is unique that the temperature decreases rapidly with increasing depth. Below the thermocline temperature decrease is gradual up to 4000m. Beneath this depth the temperature of ocean water is constant at 4°C (Figure 5.14).

Salinity of the ocean

- Salinity is defined as the ratio between the weights of dissolved salts (in grams) per 1000 grams of water. It is expressed as part per thousand (‰) and has no units. Example: 30‰ means 30 grams in 1,000 grams of sea water. The average ocean salinity is 35%

- Sources of salt in the ocean: Sea water is a weak but complex solution made up of many things including mineral salts and decayed biological marine organisms. Most of the ocean salts are derived from

weathering and erosion of the earth's crust by the rivers. Some of the ocean salts have been dissolved from rocks and sediments below the sea floor, while others have escaped from the earth's crust through volcanic vents as solid and gaseous materials.

In partially enclosed seas, their bottom relief and the submarine ridges with shallow water do not allow free mixing of open sea water. The temperature at the depth of 1800m in the Red Sea is higher than the

temperature recorded at the same depth in the Indian Ocean.

Depth of water is measured in the unit 'Fathom'. One fathom is equal to 1.8 metre (six feet)

Factors affecting the salinity of ocean water

The salinity of ocean water depends upon

a. The rate of evaporation
b. Amount of precipitation,
c. Addition of fresh water flow from rivers
d. Ice in Polar Regions
e. Upwelling of deep water initiated by prevailing winds and
f. Mixing of water by ocean currents.

Distribution of salinity

- On an average the salinity decreases from equator towards the poles. The highest salinity is observed between 20° and 40° north latitudes because this zone is characterized by high temperature, high evaporation but less rain than the equatorial region.

- The marginal areas of the oceans bordering the continents have lower salinity than their interior due to addition of fresh water to the marginal areas through the rivers (Figure 5.15).

- Very high salinity is recorded in Lake Von, Turkey (330%) Dead Sea (238%) and Great Salt Lake, Utah, USA (220%).

Raking refers to the use of a rake, a traditional wooden tool with the long handle and long pointed wooden toothed spade at the bottom for collecting salt.

Isohaline is an imaginary line drawn to join places having equal salinity.

Salinity of Dead Sea is 8.6 times saltier than other oceans. The shore of Dead Sea is 423m below sea level. It has the lowest elevation on land. The sea is 377m deep. The high salt content will make people float on the sea. The high salt content has made the Dead Sea devoid of life in it

Ocean movements

- Water in the ocean is never in a state of rest. Ocean water is always in motion. It moves horizontally as well as vertically. The movement of ocean water takes place in three different ways as waves, tides and ocean currents.

Waves

- The waves are oscillating movements in the ocean water which transfer energy from place to place. They are caused by friction of wind on the surface of water or any other disturbances' on the sea bottom.

Parts of Waves

1. **Crest:** The upper or highest part of a wave is called the crest
.
2. **Trough:** The lowest part of a wave is called the trough.

3. **Wave height**: The vertical distance between the crest and the trough is known as wave height.

4. **Wave length**: The horizontal distance between two crests or two troughs is known as wave length.

5. **Wave amplitude**: Wave amplitude is one-half of the wave height.

6. **Fetch:** The distance of open water across which the wind can blow without interruption is called fetch.

7. **Frequency:** The number of wavelengths that pass a fixed point per unit of time is frequency. Example, 100 waves per sec per cm.

8. **Period:** The time taken by one wavelength to pass a fixed point is known as period.

9. **Velocity**: Refers to speed and direction.

10. **Steepness:** Steepness of the wave is equal to the height divided by length.(H/L)

Tides

- The rhythmic rise and fall of the sea water due to gravitational pull of the moon and the sun is called a Tide. Isaac Newton (1642– 1727) was the first person to explain tides scientifically. The rise of seawater towards the land is known as High tide or flow tide. The fall of seawater more towards sea is known as 'Low tide water' or ebb tide. On any day there will be two high tides and two low tides. The highest high tide occurs on full moon day and new moon day. It is known as spring tide (Figure 5.17). Spring tide happens when the sun, earth and moon aligned in straight line. The lowest low tide is

known as neap tide. It happens when the sun, earth and moon are positioned at right angles.

- The movement of ocean water as a result of tidal action is known as a tidal current. In places of narrow coastal inlet these tidal currents flow rapidly through the mouth with greater height and velocity. For example in the Bay of Fundy, between Nova Scotia and New Brunswick of Canada, the difference between high and low tides is as high as 14m. Ports which utilize the tidal current for entry and exit of ships from

the harbour are known as tidal ports. In India Kolkatta and Kandla are examples of tidal harbours.

- The Gulf of Cambay and the Gulf of Kutch in Gujarat on the west coast have the maximum tidal range of 11m and 8m with average tidal range of 6.77m and 5.23m respectively. Tides help to clear the sediments deposited by rivers on their bed and thus prevent siltation of harbours. The energy of the tides is used to generate electricity. Tidal power stations have been set up in UK, Canada, France and Japan. In India Gulf of Khambhat, Gulf of Kutch and Sundarbans have scope for tidal energy production.

> A harbour is a sheltered water body where ships are anchored. A port is the area at the edge of a water body where boats and ships are docked, where transfer of goods and passengers take place and where trading is facilitated.

Ocean currents

- Large mass of moving water from one part of the ocean to another in a definite direction is called as ocean current. The movement is produced due to earth's rotation, temperature difference of ocean water, salinity, density and some extentdue to air pressure and winds. Ocean currents can be classified on the basis of mode of origin, volume and velocity and boundaries.

- In the order of velocity ocean currents can be classified as drifts, currents and streams. Drifts are movement of surface water of low velocity influenced by prevailing winds, currents are movement of oceanic water in definite direction and greater velocity and streams are larger mass of water moving in a definite direction and much greater velocity than the drifts and currents. Ocean currents are distinguished by the temperature they possess. When ocean currents originate f rom equator it is ter med as warm current. Likewise when a current starts from polar region it is termed as cold current.

- Vertical circulation of ocean water takes place due to difference in salinity and temperature between the surface and the water deep below. Upwelling is an oceanographic phenomenon that involves movement of dense, cooler, and usually nutrient-rich water towards the ocean surface, replacing the warmer, usually nutrient-depleted surface water. Down welling is the process of accumulation and sinking of cold high saline water beneath warmer or fresher water.

Major ocean currents of the world

- In every ocean, there is circulation of ocean water from Equator to pole and from pole to equator. The warm currents from the equator flows over the surface of ocean towards the pole and sink to the bottom of the ocean floor in the higher latitudes due to high density and flow towards the equator to complete the circulation. This large scale circulation is known as gyre.

- The gyre circulates is clockwise in the northern hemisphere and anti-clockwise in the southern hemisphere.

a. Ocean currents of the Pacific Ocean

1. North Equatorial current.

North equatorial current originates from Revilla Gigedo island west of Mexico and flows towards the Philippines Island covering a distance of about 12,000 km from east west. It is a warm current. It derives from its water from the Californian current and the South east Monsoon drift which flows north along the Mexican coast. The volume of water increases from east to west as many small currents join it from right. It gets divided into two and the northern branch joins the Kuroshio Current and the southern branch abruptly turns and forms the Pacific counter current.

2. South equatorial current.

South equatorial current is originated due the action of the trade winds from east to west. It is a warm current. It extends for about 13,600km from east to west. It is stronger than the North equatorial current. It is further divided into many branches due to the presence of many islands and uneven surface topography.

3. Kuroshio current (Black Tide)

It is a warm ocean current flowing in north easterly direction up to 30o N latitude and it carries warm water off the Formosa coast. It flows towards north and meets Oyashiocold current off the Kuril Islands. It is also called as Japan current.

4. Oyashio Current(Parental Tide)

It originates from the Bering Strait and flows towards south carrying cold water. It is a cold current. It meets with Kuroshio warm current and Aleutian current.

5. Californian Current.

Californian current is flowing towards south along the west coast of U.S.A between 48o N and 23o N latitudes. It is cold current which exhibits great amount of up welled water. When it enters the region of Trade winds, it is deflected to the right and joins the equatorial current.

6. Peru Current.

Peru Current is perhaps the best studied ocean current of the Pacific Ocean. Alexander Von Humboldt in 1802 noted the details of the Peru Current. Hence, it is also known as Humboldt Current. It is a cold current. It is flowing towards north along the west coast of South America carrying cold water from northerly deflection of the Sub-Antarctica water moving in 40° S.

7. El Nino or Counter current.

It is a warm counter ocean current of the pacific equatorial waters flowing south ward at 400 m depth to a distance about 180 km.

8. West Wind Drift.

It is an easterly moving drift in the Pacific Ocean extending from Tasmania to the South American coast. It is a cold current. The speed of the drift is greater underthe influence of Roaring Forties. It splits into two branches and one moves south around the Cape Horn into the Atlantic Ocean and the Other one moves northward along the Peruvian coast due to deflection and joins the Peru Current.

b. Currents of the Atlantic Ocean

1. North equatorial current.

North equatorial current is flowing from east to west. It is a warm current. It is situated between 5o – 20o N latitudes. After leaving the west coast of Africa, it attains its main characteristics. When it reaches the east coast of South America, it splits into two branches and one branch called Antilles current is moving along the coast of West Indies and other branch is diverted into the Caribbean sea.

2. South Equatorial current.

It is flowing south of equator within 0o – 12o S latitude in between the coast of Africa and South America. It is a warm current. It is a northern continuation of Benguela current. It is stronger than the North equatorial ocean current. It is caused by the action of Trade winds.

3. Gulf Stream.

Gulf Stream starts from the Gulf of Mexico and carries warm waters into the colder latitudes. It is a warm current. It bends with the coastline up to 40th parallel after which the direction is almost to the east, due to the force and the direction of the westerlies and the deflective forceof the earth. It joins the labrador cold current near New Found land, Canada after passing through the strait of Florida. The Gulf Stream was discovered by Ponce de Leon in 1513.

4. Canaries Current.

The ocean current flowing along the Western coast of North Africa between Maderia and Cape verde is known as the Canaries Current. It is a cold current. It is flowing towards south and merging with the North equatorial current.

5. Labrador Current.

In the north Atlantic, a cold current flows from the Baffin Bay and Davis Strait towards south. It brings cold waters from polar zone and moves along the coast of green land.

6. Benguela current.

It is a cold current flowing northward along the western coast of Africa is known as the Benguela current. It carries cold waters from sub-Antarctica surface water and mixes with south equatorial current.

The Sargasso Sea - Sea with landless border

The Sargasso Sea occupies about two thirds of the North Atlantic Ocean, stretching seven hundred miles wide and two thousand miles long. The only "sea" with absolutely no land around it, the Sargasso Sea got its name from common brown seaweed called Sargassum that floats in vast mats in its waters. The Sargasso Sea is surrounded only by ocean currents. It lies within the Northern Atlantic Subtropical Gyre. The Gulf Stream establishes the Sargasso Sea's western boundary, while the Sea is further defined to the north by the North Atlantic Current, to the east by the Canary Current, and to the south by the North Atlantic Equatorial Current. Since this area is defined by boundary currents, its borders are dynamic

c. Currents of the Indian Ocean

- The south Indian gyre is formed by south equatorial current, Madagascar current west wind drift and west Australian current. To the north of equator the currents in the

Arabian Sea and Bay of Bengal flow in the clockwisedirection as southwest monsoon drift and in the anti-clockwise direction as northeast monsoon drift due to the influence of monsoon winds.

- The Antarctic circumpolar current flows between 40 to 60° S latitude. It flows from west to east influenced by the westerly and circles around entire Antarctica. There is a counter west ward current within this circum polar current.

d. Currents of the Southern ocean

- The southern ocean surrounds the continent of Antarctica. The large oceans, the pacific, the Atlantic and the Indian Ocean merge into this circum-global zone of water to their south. The movement of water in the southern ocean is in one sense a relatively simple, generally west-east circum-polar drift caused under the influence of northwesterly winds. This general flow sends offshoots to the three major oceans to its north. The Peru or Humboldt Current in the Pacific Ocean, the Falkland Current and the Benguela Current in the Atlantic Ocean and the West Australian Current in the

- Indian Ocean receive a part of their cold waters from the Southern Ocean. Besides the surface currents, there is also a very complex system of subsurface currents between the southern Ocean and the oceans to its north.

- Generally the water moves from this ocean towards the equator on the surface and at great depths but at in remediate depth, thereis a movement of water from the equatorial areas towards the Southern Ocean.

The significance of Ocean Currents

1. Ocean currents play an important role in the earth's climate. They distribute energy and nutrients within the ocean.
2. Fog is formed where warm current and cold current meet. For example, when the Gulf Stream and Labrador Current meet near New Found land one of the densest fogs is formed.
3. The warm ocean current increases the temperature of an area where it flows to and Cold Ocean current decreases the temperature of the area.
4. The warm current brings heavy rainfall when the wind blows over it becomes warm while the cold current brings drought when the wind blows over it becomes cold and dry. For example, the wind blowing over the Peru Current is cold and dry causing the formation of the Atacama Desert located on the west coast of Peru.
5. It regulates the global temperature. It gives free navigation. The Gulf Stream keeps ports & harbours of Russia and Scandinavia navigable throughout the year. The Kuroshio Current makes ports on Japan navigable during winter.
6. It distributes minerals and pollution added to it becomes highly diluted and later negligible.
7. It helps in growth of juveniles of certain fish and its distribution to other countries - from its place of origin. Some up welling and down welling are due to currents

which bring minerals to photic zone used by phytoplankton. Major fishing grounds are located in the zones where cold current and warm current meet.

Normal Situation	El Nino Situation
• Near equator the water of the Pacific Ocean is warmer in the western side and cooler in the eastern side due to upwelling of the cold current. • Air (Walker) circulation is dominant in the western Pacific Ocean. The air ascends in the western side and descends over the cooler eastern side • Heavy rain is experienced in the western warmer region and dry conditions prevail in the cooler region. • The Southeast Asia and Australia receive heavy rain on normal years. • West coast of South America experiences dry weather.	• Near equator the warm water in the Pacific Ocean extends from western side to eastern side suppressing the • upwelling of the cold water. • Air (Walker) circulation is dominant in the eastern part of Pacific Ocean. The air ascends in the warm eastern Pacific Ocean. • Heavy rain is experienced in the eastern warmer region and dry condition prevails in the western part. • Southeast Asia and Australia experience dry weather conditions. • West coast of South America receives heavy rainfall.

El Nino

- El Nino is a phenomenon that occurs in the equatorial Pacific Ocean characterized by a positive sea surface temperature departure from normal (1971-2000 base period) in the region lying within the latitude 5°N to 5°S and longitudes 120° W to 170°W . This phenomenon occurs every two to seven years (Figure 5.19).

El Nino happens when

- Sea surface temperature increases between the central and eastern equatorial Pacific Ocean between the country Ecuador and the International Date Line
- The increase in temperature is sustained for a period of eighteen months to Two years.
- The temperature increase is up to 30 m beneath the ocean surface.
- When there is a modified vertical air circulation above the Pacific Ocean

Global influence of El Nino

- El Nino effect is experienced at Global level. The change in air circulation affects the economy of different countries also. Global weather patterns are altered to such an

extent that they affect eco system, agriculture, tropical cyclone, drought, forest fire, floods and flood related health hazards. El Nino influences the jet streams. Due to this phenomenon California experiences heavy rainfall, northern Europe experiences dry winter, Southern Europe experiences mild wet winters, there are less number of cyclones in Sea of Japan, and heavy rain in East Africa. South East Asia experiences severe drought and forest fire. Peru in South America receives heavy rainfall during El Nino.

- Increase of temperature in the east Pacific Ocean is correlated with normal monsoon conditions in India while the increase of temperature in the central Pacific has high correlation with drought conditions in India. When temperature increases further to the west it suppresses the Indian Monsoon.

La Nina

- La Nina is just the opposite to the condition of El Nino. When trade winds are strong, colder water up wells on the East Pacific Ocean, walker air circulation is confined to the west Pacific, wet condition in Southeast Asia and dry weather in South America is observed.

- The difference in the atmospheric pressure between the west and east tropical Southern Pacific Ocean is referred to as Southern Oscillation. Meteorologists have established a close inter link between Southern Oscillation and occurrences of El Nino and La Nina events. The acronym 'ENSO'(El Nino Southern Oscillation) is often used to study both the phenomena.

> Peruvian fishermen named the weather phenomenon El Nino meaning 'little boy' or 'New born Christ' and La Nina meaning 'Little girl' as the phenomenon was first noticed during Christmas time.

Thermohaline circulation

- As the name indicates there is a large scale churning of ocean water due to difference in temperature and salinity. The down welling of ocean water occurs in the extreme ends of Atlantic Ocean one near the Norwegian coast and another at Weddell Sea. Upwelling of cold water occurs in the North Pacific Ocean and in the Indian Ocean. This cycle of water movement within the Global Ocean is also known as Conveyor Belt (Figure 5.20). The slow, steady and three dimensional flow of water in the conveyor belt distributes dissolved gases and solids, mixes nutrients and carries it to various ocean basins. This cycle provides a stabilizing effect on climate of the earth. If it is disturbed, it is capable of causing sudden climatic change within the period of a few decades. The conveyor belt is a simplified version of actual circulation in the oceans.

Glossary

1. **Abyssal plains:** An extremely large, flat, under water plain on the deep ocean floor.

2. **Continental rise:** is area between the continental slope and the sea floor.
3. **Exclusive Economic Zone (EEZ):** extends from the base line to a maximum of 200 nautical miles (370.4 km).
4. **Isthmus:** A narrow steep of land that connects two large land masses and separates two bodies of water.
5. **Hot spot:** An area is the mantle from where rocks melt and magma rises through circular to form volcano.
6. **Permafrost:** is the condition prevailing when water freezes above and below the ground, (including rock or soil) for more than two consecutive years
7. **Trace elements**: A chemical element present in minute amount in a particular sample or environment.
8. **Isohaline:** is an imaginary line drawn to join places having equal salinity
9. **Swell:** is a type of wind-generated waves that is not affected by the local wind.
10. **Thermohaline circulation**: is large circulation of ocean water due to difference in temperature and salinity.

Unit 6 - Atmosphere

Introduction

You must have heard people, in the countryside, saying

"When sheep collect and huddle,
Tomorrow will puddle!"
"If ants march in a straight line,
expect rain"

- Phrases like 'a cold morning', 'sunny day', 'cloudy day' and rainy day refer to the weather. Weather refers to the state of atmosphere at a particular place at any given time denoting the short term variations of atmosphere in terms of temperature, pressure, wind,moisture, cloudiness, precipitation and other elements. Weather is highly variable from time to time, day to day and place to place. Weather is not constant. It is always changing within hours or a day.

- On the other hand, climate is the average weather conditions of an area for a long period of time. The World Meteorological Organisation (WMO) has suggested data for a period of 30 consecutive years to be referred for calculating the climatic averages of various weather elements. Climate is constant. It is a permanent condition of a place.

- The ancient Greeks called the tilt of latitude as 'klima', literally meaning 'slope' or 'inclination'. Then the earth was divided into seven latitudinal regions, called 'klimata'. The word came into modern European languages as clime or 'climate', denoting the average weather condition.

Composition of the Atmosphere

- The atmosphere is essential for the survival of all the organisms on the earth. The atmosphere is a blanket of gases and suspended particles that entirely envelope the earth. It extends outward over thousands of kilometres from the earth's surface. Water vapour, aerosols and tiny solid particles occur in varying quantities as suspended material. Tese are responsible for weather phenomena as they have ability to absorb and release heat energy. The atmosphere is composed of mixture of many gases, water vapour and other solid particles. The major components are nitrogen (78%), oxygen (21%) and other gases (1%). Argon, Carbon dioxide, Neon and the other gases found in the atmosphere (Figure 6.1).

Layers of the Atmosphere

- The atmosphere is divided into five distinct layers (Figure.6.2) based on the temperature variations. They are,

1. Troposphere
2. Stratosphere
3. Mesosphere
4. Ionosphere(Thermosphere) and
5. Exosphere

Troposphere

- The troposphere(Figure 6.2) is the lower most layer of the atmosphere. It extendsapproximately to a height of 8 km from the poles and 18 km from the equator. The height of the troposphere changes seasonally also. It increases during summer and decreases during winter.

- All weather phenomena occur in this layer as it has dust particles and water vapour. This layer has clouds which produce precipitation on the earth. The Sun's rays directly fall on the earth and then they are reflected back into the atmosphere. The temperature decreases in the troposphere with increase in altitude at the rate of 1 °C for 165 metre or 6.5 °C for every 1000 metres of ascent. This is known as lapse rate of temperature. This is the densest layer as it contains 70 to 80 percent of gases. The outer boundary of the troposphere is called tropopause, which is about 1.5 kilometre thick.

Stratosphere

- It is the second layer of the atmosphere found above the troposphere. It approximately extends up to a height of 50 km from the earth's surface. Temperature is constant up to a height of 20 km and increases gradually up to the stratopause where temperature is nearly -4°C. The lower part of this layer is highly concentrated with ozone gas which is called as 'ozonosphere'. It prevents the ultra-violet rays from the Sun to enter into the lower part of the atmosphere as the rays are highly harmful it causes skin cancer and other ill effects to living organisms. But the ozone layer safeguards the life on the earth.

Mesosphere

- The mesosphere is the third layer of the atmosphere found approximately up to a height of 85 km above the surface of the earth. It is the coldest layer of the atmosphere. The temperature decreases with increase of altitude due to the absence of ozone. Its upper boundary is called mesopause where temperature reaches — 90°C. Luminous noctilucent clouds form here due to the presence of cosmic dust. Meteors falling from the space get burned in this layer. It is because when meteors hit the air, the air gets compressed and heated up causing meteors to burn out.

Ionosphere (Thermosphere)

- The ionosphere is the fourth layer of the atmosphere extending approximately up to a height of 400 km. The temperature increases rapidly up to 1,000°C. It is due to the absorption of very short wave and high energy solar radiation by the atoms of hydrogen

and oxygen gases. When light energy is transformed into heat energy some gas molecules lose or gain electrons and become the charged particles called ions. The charged particles forming the lower part of the thermosphere as a zone, is called Ionosphere (Figure 6.4). These ionised particles create auroras at higher latitudes. Ionosphere can reflect radio waves back to the earth. This facilitates long distance wireless satellite communication. The credit of discovering ionosphere goes to Kennelly and Heaviside.

Exosphere

- The upper most layer of the atmosphere which extends into the outer space from above 400 km up to 1600km. It has rarefied contents. It contains mainly oxygen and hydrogen atoms. These atoms can travel hundreds of kilometres without colliding with one another. Thus, the exosphere has no longer behaves like a gas. The temperature increases with increase of altitude and it ranges as high as 1650 °C. The gravitational pull is minimal in this layer. Tis layer gradually merges with the space.

Ozone and Ozone Depletion

- Ozone (O3) is form of oxygen that combines three atoms into each molecule. It absorbs and filters the harmful ultraviolet B radiation coming from the sun. This way the ozone layer protects all life on earth. However, ozone is harmful when it develops near the ground. It causes health problems like asthma and other respiratory illness.

Ozone Depletion: A steady decline in the concentration of ozone in the earth's stratosphere (the ozone layer) is called ozone depletion.

- **Ozone depletion** occurs when chlorofluoro carbon (CFC) and halon gases, formerly found in aerosol spray cans and refrigerants are released into theatmosphere and they cause chemical reactions that break down ozone molecules and reduce the concentration of them. Nitrogen oxide released by emitted by supersonic aircrafts can also destroy the ozone molecules to break down. Ozone-depleting substances are present throughout the stratospheric ozone layer because they are transported great distances by atmospheric air motions. The severe depletion of the Antarctic ozone layer known as the "ozone hole" occurs because of the special atmospheric and chemical conditions that exist there and nowhere else on the globe. The very low winter temperatures in the Antarctic stratosphere cause polar stratospheric clouds (PSCs) to form. Special reactions that occur on PSCs, combined with the relative isolation of polar stratospheric air, allow chlorine and bromine reactions

to produce the ozone hole in Antarctic springtime.

- Satellite images of the earth over last decades observed that the atmospheric ozone layer is getting thinner. On October 2, 2015, the ozone hole was recorded to its maximum size of 28.2 million sq.km over Antarctica (Figure 6.5). The size of the ozone hole is larger than the size of continent of North America. The ozone holes over Antarctica allow the ultraviolet radiation to enter and cause global warming, skin cancer, eye cataract and even blindness.

- Depletion of the ozone layer has consequences on human, animal, plants and micro-organisms. This typically results from higher UV levels reaching us on earth. Research confirms that high levels of UV rays cause non-melanoma skin cancer.
- To protect the ozone layer for our future generation, avoid using products which are emitting pollutants such as aerosol sprays, blowing agents for foams and packing materials, as solvents and as refrigerants.

The Dobson Unit (DU) is the unit of measurement for total ozone

Temperature and Heat Budget

- Air temperature of a particular place denotes the degree of hotness or coldness of air at a given place. It is measured in Celsius. Let us understand how the earth is heated. The surface of the earth is heated by the sun's rays in the form of short wave radiation. The heat received by the earth is called 'Solar Radiation' or 'Insolation'. Heating of atmosphere is an indirect process. The processes are:

a. Terrestrial radiation

- The solar radiation reflected by the earth's surface is called 'Terrestrial radiation'.Terrestrial radiation supplies more heat energy to the atmosphere due to its long wave length.

b. Conduction

- The heat energy from the earth's surface is transferred to the lower atmosphere which is directly in contact with the surface by the process of conduction.

c. Convection and advection

- The movement of air molecules in vertical and horizontal direction is called as 'convection and advection' respectively. Tis movement carries heat energy to the various parts of the earth and at different altitudes.

Heat budget

- The heat energy reflected, absorbed and radiated back into the space equals the energy received by the earth. Incoming radiation and the outgoing radiation pass through the atmosphere. The earth maintains its optimum temperature.

- When 100% solar radiation reaches the earth's atmosphere, 35% is reflected back to space by clouds, water bodies and ice covered areas. This heat does not heat either the earth or atmosphere.

- Of the remaining 65% of heat, 14% are absorbed by the atmosphere and 51% are absorbed by the earth's surface (34% of direct solar radiation and 17% from scattered radiation). 51% received by the earth are radiated back to the space directly as terrestrial radiation.

- In total, 17% are radiated to space directly and 48% are absorbed by the atmosphere (14% from insolation and 34% from terrestrial radiation) are radiated back to space gradually. Therefore, 65% heat received from the sun is balancedby the 65% radiated by the earth. This balance between the incoming and the outgoing heat energy is called the global heat energy balance.

Distribution of Temperature

Distribution of temperature varies both horizontally and vertically. Let us study it under

a. HorizontalDistribution of Temperature
b. Vertical Distribution of Temperature

a. Horizontal Distribution of Temperature

- Distribution of temperature across the latitudes over the surface of the earth is called horizontal distribution of temperature. On maps, the horizontal distribution of temperature is commonly shown by isotherms. Isotherms are line connecting points that have an equal temperature at mean sea level.

> The average time taken by the solar radiation to reach the earth's surface is 8 minutes 20 seconds.

Factors Affecting the Horizontal Distribution of Temperature

- The horizontal distribution of temperature on the earth's surface varies from place to place. Following are the factors affecting the horizontal distribution of temperature of the earth:

a. **Latitude:** The angle formed by the solar radiation to the ground is called 'angle of incidence'. The solar radiation passes vertically along the equator. The angle of incidence decreases from equator towards the poles. The area heated by the solar radiation increases towards the poles and therefore, temperature decreases from the equator to the poles.

b. **Distribution of land and water**: Land is heated and cooled at a faster rate due the conduction process whereas water is heated and cooled at slower rate due to convection process. Water takes 2.5 times of heat energy to heat a unit area compared to land. Thus, the land will have higher temperature than the water in summer and vice versa during the winter. So more land mass in northern

hemisphere (15.28C) leads to higher average temperature than the southern hemisphere (13.38C).

c. **Ocean currents**: Warm ocean currents carry warm water from the tropical region towards the poles and increase the temperature while cold ocean currents carry cold water from Polar Regions and reduce the temperature along the coasts.

d. **Prevailing winds**: Warm winds like trade wind and westerly, that carry higher heat energy, increase the temperature while cold polar easterlies carry lower heat energy from polar region reduces the temperature.

e. **Cloudiness:** The cloudy sky obstructs the solar radiation from the sun to earth and reduces the temperature. But the clear sky during the day allows more solar radiation to reach the earth's surface and increases the temperature. Meanwhile clear sky at night allows more terrestrial radiation to escape. For example, the tropical hot deserts experience higher temperature at day and lower temperature at night.

f. **Nature of the surface**: The reflection from surface varies based on the natureof land cover. The more reflection from the snow surface leads to low temperature accumulation. But the dense forest, which reflects less heat energy and absorbs more heat energy, leads to higher temperature.

g. **Mountain barriers:** If a wind or air mass blows towards the mountain, it influences the distribution of temperature on either side of the mountain.For example, polar easterlies and blizzards are obstructed by Himalayas in Asia and Alps in Europe respectively. This leads to lower temperature in the northern slopes and higher temperature in the southern slopes of the respective mountains.

Factors Affecting the Vertical Distribution of Temperature

- We all know that the temperature decreases with increasing altitude from the surface of the earth. The vertical decrease in temperature of troposphere is called as 'Normal Lapse Rate' or 'vertical temperature (Figure 6.7) gradient' at which the temperature reduces at the rate of 6.5 8C per 1000 meter of ascent. This is influenced by the following factor

a. Amount of terrestrial radiation reaching the altitude and
b. Density of air to absorb the heat energy at higher altitude.

As both the above said factors decrease with altitude, the temperature also decreases (Figure 6.5).

Inversion of Temperature

- The condition at which the temperature increases with altitude is called as 'inversion of temperature'. In this condition, warm air lies over cold air.The conditions for inversion of temperature are:

a. **Long winter nights:**The bottom layer of the atmosphere in contact with the ground is cooled and the upper layer remains relatively warm.

b. **Cloudless sky:** The higher amount of terrestrial radiation reaches the higher altitude which leads to lower temperature at low level due to clear sky.

c. **Dry airnear the surface:** the dry air absorbs less terrestrial radiation and allows them to escape into space.

d. **Snow covered ground:** During night, due to terrestrial radiation and higher albedo, most of the heat is lost to the atmosphere and the surface is cooled.

e. **Formation of fronts:** the movement of warm air over the cold air during the formation of the various fronts leads to inversion condition.

f. **Mountain wind:** The subsidence of cold mountain wind at the early morning leads to the displacement of warm air from the valley to higher altitude. This type of inversion is called as 'valley inversion'.

> Albedo is the amount of solar radiation reflected from the surface. The variation is based on the nature of the earth's surface. Snow has higher albedo compared to forest.

Measurements of Temperature

Unit of Temperature	Scientist	Year
Fahrenheit	Gabriel Fahrenheit	1714
Celsius	Andrew Celsius	1742
Kelvin	Lord Kelvin	1848

Conversion of Units	
Celsius to Fahrenheit Ex. 20°C, F = (C × 1.8) + 32 F = (20×1.8) + 32, F = 36 + 32, F = 68	**Celsius to Kelvin Ex.20°C,** K = C + 273.15 k K = 20° + 273.15k, K = 293.150k

Heat Zones of the World

- The earth has been divided into three heat zones according the amount of insolation received. These are the Torrid Zone, the Temperate zone and the Frigid Zone.

Torrid Zone (23 ½ °N to 23 ½ °S)

- The zone lying between the Tropic of cancer and Tropic of Capricorn is called'Torrid zone' (Figure 6.8). The sun's rays are vertical throughout the year and it receives maximum insolation. Thus, this is the hottest zone.

Temperate Zone (23 ½ °N to 66 ½ °N and 23 ½ °S to 66 ½ °S)

- The temperate zone lies between the Tropic of Cancer and Arctic Circle in the northern hemisphere and the Tropic of Capricorn and Antarctic circle in the southern hemisphere. This region never experiences over-head sun light but experiences longer days and shorter nights during summer and vice versa during winter. This region experiences moderate temperature and is therefore called as Temperate zone'.

Polar Zone (Frigid Zone - 66 ½ °N to 90°N and 66 ½ S to 90°S)

- The region between North pole and Arctic Circle in the northern hemisphere and South pole and Antarctic Circle in the southern hemisphere is called 'Polar Zone'. This region always receives more oblique rays of the sun and so the temperature is very low. It is the coldest zone. This region experiences 24 hours of day and night during peak summer and winter respectively.

- **Annual Temperature:**The average annual temperature of a region for a year.
- **Mean Annual Temperature:** The average of 30 years of annual temperature of the region.
- **Range of Temperature**: Difference between highest and lowest temperature of a place.
- **Annual Range of Temperature:** The difference between highest and lowest

temperature of a place in a year.
- **Diurnal range of Temperature**: The difference between highest temperature and lowest temperature of a place in a day.

From the above discussion, it is clear that the energy for the earth is from the sun.

Green House Effect: As seen in the heat budget, the longer wavelengths are absorbed by greenhouse gases in the atmosphere, increases the temperature of atmosphere. These greenhouse gases act like a green-house and retains some of the heat energy would otherwise be lost to space. The retaining of heat energy by the atmosphere is called the 'greenhouse effect'.

Global Warming

- Global warming is observed in a centuryscale. The temperature increase over the years has been due tothe greenhouse gas concentration such as carbon dioxide (CO2), water vapour, methane and ozone. Greenhouse gases are those gases that contribute to the greenhouse effect. The largest contributing source of greenhouse gas is the burning of fossil fuels leading to the emission of carbon dioxide from industries, automobiles and domestic.

Urban Heat Island (UHI)

- An urban heat island is an urban area or metropolitan area that is significantly warmer than its surrounding rural area due to high concentration of high rise concrete buildings, metal roads, sparse vegetation cover and less exposure of soil. These factors cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures (Figure. 6.9).

Ways to reduce the impact of urban heat island:

1. Increase shade around your home: Planting trees and other vegetation, provides shade and cooling effect through evapotranspiration and it lowers the surface and air temperature.
2. Install green and cool roofs.
3. Use energy-efficient appliances and equipments.
4. Shift all industries away from the urban area.
5. Reduce emission from automobiles.

Atmospheric Pressure and Winds

- Atmospheric pressure is defined as the force per unit area exerted against a surface by the weight of the air molecules above the earth surface. In the Figure below (Figure 6.10), the pressure at point 'X' increases as the weight of the air increases. The atmospheric pressure is not distributed uniformly over the earth. Theamount of pressure

increases or decreases, according to the amount of molecules that exerts the force on the surface.

- When temperature of the air increases, the air expands and reduces the number of molecules over the unit area. It leads to reduction in pressure. Similarly, when the temperature falls, the air contracts and the pressure increase. Therefore, the temperature and atmospheric pressure are inversely related.

Atmospheric pressure is measured by an instrument called 'Barometer'

Vertical Distribution of Atmospheric Pressure

- The relationship analysis between altitude and atmospheric pressure is very peculiar. The upper atmosphere is thin and less dense. The pressure at sea level is highest and keeps decreasing rapidly with increasing altitude because of the progressive reduction of the massIsobar is an imaginary line connecting the places of uniform atmospheric pressure reduced to mean sea level above the point where it is measured (Figure 6.12). Relationship between Standard Pressure and Altitude

Altitude in m	Atmospheric pressure in m b
Sea level	1013.25
1,000	898.76
2,000	795.01
3,000	701.01
4,000	616.60
5,000	540.48
10,000	264.0

Horizontal Distribution of the Atmospheric Pressure

- When the air gets heated it expands, becomes light and rises vertically. As air rises, the pressure it exerts on the earth surface is reduced, causing a low pressure area (Figure 6.13).

- On the other hand, cool air is dense and heavy. As a consequence it sinksvertically. It results in additional weight and pressure which cause a high pressure area to occur on the ground.

The rotation of the earth affects the moving objects on the earth surface. Free moving objects, affected by the rotation of the earth, do not follow a straight line. In the northern hemisphere they drift towards right and towards left in the southern hemisphere. A car travelling down a straight road at 95 km/hr in northern hemisphere would drift to the right of the path if the friction between surface and tyre is absent. The tendency is called as Coriolis Effect as it was discovered by G.G. Coriolis. This is the reason why racket launching stations are located on the east coastal areas. Example: Sriharihota, French Guyana.

Pressure Belts of the Earth

- The atmospheric pressure belts envelope on the surface of the earth. They are equatorial low pressure belt, sub-tropical high pressure belts, sub polar low pressure belts and polar high pressure belts

Wind Systems

- Wind is the horizontal movement of air molecules from areas of high pressure to areas of low pressure to maintain the atmospheric equilibrium. The wind always moves perpendicular to isobars. If the earth did not rotate, the winds would blow in a straight path. Then the rotation of the earth results in corilois effect and it deflects the direction of the wind. Wind direction is identified by an instrument called Wind Vane and wind speed is measured by Anemometer.

Types of Winds

Winds are classified based on the nature and area of influence as follows;

General Atmospheric Circulation, Pressure Belts and Primary Wind System

- Fromtheequator to the poles,each hemisphere has four pressure belts andtotally there are seven belts on the globe. The pressure belts lead to formation of primary wind system as follows (Figure 6.14):

a. The equatorial low pressure belt (between 58°N and 58°S):

- Thisis the region of calm, weak and changeable winds. Due to the high temperature over this region, the air gets heated expands and become lighter and rises upward and creates low pressure over the region. This region is a belt of calm and referred to as the 'Doldrums'. The winds blow from the sub-tropical high pressure belt towards the equatorial low pressure belt. Due to Coriolis Effect these winds are deflected to the right in the northern hemisphere and to the left in the southern hemisphere. As winds are named after the direction from which they originate they are called as the North East

and South east trade winds. As the winds favoured trading ships they are called as 'Trade winds'.

b. The sub-tropical high pressure belt (25° to 35° N and S):

- Air begins to cool when it reaches higher altitude over equatorial region and flows towards the poles. This wind collides with the wind coming from the polar region at higher altitude and subsides down over sub-tropical latitudes. This leads to formation of high pressure belt along the sub-tropical region. It is said that to avoid the slowing down of ship due to high pressure the horses were thrown into the sea. So this belt is called as 'Horse latitude'. The sinking air bifurcated in to two branches towards the equator and poles, they are called as trade winds and westerly respectively. Westerlies flow towards the pole from sub tropics and turn towards right andleftin northern hemisphere and southern hemisphere respectively.

c. The sub polar low pressure belt (50° to 60° N and S):

- The warm westerly wind from sub-tropical region moves towards the pole and collide with the cold polar easterly wind from polar high pressure region and raises up to form sub polar low pressure belt.

d. Polar high pressure belt (80° N and S to pole):

- The constant low temperature at the poles due to inclined solar radiation and reduced insolation leads to the formation of polar high pressure belt on both poles.

Ocean is dominant in the southern hemisphere between the latitudes 40ºand60ºS. Hence the westerlies are so powerful and persistent that the sailors used such expressions as "Roaring Forties", "Furious Fifties" and "Screeching Sixties" for these high velocity winds in the latitudes of 40º, 50º and 60º respectively.

- The high pressure on the surface always coincide with the low pressure at higher altitude while the low pressure on the surface always coincide with higher pressure on the higher altitude. High pressure always has divergence of air masses from the centre but low pressure has convergence of air.

Basis of Formation of Pressure Belts

There are two important bases on which the pressure belts are formed. They are;

a. **Temperature:** The equatorial low pressure and polar high pressure belts are formed due to high and low temperature respectively. So they are called as 'Thermally formed pressure belts!

b. **Dynamism:** The sub-tropical high and sub polar low pressure belts are formed due to movement and collision of wind system. So they are called as 'Dynamically formed pressure belt system'.

Meridional Cell System

- The cell along with trade winds, equatorial low and sub-tropical high pressure belts is called as 'Hadley cell", meanwhile the cell formed by westerly wind along with sub-tropical high and sub polar low pressure belt is called Terrell's cell'. The cell at polar formed by polar easterlies with polar high and sub polar low pressure belt is called as 'Polar cell'(Figure 6.15).

ITCZ - Inter Tropical Convergent Zone

- The region where both trade wind systems meet is known as 'Inter Tropical Convergent Zone'

Shifting of Pressure Belts and Primary Wind System

- These pressure belts and primary wind systems are dynamic in character asthey shift 58 north and 58 south from their position along with the apparent movement of the sun.

Secondary Wind System

- Both monsoon and cyclonesareconsidered as secondary or regional wind systems.

Monsoons

- The word 'Monsoon' is derived from the Arabic word, 'Mausin, which means 'Season'. Monsoons are seasonal winds which reverse their direction due to unequal heating and cooling of the land and the water.

Mechanism of Monsoon

- The land absorbs more heat energy during summer, which leads to the formation of low pressure over continent. But the ocean will have relatively lower temperature than the continent leading to the formation of high pressure system over ocean. So, the wind blows from sea to land during summer season. Meanwhile the land reradiatesmore heat energy to space during winter leading to the formation of high pressure above the continent. But the ocean will have relatively higher temperature than the continent leading to formation of low pressure system over ocean. So, wind blows from land to sea during the winter season. T is mechanism has an important effect on rainfall received over the region.

Nature of Monsoon System

- There are three distinct characteristics related to monsoon wind system which differentiates it from other wind systems. They are;
  1. Minimum 1608 reversal of wind direction between seasons.
  2. They affect a large part of the continents and oceans.
  3. The formation of low and high pressure systems over land and water and their interchange between the seasons.

- Monsoon system is classified into two groups based on the location. They are;
  a. Asian Monsoon
  b. South Asian Monsoon

a. Asian Monsoon

- The Asian monsoon system is divided into two components based on season it flows. The presence of high temperature with low pressure in the lake Baikal region and low temperature with high pressure in the Aleutian islands region leading to flow of wind from Pacific Ocean to interior part of Asia during summer is called 'Summer

- Monsoon of Asia'. This leads to rainfall in the east coast of Asia.Meanwhile, in winter the low temperature and high pressure in the Lake Baikal region and high temperature and low pressure in the Aleutian Island region leading to flow of wind from Central Asia to Pacific Ocean is known as 'Winter Monsoon of Asia'. As the wind system flows off shore, the rainfall does not occur in the continent of Asia except western coast of Japan.

b. South Asian Monsoon

- South Asian Monsoon includes the countries in the southern part of Himalayas, that is India, Pakistan, Bangladesh, Sri lanka, Maldives, Nepal and Bhutan. This monsoon system has been classified into two groups based on the direction of origin of wind namely south west monsoon and north east monsoon (Figure 6.16).

South West Monsoon

- During summer the Indian peninsula is heated more than the sea around it. Intense low pressure is formed in the region of Peshawar of Pakistan. At the same time, the Indian Ocean has higher pressure due to relatively low temperature. So the wind blows from Indian Ocean towards South Asia as Southeast Winds. The wind turns towards right due to Coriolis Effect and blows as south west winds which bring heavy rains around four months of the year. This is known as south west monsoon in Indian Sub-continent. This wind system bifurcates into two branches as Arabian Sea branch and Bay of Bengal branch.

Arabian Sea Branch

- The Arabian Sea branch strikes the Western Ghats at perpendicular direction and rises over it. The orographic effect by the Western Ghats results in heavy rainfall in the windward side and low rainfall in the leeward side. So the west coast of India receives high rainfall when compared to the eastern side of the Western Ghats. Kerala is the first state to receive rainfall from the south west monsoon in India, which occurs during first week of June. Ten, the wind gradually moves towards the north of the western coast and leads to gradual development of the monsoon in parts of Karnataka, Goa, Maharashtra, Gujarat and Rajasthan. The wind further advances towards foot hill of the Himalayas and creates orographic rainfall in the Himalayan states, Punjab and Haryana. The other part of the Arabian Sea branch moves towards the east and results in onset of monsoon in Uttar Pradesh and Bihar. Here, it unites with the Bay of Bengal branch and leads to heavy rainfall and food.

Bay of Bengal Branch

- Bay of Bengal branch flows from south west which results in orographic rainfall in Sri Lanka and reaches Andaman and Nicobar Islands and results in orographic rainfall. Indira point in the Great Nicobar is the first place which receives rainfall during south west monsoon in India during middle of May. The wind flows parallel to the east coast of India and Eastern Ghats. So Coromandel Coast of India doesn't get enough rainfall during south west monsoon. The wind strikes Arakanyoma Mountain in Myanmar and results in heavy rainfall in western coast of Myanmar. The wind funnels towards north eastern part of India after defected by the Arakanyoma Mountain in Myanmar. This wind strikes Meghalaya plateau which leads to heavy rainfall in Bangladesh andNorth eastern part of India. Mawsynram, the wettest place (highest annual rainfall) in the world, is located in the windward side of Meghalaya plateau.

- The wind further advances towards the Himalayas where it creates heavy rainfall in the southern slopes. This leads to flood in River Brahmaputra. The wind gradually moves towards the west and results in onset of monsoon in Bhutan, Sikkim, West Bengal, Nepal and Bihar. It joins with Arabian Sea branch in Bihar and results in heavy rainfall and flood.

- The south west monsoon gradually withdraws from south Asian continent due to apparent movement of the Sun towards the southern hemisphere. This is called as 'Withdrawal of South West Monsoon'.

North East Monsoon

- During winter the Indian Subcontinent becomes colder than the Indian Ocean. As a result the wind blows from Northeast to South West direction. This is dry wind system and it does not produce rainfall in the coastal region of south Asia except the Coromandel Coast of India and Sri Lanka.

Mawsynram, world's wettest place!

''It was the kind of rain you wouldn't see anywhere else. We could barely see four feet ahead of us. We could touch the clouds, smell the clouds, and taste the clouds'' said a local resident. Yes, it is about Mawsynram which is located in Meghalaya's East Khasi Hills, with the cluster of about 1,000 homes. It holds the Guinness Record for "the wettest place on earth". The average annual rainfall is 11,861mm, according to the Guinness website.

However, the soil in the limestone plateau doesn't absorb water. "There is barely any forest cover, so a lot of erosion of top soil happens. All of it flows down into Bangladesh. The irony is that "the wettest place on earth" grapples with an acute water shortage after monsoon ends around October. Hence, people call world's rainiest place Mawsynram, which is also world's wettest desert.

- This is known as North East Monsoon or Retreating Monsoon in South Asia. Agriculture in India mostly depends on the rainfall brought by the monsoons.

- During the El Nino year the temperature of the ocean water increases. Tis weakens the high pressure over Indian Ocean thereby reduces the strength of south west monsoon over south Asia. However during winter, it induces the low pressure over the ocean resulting in severe depressions and cyclones.

Tertiary Winds

- The tertiary winds are formed due to pressure gradients which may develop on a local scale because of differences in the heating and cooling of the earth's surface.

Sea and Land Breezes

- During daytime, land heats up much faster than water. The air over the land warms and expands leading to form low pressure. At the same time, the air over the ocean becomes cool because of water's slower rate of heating and results in formation of high pressure. Air begins to blow from high pressure over ocean to the low pressure over the land. This is called as 'Sea breeze'. During night time, the wind blows from land to sea and it is called as 'Land breeze' (Figure 6.17).

Sea breeze and land breeze influence the movement of boats near the coastal region and fisher men use these winds for their daily fish catching. Fishermen go for fishing at early morning along the land breeze and return to the shore in the evening with the sea breeze.

Mountain and Valley Breezes

- A valley breeze develops during the day as the sun heats the land surface and air at the valley bottom and sides. As the air getsMountain and valley wind systems influence the weather pattern of the mountain top and valley bottom. Mountain top can be seen clearly at early morning and valley bottom at evening. But mountain top will be covered with clouds at evening due to rising of valley wind system and valley bottom would be covered by clouds at early morning due to arrival of mountain wind system. These clouds are sometimes called as 'fog' which is used for cultivation in the dry regions like Yemen.heated it becomes less dense and begins to blow gently up the valley sides. This is called as 'valley wind'. Tis process reverses at night leading to blow of wind from mountain top to valley bottom referred to as 'mountain wind' (Figure 6.18).

Local Winds

Local wind systems influence the weather pattern where ever they blow (Figure 6.19). Some important local winds are;

1. **Bora**: North easterly from eastern Europe to north eastern Italy
2. **Chinook:** Warm dry westerly off the Rocky Mountains
3. **Fohn:** Warm dry southerly off the northern side of the Alps and Switzerland.
4. **Harmattan:** Dry northerly wind across central Africa
5. **Karaburan:** 'Black storm' a spring and summer katabatic wind of central Asia
6. **Khamsin**: South easterly from North Africa to the eastern Mediterranean
7. **Loo:** Hot and dry wind which blows over plains of India and Pakistan.
8. **Mistral:**Cold northerly from central France and the Alps to Mediterranean.
9. **Nor'easter:** Strong winds from **the** northeast **in** the eastern United States, especially New England
10. **NorVester:** Wind that brings rain to the West Coast, and warm dry winds to the East Coast of New Zealand's South Island, caused by **the** moist prevailing winds being uplifted over the Southern Alps, often accompanied by a distinctive arched cloud pattern.
11. **Pampero:** Argentina, very strong wind which blows in the Pampa.
12. **Simoom:** Strong, dry, desert wind that blows in the Sahara, Israel, Jordan, Syria, and the desert of Arabia.
13. **Sirocco**: Southerly from North Africa to southern Europe.
14. **Zonda wind:** On the eastern slope of the Andes in Argentina.

Jet Streams

- Jet streams are high altitude westerly wind system blows at a height of 6 to 14 km, with very high speed up to 450 km/h in wavy form at both hemispheres. As they encircle the polesthey are called as 'Circum polar wind system' (Figure 6.20).

The wavy structure of the Jet stream **is** represented as 'Ross by waves'.

- Although the jet streams flow at higher altitude they also influences the surface weather pattern of the Earth.

Jet streams were discovered during the Second World War as the jet pilots felt the strong obstruction in the higher altitudes.

The Major impacts of Jet streams

1. **Creation of Polar vortex:**
   Polar westerly jet stream will carry cold polar air masses towards temperate region which creates severe cold waves in North America and Eurasia during winter.

2. **Sudden burst of South west monsoon:**
   Sudden withdrawal of polar westerly jet stream from Indian sub-continent to northern part of Pamir, leads to sudden burst of South west monsoon into Indian Sub-continent.

3. **Late and early monsoon in South Asia:**
   Rate of with drawl of polar westerly jet stream decides the onset of south west monsoon. Slower and faster rate of with drawl leads to late and early onset of south west monsoon.

4. **Intensity of monsoon rainfall:**
   The arrival of tropical easterly jet stream influences the intensity of south west monsoon. This leads to increasing intensity of rainfall during south west monsoon.

5. **Bringing rainfall to India by western disturbances:**
   Polar westerly jet stream carries rainy clouds from cyclones formed over Mediterranean Sea during winter towards India. These clouds piles up on the Himalayas and results in rainfall over the states of Punjab and Haryana. This assists in the cultivation of wheat in India.

6. **Development of super cyclone**:
   The condition at which the speed of the jet stream is transferred to tropical cyclone may leads to development of super cyclone.

Humidity, Condensation and Clouds

- Humidity is the amount of water vapour in the atmosphere. Temperature of the air controls the capacity of the air to hold moisture. The maximum amount of moisture that can be hold by the air in the particular temperature is called as Humidity Capacity. As the volume increases with the temperature of the air, it can hold more moisture. So,

humidity capacity increases with temperature. It is measured as weight of humidity or volume of the air.

Humidity of the air can be expressed in the following ways.

a. **Absolute Humidity:** This measures the total amount of water vapour present in the air at particular time. It is highly variable based on the surface on which the air moves. It is measured as weight of humidity volume of the air. Hygrometer is used to measure the relative humidity of a region.

b. **Relative Humidity (RH%):** This is the ratio of Absolute humidity and humidity capacity in term of percentage. It reveals the condition of air to get saturated. This is controlled by both temperature and moisture content of the air. The condition is that when the temperature increases RH% decreases. But when absolute humidity increases RH% increases.

Process of Condensation

- Condensation is the change of the physical state of water vapour (gas state) into water (liquid state). The following process explains mechanism of condensation in the atmosphere.

- If an air reaches 100% relative humidity, it means that the air is completely filled with moisture content. It indicates that both the absolute humidity and the humidity capacity of the air are in same level. This condition is called 'saturation of air' which can be attained by reducing the temperature of the air or increasing the moisture content. The temperature at which the air gets saturated is called as 'dew point'. The RH crosses the 100% when the temperature of the air drops below its dew point. This condition is called as 'super saturation' of the air. In this condition the air releases the excess moisture out of it in the form of tiny water droplets which floats and form clouds in the atmosphere.

- If the same process occurs on the surface of the earth, it is called as 'fog' or cloud on the ground.

The moisture in the atmosphere is based on the following processes:

a. Evaporation - Water changes from liquid state to gaseous (vapour) state.
b. Transpiration - Water state changes from liquid in to (gas) vapour state due to the activity of plants.
c. Evapotranspiration - This denotes that the total amount of (liquid) water state changed in to (gas) vapour state due to evaporation and the activity of plants transpiration.

Clouds and its Types

Clouds are tiny water droplets suspended in the air formed due to the condensation.

Isonephs - The imaginary line connecting the places having equal amount of cloudiness.

- The clouds can be classified based on their form, height and appearance as follows: (Figure 6.22)

a. **High clouds:**

- Mainly cirrus (Ci) which are feathery form at 6 km above the ground.

i. Cirrus (Ci) – This looks fibrous and appears as wisps cotton in the blue sky. It indicates fair weather and gives brilliant sun set.
ii. Cirro Cumulus (Cc) – This appears as white globular masses, forming a mackerel sky.
iii. Cirro Stratus (Cs) – Tis resembles a thin white sheet. The sky looks milky and the sun and moon shines through this clouds and form a 'halo'.

b. **Middle Clouds:**

- Mainly Alto (Alt) clouds at 2 km to 6 km above the ground.

i. Altocumulus (Alt-Cu): These are woolly, bumpy clouds arranged in layers appearing like waves in the blue sky. They indicate fine weather.
ii. Altostratus (Alt-St): These are denser and have watery look.

c. **Low Clouds:**

- Mainly Stratus or sheet clouds below 2 km height.

i. Stratocumulus (St-Cu): This is rough and bumpy clouds with wavy structure.
ii. Stratus (St): This is very low cloud, uniformly grey and thick, appears like highland fog. It brings dull weather and light drizzle. It reduces the visibility and is a hindrance to air transportation.
iii. Nimbostratus (Ni-St): This is dark dull cloud, clearly layered, as it brings rain, snow and sleet and it is called as rainy cloud.

d. Clouds with vertical extent:

These are mainly cumulus clouds whoseheights extend from 2 km to 10 km approximately.

i. Cumulus (Cu): This is vertical cloud with rounded top and horizontal base, associated with convectional process in the tropical region. It also called as 'fair weather cloud'.
ii. Cumulonimbus (Cu-Ni): This is over grown cumulus cloud with great vertical extent, with black and white globular mass. The cauliflower top spreads like an anvil. This is formed due to heavy convection in the tropical regions. It is accompanied by lightning, thunder and heavy rainfall.

Fog, Mist and Smog

- **'Fog'** is defined as almost microscopic droplets of water condensed from super saturated air and suspended over or near the surface of the earth. Fogs reduce the visibility to less than 1 km. Fog occurs during calm or light wind conditions. It is more common in the areas near to the ocean due to the supply of more moisture by sea breeze. In the interior of the continents fog is formed due to reduction of temperature to extreme low during the winter nights.

- If the fog has higher visibility due to lesser water drops near the surface it is termed as 'mist'.

- In large industrial areas the air is more polluted. If the fog forms in that area it mixes with the pollutants and turns into smog (smoke 1 fog 5 smog) which is more hazardous to the health of the people.

Hydrological Cycle

- Continuous movement of water among the three spheres is known as Hydrological Cycle.Hydrological cycle involves evaporation, condensation, precipitation, advection, interception, evapotranspiration, infiltration, percolation and runoff to the ocean (Figure 6.24).

Evaporation is the process by which water in liquid state changes into vapour state using heat energy from Sun. Evaporation is maximum when the temperature is high, on the large expanse of water and when dry winds blow over water surface.

Condensation is the process by which water vapour cools to form water droplet by lossing temperature. The condensation occurs when dew point is reached in the atmosphere.

Precipitation is the process by which all forms of water particles fall from the atmosphere and reach the ground.
The rain drop that falls may get evaporated before it reaches the ground in an extremely arid region.

Air Masses and Fronts

- The study of air mass is very important part of Meteorology. Air always takes some of the properties of the area over which it lies. This parcel of air may remain stationary for several days and develops its own characteristics. Under this situation, the air becomes recognisable as an air mass.

- An air mass is defined as 'an immense body of air several kilometres in length and breadth and thickness which is characterised by homogeneous physical properties (like temperature, moisture) in horizontal direction at any level'.

- Such an extensive portion of the surface area over which air mass has acquired its qualities is called as 'Air mass source region'. The source region may be land or water body. For example,Sahara desert, Siberia, the Great Plain of North America, Northern Plain of Europe, Western Australia, Antarctica, Green Land, Arctic Ocean, Northern and Southern Pacific, Atlantic Oceans are favourable locations as source region for air masses.

The air masses can be classified based on the following factors;

a. Latitude - Tropical(T) and Polar (P) air masses
b. Nature of the surface – Continent (c) and marine (m) air masses
c. Temperature – warm (w) and Cold (k) air masses
d. Stability – stable (s) and unstable (u) air masses

- Air masses normally migrate from their source region to other regions, which have different surface properties, mostly along with primary winds. As the air masses move out from their source regions, they not only modify the weather of the areas they occupy, but also modify themselves according to the surface over which it moves.

Fronts

- When two air masses with different physical characters meet, there is usuallyUtile mixing of the air. The zone of transition between two contrasting air masses is called as 'Fronts*. As heavier air mass always tends to push up the lighter air mass, the front always slopes over the cold air mass.

- If cold air mass moves forward rapidly and causes the warm air to rise vertically, it leads to the formation of steep slope called as 'Cold front*. Cold fronts result in the formation of cumulo nimbus clouds with heavy rainfall associated with lightning and thunder.

- If warm air is moving over cold air mass, it produces a gentle slope called as 'Warm front*. Warm fronts result in the formation of stratus and nimbo stratus clouds and cover over large areas, leading to moderate rainfall (Figure 6.26).

Condition for Formation of Fronts:

1. There must be two air masses with contrasting physical characters.
2. There must be collision of air masses.

At the equatorial low pressure belt although two trade wind systems meet, they do not form any front, because the air masses are of similar physical characteristics (both warm) and they do not collide with each other. Whereas the sub polar low pressure belt contrasting air masses collide with each other forming fronts.

Precipitation

- Precipitation is theproductofcondensation of atmospheric water vapour that falls under gravity and reaches the surface ofthe earth. In order to fall as rain drop or snow, the tiny drop lets in a cloud must grow larger. The droplets accumulate over the nuclei and combine to grow large enough to fall and reach the surface of the earth due to gravity.

Acid Rain

Acid rain is a rain that is unusually acidic, it has elevated levels of hydrogen ions. It is caused by a chemical reaction of compounds like sulphur dioxide and nitrogen oxides that are released into the air from anthropogenic activities and from volcanic eruptions. These substances can rise very high into the atmosphere, where they mix as hygroscopic nuclei and react with water vapour, oxygen, and other gases to form more acidic water which falls to the ground as acid rain. It is harmful for plants, animals, human and environment. Normally the rainfall is slightly acidic because of the presence of dissolved carbonic acid. The pH of normal rain has been given a value of 5.6. Acid rain has the pH value of less than 5.6. A great way to reduce acid rain is by using renewable energy resources, such as solar and wind power and reducing the use of fossil fuels.

- If the drop is smaller it falls slowly so that it evaporates before it reaches the ground. Ice crystals in cloud also cause precipitation. Each ice crystal grows by cooling so that they become large in size and fall to the ground. They melt on the way due to friction with the atmosphere and fall as rain.

Forms of Precipitation

- The precipitation has various forms based on the condition of occurrence (Figure 6.27). The various forms are;

Rainfall: When water droplets of more than 0.5 mm diameter falls from the atmosphere to the ground it is called as 'Rainfall'. If the diameter is less than 0.5mm, it is called as 'Drizzle'.

Hail: When precipitation occurs at sub zero temperature, the water droplets crystallise and fall as ice pellets with the size of 5 to 50 mm or some times more. This is called as 'Hail'.

Sleet: Precipitation occurs as falling of raindrop along with ice pellets less than 5 mm diameter or snow, called as 'Sleet'.

Snow: Precipitation occurs at below freezing point and falls as thin ice flakes or powdery ice, called as 'Snow'.

Dew: Condensation of water droplets on the objects at the surface of the earth such as leaves and grasses are called as 'Dew'.

Cloud Seeding or Artificial Rainfall

People have always wanted to create rain, so that they would not suffer from drought. Modern science has been successful in causing rain in a limited way through cloud seeding. This method is based on the knowledge of growing ice crystals in clouds.

One method to cause rainfall from clouds is to introduce particles of dry ice (solid CO2) into the cloud from an air plane. The dry ice causes ice crystals to form in the cloud. These ice crystals coalesce, grow, melt and fall as rain. Cloud seeding will not be successful unless the cloud is already saturated with water vapour.

Types of Precipitation (Rainfall):

- Precipitation can be classified based on the causes for the rising up of air,

1. Convectional rainfall
2. Orographic or Relief rainfall
3. Cyclonic or Frontal rainfall

Convectional Rainfall:

- As a result of heating of the surface air, the warm moist air expands and is forced to rise to a great height. As the air rises, it cools, reaches dew point and condenses

toform clouds. This process influences the upper tropospheric circulation. By further cooling, precipitation takes place as rainfall. This rainfall occurs throughout the year near the equator in the afternoon. It is called as 4 'O' clock rainfall region. In middle latitudes, convectional rainfall occurs in early summer in the continental interiors (Figure 6.29).

Orographic or Relief Rainfall

- It occurs when large mass of air is forced to rise across land barriers, such as high mountain ranges, plateaus, escarpments, or over high hills. On the windward side of the region the warm moist air raises, temperature of the air falls below its dew point, forming clouds which give subsequent rainfall. As the wind moves to the leeward side it has emptied itself of moisture and thus descends the slope as warm dry winds. The leeward side of the mountain therefore is called as the rain shadow region (Figure 6.30).

Cyclonic or Frontal Rainfall

- This type of precipitation is associated with a cyclonic activity (Tropical and Temperate) and also occurs along the frontal zone. Cyclonic rainfall is associated with Cumulo Nimbus (CuNi) clouds. The rainfall is very heavy and accompanied with lightning and thunder and high speed winds which has the potential to cause damage.

- 'Frontal rainfall' is associated with fronts which form due to collision of different air masses. Warm front is formed due to advent of warm air masses which leads to moderate rainfall. In the same way coldfront is formed due to advent of cold air mass which leads to heavy rainfall with lightning and thunder.

An isohyets or isohyetal line is a line joining points of equal rainfall on a map in a given period. A map with isohyets is called an isohyetal map.

When altitude increases, the rainfall also increases in orographic pattern. But the rainfall decreases with altitude, once the amount of moisture reduces in the air after a point where it reaches maximum rainfall which is called as 'Maximum Rainfall Line'. This condition where the rainfall decreases with altitude is called 'Inversion of Rainfall'.

Cloud Burst

- A 'cloud burst' is a sudden aggressive rainstorm falling in a short period of time limited to a small geographical area. Meteorologists say that the rain from a cloud burst is usually of the heavier rain with a fall rate equal to or greater than 100 mm (3.94 inches) per hour. Generally cloudbursts are associated with thunderstorms. The air currents rushing up words in a rain storm hold up a large amount of water. For example cloud bursts in the region of Uttarkhand (2013) and Chennai (2015).

Lightning and Thunder are caused by differences in the electrical charge of different parts of the cloud. The top of the cloud becomes positively charged and the bottom is mostly negatively charged. When the difference is great lightning occurs. Differences in the charge between cloud and the earth surface also cause lightning.

Thunder is caused by rapid expansion of the air that is heated as the lightning passes through it.

Atmospheric Disturbances (Cyclone and Anti Cyclone)

- The atmospheric disturbances which involve a closed circulation of air around a low pressure at centre and high pressure at periphery, rotating anticlockwise in northern hemisphere and clockwise in southern hemisphere is called 'Cyclones' (Figure 6.31). Cyclones may be classified into two types based on latitude of its origin.

They are: a. Tropical cyclone b. Temperate cyclone

A. Tropical Cyclone

- Cyclone formed in the low latitudes is called as Tropical cyclone. They form over warm ocean waters in the tropical regions. The warm air rises, and causes an area of low air pressure.

6.8.1 Stages of Development of Tropical Cyclone

- As per the criteria adopted by the World Meteorological Organisation (W.M.O.), India Meteorological Departmentclassifies the low pressure systems in to vary classes based on wind speed

1. Tropical Disturbances
2. Tropical depressions Low winds with a speed between 31 and 61 km ph.
3. Tropical cyclone wind speed from 62 to 88 km ph and it is assigned a name.
4. Severe Cyclonic Storm (SCS) wind speed is between 89 to 118 km ph
5. Very SCS wind speed between 119 to 221 km ph and
6. Super Cyclonic Storm when wind exceeds 221 km ph.

Origin of Tropical Cyclone

- Tropical cyclones have certain mechanism for their formation. These are

A source of warm, moist air derived from tropical oceans with sea surface temperature normally near to or in excess of 27 °C (Figure 6.32)
Wind near the ocean surface is blowing from different directions converging and causing air to rise and storm clouds to form. Winds which do not vary greatly with height are known as low wind shear. This allows the storm clouds to rise vertically to high level;Coriolis force is induced by the rotation of the Earth. The mechanisms of formation vary across the world, but once a cluster of storm clouds starts to rotate, it becomes a tropical depression. If it continues to develop it becomes a tropical storm, and later a cyclone/ super cyclone.

Characteristics of the Tropical Cyclone

- The centre of the cyclone where the wind system converges and vertically rises is called as Eye. The eye is a Calm region with no rainfall and experiences highest temperature and lowest pressure within the cyclonic system (Figure 6.32).

- Cyclone wall is made up of Cumulo Nimbus clouds with no visibility, higher wind velocity and heavy rain fall with lightning and thunder.

- Tropical cyclones mostly move along with the direction of trade wind system. So they travel from east to west and make land fall on the eastern coast of the continents (Figure 6.33).

Landfall: The condition at which the eye of the tropical cyclone crosses the land is called 'Land fall' of the cyclone (Figure 6.34).

Naming of Tropical Cyclones

- The practice of naming storms (tropical cyclones) began years ago, in order to help in the quick identification of storms in warning messages because names are presumed to be far easier to remember than numbers and technical terms (Figure 6.35).

- In the pursuit of a more organized and efficient naming system, meteorologists later decided to identify storms using names from a list arranged alphabetically. Since 1953, Atlantic tropical storms have been named from lists originated by the National Hurricane Centre. They are now maintained and updated by an international committee of the World Meteorological Organization (WMO).

- Large scale destruction caused by Odisha cyclone in 1999, triggered the issue of naming tropical cyclones developed in the North Indian ocean. As a result, naming conventions for storms that develop in the Indian Ocean began in 2004. WMO (World Meteorological Organisation)had informed each of the eight South Asianmember countries to submit a list of their own eight names for the cyclones.

Condition of Super Cyclone Formation

1. Longer travel or stay of low pressure system over warm ocean water.
2. The speed of jet stream may influence the formation of super cyclone.

Tornado and Water Spouts

It is a very small intense, funnel shaped very speed whirl wind system. Its speed and direction of the movement are erratic (Figure 6.36). The winds are always as fast as 500 km ph. The fast moving air converges in the middle and rises up. The uplift is capable of rising dust, trees andother weaker objects in its path. South and western part of Gulf States of USA experiences frequent tornados.

- Water spouts are formed over water body similar to tornados in the formation and structure. This sometimes leads to fish rain, if the mass of fish comes under the water spout.

B. Temperate Cyclone

- The cyclone formed in the mid-latitudes is called as temperate cyclone. As they are formed due to movement of air masses and front, they are called as 'Dynamic cyclone' and 'Wave cyclone'. This cyclone is characterised by the four different sectors, which are varied with their weather patterns (Figure 6.37).

Stages in the Formation of Temperate Cyclone

a. Frontogenesis –Formation of front due to collision of two contrasting air masses (Figure 6.38).
b. Cyclone genesis – Formation of cyclone due to conversion of fronts into various sectors.
c. Advancing Stage – The stage where cold front advances towards warm front.
d. Occlusion stage - The stage where the cold front over takes warm front
e. Frontalysis – The last stage where fronts disappear and cyclone ends its life.

Characters

- Unlike tropical cyclone, temperate cyclone forms over both land and water in all seasons. It covers larger area than tropical cyclone and stays for a longer period.

Track

- Temperate cyclone moves along with the westerly wind system from west to east.

Anti-Cyclones

- Anti-cyclone is a whirlwind system in which high pressure area at the centre and surrounded by low pressure at periphery rotating clockwise in northern hemisphere and anti-clock wise in southern hemisphere(Figure 6.39).

- This is the largest among the whirl wind systems. Normally, they are associated with high pressure belts of sub-tropical and polar region.

Anti-cyclones are classified as warm core and cold core, based on their temperature, which are resulted in aridity and cold waves respectively.

Glossary

1. **Buoyant**: Able to keep afoot on the top of air or liquid.
2. **Collision:** Hit by accident when moving.
3. **Equilibrium:** A balanced state of molecules where the acting forces are equal.
4. **Escarpment:** A long, steep slope especially one of the edge of a plateau or surface.
5. **Expansion:** The action of becoming larger or more extensive.
6. **Funnelling:** Guided through the area that has widening at front and narrow at the end.
7. **Hygroscopic:** Tending to observe moisture from air.
8. **Insolation:** Amount of solar radiation reaching a given area.
9. **Meteorology:** is a branch of the atmospheric sciences which includes atmospheric physics and chemistry, with a major focus on weather forecasting.
10. **Molecules:** A group of atoms bonded together.
11. **Permeable:** Allowing liquids or gases to pass through it.
12. **Subsistence:** The gradual movement of air molecules from higher altitude to lower altitude.
13. **Torrid:** Region of Very hot and dry condition.
14. **Vortex:** A whirling or rotating mass of fluid or air.

Unit - 7
The Biosphere

- "Man's attitude towards nature is today critically important simply because we have now acquired a fateful power to alter and destroy nature is inevitably a war against himself".

-Rachel Carson

Introduction

- The earth was formed 4.6 billion years ago. Geographers are concerned about the earth and its various spheres. These spheres did not exist on the primitive earth as they are today. They evolved over a long period of time after the earth was formed. There was no life on earth for a very long time. Scientists believe that the first life forms on earth came into existence about 3.5 billion years ago. Which marked, 'The birth of the biosphere'.

- Since then life has multiplied in numbers and varieties and evolved to the present biosphere that we are part of and which we are gifted with.

- In the last 100 years, man has had used, overused and misused the natural resources of the earth. This has disturbed the ecological balance of the earth. The realization about the damage caused to earth by our action came when we began to experience global warming, desertification, increase in disease and distress and recurrence of severe natural disasters.
- It was in 1962 that Rachel Carson published the book 'Silent Spring' which inspired an environmental movement thatled International agencies to focus their attention on protecting and sustaining the biosphere.

- In 1971, UNESCO launched the Man and the Biosphere Programme to study our impact on nature and how it could be minimized. Even after several decades the programme still continues to shape the future of sustainability of the earth.

Biosphere

- The word Biosphere originates from the Greek words bios = life and sphaira = sphere. Earth is the only planet in the solar system that supports life. There are many reasons that contribute to this and the most important being the earth's distance from the sun, the presence of oxygen in the atmosphere and the presence of water. The above factors, alongwith the existence and interaction of the three spheres of the earth (the lithosphere, hydrosphere and atmosphere) gives rise to the fourth sphere which is the life sphere or biosphere (Figure 7.1). The term Biosphere was coined by Eduard Suess in 1875. Later contributions to the study of biosphere were from, Charles Darwin and many other scientists.

- Thus, in the biosphere, life exists on land, water and air and life forms range from microorganisms to plants, animals, birds, amphibians, reptiles and mammals including human beings.The biosphere is formed of biotic components. It consists of organisms, population, community and ecosystem.

Ecosystem

Organism - includes animals, plants and micro-organisms.

Population - is a group of similar plants or animals living in anarea.

Community - refers to all the plants and animals living in an area.

Ecosystem- all living and non-living things and their interaction within an area.

- Life cannot exist in isolation. It flourishes in an environment which supplies and fulfills its material and energy requirements. A biotic community and its physical environment in which matter and energy flow and cycle is called as ecosystem.

- The term ecosystem was first proposed by Arthur George Tansley in 1935. Tansley defined ecosystem as, 'the system resulting from the integration of all living and non-living factors of the environment'. The ecosystems can vary in size. It can be very small, extending to about a few square centimeters or it can extend over many square kilometres. Example; tropical forests.

Major components of an ecosystem

- The ecosystem is made up of two main components:

A. Abiotic Component and
B. Biotic Component

A. **Abiotic Component:** This component of the ecosystem includes the non-living substance of the environment. Example; light, air, soil, water, climate, minerals, etc. Sun is the main source of energy for the earth.

B. **Biotic Component:** This includes a variety of living organisms such as microorganisms, plants and animals. The biotic component of an ecosystem can be further divided into producers, consumers and decomposers based on their capacity to sustain themselves (Figure 7.2).

a. **Producers:** Organisms that can produce or manufacture their own food are known as producers. Plants that have green pigments or chlorophyll, produce their own food in the presence of CO^2 in the atmosphere, water from the soil and sunlight through a process called 'photosynthesis'. These green

plants are called as 'autotrophs' (auto – self; trophs – nourishing) as they manufacture their own food.

b. **Consumers:** Consumers are organisms that cannot manufacture their own food and get their food and nutrients from producers directly or from other organisms. They are called as 'heterotrophs' (hetero – others; trophs – nourishing).

- Consumers can be divided into primary, secondary and tertiary consumers.

1. **Primary Consumers**

- Organisms that feed on producers (green plants) are called primary consumers. They are also called as 'herbivores' or plant eating organisms. Examples of terrestrial herbivoreare grasshopper,sheep, goats, cow, rabbit, deer, elephant etc. Examples of aquatic herbivores are zoo plankton, krill, squid, small fish, sea urchin, etc.

2. **Secondary Consumers**

- Animals that kill and eat the herbivores or plant eating animals are called secondary consumers. They are also called as 'carnivores', Example; lion, tiger, foxes, frogs, snakes, spider, crocodiles, etc.

3. **Tertiary Consumers**

- They are top predators in a food chain. They are carnivores at the topmost level in a food chain that feed on other carnivores or secondary consumers. Example: an owl eats a snake but an owl is eaten by a hawk, therefore a hawk is a tertiary consumer. Tertiary consumers that occupy the top trophic level, and are not predated by any other animals are called 'apex predators'. However, when they die their bodies will be consumed by scavengers besides the decomposers Example; alligator andhawk.

- Some organisms eat both plants and animals. These animals are called as 'omnivores. Example; cockroach, foxes, seagull and human.Some omnivores are 'scavengers', which eat food that other animals have left behind Example; hyena and vultures.

- Plants and animals that live on or inside other plants or animals are called as Parasites. Example; mistletoe lives on other plants. Other examples are tapeworms, round worms, lice, ticks, flea etc.'Detritivores' are consumers that feed on detritus. Detritus includes fallen leaves, parts of dead trees and faecal wastes of animals. Ants, termites, earthworms, millipedes, dung beetle, fiddler crabs and sea cucumbers are detritivores.

4. **Decomposers:**

- Decomposers are organisms that help decompose dead or decaying organisms. Decomposers are also heterotrophs. Decomposers are nature's built-in recycling system. By breaking down materials – decomposers return nutrients to the soil. They, in turn, create another food source for producers within the ecosystem. Mushrooms, yeast, mould, fungi and bacteria are common decomposers.

The earthworm is called as the friend of the farmer. Find out the reason why?

Food Chain and Food Web

- Every living creature in an ecosystem has a role to play. Without producers, the consumers and decomposers would not survive because they would have no food to eat.Without consumers, the populations of producers and decomposers would grow out of control. And without decomposers, dead producers and consumers would accumulate as wastes and pollute the environment.

- All organisms of an ecosystem depend on one another for their survival. Each organism living in an ecosystem plays an important role in the flow of energy within the system. Organisms need energy for respiration, growth, locomotion, and reproduction. This movement of energy is usually understood through food chains or food webs. While a food chain shows one path along which energy can move through an ecosystem, food webs show all the overlapping ways that organisms live with and depend upon one another.

A. Food Chain

- A food chain describes the flow of food in an ecosystem. This flow or feeding structure in an ecosystem is called 'trophic structure'. Each level in this structure is called a trophic level. A food chain starts the movement of energy from one trophic level to the next (Figure 7.3). Example; Plant (primary producer) is eaten by a rabbit (herbivores, primary consumer), rabbit is eaten by a snake (carnivores, consumer or primary carnivore)and the snake is eaten by a hawk (tertiary consumer).

Food Web

- A Food Web is a complex network of interconnected food chains. Food chains show a direct transfer of energy between organisms. A chain might involve a mouse eating some seeds on the forest floor, a snake eating the mouse and later an eagle eating the snake. With each step, some of the energy from the sun, which is trapped within the seeds, is getting passed on.

- In a food web, the mouse might eat seeds, but it also might eat some grains, or maybe even some grass. The mouse might be eaten by a snake, or the eagle, or even a fox. The snake could be eaten by the eagle, but also might be eaten by a fox in the forest.Since each organism can eat multiple organisms and be eaten by multiple

organisms, a food web is a much more realistic scheme of the transfer of energy within an ecosystem (Figure 7.4).Food chains and food webs are found in both terrestrial and aquatic ecosystems.

- Organisms in a food chain or food web are linked and dependent on one another for survival. If organisms in one trophic level become threatened, it impacts the organisms in other trophic levels. Primary consumers get less food due to loss or destruction of habitat.This in turn means less primary consumers for secondary and tertiaryconsumers to feed on. The plant and animal species in such an environment could become endangered or even extinct. For this reason, it is vital that an ecosystem remains balanced containing an appropriate proportion of producers and consumers.

Energy Flow in an Ecosystem

- Energy in an ecosystem flows from producers to consumers. The available energy in a food chain decreases with each step or trophic levels up in the food chain. As such, there is less energy available to support organisms at the top of the food chain. That is why the tertiary and quaternary consumers are far less in number in an ecosystem than organisms at lower trophic levels.

Energy Pyramids

- Energy pyramids are another tool that ecologists use to understand the role of organisms within an ecosystem. As you can see, most of the energy in an ecosystem is available at the producer level. As you move up on the pyramid, the amount of available energy decreases significantly. It is estimated that only about 10% of the energy available at one trophic level gets transferred to the next level of the energy pyramid. The remaining 90 percent of energy is either utilized by the organisms within that level for respiration and other metabolic activities or lost to the environment as heat.The energy pyramid shows how ecosystems naturally limit the number of each type of organism it can sustain (Figure 7.5).

Cycles in an Ecosystem

- Nutrients move through the ecosystem in cycles is called 'biogeochemical cycles'. A biogeochemical cycle is a circuit or pathway by which a chemical element moves through the biotic and the abiotic components of an ecosystem. All life processes are associated with the atmosphere by important cycles such as the Carbon, Oxygen, Nitrogen cycles etc. Through these cycles energy and materials are transferred, stored and released into various ecosystems. Let us discuss one of biogeochemical cycles in detail - the Carbon cycle.

The Carbon Cycle

- Carbon is exchanged, or cycled among all the spheres of the earth. All living organisms are built of carbon compounds. It is the fundamental building block of life

and an important component of many chemical processes. Living things need carbon to live, grow and reproduce. Carbon is a finite resource that cycle through the earth in many forms.

- Carbon is an essential element in all organic compounds and since there is only a limited amount available it must be recycled continuously. This takes place in the biosphere. Atmospheric carbon is fixed in green plants through photosynthesis.

- This carbon is passed on to other living organisms through the food chain. The carbon food compound is utilized and later released to the atmosphere through the process of respiration.By-products of respiration are carbon-dioxide and water which are returned to the air.

A carbon cycle is completed by decomposers like bacteria and fungi which break down dead plants and animal tissues there by releasing some carbon to the air, water and soil.

- All producers and consumers are not decomposed. The organic matter of some of them is preserved in fossil fuels such as coal and petroleum for millions of years.In a carbon cycle (Figure 7.6), carbon moves between reservoirs. Carbon reservoirs include the atmosphere, the oceans, vegetation, rocks, and soil.

- Today, the carbon cycle is changing. Human activities have added more carbon into the atmosphere. More carbon is moving to the atmosphere when fossil fuels, like coal and oil, are burned. More carbon is moving to the atmosphere as humans destroy the forest. This increase in carbon in the atmosphere causes the earth to warm up more than the normal level, leading to climate change and many problems connected with it.

- A carbon sinkis a natural or artificial reservoir that accumulates andstores carbon for an indefinite period. The process by which carbon sinks remove carbon dioxide (CO^2) from the atmosphere is known as carbon sequestration. The main natural carbon sinks are plants, the ocean and soil.

Biomes

- An ecosystem as already explained consists of a biological community and an abiotic environment. Ecosystem may be broadly divided into land or terrestrial ecosystem and water or aquatic ecosystem. The aquatic ecosystem can be further divided into freshwater and marine ecosystem.An ecosystem becomes a biome when it extends over a large area. According toI.G. Simmons (1982) the most extensive ecosystem unit which is convenient to designate is called a 'Biome'. It may be concluded that a biome is in fact a large ecosystem where we study the total assemblage of plant and animal communities. Since vegetation is the most dominant component of a biome and as vegetation and climate are very intimately related, the world is divided into a number of biomes based on major world climatic types (Figure 7.7).

Types of Biomes

- World Biomes are mega ecosystems existing and operating over large areas. These divisions are based on climate pattern, soil types, and the animals and plants that inhabit an area. Basically, biomes are classified into two major groups such as Aquatic biomes and Terrestrial biomes.Wetlands are transition zones between aquatic and terrestrial biomesTo understand the earth biomes, it is necessary to understand the following:

1. The characteristics of regional climates.
2. Aspects of the physical environment.
3. The type of soil and the processes contributing to soil development.
4. The distribution of flora in the area.
5. The distribution of fauna in the area and their adaptation to the environment.

A. Aquatic Biomes

- The aquatic biomes are the most important of all the biomes as, the water forms the vital resource and is essential for any life form. Since many types of species live in the water, it is one of the most important natural resources that need to be protected.

Aquatic Biome is further divided into:

a. Fresh Water Biome and
b. Marine Biome

a. Fresh Water Biome

- These biomes are spread over all parts of the earth and have different set of species depending on their location and climate. Fresh water biomes include areas of ponds, lakes, streams, rivers and wetlands. Lakes and ponds are stagnant water bodies and are smaller in their area. The diversity of life forms in river changes with increasing water volume. For example, Dolphins are found in theriver Ganges, Brahmaputra and the Indus which carry huge volumes of water.

b. Marine Biome

- Marine biome is an aquatic biome which is salt water biome occupying seas and oceans of the world. Marine biome plants have various roles, plants such as sea grasses and macro algae give shelter and nutrient for many animals.

- Marine plants are sources of nutrients for the corals and help corals to build up reefs. The reefs are kept intact by plants like coralline algae.

- Corals are marine invertebrates which live in compact colonies. They inhabit tropical oceans and seas. Corals cannot survive in waters below 20°C but grow optimally in temperatures between 23°–29° Celsius. Coral reefs are marine ecosystems which are held together by structures made of calcium carbonate secreted by the corals. Coral reefs are mainly classified into three types – Fringing reef, Barrier reef and Atoll.

Sea grasses are plants that live in saltwater. There are over 50 species of sea grasses. Sea grasses have flowers, roots, and specialized cells to transport nutrients within a plant. This makes them similar to land plants and different from algae or seaweeds.

Fringing reefs grow seaward from the shore along the coast forming a fringe. They are the common type of reefs.

Barrier reefs also border the shoreline but are separated from the coast by an expanse of water or lagoon.

Atolls are coral reefs that are circular in shape enclosing a lagoon with absence of an island in the center.

Marine biome includes fishes, whales, crustaceans, molluscs, sea anemones, fungi and bacteria. Marine species are continuously impacted by change in climatic condition and the oceans are frequently disturbed by ocean waves and currents.

c. Wetlands:

- A wetland is an area of land which is permanently or periodically saturated with water and exists as a distinct ecosystem. Wetlands play many roles in the environment, such as water purification, flood control, carbon sink and shoreline stability. Wetlands are home to a wide range of aquatic plants and animal life. Wetlands can be freshwater, brackish, or saltwater. Examples of aquatic vegetation that thrive in wetlands are milkweed, bald cypress trees, mangroves and cattails.

- **Crustaceans** are chiefly aquatic arthropods having a body covered with a hard shell or crust and several pairs of legs. Example: crab, lobsters, crayfish, barnacles shrimps, krill etc.
- **Molluscs** are organisms with soft bodies. Often their bodies are covered by hard shells. Example: snail, slug, squid, cuttlefish, mussel, clams, oysters, octopuses etc.

B. Terrestrial Biome

Terrestrial biomes are very large ecosystems over land and they vary according to latitude and climate. They can be divided into numerous sub-types. In this lesson they are broadly divided into eight types.

- **A Bog** is a type of wetland ecosystem characterized by wet, spongy, poorly drained peaty soil formed from dead plants specially moss. Bogs have moss, sedges, grasses, such as cotton grass; insectivorous plants like pitcher plants; and many orchids. The gradual accumulation of decayed plant material in a

bog functions as a carbon sink.

- **A Fen** is a low land that is covered wholly or partly with water. They receive nutrients from ground water and have peaty alkaline soil. Their characteristic floras are sedges and reeds.

- **Mangrove swamps** are coastal wetlands found in tropical and subtropical regions. These wetlands are often found in estuaries, where fresh water meets salt water. Mangrove trees dominate this wetland ecosystem due to their ability to survive in both salt and fresh water. The Sundarbans is the largest Mangrove region in the world and a UNESCO World Heritage Site.

- **Mangrove forests of Tamil Nadu:**Mangrove forests are found along the coast of Tamil Nadu in Pichavaram, Muthupet, Ramnad, Gulf of Mannar and Punnakayal.

i. Tropical Evergreen Rain Forest Biome

- Tropical Evergreen Rain Forest Biome extends between 10° North and Southof the equator (Figure 7.8). This biome is seen in the Amazon Basin of South America, Congo Basin of Africa and the Indo Malaysian Region of Southeast Asia (Java, Sumatra, Borneo, Malaysia and Guinea)

This biome receives direct sunlight throughout the year and so temperatures are high year round. The average annual temperature is 20°C to 30°C. The average annual rainfall of the tropical evergreen rain forest is 200cm.

- The Tropical Evergreen Rain Forest Biome has the largest number of plant and animal species. Broad leaved, tall evergreen hard wood trees are found in this biome. Trees grow up to 20 to 35 meters high. The forest is characterized by thick undergrowth and creepers. The main trees in this biome are mahogany, rose wood, ebony, cinchona, rubber, coconut palm, cane, bamboo etc.This forest biome has innumerable insects, birds, reptiles and furless animals. At the edge of the forest animals like gorilla, and monkey are found.

- Important tribes inhabit this biome, for example the Pygmies in the jungles of Africa and the Yanomani and Tikuna tribes of the Amazon region. Traditionally they live by hunting and gathering food. In the recent years in South East Asia, the tropical evergreen rainforest has been slowly replaced by rubber and sugarcane plantations. The human settlements in this biome are small and scattered.

The forests of the Silent Valley National Park in Kerala on the Western Ghats arethe last remaining tropical evergreen forests in India. It is part of the Nilgiris Biosphere Reserve

ii Tropical deciduous Forest/Monsoon Forest

- Tropical deciduous forest is found in the regions experiencing monsoon climate. This biome is also called as the dry forest or monsoon forest biome.

- This is found in South and South East Asia in parts of India, Myanmar, Vietnam, Thailand, Cambodia and southern coastal China. It is also found in eastern Brazil and in smaller areas in South and Central America, the West Indies, southeastern Africa, and northern Australia.

- In this biome, the temperature varies from one season to another season. In summer the maximum temperature ranges from 38°C to 48°C. Summer season is warm and humid. In the dry winter season temperature ranges between 10°C to 27°C. The total amount of precipitation is 75 to 150 cm/year and this affects the natural vegetation of the tropical deciduous forest biome.

- The plants shed their leaves during the dry season. Trees here have huge trunks with thick rough barks. The plants grow at three different levels. The common trees are teak, sal, sandalwood,mahua (illupai), Mango, Wattle, Bamboo, semal (Illavamaram), sheesham (Karuvellamaram) and banyan.

- The animals of this biome are elephant, lion, tiger, leopards, bison, tapier, hippopotamus, wild boar, flying squirrel along with a wide variety of bird species. This biome faces rapid rate of deforestation and is, therefore, one of the most disturbed ecosystem in the world. Large tracts of forests have been destroyed for agriculture and urban development. Several species of precious animals have now become endangered Example: lions, tigers, leopards, etc.

iii. Temperate Deciduous Forest Biome

- The temperate deciduous forest is a biome that is always changing. This biome lies in the mid- latitude areas of the earth, between the tropics and Arctic Circle i.e., between 30° and 50° north and south of the equator. The temperate deciduous forest biome can be seen in the eastern United States, most parts of Europe, China, Japan, North and South Korea (Figure 7.9). The average annual temperature is 10°C.
- These biomes have four seasons such as winter, spring, summer and fall. Winters are cold and summers are warm. As winter approaches, the duration of day light decreases. In this biome, deciduous trees shed their leaves in the fall. The production of chlorophyll in the leaves slows and eventually stops revealing leaves having bright red, yellow and orange colors. These forests are also known as broad leaved forest, because the trees have wide flat leaves. Some important trees found here are oak, maple, beech, hickory, cedar and chestnut. On the forest floorsthat receive very little sunlight are found mosses, azaleas and mountain laurels.

- Inhabiting the temperate deciduous forest are ants, insects, flies, bees, wasps, cicadas, walking sticks, moths, butterfly, dragon flies, mosquitoes and praying mantises.

- Frogs, toads, snakes and salamanders are some of the reptiles in this biome. Common birds found in this biome are woodpecker, robin, jays, cardinals, owls, turkeys, hawks and eagles. Small mammals like rabbits, otters, monkeys, beavers, squirrels and porcupine are also seen in this biome along with bears, grey fox, wolves, white tailed deer and moose. Animals that live in this biome adapt to the changing seasons. Some animals migrate or hibernate in winter.

- Most of these forests on the earth are cleared for agriculture. The soil here is very fertile. This is one of the most important agricultural regions of the world.

Grasslands

- Grasslands are found bordering the deserts and make up for one fourth of the natural vegetation of the earth. Those that lie in the low latitudes are called tropical grasslands and the ones which lie in the mid-latitudes are called temperate grasslands.

iv. Tropical Grassland BiomeorSavanna Biome

- The tropical grass land biome is generally referred to as the Savanna biome. A savanna is a rolling topography that features vast open grasslands scattered with small shrubs and isolated trees. It is found between the tropical rainforest and desert biome. Tropical grassland biomes are mainly found in Africa, South America and Australia. Tropical grasslands in Africa is known as the savannas. Tropical grasslands are called as llanos in Columbia and Venezuela and as Campos in Brazil of South America.

- Savanna biomes experience warm temperature year around. It has very long and dry winter season and a very wet summer season. The grass here is very tall often one or two metres tall scattered with small shrubs and isolated umbrella shaped trees like the acacia and the baobab trees which store water in their trunks.

- Most of the animals in the savanna have long legs, like the giraffe and kangaroo. The carnivorous animals like lions, leopards, cheetahs, jackal and hyenas live in this biome. Zebras and elephants are also found in this biome.

- In many parts of the savannas of Africa people have started using the grassland for grazing their cattle and goats. Due to overgrazing in this region most of the tropical grasslands here are lost to the Sahara desert year after year.

v. Temperate Grassland Biome or Steppe

- The temperate grassland biomes are generally found in the interior of the continents in the mid-latitudes. These grassland biomes are found in the transitional zone between the humid coastal areas and the mid latitude deserts.

- The temperate grasslands are known as Steppes in Europe and Asia, Prairies in North America (Canada and USA), Pampas in South America, Veldts in South Africa, Downs in Australia and Puszta in Hungary. The annual range of temperature is quite large with summer temperature reaching as high as 38°C and winter temperatures falling down to -40° C. The rainfall is moderate from 25 cm to 50 cm. Grasses form a major part of the vegetation in the temperate grasslands.

- The height of the grasses depends upon the amount and distribution of rainfall.The animals in this area include the bison, wolves of the Prairies of North America. The other animals and birds are coyotes, prairie dog, foxes, mice, rabbits, badgers, rattle snakes, pocket gophers, weasel, grasshoppers, quails and hawks.

vi. Tropical Desert Biome

- A tropical desert is the hottest and driest place on earth where rainfall is very scanty and irregular. This biome is typically found in the western parts of the continents within the tropics.

- In the northern hemisphere, the Afro – Asian deserts form the longest belt which includes the Sahara desert, Arabian desert and the That deserts. In North America the tropical deserts cover, California, Arizona and New Mexico states of USA and it further extends to Mexico. The deserts in the southern hemisphere are, the Atacama desert west of Andes mountains in South America, the Namibian and the Kalahari deserts in southern Africa and the Great Australian desert in the central and southern parts of Australia.

- The tropical deserts are not conducive for the growth of vegetation due to shortage of water. The plants found here are the xerophytes which have their own moisture conserving methods such as long- roots, thick barks, waxy leaves,thorns and small leaves so as to avoid evapotranspiration.

- The main trees and bushes found in this region are acacia, cacti, date palm, kikar, babul etc.The animals in this biome are limited in number. They are able to bear the drought and the heat of the desert. Animals like the camel, antelopes, fox, spotted hyena, fallow deer, cape hare, hedgehog etc., live in the desert.

- The tropical desert biomes are agriculturally unproductive except in and near the oasis. In the oasis, cultivation is carried through irrigation either from streams or from underground sources. Date palms are widely grown here.

- The people in the deserts are generally nomads living in tents and moving from place to place. They are the Berbers of North Africa, the Bedouins of the Arabian deserts, the Damara in Namibia, the Bushman of the Kalahari Desert and the Aborigines of Australia. They practice food gathering and hunting while some herd cattle, goats and camel and some of them practice very simple subsistence farming.

- One of the toughest foot races in the world is held in Sahara every year in April. This race is called The Marathon des Sables (MDS) and participants have to cover a distance of 250km over Sahara desert in southern Morocco in a span of 7 days. About 1500 participants aged between 16 to 79 from all over the world participate in this race.

Source: Morocco World News

vii. Taiga or Boreal Forest Biome

- The taiga biome is the largest terrestrial biome and extends across Europe, North America and Asia. The taiga biome is also known as coniferous forest or boreal forest biome. It extends from about 50° to 55° North to 65 ° to 70° North latitudes. This region lies between the temperate grassland in the south and the polar tundra in the north. The taiga region is absent in the southern hemisphere mainly because of the narrowing of continents towards the South Pole.

- This biome has short wet summer and long cold winters. The taiga region has low mean annual precipitation ranging between 35 cm and 60 cm and the rainfall occurs mostly in summer. It receives plenty of snow during winter.The taiga or boreal forest biome consists mainly of evergreen coniferous forests. The important coniferous trees in this biome are pines, spruces, firs, maples and cedars. During the short summer season snow melts and this helps lichens, mosses and short grasses to grow and cover the ground. These are called 'meadows'.

- Taiga is the home of some larger animals like moose, deer, and bears, while smaller animals like bobcats, squirrels, chipmunks, ermine, and moles are also found. Animals of the taiga have specialised adaptation including lot of thick fur or feathers and the ability to change colours during different seasons example ermine.The ermine is a small mammal, which is covered with thick dark brown fur in summer. This changes to white in the winter, an adaptation which helps the ermine to blend into its surroundings and makes it more difficult for the predators to spot them.

- Lumbering is the main occupation of the people in areas which are easily accessible. The softwood from the coniferous forests is widely used in the manufacture of wood pulp and paper, newsprint, matches, furniture and building materials.

- The hunting of fur bearing animals like musk rats, ermine, and silver fox are important economic activities. The taiga forest is endangered due to logging and mining by humans. When trees are cut down in the taiga it takes a very long time to restore itself because of the very short growing season.

viii Tundra Biome

- Tundra is a Finnish word which means barren land. The tundra region is a vast bowl lying beyond the Arctic Circle (66.5° North latitude) in the northern hemisphere along the shores of the Arctic Ocean. TheArctic tundra extends southwards from North Pole to the Taiga forest. Tundra is also found in the high altitudes especially in the

Alpine region.Due to long and severe cold winters, this region is treeless and has very little vegetation. The growing season for plants is very short. Natural vegetation mainly consists of shrubs, sedges, grasses, mosses and lichens.

- The main features of this climate in the tundra region are the general absence of insolation and presence of very low temperature throughout the year. The average annual temperature is about -12°C. The ground surface is covered with snow for at least 8 to 9 months in a year. In this biome, the sub soil remains permanently frozen and is known as permafrost. Permafrost tundra covers vast barren areas of northern Russia and Canada. Algae and fungi are found on the rocky cliffs and rosette plants grow in rock and gravel beds. Spongy turf and lichen develop in the drier inland tundra.

- Animals common to Arctic tundra are the polar bear, arctic wolf, arctic fox, arctic hare and arctic weasel. Large herbivores such as musk oxen, caribou and reindeer are found. Lemmings are also found in this Biome. Insects like moths, butterflies, beetles, mosquitoes and black flies are common in the Arctic tundra. Migratory birds include tundra swans, harlequin ducks, sand pipers, plovers, geese and gulls.

- The Antarctic region is covered with ice sheets. It is too cold and dry to support vegetation. However, some portions of the continent have areas of rocky soil that support plant life. Vegetation comprises of mosses, lichens and liver worts. This area is referred to as Antarctic tundra. Seals and Penguins inhabit the shore areas of Antarctica.

Biodiversity

- The term biological diversity was used as early as 1968 by wildlife conservationist Raymond F. Dasmann. Latter in 1988,entomologist E.O. Wilson used the term Biodiversity and this term has been used since then. Biodiversity refers to the variety of life on Earth. This includes the number of species of plants, animals and microorganisms along with the diversity of genes in these species. Moreover, it embodies the different ecosystems on the planet, for example forests, deserts, coral reefs and wetlands.

- Biodiversity is the variability among living organisms. This includes diversity within species, between species, and between ecosystems. The variety of biodiversity or the number of species in a given area is referred to as species richness. Normally variety of life increases with size of area.

Biodiversity can be identified at three levels:

A. Genetic diversity
B. Species diversity
C. Ecosystem diversity

A. **Genetic diversity** refers to the total number of genetic characteristics in the genetic makeup of a species. Example: Each human being is very different from others. Genetic diversity helps the population to adapt to changes in the environment or

adapt to different environments. Domestication of dogs can be taken as a common example.

B. **Species diversity** is the number of different species of plants and animals that are present in a region. A community with more number of species enjoys species richness. Naturally undisturbed forests have greater species richness than reforested areas or plantations.There are three types of Species:

   a. **Endemic species** - is one whose habitat is restricted only to a particular area because of which it is often endangered. It differs from "indigenous," or "native," which although it occurs naturally in an area, is also found in other areas.
   b. **Exotic Species** - is any species intentionally or accidentally transported and released by man into an environment outside its original range. These are often the most severe agents of habitat alteration and degradation, and a major cause of the continuing loss of biological diversity throughout the world.
   c. **Cosmopolitan Species –** It is a species that is found to be distributed over most regions of the earth example: cats, dogs, human beings. The killer whale is considered as the most cosmopolitan species in the world.

C. **Ecosystem diversity** refers to the variety of life forms in a prescribed ecosystem. Ecosystems may be both terrestrial and aquatic. Distinctive terrestrial ecosystems include forests, grasslands, deserts, etc. while aquatic ecosystems are rivers, lakes, oceans etc.

- In understanding biodiversity, the most common question that arises in our mind is how many different plant and animal species are there on earth? There can be no definite answer to this question. At presentthe conservationscientists have identified over 8.7 million species worldwide. Of this only about 2 million are known to us ranging from microorganisms to giant mammals and reptiles. New species are being discovered while many species are also disappearing from the face of the earth.

Biodiversity hotspots

- Areas that are rich in species diversity are called as "Hotspots". The hottest spots for species diversity are the tropical rainforests. Tropical rainforests comprise of only 7% of all land on earth, yet are home to nearly 50% of all the species on Earth! India is among the World's 17 nations that are exceptionally rich in species diversity.

- The British biologist Norman Myers coined the term 'biodiversity hotspot' in 1988. According to him, a biodiversity hotspot is a biogeographic region characterised both by exceptional levels of plant endemism and by serious levels of habitat loss. Conservation International (CI) adopted Myers concept of 'hotspots' and it made an extensive global study of hotspots in 1999. According to CI, to qualify as a hotspot a region must meet two strict criteria: (i) It must contain at least 1,500 species of endemic plants, and (ii) It must have lost at least 70% of its original habitat. In 1999, CI's book 'Hotspots: Earth's

Biologically Richest and Most Endangered Terrestrial Ecoregions', identified 34 biodiversity hotspots in the different countries of the world.

- Currently there are 34 biodiversity hotspots that have been identified and, most of them occur in tropical forests (Figure 7.10). They represent just 2.3% of Earth's land surface, but between themthey contain around 50% of the world's endemic plant species and 42% of all terrestrial vertebrates. India has 4 biodiversity hotspots: the Western Ghats, the Himalayas, the Indo-Burma region and the Sundaland [includes Nicobar group of Islands].

> Norman Myers (born 24 August 1934) is a British environmentalist specialising in Biodiversity hotspots. Professor Norman Myers was the first to alert global community to tropical deforestation, the mass extinction underway and environmental security.

- Endemism is an ecological word meaning that a plant or animal lives only in a particular geographical location, such as a specific island, habitat type, country or any defined zone. For example, The Asiatic Lion of the Gir forest of Gujarat. The Kashmir Stag known as Hangul, which is found in the riverine forests of Kashmir Valley and Chamba in Himachal Pradesh. The Lion Tailed Macaque is India's most threatened monkey which is endemic to the Western Ghats of South India.

The 34 biodiversity hotspots of the World	
1. The Tropical Andes	18. The Philippines
2. Mesoamerica	19. Indo-Burma
3. The Caribbean Islands	20. The Mountains of Southwest China
4. The Atlantic Forest	21. Western Ghats and Sri Lanka
5. Tumbes-Chocó-Magdalena	22. Southwest Australia
6. The Cerrado	23. New Caledonia
7. Chilean Winter Rainfall-Valdivian Forests	24. New Zealand
8. Chilean Winter Rainfall-Valdivian Forests	25. Polynesia and Micronesia
9. Madagascar and the Indian Ocean Islands	26. The Madrean Pine-Oak Woodlands

10. The Coastal Forests of Eastern Africa	27. Maputaland-Pondoland-Albany
11. The Guinean Forests of West Africa	28. The Eastern Afromontane
12. The Cape Floristic Region	29. The Horn of Africa
13. The Succulent Karoo	30. The Irano-Anatolian
14.The Mediterranean Basin	31. The Mountains of Central Asia
15. The Caucasus	32. Eastern Himalaya
16. Sundaland	33. Japan
17. Wallacea	34. East Melanesian Islands

- **Conservation International** (CI) is an American non-profit environmentalorganization founded in 1987 in Virginia. Its goal is to protect nature as a source for food, fresh water, livelihood and a stable climate.
- CI has helped to support 1,200 protected areas across 77 countries, safeguarding more than 601 million hectares of marine and coastal areas.

Endangered species

- Rare, endangered or threatened plants and animals are elements of our natural heritage that are declining rapidly. If we cherish these species, like we do other rare and beautiful objects, these living organisms become treasures of the highest magnitude.

- The International Union for the Conservation of Nature (IUCN) has identified and classified species based on the nature of their depleting numbers. The IUCN's Red List of Threatened Species, identified in 1964, is the world'smost important inventory of the global conservation status of biological species.Species are classified by the IUCN Red List into nine groups specified through criteria such as rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation (Figure 7.11).

- Extinct (EX) – The species has disappeared and no known individuals remaining
- Extinct in the wild (EW) – Known only to survive in captivity, or as a naturalized population outside its historic range
- Critically Endangered (CR) – Species that have drastically dwindled and are at extremely high risk of extinction in the wild
- Endangered (EN) – High risk of extinction in the wild
- Vulnerable (VU) – High risk of endangerment in the wild
- Near threatened (nt) – Likely to become endangered in the near future.
- Least concern (lc) – Lowest risk widespread and abundant

- Conservation dependent (cd) – This group has now merged with near threatened.
- Data deficient (dd) – Not enough data to assess the risk of extinction of the species.
- Not evaluated (ne) – Species not yet been evaluated against the criteria.

- In the context of the IUCN Red List, 'threatened' embraces the three categories of Critically Endangered, Endangered, and Vulnerable.
- According to the IUCN those species that have dwindled drastically are called as Critically Endangered and are included as Red List. Species that have disappeared are called as extinct species. In the Red List of 2012 that was released on 19 July 2012 at Rio+20 Earth Summit 19,817 species were threatened with extinction.

> The IUCN Red List of Threatened Species (also known as the IUCN Red List or Red Data List), founded in 1964, is the world's most comprehensive inventory of the global conservation status of biological species. The International Union for Conservation of Nature (IUCN) is the world's main authority on the conservation status of species. A series of Regional Red Lists are produced by countries or organizations, which assess the risk of extinction to species within a political management unit.

- A Hawaiian plant species called Alula locally referred to as cabbage on a stick has moved from Critically Endangered to Extinct in the Wild. It is one of the 38 Red Listed Hawaiian plant species with less than five wild individuals remaining. It used to grow on the windy sea cliffs of Kauai. Alula was destroyed by hurricanes Iwa and Inki in 1982 and 1992 leaving only less than 10 plants alive.

- The majority of the great ape species are now Critically Endangered. The Eastern Gorilla the largest living primate is endemic to the Eastern Democratic Republic of Congo, south western Uganda and Rwanda. This species which was listed as Endangered has moved to Critically Endangered in 2016 due to an on-going population decline. This decline is due to illegal hunting and destruction of forests for agriculture. If this trend continues, around 93% of Eastern Gorillas will be eliminated by 2054.

- The Pygmy Hog: It is the smallest and rarest wild pig on earth and itis a Critically Endangered species previously spread across Bangladesh, Bhutan, India and Nepal. but now only found in Assam, India. In 1995, the Pygmy Hog Conservation Programme was started by Goutam Narayan of Ecosystems-India, with the help of the Assam government and now their numbers have increased to about 150.There are many other critically endangered species in India and some of them are listed below

Critically Endangered species in India 2016

Arthropod

- Rameshwaram parachute spider
- Peacock tarantula

Birds

- White-bellied heron
- Great Indian bustard
- Forest owlet
- Spoon-billed sandpiper
- Siberian crane
- Indian vulture
- Himalayan quail
- Pink-headed duck

Fish

- Wayanadmahseer
- Pondicherry shark
- Ganges shark
- Pookode Lake barb
- Common sawfish

Insects

- Pygmy Hog Sucking Louse

Reptiles and amphibians

- Madras spotted skink
- Gharial
- Toad-skinned frog
- Charles Darwin's frog
- White-spotted bush frog
- Munnar bush frog
- Ponmudi bush frog
- Anaimalai flying frog

Mammals

- Asiatic cheetah
- Namdapha flying squirrel
- Himalayan wolf
- Andaman shrew
- Nicobar shrew
- Northern Sumatran rhinoceros
- Chinese pangolin

- Pygmy hog
- Indian Javan rhinoceros
- Malabar large-spotted civet

- The plant Alliumiatrouinum of the Mediterranean, belonging to the onion family was added to the IUCN Red List as Critically Endangered (CR) in 2017. Currently this plant is known to exist only on Mount Ochi in the southern part of Evvia Island, Greece. It is understood that the threat was from the numerous wind parks and wind turbines developed in the area.An endemic species of small trees growing at low altitudes in New Caledonia called Pittosporumbrevispinium has declined causing it to move from Endangered to Critically Endangered in 2017. The species decline has been attributed to conversion of dry forests to pasture land and degradation of forest by the Rusa deer.

- The Red-legged FireMillipede is found in the rainforests of Madagascar. It entered the IUCN Red List in 2017 as, Critically Endangered (CR).The degradation of its habitat due to slash and burn agriculture and cutting of trees for firewood by local communities has caused its decline.The IUCN Red List in 2017 declared the Christmas Island Whiptail-skink endemic to Christmas Island as Extinct. The last known individual died in captivity in 2014. This dramatic decline and extinction was due to the impact of the introduction of Yellow Crazy Ant, Indian Wolf Snake and other new species on Christmas Island along with deforestation due to mining.

The status of the Rodrigues Flying Fox moved from Critically Endangered to Endangered in 2017. This was due to a number of conservation measures taken, such as, captive breeding programme involving 46 zoos around the world, restoration of natural habitat, watershed protection, and awareness rising through education programmes. Its population has increased from 4,000 in 2003 to about 20,000 individuals in 2016. The future survival of this species will depend on continued conservation efforts.

Causes of Extinction of Species

- Extinction is defined as the permanent disappearance of an organism from the face of the earth. In other words, all members of a species have died. This means a loss of biodiversity. Extinction of species may take place (Figure 7.12) due to a variety of causes as given below:

- Sudden and rapid changes of environmental conditions

1. The sudden outbreak of disease and pest infections.
2. Some sudden events like forest fires, volcanic eruption etc.
3. Direct hunting and persecution of species leading to 'selective mass extinction.
4. Ecological substitution by other species of large carnivorous animals which compete for the same food resources.

5. Climatic change accelerates the competition between large mammals for shelter and food.
6. Extinction of weak species during the course of competition with more powerful and stronger species.
7. Man-induced environmental changes also cause species extinctions.

Between 1600 and 1900 it is estimated that one species went extinct every four years. In modern times, the rate is soaring. The graph below (Figure 7.12.) shows how the rate of extinction of species has increased over the past 50 years. This could be attributed to the rapid increase in population during the same period of time.According to IUCN the rate of extinction of mammals and birds had started much earlier by 1700 itself at a much faster rate as shown in the graph below (Figure 7.13).

Major Threats to Biodiversity

- The following are some of the major threats to biodiversity:

a. Habitat destruction and degradation
b. Invasive alien species-these can destroy native species Example, lantana Camera plant in India.
c. Climate Change- Example, bleaching and loss of coral reefs due to global warming
d. Pollution of air, water and soil – Pollution can alter the growth and life of organisms in a great way.
e. Over exploitation of one resource – Over exploitation through Hunting or Poaching, Deforestation etc., can influence the life of all the interdependent species.

- Despite rapid efforts in protecting terrestrial and marine habitats, world's diversity of species is still dwindling. Since the 1960's over 100,000 'protected areas' have been established. This represents 11,265,408 sq.km of land and 1,609,344 sq.km of ocean. Yet, terrestrial and marine species have declined over the same period. This suggests that the common conservation strategy of protecting areas of land and sea is inadequate.

Conservation of Biodiversity

- Conservation of bio-diversity is the proper management of the biosphere by human beings in such a way that it gives maximum benefits for the present generation and also develops its potential to meet the needs of the future generations.

- The three basic objectives of biodiversity conservation are :

a. To maintain essential ecological processes and life supporting systems.
b. To preserve the diversity of species.
c. To make sustainable utilization of species and ecosystems.

- There are two types of conservation methods (Figure 7.15) namely in-situ and ex-situ conservations.In-situ conservation means the conservation of species within their

natural habitats. This strategy involves identification of species rich areas and adopting methods to protect it in the form of National Park or Wildlife Sanctuary or Biosphere Reserve etc. In this way biodiversity can be conserved in their natural habitat from human activities.

- Ex-situ conservation involves maintenance and breeding of endangered plants and animals under partially or wholly controlled conditions in specific areas like zoo, gardens, nurseries etc.Other examples of ex-situ conservation include:

i. Seed gene bank
ii. Field gene bank
iii. Botanical gardens

Biodiversity conservation in India

- India is one of the 17 mega bio-diverse countries of the world (according to Conservation International). With only 2.4% of the world's land area, 16.7% of the world's human population and 18% of livestock, it contributes about 8% of the known global biodiversity. India has a number of globally important endangered species like Asiatic lion, Asian elephant, one-horned rhinoceros, Gangetic river dolphin, snow leopard, Kashmir stag, dugong, gharial, great Indian bustard, lion tailed macaque etc. The following steps have thus been taken to protect and manage the wildlife of the country.

1. The Government of India enacted the Wild Life (Protection) Act 1972 with the objective of effectively protecting the wild life of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives.

2. The National Board for Wildlife (NBWL) chaired by the Prime Minister of Indiaprovides for policy framework for wildlife conservation in the country.

3. The National Wildlife Action Plan (2002–2016) was adopted in 2002, emphasizing the people's participation and their support for wildlife conservation.

4. The Indian Constitution lays the subject of forests and wildlife in the Concurrent list thus laying the responsibility of wildlife conservation on both the Centre and the State.

5. Specialised projects: To save the endangered species of animals, specialised projects are being implemented with international cooperation (WWF, UNDP, UNEP, IUCN) as well as on a stand-alone basis like the following: (Table 7.1)More recently, the Black Buck (chinkara) the Great Indian Bustard and the snow leopard have been given full or partial legal protection against hunting and trade throughout India.

6. **The Protected Areas of India**Protected areas are those in which human occupation is small and exploitation of resources is limited. These are defined according to the categorization (Table 7.2).

There are 4 categories of the Protected Areas in India.

- National Parks,
- Wildlife Sanctuaries,
- Conservation Reserves, and
- Community Reserves.

Protected Areas	Number	Total Area in sq Km	% of the Country
National Parks (NPs)	103	40500	1.2
Wild life Sanctuaries (WLSs)	537	118005	3.6
Conservation Reserves (CRs)	67	2350	0.1
Community Reserves	26	47	0.01
Total Protected Areas (PAs)	733	160902	4.91
Source: ENVIS Centre on Wildlife & Protected Areas (http://www.wiienvis.nic.in/Database/ConservationAreas_844.aspx)			

National Park

1. National parks in India are IUCN category II protected areas.
2. A National park is an area with ecological, geomorphological and natural significance with rich fauna and flora, designed to protect and to develop wildlife or its environment.
3. Activities like grazing, hunting, forestry or cultivation etc. are strictly prohibited.
4. No human activity is permitted inside the national park.
5. India's first national park was established in 1936 as Hailey National Park, now known as Jim Corbett National Park, Uttarkhand.
6. There are 103 national parks in India (National Wildlife Database, April 2015).

Wildlife Sanctuary

1. The difference between a Sanctuary and a national park lies mainly in the rights of people living inside. In a Sanctuary, certain rights are allowed but in a national park, no rights are allowed for grazing of any livestock. In a

wildlife Sanctuary, the Chief Wildlife Warden may regulate, control or prohibit certain activities.

2. There are a total of 537 wildlife sanctuaries in India.

Conservation reserves and community reserves in India:

1. These terms denote the protected areas of India which typically act asbuffer zones between established national parks, wildlife sanctuaries and reserved and protected forests of India.
2. They are called as 'Conservation Reserves' if they are uninhabited and completely owned by the Government of India but used for subsistence by communities.

They are called 'Community Reserves' if a part of the land is privately owned.

7. **Biosphere Reserves**: A biosphere reserve is an area of land or water that is protected by law in order to support, sustain and conserve ecosystems.Biosphere Reserves of India protect very large areas of natural habitat that are much bigger than national parks or wildlife sanctuaries. Biosphere reserves may cover multiple national parks, sanctuaries and reserves which are contiguous.example, the Nilgiri Biosphere covers: Bandipur National Park, Mudumalai Tiger Reserve, Silent Valley National Park, Nagarhole National Park and Mukurthi National Park.(Figure 7.16)

- Biosphere reserves are traditionally organized into 3 interrelated zones, known as: Core area, Buffer zone, and Transition zone.
- Presently, there are 18 notified biosphere reserves in India. Ten out of the eighteen biosphere reserves are a part of the World Network of Biosphere Reserves, based on UNESCO's Man and the Biosphere (MAB) Programmed list.

8. Some Other Important Conservation Sites

1. Tiger Reserves – Project Tiger was launched by the Government of India in the year 1973 to save the endangered species of tiger in the country. Starting from nine (9) reserves in 1973 the number has now grown to fifty (50) in 2016. Table 7.2. gives a list of conservation sites and their numbers in India.

9. **Role of communities:** Communities are playing a vital role in the conservation and protection of wildlife in India, example:
   1. **Sariska Tiger Reserve:** In Sariska tiger reserve Rajasthan villagers have fought against mining by citing the wildlife protection act. In many areas, villagers themselves are protecting habitats and explicitly rejecting government involvement.
   2. **BhairodevDakavSonchuri:** The inhabitants of five villages in the Alwar district of Rajasthan have declared 1200 hectares of forests as theBhairodevDakavSonchuri declaring their own set of rules and regulation

which do not allow hunting, and are protecting the wildlife against any outside encroachments.

3. **Bishnoi villages:** In and around Bishnoi villages in Rajasthan, herds of blackbuck, nilgai and peacocks can be seen as an integral part of the community and nobody harms them.

The Role of GIS in Conservation of Nature

- Recently Geographic Information System (GIS) has been used as a tool to identify new areas that need to be conserved. In the last 15 years Remote Sensing and GIS has been used to developed gap analysis as a method to identify biodiversity (i.e., species, ecosystems and ecological processes) that is not adequately conserved within a protected area network or through other effective and long-term conservation measures. Gap analysis is a method of comparison of actual performance with potential or desired performance. It was thus developed in response to recognition that protectedareas of all types and in all parts of the world do not fully protect biodiversity. Gap analysis is usually applied to fairly large areas of study.

Reserves/Conservation Sites	Numbers	Total Area in Sq km
Tiger Reserves	50	71027
Elephant Reserves	32	69583
Biosphere Reserves	18	87492
RAMSAR Wetland Sites	26	12119
Natural World Heritage Sites	07	11756
Important Coastal and Marine Biodiversity Areas	107	10773
Marine Protected Areas	131	9801
Potential/ Important Bird Areas	563	-
Source: ENVIS Centre on Wildlife & Protected Areas (http://www.wiienvis.nic.in/Database/ ConservationAreas_844.aspx)		

Highlight: In 1798, in a small village called Vedanthangal near Chennai, theBritish soldiers shot some storks in the local wetland. The villagers stormed the Collector's office and made him issue an order not to harm the nesting birds. This took place long before the concept of conservation of

biosphere entered our thoughts. India has experienced many such incidents only some of which have been recorded.

- Biodiversity is necessary for our existence as well as valuable in its own right. This is because it provides the fundamental building blocks for the goods and services that provide us with a healthy environment. Biodiversity includesfundamental things to our health like fresh water clean air and food products, as well as many other products like timber, medicine and fibre.

- Biodiversity also includes various other important things and services such as cultural, recreational and spiritual nourishment that play an important role in maintaining our personal life and social life.

It is therefore the duty of every citizen to conserve this valuable life on earth, the most precious gift we can pass on to the future generations.

The Asiatic Cheetah of India Becomes Extinct

- Cheetah is found in Africa and Asia. It is the fastest land animal on Earth. The Asiatic cheetah, is slightly smaller than the African cheetah. It has a fawn-coloured body with black spots and distinctive black "tear marks" running from the corner of each eye down the side of its nose.
- The Asiatic cheetah also known as the Iranian cheetah is a Critically Endangered subspecies surviving today only in Iran. It was once found in the Arabian Peninsula, Near East, Kyzyl-Kum desert, Caspian region, Pakistan and India.
- Asiatic cheetahs were once widespread across the continent but were eradicated in India, where they were hunted for sport. The spread of farming also greatly reduced their numbers in the 19th and 20th centuries. Eventually the animal was wiped out in Asia to which it was once native.
- Cheetah has been known to exist in India for a very long time. They were kept by Kings and princes, but hunting led to their extinction in the country. In 1948, Maharajah RamanujPratap Singh Deo shot three of the last cheetahs in India, in Surguja, State of Madhya Pradesh which is present day Northern Chhattisgarh.
- The Indian government had plans to reintroduce cheetahs back in India in 2009 but this project has not yet been taken up.

Unit VIII Natural Disasters Public Awareness for Disaster Risk Reduction

Introduction

On an average, 232 million people are affected by different types of disasters every year. In recent years disaster risks have been on the rise due to factors such as population growth, unplanned urbanization, environmental degradation, conflicts and competition for scarce resources, climate change, disease epidemics, poverty and pressure from development within high-risk zones. Hence, disaster risk reduction is the need of hour.

Recognizing the importance of Disaster Risk Reduction in 2005, 168 governments and all leading development and humanitarian actors signed the Hyogo Framework for Action (HFA), committing themselves to a ten-year multi-stakeholder and multi-sector plan to invest in disaster risk reduction as a means to building disaster-resilient societies. Public awareness campaigns can be started modestly and tailored to meet the needs of specific populations and target groups. These approaches canbe integrated into almost all existing initiatives, whenever and wherever they take place. They can build on and support existing volunteer mobilisation and peer-to-peer communications. To support this, it requires strong and unified disaster reduction messages and clear and targeted information, education and communication materials.

Public awareness for disaster risk reduction

There are four key approaches to public awareness for disaster risk reduction: Campaigns, participatory learning, informal education, and formal school-based interventions.Let's take formal school based interventions to learn in detail.

Formal school-based interventions:

The focus of formal school-based interventions cover two areas: school disaster management and disaster risk reduction in school curricula. These are considered to be formal because accountability and responsibility for school safety and curricula belong exclusively to education authorities, so they require support for long-term planning and capacity building.

School disaster management:

The primary goals of school disaster management are to ensure the safety of students and staff. Sustained school disaster management requires the familiar participatory and on-going process of identification of hazards and risks, mitigation and reduction of risks, and developing response capacity.

A school disaster management plan, developed at the school level, should be the living document that expressesthe awareness of public for disaster risk reduction. Every school has to setup the following school disaster committees:

1. Coordination Committees

2. Awareness generation Team
3. Search Rescue and Evacuation Team
4. Site safety Team
5. First Aid Team
6. Warning and Information Team
7. Bus safety Team
8. Water / Food Arrangement Team.

All the teams should participate in the mock drill.

Mock drillsform a vital part of the school disaster management process, and provide an intensive learning experience. They should be followed by reflection and assessment by all members of the school community. Lessons learned are incorporated into the school disaster management plan, and goals set for improvement next time. Depending on hazards faced, there are several major types of drills that can be practiced:

Disasters and Rules of actions during disasters

Earthquake

An earthquake is sudden, rapid shaking of the ground caused by the shifting of rocks beneath the earth's surface. Earthquakes strike suddenly without warning and can occur at any-time. The impacts of the earthquakes include deaths, injuries and damage of property. You have learnedabout occurrence of the earthquake and other related information in the earlier part of the book.

Nepal - India Earthquake

The April 2015 Nepal Earthquake (also known as the Gorkha Earthquake) killed nearly 9,000 people and injured nearly 22,000. It occurred on 25 April, with a magnitude of 8.1 Richter scale. Its epicentre was east of Gorkha District at Barpak. It was the worst natural disaster to strike Nepal since 1934 Nepal-Bihar earthquake. The earthquake triggered an avalanche on Mount Everest, killing 21 people making April 25, 2015 the deadliest day on Nepal's history. The earthquake triggered another huge avalanche in the Langtang Valley, where 250 people were reported missing.

Mock drill: Earthquake

In case we are inside the class when earthquake occurs, instruct loudly "earth quake position - drop, cover, and hold on". Drop down on your knee. Cover your head, neck and face. Go under a table to protect your head.

Rules of actions during an earthquake:

1. Stay calm, do not panic.
2. If you are in a building, sit down on the floor under a table or any other furniture and firmly hold on to it until the earthquake has stopped.

3. If there is no table nearby, cover your face and head with your hands and sit on the floor in a corner of the room.
4. Keep away from glass windows, glass doors and things that can fall down.
5. Do not try to leave the building quickly; during earthquakes people mostly die because they try to run out of thebuilding and become trapped under ruins if the building is destroyed.
6. Do not go to the staircase, a balcony or an elevator.
7. If you are in the street, keep away from buildings; try to get into an open space and avoid power transmission lines.
8. If you are at home, turn off electrical equipment and gas quickly.
9. If you are in chemistry class or a laboratory where chemicals are stored, try to leave the room because chemicals may cause injuries;

After earthquake:

1. First check if you have any injuries, and then check the condition of the surrounding people. If you cannot do this, wait for the rescue team;
2. After the earthquake when you leave the shelter, do not return for 2-3 hours because the quakes may repeat (an aftershock).
3. Check if there is fire; in case of a mild one try to extinguish it.
4. Be cautious about the possibility of gas leakage and damage caused to electrical wiring.
5. Be careful while opening wardrobe doors to take necessary items;
6. Use only lanterns; do not use an oil lamp or a candle.
7. Listen to the radio to receive information about the earthquake.

Landslide

A landslide is defined as the movement of a mass of rock debris down a slope. Landslides are caused by the directinfluence of gravity. Landslides can be caused by rainfall, snowmelt, stream erosion, and flood, earthquakes, volcanic activity, disturbance by human activities, or any combination of these factors.Landslides cause property damage, injury and death and adversely affect a variety of resources. For example, water supplies, fisheries, sewage disposal systems, forests, dams and roadways can be affected.

During a Landslide

1. Listen for any unusual sounds that might indicate moving debris, such as trees cracking or boulders knocking together.
2. If you are near a river, be alert for any sudden increase or decrease in water flow and for a change from clear to muddy water. Such changes may indicate landslide activity upstream, so be prepared to move quickly.
3. Be alert especially when driving. Embankments along roadsides are particularly susceptible to landslides.
4. Disconnect the power supply in the areas of landslide.

After the Landslide

1. Stay away from the slide area. There may be danger of additional slides
2. Check for injured and trapped persons near the slide, without entering the direct slide area.
3. Direct rescuers to their locations.
4. Listen to local radio or television for the latest emergency information
5. Watch for flooding, which may occur after a landslide or debris flow.

Cyclone

The major natural disaster that affects the coastal regions of India is cyclone and as India has a coastline of about 7516 km; it is exposed to nearly 10 percent of the world's tropical cyclones.About 71 percent of flood prone areas are in ten states (Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Pondicherry, Andhra Pradesh, Orissa and West Bengal). The islands of Andaman, Nicobar and Lakshadweep are also prone to cyclones.

Districts in Tamil Nadu which are frequently affected by cyclones: All the 13 coastal Districts of Tamil Nadu are affected by cyclonic storms which occur during May-June and in October-November months. These Districts are: Tiruvallur, Chennai, Kancheepuram, Villupuram, Cuddalore,Nagapattinam, Tiruvarur, Tanjavur, Pudukkottai, Ramanathapuram, Tuticorin, Tirunelveli and Kanniyakumari.

On an average, about five or six tropical cyclones form in the Bay of Bengal and Arabian sea and hit the coast every year. Out of these, two or three are severe. When a cyclone approaches to the coast, a risk of serious loss or damage occurs from severe winds, heavy rainfall, storm surges and river floods. The effect of a storm surge is most pronounced in wide and shallow bays exposed to cyclones such as in the northern part of Bay of Bengal. Most cyclones occur in the Bay of Bengalfollowed by those in the Arabian Sea and the ratio is approximately 4:1. During the cyclonic of cyclonic storms, wind speed is between 65 km/h and117 km/h.

Rules of action before a cyclone

1. Go to high-lying places from low-lying areas
2. Those residing in old buildings should temporarily relocate to safer buildings; Jewels and documents should be kept in safe custody.
3. Battery-operated radio, plastic torchlight, lamp, kerosene, match-box should be kept safely for future use.
4. Keep in ready all the first-aid kit and material available with you.
5. Keep in stock foodstuffs, material, fuel, drinking water and life-saving drugs needed for the next week.
6. It is also important to take cattle and other pets to safer places.
7. It is important to know that if we see quickly approaching storm clouds it is possible to predict strong winds several minutes in advance.

During a cyclone

1. If you are in a building during a strong gust, it is necessary to close and fasten windows and doors. It is better to stay in the rooms.
2. Turn off all electrical devices.
3. Protect yourself with your hands or a scarf. Protect the eyes, nose and mouth from dust.
4. If you are in a wildlife area, try to find a place protected from the wind. If there is no such place nearby, lie down on the ground.
5. If you are in a car it is better to stay there and close the windows. Do not park the car under unstable objects that can break down and fall on the car.

After cyclone

1. Turn off electricity, gas and water and unplug all electric appliances.
2. Beware of snakes and other animals immediately after the cyclone.
3. Do not go for sightseeing.
4. Stay away from damaged power lines, falling trees and flood water.
5. Boil and purify water before drinking.

Flood

Flood destructions have always brought miseries to numerous people, especially in rural areas. Flood results in the outbreak of serious epidemics, specially malaria and cholera. Simultaneously, scarcity of water also arises. It has a drastic effect on agricultural produce. Sometimes, water remains standing over large areas for long span of time hampering the Rabi crops.

India is one of the most flood prone countries in the world. The principal reasons for flood lie in the very nature of natural ecological systems in this country,namely, the monsoon, the highly silted river systems and the steep highly erodible mountains, particularly those of the Himalayan ranges. The average rainfall in India is 1,150 mm with significant variation across the country. The annual rainfall along the western coast and the Western Ghats, Khasi hills and over most of the Brahmaputra valley amounts to more than 2,500 mm. Twenty-three of the states (29) and union territories (6)in the country are subject to floods and 40 million hectares of land, roughly one-eighth of the country's geographical area, is prone to floods. The National Flood Control Program was launched in the country in 1954.

Mock Drill means Practicing of something that can happen in future so that it can be easily dealt with in.

- Tropical Cyclone Vardha hit Chennai on 12 December, 2016. National Disaster Management Authority (NDMA) reports that at least 10 people have died in Tamil Nadu.

- Maximum sustained wind speeds of over 130 km/h were recorded, and the storm has caused severe damage to parts of the city of Chennai. Over 4,000 trees have been uprooted, power lines downed and buildings damaged.

Do's before flood

1. Keep furniture and electrical appliances on beds and tables
2. Put sandbags in the toilet bowl and cover all drain holes to prevent sewage back flow.
3. Keep your mobile charged
4. Listen to radio or watch television for the latest weather bulletin and flood warnings.
5. Keepstrong ropes, a lantern, battery operated torches, extra batteries ready.
6. Keep umbrellas and bamboo sticks with you for protection from snakes.

Drought

The above map shows most the acute shortage of water in Tamil Nadu in 10 years. (2017)Drought is a period of time (months or years) during which a part of the land has shortage of rain, causing severe damage to the soil, crops, animals, and people. It sometimes causes even death. During drought high temperature is experienced. Such conditions may affect our health.

The primary cause of drought is deficiency of rainfall and in particular, the timing, distribution and intensity. In India around 68 percent of the country is prone to drought. Of the entire area 35 percent receives rain falls between 750 mm and 1,125 mm which is considered drought prone while 33percent areas receive rainfalls less than 750 mm is considered to be chronically drought prone.

Rules of action before, during and after Drought

Before drought:

1. Rainwater harvesting should be followed.
2. Sewage water should be recycled and used for domestic purpose.
3. Building canals or redirecting rivers for irrigation.
4. Utilise water economically.

During drought:

1. Wear cotton clothing and a hat.
2. In case of overheating, immediately move to a shady area.
3. Consume adequate amounts of water stay.

After drought:

1. If anyone faints after sunstroke, emergency medical measures should be taken.
2. Contact local government agencies to receive information about disaster and assistance for the population.

Lightning

Lightning is an atmospheric electrostatic discharge (spark) accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. Lightning generates 10-20 ampere currentand it is therefore fatal. It is especially dangerous for people in an open area.

- You can hear thunder from about 16 km of its starting point.
- Lightning bolts travel at the speed of up to 80,000 km / second.
- The average length of a single lightning bolt is 3-4km.

Lightning strikes often have fatal consequences. On an average, 2000 people die from lightning in the world every year. Lightning mostly strikes tall things, such as trees that break down and catch fire or it may strike power transmission linesand antennas fastened on roofs and buildings which causing fire. The air temperature, when lightning occurs, is as hot as 9982.2 °C.

Thunder is the sound caused by lightning. A charged, superheated lightning bolt creates a "resonating tube" as it travels. The air in the tube rapidly expands and contracts causing vibrations that we hear as the rumble of thunder.Lightning strikes can explode a tree. Imagine 15 million volts of electricity hitting a tree branch. The heat travels through the tree, vaporizing its sap and creating steam that causes the trunk to explode.

Before lightning

1. If you are planning to go to the countryside, check the weather forecast.
2. If a thunderstorm is expected it is better to postpone the trip.
3. It is good if you can estimate the distance to the front line of a thunderstorm. In order to do this you must check the time interval from the moment you see the lightning until you hear thunder. Lightning always precedes thunder. We know that the sound speed travels on average about 1km every 3 seconds. Reduction of the time interval between the sight of lightning and the resulting thunder means that the danger is approaching and protective measures must be taken. If there is no interval between lightning and thunder means, it means that the cloud is already over your head.

During Lightning:

1. If you are in a building it is necessary to close windows, doors, ventilation pipes and chimneys.
2. It is necessary to turn off the telephone, TV set, and other electrical equipment because lightning may strike electrical cables and pass through wiring.

3. Do not take a shower because both water and metal conduct electricity.
4. Do not light the fireplace because the heat coming from the chimney may attract lightning.
5. It is better to stay away from electric wires, lightning rods, water pipes, antennas and windows.
6. If you are in an open area during a thunderstorm, do not stand under a tall tree. Lighting is most damaging for tall trees. It is better to stay 30-40 meters away from them. Avoid trees that are standing separately. Remember that lightning does not strike bushes.
7. If the area is open, it is better to find a lower place or a cavity and squat there.It is dangerous to stand or lie down on the ground, because this increases the exposure area.
8. It is necessary to get rid of metal items such as a bicycle, coins etc.
9. Do not stand under an umbrella.
10. Do not run during the occurrence of lightning; move slowly towards a shelter because the air flow may attract lightning;
11. If you are in a car, do not get out. It is better to close the windows and turn of the antenna. Do not park your car under tall trees or any structures that may fall down and hit you.
12. If there is an injured person next to you, remember that the victim may lose consciousness. It is necessary to provide first aid.
13. Cover your mouth with a wet cloth in order to protect your lungs.

Glossary

1. **Disaster:** A serious disruption of the functioning of a society involving human, and material, and impacts that exceed the ability of the affected society to cope using its own resources.
2. **Disaster risk reduction:** The practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters.
3. **Mitigation** : The lessening of the adverse impacts of hazards and related disasters
4. **Preparedness:** The capacity developed by organizations, to effectively anticipate, respond to, and recovers from the impacts of disaster events.
5. **Prevention**: The outright avoidance of adverse impacts of hazards and related disasters.
6. **Public awareness:** The extent of common knowledge about disaster risks, the factors that lead to disastersand the actions that can be taken, to reduce vulnerability to hazards.
7. **Resilience:** The ability of a society exposed to hazards to resist, absorb, adapt to and recover from the effects of a disaster.
8. **Hyogo Framework for Action–** A global blueprint for disaster risk reduction efforts between 2005 and 2015 – by providing specific operational guidance for promoting disaster risk reduction.

1. POPULATION GEOGRAPHY

Introduction

Do you know that 3, 60, 000 persons born every day in the world? Four births take place every second in the world. 'Professor Stephen Hawking thinks the human species will have to populate a new planet within 100 years if it is to survive,' the BBC confirmed.

'With climate change, overdue asteroid strikes, epidemics and Population growth, our own planet is increasingly precarious,' the news outlet continued.

Human being is an important element of the environment and is probably the latest occupant of the earth, as its evolution took place less than two million years ago. Although distribution and growth of human population are influenced greatly by the physical environment, they have tremendous capacity to modify the physical environment. **Demography** is the statistical study of human population. It includes the study of size, structure and distribution of population as well as changes in time and location in response to birth, migration, aging and death. **'Population explosion'** is one of the greatest challenges that we are facing today.

Distribution of world population

People have inhabited the earth for several thousands of years, but for a long period of time, their numbers remained limited. It is only during last few hundred years that human population has increased at an alarming rate. Population is spread unevenly across the continents. Only a few areas support large concentration of people while vast areas support the factors influencing the distribution few people. A large number of factors influence the distribution and growth of population over the earth's surface.

The factors influencing the distribution of population

1. Relief

Rugged mountains pose various obstacles such as unsuitable conditions for the construction of rail-roads and highways, unfavorable conditions for agricultural crops because of short growing season, lack of cultivable land and snowy winters do not encourage large settlement areas. Hence, the mountainous areas support a few people. On the other hand, a large concentration of population is found in the fertile lowlands such as the Ganges and Brahmaputra in India, Hwang-Ho in China and plains of North-Western Europe and the USA. This is mainly due to flat level land which is fertile, favorable conditions for agriculture, long growing seasons and suitable condition for the settlement.

2. Accessibility

Areas with well-developed transport infrastructure and links through road, rail, shipping, canals and air are likely to be more densely populated than areas which are poorly connected with transport network.

In earlier times, in the absence of water transport, all islands remained virtually uninhabited. One of the reasons why mountains are not inhabited by people is lack of accessibility.

3. Adequate water supply

Population distribution is affected very much by the presence or absence of water in any region. Water supply is essential for human survival and development. Areas which have sufficient water tend to have denser population than areas which are dry or suffer from regular drought. Well watered regions of the Great Northern plains of India are densely populated whereas drought prone areas of Sahara are sparsely populated.

4. Soil

Fertile alluvial soils of river valleys throughout the world have encouraged dense settlement of population because they support Agricultural activities. The high density of population in parts of East and South-East Asia is dependent mainly on fertile soil. For example, dense population is found in the Ganges valley of India, in Indus valley of Pakistan and Hwang-Ho valley of China. On the other hand, desert soil of Sahara region is sparsely populated.

5. Economic and political factors

Unfavorable economic condition, unemployment, religious intolerance, conflicts and wars do not favour more population.

The patterns of Population Distribution

The analysis of the pattern of population distribution and density is fundamental to the study of demographic characteristics of any area. The population distribution refers to the way the people are spread over the earth's surface. The population distribution is uneven worldwide. Ten most populous countries of the world together make up nearly 60% of the world's population.

Density of Population

Absolute numbers do not give any indication of the impact of population on the land and its resources. The number of persons living per unit of land areas gives a better picture. This is expressed in the form of density of population per sq.km of land area.

Density of population = Total population
Total area of the country

It is obtained by dividing the total land area by the total population, the quotient being the number of people per square kilometer. Compared with simple arithmetic density, physiological or nutritional density is a more refined method of calculating man-land ratios.

Physiological or Nutritional density is the ratio between total population and total cropped area. The total arable land in the world is **13.3%** and the nutritional density of the world is **325 per sq.km** of land. The total percentage of arable land is 48.83 in India and its nutritional density is 753 per sq.km of land. Singapore has the highest nutritional density of population of **440,998 per sq.km** of land the world. The areas of density of population can be divided into three as follows:

1. High density areas of population

Fertile plains with favorable climate and highly industrialised and urbanised areas are generally densely populated. There are four major areas of high density of population with more than 100 persons per sq.km. Areas include:

a. Eastern Asia, including china, Japan and Republic of Korea.
b. Southern Asia, comprising India, Bangladesh and Sri Lanka.
c. North-Eastern part of the United States of America.
d. Central and North-Western Europe. Of the four regions given, the first two i.e. Eastern Asia and South Asia have high density of population due to favourable environmental conditions such as favourable climate, fertile soil and large areas of plains which encourage the growth of agriculture. The plains and river valleys of India and China are densely populated. In the last two groups i.e. North Eastern United States of America and North – Western Europe which are densely populated due to the concentration of manufacturing industries.

HOTS

Why has Singapore the highest physiological/nutritional density of population in the world?

2. Moderate density areas of population

The areas of moderate density of population have between 10 and 80 persons per sq.km. The areas of moderate density of population include Central part of the United States of America, Tropical Western Africa, Western blocks of Russia, Eastern Europe, Deccan Plateau of India, Central China, Southern portion of the Plateau of Mexico, North-Eastern Brazil and Central Chile, The above areas are characterized by the well-developed agricultural activities, favorable climate, fertile soils, fishing, etc.,.

3. Low density areas of population

About half the area of the world has population less than 10 persons per sq.km. Certain vast areas remain completely uninhabited. The main areas are

a. Amazon forest region of South America and Congo forest region of Africa.

b. Arctic area of Canada, Greenland and the Polar regions.

c. Great deserts of the world i.e. Sahara, Kalahari, Arabia, Great desert of Australia, Atacama Desert of South America, desert regions of Western United States and Thar Desert of India.

d. High mountainous regions in all continents.

e. Antarctica.

Australia with an average density of population of 2 persons per sq.km is one of the most sparsely populated countries of the world. However, inhabitants of these areas have high standard of living. The reasons for low density of population are

a. Bad and unfavorable Environment conditions for human settlement.
b. Lack of economic activities.
c. Lack of transport and communication.
d. Government policy.

Terms related population

1. Population: A group of individuals of the same species occupying a particular geographic area.

2. People: The members of a particular nation, community, or ethnic group.

3. Crude Birth rate (Natality Rate): Number of live births per thousand people in a year.

4. Crude Death Rate (Mortality Rate): Number of deaths per thousand people in a year.

5. Net Migration Rate: the formula for net migration rate is simple:

$N = 1000 \times (I - E) / P$

N= net migration rate

E= number of people emigrating out of the country

I= number of people immigrating into the country

P= the estimated mid-year population

6. Fertility Rate: is the number of live births expected per 1000 women in their life times in a specified geographic area and for a specific point in time, usually a calendar year. Niger has the highest fertility rate of 6.49 while Singapore has the lowest fertility rate of 0.83. Can you guess why there is variation between these countries?

7. Dependency ratio: Number of dependents in a population divided by the number of working age people. It's a calculation which groups those aged under 15 with those over 65 years as the 'dependants' and classifying those aged 15-64 years as 'the working-age population'.

8. Growth Rate: = CBR – CDR +/- Net Migration Rate/ 1000

South Sudan has the highest population growth rate of 3.83% in 2017.

9. Rate of Natural Increase (RNI) = CBR-CDR (No Migration) CBR>CDR = ↑ population RNI usually expressed as % e.g., 2% = 2/100 = 20/1000 RNI ≠ population growth if migration significant 10. Adult Literacy Rate: The Adult literacy index (ALI) is a statistical measure used to determine how many adults can read and write in a certain area or nation. Adult literacy is one of the factors in measuring the Human Development Index (HDI) of each nation, along with life expectancy, education, and standard of living. Burkina faso has the lowest literacy rate of 21.8% (2015). How does literacy rate affect the standard of living of a country? 11. Life expectancy rate: Life expectancy equals the average number of years a person born in a given country is expected to live. As of 2015, the country with the highest life expectancy is Monaco at 89.52 years; the country with the lowest is Chad at 49.81 years.

Growth of world population

After the introduction of agriculture about 8,000 to 12,000 years ago, the size of population was small, roughly 8 million. In the first century (C.E) it was below 300 million. The expanding world trade during the sixteenth and seventeenth Century set the stage for rapid population growth. Around 1750, at the dawn of Industrial Revolution, the world population was 550 million. World population exploded in the eighteenth century after the Industrial Revolution. Technological advancement achieved so far helped in the reduction of birth rate and provided a stage for accelerated population growth.

The current world population of 7.6 billion is expected to reach 8.6 billion in 2030, 9.8 billion in 2050 and 11.2 billion in 2100, according to a new United Nations report being launched. With roughly 83 million people being added to the world's population every year, the upward trend in population size is expected to continue, even assuming that fertility levels will continue to decline.

The current world population, according to UN Department of Economic and Social Affairs, Feb, 2019, is 7,685,036,620.

The new projections include some notable findings at the country level. China **(with 1.4 billion inhabitants) and India (1.3 billion inhabitants) remain the two most populous countries, comprising 19% and 18% of the total global population respectively**. In roughly seven years, or around 2024, the population of India is expected to surpass that of China.

Among the ten largest countries worldwide, **Nigeria** is growing the most rapidly. Consequently, the population of Nigeria, currently the world's 7th largest, is projected to surpass that of the United States and become the third largest country in the world shortly before 2050.

Most of the global increase is attributable to a small number of countries.

From 2017 to 2050, it is expected that half of the world's population growth will be concentrated in just nine countries: India, Nigeria, Congo, Pakistan, Ethiopia, the United Republic of Tanzania, the United States of America, Uganda and Indonesia (ordered by their expected contribution to total growth).

The group of 47 least developed countries (LDCs) continues to have a relatively high level of fertility, which stood at 4.3 births per woman in 2010-2015. As a result, the population of these countries has been growing rapidly, at around 2.4 % per year. Although this rate of increase is expected to slow significantly over the coming decades, the combined population of the LDCs, roughly one billion in 2017, is projected to increase by 33 % between 2017 and 2030, world population will reach 9.7 billion in 2050.

Similarly, Africa continues to experience high rates of population growth. Between 2017 and 2050, the populations of 26 African countries are projected to expand to at least double their current size.

The concentration of global population growth in the poorest countries presents a considerable challenge to governments in implementing the 2030 Agenda for Sustainable Development, which seeks to end poverty and hunger, expand and update health and education systems, achieve gender equality and women's empowerment, reduce inequality and ensure that no one is left behind.

Population in the world is currently (2019) growing at a rate of around 1.09% per year (down from 1.12% in 2017 and 1.14% in 2016). It is estimated to reach 1% by 2023, less

than 0.5% by 2052, and 0.25% in 2076. In 2100, it should be only 0.09% or an addition of only 10 million people to a total population of 11.2 billion. World population will, therefore, continue to grow in the 21st century.

Doubling Time of population

Doubling time is the amount of time it takes for a given quantity of population to double in size at a constant growth rate. We can find the doubling time for a population undergoing exponential growth by using the Rule of 70. It is because the population of a country becomes double in 70 years if the growth rate is 1%. Thus, we divide 70 by the growth rate and we get the doubling time of population growth rate. For example if the growth rate is 2.08, divide 70 by 2.08 and we get 33.6 years as the doubling time of population.

World population has doubled in 40 years from 1959 (3 billion) to 1999 (6 billion). It is now estimated that it will take another nearly 40 years to increase by another 50% to become 9 billion by 2037. The latest world population projections indicate that world population will reach 10 billion persons in the year 2055 and 11 billion in the year 2088.

World Population Milestones

According to the United Nations, the 6 billion figures were reached on October 12, 1999 (celebrated as the Day of 6 Billion). World population reached 7 Billion on October 31, 2011. The current world population is 7.7 billion as of Feb 2019 according to the most recent United Nations estimates. The United Nations projects world population to reach 8 billion in 2023 and 10 billion in the year 2056.]

Regional division on the basis of growth rate

On the basis of the growth rate of population the world can be divided into the following three types of areas:

1. Areas of Low Growth Rate

Developed countries like US, Canada, Japan, Australia, New Zealand and countries of western Europe have a low growth rate of population in these countries is due to low birth rates and low death rates. The difference between the birth rate and the death rate in these countries is the lowest.

2. Areas of Moderate Growth Rate

This category includes the developing countries like Pakistan, Afghanistan, Brazil, Bolivia, Mongolia, Indonesia and many other Africa and South American countries, where the growth rate of nearly 2 % is also included among these countries though the growth rate here has started declining.

3. Areas of High Growth Rate

Countries like Mexico, Iran, Colombia, Venezuela, Peru, Libya, Algeria, Sudan, Kenya and Kuwait make this category. In fact, most of the African countries with a growth rate of 3% fall in this category.

Population Concepts

i. **Over population:** situation whereby the population is considered too large for the available resources.

ii. **Under – population:** a situation where the population is less than the available resources of a country.

iii. **Optimum – population:** a situation where the number of people that can be supported is the same as the available resources.

FACT FILE

India - Population

- The current population of India is 1,363,413,725 as of Feb 19, 2019, based on the latest United Nations estimates.
- India population is 17.74% of the total world population.
- India ranks number 2 in the list of countries (and dependencies) by population.
- The population density in India is 455 per Km2.
- 33.6 % of the population is urban (460,249,853 people in 2019)

Composition of Population

Composition of Population includes sex ratio, literacy rate, age pyramids etc.

Sex Ratio

The sex ratio is the ratio of males to females in a population.

FACT FILE

Qatar-315 Males per 100 females (2019)

With an astounding ratio of 315 males to a 100 females, Qatar holds the number one spot among **countries with the highest male to female ratio in the world in 2018.**

As of 2014, the global sex ratio at birth is estimated at 107 boys to 100 girls (1000 boys per 934 girls).

The sex ratio of India is 933 females for every 1000 males according to 2011.

Kerala has the highest sex ratio in the country with 1084 females for 1000 males followed by Puducherry with 1037 females for 1000 males and Tamil Nadu with 996 females for 1000 males.

Do you know?

Cisgender (often abbreviated to simply cis) is a term for people whose gender identity matches the sex that they were assigned at birth. It is the opposite of the term **transgender.**

What Are Population Age Pyramids?

Population pyramids are graphical representations of the age and sex of a population. For this reason, population pyramids are also referred to as **age-sex pyramids**. We refer to these graphs as pyramids because they are usually shaped like triangles and population pyramids also take other shapes. Population pyramids usually have males on

the left side and females on the right. There is also a vertical line in the middle of the graph that separates the males from the females.

FACT FILE

Latvia, country with the highest sex ratio in the world.

Latvia is a former Soviet Union country and experienced a great decline in male population during World War two. By 2015, there were 84.8 males for every 100 females. The proportion of the female was 54.10% of the total population. Men in Latvia have a high mortality rate due to issues such as alcoholism, smoking, and careless car driving. Around 80% of suicides in Latvia are committed by men, often because of unemployment and unrealized financial goals. Women enjoy a longer life expectancy living 11 years more than men.

Literacy Rate

Total number of literate persons in a given age group, expressed as a percentage of the total population in that age group.

Literacy rates continue to rise from one generation to the next. Yet according to new data from the UNESCO Institute for Statistics, there are still 750 million illiterate adults, two-thirds of whom are women. These numbers are a stark reminder of the work ahead to meet Sustainable Development Goals (SDGs) 4 and 5 and the Education 2030 targets.

Literacy rate variations between states in India

India's literacy rate is at 74.04%. **Kerala** has achieved a literacy rate of **93.91%. Bihar** is the least literate state in India, with a literacy of **63.82%.** Several other social indicators of the two states are correlated with these rates, such as life expectancy at birth (71.61 for males and 75 for females in Kerala, 65.66 for males and 64.79 for females in Bihar), infant mortality per 1,000 live births (10 in Kerala, 61 in Bihar), birth rate per 1,000 people (16.9 in Kerala, 30.9 in Bihar) and death rate per 1,000 people (6.4 in Kerala, 7.9 in Bihar).

Six Indian states account for about 70% of all illiterates in India: Uttar Pradesh, Bihar, Madhya Pradesh, Rajasthan, Andhra Pradesh and West Bengal. Slightly less than half of all Indian illiterates (48.12%) are in the six Hindi-speaking states of Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh, Jharkhand and Chhattisgarh.

Age - Sex pyramids

There are three types of Age - Sex pyramids: expansive, constrictive, and stationary

Expansive Age - Sex pyramids depict populations that have a larger percentage of people in younger age groups. Populations with this shape usually have high fertility rates with lower life expectancies. Many third world countries have expansive Age - Sex pyramids. Such a population pyramid is a characteristic of newly developing countries such as Afghanistan, Bangladesh, Kenya, and some countries of Latin America.

Constrictive Age - Sex pyramids are named so because they are constricted at the bottom. There are a lower percentage of younger people. Constrictive Age - Sex pyramids

show declining birth rates, since each succeeding age group is getting smaller and smaller. **The United States has a constrictive Age - Sex pyramid.**

Tripura Literacy success

Presently **Tripura** has the **highest** literacy rate in India**, 94.65 percent.** According to the 2011 census, literacy level was 93.91 percent in Kerala and 91.58 percent in Mizoram, among the most literate states in the country. The national literacy rate, according to the 2011 census, was 74.04 percent. The Tripura success story is attributed to the involvement of local government bodies, including Gram panchayats, NGOs and local clubs under the close supervision of the State Literacy Mission Authority (SLMA) headed by the chief minister. Tripura attained 87.75 percent literacy in the 2011 census, from the 12th position in the 2001 census to the 4th position in the 2011 census. Among projects implemented by the state government to increase literacy in the state are

- 10,000 anganwadi centres have 100 percent enrollment.
- Policy of no fail till class VIII to prevent children from dropping out.
- Midday meals in all schools with an eclectic menu for all days of the week to attract more students.
- No tuition fee in government colleges.

The holistic education system, implemented with equal interest in Agartala, remote areas and the tribal autonomic areas makes sure that people in Tripura do not just become literate but educated, officials emphasized. One pointer to the government's interest in education is the near-total absence of child labor in Tripura.

Stationary Age-sex pyramids

Stationary Age - Sex pyramids are those that show a somewhat equal proportion of the population in each age group. There is not a decrease or increase in population; it is stable. **Austria has a stationary**
Age - Sex pyramid.

The Purpose of the Age - Sex Pyramid

The purpose of making this Age - Sex pyramid is to find out the comparison between the number of men and women, the number of workers, and the structure of the population in a country quickly. In addition, the creation of the Age - Sex Pyramid also has a purpose to assist the government in taking development policies.

Migration

Migration means the movement of people from one place to the other. It is an important control of population growth after fertility and mortality. Migration of people into an area from outside is called immigration or in-migration while movement out of an area to other regions is called emigration or out-migration.

Immigration leads to an increased growth rate of population, emigration lowers the growth rate of population in the source region. Mexico's emigration problem is a unique one, with more than 98% of all Mexican migrants living in the U.S.A, the country with

which Mexico shares a border that runs 3110 km in length. The Mexican emigration rate increased substantially since the 1960s and, with more than 11% of Mexicans living abroad, **Mexico is the country with the largest number of emigrants in the world.** According to estimates from the UN 2015 report, in 2013, the **United States, Germany** and **Russia** had the largest number of immigrants of any country, while **Tuvalu** and **Tokelau** had the lowest immigrant.

Types of migration

1 Net Migration

Net Migration is the difference between immigration (in-migration) and emigration (out-migration).

Positive value of net migration is that more people coming in and population growth, for example, 44% of North America and 88% of Europe. Negative value of migration is more people coming out and population decline.

2 International Migrations

Emigration is an indicator of economic and or social failures of a society. It is a crossing of a national boundary. It is easier to control and monitor. There are laws to control or inhibit these movements. Between 2 million and 3 million people emigrate each year. Between 1965 and 2000, 175 million people have migrated: it accounts for 3% of the global population.

3 Internal Migrations

It occurs within a country. It is crossing of population within domestic jurisdictional boundaries. It is the movement of people between states or provinces. There is little government control over internal migration.

4 Local Migrations

Local migrations are the migration of the people within state or district. No state boundaries are crossed in the local migration. It happens for several reasons such as buying a new house in the same town or city, difficult to research since they are usually missed in census data. It is based on change of income or lifestyle. Americans change residence every 5 to 7 years.

5 Voluntary migrations

Voluntary migrationsare where the migrant makes the decision to move. Most migration is voluntary.

6 Involuntary migrations

It is a forced migration in which the migrant has no role in the decision-making process. It includes mostly slavery. It is estimated that about 11 million African slaves were brought to the Americas between 1519 and 1867. In 1860, there were close to 4 million slaves in the United States. People involve in the involuntary migration are refugees due to military conscription, children of migrants, people in the situations of divorce or separation.

Brain Drain

Brain drain is related to educationally specific selective migrations. Some countries are losing the most educated segment of their population. It can be both a benefit for the receiving country and a problem to the country of origin.

Receiving country: it is getting highly qualified labor which is contributing to the economy right away. It promotes economic growth in strategic sectors: science and technology. It does not have to pay education and health costs, for example, 30% of Mexicans with a PhD are in the US.

Country of origin: Education and health costs are not paid back to the country of origin. It is losing potential leaders and talent: Between 15 and 40% of a graduating class in Canada will move to the US. It has long term impact on economic growth. It has the possibility of getting remittances. Many brain drain migrants have skills which they can't use at home: The resources and technology may not be available there. The specific labor market is not big enough.

Causes of Migration

We can divide factors causing migrations into two groups of factors as push and pull Factors.

Push and Pull factors Push and pull factors are those factors which either forcefully push people into migration or attract them. A push factor is forceful, and a factor which relates to the country from which a person migrates. A pull factor is something concerning the country to which a person migrates. It is generally a benefit that attracts people to a certain place. Push and Pull factors are usually considered as north and south poles on a magnet.

Push Factors: Not enough jobs, few opportunities, desertification, famine/ drought, political fear/ persecution, poor medical care, loss of wealth, natural disasters, death threats, slavery, pollutions, poor housing, landlords, bullying and poor chances of finding courtship

Pull Factors: job opportunities, better living conditions, political and or religious freedom, enjoyment, education, better medical care, security, family links, industry, better chances of finding courtship.

Overpopulation

Overpopulation is the state whereby the human population rises to an extent exceeding the carrying capacity of the ecological setting. In an overpopulated environment, the numbers of people might be more than the available essential materials for survival such as transport, water, shelter, food or social amenities. This regularly contributes to environmental deterioration, worsening in the quality of life, or even the disintegration of the population. Due to immigration, the decline in mortality rates, medical breakthroughs, and increased birth rates, populations will always increase and eventually gives rise to overpopulation.

Impacts of Overpopulation

Overpopulation thus contributes to some of the most compelling environmental problems which encompass:

1. Depletion of Natural Resources

As human population keeps on increasing, exhaustible natural resources such as arable land, coral reefs, fresh water, fossil fuels, and forests continue to drop sharply. This creates competitive demands on the vital life-sustaining resources and contributes to an incredible decline in the quality of life.

2. Accelerated Habitat Loss

The increased loss of the ecosystems including wetlands, wildlife, rainforests, coral reefs, aquatic life forms, and grasslands are highly influenced by overpopulation. For example, rainforests originally covered 14% of the entire earth's surface. Today, rainforest only cover about 6% of the earth's surface and scientists' project it may even become less in the next four decades judged by the current rate of vegetation removal, logging, and deforestation. Besides, due to environmental pollution, 30% of the ocean reefs have been lost because of acidification and global warming since 1980. Also, more than half of the original wetlands have been lost.

3. Amplified Climate Change and Global Warming

The more the number of people, the more the number of vehicles and industries would be. Furthermore, more population tends to increased use of energy sources such as coal and firewood which contributes to increased greenhouse gas emissions.

Hence, because of the accumulation of human generated greenhouse gases and carbon footprint in the atmosphere, the planet has continued to witness amplified global warming and climate change. The effects of climate change and global warming are resulting in extreme hunger, drought, flooding, and loss of habitat.

4. Loss of Biodiversity

Overpopulation has caused encroachment into frontier forests and destruction of natural ecosystems that has led to the mass extinction of species. The number of threatened species persists to multiply in number whereas some have completely gone extinct. This is because of human activities such as acidifying water, over exploitation of natural resources, pollution, over fishing, poaching, and destruction of natural systems which are necessary for the survival of different species.

5. Decrease of fresh water

The unrelenting nature of overpopulation on the earth has destroyed most of the world's fresh systems. Most of the lakes, streams, rivers and ground water making up fresh water have been polluted. According to the global outlook of water resources, these activities influenced by over population have only left less than 1% of the planet's fresh water readily accessible for human utilization.

Water vulnerability is already affecting many overpopulated nations, especially in some developing countries, as the demands for water tend to be more than the accessible water. Millions of fish species from freshwater ecosystems are on the verge of extinction. Thus, as human inhabitants rise in number, so will the problem of quality freshwater accessibility.

6. Lower Life Expectancy and Diminished Quality of Life

Overpopulation lowers the standards of living since it creates stress on the vital resources for survival and increases the difficulty of accessing the consistent supply of

quality food, water, energy, health, security and shelter. Consequently, it makes the poor to become poorer, and they often opt for poor living conditions to survive.

Eventually, it gives rise to lower life expectancy. The situation is serious in developing nations such as southern Asia and sub-Saharan Africa where most of the poor populations submit to inadequate and poor diets.

7. Rise in Unemployment, Crime Rate, and Violence

In overpopulated nations, the available jobs are fewer than the overall job seeking population. This contributes to high levels of unemployment. In turn, lack of unemployment leads to elevated crime rates because of theft, drug cartels, and militia groups which are exploited as options for attaining basic resources and necessities such as food, good living standards, and wealth. Violence and conflicts arise when people start competing for the available limited resources.

8. Increased Intensive Farming

As population has grown over the years, farming practices have evolved to produce enough food to feed larger numbers of people. However, intensive farming methods also cause damage to local ecosystems and the land, which may pose problems in the future.

Measures to control overpopulation

Here are some unique solutions to overpopulation:

1. Creating Awareness Campaigns

Using both social and mainstream media, we can clearly tell people around the world the truth about overpopulation crises and what must be done to solve them the right way.

2. Promotion of adopting child

Adoptions become a consideration for family planning, particularly among socially conscientious communities. And today, it has become a de-facto solution for people who are interested in starting a family, yet having concerns about overpopulation.

3. Aiming for Single-Child Families

According to statistics, hundreds of thousands of people are being added to the planet every day, which is an unsustainable rate. Hence, it is need of hour we should aim for single-child families.

4. National Security issue

Over populated countries should treat population boom as an issue of national security. As you can see, similar to food insecurity and climate change, uncontrolled and rapid population growth can be a national security threat in a way that it results to instability.

5. Changing Social Norms

Some couple chooses not to have children and we have to respect their decision. This way we will be able to help curb the problem of overpopulation.

6. Providing Tax Benefits or Concessions

Governments of various countries can come up with various regulations and policies related to tax exemption to help solve overpopulation. For example, they can waive certain parts of income tax or lower income tax rates for couples who have one or two children.

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2. HUMAN SETTLEMENTS

INDRODUTION

In simpler term we can define settlement as any form of human habitation which ranges from a single dwelling to a large city. A human settlement is defined as a place inhabited more or less permanently. It includes building in which they live or use and the streets through which they travel. It also includes the temporary camps of the hunters and herders. It may consist of only a few dwelling units called hamlets or big cluster of building called urban cities.

Origin and development of Settlement

Most anthropologists believe that humans first appeared in the Great Rift Valley of East Africa thousands of years ago. From there, they spread to the Middle East, Asia, Europe, America and Oceania. Neolithic Revolution (Agricultural Revolution) occurred in Mesopotamia, people went from hunter-gatherers and nomads to domesticators. The population grew relatively quickly. The emergence of urban population occurred also in some areas. Agriculture became especially successful largely in the river valleys of Nile, Ganges and Yangtze kiang.

These areas had fertile soil from annual flooding which led to abundant harvest. First cities arose in these areas and people were able to grow surplus food to feed a non-farming urban population thereby leading to specialization among the population. The priests, scribes, architects, farmers, soldiers, traders, blacksmiths, etc. were some other people ventured in these areas.

Site and Situation

Site

The Site of a settlement describes the physical nature of where it is located. Factors such as water supply, building materials, quality of soil, climate, shelter and defence were all considered when settlements were first established. For instance, the site of Sydney, in Australia, initially took advantage of the excellent natural harbor and surrounding fertile farmland.

Aspect and shelter are two of the most important factors that were considered when deciding where to locate a settlement. Aspect relates to the direction in which the land faces. In the Northern Hemisphere the best slopes to locate on are those that face south, as they will receive the most sunshine, and therefore be the best for agriculture. This can be seen clearly in many of the valleys of the Alps, where settlements have located on the south-facing slopes.

Shelter is also very important, particularly from the cold northerly winds and prevailing south westerly winds in the UK. A good example of settlements being sheltered by their natural surroundings are the many spring-line settlements found along the base of the chalk escarpments of the North and South Downs. These settlements would also have benefited from the good water source and fertile farmland nearby.

1. Water supply

Water supply is probably the single most important factor in deciding where a settlement might be located. Not only do rivers provide a source of clean drinking water, they also provide a food source through fishing, and a transport route. Most of the world's largest cities are located on rivers, especially the point at which they reach the sea, as this was often the first point that explorers landed.

2. Dry point sites

A dry point site is one that is slightly raised from the surrounding area, meaning that it is less likely to flood. Ely in Cambridgeshire, England, is a good example of dry point site.

3. Wet point sites

Wet point site refers to any site that has access to water, usually through being beside a river. Towns would either grow up along the river or clustered near the point at which the river enters the sea. Examples of wet point sites include the towns and villages of the Welsh valleys, which tend to extend along the flat valley floor, rather than up the steep valley sides. Spring line settlements in the North and South Downs, England are also good examples of wet point sites.

4. Defence

In medieval times, defence was one of the most important factors influencing the site of a settlement. The relief of the land often proved to be the best form of defence. Edinburgh castle sits on the top of a glacial crag, in an almost perfect position to defend itself, with very little chance for the attackers. In Italy, there are many walled hill-top villages, whilst the Maoris in New Zealand built their settlements (called Pa's) on the top of steep hills to prevent being attacked. In India, Ichhapur Defence Estate is a census town in Barrackpore, West Bengal.

The other common natural feature used for defence is water, and in particular rivers. Both Shrewsbury and Durham are very good examples of where a meander of the river has formed an area of land bounded by water on three sides. This provided both cities with excellent defence, as they only had a thin neck of land to defend.

5. Resources

The idea of resources covers a huge number of different things. For early settlers the most important resources were fuel, building materials and food. Settlements grew in areas where wood was plentiful, stone easily accessible and good soil allowed agriculture to be developed.

Since in early days of settlement many different resources have become the focal points for the growth of urban areas.

6. Mining

The coal mines of South Wales, Tin mines of Cornwall and large mining projects at Carajas in Northern Brazil, have all encouraged the rapid growth of settlements aimed at housing the workers and providing them with all that they require.

7. Precious metals

Settlements in South Africa have grown after the discovery of large deposits of precious metals such as gold. The most famous settlement Grew due to finding gold is San Francisco, after the gold rush to California in 1849.

8. Route centres

Route centres are often called Nodal Points. Nodal Points are formed by the meeting of two valleys, but settlement nowadays will grow where two main roads meet. In the UK, York is a good example of a route Centre. Birmingham also enjoys a very good location, where many routes join up, and this is one of the reasons for its growth to become one of the largest cities in the UK.

9. Bridging points

Just as water is very important for drinking, fishing, irrigation and navigation, so the ability to cross the rivers is also very important.

Many towns and cities have built up at points where it was the easiest to cross a large river. Exeter is one such example, crossing the river Exe in England.

However one of the best examples is Paris in France. The original town was based on the tiny Iledela Cite, which is an island in the middle of the River Seine. This island meant they could build two small bridges across the river rather than one large one.

Nowadays the island has been engulfed by the huge city that Paris has become, however it does still have many bridges going to it and is the point where the huge Notre Dame Cathedral is built.

10. The confluence of two rivers

Just as two valleys, or roads, make a nodal point for settlement growth, so do two rivers joining. One such example is found in Khartoum in Sudan, where the Blue and the White Nile meet. In India, Allahabad is located at the confluence of River Ganga and Yamuna and Bhavani (Tamil Nadu) is at the confluence of River Cauvery and Bhavani.

Situation

The situation of a settlement is the description of the settlement in relation to the other settlements and physical features around it. The situation of a settlement is the most important in determining whether it grows to become a large city or stays as a small town or village.

In the UK, Birmingham is an example of a city with excellent situation. It is located central to the country, with excellent links by road to the North and South to London.

As cities begin to fulfill different functions their importance can increase or decrease. Their situation plays an important part in deciding which of these functions will occur.

It refers to the location of the actual settlement. The initial choice of a site for a settlement depends on its meeting certain daily needs such as water supply, availability of potential farmland, building materials and fuels etc.

Settlements can broadly be divided into two types – rural and urban. Let us know some differences between rural and urban areas in general.

i. The major difference between rural and urban areas is the function. Rural areas have predominantly primary activities such as agriculture, whereas urban areas

have domination of secondary and tertiary activities such as manufacturing industries and service sectors.

ii. Generally the rural areas have low density of population than urban areas.
iii. Urban settlements are defined by their advanced civic amenities, opportunities for education, and facilities for transport, business and social interaction and overall better standard of living whereas rural areas lack of such amenities.
iv. Rural areas do not have pollution or traffic problems that beset regular urban areas.
v. In the rural society there was very little scope for occupational mobility. Incities there are many occupations, so occupational mobility is frequent.
vi. Rural people are less mobile and therefore the social relations among them are intimate. In urban areas, the way of life is complex and fast, hence, the social relations are formal.

Pattern of Rural Settlement

On the basis of forms or shapes of the settlements, rural settlements are classified as Linear, Rectangular, Circular, Star like, T-shaped village, Y-shaped village, Compact, Disperse, Planned, etc.

The settlement in which houses are constructed along a road, railway line, river, canal edge of a valley, or along a levee is known as Linear Pattern.

The settlements constructed in a rectangular shape are known as Rectangular Pattern. Such kind of settlements is found in plain areas and in wide inter-montane valley.

The settlements constructed in a circular shape are known as **Circular Pattern.** Such kind of settlement is found around lakes, tanks, or a planned village.

The settlements constructed in a star shape are known as Star like Pattern. Such kind of settlement is found around the points where several roads cross each other (making star shape).

Do you know?
Kraal is a group of houses surrounding an enclosure for livestock, or the social unit that inhabits these structures. The term has been more broadly used to describe the way of life associated with the kraal that is found among some African, especially South African, peoples. Kraal consists of a number of huts arranged in a circle around a cattle corral. Polygyny is common, and each wife has her own hut within the kraal. The head of the kraal may have custody of the property attached to the houses of his several wives.

The settlements in which houses are constructed at the tri-junctions of the roads are known as T-shaped Pattern. Such kind of settlement is found along the road, which meets with another road at the dead end (the straight going road ends) and bifurcates left and right (T-Shape).

The settlement, in which houses are constructed along the straight road, is known as **Y-Shape pattern**. It is further bifurcated into two roads (similar to Y shape).

Classification of Rural Settlement

Based on shape, the settlements are classified as

1. Compact or Nucleated Settlements

In the nucleated settlements, the houses are built very close to each other. Normally, fertile plain regions have such compact or nucleated settlements.

2. Dispersed Settlements

In such kind of settlements, houses are spaced far apart and often interspersed with fields; however, their market and some other activities are centralized where they participate together.

Urban settlement

The census of India, 1991 defines urban settlements as "All places which have municipality, corporation, cantonment board or notified town area committee and have a minimum population of 5000 persons, at least 75 per cent of male workers are engaged in non-agricultural pursuits and a density of population of at least 400 persons per square kilometers are urban settlements.

Evolution of Urban Settlement

The first urban settlement to reach a population of one million was the city of London by around C.E. 1810. By 1982 approximately 175 cities in the world had crossed the one million population mark. Presently 48 per cent of the world's population lives in urban settlements compared to only 3 per cent in the year 1800.

Stages of Urban Settlement

Depending on the size and the services available and functions rendered, urban centers are designated as town, city, million city, conurbation, Megalopolis.

Town (Population more than 5000 people)

The concept of 'town' can best be understood with reference to 'village'. Population size is not the only criterion. Functional contrasts between towns and villages may not always be clear cut, but specific functions such as, manufacturing, retail and wholesale trade, and professional services exist in towns.

City (Population more than 100,000)

A city may be regarded as a leading town. Cities are much larger than towns and have a greater number of economic functions. They tend to have transport terminals, major financial institutions and regional administrative offices. When the population crosses the one million mark it is designated as a million city.

Conurbation (Population of 2 or more cities combined)

The term conurbation was coined by Patrick Geddes in 1915 and applied to a large area of urban development that resulted from the merging of originally separated towns or cities. Greater London, Manchester, Chicago and Tokyo are examples. In India, Hyderabad and Cochin are the examples of conurbation cities.

Megalopolis (Population more than 10 million)

This Greek word "Megalopolis" meaning "great city", was popularized by Jean Gottman (1957) and signifies 'super- metropolitan' regionextending, as union of conurbations. The urban landscape which stretches from Boston in the north to south of Washington in the U.S.A is the best known example of a megalopolis.

Million Cities (Population more than 1million)

A city with million or more people is termed as the million city. The number of million cities in the world has been increasing as never before. London reached the million marks in 1800, followed by Paris in 1850, New York in 1860, and by 1950 there were around 80 such cities. The rate of increase in the number of million cities has been three-fold in every three decades – around 160 in 1975 to around 438 in 2005.

The fastest growing city

- Tiruppur is located at 11.1075°N and 77.3398°E on the banks of the Noyyal River. It has an average elevation of 295 metres (967 feet) and covers an area of 159.6 km2.
- Tiruppur was an agricultural town with irrigated farms and the farmers became small owners of various textile related units during the 1970s. The boom in the textile industry led to an interwoven network of the small scale units leading to growth of the city into a major textile hub.
- The recent revelation of the study conducted by Oxford Economics marked several Indian cities in top ten categories of fastest-growing cities of the world.
- Tiruppur, bags the sixth fastest growing city in India followed by Tiruchirappalli and Chennai.

Definition of Town

In 2001, places were designated as urban or towns on the following principles.

a) All places with Municipality, Corporation, Cantonment Board, Sanitary Board, Notified Area Committee etc.

b) All other places which satisfy the following criteria.

i. A minimum population of 5,000.
ii. At least 75 per cent of the male working population being engaged in non-agricultural (and allied) activity.
iii. A density of population of at least 400 persons per square kilometer (or one thousand persons per square mile).

The Urban Agglomeration

As per census 2001, it was decided that the core town or at least one of the constituent towns of an urban agglomeration should necessarily be a statutory town and the total population of all the constituents should not be less than 20,000 (as per 1991 census).

Urban agglomeration is a continuous urban spread constituting a town and its adjoining urban outgrowths (OGs), or two or more physical contiguous towns together

and any adjoining urban outgrowths of such towns. Examples of Outgrowth are railway colonies, university campuses, port area, military camps etc. that may have come up near a statutory town or city but within the revenue limits of a village or villages contiguous to the town or city. With these two basic criteria having been met, the following are the possible different situations in which urban agglomerations could be constituted.

i) A city or town with one or more contiguous outgrowths.
ii) Two or more adjoining towns with or without their outgrowths.
iii) A city and one or more adjoining towns with their outgrowths all of which form a continuous spread.

Standard urban area

A new concept that had been developed for the 1971 Census for the tabulation of certain urban data was the Standard Urban Area.

The essential of a Standard Urban Area are:

(i) It should have a core town of a minimum population size of 50,000.
(ii) The contiguous areas made up of other urban as well as rural administrative units should have close mutual socio-economic links with the core town and
(iii) The probabilities are that this entire area will get fully urbanized in a period of two to three decades.

The idea is that it should be possible to provide comparable data for a definite area of urbanization continuously for three decades which would give a meaningful picture. This replaced the concepts of Town Group that was in vogue at the 1961 Census. The town groups were made up of independent urban units not necessarily contiguous to one another but were to some extent inter-dependent. The data for such town groups became incomparable from census to census as the boundaries of the towns themselves changed and the intermediate areas were left out of account; this concept came for criticism at one of the symposium of the International Geographic Union in 1968 and the concept of Standard Urban Area came to be developed for adoption at the 1971 Census. If data for this Standard Area were to be made available in the next two or three successive censuses, it is likely to yield much more meaningful picture to study urbanisation around large urban nuclei.

Do you know?
Ecumenopolis (Ecumeno means world; polis means city) is a single city encompassing the whole world that is held to be a possibility of the future

Basis for classification of urban settlements

The definition of urban areas varies from one country to another. Some of the common bases of classification are size of population, occupational structure and Administrative setup.

Population size

In India the size of population, density of 400 persons per sq. km and share of non-agricultural workers are taken into consideration.

Occupational structure

In India if more than 50 per cent of its economically productive population is engaged in non-agricultural pursuits.

Administration Setup

For example, in India, a settlement of any size is classified as urban, if it has a municipality, Cantonment Board or Notified Area Council.

Classification of Urban Settlement

Depending upon the functionality of the urban settlement, towns are classified as **Administrative Towns**, Commercial Towns, Cultural Towns, Recreational Towns, and Industrial Towns.

The settlements that established for the administrative purpose or having largely administrative function are known as administrative towns. For example, Washington D.C., New Delhi, Canberra, Paris, Beijing, Addis Ababa, and London etc.

The settlements that facilitate commercial opportunities are known as trading and commercial towns. For example, Agra, Lahore, Baghdad as an important transport node; Manchester and St Louis in land centers; Winnipeg and Kansas City as agricultural market towns; Frankfurt and Amsterdam as banking and financial centers; etc.

The settlements established because of religious adherence are known as **cultural or religious towns**. For example, Jerusalem, Mecca, Jagannath, Puri, Madurai and Varanasi, etc.

The settlements established for the recreational purpose are known as **recreational towns**. For example, Miami (U.S.A), Panaji (India), etc.

The settlements established because of industrial development are known as **industrial towns**. For example, Pittsburgh (U.S.A), Jamshedpur (India).

The concentric zone theory

This theory was given by Ernest Burgess in 1925. He envisaged that the development of a city outwards from a center in concentric zones in a ripple-like fashion. He made the following assumptions:

a. The city grows outwards in the form of five concentric zones or rings as long as there are no physical barriers, such as rivers or hills to distort the pattern.
b. The city has a single centre.
c. Growth is accomplished by a simple extension of each zone outwards into the next zone.

The characteristic features of each of the five zones can be described as follows.

Zone A: The central business district (C.B.D)

It is the heart of the urban community where the commercial, social and civic activities are concentrated. The heart of the C.B.D. or the downtown core has office buildings, departmental stores, theatres, hotels, banks and civic government buildings, while outside this core are warehouses and light industry.

Zone B: The transition zone next to the C.B.D

It is the transition zone where the central business activities and factories mix and invade an area of aging residential dwellings. This is also the zone of residential decay

where the new migrants come and live because the rents are low and transportation costs to the workplace are minimal. Thus, these are the sites of urban slums.

Zone C: The zone of independent working men's home

This zone is inhabited by the blue-collar workers who are generally the second generation migrants. These people have the capacity to own their individual houses away from the C.B.D., but still live within easy access of their workplace. Here, the family groups are more stable and crime rates are lower.

Zone D: The zone of better residence

The next concentric zone has middle and upper class residences which are approximately 15 to 20 minutes by public transport from zone.

Zone E: The commuter zone

This outer zone encircles the city and lies beyond the continuous built-up areas. Much of this zone is still an open space and is often located beyond the city limits. Here, small villages, surrounded by open country, gradually become suburbs. Since people in this zone work in the C.B.D., the commuter zone is located within one hour's travelling time from the Centre of the city.

Burgess stressed that the outward growth of the city implies that each zone is not static. Business activities expand into the transition zone which forces low income groups to move outwards. This group, then, displaces the middle class and the wealthy that, in turn, are forced to move outwards.

Urbanization of the World and India

Urbanisation refers to the population shift from rural to urban residency, the gradual increase in the proportion of people living in urban areas and the ways in which each society adapts to this change.

It is predominantly the process by which towns and cities are formed and become larger as more people begin living and working in central areas. Although the two concepts are sometimes used interchangeably, urbanization should be distinguished from urban growth. Urbanization is "the proportion of the total national population living in areas classed as urban," while urban growth refers to "the absolute number of people living in areas classed as urban". The United Nations projected that half of the world's population would live in urban areas at the end of 2008. It is predicted that by 2050 about 64% of the developing world and 86% of the developed world will be urbanized.

That is equivalent to approximately 3 billion urbanites by 2050, much of which will occur in Africa and Asia. Notably, the United Nations has also recently projected that nearly all global population growth from 2017 to 2030 will be absorbed by cities, about 1.1 billion new urbanites over the next 13 years.

Urbanisation in India began to accelerate after independence, due to the country's adoption of a mixed economy, which gave rise to the development of the private sector. Urbanisation is taking place at a faster rate in India. Population residing in urban areas in India, according to 1901 census, was 11.4%. This count increased to 28.53% according to 2001 census, and crossing 30% as per 2011 census, standing at 31.16%. According to a

survey by UN State of the World Population report in 2007, by 2030, 40.76% of country's population is expected to reside in urban areas. As per World Bank, India, along with China, Indonesia, Nigeria, and the United States, will lead the world's urban population surge by 2050.

Mumbai saw large scale rural-urban migration in the 20th century. Mumbai, in 2018, accommodates 22.1 million people, and is the largest metropolis by population in India, followed by Delhi with 18.6 million inhabitants. Witnessing the fastest rate of urbanisation in the world, as per 2011 census, Delhi's population rises by 4.1%, Mumbai's by 3.1% and Kolkata's by 2% as per 2011 census compared to 2001 census.

Urban fringe

Urban fringe is an area of transition between well recognized urban land uses and the area devoted to agriculture. It is an area where there is a mixture of rural and urban land uses and where a process of change from rural to urban land use is taking place. The urban fringe has the appearances of a proper city with residential and commercial centers, but it often lacks proper city services such as piped water supply, sewage and garbage disposal facilities. It may include the municipal towns and fully urbanized revenue villages contiguous to the main city.

Urban sprawl or suburban sprawl

Urban sprawl or suburban sprawl describes the expansion of human population away from central urban areas into low-density, monofunctional and usually car-dependent communities, in a process called suburbanization. In addition to describing a particular form of urbanization, the term also relates to the social and environmental consequences associated with this development. In Continental Europe the term "peri-urbanisation" is often used to denote similar dynamics and phenomena, although the term urban sprawl is currently being used by the European Environment Agency. There is widespread disagreement about what constitutes sprawl and how to quantify it. For example, some commentators measure sprawl only with the average number of residential units per acre in a given area. But others associate it with decentralization (spread of population without a well-defined centre), discontinuity (leap frog development), segregation of uses, and so forth.

Causes of Urban Sprawl

Urban sprawl can be caused by many factors. They are:

Lower Land Rates: Lower cost land and houses in the outer suburbs of the cities, because the centers of urban development have really made people want to stop settling in these areas and want to venture further out.

Rise in Standard of Living: There are also increases in standards of living and average family incomes, which means that people have the ability to pay more to travel and commute longer distances to work and back home.

Lack of Urban Planning: People love to find areas that are less trafficked and more calm, which leads them to sprawl out to other sections of the town. Unprecedented development, cutting of trees, loss of green cover, long traffic jams and poor infrastructure force the people to move out to new areas.

Lower House Tax Rates: Cities will usually have high property taxes, and you can usually avoid these taxes by living in the outer suburbs because the taxes are usually lower than they are in other situations.

Rise in Population Growth: Another factor that contributes towards urban sprawl is rise in population growth. As number of people in a city grows beyond capacity, the local communities continue to spread farther and farther from city centers.

Consumer Preferences: People in high income groups have stronger preferences toward larger homes, more bedrooms, bigger balconies and bigger lawns. This also causes urban sprawl as this option is not available in crowded cities. People generally look out for low-density residential areas where they can get home according to their preference.

Problems of Urbanization

India has the second largest urban population in the world only after China. India's urban population (about 28% of the total population) is almost equal to the total population of USA. The rate of urban growth is on the upswing. People in large number are arriving in the mega and metropolitan cities, swelling urban India by more than five per cent annually. This stupendous growth of population is the cause of numerous socio-economic and environmental problems. Some of the important problems of urban India have been briefly presented below:

1**. Problem of space and scarcity of residential accommodation**

The growing population demands more space which is not easily available because of physical and geographical constraints. The scarcity of space leads to high price of land and high rents for offices and residential accommodations. Since people cannot afford high rents, it is the main cause of unwanted growth of slums.

According to one estimate, there is an annual shortage of about two million houses in Indian cities. This has forced low income group people to live in slums or occupy footpaths and road pavements. The number of such slums and pavement dwellers is rising in the metropolitan cities of India.

2. Inadequacy of Social Amenities

In most of the cities of India, there is growth and not urbanisation. In fact, the number of people is increasing in the cities while the infrastructural facilities and civic amenities are quite inadequate. With greater concentration of people in urban places, the social amenities like housing, electricity, drinking water, transport, sanitation, sewage disposal, educational institutions, hospitals, parks, playgrounds, and recreational facilities are quite under great stress.

3. Unemployment

Unemployment is the state of being involuntarily out of work. In India, the rate of urban unemployment which is more than 3 per cent annually is increasing progressively. According to one estimate, about 25 per cent of the workers in the urban centres are unemployed. The high rate of unemployment and under-employment often leads to high rate of crime.

4. Problem of Transport

Transport bottlenecks and traffic congestion are the major problems of most of the Indian cities. The larger a town grows the more important its functions become. The

workers and commuters need more transport facilities. Unfortunately, the roads in most of the cities, especially in the old towns (down-towns) are narrow which cannot cope with the growing pressure of passengers, travelers, and commuters. The number of private vehicles is rising steeply. It leads to traffic congestion, delays, irritation, and tension. If the number of vehicles is allowed to increase at the present rate without widening and upgrading the roads, the whole transport system of the major cities may collapse.

5. The Energy Crisis

The shortage of energy reduces the industrial production of goods and their distribution. In fact, energy depends on the industrial growth, efficiency of the transport and human comfort. The peak power demand in the metropolises, million and class one cities is increasing day by day and power situation is not geared to meet it.

6. Inadequacy of Water Supply

Water is the first and foremost necessity of human life. In fact, water is life, and man cannot survive without it. The average per capita consumption of water in Kolkata is 250 liters, in Mumbai175 liters and only 80 liters in Delhi as against 1200 liters in Los Angles and 1100 litres in Chicago. The acute scarcity of water in the urban places of India may be appreciated from the fact that in Chennai, Hyderabad, Jaipur, Jodhpur, Nagpur, Shimla, Solan, Surat, Udaipur, Vadodara, etc., only one to two hours of water supply in a day is permitted. The National Capital (New Delhi) also regulates water supply to only about four hours a day.

7. Environmental Pollution

Environmental pollution is the other serious problem of all the million and mega-cities. It is not only air-pollution caused by smoke emitted from vehicles, factories and houses; water and noise pollutions are equally serious. The scarcity of dumping grounds makes the rural-urban fringe unhygienic and less conducive for human health. The problem of garbage disposal (hazardous plastics, metal and package) is thus quite serious in most of the Indian cities and urban places. Unfortunately, most of the garbage is dumped into the rivers or along their banks. The cities like Mumbai, Kolkata, and Chennai continue to discharge a major part of their garbage into the sea.

8. Increase in Crimes

Increasing urban crimes are disturbing the peace of modern cities. According to sociologists, unemployment is the main cause of crimes in urban areas. The unemployed youths indulge in crime like abduction, extortion, kidnapping, murder, pick-pocketing, rape, robbery, snatching, and theft. The slums are especially infested with unemployed criminals who, in due course of time, become habitual offenders. Material culture, growing consumerism, selfishness, stiff competition, lavishness, increasing socio-economic disparities, rising unemployment and loneliness are some of the main reasons of this menace.

3. RESOURCE

Introduction

Have you heard about **Voyager 1** launched in 1977 still is travelling at the speed of **62140 km/ hour or 17 km/sec.?** Do you know what fuel is used in it? It is **hydrazine**. What, do you think, would be the future fuel? It is certainly going to be **hydrogen**. Think about how hydrogen stands as an important future fuel.

A resource is a naturally occurring exploitable material that a society perceives to be useful to its economic and material wellbeing. Willing, healthy and skilled workers also constitute a valuable resource, but without access to materials such as fertile soil or petroleum, human resources are limited in their effectiveness.

Resources are the basis of the economic development of any nation. Different countries are at different levels of economic development primarily because of the variation in the availability of natural resources. The US and west European countries are economically prosperous because they possess vast natural and human resources and technology. On the other hand, in most parts of Africa and Asia, though they are naturally rich in resources, due to their lack of knowledge, the resources are unutilized and they are not used in the service of man.

Classification of Resources

Resources are classified on various bases. Based on the continual availability, resources are classified in to **renewable** and **non- renewable resources.**

The resources which can always be used again and again are known as **renewable resources**. It means these resources have natural regeneration and are inexhaustible. Air, water, solar energy etc. are examples of renewable resources. **Non-renewable resources** are available in finite quantities and cannot be obtained once if they are utilized. If these resources are used in large scale, they will get exhausted soon and as such these resources are called as **exhaustible resources.** Coal, oil and minerals are examples of this type.

On the basis of origin, the resources are classified in to **biotic** and **abiotic resources**. When a resource is originated from living organism, the resource is known as **biotic resource**. Coal, mineral oil and forests are examples of biotic resources. **Abiotic resources** are composed of non-living inorganic matter. Air, land, water and minerals are examples of this type.

On the basis of status of development, the resources are classified in to **potential resources** and **developed resources**. Potential resources are those which are known to exist and may be used in the future. Until the resource is extracted and put in to use, it remains a potential resource. **Developed resources** are those which have been surveyed and their quality and quantity have been determined for utilisation. The development of resources depends on technology and level of their feasibility. Petroleum resource from Mumbai High is an example of Developed resources.

Apart from the above classifications, the resources which are available in nature are known as **natural resources** and the one created by man is known as **man-made resource**. Similarly the air like resources which exist everywhere is called as **ubiquitous resources** and the resources which are concentrated only at specific places are known as **localised**

resources. This kind of resource may exercise great influence on the economic development of the respective regions.

Mineral Resources

A homogeneous, naturally occurring substance which has a definite chemical composition is called a mineral. They can be identified by their physical properties and chemical components. Minerals exist in different types based on their formation. Minerals play an indispensable part of our daily activities. Almost everything we use, from a tiny particle to a huge building or a big ship all, is made up of minerals. Minerals are one of the most valuable resources of the earth. All the stages of human development or progress have been named after them. For example, stone age, copper age, bronze age and Iron Age.

They are exhaustible or non-renewable. Besides, they are distributed very unevenly. They are generally found in the form of ores. The ore contains several impurities. Minerals are separated from the ores involving a number of distinct processes.

A country's economic development is depending on the minerals. There are several types of minerals, but according to their characteristics and commercial use.

Uses of Minerals

Minerals are basic and essential raw materials in our daily lives and are vital for economic, social and technological development. They are used,

- In the construction of buildings, bridges and settlement.
- As raw materials in industries
- As fuels
- In the manufacture of defiance equipment's.
- In the field of communication like manufacturing telephone, wires, cables, electronic devices etc.
- In making of alloys for various purposes.
- In making of ornaments.
- In the manufacture of fertilizers, pesticide, fungicides etc.

Mode of Occurrence of Minerals

Minerals are generally found in 'Ores'. It is actually an accumulation of any mineral mixed with other elements. Minerals generally occur in many forms. They are

1. Veins and lodes

Minerals generally occur in the cracks, crevices, faults and joints of the igneous and metamorphic rocks. Minerals in smaller occurrence are called a 'Vein' and a larger occurrence is called a 'lode, for example, Copper and Gold are found in lodes and veins.

2. Beds or Layers

Minerals that are formed as a result of deposition, accumulation and concentration generally occur in horizontal layers. E.g. Coal, Potash, etc.

Residual mass of weathered particles

When the decomposed rocks are washed away by water, the soluble particles are removed, leaving a mass containing ores. Such occurrences are called residual mass. E.g. Bauxite

3. Alluvial deposits or placer deposits

These are the deposits found in the sands of valley floor and at the foot hills. These deposits consist of the minerals such as Gold, Silver and Platinum.

The world distribution of minerals

Metallic Minerals The minerals which contain metal in them are called as metallic minerals.

Iron - Ore

It is the basic mineral and the backbone of industrial development of the world. Iron Ore is the most widely distributed element of the earth's crust and it rarely occurs in a free state. It is found as the composition of many rocks and minerals. Iron-ore makes up 4.6% of the earth crusts. Iron is found in the form of Iron - ore. They are classified into 4 categories.

(i) Magnetite: It is red in colour and has 72% of pure Iron
(ii) Hematite: It is black in colour and has 70% of pure Iron
(iii) Limonite: Its colour varies from dark brown to yellow and has 50% of pure iron.
(iv) Siderite: It is brown in colour and contains only 30% of pure iron is present.

The iron content of these ores is highly variable. If the iron content is less than 30% in an ore, it is considered to be uneconomical. Iron is mixed with fixed proportions of Manganese, Nickel, Chromium or Vanadium to make different varieties of steel.

Distribution of Iron ore

Iron - ore is unevenly distributed in the world. Good quality Iron ore is found in Australia, Brazil, Russia, China, USA, Ukraine, Canada, etc. Russia has the largest proven reserves of iron ore in the world.

Australia is the largest producer of Iron ore in the world. Other leading producers are China, Brazil, India and Russia. The Majority of Iron ore is (84%) produced by 5 countries alone.

Iron ore

Rank	Country	Production (metric ton)	Share (%)
1	Australia	531,075,350	33.72
2	China	345,841,000	21.99
3	Brazil	271,275,900	17.22
4	India	124,852,650	7.93
5	Russia	55,550,000	3.53

	Others		15.64

Major Iron Ore Fields in the World

Country	Iron ore fields
Australia	Mt. Bruce, Mt. Goldsworthy, Mt. whaleback, etc.
China	Manchuria Region, Shandong, Sinkiang region, etc.
Brazil	Itabria in south east region.
India	Chhattisgarh and Baster region, Odisha, Chitradurg, Kdermukh, Mayurbbanj, region etc.
Russia	Ural region, Kuzbas, Angara, etc.
U.S.A	Messabi range, Marquette range, cornwall, Albama, Appalachin region, etc.
Germany	Rhur basin.
Ukraine	Krivoi rog.

Manganese ore

It is a kind of Ferro-alloy used to manufacture the special quality steel. A little manganese added to iron, removes gases and acts as a 'Cleanser' in the manufacturing process. Nearly 6 Kg of manganese is used for making one ton of steel.

Manganese is used for special quality steel making; it makes steel anti - corrosive, hard and clean. It helps to increase toughness, strength and durability to resist oxidation in blast furnaces. It is used to produce alloys with Copper, Bronze, and Nickel. It is used for producing heavy machinery, tools, bleaching powder, insecticides and paints.

Distribution and production of Manganese ore

South Africa, Australia, China, Gabon, Kazakhstan, Brazil, India, Ghana, Ukraine and Mexico are the major countries possessing manganese ore. South Africa is the largest producer of manganese ore in the world, followed by Australia. The other leading manganese producers are China, Gabon and Brazil. India is the 8th largest producer of manganese in the world though it possesses the largest reserves of manganese in the world.

Manganese-Ore Production

Rank	Country	Production (metric ton)	Share (%)
1	South Africa	4,754,560	30.84
2	Australia	2,388,500	15.50
3	China	2,150,000	13.95
4	Gabon	1,658,500	10.76
5	Brazil	1,141,684	7041
	others		21.54

Copper

Rank	Country	Production (metric ton)	Share (%)
1	Chile	5,552,600	27.20
2	Peru	2,353,859	11.53
3	China	1,851,000	9.10
4	United states	1,430,000	7.00
5	Congo	1,035,631	5.07
	Others		40.13

Copper

It is a non - ferrous, soft brown metal. It is a good conductor, with high luster, density and melting point. Copper occurs in three forms as native metal in its pure state, as oxides and as sulphide.

The chief ore of copper is copper pyrite. It yields nearly 76% of the world production of copper. Copper is extracted by the process of crushing, concentration, roasting, smelting and refining. It was discovered in the earliest stage of civilization. Copper is one of the first metals known and used by man. It is found in the igneous and metamorphic rocks. Copper is unfortunately very soft, but by mixing with tin, bronze can be obtained and mixing with zinc, brass can be obtained which is harder and tougher than pure copper. Copper is used in

(i) Electrical Engineering
(ii) Metallurgical Industries
(iii) Making of alloys and making tubes, pipes, pumps, radiators and boilers. They are also used in the production of a wide range of ornamental materials.
(iv)

Production and distribution of Copper

Copper deposits are found in almost every country. The main producers are Chile, Peru, China, USA and Congo. Chile is the largest producer of Copper in the world. It produces 27.20% of the world Copper, followed by Peru, which produces 11.53%. India holds 35th rank and it produces only 0.15% of the world's production.

Bauxite

Bauxite is an important ore which is the main source of Aluminum. It is an impure raw material. It generally occurs as an ingredient of chemical compounds in highly complex minerals such as Cryolite, Corundum and Kaolin. Bauxite occurs quite near the surface and is generally mined by open cast method. It has a wide range of applications which include construction of buildings, utensils and airplane parts.

Production and world distribution of Bauxite

The main Bauxite producers are Australia, China, Brazil, Guinea and India. The World's greatest Bauxite producers and exporters are the countries located in the tropical

and sub-tropical region. Australia is the largest producer of bauxite in the world. India is the 5th largest producer of bauxite in the world.

BAUXITE (ORE)

Rank	Country	Production MT	Share in %
1	Australia	83,516,578	29.31
2	China	65,000,000	22.81
3	Brazil	39,244,200	13.77
4	Guinea	31,117,131	10.92
5	India	24,644,632	8.66
	others		14.53

Gold

Gold is a precious metal which occurs in alluvial or placer deposits or as reefs or lodes in the underground. Gold is used extensively for jewellery and also in dentistry, glass and porcelain dyes, in medicines and other industries. The purity of gold is expressed in terms of carat. China, Australia, Russia, USA and Canada are the leading producers of gold in the world. India ranked 33rd position in the gold production in 2016.

GOLD

Rank	country	Production	Share in %
1	China	453,500	14.11
2	Australia	282,421	8.79
3	Russia	262,380	8.16
4	United states	222,211	6.91
5	Canada	165,034	5.13
	Others		56.90

Do you know?
Fool's Gold refers to pyrite of Iron Sulphide because of its similarity in shape and colour to actual gold.

Platinum

Platinum is a rare metal. It is costlier than gold. It has a very high melting point. It is a heavy, malleable, ductile, highly inactive, silverish, white transaction metal. It is one of the densest metal almost twice as dense as lead. Platinum is found with other rare metals such as osmium, Palladium, Iridium and rhodium. Platinum is also used in industrial applications. South Africa is the largest producer of platinum in the world. The other leading producers are Russia, Zimbabwe, Canada and USA.

Platinum

Rank	Country	Production	Share in%

		Kg	
1	South Africa	133,241	71.75
2	Russia	21,860	11.77
3	Zimbabwe	15,110	8.14
4	Canada	9,300	5.01
5	USA	3,891	2.10
	Others		1.33

Non- metallic minerals

The minerals which do not contain metal in them are called as non-metallic minerals.

Mica

Mica is a Latin word micare means to shine, to flash or to glitter. Mica has a crystalline and layered structure and can be split into very thin sheets. It does not react to water, acids, oil or solvents. It is lightweight, flexible and strong. It can resist extremely high temperatures or sudden changes in temperature and is able to withstand high voltages and insulate with low power loss. It can absorb or reflect light, which enables a decorative effect and protects against ultra-violet (UV) light.

Major Uses of Mica

Mica has several applications. There are several main sectors where the use of mica is identified. They are the paint and coatings sector, Cosmetics and personal care companies, Plastics and printing ink manufactures the electronics sector, the automotive sector, the construction industry and the oil industry.

Phosphate

Phosphate occurs in the sedimentary rocks or as phosphate nodules. Another source is bird dropping of Guano. It is the most important source of phosphorus. It is mainly used in fertilizer. China is the largest producer of Phosphate in the world. The other leading producers are Morocco, USA, Russia and Peru. The Guano deposits are found in Peruvian and Chilean deserts in South America. India is the 20thlargest producer of Phosphate in the world.

Phosphate (2016)

Rank	Country	Production MT	Share in %
1	China	43,319,400	51.58
2	Morocco	8,601,000	10.24
3	USA	7,615,000	9.07
4	Russia	48,36,00	5.76
5	Peru	4,103,220	4.78
	Others		18.57

Do you know?
Agencies involved in the exploration of minerals in India. GSI, ONGC, MECL, NMDC, IMB, BGML, HCL, NALCO are the departments involved in mining in different states of India.

Energy Resources

Resources may be classified into renewable and non-renewable resources. Mineral resources like coal, Petroleum and natural gas are the exhaustible or non-renewable resources. They cannot be replaced once they are consumed. Coal and petroleum are the fossil fuels, on which the modern culture relies so much.

Energy gives motion to our industrial machines and vehicles. It is the primary input in the production of goods and services. The wheel of progress moves with the flow of energy. The energy resources may be classified into two types.

(i) Nonrenewable sources of Energy

Once these resources are used, they cannot be regained again. In other words, they are exhaustible. They are coal, Petroleum natural gas and atomic fuels.

Coal

Coal is a fossil fuel. It is a flammable, black or brown sedimentary rock and is mainly composed of carbon. It is the altered remains of prehistoric vegetation that originally accumulated in swamps and peat bogs. The dense forest plants were converted into coal due to intense pressure and heat inside the earth by the process of carbonization. Most of the coal resources of the world were formed during the carboniferous period (280 to 350 million years ago). The quality of the coal is determined by its carbon content. The following types of coal have been identified on the basis of their physical properties. They are,

(i) **Peat** is the first stage of transformation of wood into coal and it has only 30 to 35% of carbon.

(ii) **Lignite or Brown** coal is the inferior quality and contains 35-45% carbon

(iii) **Bituminous or coking coal** is the second best variety of coal and contains 70-90% of carbon. It is the most widely spread and most widely used variety of coal. It is the most popular coal in commercial use.

(iv)**Anthracite** is the best quality coal, which contains more than 95% of carbon. It is very hard but emits very less smoke and leaves very less ash. However its deposits are limited.

Production and world distribution of Coal

Coal reserves are found in more than 70 countries of the world but the major coal reserves occur in the USA, Russia, China and South Africa. China is the largest producer

of steam coal in the world followed by India. The other leading producers of steam coal are USA, Indonesia, and South Africa etc.

Steam coal – It is used for producing steam and it has high sulphur content.

Steam Coal

Rank	Country	Production (metric ton)	Share in %
1	China	2,49,793,000	47.42
2	India	601,131,000	11.44
3	United states	553,936,000	10.54
4	Indonesia	459,469,000	8.74
5	South Africa	253,452,000	4.82
	others		17.04

HOTS
Why is hydrogen used as fuel in rockets?

China was the largest producer of coking coal in the world in 2016 followed by Australia. The other leading producers of coking coal are Russia, India and USA.

Cooking Coal

Rank	Country	Production MT	Share in %
1	China	591,998,000	54.67
2	Australia	189,302,000	17.48
3	Russia	83,800,000	7.74
4	India	61,661,000	5.69
5	United states	50,645,000	4.68
	Others		9.74

Major Coal Mining Centres

Country	Mining centers
China	Shansi, shantung, Fushun, Shenyang, etc.
India	Bokaro, jaria, korba, ranikanch, singerni, etc.
U.S.A	Arkansas, colorodo, illionions, Indiana, Michigan etc.
Australia	Bowen basin, Brisbane, Canberra, Sydney, New-castle, Tasmania, etc.
Russia	Moscow-Tula region, Chokot, basin, Ob basin, etc.

Trade

The main exporters of coal in the world are Australia, Indonesia, Russia, Colombia and South Africa and the main importers are China, India, Japan, Korea and Germany.

Uses of Coal

Man has used coal for hundreds of years. But it has gained importance only after industrial revolution. It contributes about 25% of global energy demand. Coal is used for various purposes. It is used as a source of steam energy, electrical energy, domestic fuel, metallurgical coke, chemical industries and byproducts such as Ammonium sulphate, Naphthalene, Phenol, Benzene, etc.

Petroleum (or) Mineral oil

Petroleum is a mineral that exists under the surface of the earth in liquid, solid and gaseous forms. Liquid petroleum may be in the form of crude oil. The solid form may be mineral waxes or asphalts. The gaseous form is natural gas. It is a main source of energy in the World due to its multiple uses. The human activities are directly or indirectly depend on the use of petroleum or its sub products.

Formation and occurrence of mineral oil

It is formed by slow chemical and bio chemical decomposition of the remains of organic matter in sedimentary rocks. It is found in the pores of the sedimentary rocks. Oil is lighter than water hence, floats over water. Drilling of oil wells is the hole drilled in the earth's crust and when it reaches the rock cap, the natural gas comes out first with a great pressure. When the pressure of gas subsides, petroleum starts flowing out when the pressure of natural gas is released.

Petroleum reserves of the world

The west Asia or Middle East is has the largest petroleum reserves, which is about 60% of the world's oil reserve. The total estimated world's oil reserves in 2008 were 1,243 (109 bbl). Saudi Arabia, Canada, Iran, Iraq and Kuwait have large reserves of petroleum.

Production and world distribution of petroleum

The petroleum producing countries of the world can be grouped in to five geographical regions:

1. West Asia (or) Middle East region
2. American region
3. Russian region
4. East & south Asian region and
5. African region

Saudi Arabia is the largest oil producer of the world with 13.62% of the world output of oil. Russia is the second largest producer in the world. India is placed at 24th position in petroleum production in the world. The distribution of oil is naturally uneven; Middle East contains 60% of global reserves and rest of the world only 40%.

Petroleum

Rank	Country	Share in %
1	Saudi Arabia	13.62

2	Russia	12.72
3	USA	12.62
4	Iraq	5.09
5	Iran	5.03
6	china	4.64
	Others	46.28

Trade

The world leading exporters of petroleum are Saudi Arabia, Russia, Iraq, UAE and Canada and the main importers are USA, China, India, Japan and Korea.

Do you know?
OPEC is the short form of the "Organisation of Petroleum Exporting Countries. It was formed in 1960 at Bagdad convention. Initially it comprised of Saudi Arabia, Iran, Iraq, Kuwait and Venezuela. Later on added in eight countries Libya, Algeria, Qatar, UAE, Nigeria, Ecuador and Angola, Indonesia left from OPEC in recently.

Major Petroleum Production Centres

Country	Production centres
Saudi Arabia	Ghawar, Abquiaq, Abuhadriya, etc.
Russia	Volga-Caspin region, Kamchatka- Sakhalin region, Ob Lena basin.
U.S.A	Tennessee- new york, ohino, Indiana, Pennsylvania, Texa, Mississippi, gulf of California, etc.
Iraq	Kirkuk, Mosul, Daura, etc.
China	Taching, Chinchou, Yemen, south china sea, etc.

Natural Gas

It is the cheapest source of energy. It is found along with or without petroleum. It is considered as an environment friendly fuel because of its low carbon dioxide emissions. Therefore, this is the only fuel for the present century and it is also called green energy. A powerful odorant, ethanethiol is added, so that leaks can be detected easily. It is prepared by refining petroleum or wet natural gas.

Natural gas reserves and Production

The known natural gas reserve in the world is about 6254 trillion cubic feet. Most of these reserves are found in Russia, Iran, Qatar, UAE, Saudi Arabia, USA etc. USA has the largest reserve and is the leading producer of natural gas in the world followed by Russia. India is the 28th producer of natural gas in the world. It is widely used as a fuel in industries and domestic cooking purposes. Petrochemical industries use it as fuel and raw material. It is also used in chemical industries, artificial rubber, plastic, fertilizers, ink, and carbon and as artificial lighting.

Natural Gas

Rank	Country	Production (metric ton)	Share (%)
1	United states	755,010	20.56
2	Russia	641,000	17.45
3	Iran	202,440	5.51
4	Qatar	181,250	4.94
5	Canada	157,179	4.28
	Others		47.28

Trade

Russia, Qatar, Norway, Canada and Algeria are the leading exporters of Natural gas in the world. Japan, Germany, China, Italy and Turkey are the leading importers of natural gas.

Nuclear Energy

It is commonly said, this energy holds the key of future. Energy contained within the nucleus of an atom is called nuclear energy. Heavy metals like Uranium, Thorium, Radium, Plutonium and Lithium are the main sources of nuclear energy. However Uranium is the most important source of nuclear energy. The nuclear energy production was started first in USA in 1950. Nuclear energy now provides about 11% of the World's electricity. At present there are more than 450 operable fission reactors in the world. The world's first commercial nuclear power station Calder Hall at Wind scale, England was opened in 1956.

Uranium (U3O8)

Rank	Country	Production (metric ton)	Share (%)
1	Kazakhstan	29,113	38.89
2	Canada	16,666	22.26

3	Australia	7,352	9.82
4	Namibia	4,302	5.75
5	Niger	4,101	5.48
	Others		17.80

Do you know?
Most devastating nuclear accidents
1. Three mile Island- March 28, 1979 USA
2. Chernobyl - April 29, 1986, Russia
3. Fukushima Daiich- March 11, 2011, Japan

Renewable sources of Energy:

All regions of the world are facing the twin problems of fast increasing demand for energy and limited supplies and rapidly depleting conventional sources of energy. Under these circumstances, non-conventional sources of energy are getting more importance. These sources are renewable, clean and non-polluting. They are solar, wind, geothermal, wave, tidal energy, bio-gas etc.

Hydel Power

Hydro electricity is produced by using the potential energy of water falling from a certain height. The falling water spins the turbine blades and energy is produced. It is a clean eco-friendly and renewable source of energy. It contributes nearly 7% of the world electricity production. China has the largest potential followed by Brazil, Indonesia, Canada and Zaire. China is the largest producer of Hydroelectricity in the world, followed by Canada.

Solar energy

It is based on mechanical conversion of solar energy into electricity. It is available in abundance but only in the recent period it gets more importance due to technological development. Solar energy is used for various purposes.

Do you know?

Noor Complex is the world's largest concentrated solar power (CSP) plant, located in the Sahara Desert.

Kamuthi, the world`s largest single solar power plant

Kamuthi Solar Power Project is a photovoltaic power station spread over an area of 2,500 acres (10 km2) in Kamuthi, Ramanathapuram district. The project was commissioned by Adani Power. With a generating capacity of 648 MW at a single location, The Kamuthi Solar Power Project was completed on 21 September 2016. Around 8,500 workers installed an average of 11 MW of capacity per day to complete the project within 8 months. The entire solar park is connected to a 400 kV substation of the Tamil Nadu Transmission Corp. The solar panels are cleaned daily by a self-charged robotic system.

USA is the major producer of solar cells at present. It is simply the energy provided by the sun, which makes production of solar electricity possible. **Solar power in India** is a fast developing industry. The country's solar installed capacity reached 26 GW as of 30 September 2018. India expanded its solar-generation capacity 8 times from 2,650 MW on 26 May 2014 to over 20 GW as on 31 January 2018. The country added 3 GW of solar capacity in 2015-2016, 5 GW in 2016-2017 and over 10 GW in 2017-2018, with the average current price of solar electricity dropping to 18% below the average price of its coal-fired counterpart.

Wind Energy

The wind is a clean, free and readily available renewable energy source. Wind turbines are capturing the wind's power and converting it to electricity. Wind power has become a pillar in their strategies to phase out fossil and nuclear energy. Wind energy is now the second fastest growing source of electricity in the world. It fulfills about 5% of world's electricity demand. The world's largest wind farm is in Altamont pass in California. India is emerging as a major wind power producer of world. The important wind farms in India - (i).The largest wind farms in India are Muppandal in Kanyakumari District of Tamil Nadu and Jaisalmer wind park in Rajasthan. They are the first and second largest wind farms of India. Based on the location of its generation it is classified into:

1. Onshore wind energy and
2. Offshore wind energy

1. Onshore wind energy –Energy generated from the plants located on the land is known as onshore wind energy. Onshore wind has the advantage of being one of the most affordable renewable energy sources. It is cheaper than any other renewable source of energy but it requires more area to install than any other energy.

2. Offshore wind energy –It refers to the use of wind farms developed in seas and oceans. The largest offshore wind farms are currently in the U.K and Germany. These two countries installed 2/3 capacity. London Array is the largest offshore wind farm in the world. The first offshore wind farm is planned near Dhanuskodi in Tamil Nadu.

Tidal energy - It is a renewable energy powered by the natural raise and fall of ocean water. Its production is very small. The first tidal power station was located in La Rance in France. The largest tidal power station is at Sihwa Lake in South Korea and it is the largest tidal power producer in the world. There are three different category of sources from which the tidal energy is generated. The sources are tidal streams, barrages and tidal lagoons.

India's first attempt to harness tidal power for generating electricity would be in the form of a 3MW plant at the Durgaduani creek in sunderbans delta of West Bengal. The Gulf of Kutch and Cambay in Gujarat and the Ganges delta in sunderbans, the world's

largest mangrove, are the 3 sites identified as potential areas for tidal power generation in India.

Geo Thermal Energy

Geo thermal energy is derived from the natural heat of the earth. The United States is the world's largest producer, and the largest geothermal development in the world is The Geysers north of San Francisco in California, the U.S.

In India, exploration and study of geothermal fields started in 1970. The GSI (Geological Survey of India) has identified 350 geothermal energy locations in the country. The most promising of these is in Puga valley of Ladakh. The estimated potential for geothermal energy in India is about 10000 MW. There are seven geothermal provinces in India: the Himalayas, Sohana, West coast, Cambay, Son- Narmada-Tapti (SONATA), Godavari, and Mahanadi.

Conservation of Resources

It takes millions of years for the formation of minerals. Compared to the present rate of consumption, the replenishment rate of minerals is very slow. Hence, mineral resources are finite and non- renewable. Due to this, it is important to conserve the mineral resources.

Ways of Conserving Resources

- Controlling population growth will reduce the demand for resources.
- Creating social awareness regarding the importance of conservation of resources.
- Reusing and recycling of resources.
- Using the renewable source of energy as an alternative to non- renewable resources.
- Developing the usage methods which minimize the wastages.
- Propagating the environmental ill effects caused by various products.
- Choosing the products with less packaging.

4. Economic activities

INTRODUCTION

Waymo car

Have you heard about Waymo car? A car without brakes, accelerators or steering wheel – a driverless car is indeed a dream come true.

Google started testing self-driving technology with the Toyota Prius on freeways in California in 2009.

A new development was the unveiling of a new prototype vehicle in 2014, capable of being a fully self-driving car. These intelligent cars use sensors and software to detect objects like pedestrians, cyclists and can safely drive around them. According to Google, the car can process both map and sensor information to find out its exact location - precisely which street or lane it is driving in. The sensors are so powerful that it can detect all kinds of objects. What's more interesting, the software can predict what these objects around the car will do next and take action accordingly.

In an instance, where the traffic signal turned green and the car was about to move forward, the car sensed an ambulance coming from the right side and it stopped, making way for the ambulance. Google calls its cars, 'experienced drivers'. Each car's speed is capped safely at 25 mph (40 km/hr). The cars halt for 1.5 seconds after the signal turns green at a junction as many accidents happen during this time.

But the cars can travel as fast as 161 km/hr. To ensure safety, the front side has about 2 feet of foam and the windshield is made of plastic instead of glass. This is the amazing product of secondary industries which we learn about as part of economic activities in this lesson

Economic activity refers to the activity of making, providing, purchasing and selling goods or services. Economic activities exist at all levels within a society. Human beings are engaged in various kinds of economic activities. In general all the economic activities are broadly categorised into Primary, Secondary and Tertiary activities. The Tertiary activities are further sub divided into Quaternary and Quinary activities.

Let us first understand the meaning and concept of the different categories of economic activities.

Types of Economic system:

1. **Subsistence economy:** Goods and services which are created for the use of the producers and their kinship groups.

2. **Commercial economy:** Goods and services which are produced mainly for sale. Market competition is the primary force determining the production and distributions.

3. **Planned economy:** Goods and services created are controlled by government agencies. Supply and price are controlled by the state. It was practiced earlier by the Communist controlled societies.

Primary activities

Primary activities help man to fulfill his needs and desires, by using resources which are gifted to man by nature. These activities are directly connected with nature. Hunting, Gathering, Pastoralism, Fishing, Forestry, Mining and Agriculture are the primary activities.

Hunting and Gathering

Until 12,000 years ago, all humans lived as hunters and gatherers. At present only 0.0001% human live as hunters and gatherers. Gathering and hunting are the oldest known economic activity in the world. It often involves primitive societies which collect both plants and animals to satisfy their needs for food, shelter and clothing. These primitive activities are being carried out still in a very few parts of the world. Gathering is practiced in the areas of High altitude zones of Northern Canada, Northern Eurasia and Southern Chile and in the low altitude zones of the Amazon Basin, Tropical Africa, Northern fringe of Australia and interior parts of South East Asia. Present day gatherers and hunters are confined to a few pockets. Inuit in the Arctic region, Pygmies of Kalahari, Pintupi, Aborgines of Australians, and Paliyan of South India are the examples of foragers.

Pastoralism

Pastoralism is the process of grazing and rearing of different types of animals like cattle, sheep, goats, etc. in an organised manner to get animals products. The animals rearing can be primitive which is carried on by nomads or highly scientific means on a commercial scale. So, animal grazing and rearing can be divided into two broad categories as Nomadic Herding and Commercial Livestock Rearing.

Nomadic Herding (or) Pastoral Nomadism

It is a primitive subsistence activity in which the herders rely on animals for food, clothing, shelter, tools and transport. They move from place to place along with their livestock, depending on the availability of pastures and water. These people do not lead a settled life but keep on moving from place to place. Pastoral nomadism is commonly practiced in regions with little arable land, typically in the developing world. They are mostly found in central and western Asia, Northern and Western regions of Africa and some parts of southern Africa and Tundra regions.

Transhumance

Transhumance is the seasonal movement of people with their livestock between fixed summer and winter pastures. In mountain region it implies movement between higher altitude pastures during summer and valleys in winter.

Gujiars, Bakarwals, Gaddis and Bhotiyas in the Himalayan region migrate from plains to the mountain in summer and to the plains from the high altitude pastures in winter. In the tundra regions, herders move from south to north in summer and from north to south in winter. The number of pastoral nomads has been decreasing and the

areas operated by them shrinks due to developments and spreading of other economic activities.

Commercial Livestock Rearing

Commercial livestock rearing is more organised and capital intensive activity in comparison with the Nomadic pastoralism. It is generally practiced in permanent ranches. Ranches refer to the large stock farms, usually fenced in, where animals are breed and reared on a commercial scale. Animals are grazed over large areas which are known as ranches in Prairies and estancia in Pampas. Most modern technology is used for commercial grazing, great emphasis is laid on breeding, genetic improvement, disease control and health of the animals. Products such as meat, wool, hides and skin are processed and packed scientifically and exported to different world markets. New Zealand, Australia, Argentina, Uruguay and USA are the major countries where commercial livestock rearing is practiced.

Do you know?

Employees of the economic activity	
Economic activity	**Name**
Primary	Red collar
Secondary	Blue collar
Tertiary	Pink collar
Quaternary	White collar
Quinary	Gold collar

Agriculture

Agriculture is the most fundamental form of human activity and includes not only cultivation of crops but also the domestication of animals. The following are the major agricultural types and their characteristic features.

Shifting Cultivation

Shifting Cultivation is a kind of traditional farming practiced by tribes in the hilly and forest regions. It is practiced especially in tropical Africa. In this farming an area of ground is cleared of vegetation and cultivated for a few years and then abandoned for a new area until its fertility has been naturally restored. They are called with different names in different regions as follows Shifting Cultivation in Northeast India.

S.No	Name	Region
1	Jhuming/Bewar	North eastern states of India
2	Ladang	Malaysia
3	Chengin/Kaingin	Philippines
4	Milpa	Central America and Mexico
5	Konuko	Venezuela
6	Roca	Brazil
7	Masole	Congo
8	Ray	Vietnam

9	Humah	Indonesia
10	Taungya	Myanmar
11	Chen	Sri Lanka

Subsistence agriculture

Subsistence Agriculture is a type of farming in which output is consumed almost entirely by the farmers and their families leaving only a small proportion for sale. Farmers follow traditional method of cultivation in this kind of farming.

Intensive agriculture

Intensive Agriculture is the one in which the agricultural land is utilised intensively. Farmers prefer the cultivation of short duration crops which enables the cultivation of two or three crops in the same piece of land in a year. Generally it is practiced wherein the size of the agricultural land holding is small.

Plantation Agriculture

Plantation agriculture is a form of commercial farming where crops are grown for profit. Large land areas are needed for this type of agriculture. Countries that have plantation Agriculture usually experience high annual temperatures and receive high annual rainfall. Plantation is mainly found in countries that have a tropical climate. The important plantation crops are tea, coffee, cocoa, rubber, oil palm, sugarcane, bananas and pineapples.

Extensive Farming

It is a kind of farming practiced in the regions where the size of the land holding is very large. It is practiced in the Interior parts of semi-arid lands of the mid-latitudes. Wheat is the major crop of this region and the farming is highly mechanized.

Mixed Farming

It is an agricultural system in which a farmer conducts different agricultural practice together, such as crops, fishing and livestock. The aim is to increase income through different sources and to complement land and labour demands across the year.

Do you know?

Pomology – the study of growing fruits.
Olericulture – science of vegetable growing.
Floriculture – refers to cultivation of flowers.
Sericulture – refers to Rearing of Silkworms

Mediterranean Agriculture

Mediterranean agriculture is highly specialised commercial agriculture. It is practised in the countries on either side of the Mediterranean Sea in Europe and in North Africa from Tunisia to Atlantic coast, southern California, central Chile, south western parts of South Africa and south and south western parts of Australia. This region is an important supplier of citrus fruits. Viticulture or grape cultivation is a speciality ofthe Mediterranean region. Best quality wines in the world with distinctive flavours are produced from high quality grapes in various countries of this region. The inferior grapes

are dried into raisins and currants. This region also produces olives and figs. The advantage of Mediterranean agriculture is that more valuable crops such as fruits and vegetables are grown in winters when there is great demand in European and North American markets.

Horticulture

Specialised cultivation of flowers, vegetables and fruits is called horticulture. It is also termed as "truck farming". These crops are grown on small farms which are well connected to the markets by cheap and efficient means of transportation. It is labour and capital intensive crops. The main areas are northwest Europe, northern eastern USA and Mediterranean region. The study of grape cultivation is known as viticulture.

Von Thunen model of agriculture

The Von Thunen model of agricultural land use was created by the farmer, landowner, and economist Von Thunen in 1826 in a book called The Isolated State. Von Thunen model was created before industrialization and is based on the following limiting assumptions:

The city is located centrally within an "Isolated State" that is self-sufficient and has no external influences.

- The Isolated State is surrounded by an unoccupied wilderness.
- The land of the State is completely flat and has no rivers or mountains to interrupt the terrain.
- The soil quality and climate are consistent throughout the State.
- Farmers in the Isolated State transport their own goods to market via ox cart, across the land, directly to the central city. Therefore, there are no roads.
- Farmers act to maximize profits.

In an Isolated State with the foregoing statements being true, Von Thunen hypothesized that a pattern of rings around the city would develop based on land cost and transportation cost.

The Four Rings

Ring 1: Dairying and intensive farming occur in the ring closest to the city. Because vegetables, fruit, milk, and other dairy products must get to market quickly, they would be produced close to the city. The first ring of land is also more expensive, so the agricultural products would have to be highly valuable ones and the rate of return is maximized.

Ring 2: Timber and firewood would be produced for fuel and building materials in the second zone. Before industrialization and coal power, wood was a very important fuel for heating and cooking. Wood is very heavy and difficult to transport, so it is located as close to the city as possible.

Ring 3: The third zone consists of extensive field crops such as grains for bread. As grains last longer than dairy products and they are much lighter than fuel, to reduce transport costs, they can be located farther from the city.

Ring 4: Ranching is located in the final ring surrounding the central city. Animals can be raised far from the city because they are self-transporting.

What the Model Tells Us?

Even though the Von Thunen model was created in a time before factories, highways, and even railroads, it is still an important model in geography. The Von Thunen model is an excellent illustration of the balance between land cost and transportation costs. When one gets closer to a city, the price of land increases. The farmers of the Isolated State balance the cost of transportation, land, and profit and produce the most cost-effective product for market. Of course, in the real world, things do not happen as they would in a model.

Mining

The process of extracting minerals from the earth crust is known as mining. The discovery of minerals in the history of human development is reflected in many stages in terms of copper, Bronze and Iron Age. The use of minerals in ancient times was largely confined to making of tools, utensils and weapons. The actual development of mining began with the industrial revolution and its importance is continuously increasing.

Types of Mining

Open-pit or opencast mining

Open pit mining involves mining minerals ore that can be found near the surface layer of the site. Some quarries can be over 1000 meters deep. This form of mining doesn't require tunneling into the earth and is a simple method of mining that yields high production.

Surface Mining

Surface mining is the process of mining the ores found on the surface of the earth. In this process, any unwanted soil is stripped off from the land and the ore beneath is extracted. Surface mining often leaves behind large areas of infertile land and waste rock as 70% of the mined earth is waste materials.

Underground or sub surface mining/Shaft mining

Sub-surface mining involves the digging of a network of shafts and tunnels into the earth to reach and extract the deposit of mineral ore beneath the earth. In comparison to other methods, underground mines impacts are less on the environment and are more harmful to those working within them. In modern practice, underground mines are pre-assessed for oxygen toxicity levels and a system of ventilation machines and protocols are in place to ensure workplace safety.

In-Situ Mining

It is a rarely used method of mining material. It is also called as solution mining. It is the process of pumping a solution into the ore body, which dissolves the ore and is then extracted by a second pump. This method is used most in mining uranium deposits.

Secondary Activities

Secondary sector transforms the raw materials obtained from the primary sector into consumer goods. So it consists of manufacturing and industrial activities. Since it adds value for the raw materials, it is also called as value addition sector. Industries consume large quantities of energy and require factories and machinery to convert the raw materials into goods and products. The secondary sector supports both the primary and tertiary sectors.

Factors affecting location of Industries

1. Availability of raw-materials or nearness to raw-materials: Availability of raw materials or nearness to raw materials is a primary factor which governs location of industries. An industry is located in a place where raw materials are available in abundance and at cheaper rates. It is more so for the weight loosing and bulky raw materials. For example, oil refinery factories are established at Visakhapatnam because oil is imported through Vizag port.

2. Availability of power: Availability of power is another important factor of concentration or location of industries. In olden days steam was used for running industries. As a result industry is established near the coal mines. But with the invention of electricity, today industries are located in any place where electricity is available. Industries like aluminum units are located near the hydroelectric projects.

3. Transport costs: Transport costs also influence the location of industries. Industries incur transport costs for bringing raw-materials and for sending the finished goods into the markets. It is economical to start an industry near the area where transport costs are minimum and low. Raw-materials which are heavy and occupy large place, require huge cost for transporting them. So an industry must be located near the area where the transport costs are minimal.

4. Nearness to the market: This is a chief factor governing the location of an industry in modern period. Several advantages are secured when an industry is established near the market. Production can be carried on in accordance with the changes in the consumers' tastes. Economies of transport can be secured in importing raw-materials.

5. Availability of labour: Labour is required for organizing the productive affairs of an industry. The entrepreneurs like to start industries in those areas where labour is abundantly available. The growth of cotton textile industry near Bombay is due to the availability of cheap labour.

6. Government policy: The policy of government also influences the location of industries. The Government may establish an industry on political considerations by giving several

incentives. It provides finance, land, water, and transport and communication facilities in backward regions with a view to developing them. It also provides tax concession, marketing consultancy, export and import facilities.

7. Availability of capital: Capital is the most essential factor for the establishment of an industry in a locality.

Weber's Theory of Location

Weber has developed an industrial location emphasising the least cost principle. This is based on assumptions relating to transport costs and other conditions. From his theory, industrial locations for three different situations are made clear.

Assumptions:

1. Some resources are available only in certain regions. Yet, resources such as water are ubiquitous (present everywhere).

2. Markets are found only in specific places.

3. Transport costs are determined based on the weight of the raw materials and distance of transfer.

4. There is competition in the markets for the commodities produced at the industry.
5. Humans use their discretion in their consumer behavior in relation to the industrial commodities.

Based on these assumptions, together with the notion of high profits with least costs and imagination, Weber describes his theory of industrial location.

Weber uses a triangular structure to elaborate on his theory of industrial location using least transport cost principle. The two corners of the triangle defined by the base line represent the places where raw materials are found (R1 and R2). The market (M) is at the apex of the triangle. In the figure below, R1 and R2 are resource locations, consisting of two types of resources. M is the market and P is the industrial location.

As the logic behind Weber's location indicates, some industries produce finished products which lose weight (weight losing raw materials). In this case, the transport cost for raw materials transfer to the industrial location is higher than the transport cost of moving finished products from industrial location to market. It is because the waste from raw materials at the industrial site will be high. Hence, it is profitable to have industry at the raw materials' locations.

If industry is located at the raw material source R1, then raw material R2 must be transported to industrial location R1 and the finished products must be transported to the market M. This results in transport costs. Likewise the industry could be located at R2, too. But if it is located at M, R1 and R2 resources must be transported to market M. This would also involve transport costs. If on the other hand, the industry is located half way between R1 and R2, and then the transport cost to bring the raw materials from R1 and R2 is equal. Transport cost involved in transporting the finished products to the Market decreases

because of small distance to market M (if transport cost is assumed to increase with distance).

In the final analysis, the transport cost for raw materials to the industrial location P and the finished products to market M from P together is the least when industry is located at P. There is thus a chance for increased profit for the industry.

The triangle at top left represents a location where distance to be covered by transport is at minimum, the triangle at the top right illustrates the location of a 'weight – losing industry' and the triangle at the bottom left represents the location of a 'weight – gaining industry'. Hence, the location of industry at P is an 'optimal industrial location'.

As the industry is located at a point between the raw materials locations, transport cost to transfer bulky raw materials is reduced considerably. The transport cost for transferring the finished products from the industry to the market is also small. In such a context, Weber believes that it is profitable to set up the industry at a location in between the industry.

There are some industries which manufacture finished products gaining weight in the process. The transport cost between raw materials location and industry is lower than the transport cost of finished products from industrial location to the market. It is logical therefore to locate the industry at the market. According to Weber, this location is more profitable to the industry than any other. The Weber's location theory is that it is based on the transport cost. Nevertheless, this theory of industrial location is considered superior to other industrial location theories for its logical conclusion.

On the Basis of Labour

Large Scale Industries

Industries which employ a large number of labourers with huge capital are called large-scale industries. Cotton and jute textile industries are large scale industries.

Small Scale Industries

Industries which employ a small number of labourers with small investments are called small scale industries. They include nut & bolt making, coir making, plastic bags industries, dying industry, match box making, weaving industry are some examples for small scale industries

Cottage Industries

Those industries whose labour force consists of family units or individuals working at home with their own equipments are called cottage industries. It is a small and often informally organized industry. The industries like weaving and pottery are the examples this category. On the Basis of size of raw-Material and Finished Goods

Heavy Industries

Industries which use heavy and bulky raw-materials and produce products of the same category are called heavy industries. Iron and steel industry presents a good example of heavy industries.

Light Industries

The light industries use light raw-materials and produce light finished products. Electric fans, sewing machines are light industries.

On the basis of Ownership

Private Sector Industries

Industries owned by individuals or firms such as Bajaj Auto or TISCO situated at Jamshedpur are called private sector industries.

Public Sector Industries

Industries owned by the state and its agencies like Bharat Heavy Electricals Ltd., or Bhilai Steel Plant or Durgapur Steel Plant are public sector industries.

Joint Sector Industries

Industries owned jointly by the private firms and the state or its agencies such as Gujarat Alkalies Ltd., or Oil India Ltd. fall in the group of joint sector industries.

Co-operative Sector Industries

Industries owned and run co-operatively by a group of people who are generally producers of raw materials of the given industry such as a sugar mill owned and run by farmers are called co-operative sector industries.

On the Basis of Source of Raw Materials

Agro Based Industries

Agro based industries are those industries which obtain raw-material from agriculture. Cotton textile, jute textile, sugar and vegetable oil are representative industries of agro-based group of industries.

Mineral Based Industries

The industries that receive raw materials primarily from minerals such as iron and steel, aluminum and cement industries fall in this category.

Pastoral-Based Industries

These industries depend upon animals for their raw material. Hides, skins, bones, horns, shoes, dairy, etc. are some of the pastoral-based industries.

Forest Based Industries

Paper card-board, lac, rayon, resin, tanning of leather, leave- utensils, basket industries are included in this type of industries.

Classification based on Nature of products

Based on the nature of products it is classified into basic industries and consumer goods. Basic industries are manufacturing goods by using them as raw materials are basic industries. For example Iron and steel machines for textile industry. Consumer industries are producing goods for consumers. For example, Television, soap, biscuits, etc.

Tertiary activities

The tertiary industry provides services to its consumers. It is also known as service industry/sector.

All types of services and special skills provided in exchange of payments are called tertiary activities. Health, education, law, governance and recreation etc.; require professional skills. These services require other theoretical knowledge and practical training. Most of the tertiary activities are performed by skilled workers and professionally trained experts and consultants.

Tertiary activities involve commercial output of services rather than the production of tangible goods. Expertise provided by service relies more heavily on special skills, experience and knowledge of the workers rather than on the production techniques, machinery and factory processes. Trade and commerce, transport, communication and services are the categories of tertiary sector. Tertiary sector is further divided into quaternary and quinary sector.

Quaternary Activities

The quaternary sector of the economy consists of intellectual activities, example, libraries, scientific research, education, and information technology. The workforce who is readily involved in this sector is typically well-educated, and people are often seen earning well through their participation in this industry.

Quinary Activities

The professions of the people working in this industry are generally referred to as "gold collar" professions since the services included in the sector focus on interpretation of existing or the new ideas, evaluation of new technologies, and the creation of services. It involves highly paid professionals, research scientists, and government officials. The people are designated with high positions and powers, and those who make important decisions that are especially far-reaching in the world around them often belong to this category.

Division of the world

For analytical purposes, World Economic Situation and Prospects classifies (WESP) all countries of the world into one of three broad categories: developed countries, countries in transition (South-Eastern Europe Commonwealth of Independent States and Georgia) less developed countries and developing countries.

The classification of countries is based on the economic status such as Gross Domestic Product (GDP), Gross National Product (GNP), per capita income, industrialization, the standard of living, etc. Developed Countries refer to the sovereign state, whose economy has highly progressed and possess great technological infrastructure, as compared to other nations.

Developed countries

A developed country, industrialized country, more developed country, or more economically developed country (MEDC), is a country that has a developed economy and advanced technological infrastructure relative to other less industrialized nations. Most

commonly, the criteria for evaluating the degree of economic development are gross domestic product (GDP), gross national product (GNP), the per capita income, level of industrialization, amount of widespread infrastructure and general standard of living.

Developed countries have generally post-industrial economies, meaning the service sector provides more wealth than the industrial sector. As of 2015, advanced economies comprise 60.8% of global GDP based on nominal values and 42.9% of global GDP based on purchasing-power parity (PPP) according to the International Monetary Fund. In 2017, the ten largest advanced economies by GDP in both nominal and PPP terms were Australia, Canada, France, Germany, Italy, Japan, South Korea, Spain, the United Kingdom, and the United States.

Countries in transition

A country in transition economy or transitional economy is an economy which is changing from a centrally planned economy to a market economy. Transition economies undergo a set of structural transformations intended to develop market-based institutions. These include economic liberalization, where prices are set by market forces rather than by a central planning organization. The process has been applied in the former Soviet Union and Eastern bloc countries of Europe and some Third world countries, and detailed work has been undertaken on its economic and social effects.

The Least Developed Countries

The Least Developed Countries is a list of countries that, according to the United Nations, exhibit the lowest indicators of socioeconomic development, with the lowest Human Development Index ratings of all countries in the world. A country is classified among the Least Developed Countries if it meets three criteria.

- Poverty – adjustable criterion based on GNI per capita averaged over three years. As of 2018 a country must have GNI per capita less than US$1,025 to be included on the list, and over $1,230 to graduate from it.
- Human resource weakness (based on indicators of nutrition, health, education and adult literacy).
- Economic vulnerability (based on instability of agricultural production, instability of exports of goods and services, economic importance of non-traditional activities, merchandise export concentration, handicap of economic smallness, and the percentage of population displaced by natural disasters).

The world's 10 biggest economies in 2017

The economy of the United States is the largest in the world. At $18 trillion, it represents a quarter share of the global economy (24.3%), according to the latest World Bank figures.

China follows, with $11 trillion, or 14.8% of the world economy. Japan is in third place with an economy of $4.4 trillion, which represents almost 6% of the world economy. European countries take the next three places on the list: Germany in fourth position, with a $3.3 trillion economy; the United Kingdom in fifth with $2.9 trillion; and France in sixth

with $2.4 trillion. India is in seventh place with $2 trillion, and Italy in eighth with an economy of over $1.8 trillion. Ninth place goes to Brazil, with an almost $1.8 trillion economy. And in 10th is Canada, with an economy of over $1.5 trillion. The economy of the United States is larger than the combined economies of numbers three to 10 on the list.

Fastest-growing economy

Although China trails the US by $7 trillion, it's catching up. China's economy grew by 6.7% in 2016, compared with America's 1.6%, according to the IMF. It has also overtaken India as the fastest-growing large economy. The IMF's World Economic Outlook estimated China's economy grew at 6.7% in 2016, compared with India's 6.6%. The chart above shows the world's 40 biggest economies individually, but grouped by colour into continents. The Asian bloc clearly has a larger share than anywhere else, representing just over a third (33.84%) of global GDP. That's compared to North America, which represents just over a quarter, at 27.95%. Europe comes third with just over one-fifth of global GDP (21.37%). Together, these three blocs generatemore than four-fifths(83.16%) of the world's total output.

6. Cultural and Political Geography

Introduction

An interesting traditional Chinese custom says that a husband should carry his bride over a pan of burning coals before crossing the threshold of their home as husband and wife. According to tradition, the ritual ensures that the wife will have an easy and successful labour. Fire walking is also performed by some Chinese people as a means to prevent natural disaster'. 'In Cypriot culture, do not give white lilies as they are used at funerals. It is polite to finish everything on your plate. If you have not finished eating, cross your knife and fork on your plate with the fork over the knife'. It indicates you have finished eating by laying your knife and fork parallel across the right side of your plate'. Do you know some interesting custom practiced in our culture?

Culture is the total way of life that characterizes a group of people. There are thousands of cultures existing today and each contributes to global diversity. There are so many ways that people can be culturally different. Specifically, a culture consists of numerous cultural components that vary from one culture group to the other. Some of the cultural parameters are religion, language, architecture, cuisine, technology, music, dress, gender roles, law, education, government, agriculture, economy, sport, values, and many more.

Culture Region

A culture region is a portion of Earth that has common cultural elements and has distinct cultural authority from other regions. Any number of cultural components may be used to define culture regions. A map of world religions, for example, includes a shaded area in South Asia where Hinduism is dominant.

Culture regions differ greatly in size. Some are exceedingly large, like the Islamic culture region that encompasses millions of square km of North Africa and Southwest Asia. Some are very small, like Spanish Harlem, which encompasses about three square km of Manhattan. Many others are of intermediate size, like the Corn Belt, which occupies a portion of the mid-western United States.

Cultural Diffusion

Cultural diffusion is the spread of cultural beliefs and social activities from out group of people to another. Mixing of world culture through different ethnicities, religions and nationalities has only increases with advanced communication, transport and technology.

Cultural Landscape

Cultural Landscapes have been defined by the World Heritage Committee as "cultural properties representing the combined works of nature and of man".

The World Heritage Committee has identified and adopted three categories of cultural landscape. The three categories extracted from the Committee's Operational Guidelines, are as follows:

(i) "A landscape designed and created intentionally by man".
(ii) An "organically evolved landscape" which may be a "relict (or fossil) landscape" or a "continuing landscape";
(iii) An "associative cultural landscape" which may be valued because of the "religious, artistic or cultural associations of the natural element".

Cultural Interaction

Cultural interaction focuses on the relationships that often exist between cultural components that characterize a given community. Different factors interact with each other and give rise to prevalent trait.

What language do you speak? What dress do you wear? What food do you like? What is the structure of the house you live in? For the above question by searching the answer we can learn the culture of a human society.

Culture shapes our identity and influences our behaviours. Culture refers to the sharing language, beliefs, values, norms, behaviors and material objects, which are passed from one generation to the next generation. Cultural geography is the branch of human geography which deals about the areal organization of various cultural aspects in relation to total environment. Some of the cultural aspects are as follows:

Language

Language plays great force in socialization and historical transmission, which is the primary instrument for transmitting culture. Human can bind any group of people

through the network of interaction. Languages are in written or oral form. India (780) has the world's second highest number of languages, after Papua New Guinea (839).

Customs

Custom in law is the established pattern of behavior that can be objectively verified within a particular social setting. A claim can be carried out in defense of what has always been done and accepted by law. It becomes characteristic of the group of people performing the act.

Habit is a similar word which is adopted by an individual and it has been adopted by most of the people of the ethnic group or society.

Norms

Norms refers to attitude and behaviours that are considered normal, typical or average within the group. Cultural norms are the standards we live by. They are the shared expectations and rules that guide behaviour of people within social groups. Cultural norms are learned and reinforced from parents, friends, teachers and others while growing up in a society. Norms often differ across cultures, contributing to cross-cultural misunderstandings.

Values

Values refer to intangible quality or beliefs accepted and endorsed by a society. A culture's values are its ideas about what is good, right, fair, and just. Sociologists disagree, however, on how to conceptualize values. Conflict theory focuses on how values differ between groups within a culture, while functionalism focuses on the shared values within a culture.

Cultural Heritage

Cultural Heritage is an expression of the ways of living developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions and values. Cultural Heritage is often expressed as either Intangible or Tangible Cultural Heritage. As part of human activity Cultural Heritage produces tangible representations of the value systems, beliefs, traditions and lifestyles. As an essential part of culture as a whole, Cultural Heritage, contains these visible and tangible traces form antiquity to the recent past.

Cultural Heritage types

Cultural Heritage can be distinguished in: Built Environment (Buildings, Townscapes, and Archaeological remains), Natural Environment (Rural landscapes, Coasts and shorelines, agricultural heritage) and Artefacts (Books & Documents, Objects, and Pictures).

Cultural diversity

Cultural diversity refers to having different cultures, respect to each other differences. Cultural diversity is important; because of work place and show increasingly consist of various cultural, racial and ethnic groups. We can learn from one another but first we must have a level of understanding. Cultural diversity exists in many countries around the world, but it can be challenging and, at times, problematic. Through this

lesson, you will learn how to define cultural diversity and explore some of the ways in which it influences society.

Cultural Traits

A cultural trait is a characteristic of human action that's acquired by people socially and transmitted via various modes of communication. Cultural traits are things that allow for a part of one culture to be transmitted to another. There are millions of culture traits, a trait can be an object, a technique, a belief or an attitude. Culture traits are interrelated with each other, their collective function forms culture complex.

Cultural Realms of the World

Cultural realm refers to a type of cultural region. Cultural region is a continuous geographical area characterized by cultural homogeneity. It may be classified into three categories as macro, meso and micro region. Cultural realm is classified based on the attitude, religious belief, language, racial group, technological development, etc. There are twelve Cultural realms in the modern world. Let us discuss some of them briefly.

Occidental Realm

Occidental culture is the culture of the European society. It is influenced, to a great extent, by Christianity. It has regional modifications on the basis of varying levels of industrialisation, political and economic thought, colonisation, commercialisation, urbanisation, and development of transport system, land development of social, political and economic institutions.

In many parts of the occidental culture, the impact of non-religious factors, particularly the effect of modernisation, is so great that the religious values are sidelined. Post- industrial Europe is fast emerging as a society where traditional values are nearly abandoned. The occidental culture covers a vast area. It is further divided into six sub-regions considering the impact of regional environment.

(i) West European is the most industrialised and urbanised culture.

(ii) Continental European culture is influenced by different political and economic thoughts, while Christianity remains an important influence.

(iii) Mediterranean Europe includes countries lying to the south of the Alps. It is the region of dominance of Christianity.

(iv)Anglo-American and

(v) Australian cultural realms are practically the offspring's of west European culture. Both are inhabited by migrants from west Europe. There are only some regional differences.

(vi)Latin American culture is very similar to the Mediterranean culture. It is the only region of occidental culture which lies in the tropics and is underdeveloped. It became a part of the occidental culture as a result of conversion of tribes into Christianity. The colonial languages, Spanish and Portuguese, have become the state languages. Regional architecture has been influenced by the Spanish and Portuguese styles.

Practically all countries maintain economic, cultural and social ties with the Mediterranean countries.

Islamic Cultural Realm

The Islamic Cultural Realm is influenced by Islamic values. It covers a vast geographical area from Morocco in the west to Pakistan in the east. The population is sparsely distributed due to inhospitable environment. The coasts, river basins and oases have been the cradles of Arabian culture in this realm. The British call it the Middle-East while the Germans call it a region of oriental culture. This cultural realm lies between the traditional Indian culture in the east and the modernised European culture in the west.

Islamic culture is highly orthodox and based on traditional beliefs, the impact of which can be seen in high female illiteracy rates. These countries have very high per capita incomes, but the level of modernisation is very low.

Indie Cultural Realm

Indie Cultural Realm is the culture of the Indian sub-continent. Baker called it a sub-continental culture, while D. Stamp used the term paddy culture. This cultural realm is well-defined; it lies between Himalayas in the north, Indian Ocean in the south and Hindukush Mountains in the west.

This cultural realm is characterized by joint family, village community, caste system, semi-feudal land relations, subsistence agriculture, paddy farming, seasonal climate changes and agricultural season coming at the same time all over the region. The culture of this region is greatly influenced by Vedic values. Though the region is inhabited by various communities, the social system has the hidden impact of Vedic cultural values.

East Asian Culture

This culture is basically a Buddhist culture with regional modifications. True Buddhist culture can be seen in South Korea and Japan. Even these two countries have felt the impact of industrialisation, urbanisation and modernisation. The culture of mainland China has modified the Buddhist system. This culture was adopted after the Second World War.

South-East Asian Culture

It is a transitional culture lying at a place where different cultures have intermingled. Dominance of Buddhism can be seen in Myanmar, Thailand and Vietnam. Influence of Christianity can be seen in the Philippines and of Indie culture over islands of Indonesia. The Islamic influence is evident in Malaysia and the Indonesian islands. No other region has such peculiarities.

Meso-African Culture

This culture is also known as the Negro culture. It principally includes tropical Africa. Similar cultural systems can be seen among the American Red Indians, Latin American tribes, Australian aboriginals and several tribes of Asia-Pacific region.

Historian Toynbee has used the term 'marginalised culture' for these traditional culture units. Some geographers even include Eskimos under this cultural realm. Thus, it

is a widely scattered cultural realm characterised by marginalised and relatively isolated communities.

Major Culture Hearths

Areas from which important culture traits, including ideas, technology, and social structures, are originated.

Folk Culture

Culture traits that are traditional, no longer widely practiced by a large number of people, and generally isolated in small, often rural, areas.

Races

The race is a group of people with more or less permanent distinguishing characteristics. There are skin colour and hair colour to which persons concerned attach certain interpretations. Objectives and scientific classification are the division of mankind in to racial groups should be done on the basis of measurable physical features and qualities inherited from a common ancestor. The important features on the basis of which the races are identified and classified include skin colour, stature, shape of head, face, nose, eye, type of hair, and blood group. Human races are classified in to four broad groups:

1. Negroid, 2. Caucasoid, 3.Mongoloid and 4.Australoid.

HOTS

If human being originated from one point, Africa and spread to rest of the world, how could they become different races?

1. The Negroid

They are usually called as "black race". They have the darkest skin tone than other races, and other common characteristics are the slopped forehead, thick lips, wide nose, and dark hairs. They are living in Sub-Sahara Africa.

2. The Mongoloid

They have the folding eye lids, almond shaped eyes, yellowish skin tone, and V shaped cheeks. Native Americans and Eskimo are also classified as Mongoloid. Compared to the other races, they have the least body hair, least body odour, and smallest limb ratio. Their facial structure is likely to adapt cold mild wind. They are living in East Asia.

3. The Caucasoid

The Caucasoid is known as "white people" characterised by the pointy nose, vertical forehead, pinkish/orange skin tone, visible brow ridge, and colorful eyes/hair. Some believe that their light skin tone is meant to receive more sunlight due to Europe's climate. Some believe that their nose structure is meant to keep the nose moisture from getting dried by the wind. They are living in Europe and Middle East.

4. Australoid Race

They have visible eye ridge, wide nose, curly hair, dark skin tone, and short in height. Some believe that their visible ridge helps them to eat stiff foods. They are living in Australia and Papua New Guinea.

Characteristic of Major Races

Feature	Caucasoid	Monogoloid	Negroid
Skin colour	Pale reddish white to olive brown.	Saffron to yellow brown, reddish brown.	Brown to black brown yellow brown.
Stature	Medium to tall.	Medium tall to medium short	Tall to very short.
Face	Narrow to medium broad, tends to high no prognathism.	Medium broad to very broad malars high and flat tends to medium.	Medium broad to narrow tends to medium high strong prognathism.
Head form	Long-broad and short medium, high-very high	Medium height, predominantly broad.	Predominantly long low height.
Hair colour	Light blonde to dark brown, straight to wavy.	Brown to brown black, straight.	Brown black light curl and wooly.
Body build	Linear to lateral slender to refuge.	Tend to be lateral, some linearity evident.	Tend to be linear and muscular.
Nose	Usually high, narrow to medium broad.	Low to medium form, medium broad.	Low, medium to very broad.
Blood group	more A than B	High in B	High is Rh(D)
Eye	Colour: light blue to dark brown, lateral eye –fold occasional.	Colour: brown to dark brown, medial epicanthic fold very common.	Colour: brown to brown block, vertical eye-fold common.

Ethnicity

Ethnicity is a concept referring to a shared culture and a way of life. This can be reflected in language, religion, material culture such as clothing and cuisine, and cultural products such as music and art. Ethnicity is often a major source of social cohesion and social conflict. The world is home to thousands of different ethnic groups, from the Han Chinese (the largest ethnic group in the world) to the smallest indigenous groups, some of which include only a few dozen people. Almost all of these groups possess a shared history, language, religion, and culture, which provide group members with a common identity.

India is a unique country with great diversity in ethnicities, race, religion, language, culture, cuisine and in every other aspect of the human society. Indian civilization is one of the oldest in the world and primarily consists of the Indo-Aryans of North India and the Dravidians of South India, the people of the Indus Valley Civilization while the former

migrated to the country at about 1800 BC. As India has such a diverse cultural demographic, it makes sense that the country is also.

Dravidians

The Dravidian people are any native speakers of the Dravidian languages in the Indian Subcontinent. Almost all the Dravidians live in the southern part of India. The five major ethnic groups of Dravidian people in India are Tamil, Telugu, Kannada, Malayalam, and Tulu.

The ancient Indus Valley civilization in India was believed to have been of Dravidian origin in northern India, but then the Dravidian people were pushed south when the Indo- Aryans came in and the Kuru Kingdom in northern Indian arose. Later South India was dominated by the three Dravidian kingdoms of the Cheras, Cholas, and the Pandyas. These three kingdoms have been shown to sponsor the growth of literature, music, and the arts and to have done extensive trading. The three kingdoms also supported and were tolerant of Buddhism, Jainism, and Hinduism. The major languages spoken by the Dravidian people are Tamil, Telugu, Kannada, Malayalam, and Brahui.

Do you know?

Arabic script Brahui is the only Dravidian language which is not known to have been written in a Brahmi based script, instead, it has been written in the Arabic script since the second half of the 20th century in Iran Pakistan and Afghanistan.

Religion

Religion is not a vague fear or unknown powers not the child of terror, but rather a relation of all the members of a community to a power that has the good of the community at heart and protects its law and moral order. Religion produces a distinct attitude towards life which affects the further development of the society. Indeed most cultural situations show the mutual interaction between religion and socio-economic and politico-cultural factors.

Classification of religion

Religion may be classified based on the belief in god. Monotheistic: the followers of monotheism believe in a single god (Islam, Christianity). Polytheistic: the followers of polytheism believe in many gods (Hinduism). Another classification is on the basis of areas of origin such as Eastern religion, Western religion, far Eastern religion, African religion, Indian religion, etc. Geographers generally classify religions into following;

- Universalizing religions – Christianity, Islam, and Buddhism.
- Ethnic religions – Hinduism, Shintoism (Japan), Chinese faiths, Judaism.
- Tribal or traditional religions – animism, shamanism, secular (non-religious and atheists).

Major religions of the world

Major religions of the world are classified based on the followers. They are Christianity, Islam, Hinduism, Buddhism, and Judaism. Other important religions include Chinese folk religions, Sikhism, Confucianism, Shintoism etc.

Christianity is a universal religion which has the largest number of followers in the world. They are spread in Europe, Anglo America, Latin America, Africa, Asia and Oceania. Its sacred book is "Bible". Islam is the second largest religion of the world. The largest concentration of the Islam is in the South West Asia, Central Asia, South Asia and South East Asia Followed by the North Africa. Shia and Sunni are its two main sects. Its sacred book is Kuran.

Hinduism is the oldest ethnic religion of the world which was founded about 3000 B.C (B.C.E) in India. Today it has over 8 million followers in the world but main concentration is in India and Nepal. Nearly 99 percent of the total Hindu population is concentrated in south Asia. Its sacred books include the Vedas, the Upanishads, the Epics, the Ramayana and Mahabharata, and the Bhagavad Gita. Buddhism is also one of the oldest religions of India which was founded by Lord Buddha around 525 B.C (B.C.E). Its spread in several Asian countries (China, Myanmar, India, Srilanka, japan, Mangolia, Korea and South East Asian countries) due to its liberal philosophy. Its two main sects are Hinayana and Mahayana.

Judaism is the oldest Monotheistic faith which is regarded as the parent of Christianity. It originates 4000 years ago in the Middle East. At present it has about 14 million followers living in U.S.A, Europe and Asia. Chinese religions include two main beliefs called Confucianism and tao-ism. Confucianism was established by Confucious (551-479 B.C (BCE)). Taoism was established by Lao Tse (604-517 B.C (BCE)).

Jainism is also born in India as a reaction to orthodox Hinduism. It was founded by Lord Mahavir who was a Contemporary of Lord Buddha. Its followers are mostly concentrated in India. It is an offshoot of Hinduism which was established in the 15th century by Guru Nanak. It remained confined to Punjab state and has accepted Gurumukhi as its language.

Tribal Religions

Tribal religions are the special forms of ethnic religion. The tribal people are generally in the Neolithic stage of social development. Tribal people are strikingly different and diverse in their culture, social and economic life. They cherish their own distinct and have maintained a close relationship to the land and natural environment. Most of them live according to their traditions and are engaged in food gathering, hunting, fishing, primitive agriculture etc, there are about 300 million indigenous people worldwide, constituting about four percent of the total population of the world living in more than sixty countries.

Do you know?
The percentage of tribal to total population is as high as over 90 percent in Greenland, 66 percent in Bolivia and 40 percent in Peru. In India share of tribal people to total population is 8.2 percent.

Sometimes the tribal people are being termed as the fourth world. The first – second and third world believed that "the land belongs to the people" whereas the fourth world believes that "the people belongs to the land

Tribal Distribution in world

Some major tribal group of the world particularly who are living and struggling

1. Equatorial Forest region: Pigmy, Semang, Sakai, Boro, Papuan, etc.

2. Grasslands: Masai, Kyrghizs, etc.

3. Tropical deserts: Bedowin, Bushman, Aborigines etc.

4. Mountainous region: Bhotia, gujjar, Naga etc.

5. Monsoon regions: Gonds, Santhals, Todas, Bhils, etc.

6. Arctic cold regions: Eskimo, Lapp, Alute, Chukchi etc.

Pigmies

The pigmies are Negroid people and are also called Negrillos. They are the nearest approximation of human being to animal. They are short stature, flat nosed, wooly haired, long headed and black people. The average height of men and women are found 150cm. So they are also called dwarf. The pigmies are those who live in scattered parts of tropical Central Africa. They are found in many sub-groups in the equatorial forest region of Africa mainly in Congo basin 3^{o}N and 3^{o}S latitudes along both sides of the equator. In addition some groups of Pigmies are also found in the forests of Philippines and New Guinea.

Masai

The Masai of east Africa belong to the pastoral society and are known as the best and most typical cattle herders not only of Africa but also of the world. Masai people are tall and slender with ling feet, hands and fingers. Their skin colour ranges from light chocolate to dark brown. They have high and long head, thin face and nose. Their lips are less thick than that of Negroid people. Masai occupy the interior plateau of the equatorial Africa. The territory of the Masai lies between 1^{o}N and 6^{o}S latitudes and covers all the rift valleys in this region.

Bedouin

In Arabic, Bedouin means desert dwellers. The Bedouins are most important among the tribal of South West-Asia and North Africa. They are pastoral nomads and keep camel, sheep, goats, horse etc. The Bedouins occupy the desert areas of the Arabian Peninsula including Saudi Arabia, Yemen, Oman, Syria and Jordan. The Bedouins belongs to the mixture of Mediterranean and Armenian races. They are medium stature people with long narrow face, prominent nose, dark eyes and hair. Their complexion is wheatish to pale.

Bushman

Bushman is the tribal people of Kalahari Desert in southern Africa who are still engaged in hunting and gathering economics. They are on constant run for both food and water. Their homeland Kalahari Desert lies in Botswana, Namibia and southern Angola. The bushman territory is a wide plateau about 2000 meters above the sea level with sub-tropical climate. The bushman are including in the Negroid stock. They are very short in

stature and have long head, short and flat ears, and yellowish brown complexion. On the whole the Negroid characteristics prevail among the Bushman.

Eskimos

Eskimos also called Inuits are tribes of tundra cold region in Canadian northland, Alaska, Greenland and north-eastern Siberian coastal region. The Eskimos are Mongoloid race. The main physical characteristics of the Eskimos are short stature, Flat narrow face, small snub nose, yellow –brown complexion and coarse straight black hair. Hunting and fishing are the main occupations of the Eskimos. They live in igloo and practice hunting way known as Maupak. The Eskimos wear clothes of caribous or reindeers skin and other furs.

Eskimos are migratory by nature and construct ice houses called Igloos. For travelling on ice shield the Eskimos use sledge which is usually built either of whale bone or of wood whichever is available. It is drawn by two or more dogs, caribous or rain deer.

Tribal in India

India is the home to large number of indigenous people, who are still untouched by the lifestyle of the modern world. With more than 84.4 million, India has the largest population of the tribal people in the world. These tribal people also known as the adivasis are the poorest in the country, which are still dependent on haunting, agriculture and fishing. Some of the major tribal groups in India include Gonds, Santhals, Khasis, Angamis, Bhils, Bhutias and Great Andamanese. All these tribal people have their own culture, tradition, language and lifestyle. There are more than 50 tribal groups in India. Most of the tribal belong basically to the Negrito, Australoid and Mongoloid racial stocks.

Bhils

Bhils are popularly known as the bow men of Rajasthan. They are the most widely distributed tribal groups in India. They form the largest tribe of the whole South Asia. Bhils are mainly divided into two main groups the central or pure bills and eastern or Rajput Bhils.

Gonds

The Gonds are the tribal community mostly found in the Gond forests of the central India. They are one of the largest tribal groups in the world. Gonds have been largely influenced by the Hindus and for the long time have been practicing the Hindus culture and traditions.

Santhals

Santhals are the third largest tribe in India. They are mostly found in the states of West Bengal, Bihar, Odisha, Jharkhand and Assam. They belong to the pre- Aryan period and have been the great fighters from the time of the British.

Munda

Munda tribe mainly inhabit in the region of Jharkhand, although they are well spread in the states of West Bengal, Chhattisgarh, Odisha and Bihar. Munda generally means headman of the village. Hunting is the main occupation of the Mundas tribe.

Khasi

Khasi tribe is mainly found in the KhasiJaintia hills in Meghalaya and in the states of Punjab, Uttar Pradesh, Manipur, West Bengal and Jammu and Kashmir. They form the large part of the population in the state of Meghalaya.

Angami

Angami tribe belongs to the extreme north eastern part of the country, in the state of Nagaland. The total population of the Angamis is around 12 million. They are quite popular for their woodcraft and artwork. Sekrenyi is the main festival celebrated among the Angamis in Nagaland.

Bhutia

Bhutia tribes are of the Tibetan origin. They migrated to Sikkim around 16th century. In the northern part of the Sikkim they are known as the Lachenpas and Lachungpas. Bhutias forms 14% of the total population of Sikkim. Losar and Losoong are the main festivals celebrated among the Bhutia tribes.

The Sentinelese tribe, the most dangerous tribe in the world!

Located far into Andaman and Nicobar Islands, the Bay of Bengal in the Indian Ocean, North Sentinel Island is one of the most isolated places on earth. This remote island is home to the Sentinelese tribe, the most dangerous tribe in the world. The Sentinelese is hunter-gatherers, as agriculture is not known to them. Their diet consists mainly of coconuts and fish that can be found in the shallow waters around their shores. The Sentinelese would be described as Stone Age people. The women wear fibre strings tied around their waists, necks and heads. The men also wear necklaces and headbands, but with a thicker waist belt. The men carry spears, bows and arrows. Sometimes the Sentinelese appeared to make friendly gestures at others they would take the gifts into the forest and then fire arrows at the contact party. The population of North Sentinel Island is estimated at 250 individuals. The Sentinelesedoes not want help from outsiders.

Chenchu

Chenchu inhabit in the Nallamalai hills, which have been the part of the Nagarjuna Segar Tiger Sanctuary for centuries in Andhra Pradesh, India. They are mainly found in the districts of Mahabubnagar, Nalgonda, Praksham, Guntur, and Kurnool.

Great Andamanese

Great Andamanese is the Negrito tribe inhabitant in the Andaman group of Islands. They form the largest population among the other tribes found in these islands. According to the census the population of Great Andamanese is now limited to few individuals.

Tribals in Tamil Nadu

Tribes of Tamil Nadu are concentrated mainly in the district of Nilgiris. Of all the distinct tribes, the Kodas, the Thodas, the Irulas, the Kurumbas and the Badagas form the

larger groups, who mainly had a pastoral existence. Other tribes include, Kattunayakan and Paliyan amongst others.

According to census 2011, tribal population in Tamil Nadu is 7, 94,697. There are around 38 tribes and sub-tribes in Tamil Nadu. The tribal people are predominantly farmers and cultivators and they are much dependent on the forest lands.

Toda: Men from the family of the tribes are occupied in milking and grazing their large herds of buffaloes. Their settlements are known as 'Munds'. They do not worship any god and their consciousness is cosmic. They live in Nilgiris. Today, there are about a thousand Todas left.

Badaga: The Badagas belong to the backward class and are not classified as tribal. They are an agricultural community, dwelling in the higher plateau of the Nilgiris district in the state of Tamil Nadu. They are engaged in tea cultivation and potato growing. They form the largest group of tribes and boast a rich oral tradition of Folk tales, songs and poetry. These tribes are Hindu and belong to the Shiva sect.

Kota: The Kotas are mainly concentrated in the Tiruchigadi area in the Nilagiri hills. They are distinguished by their colorful Folk dances and are basically musicians, who play at Badaa funerals. They are mainly engaged in producing handicrafts. These tribes of Tamil Nadu are expert iron smiths, potters and carpenters. In order to maintain distance and status in society, the Kotas implement elaborate tattoos.

Kurumbas: The Kurumbas tribes of this state inhabit the intermediate valleys and forests in Villages and were known for their black magic and witchcraft in the past. Their way of living today has changed from their original gathering and hunting existence to working in Coffee and Tea plantations as laborers. Kurumbas are perhaps the only main caste in southern India that has a specialized and distinctive Kurumbas Language.

Irula: The Irula tribes of Tamil Nadu occupy the lower slopes and forests at the base of the Nilgiri Hills. They constitute the second largest group of tribes after the Badagas and are similar to the Kurumbas in many ways. This tribe produces honey, fruits, herbs, roots, gum, dyes etc., and trades them with the people in the plains. In the recent times the Irulas help in catching snakes and collect the snake venom.

Paliyan: They are of the food gathering communities of Tamil Nadu. It is believed that the Paliyan originally belonged to the Palani hills. They are distributed in the districts of Madurai, Tanjavour, Pudukkottai, Tirunelveli and Coimbatore.

Language

Language is an identification mark for different cultures. Because language is essential to communication, it strongly influences the sort of political, social and economic we create. As a result, economic and religious system frequently follows patterns of language distribution and political borders quite often parallel linguistic boundaries. In modern times linguistic diffusion has been facilitated by trade, tourism, media and

international organizations. It has helped in the development of the linguistic pluralism. The greatest linguistic diversity is attributed to heterogeneous societies.

Do you know?
Tamil is one of the longest-surviving classical languages in the world. The earliest period of Tamil literature, Sangam literature, is dated from 300 BC (BCE) – AD (CE) 300. It has the oldest extant literature among Dravidian languages.

Major linguistic Families of the World

The classification of languages by origin and historical development is known as a genetic classification. The languages which are the descendants of common ancestral language are called proto – language.

G.L. Trage has classified the languages of the world into 7 linguistic phylum and 30 linguistic families. Linguistic families are further classified in to sub families of languages, which denote major languages.

- 1.Indo-European - a. Indo-Iranian, b. Latin or Romantic, c. Germanic, d. Balto – Slavic, e. Celtic, f. Hellenic
- Sino-Tibetan - a. Chinese, b. Tibetan, c. Burman
- Afro-Asiatic – a. Semitic, b. Egyptian, c. Cushitic, d. Chadic
- African – a. Niger – Congo (Atlantic, Voltaic, Benu-Nagar)
  b. Sudanic (Chari-Nile, Saharan,)
  c. Click Languages (Khoisan)
- Ural-Altaic - a. Finno-Igric, b. Turkic, c. Mangolic, d. Tunguzic
- Dravidian- malayo – Polynesian- - a. Dravidian, b. Malayan, c. Melanesian, d. Micronesian, e. Polynesian, f. Austro- Asiatic.
- Palaeo Asiatic- a.Yukaghir

Do you know?
As many as half of the world's 7,000 languages are expected to be extinct by the end of this century; it is estimated that one language dies out every 14 days.

Major Languages of India

India has a rich Linguistic heritage and has heterogeneous ethnic and social groups, which have their own languages and dialects. According to census of India 1961, there were 187 languages spoken by various sections of Indian society. 23 major languages were spoken by about 97 percent population of the country. 22 languages excluding English are mentioned in the eighth schedule of the constitution of India as follows; Kashmiri, Punjabi, Hindi, Urdu, Bengali, Assamese, Guajarati, Marathi, Kannada, Tamil, Telugu, Malayalam, Sindhi, Sanskrit, Oriya, Nepali, Kongani, Manipuri, Bodo, Dogri, Maithili and Santali of these languages, 14 were initially included in the Constitution. Subsequently, Sindhi was added in 1967 by 21st constitutional amendment act; Konkani, Manipuri and Nepali were added in 1992 by 71st Constitutional Amendment Act; and Bodo, Dogri, Maithili and Santali were added in 2003 by 92nd Constitutional Amendment Act. Indian Languages belong mainly to four linguistic families

- Austric – Munda, Mon-Khmer
- Dravidan – Tamil, Telugu, Kannada, Malayalam, Gondi, kurukh, orean, etc.

- Sino- Tibetan- Bodo, Karen, Manipuri, etc.
- Indo - Aryan – Hindi, Urdu, Sans.

Dialect

A distinct linguistic form peculiar to a region or social group but which nevertheless, can be understood by speakers of other forms of the same language. The two main types of dialects are the **geographic dialect,** spoken by the people of the same area or locality, and the **social dialect** used by people of the same social class, educational level or occupational group.

Major dialects in India

More than 40 languages or dialects in India are considered to be endangered and are believed to be heading towards extinction as only a few thousand people speak them officials said.

According to a report of the census Directorate, there are 22 scheduled languages and 100 non –scheduled languages in India. The scheduled languages are 11 from Andaman and Nicobar, Seven from Manipur and Four from Himachal Pradesh. There are 42 languages spoken by less than 10,000 people. Some other languages also are in endangered position in India.

Major dialects in Tamil Nadu

Tamil is an interesting language with a range of native dialects. The language has several charming improvisations in different regions of the state. Many people are familiar with the old and familiar dialects of Tamil such as Chennai, Coimbatore, Madurai and Tirunelveli

UNESCO'S five levels of language risk:

Safe: Widely spoken
Vulnerable: Not spoken by children outside the home (600 languages)
Definitely endangered: Children not speaking (646 languages)
Severely endangered: Only spoken by oldest generations (527 languages)
Critically endangered: Spoken by only a few members of the oldest generation, often semi-speakers (577 languages)

Political Geography - Concept of Nation and State

Nation

A nation is a group of people who see themselves as a cohesive and coherent unit based on shared cultural or historical criteria. Nations are socially constructed units, not given by nature. Their existence, definition, and members can change dramatically based on circumstances. Nations in some ways can be thought of as "imagined communities" that are bound together by notions of unity that can pivot around religion, ethnic identity, language, cultural practice and so forth.

State

A State is an independent, sovereign government exercising control over a certain spatially defined and bounded area, whose borders are usually clearly defined and internationally recognized by other states.

Do you know?
Vaishali was established as a republic by the 6th century B.C (BCE), prior to the birth of Gautama Buddha in 563 B.C (BCE), making it the world's first republic.

Nation-State

The nation state is a system of organization defined by geography, politics and culture. The nation is cultural identity that is shared by the people, and the state is the governing administration. A nation state must have a shared national identity, physical borders, and a single government.

A nation-state is a political unit with a well-defined territory, inhabited by a people who are well-organised, possess sufficient powers and consider them to be a nation by virtue of certain binding factors which may be emotional and which are reflected in law and governance.

Frontiers and Boundaries

Frontiers: International frontiers and boundaries separate land, rivers and lakes subject to different sovereignties. In 1900 frontiers had almost disappeared and had been replaced by boundaries that are lines. A Frontier is a politico geographical area, lying beyond defined borders of a political unit into which expansion could take place.

Types of Boundaries

Boundaries can be classified according to their relationship with the cultural landscape. Some boundaries were established prior to the permanent occupation of areas by the present inhabitants. In some cases patterns of settlement were already developing so that the boundary ultimately established has a different relationship to the cultural realities of the area involved. This classification is known as the functional or genetic classification of boundaries.

Different between Frontier and Boundary

Frontier	Boundary
1. Natural	1. Mostly Anthropogenic.
2. Areal Concept	2. Linear Concept.
3. Frontiers have no political dispute.	3. Boundaries vary often disputable by the rival nations.
4. Frontiers generally have mountainous area, desert, marshes, etc. Thus, inhabitable.	4. But boundaries have no such criteria.
5. Frontiers are dynamic.	5. Boundaries are static because once fixed, they hardly change.

Boundaries: A boundary is a line demarcating the recognised limit of an established political unit, administrative region or geographical region e. g a state, country or district.

Do you know?
China has the maximum number of neighbors touching its border. The 14 countries touching its border are: India, Pakistan, Afghanistan, Tajikistan, Kyrgyzstan, Kazakhstan, Mongolia, Russia, North Korea, Vietnam, Laos, Myanmar, Bhutan and Nepal

Do you know?
Canada, the world's second largest country, shares the longest international land border with the United States. The Canada- US land border is 8,893 km long.

Genetic Classification of the boundaries

1. Antecedent Boundaries
The boundaries drawn before the cultural-political realm.

Such boundaries were non-contentious.
E .g, N. Africa and the state boundaries of USA.

2. The Subsequent Boundaries
When the cultural realms are fully developed & political boundaries are contentious.

Such boundaries are irregular or amorphic boundaries.
E.g. the countries of Europe.

3. Superimposed Boundaries
When a political boundary divides a homogenous cultural region and across the boundary the people with similar ethnicity are found.
E.g. Pok

4. Relict Boundaries
Historical boundaries which only exist in the books.

E .g. Persia, the boundary between east & West Germany.

Geopolitics: Global Strategic views

The study of the way a country's size, position, etc, influence its power and its relationships with other countries. Political activity is influenced by the physical features of a country or area of the world. Geo politics is concerned with how geographical factors including territory, population, strategic location, and natural resources endowments as modified by economics and technology affect the relations between states and the struggle forward domination. It is battle between land power and sea power which is going to lead the world continents by one.

Mackinder described the political history of the world as continuous struggle between land and sea powers. According to him, the Columbian era of sea powers, which gave Europe its pivotal position for four centuries is coming to an end. And in the struggle between land and sea powers, the ultimate victory is going to be of one possessing land powers. He divided the earth into 3 tiers.

1) The Heartland - area of interior and Arctic drainage in the Eastern Europe, covered by mountains on three sides and Arctic in north. This is a natural fortress on earth, inaccessible to sea powers.

2) The Inner or Marginal Crescent - area of Europe and Asia adjoining the Heartland and Africa, north of Sahara.

3) The Outer or Insular Crescent - It includes North and South America, Africa (south of Sahara) and Australia. Besides, it also includes the Great Britain and Japan because of their insularity from Eurasia.

According to Mackinder, one with control over Heartland will be in an unstoppable position to rule the world. Heartland, with its agricultural and industrial resources would conquer the inner crescent and Outer crescent would follow later. He conceptualized his theory as:

Who rules East Europe commands the Heartland.

Who rules Heartland commands World Island.

Who rules World Island commands the World.

Mackinder later argued that key to control Heartland lays in Eastern Europe, reflecting a powerful strand of pre and post- Versailles geographical thinking concerning the news to separate the powerful states of Germany and Russia by the creation of 'buffer states'.

Influence - His theory was put to test during the World War II when the Heartland could become the power center of the world if either Germany unites with Russia or China or Japan thrashes Russia. But the shattering defeat of Germany turned Heartland into a power vacuum.

The area highlighted in red is the heartland, blue is rim land and the encircled area is the world island.

The heartland is inaccessible from top because North Sea, Norwegian Sea, Barents Sea, Kara Sea, Laptev Sea, East Siberian Sea are all frozen throughout the year. The hearland is inaccessible from the bottom because of Middle Eastern desert, Iranian Plateau, Himalayas, Plateau's of Tibet and Siberian mountains. This makes heartland immune to any conquests from any other side than Eastern Europe.

The only gateway to the heartland is through Eastern Europe. So, protecting one gateway would be far easier than protecting the whole land. Moreover, the heartland was self-sufficient with most of the resources and wasn't dependent on trade from outside world.

So, Mackinder believed that the one who controls the heartland would be able to control the Rimland and as a result the world-Island, and the one, who rules the world Island, would rule the world. Although this theory made sense at that time (1904), when there was no significant aviation and naval power, it does not make much sense now.

Century Geopolitics of the multipolar world order

To put it succinctly, the unipolar world is characterized by the US' predominant hegemony in a wide variety of spheres, whether exercised directly through unilateral initiatives or indirectly ("Lead From Behind") through its regional and institutional partners. The Multipolar forces in the world are working to replace the US-led international order with a diversified array of multiple stakeholders in order to bring balance to International Affairs. Importantly, they seek to do this through progressively reforming international institutions such as the UN, IMF, World Bank, and others, as well as creating their own counterparts to some of them like the BRICS New Development Bank or outright forming entirely new and unprecedented organizations like the SCO.

One of the latest proposals has been to broaden the BRICS format through what has now been called the "BRICS-Plus" strategy, which essentially seeks to have each of the five member states encourage multilateral cooperation between each other's respective regional integration organizations. As Russian Valdai Club expert YaroslavLissovolik describes it, this could see Mercosur, the SADC, and the Eurasian Economic Union, SCO, SAARC, and ASEAN all cooperating with one another in changing the world order.

Missile Defense Shield, Prompt Global Strike, and the Naval Race

Thebasis of American control over the world is through economic means as enforced by military ones. In certain cases, though, the US is unable to directly attack its rivals such as Russia and China without suffering unacceptable damage through a nuclear second strike, ergo why Washington is pushing to build anti-missile installations all around Eurasia in order to ring in these Great Powers and diminish their most credible deterrent capability. Complementary with this are the US' space weapons, whether based in this theatre (X37-B and the policy of "Prompt Global Strike") or directed towards it (anti-satellite weapons, whether kinetic such as missiles or non-kinetic like lasers).

Neither the US' missile shields nor its space-related weaponry are sufficient enough for ensuring that the country is defended from submarine-launched ballistic missiles, which form a crucial component of any country's nuclear triad. This explains why there's an ongoing naval race across the world as the US seeks to ensure its dominance in the high seas in the face of rising competition from Russia, China, and others. The global ocean is also important for another reason as well, and this one relates back to the economic basis of American dominance over the world. China depends on the international waterways for the vast majority of its trade, which makes it inordinately vulnerable to any US efforts to block certain chokepoints such as the Strait of Malacca and Suez Canal.

OBOR's Global Reorganization

Understanding the sudden systemic-shaking consequences that any hostile action like this could inflict for China's domestic socio-economic stability, the People's Republic prudently foresaw the need to pioneer ambitious trans-continental trade routes to its crucial European partner, as well as secure the Sea Lines Of Communication (SLOC) along its existing maritime ones in order to safeguard its access to the growing economics of Africa. The latter are exceptionally important nowadays because their growth is expected to allow Beijing to relieve itself of its industrial overproduction so long as it can succeed in building up these marketplaces and stabilizing them. As for the Western Hemisphere, China wants to increase its soft presence here as a means of competing with the US and asymmetrically countering America's moves in the South China Sea.

Altogether, the above stratagem explains the essence of China's One Belt One Road (OBOR) global vision of New Silk Road connectivity, which is designed to transform the world's trading networks so as to facilitate the transition from a unipolar American-led international order to a diversified Multipolar one safeguarded by a host of Great Powers. It also, however, provides the blueprint for how the US will oppose the greatest threat thus far to its worldwide hegemony, as all that Washington has to do is encourage identity-centric Hybrid Wars in the geostrategic transit states along these corridors in order to disrupt, control, or influence them in ways which remove their Multipolar game-changing impact.

Geopolitics and the New World Order

The global elite–leading academics, intellectuals, foreign policy analysts, foundation heads and corporate power brokers, as well as many Western leaders–may largely have forgotten about it. But what we're witnessing now is geography's revenge in the East-West struggle for control of the buffer state of Ukraine, in the post–Arab Spring fracturing of artificial Middle Eastern states into ethnic and sectarian fiefs and in the unprecedented arms race being undertaken by East Asian states as they dispute potentially resource-rich waters. Technology hasn't negated geography it has only made it more precious and claustrophobic.

Whereas the West has come to think about international relations in terms of laws and multinational agreements, most of the rest of the world still thinks in terms of deserts, mountain ranges, all-weather ports and tracts of land and water. The world is back to the maps of elementary school as a starting point for an understanding of history, culture, religion and ethnicity–not to mention power struggles over trade routes and natural resources.

Europe's modern era is supposed to be about the European Union triumphing over the bonds of blood and ethnicity, building a system of laws from Iberia to the Black Sea–and eventually from Lisbon to Moscow. But the E.U.'s long financial crisis has weakened its political influence in Central and Eastern Europe. And while its democratic ideals have been appealing to many in Ukraine, the dictates of geography make it nearly impossible for that nation to reorient itself entirely toward the West.

Russia is still big, and Russia is still autocratic after all it remains a sprawling and insecure land power that has enjoyed no cartographic impediments to invasion from French, Germans, Swedes, Lithuanians and Poles over the course of its history. The

southern Crimean Peninsula is still heavily ethnic Russian, and it is the home of Russia's Black Sea fleet, providing Russia's only outlet to the Mediterranean.

In short, Russia will use every geographical and linguistic advantage to weaken Ukraine as a state. Ukraine is simply located too far east, and is too spatially exposed to Russia, for it ever to be in the interests of any government in Moscow–democratic or not– to allow Ukraine's complete alignment with the West.

To live in a world where geography is respected and not ignored is to understand the constraints. Many obstacles simply cannot be overcome. That is why the greatest statesmen work near the edges of what is possible. Geography establishes the broad parameters– only within its bounds doe's human agency have a chance to succeed.

While our foreign policy must be morally based, the analysis behind it must be cold-blooded, with geography as its starting point. In geopolitics, the past never dies and there is no modern world.

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6. Geoinformatics

Introduction

Geoinformatics is the integration of remote sensing, Global Navigation Satellite System and Geographic Information System dealing with spatial information. The advent of remote sensing, Global Navigation Satellite System and Geographic Information System has made significant changes in surveying and map making. A basic understanding of these components is crucial for carrying out various types of surveys, navigation, hydrology, disaster management, etc.

Remote sensing

Remote sensing is an integrated discipline encompassing some branches of arts, science and technology of collecting information about the terrestrial objects using camera and sensor system. The field of Remote Sensing and GIS has become exciting with rapidly expanding opportunities. Geoinformatics has three major components namely remote sensing, GIS and GNSS.

Elements of Remote Sensing

1. Energy Source

The primary requirement for remote sensing is to have an energy service, which provides electromagnetic energy to the target of interest. The sun being a major source of energy, radiation and illumination having a sharp power allows capturing reflected light with conventional cameras and films.

2. Radiation and the Atmosphere

The energy is required to illuminate the target. This energy is in the form of Electromagnetic radiation. Electromagnetic radiation is a dynamic form of energy that propagates as wave motion at a velocity in space.

3. Interaction with the target

The interaction of Electromagnetic radiation with the target is important to remote sensing for two main reasons. First, information carried Electromagnetic radiation reflected by the earth's surface is modified while traversing through the atmosphere. Second, the interaction of Electromagnetic radiation with the atmosphere can be used to obtain useful information about the atmosphere itself. The total energy is subjected to modification by the several physical process, scattering, absorption and refraction. Scattering is the re-direction of Electromagnetic radiation by particles suspended in the atmosphere or by large molecules of atmospheric gases. The amount of scattering depends upon the size of the particles and their abundance. The wave length of radiation, depth of the atmosphere through which the energy is travelling. Absorption is the process by which the gas molecules present in the atmosphere strongly absorb the Electromagnetic radiation through the atmosphere in certain spectral bands.

4. Recording of energy by the sensor

After the energy has been scattered by or emitted from the target, we require a sensor (remote not in contact with the target) to collect and record the electromagnetic radiation. A sensor is highly sensitive to all the wave lengths yielding spatially detailed

data on absolute brightness. On the basis of the source of electromagnetic energy, the sensor can be classified into two ways. They are active sensor or passive sensor. Active sensor generates and uses its own energy to illuminate the target and records the reflected energy. It operates in the microwave regions of the electromagnetic spectrum. Their wave lengths are longer than 1 mm.

5. Transmission, Reception and Processing

The energy recorded by the sensor has to be transmitted in electronic form, to a receiving and processing station where the data processed into an image. The Image processing methods may be grouped into three functional categories such as Image Restoration, Image Enhancement and Information Extraction.

Image Restoration: Restoration processes are designed to recognize and compensate for errors, noise and geometric distortion introduced into the data during the scanning transmission and recording processes. The objective is to make the image resemble the original scene. Image restoration is relatively simple because the pixels from each band are processed separately.

Image Enhancement: Enhancement is the modification of an image, to alter its impact on viewer. General enhancement distorts the original digital values; therefore enhancement is not done until the restoration processes are completed.

Information extraction: Image restoration and enhancement process utilize computers to provide corrected and improved images for study by human interpreters. The computer makes no decision in these procedures. The human operator must instruct the computer and must evaluate the significance of the extracted information.

6. Interpretation and Analysis

Image interpretation is defined as the act of examining images to identify objects and judge their significance. An interpreter studies remotely sensed data and attempts through logical process to detect, identify, measure and evaluate the significance of environment and cultural object pattern and spatial relationship.

The quality of an image is based on the inherent characteristics of the objects. Further it depends on the following aspects.

- Sensor characteristics
- Season of the year, time of the day when the photo is taken
- Atmospheric effects
- Resolution of the image on scale.
- Image motion etc.

Image interpretation is essential for the efficient and effective use of the data. The elements of image interpretation such as image tone, shape, size, pattern, image texture, shadow and association are helpful to identify the exact target and to analyze.

Classification of remote sensing

On the basis of the sources of electromagnetic energy, the remote sensing can be classified as passive and active remote sensing. In a simple way, we can understand that

the passive remote sensing is similar to taking a picture with an ordinary camera where as active remote sensing is analogous to taking picture with camera having built-in flash.

On the basis of the energy source, the active remote sensing generates and uses its own energy to illuminate the target and records the reflected energy whereas the passive remote sensing depend on solar radiation to illuminate the target. On the basis of region of spectrum in which they operate, the active remote sensing operates in the microwave region of the electromagnetic spectrum whereas the passive remote sensing operates in the visible and infrared region of the electromagnetic spectrum. The wave lengths of the active remote sensing are longer than 1 mm whereas the passive remote sensing, the wave length range from 0.4 to 1.0 mm.

Some examples of active sensors are fluorosensor and Synthetic Aperture Radar (SAR). Passive sensors record radiation reflected from the earth's surface. The source of this radiation must come from outside the sensor; in most cases, this is solar energy. Because of this energy requirement, passive solar sensors can only capture data during daylight hours. Active sensors are different from passive sensors. Unlike passive sensors, active sensors require the energy source to come from within the sensor. A laser-beam remote sensing system is an active sensor that sends out a beam of light with a known wavelength and frequency. This beam of light hits the earth and is reflected back to the sensor, which records the time it took for the beam of light to return.

Remote sensing platform

The platform is a stage to mount the camera or sensor to acquire the information about a target under investigation. Based on the altitude above the earth surface, the platform can be classified as Ground borne platform, Air borne platform and Space borne platform.

Ground borne platform

Ground based platforms are used to record detailed information about the surface which is compared with information collected from aircraft or satellite sensors. They are close to the ground. These sensors may be placed on a ladder, scaffolding tall-building, crane etc.

A wide variety of ground based platforms are used in remote sensing. Some of the more common ones are hand held devices, tripods, towers and cranes. Instruments that are ground-based are often used to measure the quantity and quality of light coming from the sun or for close range characterization of objects Permanent ground platforms are typically used for monitoring atmospheric phenomenon although they are also used for long-term monitoring of terrestrial features.

Air borne platform

Aircrafts are generally used to acquire aerial photographs for photo interpretation and photogrammetric purposes. They are classified into two types. They are

- Low altitude aerial remote sensing
- High altitude aerial remote sensing

Balloon

Balloons are used for remote sensing observation (aerial photography) and nature conservation studies. The first aerial images were acquired with a camera carried aloft by a balloon in 1859. Balloon floats at a constant height of about 30 km.

Drone

Drone is a miniature remotely piloted aircraft. It is designed to fulfill requirements for a low cost platform, with long endurance, moderate payload capacity and capability to operate without a runway or small runway. Drone includes equipment of photography, infrared detection, radar observation and TV surveillance. It uses satellite communication link. An onboard computer controls the payload and stores data from different sensors and instruments. The unique advantage is that it could be accurately located above the area for which data was required and capable to provide both night and day data.

Aircraft

The first known aerial photograph was taken in 1858 by French photographer and balloonist, Gaspar Felix Tournachon, known as "Nadar". In 1855 Special aircraft with cameras and sensors on vibration less platforms are traditionally used to acquire aerial photographs and images of land surface features. While low altitude aerial photography results in large scale images providing detailed information on the terrain, the high altitude smaller scale images offer advantage to cover a larger study area with low spatial resolution.

Space borne platform

The satellites are normally used for the space borne remote sensing. The satellite moves in their orbit. The closed path of a satellite around the earth is called its orbit. These platforms are freely moving in their orbit around the earth and the entire earth or any part of the earth can be covered at specified intervals. The coverage mainly depends on the orbit of the satellite. It is through these space borne platforms, we get the enormous amount of remote sensing data. In space borne remote sensing, sensors are mounted on-board a spacecraft (space shuttle or satellite) orbiting the earth. Space borne remote sensing provides the following advantages:

1. Large area coverage.
2. Frequent and repetitive coverage of an area of interest.
3. Quantitative measurement of ground features using radio metrically calibrated sensors.
4. Semi-automated computerised processing and analysis.
5. Relatively lower cost per unit area of coverage.

Types of satellite orbits

Satellite orbits are designed according to the capacity and objective of the sensors they carry. Depending on their altitude, orientation and rotation relative to the earth satellites can be categorized as

1) Geostationary satellite
2) Polar Orbiting and Sun-Synchronous satellite
3) Spy satellite

Geostationary Satellites

Geostationary Satellite is an equatorial west to east satellite orbiting the earth at an altitude of 35000 km, the altitude at which it makes on revolution in 24 hours. These platforms are covering the same place and give continuous near hemispheric coverage

over the same area day and night. These satellites are put in equatorial plane orbiting from west to east. Its coverage is limited to 70°N to 70°S latitudes and one satellite can view one-third globe. These are mainly used for communication and meteorological applications viz. GOES, METEOSAT, INTELSAT, and INSAT satellites. On June 19, 1981 India launched its first geostationary satellite called APPLE. It was an experimental communication satellite launched by the Indian Space Research Organisation (ISRO) with a C-band transponder.

The Ariane Passenger Payload Experiment (APPLE) was ISRO's first indigenous, experimental communication satellite.

Do you know?
India is the only one country which has reached to the mars in its first attempt.

Sun-synchronous satellites

As the satellite orbits the Earth from pole to pole, its east-west position would not change if the Earth did not rotate. However, as seen from the Earth, it seems that the satellite is shifting westward because the Earth is rotating (from west to east) beneath it.

This apparent movement allows the satellite swath to cover a new area with each pass. All the remote sensing resource satellites may be grouped in this category. Few of these satellites are LANDSAT series, SPOT series, IRS series, NOAA SEASAT, TIROS, HCMM, SKYLAB, and SPACE SHUTTLE etc.

Spy satellites

Spy satellites are robotic observational platforms that orbit the Earth in order to image its surface and to record radio signals for military and political purposes. They transmit their data to Earth, where it is interpreted by specialists in centralised, secretive facilities such as the U.S. National Photographic Interpretation Centre in Washington, D.C. Spy satellites have been essential not only to military operations and the formation of national policy but to the verification of arms control treaties such as SALT I, SALT II, etc.

The four basic types of spy satellite are: (1) photo reconnaissance systems that take pictures in visible and infrared light, (2) infrared telescopes designed to detect missile launches, (3) radars that image sea or land even through cloud cover and in darkness, and (4) signals intelligence (SIGINT) satellites (also termed "ferrets"), which are optimised either for characterising ground-based radar systems or for eavesdropping on communications. Sometimes photo reconnaissance and SIGINT functions are combined in single, massive platforms such as the U.S. Keyhole-series satellites.

Although a number of nations have launched spy satellites, the U.S. and the Soviet Union are responsible for by far the greatest number. The Russian Federation, which inherited most of the Soviet Union's space system after 1991, has been unable to afford the cost of adequately updating its spy satellite network. In contrast, the U.S. has continued to deploy ever-more-sophisticated systems in a steady stream. Thus, the majority of spy satellites in orbit today, including all the most capable units, are U.S.-owned. Early U.S. Spy Satellites: Corona, MIDAS, SAMOS.

Do you know?

The Gaofen 4 is the world's most powerful GEO spy satellite (launched in 2015) which can provide instant coverage of earthquake or typhoon hit areas to support humanitarian relief. It will also allow China to monitor strategic foreign sites such as WMD facilities and naval bases inside its observation box.

Applications of remote sensing

1. Agriculture

The satellites have ability to image individual fields, regions and countries on a frequent revisit cycle. Customers can receive field-based information including crop identification, crop area determination and crop condition monitoring (health and viability). Satellite data are employed in precision agriculture to manage and monitor farming practices at different levels.

2. Forest Management

The forest - fire, sudden deforestation, encroachment of forest- land are recent challenges to the ecologist. It can be easily identified and curbed with the help of remote sensing satellite pictures.

3. Geology

Various fields Remote sensing techniques used in geology are

- Lithological mapping
- Structural mapping
- Geomorphological mapping
- Mineral exploration
- Hydrocarbon exploration
- Sedimentation mapping and monitoring
- Geo-hazard mapping

NASA launches world's lightest satellite designed by 18-year-old Tamil Nadu student.

India once again broke a global space record by launching the world's lightest satellite weighing a mere 64 grams, called Kalamsat. It was designed and developed not by professional space scientists and engineers, but by 18-year-old Tamil Nadu student RifathSharook and his team. The tiny satellite, named after Abdul Kalam, was flown by a NASA sounding rocket on 22 June, 2017 and Kalamsat was the only Indian payload in the mission. Mission director SrimathyKesan that the total flight time of the rocket was 240 minutes. The satellite, assembled at her T.Nagar residence in Chennai. The satellite was separated from the rocket after spending 125 minutes in the space's micro-gravity environment. Sharook's project, the first to be manufactured via 3D printing, got selected through a competition, 'Cubes in Space', sponsored jointly by NASA and 'I Doodle Learning'. The project aims to take the performance of new technology to space.

4. Oceanography

Satellite remote sensing plays an important role in coastal zone management. There it allows us to locate and regularly monitor various aspects such as bathymetry (the

measurement of the depth of water in water bodies), chlorophyll content, suspended sediment concentration, etc.

5. Cartography

Remote sensing aids in extensive surveys that are made from high altitudes to show the urban development, rural development, mountain areas, desserts, etc. which help the cartographers. High-resolution satellite cameras located at altitudes of several hundred kilometers can record details as small as a few meters on the surface of the Earth.

6. Meteorology

The radar system is basically used to collect the weather data. It collects meteorological data from unmanned land/ ocean based Data collection platforms and serves as a communication satellite for rapid exchange of meteorological data among centres and for rapid dissemination of weather forecasts warnings etc, to user agencies.

7. Topography

Topography specifically involves the recording of relief or terrain, the three-dimensional quality of the surface, and the identification of specific landforms. Topographic maps usually portray both natural and manmade features. They show and name works of nature including mountains, valleys, plains, lakes, rivers, and vegetation. They also identify the principal works of man, such as roads, boundaries, transmission lines, and major buildings.

8. Urban Planning

These information systems also offer interpretation of physical (spatial) data with other socio-economic data, and thereby providing an important linkage in the total planning process and making it more effective and meaningful. Digitization of planning base maps has facilitated updating of base maps wherever changes have taken place in terms of land development etc. Superimposition of any two digital maps which are on two different scales is feasible.

Geographic Information System (GIS)

The Geographic information systems have emerged in the past two decades as an essential tool for urban and resource planning and management. It includes the functions of data entry, data display, data management, information retrieval and analysis. While GIS deals with entire geography of the earth including land, ocean and atmosphere, the art, science and technology dealing with the acquisition, storage, processing, production, presentation and dissemination of the earth's information is called the Geoinformatics. It is the popular means of studies in recent decades which cater the real and useful information to the field of Geography, Environmental Studies, Town planning, rural development studies, and Defense and Agricultural promotion.

Generation of the computers

1940 – 1956: First Generation – Vacuum Tubes
1956 – 1963: Second Generation – Transistors
1964 – 1971: Third Generation – Integrated Circuits
1972 – 2010: Fourth Generation – Microprocessors

2010 – Fifth Generation – Artificial Intelligence

Components of GIS

The components of GIS can be broadly classified into five types. They are mentioned below.

A. Hardware

Hardware is Computer on which GIS software runs. Nowadays there are a different ranges of computer, it might be Desktop or server based. ArcGIS Server is server based computer where GIS software runs on network computer or cloud based. For computer to perform well all hardware components must have high capacity. Some of the hardware components are: Motherboard, Hard driver, processor, graphics card, printer and so on. These all component function together to run GIS software smoothly.

B. Software

Next component is GIS software which provides tools to run and edit spatial information. It helps to query, edit, run and display GIS data. It uses RDBMS (Relational Database Management System) to store the data. Few GIS software list: ArcGis, ArcView 3.2, QGIS, SAGA GIS. Software Components: GIS Tools, RDBMS, Query Tools, GUI and Layout.

C. Data

Geographic data and related tabular data can be collected in-house compiled to custom specifications and requirements (or) purchased from a commercial data provider.

A GIS can integrate spatial data with other existing data resources often stored in a corporate data base management System. The data can be broadly classified as

i. Attribute data
ii. Spatial data
iii. Remote sensing data
iv. Global data base.

You will learn in detail about each of the above classification of data in higher studies.

D. People

The GIS technology is used by a huge number of industrialists and agencies to help plan, design, engineer, build and maintain information infrastructures that affects our everyday lives.

E. Methods or Procedures

Methods here refer to well-defined, consistent procedures that are required to produce accurate, reproducible result. A neatly conceived implementation plan and business rules are the models and operating practices are unique to each organization. There is need to properly integrate the sophisticated tool through bringing out well-defined procedures in well documented form into the entire business strategy and operation to make the technology effective. Meta data i.e., (data about the data) is the key for documenting these processes.

Functions of GIS

The functions of GIS describe the steps that have to be taken to implement a GIS. These steps have to be followed in order to obtain a systematic and efficient system. The steps involved are data capture, data storage (GIS Data Models), manipulation and analysis.

Data Capture

The input of data into a GIS can be achieved through many different methods of gathering. For example, aerial photography, scanning, digitizing, GNSS is just a few of the ways a GIS user could obtain data. Digitization: A conversion process which converts paper maps into numerical digits that can be stored in the computer. Digitizing simplifies map data into sets of points, lines or cells that can be stored in the GIS computer. In this stage, digitization is carried out. There are two basic methods of digitization: Manual digitizing & scanning.

Data Storage

Some data is stored such as a map in a drawer, while others, such as digital data, can be as a hardcopy, stored on CD or on your hard drive. Once the data have been digitally compiled, digital map files in the GIS are stored on magnetic or other digital media. Data storage is based on a Generic Data Model that is used to convert map data into a digital form. The two most common types of data models are Raster and Vector. Both types are used to simplify the data shown on a map into a more basic form that can be easily and efficiently stored in the computer.

Data Manipulation

The digital geographical data can be edited, this allows for many attribute to be added, edited, or deleted to the specification of the project. Once data are stored in a GIS, many manipulation options are available to users. These functions are often available in the form of "Toolkits." A toolkit is a set of generic functions that a GIS user can employ to manipulate and analyse geographical data. Toolkits provide processing functions such as data retrieval measuring area and perimeter, overlaying maps, performing map algebra, and reclassifying map data. Data manipulation tools include coordinate change, projections, and edge matching, which allow a GIS to reconcile irregularities between map layers or adjacent map sheets called Tiles.

Query and Analysis

GIS was used widely in decision making process for the new commission districts. We use population data to help establish an equal representation of population to area for each district. The heart of GIS is the analytical capabilities of the system.

Global Navigation Satellite System (GNSS)

GNSS refers to the collection of the world's global satellite based positioning systems. It includes GPS (United States) GLONASS (Russia) GALILEO (European Union) BEODOU (China) IRNSS (India) QZSS (Japan). GNSS can provide centimeter level accuracy with a low-cost receiver, if an error correction technique is used. GNSS are recognized to be the systems of choice in outdoor environments and, to a great extent, one of the most accurate source of position (and precise timing) information when it is available.

The first satellite navigation system was Transit, a system deployed by the US military in 1960's. Transit's operations were based on the Doppler Effect: the satellites travelled on well-known paths and broadcast their signals on well-known radio frequency. The received frequency will differ slightly from the broadcast frequency because of the movement of the satellite with respect to the receiver. The satellite broad cast signals that contains orbital data (from which the position of the satellite can be calculated) and the precise time, the signals is transmitted. There are multiple constellations of GNSS satellites orbiting the earth. GNSS satellites' orbit situated about 20,000 km above the earth's surface. They are moving very fast, several kilometers per second. The latest generation of GNSS satellites (Block IIF) weight over 1,400 kg.

GNSS system operated in different countries

The following are the Global Navigation satellite Systems:

GPS (United States)

GPS was the first GNSS system. GPS was launched in the late 1970s by the United States Department of Defence. It uses a constellation of 24 satellites, and provides global coverage.

GLONASS (Russia)

The premier Soviet military navigation network was to be comprised of Uragan satellites. At the end of the Cold War, the constellation was unclassified under the name GLONASS -- a Russian abbreviation of Global Navigation Satellite System. Global Navigation Satellite System by Russian Aerospace Defense Forces is a space-based satellite navigation system.

The life style of GNSS satellites 5-7 years and new satellites are to be launched after a specific time interval in order to fill the gap due to ageing satellites. GLONASS proves very beneficial for Russian territory by 2010. In 2011, restoration of system is improved to enable full global coverage.

GALILEO (European Union)

Galileo is Europe's own global navigation satellite system, providing a highly accurate, guaranteed global positioning service under civilian control. Currently providing Initial Services, Galileo is interoperable with GPS and Glonass, the US and Russian global satellite navigation systems. By offering dual frequency as standard, Galileo is set to deliver real-time positioning accuracy down to the meter range. The Galileo constellation in space will comprise 30 satellites in total. There will be 24 operational satellites, plus 6 spare satellites, circulating in medium Earth orbit on three orbital planes.

BEIDOU (China)

BeiDou Navigation Satellite System (BDS) is a Chinese satellite Navigation system. It consists of two separate satellite constellations. The first BeiDou system is officially called the BeiDou Satellite Navigation Experimental System and also known as BeiDou-1.

On December 27, 2018, Beidou-3 officially began to provide global services. The Beidou-3M/G/I satellites represent the orbital segment of the third phase of the Chinese

Beidou navigation system which uses satellites in Medium Earth Orbit and Geosynchronous Orbit and is also known as the Compass Navigation Satellite System.

Japan Aerospace Exploration Agency (QZSS Japan)

QZSS is a regional navigation satellite system that provides service to Japan and the Asia-Oceania region. QZSS (nickname of Michibiki - meaning to 'guide' or 'show the way') QZSS is a Japanese satellite positioning system composed mainly of satellites in quasi-zenith orbits (QZO). However, the term "Quasi-Zenith Satellite (QZS)" can refer to both satellites in QZO and geostationary orbits (GEO). For that reason, the name "QZO satellite" is used when it is necessary to specifically refer to satellites in QZO. Satellite positioning systems use satellite signals to calculate position information. The QZSS is sometimes called the "Japanese GPS."

IRNSS (Indian Regional Navigational Satellite System)

IRNSS is an autonomous regional satellite navigation system being developed by ISRO (Indian Space Research Organization). It is designed to provide geospatial positioning information within the Indian sub-continent. It enables users to map out their location (altitude, longitude and latitude). The objective of developing IRNSS was to cut down India's dependency on foreign navigation satellite systems.

It provides location information service to users in India and the region extending for up to 1,500 km from the Indian boundary. This is the primary service area of IRNSS information service to users in India and the region extending up to 1500 km from Indian boundary.

IRNSS aims to provide the following services:

1. Standard Positioning Service (SPS) for civilian, research & commercial use,
2. Restricted Service (RS) for authorized users. For example in defense, IRNSS is used for ground, aerial and marine navigation, disaster management, mobile phone integration, mapping and visual & voice navigation for drivers, among others.

The battle for the world's fastest supercomputer has a new victor: Summit
According to IBM, Summit is able to achieve 200 peta flops of performance, or 200 quadrillion calculations per second. This power marks a significant gain on Sunway TaihuLight, which performs a still-staggering 87 petaflops. Summit holds more than 10 peta bytes of RAM, and its funding came as part of a $325 million program funded by the United States Department of Energy. Each of Summit's 4,608 nodes holds two IBM Power9 chips that run at 3.1 GHz.

Applications of GNSS

GNSS applications are widely used to get the quick information about a particular field. Some of the commercial applications are Consumers, Transportation, GIS, Machine Control Port Automation, Precision Agriculture, Construction, Marine Mining, Unmanned Vehicles Surveying, Defence, and Aerial Photogrammetry, etc.

Consumer

GNSS technology has been adopted by the consumer market, in an ever-increasing range of products. GNSS receivers are now routinely integrated into smart phones, to

support applications that display maps showing the location of and best route to stores and restaurants.

Transportation

In rail transportation, GNSS is used to track the location of locomotives and rail cars, maintenance vehicles and wayside equipment, for display at central monitoring consoles. Knowing the precise location of rail equipment reduces accidents, delays, and operating costs, enhancing safety, track capacity, and customer service. In aviation, GNSS is being used for aircraft navigation from departure, en route, to landing.

Port Automation

Using GNSS, shipping hubs can improve their operating efficiency by tracking the movement and placement of containers about their yards. Many cranes are equipped with GNSS based steering devices that determine the crane's position and keep it travelling in the desired path, improving accuracy and productivity as well as the safety of operators and workers on the ground.

Machine Control

GNSS technology is being integrated into equipment such as bulldozers, excavators, graders, pavers and farm machinery to enhance productivity in the real-time operation of this equipment, and to provide situational awareness information to the equipment operator.

Precision Agriculture

In precision agriculture, GNSS-based applications are used to support farm planning, field mapping, soil sampling, tractor guidance, and crop assessment. More precise application of fertilizers, pesticides and herbicides reduces cost and environmental impact.

Surface Mining

GNSS information is being used to efficiently manage the mining of an ore body and the movement of waste material. GNSS equipment installed on shovels and haul trucks provides position information to a computer-controlled dispatch system to optimally route haul trucks to and from each shovel.

Survey

Using GNSS, it is possible for a single surveyor to accomplish in one day what might have taken a survey crew of three people a week to complete. Determining a new survey position once required measuring distances and bearings from an existing (known) survey point to the new point.

7. Sustainable Development

Introduction

In the last few centuries there has been a drastic change in the lifestyle of man. Agricultural growth, industrialization, urbanization, rapid advancement in science and technology have decreased mortality rates and caused rapid growth of

population over the earth. With increase in population there is an increase in the demand for natural resources leading to overuse, of nature and its resources. Nations began to wake up to the fact that the earth's resources are depleting at an alarming rate and that something has to be done to sustain them. This led to develop the world in a sustainable way. Sustainability is supported by four pillars which are cultural vitality, economic health, environmental responsibility and social equity. All nations in the world focus on sustainable development as a major task.

United Nations and Sustainable Development

Sustainability was first featured in the principles adopted by the United Nations Conference on the Human Environment held at Stockholm on 16 June 1972. It was now realized that development needed to be sustainable – it should not only focus on economic and social matters, but also on matters related to the use of natural resources. The United Nations commissioned a group of 22 people from both developed and developing countries to identify long-term environmental strategies for the international community. This World Commission on Environment and Development (WCED), was headed by Gro Harlem Brundtland, then the Prime Minister of Norway. This commission came to be known as the **Brundtland Commission,** which submitted its report, entitled our common future, to the UN in 1987.

The **Brundtland Report** focused on the needs and interests of humans. It was concerned with securing a global equity for future generations by redistributing resources towards poorer nations to encourage their economic growth in order to enable all human beings to achieve their basic needs. The report highlighted the three fundamental components of sustainable development, the environment, the economy, and society, which later became known as **the triple bottom line**.

The 1992 and 2002 Earth Summits held at Rio de Janeiro and Johannesburg were the United Nations Conference on Environment and Development (UNCED), a direct result of the Brundtland Commission. An important achievement of the Rio summit was an agreement on the Climate Change Convention which led to the Kyoto Protocol which you have learned about earlier. The United Nations Conference on Sustainable Development (UNCSD), also known as R**io 2012, Rio+20 or Earth Summit 2012** was the third and recent International conference on sustainable development. It was hosted by Brazil in Rio de Janeiro from 13 to 22 June 2012.

Concept and Goals of Sustainable Development

In 1980 the International Union for the Conservation of Nature introduced the term "sustainable development". Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

A primary goal of sustainable development is to achieve a reasonable and equitably distributed level of economic wellbeing that can be continued for many human generations.

Sustainable Development Goals (SDGs)

In 1992, the UN Conference on Environment and Development published the Earth Charter, which outlined the building of a just, sustainable, and peaceful global society in the 21st century. The action plan was known as 'Agenda 21' for sustainable development.

In September 2015, the United Nations General Assembly formally adopted the "Universal, integrated and transformative" 2030 Agenda for Sustainable Development, a set of 17 Sustainable Development Goals (SDGs). The goals are to be implemented and achieved in every country from the year 2016 to 2030.

Countries adopted a set of goals to end poverty, protect the planet and ensure prosperity for all as part of a new sustainable development agenda. Each goal has specific targets to be achieved over the next 15 years.

For the goals to be reached, everyone needs to do their part: governments, the private sector, civil society and people.

Goal 1: End poverty in all its forms everywhere

One in five people in developing countries still live on less than $1.90 a day, many people risk slipping back into poverty. Economic growth must be inclusive to provide sustainable jobs and promote equality.

Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Agriculture, forestry and fisheries can provide nutritious food for all and generate decent incomes, while supporting people-centered rural development and protecting the environment. A profound change of the global food and agriculture system is needed if we are to nourish today's 815 million hungry and the additional 2 billion people expected by 2050.

Goal 3: Ensure healthy lives and promote well-being for all at all ages

Significant strides have been made in increasing life expectancy and reducing some of the common killers associated with child and maternal mortality. Major progress has been made on increasing access to clean water and sanitation, reducing malaria, tuberculosis, polio and the spread of HIV/AIDS.

Goal 4: Ensure inclusive and quality education for all and promote lifelong learning

Major progress has been made towards increasing access to education at all levels and increasing enrolment rates in schools particularly for women and girls. For example, the world has achieved equality in primary education between girls and boys, but few countries have achieved that target at all levels of education.

Goal 5: Achieve gender equality and empower all women and girls

Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world.

Goal 6: Ensure access to water and sanitation for all

Clean, accessible water for all is an essential part of the world we want to live in. There is sufficient fresh water on the planet to achieve this. But due to bad economics or poor infrastructure, every year millions of people, most of them children, die from diseases associated with inadequate water supply, sanitation and hygiene. By 2050, at least one in four people is likely to live in a country affected by chronic or recurring shortages of fresh water.

Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all

Energy is central to nearly every major challenge and opportunity the world faces today. Sustainable energy is opportunity – it transforms lives, economies and the planet.

Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all

Sustainable economic growth will require societies to create the conditions that allow people to have quality jobs that stimulate the economy while not harming the environment. Job opportunities and decent working conditions are also required for the whole working age population.

Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation

Inclusive and sustainable industrial development is the primary source of income generation, allows for rapid and sustained increases in living standards for all people, and provides the technological solutions to environmentally sound industrialization.

Goal 10: Reduce inequality within and among countries

To reduce inequality, policies should be universal in principle paying attention to the needs of disadvantaged and marginalized populations.

Goal 11: Make cities inclusive, safe, resilient and sustainable

Cities are hubs for ideas, commerce, culture, science, productivity, social development and much more. At their best, cities have enabled people to advance socially and economically Common urban challenges include congestion, lack of funds to provide basic services, a shortage of adequate housing and declining infrastructure.

Goal 12: Ensure sustainable consumption and production patterns

Sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all. Its implementation helps to achieve overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty.

Goal 13: Take urgent action to combat climate change and its impacts

Climate change is now affecting every country on every continent. It is disrupting national economies and affecting lives, costing people, communities and countries dearly today and may be even more tomorrow.

Goal 14: Conserve and sustainably use the oceans, seas and marine resources

The world's oceans – their temperature, currents and life – drive global systems that make the earth habitable for humankind. Careful management of this essential global resource is a key feature of a sustainable future.

Goal 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss

Forests cover 30 per cent of the Earth's surface and in addition to providing food security and shelter, forests are key to combating climate change, protecting biodiversity

and the homes of the indigenous population. Thirteen million hectares of forests are being lost every year while the persistent degradation of dry lands has led to the desertification of 3.6 billion hectares.

Goal 16: Promote just, peaceful and inclusive societies

This Goal is dedicated to the promotion of peaceful and inclusive societies for sustainable development, the provision of access to justice for all, and building effective, accountable institutions at all levels.

Goal 17: Revitalize the global partnership for sustainable development

A successful sustainable development agenda requires partnerships between governments, the private sector and civil society. These inclusive partnerships built upon principles and values, a shared vision, and shared goals that place people and the planet at the center, are needed at the global, regional, national and local level.

Paris Agreement

To address climate change, countries adopted the Paris Agreement at the COP21 in Paris on 12 December 2015. The Agreement entered into force shortly thereafter, on 4 November 2016. In the agreement, all countries agreed to work to limit global temperature rise to well below 2°C, and given the grave risks, to strive for 1.5°C.

Climate Change and Sustainability

The Earth's climate has changed throughout history. In the last 650,000 years there have been several cycles of glacial and warm periods each lasting thousands or millions of years. Most of these climate changes are attributed to very small variations in earth's orbit that changes the amount of solar energy our planet receives. It is understood that at present the Earth's climate is getting warmer which is referred to as 'Global Warming'. Earth's temperature has gone up about one degree Fahrenheit in the last 100 years. This is a very small change but small changes in earth's temperature can have big effects. Some effects are already happening such as melting of glaciers, rise in the level of oceans, prolonged droughts, excessive rain and floods, etc.

Reasons for Climate change

Burning fossil fuels emits gases into the atmosphere. Burning fossil fuel to provide energy, coupled with the effects of major transportation and deforestation causes a rapid increase in global temperatures. This can change the climate of a place.

Effects of climate change – Scientists had predicted in the past that the result from global climate change are now occurring, loss of sea ice, accelerated sea level rise and longer, more intense heat waves.

1. **Temperatures will continue to rise -** Experts agree that greenhouse gases which trap heat and prevent it from leaving the earth's atmosphere are mostly responsible for the temperature spike.

2. **Frost- free season (and growing season) will lengthen -** it could actually have detrimental effects on the crops we grow. Warmer weather helps pests survive longer which can destroy crops. Rising temperatures are also expected to contribute to a shift in areas which are agriculturally most productive and the crops that grow there.

3. **Changes in precipitation patterns -** The contrast between wet and dry areas will increase globally. In other words, the wet areas will get wetter and the dry areas will get drier.

4. **More droughts and heat waves -** With rising temperatures and shifting rainfall patterns, heat waves and droughts are increasing in frequency and intensity.

5. **Sea level rise -** Scientists have determined that global sea level has been steadily rising since 1900 at a rate of at least 0.1 to 0.25 centimeter per year. Sea level can rise by two different mechanisms with respect to climate change.

6. **Arctic likely to become ice-free -** The Arctic Ocean is expected to become essentially ice free in summer before mid-century.

Response to Climate Change

There are two main responses to climate change.

1. **Mitigation -**Which addresses the root causes of climate change, by reducing greenhouse gas emissions.

2. **Adaptation -** seeks to lower the risks posed by the consequences of climatic changes. Both approaches will be necessary to deal with the global changes that have already been set in motion.

Mitigation measures:

It is important that we learn how to reduce climate change, and put them into practice now, before it is too late.

1. **Cleaner alternative energy sources:** One important way to fight climate change is to reduce our reliance on and usage of fossil fuels, and depend on alternative renewable and greener sources of energy such as wind energy, solar energy, water or hydropower, biomass, and geothermal energy.

2. **Energy saving tips -** we can adopt energy saving tips by investing in more expensive energy-saving appliances like the compact fluorescent light (CFL) bulbs, Air-conditioners, refrigerators etc. Switching off our electrical appliances when not in use.

3. **Green driving tips -** The best strategy to reduce toxic gas emissions is definitely to reduce the use of automobiles. Use public transport, carpooling, use of electricity powered cars or two wheelers can be an alternative.

4. **Reduce - Reuse - Recycle practices -** Reducing, reusing and recycling helps us conserve resources and energy, and reduce pollution and greenhouse gas emissions produced thereby.

5. **Re-forestation -** The cleanest and most efficient remover of carbon dioxide from our atmosphere actually is nothing but green plants and trees. The rate at which we are cutting down our trees and forests to make way for human developments has greatly reduced the earth's ability to remove carbon dioxide from the atmosphere.

6. **Organic farming -** Soils are an important sink for atmospheric carbon dioxide. Nevertheless, deforestation making way for conventional agriculture is increasingly depleting this sink. Sustainable and organic agriculture helps to counteract climate change by restoring soil organic matter content as well as reduce soil erosion and improve soil physical structure. Organic farming uses natural fertilizers and helps maintain crop yields.

Watershed management and its importance

Watershed is a geographical area drained by a stream or a system connecting stream in which water from all over an area flow under gravity to a common drainage channel. A watershed system delivers water through rills, gullies and streams to a larger body of water.

Watershed management is proper utilization of land and water resource for optimum production with minimum hazards to natural resources. It relates to soil and water conservation proper land uses, promote afforestation and sustainable farming practices, conserve farmland and pastureland, maintaining soil fertility, proper management of local water for farming, drainage, construct small dams for flood protection, improving individuals standard of living and thereby promote ecological balance.

Key steps in watershed management

Watershed plans should first identify the characteristics of the watershed and inventory the watershed's natural resources. The first steps in watershed management planning are to:

i. Delineate and map the watershed's boundaries and the smaller drainage basins within the watershed.

ii. Map and prepare an Inventory of resources in the watershed.

iii. Prepare an Inventory and map the natural and manmade drainage systems in the watershed.

iv. Prepare an Inventory and map land use and land cover.

v. Prepare a soil map of the watershed.

vi. Identify areas of erosion, including stream banks and construction sites.
vii. Identify the quality of water resources in the watershed as a baseline; and

viii. Prepare a map and Inventory of pollution sources, both point sources (such as industrial discharge pipes) and nonpoint sources (such as municipal storm water systems, failing septic systems, illicit discharges).

Watershed Management in India:

Watershed development project in the country has been sponsored and implemented by Government of India from early 1970s onwards. Various watershed development programs like Drought Prone Area Program (DPAP), Desert Development Program (DDP), and river Valley Project (RVP), National Watershed Development Project for Rain-fed Areas (NWDPRA) and Integrated Wasteland Development Program (IWDP) were launched subsequently in various hydro-ecological regions. Entire watershed development programs primarily focused on soil conservation and rainwater harvesting during 1980s and before.

Rain Water Harvesting (RWH)

Millions of people throughout the world do not have access to clean water for domestic purposes. In many parts of the world conventional piped water is either absent, unreliable or too expensive. One of the biggest challenges of the 21st century is to overcome the growing water shortage. Rain Water Harvesting (RWH) has thus regained its importance as a valuable alternative or supplementary water resource, along with more conventional water supply technologies. Water shortages can be relieved if rain water harvesting is practiced more widely.

Need for Rain Water Harvesting

i) To overcome the situation of inadequacy of water supply.
ii) The most economical way to increase the ground water table.
iii) To replenish the sub soil of the urban area covered with pavements.
iv) To recharge the underground water table at places where the availability of rain water is higher or to overcome the situation of water logging.
v) Rain water harvesting also improves the quality of underground water through a process called dilution.
vi) To get water for irrigation of greenbelts, farms, gardens, etc.

Rain Water Harvesting Techniques

There are two main techniques of rain water harvestings:

1) Storage of rain water on surface for future use.

2) Recharge to ground water.

The storage of rain water on surface is a traditional technique and structures used were underground tanks, ponds, check dams, weirs, etc. Recharge of ground water is a new concept of rain water harvesting and the structures generally used are: Recharge pits filled with boulders, gravels, and coarse-sand, Wells, Trenches etc.

Environmental Impact Assessment

Every country strives to progress ahead. One aspect of progress is economic development through manufacturing and trading. Every country builds industries which provide employment, serve the consumers' needs and help to generate revenue. The dominant pattern of development that humankind has followed in recent decades has brought about large scale changes in the earth systems. We are already feeling the impact of these changes upon our health, livelihoods and safety. On the other hand, the fruits of development are not equally distributed. Some countries and some communities have a high standard of living, while others are not able to meet their basic needs.

Development projects in the past were undertaken without any consideration about their environmental consequences. As a result rivers and lakes have been polluted, air pollution has reached threatening levels and pilling of domestic and industrial wastes has resulted in land degradation. Industrialization and economic growth provided material comforts but at the same time deteriorated the quality of life.

The Objective of EIA

(i) To identify, predict and evaluate the economic, environmental and social impact of development activities
(ii) To provide information on the environmental consequences for decision making and
(iii) To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

Steps in the EIA Process

The eight steps of the EIA process:

i) **Screening:** First Stage of EIA, which determines whether the proposed project, requires an EIA and if it does, then the level of assessment required.

ii) **Scoping:** This stage identifies the key impacts that should be investigated. This stage also defines the time limit of the study.

iii) **Impact analysis:** This stage of EIA identifies and predicts the likely environmental and social impact of the proposed project and evaluates the significance.

iv) **Mitigation:** This step in EIA recommends the actions to reduce and avoid the potential adverse environmental consequences of development activities.

v) **Reporting:** This stage presents the result of EIA in a form of a report to the decision-making body and other interested parties.

vi) Review of EIA: It examines the adequacy and effectiveness of the EIA report and provides the information necessary for decision –making.

vii) Decision-making: It decides whether the project is rejected, approved or needs further change.

viii) Post monitoring: This stage comes into play once the project is commissioned. It checks to ensure that the impacts of the project do not exceed the legal standards and implementation of the mitigation measures are in the manner as described in the EIA report.

Environmental Impact Assessment in India

EIA was introduced in India in 1978, with respect to river valley projects. On 27 January 1994, the Union Ministry of Environment and Forests (MEF), Government of India, under the Environmental (Protection) Act 1986, made Environmental Clearance (EC) mandatory for expansion or modernisation or for setting up new projects listed in Schedule 1 of the notification. Since then there have been 12 amendments made in the EIA notification of 1994. Both central and state authorities share the responsibility of EIA's development and management. EIA is now mandatory for 30 categories of projects, and these projects get Environmental Clearance (EC) only after the EIA requirements are fulfilled.

The MoEF recently notified new EIA legislation in September 2006. The notification makes it mandatory for all projects to get environment clearance from the central government under the following categories:

1) Industries
2) Mining
3) Thermal power plants
4) River valley projects
5) Infrastructure and CRZ (Coastal Regulation Zone)
6) Nuclear power projects.

However, the new legislation has entrusted the decision of clearing projects on the state government depending on the size/ capacity of the project. EIA appraises the environmental health and social implications of planned developmental projects. It thus links environment with development. The goal of EIA is to ensure environmentally safe and sustainable development.

Measures for Promotion of Sustainable Development

As discussed earlier, the United Nations 17 Sustainable Development Goals and 169 targets are part of the 2030 Agenda for Sustainable Development adopted by 193 Member States at the UN General Assembly Summit in September 2015, and which came into effect on 1 January 2016. These goals are the result of international consultations that brought national governments and millions of citizens from across the globe together to negotiate and adopt the global path to sustainable development for the next 15 year.

The SDGs and targets will stimulate action in the following critically important areas: poverty, hunger, education, health and well-being, education, gender equality, water and sanitation, energy, economic growth and decent work, infrastructure, industry and innovation, reducing inequalities, sustainable cities, consumption and production, climate action, ecosystems, peace and justice, and partnership. This agenda recognises that it is not enough to focus on economic growth alone but in creating more equal societies, and a safer and more prosperous planet.

Which countries are achieving the UN Sustainable Development Goals fastest?

The ultimate aim of the Sustainable Development Goals is to end poverty, protect the planet and ensure prosperity for everyone. Each goal has specific targets that need to be met by 2030.

So how close are countries to meeting them? To find out, non-profit organization Bertelsmann Stiftung and the UN Sustainable Development Solutions Network have created a prototype index that measures their performance.

Sweden leads the list, followed by Denmark and Finland. Among the G7 countries, only Germany and France can be found among the top ten performers. The United States ranks 42nd on the Index, while Russia and China rank 62nd and 71st respectively. Also in the top 20 were Canada (13th), the Czech Republic (15th) and Slovenia (17th). Asia-Pacific's top performers Japan, Singapore and Australia rounded off the list at 18th, 19th and 20th, respectively. The SDG Index underlines that despite achieving high percentages, all countries still have their work cut out to close the remaining gap.

India ranks 116 out of 157 nations on a global index that assesses the performance of countries towards achieving the ambitious sustainable development goals (SDGs).

8. MAN- MADE DISATERS

Introduction

"Mumbai railway station stampede kills at least 22"

"Rush-hour crush on footbridge connecting two stations was triggered by falling concrete that caused panic!" At least 22 people have been killed and more than 30 injured during a rush-hour stampede on a bridge between two railway stations in Mumbai. The crush occurred on a narrow footbridge connecting Prabhadevi station, formerly Elphinstone, and Parel station during the Friday, September 29, 2017 morning commuter rush and amid heavy rain. "There was a huge crowd on the foot over bridge. Everybody tried to leave at once and it appeared one of them slipped and fell, triggering the stampede," said an Indian Railways spokesman. Another spokesman said the number of people on the bridge was higher than usual because people were using the station to shelter from the rain.The above incident throws some lights on how to be aware of the accidents we encounter in our daily walk of life. Let us try to answer the following questions:

1. Which is more important life or the scheduled journey to be completed?
2. Why rushing in anything may be disastrous?
3. Why timely communication is more important to avoid accident?

The root of the word disaster ("bad star" in Greek and Latin) comes from an astrological theme in which ancients used to refer to the destruction of a star as a disaster.

Terms to know:

1. Hazard is a potentially damaging physical event or human activity which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.
2. Disaster is a serious disruption of a society functioning, causing widespread human, material losses which exceed the ability of the affected society to cope using its own resources.
3. Disaster risk management is a set of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of disaster.
4. Capacity - the assets, resources and skills available within a community that can be used to reduce the risks or effects of a disaster.
5. Disaster risk reduction includes activities that will minimize disaster-related losses of life and property.

Disaster is a serious disruption, causing damage or injury to people, buildings, roads, livelihoods, or the environment, which exceed the community's ability to cope.

The magnitude and impact of disasters are increasing and disasters have disrupted social, economic and environmental community activities worldwide. International data shows that disasters have taken, over the last 10 years, more than 478,000 lives. It has affected 2.5 billion people and caused direct economic losses in the amount of 690 billion US dollars worldwide.

Recent financial studies underline the urgent need for a shift from sole disaster response to disaster risk reduction. Therefore, efforts should be made to ensure that disaster risk reduction is an important aspect of poverty reduction and general development initiatives in the coming years.

Community-Based Disaster Risk Reduction

Community is a group of people living in the same place having homogenous characteristics. It includes shared experiences, locality, culture, language and social interests. Community-based disaster risk reduction is a process within a community and for the community. Reducing risk in communities should address the root causes of risks and address it through local knowledge and expertise. Performance and the arts provide a variety of creative opportunities to communicate. Important messages through live experiences. Examples include: Street theatre, dramatic readings, skits and plays, puppet shows, poetry reading.

Dance, flash mob activities in large urban settings (a group of people who assemble suddenly in a public place, perform an unusual act and then disperse), tapping into oral traditions such as story-telling, music and sing-along, mural-making and other hands-on art and design activities. All of these can involve volunteers and community members, as performers and audiences. Skilled performers find creative ways to engage their audience.

Man - made Disasters

Disasters induced by human beings are man-made disasters. It includes fire accident, transport accident, structure failure, mining accidents, explosions, stampede etc. In this lesson, we study about some of the man-made disasters.

Stampede

The term stampede is a sudden rush of a crowd of people, usually resulting in injuries and death from suffocation and trampling. In stampede, the term mob or crowd is used to refer to a congregated, active, polarized aggregate of people, which is basically heterogeneous and complex. Its most salient features include homogeneity of thought and action among its participants and their impulsive and irrational actions.

Causes of stampede

Incidents of stampedes can occur in numerous socio-cultural situations. These stampede incidents can be categorized into the following types: Entertainment events, escalator and moving walkways, food distribution, processions, natural disasters, power failure, religious events, fire incidents during religious/ other events, riots, sports events and weather related events.

Large religious gatherings are a particular stampede danger in the developing world. A 2013 paper out of India, for example, found that 79 percent of stampedes in that country have taken place at religious events, as opposed to political or entertainment-related events.

Stampede Management

Crowd management is defined as the systematic planning and supervision of the orderly movement and assembly of people. Crowd control is the restriction or limitation of group behavior.

The rules of action for stampede

1. Notice Alternate Exit: First thing to know in such situations is the route out. If you are attending an event, one of the things you can do in preparation is to try and know the topography of the place. This will help you find the exits. So, when struck in a stampede, try to identify these exits.

2. Keep Your Hands by Your Chest: Your hands must be up by your chest like they would be in a boxing position. This makes it easy to move. It also stops your ribs from getting crushed by the crowd on both sides. When the crowd pushes you from front and back, your lungs will be affected. You will suffer of suffocation.

3. How to move when on your feet: In the middle of a moving crowd, do not resist the flow by standing still or sitting down. The force is too much to fight. Like in a wave, there is force and in crowd situation. Keep moving diagonally between the pockets of people whenever there is a lull. Try to move towards the exits but not towards walls or fences where you might be cornered. Keep moving with the crowd to avoid falling.

4. How to move if you fall: If you fall and get back on your feet, cover your head with your hands and hurl up in a fetal position. Basically, avoid exposing your lungs to the crowd. Keep trying to find an opportunity to get up.

5. Communicate smartly: When trapped in the crowd, use sign language such as waving your hands up one side after another so that you will not get exhausted.

6. Conserve energy: Keep calm and do not try to scream. That only increases panic.

7. Set a meeting place: Arrange a meeting place, in case you get separated, one inside and another one outside.
If someone extends his/her hand for help, grab hold to keep them up.

Child safety Tips: Take a second, take a photo.
Before taking children out to any event, pull out your phone and take a photo of each child individually a selfie. That way you have a picture of how they looked that day. The photo can be sent to police to aid in locating the child in case the child is lost in a crowd.

Drowning

Drowning is the 3rd leading cause of unintentional injury death worldwide, accounting for 7% of all injury-related deaths. There are an estimated 3,72,000 annual drowning deaths worldwide. Children, males and individuals with increased access to water are most at risk of drowning. Drowning is the process of experiencing respiratory

impairment from submersion/immersion in liquid; outcomes are classified as death, morbidity and no morbidity.

Fact File

It is one of our most visceral fears; thrashing in the deep, far below the water's surface, lungs burning for oxygen. Drowning claims hundreds of thousands of lives every year, a great many of whom are young children. Of course, exposure to water is a key factor in drowning, but there is a strong economic correlation as well. Those in poorer countries are far more likely to be drowning. In Bangladesh, 17,000 children drown annually that's 46 a day.

Below are 10 facts about drowning; from a lake that never surrenders its victims to a party for lifeguards that ended in deadly irony.

Fresh Water and Salt Water Drown You Differently.

Males are especially at risk of drowning, with twice the overall mortality rate of females. Studies suggest that the higher drowning rates among males are due to increased exposure to water and riskier behavior such as swimming alone, drinking alcohol before swimming alone and boating. Drowning accounts for 75% of deaths in flood disasters.

Prevention

There are many actions to prevent drowning. Installing barriers (e.g. covering wells, using doorway barriers and playpens, fencing swimming pools etc.) to control access to water hazards, or removing water hazards entirely greatly reduces water hazard exposure and risk. Community-based, supervised child care for pre-school children can reduce drowning risk and has other proven health benefits. Teaching school-age children basic swimming, water safety and safe rescue skills is another approach. Setting and enforcing safe boating, shipping and ferry regulations is an important part of improving safety on the water and preventing drowning. Building resilience to flooding and managing flood risks through better disaster preparedness planning, land use planning, and early warning systems can prevent drowning during flood disasters.

Fire Accident

Massive forest fires may start in hot and droughty weather as a result of lightning, and human carelessness or from other causal factors. Fires can lead to the destruction of buildings, wooden bridges and poles, power, transmission and telecommunication lines, warehouses of containing oil products and other fuel. It causes injury to people and animals.

Students' activity Mock Drill:

To escape a fire, **stop, drop, and roll.** In case your clothes burn, stop running, drop on the floor and roll to stop fi re spreading.

During droughts or windy weather, fire may destroy low vegetation and trees. The spreading speed of low fire is 1-3 m/sec and high fire may reach up to 100m/sec.

Rule of actions for Fire Accident-Do's

1. When Fire accident occurs, warning should be given by shouting or ringing bell.
2. Extinguish the fire using sand and other fire extinguishers.
3. Main switch should be switched off immediately.
4. If clothes started burning, the victim should roll on the ground to extinguish the fire.
5. The combustible materials found near the fire accident place, have to be discarded so that the fire does not spread to them.
6. If fire breaks out with smoke spreading, cover the nose, crawl and move out.
7. Think that life is more valuable than belongings.
8. Move from the fire accident place to a safe place.

Preventive Measures

1. Create a safe zone between the house and flammable plants.
2. Cut off all the branches of trees with below three meter height standing near your house.
3. Remove moss and dry branches from plants standing near the house.
4. Clean ditches and pits from dry branches, leaves and cones.
5. Keep flammable materials in the checked safe containers.
6. Ask your relative or friend living in a different location to be your contact person.
7. Have a fire extinguisher and know how to use it.

Do you know?

A natural gas vent in Iraq known as The Eternal Fire of Baba Gurgur, meaning 'Father of Fire' has been burning continuously for over 4,000 years, and it has been mentioned by Herodotus, and Plutarch.

During fire accident

1. When water cannot be used (because the equipment is plugged-in) or there is no water and the fire is not strong, you can use cooking soda or calcite soda, washing powder, sand, soil.
2. Keep your head no higher than 30 cm above the floor; above this height accumulation of heavy poisonous gases is possible.
3. If there is no opportunity to leave the room, move towards a window, and try to get the attention of people by giving signals.
4. If your clothing has caught fire do not run because this will intensify burning. Take the clothes off, throw them in a safe place and put out the fire.
5. If you are near a fire in a forest and cannot extinguish the fire by yourself, immediately inform people who are nearby about the necessity to leave the hazard zone.

Things that must never be done during a fire

1. Never pour water on burning electrical equipment if it is switched on. If a TV set, a refrigerator is burning, turn off the electricity from the main switch.
2. Do not jump from windows of upper floors.
3. Do not panic.
4. Do not try to extinguish the fire by yourself.

Industrial Disasters

Industrial hazards consist of four principle hazards. The hazards encountered are fire, explosion, toxic release and environmental damage. This is because industries employ many different processes involving a wide range of different raw materials, waste products and final products. Danger originates from technological or industrial accidents, dangerous procedures, infrastructure failures or certain human activities. It may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Fire: This is the most frequent hazard. Fire can also produce toxic fumes like Acrolein, Carbon monoxide and Cyanides. Physical structures can be damaged either by the intensity of the heat or combustion. It may also have an effect on essential services like power and instrumentation.

Explosion: Explosions is the result of a shock wave. This overpressure can kill people but usually the indirect effects of collapsing buildings, flying glass and debris causes far more loss of life and severe injuries. There are different types of explosions which include gas explosions and dust explosions. Gas explosions occur when a flammable gas mixes with air. Dust explosions occur when flammable solids, especially metals, in the form of fine powders are intensively mixed with air and ignited.

Chemical release: Sudden release of toxic vapors has the potential to cause death and severe injuries several kilometers from the release point. They are carried by water and air. Their release into public sewage systems, rivers, canals and other water courses, either directly or through contaminated water used in firefighting can result in serious threat to public. The number of casualties depends on the weather conditions, population density in the path of the cloud and the effectiveness of the emergency arrangements.

Environmental Damage: Release of other substances, not directly toxic to humans can cause major pollution problems. It is becoming increasingly recognized that damage to natural resources such as plant and animal life can have serious long term consequences. E.g. destruction of trees is increasing the effect of global warming and extinction of animals are severely disrupting food webs and causing an increase in pests.

Means of reducing the industrial hazards

Process Safety Management: Reliability assessment of process equipment, incorporating safety tips, scrubbing system, etc, should be done before effecting major process changes.

Safety Audits: Periodical assessment of safety procedures, performance of safety systems and gadgets along with follow up measures should be carried out.

Emergency Planning: A comprehensive risk analysis indicating the impact of consequences and practiced emergency procedures should be done. This can be done by communities as well as national or regional corporation authorities.

Training: Proper training of employees and protective services should be done.

Road accident

It is estimated that 1.34 million people are killed in the road accidents every year. Road accident is the 8th leading cause of death globally. Every year, up to 50 million people suffer serious, life-altering injuries which, in many low- and middle-income countries, directly contribute to the poverty cycle.

Primary road safety risk factors in low and middle-income countries include:

1. Speeding
2. Drink-driving
3. Non-use, or improper use of helmets, and
4. Non-use, or improper use of seatbelts

Strengthening the capability of the road traffic police to enforce traffic laws is fundamental to deterring road users from violating the laws, to reduce harm and toreduce inappropriate and unsafe behaviors on the roads.

Basic road safety rules for students:

1. Aware of the road signals

Assist students to learn the traffic lights and signs. Check out the relevance of each color:

- Green light is an indication for "go"- Whenever the signal turns green, the vehicle can move ahead.
- Red light is an indication "to stop"- All the vehicles have to stop, when the red light is on.
- Yellow light is an indication "to slow down"- When the yellow light turns on, you should slow down your vehicle and prepare to stop.
- "Walking man" signal at intersections are constructed for the pedestrians. Recall the fact that you will be authorized to cross the road only when the signal turns green. Ensure that there are no vehicles, both on the left and right side of the road.
- Never attempt to cross the road, if the signboard signifies "Don't walk" message or the walking symbol turns red.

2. Stop, look, and cross

In fact, students will either walk to school or to the bus stop for waiting their respective school bus. The only task of students is to cross the road prudently, right after the school bus drops them off. Hence, we should undertake the responsibility to provide adequate guidance for crossing the road cautiously.

We teach them to be aware of various road signs and recommend them to utilize the zebra crossing while crossing the road. If there are no markings or signs, the following procedures can be worthwhile:

- Check the right side, after that to the left side of the road for the incoming vehicles.

- If you notice a vehicle is approaching, wait for the vehicle to pass and then safely cross the road.
- Do not cross the road at the turns, it is unsafe.
- Never cross the road between the stopped vehicles.

However, accompaniment is required for the children aged below 6 years and you should compulsorily hold their hands while crossing the road.

3. Listen

Educate the child to be extra vigilant while they cross the road at the turns. As a consequence, listening can only aid them. For this reason, instruct your child to listen and ensure whether a vehicle is approaching or not. Ordinarily, vehicles apply horns at turns and at unmanned intersections to providea warning to other road users. Meanwhile, you can interpret the following instances to students:

- If a horn is heard, stop and cross only after ensuring that no vehicle approaches you from left or right side of the road.

4. Don't rush on roads

Students will not be tolerant and have a tendency to dash across the road to reach the other side. In addition, they become absent-minded when they are having fun and henceforth bound across or along the road. Therefore, teach them to remain placid while they are near the road.

5. Relevance of Sidewalks

Persuade students to avail the service of sidewalks whenever they walk on the road. Demonstrate them how to cross the road safely. Motivate them to avail the sidewalks even though it is not a busy street.

6. Crossroads and pedestrian crossings

Students will have a tendency to scoot across the street. This will become particularly perilous since vehicles will never slow down unless there is a cross road or relevant signal. Notify your students to cross only at intersections and avail the pedestrian crossings. If there is no crossroad or pedestrian crossing, you can admonish students to comply the rules mentioned above.

7. Place the hands inside the vehicle

A multitude of students have the habit of placing their hands outside the vehicle while it is moving. They will lay their head out and wave with exhilaration. This is a familiar sight among the school bus students. Nevertheless, these behaviors can have significant consequences. Due to carelessness, they will be injured by vehicles, which advance from the opposite direction.

8. Never cross road at bends

Bends are evidently the blind spot for motorists. When you attempt to cross at bends, the driver will be unable to recognize you and stop the car at the right time. As a result, students will be hurt while crossing at bends.

9. Remain safe on a bicycle

If students ride bicycle to reach the school, ensure that they adhere to the following cycling rules:

- Utilize the bicycle lane. If such a lane does not exist, ride the bike either on the extreme left or right side of the road and glide along with the traffic.
- Never permit your students to ride on congested streets without your supervision.

10. Staying safe in a moving vehicle

In a moving vehicle, you can ensure the student's safety with the assistance of a seat belt. Let them practice the following safety rules in your absence:

- Never stand, stroll or sprint inside a moving vehicle.
- Remain seated and hold the rails on the seats until the school bus halts.
- Do not put your hands outside the moving vehicle.

11. Get off the vehicle at the curb side

Ask your students to memorize the following safety tips and conform to the rules while they get down from the school bus:

- Ensure that you reach the bus stop prior to the scheduled bus timing in order to avert the circumstance of running behind the school bus.
- Form a queue to board or descend the school bus.
- Disembark the school bus at the curbside in order to evade unnecessary endangerment and hindrance to other vehicles.