

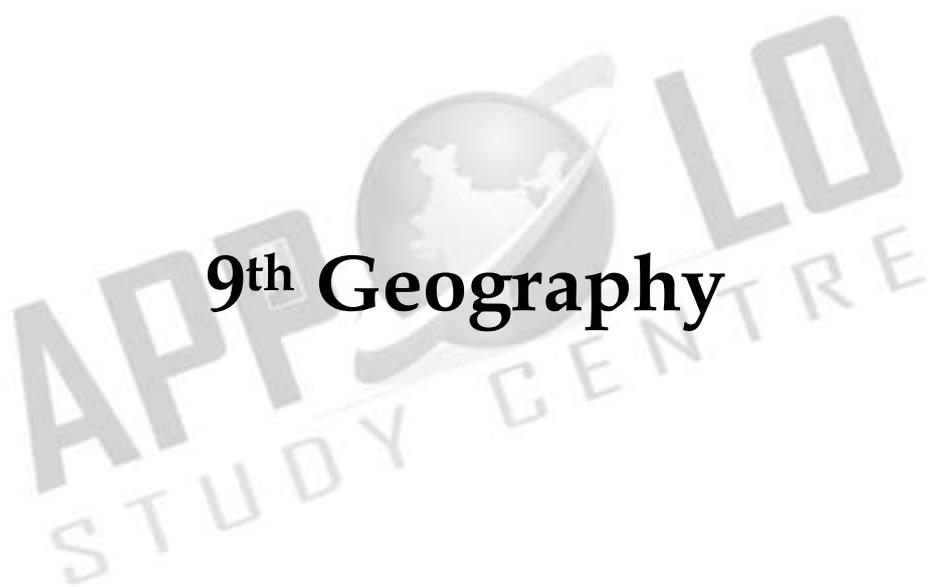
Appolo Study Centre

9th, 10th New School Book

GEOGRAPHY

TABLE OF CONTENTS

S. No	Title	Page
9th Std		
1.	Lithosphere - I Endogenetic Process	3
2.	Lithosphere - II Exogenetic Process	12
3.	Atmosphere	23
4.	Hydrosphere	37
5.	Biosphere	46
6.	Man and Environment	53
7.	Mapping Skills	71
8.	Disaster Management- Responding to Disasters	85
10th Std		
1.	India - Location Relief and Ddrainage	92
2.	Climate and Natural Vegetation of India	107
3.	Components of Agriculture	118
4.	Resources and Industries	137
5.	India - Population, Transport, Communication and Trade	155



9th Geography

1. Lithosphere – I Endogenetic Processes

Pathway

The Earth is a unique planet of the Solar family. The Earth is composed of four spheres namely, the lithosphere, the atmosphere, the hydrosphere and the biosphere. This lesson focuses on the internal processes of the Earth. The sequence of lessons generally follows the spheres of the Earth system in a comprehensive manner.

Spheres of the Earth

Earth's surface is a vast area of 510 million sq.km, where four spheres of the Earth interact. The abiotic spheres are the lithosphere, atmosphere and hydrosphere. The biotic sphere is the biosphere. Together, these spheres constitute the planet, Earth. This topic 'lithosphere' has been bifurcated for the sake of convenience. It is divided into Endogenetic processes (Internal processes) and Exogenetic processes (External processes). This lesson deals with the Endogenetic processes in detail, the next lesson will deal with the Exogenetic processes.

Spheres of Earth

The outer surface and inner core of the Earth are totally different in their nature and structure. The structure of the Earth's interior is divided into three layers namely the crust, the mantle and the core.

Crust

Crust is the outer layer of the Earth, where we live. It is the skin of our Earth, which ranges between 5 to 30 km. It is the solid and rigid layer of the Earth. The thickness of the crust is greater below the continents than the ocean floor. The crust is classified as continental crust and oceanic crust. The major elements of crust are Silica (Si) and Aluminium (Al) and thus, it is termed as SIAL.

Mantle

The interior part beneath the crust is called mantle, which is about 2,900 km thick. The major elements of the mantle are Silica (Si) and Magnesium (Mg) and hence it is also termed as SIMA. In the upper part of the mantle, the rock remains solid, whereas in the lower part of the mantle, rocks are in molten form. This molten rock inside the Earth is called 'magma'.

Core

The core is the innermost and hottest layer of the Earth which lies below the mantle. It is composed mainly of Nickel (Ni) and Iron (Fe). Hence it is called NIFE. The core is divided into Solid inner core and Liquid outer core. The presence of large quantities of iron in the core is responsible for the Earth's gravitational force. As the Earth rotates on its axis, the liquid outer core spins over the solid inner core and generates the Earth's magnetic field. This is responsible for the functioning of the magnetic compass. Due to high pressure, the materials in the inner core are unable to move and hence remain solid.

DATA ON THE EARTH'S INTERIOR				
Layers	Thickness (km)	Top	Bottom density (g/cm ³)	Types of rocks found
Crust	30	2.2	- 2.9	Silicic Rocks Andesite, Basalt at base, Aluminum
Upper mantle	720	3.4	- 4.4	Peridotite, Eclogite, Olivine, Spinel, Garnet, Pyroxene Perovskite, Oxides
Lower Mantle	2,171	4.4	-	Magnesium and silicon oxides
Outer core	2,259	9.9	- 12.2	Iron oxides, Sulphur, Nickel Alloy
Inner core	1,22,	12.8	-	Iron oxides, Sulphur, Nickel Alloy
Total Thickness	6,401			

Rocks: The crust is a storehouse of rocks. An aggregate of minerals on the Earth's crust is called 'rock'. It may be hard and compact like 'granite' or soft as 'clay' or loose as 'sand'.

Types of Rock: Based on formation, rocks are classified as: 1. Igneous, 2. Sedimentary and 3. Metamorphic.

1. **Igneous Rocks:** The word 'igneous' is derived from the Latin word Ignis meaning 'Fire'. The interior of the Earth contains very hot molten material called 'Magma'. When the magma reaches the Earth's surface, it is referred to as 'Lava'. The lava on the surface cools down and gets solidified as rocks called igneous rocks. Granite and basalt are examples of such rocks. Igneous rocks are also called Primary or Mother rocks because all other rocks are directly or indirectly formed from them.
2. **Sedimentary Rocks:** These sedimentary rocks are named after the latin word 'sediment' meaning 'settle'. Rivers, glaciers and winds carry bits of rock and soil and deposit them in layers. After a few million years, these deposits harden into compact rocks and are called Sedimentary rocks. The bodies of plants and animals that fall on the deposits get embedded in the layers and form Fossils. Sandstone, limestone, chalk, gypsum, coal and conglomerate are examples of sedimentary rocks.
3. **Metamorphic Rocks:** The term 'metamorphic' is derived from the word 'metamorphosis', which means, 'change of form'. When igneous or sedimentary rocks are subjected to extreme heat and pressure, they undergo a complete change in their form and character .i.e., in course of time, granite may get transformed to gneiss, basalt to schist, limestone to marble and sandstone to quartzite.

Types of Rocks	Examples	Uses
Igneous	Granite Basalt	Construction work Laying roads
Sedimentary	Gypsum Limestone	Manufacturing of wall board, cement, plaster of Paris etc. Construction and purification of Iron in blast furnaces
Metamorphic	Diamond Marble	Jewellery making Sculpture and construction

Rock Cycle: The Rock cycle is a continuous process through which igneous, sedimentary and metamorphic rocks are transformed from one form to another.

Geomorphic Processes

- The formation and deformation of landforms on the surface of the Earth is a continuous activity of two broad processes i.e. internal and external. These processes cause stress and deformation on Earth materials and finally bring changes on the surface of the Earth. These are referred as Geomorphic Processes.
- The forces that act from the Earth's interior towards the Earth's surface are called Internal processes or Endogenetic processes. These forces build the landscape and create topographic relief.
- The forces that act on the surface of the Earth due to natural agents like running water, glacier, wind, waves etc. are called External processes or Exogenetic processes. These external processes tear the landscape down into relatively low elevated plains.

Internal Processes: The internal processes generate heat and eject materials from deep below the Earth's crust. Internal radioactivity is the principal source of power for this process.

Plate Tectonics:

The lithosphere is divided into a number of huge slabs of rocks called 'Tectonic plates.' These tectonic plates are divided into major and minor plates. These plates float independently over the mantle. Collisions of these plates produce mountain ranges and other irregular surface features, both on land and the ocean floor. This phenomenon is called 'plate tectonics'. The movement of tectonic plates is due to thermal energy from the mantle. Now we have a better understanding about the plate movements and its relation to Earthquake and volcanic activities.

Types of Plate Boundaries

- **Convergent Boundary:** Here the plate moves toward each other and sometimes, a plate sinks under another. The location where the sinking of a plate occurs is called a subduction zone.
- **Divergent Boundary:** Here the plates pull away from each other as magma pushes up from the mantle.
- **Transform Boundary:** Here the plates slide horizontally past each other.

Movements of Continental Plates

Due to lateral compressional forces, the plates are forced to move upwards and downwards. This is called 'Folding'. Mountains formed by folding are called fold mountains. The process of folding creates lofty mountain ranges such as the Himalayas and the Alps. The movement of plates also creates stress and tension in the rocks, causing them to stretch and crack. This is called 'Faulting'. The great rift valley of East Africa is a notable example for the process of faulting. The process of folding and faulting together with volcanoes and Earthquakes continually reshape the continents and seafloor.

According to plate tectonics, the plates are in constant motion with an average rate of few centimetres per year. The movement might seem slow, but over millions of years, the plates and the continents riding on them move a long way. For example, about 250 million years ago, the Indian Plate was a part of the Gondwana land, which comprised of modern Africa, Australia, Antarctica, and South America.

Approximately 140 million years ago, the Indian plate broke away from the ancient super continent 'Gondwana' and began moving north and collided with Asia. The collision with the Eurasian Plate along the boundary between India and Nepal formed the Orogenic belt that created the Tibetan Plateau and the mighty Himalayan Mountains.

Earthquake

Earthquakes are generally caused by the sudden vibrations in the Earth's crust, which spreads outward in all directions as waves from the source of disturbance. The point of origin of an Earthquake is called 'Focus' (Hypocenter) which generates a series of elastic waves. 'Epicentre' is a point on the Earth's surface that lies directly above the focus. The impact of the Earthquake is felt the most at the epicentre.

Seismic Waves

- **Earthquakes generate seismic waves:** The nature, force and speed of these seismic waves depend on the nature of the medium through which it passes. Accordingly, there are three major types of waves.
- **Primary or P-waves** are the fastest of all the Earthquake waves and the first to reach the epicentre. These waves pass through solids, liquids and gases, either through push or pull with an average velocity of 5.3km per second to 10.6 km per second.

- **Secondary or S-waves** travel only through solids. These transverse waves shake the ground perpendicular to the direction in which they propagate. The average velocity of these waves is 1Km per second to 8 km per second.
- **Surface Waves (or) L-waves** are similar to P-waves but they travel primarily along the ground surface. These waves travel comparatively slower and are the most destructive waves. The average velocity of these waves are 1 km per second to 5 km per second.

Tsunami

The word 'Tsunami' is a Japanese term, meaning harbour waves. It is adopted to describe large seismically generated sea waves caused by Earthquakes, submarine explosions and landslides. These waves travel at a great speed (more than 500 km per hour) and the length of the waves exceeds 600 km. These waves reach to a height of more than 15 m near the sea shore and are capable of causing destruction along the coastal area. The 2004 Indian Ocean Earthquake that caused tsunami is the sixth-deadliest natural disaster which travelled at a speed of 600 km per hour with an estimated death toll of 2,80,000. The Earthquake which occurred near Indonesia at 00.58 hours took nearly 7 hours to reach Chennai.

Volcanoes

A volcano is a vent or an opening on the surface of the Earth crust, through which hot solid, liquid and gaseous materials (Magma) erupt out to the surface from the Earth's interior. Magma rises up and ejects on the surface as Lava. Volcanoes are also formed when plates move apart. Volcanoes generally have the following major components. They are:

- Magma chamber:** a large pool of liquid rock found beneath the surface of the Earth
- Vents:** an opening serving as an outlet for air, smoke, fumes, magma etc
- Volcanic cone:** a landform built by the magma ejected from the vent in the shape of a cone.
- Crater:** a bowl shaped depression found at the top of the volcano through which the magma flows out.

Based on the periodicity of eruptions, volcanoes are classified into i. Active volcano, ii. Dormant volcano, iii. Extinct volcano.

- i. Active Volcano:** Active volcanoes are those which constantly eject volcanic lava, gases and fragmented materials. (eg.) Mount St. Helens in the United States.
- ii. Dormant Volcano:** Volcanoes that do not show any sign of volcanic activity for a long period of time are known as dormant volcanoes. Sometimes there may be a sudden explosion which may cause unimaginable loss to life and property (e.g.) Mt. Fuji , Japan
- iii. Extinct or Dead Volcano:** When a volcano permanently stops its volcanic activity, then it is called as extinct or dead volcano (e.g.) Mt. Kilimanjaro, Tanzania

Volcanoes can also be classified based on their structure and composition as composite volcano, shield volcano and dome volcano

- **Composite Volcano:** Composite volcano, also known as strata volcano, is a conical volcano built by many layers of hardened lava, pumice and volcanic ash. These are commonly found in the Pacific Ocean Eg. Mt. Fuji, Japan
- **Volcanic Dome:** A lava dome or volcanic dome is roughly a circular mound formed due to the slow ejection of viscous lava from a volcano. As the lava is rich in silica with intense viscosity, it is prevented from flowing far from its vent. e.g. Paricutin, Mexico
- **Shield Volcano:** Shield volcanoes are formed by intense viscous lava. These are shallow depositions with gently sloping sides. Hence the lava flows out in all directions to create a shield. E.g., Mauna Loa, Hawaii

Distribution of Earthquakes and Volcanoes

Most Earthquakes and volcanic eruptions do not strike randomly, but occur along the plate boundaries. One such area is the circum-Pacific Ring of Fire, where the Pacific Plate meets many surrounding plates. The Ring of Fire is the most seismically and volcanically active zone in the world. The other distinctive major belts are Mid-Oceanic Ridges and Mid- Continental Belts.

Effect of Volcanoes

Constructive Effects

Volcanic materials enrich the soil fertility that promotes agricultural activities. The hot volcanic region helps in generating geothermal energy.

Many dormant and active volcanoes are the most attractive tourist spots of the world. Most of the volcanic materials are used as building materials.

Destructive Effects

Volcanic eruption causes Earthquakes, fast floods, mud slide and rock fall. Lava can travel very far and burn, bury, or damage anything in its path. The large amount of dust and ash makes breathing hard and irritable. Volcanic eruptions can alter the weather conditions and disrupt transport (Iceland volcanic eruption) in and around the volcanic region.

NOTE

- ❖ “The Earth can physically be described as a ball of rock (the lithosphere), partly covered by water (the hydrosphere) and wrapped in an envelope of air (the atmosphere). To these three physical zones it is convenient to add a biological zone which includes all the living organisms (the biosphere).”- Arthur Holmes
- ❖ The ‘Pedosphere’ is a part of the lithosphere made up of soil and dirt. It exists at the interface of lithosphere, atmosphere, hydrosphere and biosphere.
- ❖ The lithosphere is the solid outer part of the Earth.
- ❖ The atmosphere is a thin layer of gases that surrounds the Earth.
- ❖ The hydrosphere is the watery part of the Earth’s surface including oceans, rivers, lakes and water vapour
- ❖ The biosphere is the layer of Earth where life exists.
- ❖ The terms ‘lithosphere’ and ‘crust’ are not the same. The lithosphere includes the crust and the uppermost part of the mantle.
- ❖ All terrestrial planets have lithosphere. The lithospheres of Mercury, Venus, and Mars are much thicker and more rigid than that of the Earth.
- ❖ The Deepest Place ever reached by human technology vary from time to time. Till 2011 Kola Super Hole (12,262m) in Murmansk, Russia was the deepest place. But in 2012, Z-44 Chavyo Well (12,376m) broke the record, and is supposed to be 15 times the height of Burj Khalifa in Dubai. The exploration of Earth’s interior continues.
- ❖ The ancient city of Petra in Jordan is an example of an entire city carved out of rocks. There are many specimens of magnificent rock-cut architecture in India, like the Ajanta and Ellora caves in Maharashtra, the Aihole and Badami temples in Karnataka, the Konark temple in Odisha and Mamallapuram in Tamil Nadu.
- ❖ C.F. Richter devised a scale to measure the magnitude of Earthquakes. This scale relates to the energy released at the epicentre and provides an estimation of the severity of an Earthquake. It is an open ended scale. The

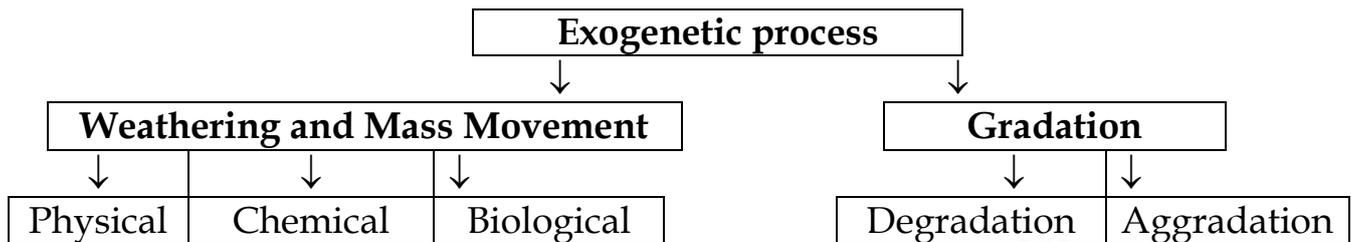
highest magnitude ever recorded is 9.5 on Richter scale (Bio-Bio, Chile in 1960).

- ❖ The instrument which records the Earthquake waves is called 'seismograph' or 'seismometer'. The science that deals with Earthquakes is called 'seismology'.
- ❖ On 26 December 2004 a tsunami occurred in the Indian Ocean. It was the result of the Indian- Australian Plate subducting below the Eurasian Plate. It was caused by an Earthquake measuring a magnitude of above 9 in the Richter scale. The Earthquake caused the seafloor to uplift, displacing the seawater above.
- ❖ The term 'volcano' is derived from the Latin term VULCAN, which is the name of Roman "God of Fire".



2 - Lithosphere - II Exogenetic Processes

The Earth is a dynamic system that undergoes various changes due to internal and external processes. The continuous interaction of these two processes controls the structure of the earth's surface. The external processes are the consequence of solar energy and gravitational forces, whereas the internal processes are an outcome of the earth's internal heat.



Weathering and Mass Movement

Weathering is the disintegration and decomposition of materials of the earth's crust by their exposure to atmosphere. Movement of huge volumes of weathered rock material down the slope due to gravity is called mass movement or mass wastage. Example: rock slide, land slide, debris fall, mud flow. The nature and magnitude of weathering differs from place to place and region to region. Weathering is affected and controlled by factors such as temperature, rock structure, land slope and vegetation. There are three types of weathering 1. Physical weathering, 2. Chemical weathering and 3. Biological weathering

Physical weathering

It is the breakdown of rocks without changing their chemical composition, through the action of physical forces. The constant freezing and thawing of rocks during the night and day leads to the expansion and contraction of rocks. Cracks are formed and disintegration occurs eventually. Exfoliation, block disintegration, granular disintegration etc., are the different types of weathering.

- ✓ **Exfoliation:** The alternate heating and cooling on rounded rock surfaces leads to the peeling of rocks, layer by layer like an onion. This is called exfoliation. Sheetting and shattering are the other forms of exfoliation.
- ✓ **Granular Disintegration:** Granular disintegration takes place in crystalline rocks where the grains of the rocks become loose and fall out. This is due to the action of temperature and frost.

- ✓ **Block Disintegration:** Repeated expansion and contraction of rocks during day and night respectively causes stress on the joints of the rocks which results in block disintegration.

Chemical Weathering

Disintegration and decomposition of rocks due to chemical reactions is called Chemical Weathering. This is predominantly high in the hot and humid regions such as the equatorial, tropical and sub tropical zones. Chemical weathering takes place through the processes of oxidation, carbonation, solution, and hydration. The agents of Chemical weathering are Oxygen, Carbon-dioxide and Hydrogen.

- ✓ **Oxidation:** Oxygen in the atmosphere reacts with the iron found in rocks, thus leads to the formation of iron oxide. This process is known as oxidation, which results in the weakening of rocks.
- ✓ **Carbonation:** Carbonation is the mixing of water with the atmospheric carbon-dioxide, forming carbonic acid. Carbonation is important in the formation of caves, in limestone region. When the carbonic acid reacts with the carbonate rocks, the rocks get disintegrated.
- ✓ **Solution:** The process of dissolution of rock substances in water result in the loosening of the rock particles. This inturn breaks down the rocks.
- ✓ **Hydration:** Certain chemicals in the rock enlarge in size in humid conditions. These minerals found in the rock swell and this results in the development of cracks and the rock wears down. This type of weathering is called hydration.

Biological Weathering

Biological weathering occurs due to the penetration and expansion of plant roots, earthworms, burrowing animals (rabbits, rats) and some human activities.

Gradation: Gradation is the process of levelling of the land by means of natural agents like rivers, ground water, winds, glaciers, and sea waves. These agents produce various gradational relief features in due course of time. Gradation takes place in two ways: degradation and aggradation

- **Degradation or denudation** is the wearing down of the land surface by various natural agents.
- **Aggradation** is building up of landforms due to natural agents.

- **Gradation** = Erosion + Transportation + Deposition

Agents of Gradation

Running water (River)

The work of running water (rivers) is the most extensive among all the other agents of gradation. Rivers originate on higher landforms like, mountains, hills and plateaus that receive water from various sources like the rain, glaciers, springs, lakes, etc. The place where the river originates is called its source and where it joins the sea is known as its mouth. The primary functions of a river are (i) erosion (ii) transportation and (iii) deposition. The work of a river depends on various factors such as volume of water, velocity of the river, slope of land, load of sediment and structure of rock, and load of sediment.

Courses of River:

Rivers generally originate from mountains and end in a sea or lake. The whole path that a river flows through is called its course. The course of a river is divided into: i. The upper course, ii. The middle course and, iii. The lower course

- The Upper Course:** Erosion is the most dominant action of river in the upper course. In this course, a river usually tumbles down the steep mountain slopes. The steep gradient increases the velocity and the river channel performs erosion with great force to widen and deepen its valley. The land features carved by a river in its upper course are V- shaped valleys, gorges, canyons, rapids, pot holes, spurs, and waterfalls.
- The Middle Course:** The River enters the plain in its middle course. The volume of water increases with the confluence of many tributaries and thus increases the load of the river. Thus, the predominant action of a river is transportation. Deposition also occurs due to the sudden decrease in velocity. The river in the middle course develops some typical landforms like alluvial fans, flood plains, meanders, ox-bow lakes etc.,
- The Lower course:** The River, moving downstream across a broad, level plain is loaded with debris, brought down from its upper and middle courses. Large deposits of sediments are found at the level bed and the river, splits into a number of channels called distributaries. The main work of the river here is deposition and it develops typical landforms like delta and estuary.

Erosional Landforms of River

- ✓ **Gorges and Canyons:** When the river flows through a mountainous region made up of hard rocks, it forms a valley with almost vertical sides called gorge. In India, deep gorges have been formed by Brahmaputra and Indus in the Himalayas. A deep gorge with steep sides that runs for hundreds of kilometres is referred to as canyon e.g. Grand Canyon of the river Colorado in the U.S.A.
- ✓ **Waterfall:** When a river flows in a region where hard rocks lie over soft rocks horizontally, the soft rocks get eroded quickly and the hard rocks projects outwards. Thus, the river falls vertically from a steep slope to form a waterfall. When the water falls with great force, it erodes the rock material beneath and creates a depression called a plunge pool. Shallow fast flowing water in a stream is called a rapid.
- ✓ **V-shaped valley:** A 'V'- shaped valley is formed by the vertical erosion of the river where the valley is deepened and widened.
- ✓ **Pot hole:** Due to the river action, cylindrical holes are drilled vertically in the river bed, with varying depth and diameter. These are called pot holes.
- ✓ **Meander:** As the river loaded with debris flows slowly, it forms sweeping loops and bends. It is referred to as meanders.
- ✓ **Ox bow lake:** Meanders in due course of time become almost a complete circle with narrow necks. This in turn gets abandoned and forms a lake. This is called an Ox-bow lake.

Depositional Landforms of River

- ✓ **Alluvial Fan:** A fan shaped deposition made by the river at the foothills is called an alluvial plain
- ✓ **Flood Plain:** Fine sediments are deposited on river banks when a river floods. These sediments make the region rich and fertile. This is called a flood plain. As the height of the river banks gets increases due to continuous deposition of a flooded river, levees are formed.
- ✓ **Estuary:** Estuary is formed where the rives meets the sea. Deposition of silt by the river is not possible here in the estuaries like delta as if the waves keep on eroding the deposits. Ex. River Narmada and Tapti.

- ✓ **Delta:** A triangular shaped low lying area formed by the river at its mouth is called delta. Deltas have fine deposits of sediments enriched with minerals. Eg. Cauvery Delta, Tamil Nadu.

Groundwater

Water that percolates through the pores and fissures of rocks gets collected beneath the earth's surface. This is normally referred to as groundwater or sub-surface water. The rate of percolation depends on the nature of the rocks. The rocks that allow water to percolate are called porous rocks or permeable rocks. The rocks that do not allow water to seep through them are called non-porous rocks or impermeable rocks. The percolated water in course of time returns back to the surface in the form of springs, geysers, hot springs, wells, tanks, artesian wells etc. that are useful for human activities. As an agent of gradation, underground water creates distinct landforms in limestone regions called Karst Topography.

Karst Topography

Ground water is an active agent in limestone regions. Karst topography is formed due to the dissolution of soluble rocks such as limestone, dolomite and gypsum. Limestone topography of Western Slovenia extends for a distance of 480 km in length and 80 km in width which is termed as Karst in the Slavic language. The world's largest karst area is the Nullarbar located on the Great Australian Coast. Karst regions are also found in Southern France, Spain, Mexico, Jamaica, Western Cuba, Central New Guinea, Sri Lanka and Myanmar. Karst topography also exhibits both erosional and depositional features.

Erosional Landforms of Underground Water

Most of erosion takes place due to the process of solution. When rain water mixes with carbon-di- oxide and enters into a limestone region, it dissolves and destroys much of the limestone. As a result, landforms such as Terra rossa, Lappies, sinkholes, swallow holes, dolines, uvalas, poljes, caves and caverns are formed.

- ✓ **Terra Rossa (Italian term for Red soil):** Deposition of red clay soil on the surface of the Earth is due to the dissolution of limestone content in rocks. The redness of the soil is due to the presence of iron oxide.
- ✓ **Lappies:** When the joints of limestone rocks are corrugated by groundwater, long furrows are formed and these are called LAPPIES.

- ✓ **Sinkhole:** A funnel shaped depressions formed due to dissolution of limestone rock is called sinkholes. Their average depth ranges between three and nine meters.

Caves and Caverns: Caves and caverns are subterranean features of karst topography. Caves are hollows that are formed by the dissolution of limestone rocks when carbon di oxide in air turns into carbonic acid after its reaction with water. They vary in size and shape. Caverns are the caves with irregular floors. Eg. Guptadham caves in Western Bihar.

All types of deposits in the caves and caverns are collectively called speleothems which includes travertines, tufa, dripstones. Swallow Holes, Uvalas, Dolines, Poljis are other erosional Features of karst regions predominant in other parts of the world.

Depositional Landforms Underground Water

It is interesting to know that a variety of depositional features are formed on the floor, ceiling and walls of the caves and caverns of the Karst Topography.

Stalactite, Stalagmite and Column

When the water containing dissolved calcite gradually drips from the ceiling of the caves, water evaporates and the remaining calcite hangs from the ceiling. Thus Stalactites are formed. When the calcite deposits rises upward like a pillar Stalagmites are formed. Sometimes, Stalactites and Stalagmites meet together to form Columns and Pillars.

Glaciers:

A Glacier is a large mass of ice that moves slowly over the land, from its place of accumulation. It is also known as 'River of ice'. The place of accumulation is called snowfield. The height above which there is a permanent snow cover in the higher altitude or latitude is called snowline. Higher the latitude, lower the snowline from sea level. The gradual transformation of snow into granular ice is called 'firn' or 'neve' and finally it becomes solid glacial ice.

Movement of Glacier

The large mass of ice creates pressure at its bottom and generates heat. Due to this, the glacier melts a little and starts to move .The rate of movement of a glacier varies from a few centimetres to several hundred meters a day. The movement of glaciers depends on slope, volume of the glacier, thickness,

roughness at the bottom (friction) etc., and Temperature. Like the rivers, glaciers also carry out erosion, transportation and deposition.

Types of Glacier

Glaciers are broadly divided into two types based on the place of occurrence, such as Continental glacier and valley glacier.

Erosional Landforms of glacier

Glaciers are powerful erosive agents. Some of the important erosional landforms are Cirque, Aretes, Matterhorn, U-shaped valley, Hanging valley, Fiords etc., Most of these glacial features are predominantly seen in countries like Switzerland, Norway etc.,

- ✓ **Cirque:** The glacier erodes the steep side walls of the mountain and forms a bowl-shaped armchair like depression, it is termed as Cirque
- ✓ **Arete:** Aretes are narrow ridges formed when two cirque walls joined together back to back, and forms narrow knife like ridges.
- ✓ **Matterhorn:** The pyramidal peaks formed when three or more cirques meet together, are referred as Matterhorns.
- ✓ **U-Shaped Valley:** When the glacier moves down along a river valley, the valley further gets eroded deep and wide to form a 'U' shaped valley.
- ✓ **Hanging Valley:** These are valleys eroded by tributary glacier and that hangs over the main valley.
- ✓ **Fjord:** Fjords are glacial valleys that are partly submerged in the sea.

Depositional Landforms of glacier

After getting eroded, fragments of rocks and boulders along with dirt form glacial debris. Glacial debris gets deposited in the low lying areas and form depositional features like moraines, drumlins, eskers, kames and outwash plains.

- ✓ **Moraine:** Landforms formed by the glacial deposits of valley or continental glaciers are termed as moraines. They are of various shapes and sizes, like ground, terminal and lateral moraines etc.
- ✓ **Drumlin:** Drumlins are deposits of glacial moraines that resemble giant inverted teaspoons or half cut eggs.

- ✓ **Esker:** Long narrow ridges composed of boulders gravel and sand deposited by streams of melting water which run parallel to a glacier are called eskers.
- ✓ **Outwash Plain:** An outwash plain consists of glacial sediments deposited by the melting ice at the terminus of a glacier. It appears as an extensive accumulation of sand, gravel and silt.
- ✓ **Wind:** When air blows horizontally at or near the earth's surface is called wind. The erosional, transportational and depositional action of wind is predominant in arid regions. This is called as Aeolian Process.

Erosional Landforms of wind

Some of the erosional landforms of wind are mushroom rocks, Inselbergs and yardangs.

- ✓ **Mushroom Rock:** Rocks are made up of hard and soft layers. When a rock's bottom is soft, the sand-laden winds blow against it and wear it down. By the constant wearing down action of the wind, the bottom gets eroded away to form a mushroom like structure. This is called a mushroom or pedestal rock. Such rocks are found near Jodhpur in Rajasthan.
- ✓ **Inselberg:** Inselberg is a German term which means an island mountain. Certain hard rocks like igneous rocks are more resistant to wind action. Such isolated residual hills rising abruptly from their surroundings are termed as inselbergs. Eg. Uluru or Ayers Rock, Australia.
- ✓ **Yardang:** In arid regions, certain rocks have hard and soft layers arranged vertically. When winds blow over these rocks, the soft layers get eroded leaving irregular crests. These are called yardangs.

Depositional Landforms of wind

Deposition occurs when the speed of wind is reduced by the presence of obstacles like bushes, forests and rock structures. The sediments carried by wind get deposited on both the wind ward and leeward sides of these obstacles. Some of the depositional landforms are sand dunes, barchans and loess.

- ✓ **Sand Dune:** In deserts, during sandstorms, wind carries loads of sand. When the speed of wind decreases, huge amount of sand gets

deposited. These mounds or hills of sand are called sand dunes. There are different types of sand dunes.

- ✓ **Barchan:** Barchans are isolated, crescent shaped sand dunes. They have gentle slopes on the windward side and steep slopes on the leeward side.
- ✓ **Transverse Dunes:** Transverse dunes are asymmetrical in shape. They are formed by alternate slow and fast winds that blow from the same direction.
- ✓ **Longitudinal Dunes:** Longitudinal dunes are long narrow ridges of sand, which extend in a direction parallel to the prevailing winds. These dunes are called Seifs in Sahara
- ✓ **Loess:** The term loess refers to the deposits of fine silt and porous sand over a vast region. Extensive loess deposits are found in Northern and Western China, the Pampas of Argentina, in Ukraine and in the Mississippi Valley of the United States.
- ✓ **Wave:** A steady up (crest) and down (trough) movement of surface water are called waves. Sea waves are the most powerful agents of gradation and their erosional, transportational and depositional processes are confined to a very narrow belt along coastal areas.

Erosional Land Forms of Waves

Some of the erosional landforms of sea waves are sea cliff, sea cave, arch, stack, beach, bar and spit and wave cut platform.

- ✓ **Sea Cave:** Prolonged wave attack on the base of a cliff erodes rock materials, which result in the formation of caves.
- ✓ **Sea Arch:** When two caves approach one another from either side of a headland and unite, they form an arch. (Eg.) Neil Island, Andaman and Nicobar
- ✓ **Sea Stack:** Further erosion by waves ultimately leads to the total collapse of the arch. The seaward portion of the headland will remain as a pillar of rock known as stack. Eg the Old man of Hoy in Scotland.
- ✓ **Sea Cliffs:** Sea cliffs are steep rock faces formed when sea waves dash against them. The rocks get eroded to form steep vertical walls.

- ✓ **Wave Cut Platforms:** Flat surface found at the foot of sea cliffs are called as wave cut platforms. Wave cut platform is also referred as beach, shelf, terrace and plain.

Depositional Landforms of Waves

- ✓ **Beach:** Sand and gravel are moved and deposited by waves along the shore to form beaches. This is the most dominant and constructive work of the sea. (Eg.) Juhu beach along Mumbai coast, Puri beach in Odisha and Marina beach in Chennai.
- ✓ **Bar:** A bar is an elongated deposit of sand, shingle or mud found in the sea, almost parallel to the shoreline.
- ✓ **Spit:** A spit is a ridge or embankment of sediment, attached to the land on one end and terminating in open water on the other end. Spits are common at the mouth of estuaries. Eg. Kakinada spit.

NOTE

- ❖ The disintegrated rock materials, in due course of time, are weathered further, to form soil. Soil is a mixture of disintegrated rock material and decayed organic matter called humus.
- ❖ **Tributary** - Small streams that join the main river. Eg. River Bhavani
- ❖ **Distributary** - River channels that get separated from the main river. E.g., River Kollidam.
- ❖ The highest waterfalls in the world is Angel falls (979 m) in Venezuela.
- ❖ The world's largest oxbow lake is Lake Chicot in Arkansas of USA. Lake Kanwar in Bihar (India) is Asia's largest fresh water ox bow lake.
- ❖ The Greek letter (Δ) pronounced delta closely resembles the triangular delta of the river Nile. The Ganga-Brahmaputra Delta is the largest delta in the world.
- ❖ The world's best known geyser is the Old Faithful geyser in the Yellowstone National Park in Wyoming, U.S.A
- ❖ **Karst Areas in India**
 - Guptadham caves - Western Bihar,
 - Robert cave and Tapkeshwar temple - Uttarakhand.
 - Pandav caves Pachmari - Madhya Pradesh,
 - Kutumsar - Bastar district in Chattisgarh,
 - Borra caves of Visakhapatnam - Andhra Pradesh.
- ❖ The World's deepest sinkhole is China's xianozhai Tienkang at 2172 feet. There are as many as 15000 Sinkholes in Illinois
- ❖ **Geo Connect:** Cave insects lose their senses of sight and develop

extraordinary long antenna to compensate the loss of sight

- ❖ The thickest known deposit of loess is, 335 metre found in the loess plateau in China.
- ❖ **Major land forms:** First order land form - continents and oceans. • Second order land form - Mountains, plateaus and plains in both continents and oceans.
- ❖ **Minor Land Forms:** Third order land forms - deltas, fjords coasts, sand dunes, beaches valleys, cirques, Mushroom rocks, limestone caves.



3. Atmosphere

Earth is a unique planet where life is found. Can you imagine life on the earth without air? No. The air is essential for the survival of all forms of life. The blanket of air that surrounds the Earth is called the atmosphere. It is held close to the earth by gravitational attraction.

1. Composition of the Atmosphere

Atmosphere is a mixture of gases, water vapour and dust particles in different proportions. Nitrogen (78%) and Oxygen (21%) are permanent gases of the atmosphere. They constitute 99% of the total composition and their percentages always remain the same without any change. The remaining one percentage is occupied by Argon (0.93%), Carbon-dioxide, (0.03%), Neon (0.0018%), Helium (0.0005%), Ozone (0.00006%) and Hydrogen (0.00005%). Krypton, Xenon and Methane are also present in trace. Water vapour (0 - 0.4%) is also found in the atmosphere, which plays an important role in predicting weather phenomenon. The other solid particles present in the atmosphere includes dust particles, salt particles, pollen grains, smoke, soot, volcanic ashes etc.,.

Oxygen is most important for living organisms. CO₂ absorbs heat and keeps the atmosphere warm by insulation and radiation. Nitrogen acts as a diluent and is chemically inactive. Ozone helps in protecting the earth from radiation. The solid particles in the atmosphere acts as nuclei on which water vapour condense to form precipitation.

2. Structure of the Atmosphere

The atmosphere is thick near the earth surface and thins out until it eventually merges with space. The five atmospheric layers are: Troposphere, stratosphere, Mesosphere, Thermosphere and Exosphere.

Troposphere:

The lowest layer of the atmosphere is the troposphere. The Greek word 'tropos' means 'turn' or change. The layer extends up to 8 kms at the poles and up to 18 kms at the Equator. The temperature decreases with increasing height. Almost all weather phenomenons take place in this layer. Hence it is called weather making layer. The upper limit of the troposphere is called as tropopause.

Stratosphere

Stratosphere lies above the troposphere. It extends to a height of about 50km above earth surface. Since this layer is a concentration of ozone molecules, it is also referred as ozonosphere. The temperature increases with increase in height in this layer. Large jet planes normally fly here. The upper limit of the stratosphere is called as stratopause.

Mesosphere

Mesosphere extends between 50km and 80km. The temperature increases with increasing height. Radio waves transmitted from earth are reflected back to earth from this layer. Most of the meteors nearing the earth get burned here. The upper most limit of the mesosphere is the mesopause.

Thermosphere

Thermosphere exists above the mesosphere. It extends to about 600 km. The composition of gases in the lower thermosphere is more or less uniform, hence it is called "Homosphere". The upper portion of the thermosphere has uneven composition of gases and hence it is referred as "Heterosphere". Here the temperature increases with increasing height. Ionosphere is a layer of the thermosphere that contains Ions and free electrons.

Exosphere

The uppermost layer of the atmosphere is called exosphere. This layer is extremely referred with gases and gradually merges with the outer space. This zone is characterized by aurora Australis and aurora borealis.

Weather and Climate

Weather and climate are the terms that are related to the atmospheric conditions. Weather denotes the way the atmosphere behaves every day and climate reveals the average of weather conditions over relatively long periods of time. The difference between the two may be clearly understood with the following table.

Weather		Climate	
Partly sunny	Weather is the study of atmospheric conditions for short duration over small	Climate is the study of the average weather condition observed over a long period of time for a larger area.	Warm Climate
Windy	The weather changes	Climate is more or less	Monsoon

	very often; hour to hour and day to day	permanent and remains the same always.	
Rainy	A place can experience different types of weather conditions in a day. Eg. A day with hot morning can have a rainy moon.	A place can experience almost the same type of climate	Wet climate
Chilly	Weather data is collected every day in the observatories	Climate is average of the weather data.	Extreme Climate
Stormy	Study of weather is called Meteorology	Study of climate is called Climatology	Cyclone

2. There are many factors that influence weather and climate.

- ✓ Distance from the equator
 - ✓ Altitude
 - ✓ Nearness to the sea
 - ✓ Nature of the prevailing winds
 - ✓ Mountain barrier
 - ✓ Cloud cover
 - ✓ Ocean currents Natural vegetation
- ✓ **Distance from the Equator:** The sun's rays fall vertically on the equator. The rays are inclined on the regions away from the equator and near the poles due to the spherical shape of the earth. The vertical rays heat up the earth more than the inclined rays. Thus, the places near the equator are warmer than the places which are far away from the equator.
- ✓ **Altitude:** Altitude refers to the height above sea level. The temperature decreases at the rate of 1° C for every 165 mt of height. This is called Normal lapse rate. So, places at the higher altitude have a lower temperature.
- ✓ **Nearness to the sea:** The climate of a place varies according to its nearness to the sea. Places near the coast experience equable climate due to the influence of the winds from the sea. Places located in the land, far from the sea, does not experience the moderating influence of the sea, such places experience a continental type of climate.
- ✓ **Nature of the Prevailing Winds:** The winds change the climate of a place based on, from where they blow. When wind blows from a warm region, it makes the place warm and cold, when blows from a colder

region. The on-shore winds cause rainfall making the place cool whereas the off-shore winds bring dry weather.

- ✓ **Mountains barriers:** The location of the mountains influence the climate of a place. The mountain chains act as natural barrier for the wind. Sometimes they prevent the entry of cold winds into the country or the escape of monsoon winds, thus having a great influence over the climate.
- ✓ **Cloud Cover:** Clouds reflect a large amount of radiation from the sun. This prevents the entry of heat to the earth's surface. So, in areas generally of cloudless sky like the deserts, temperature is very high. On the other hand under cloudy sky, the temperature is low.
- ✓ **Ocean currents:** The warm ocean currents raise the temperature of the nearby coastal areas, while the cold current lower the temperature of a place.
- ✓ **Natural vegetation:** The trees release water vapour into the air and makes it cool. Thus forest areas have lower range of temperature throughout the year in contrast to non-forested areas.

3. Elements of Weather and Climate

- ✓ Temperature
- ✓ Pressure
- ✓ Wind
- ✓ Cloud
- ✓ Precipitation
- ✓ Humidity

Temperature:

Temperature is a measure of the warmth of an object expressed in terms of Celsius or Fahrenheit, measured with thermometer. Sun is the chief source of energy for the Earth. The atmosphere acts as an insulator and maintains the temperature of the earth. Without atmosphere, the earth would experience great extremes of temperatures during day and night. Some of the processes that are responsible for atmospheric heat are radiation, Conduction, Convection and Advection.

- **Heat Zones:** Based on the amount of insolation received from the sun and the heat, Earth is classified into three heat zones namely torrid zone, temperate zone and frigid zone.

- **Torrid Zone:** This largest thermal zone covers almost 50% of the earth's surface. It is located between the Tropic of Cancer ($23\frac{1}{2}^{\circ}\text{N}$) and Tropic of Capricorn ($23\frac{1}{2}^{\circ}\text{S}$). Torrid Zone experiences vertical sun rays almost throughout the year and is hot.
- **Temperate Zones:** The Temperate Zone stretches out between Tropic of Cancer ($23\frac{1}{2}^{\circ}\text{N}$) and Arctic Circle ($66\frac{1}{2}^{\circ}\text{N}$) in the northern hemisphere and between Tropic of Capricorn ($23\frac{1}{2}^{\circ}\text{S}$) and Antarctic Circle ($66\frac{1}{2}^{\circ}\text{S}$) in the southern hemisphere. The sun's rays never fall vertical in this region. The Frigid Zone is found between Arctic Circle ($66\frac{1}{2}^{\circ}\text{N}$) and North Pole (90°N) in the northern hemisphere and stretches out between Antarctic Circle ($66\frac{1}{2}^{\circ}\text{S}$) and South Pole (90°S) in the southern hemisphere. The sun's rays fall slanting in this zone. These are the coldest regions of the world. The surface remains permanently frozen under thick snow.

Pressure

The atmospheric pressure is the weight exerted by air on a particular area of the earth surface. It is measured with a mercury barometer and the unit of measurement is millibar (mb). The distribution of atmospheric pressure on the surface of the earth is not uniform. It varies both vertically and horizontally.

Vertical distribution of atmospheric pressure:

Air pressure decreases with altitude. The air molecules become scattered and more widely spaced at higher altitudes. The air pressure decreases by 34 millibars per 300 metres increase in height.

Horizontal distribution of atmospheric pressure:

The horizontal distribution of atmospheric pressure in the world is not uniform. It varies from time to time and place to place due to (i) air temperature (ii) the earth's rotation (iii) presence of water vapour etc., The pressure belts along the latitudes are characterized by alternate high or low pressure belts. The pressure belts of the world are:

- Equatorial low
- Sub-tropical highs
- Sub-polar lows
- Polar highs

The Equatorial Low Pressure Belt: This belt extends from equator to 5° N and 5° S latitudes. At the equator, the earth gets heated by the vertical sun rays and in turn heats the air in contact with it. The heated air expands and raises upwards resulting in a low pressure belt. This belt is called doldrums due to virtual absence of surface winds.

The Subtropical High Pressure Belts: The sub-tropical high pressure belts extend from the tropics to about 35° latitudes in both the hemispheres. The air that raises in the equatorial region, becomes cold and heavy, and starts to descend in the Sub Tropical regions. This result in sub-tropical high pressure belts referred as the Horse latitude.

The Sub-polar Low Pressure Belts: The sub-polar low pressure belts extend between 45°N and the Arctic Circle in the northern hemisphere and between 45°S and the Antarctic Circle in the southern hemisphere. The air present in this layer moves to the sub-tropical high pressure belt and polar high pressure belt making it free from air pressure forming the sub polar low pressure belt. This is made possible by the rotation of the earth.

The Polar High Pressure Belts: Sun rays are always slanting at poles resulting in low temperatures. Because of low temperature, air compresses and its density increases. Hence, high pressure is found here. Winds from these belts blow towards sub-polar low pressure belts.

Winds

The horizontal movement of air along the surface of the earth is called the "Wind" while the vertical movement of air is called an "Air Current". The winds always blow from a high pressure area to a low pressure area. Wind is mostly named after the direction from which it blows. For example, the wind blowing from the east is known as the easterly wind. An "anemometer" records wind speed while a "wind vane" measures the direction of the wind. The unit of measurement is kilometre per hour or knots

Types of Winds

Winds are generally classified into the following four major types:

- Planetary winds
- Periodic winds
- Variable wind
- Local wind

- **Planetary winds**

The winds which constantly blow in the same direction throughout the year are called the planetary winds. They are also called as permanent winds or the prevailing winds. These winds include Trade winds, Westerlies and Polar Easterlies

- ✓ **Trade Winds:** Trade winds blow from the subtropical high pressure belt to the Equatorial low pressure belt in both the hemispheres. They blow with great regularity, force and in a constant direction throughout the year. These winds were very helpful to traders who depended on the winds while sailing in the seas. And so, they are named as Trade winds. As they travel over vast oceans, they collect more moisture and bring heavy rainfall to the East Coast of the continents of the tropics. As they move westwards, they become dry and do not give rainfall.
- ✓ **Westerlies:** Westerlies are the permanent winds that blow from the tropical high pressure belt to the sub polar low pressure belt in both the hemispheres. They blow from South West to North East in the northern hemisphere and North West to South East in the southern hemisphere. The velocity of westerlies become so vigorous and fast to be called Roaring Forties at 40°, Furious Fifties at 50° and Screaming Sixties at 60° latitudes.
- ✓ **Polar Easterlies:** Polar easterlies are cold and dry polar winds that blow from the polar high pressure belt to the sub polar low pressure belt. These are weak winds blowing from North East direction in the Northern Hemisphere and South East direction in the Southern Hemisphere.

- **Periodic winds:**

The periodic winds are the seasonal winds that change their direction periodically. These winds are caused by the differential heating of land and ocean. Winds which reverse their direction with the change of seasons are called monsoons. A tropical Monsoon wind of Indian subcontinent is a best example.

- **Variable winds:**

The disturbance and the changes in the local weather cause variations in the prevailing winds. These winds are known as the

variable winds. Variable winds usually end up with the development of cyclones, anticyclones and storms.

✓ **Cyclones:** The term cyclone is a Greek word meaning "coil of a snake". Cyclones are centres of low pressure where, winds from the surrounding high pressure area converge towards the centre in a spiral form. Due to the rotation of the earth, the cyclonic winds in the northern hemisphere move in anti-clock wise direction, where as they move in clockwise direction in the southern hemisphere. Cyclones can be classified into: 1. Tropical cyclones, 2. Temperate cyclones, 3. Extra tropical cyclones

▪ **Tropical cyclones:** Tropical cyclones develop in the Inter tropical convergence zone [ITCZ]. They are formed due to the differential heating of land and sea. Tropical cyclones are known as 'cyclones' in Indian ocean, 'typhoons' in the western pacific ocean, 'hurricanes' in the Atlantic and eastern Pacific ocean, 'Baguio's' in Philippines and 'willy willy' in Australia. Tropical cyclones often cause heavy loss of life and property on the coasts and become weak after reaching the landmasses.

▪ **Temperate cyclones:** Temperate cyclones are formed along a front where hot and cold air masses meet in mid-latitudes between 35° and 65°N and S. Temperate cyclones do not become weak like the tropical cyclones on reaching the land. Temperate cyclone commonly occurs over the North Atlantic Ocean, North West Europe, Mediterranean basin. Mediterranean basin's temperate cyclones extend up to Russia and India in winter. In India it is as called western disturbances.

▪ **Extra tropical cyclones:** Extra tropical cyclones occur in the latitudes between 30° and 60° in both the hemispheres. They are also called as mid-latitude cyclones. They collect energy from temperature differences which are found in higher latitudes. Extra tropical cyclones produce mild showers to heavy gales, thunderstorms, blizzards, and tornadoes.

✓ **Anticyclones:** Anticyclones are the opposite of cyclones. Here an area of high pressure region is found in the centre surrounded by low pressure on all sides. The wind from the high pressure region move outwards to the low pressure regions in a spiral form. Anticyclones are often accompanied by cold and heat waves.

Cyclonic occurrences in Tamil Nadu

Year	Cyclone Name	District	Atmospheric Pressure (in millibars)	Wind Speed (km/h)	Fatalities (in numbers)	Property loss (M-Million G-Billion)
2010	JAL	Chennai	988	100	78	1.73M
2011	THANE	Cuddalore	972	140	48	235M
2012	NILAM	Mahapalipuram & Chennai	992	85	75	56.7M
2013	MADI	Chennai	986	120	323	1.5G
2016	ROANU	Nagapattinam & Chennai	983	85	22	2.0G
2016	KYANI	Chennai	997	85	-	-
2016	NADA	Chennai	1000	75	-	-
2016	VARDAH	Chennai	982	130	38	5.1G
2017	OCKHI	Kanyakumari	975	155	245	5.07G

- **Local Winds:**

Local winds are the winds that blow only in a particular locality for a short period of time, the effect of these local winds are experienced only in that particular area. They are mostly seasonal and have local names like...

- ✓ Foehn (Alps-Europe)
- ✓ Sirocco (North coast of Africa)
- ✓ Chinook (Rockies-North America)
- ✓ Loo (Thar Desert- India)
- ✓ Mistral (Mediterranean sea in France)
- ✓ Bora (Mediterranean sea in Italy)

5. Clouds

Large amount of water evaporates each day from the surface of the sea. This is the principal source of atmospheric moisture. Cool moisture laden air, gets collected around particles like dust, salt content from the sea, smoke etc., and forms clouds. Sometimes, mixing of warmer and cooler air also produces clouds. A visible mass of condensed water vapour floating in the air above the ground level is called a cloud. The three layers of atmosphere such as troposphere, stratosphere and mesosphere are specific locations of clouds. According to their height, clouds are classified into the following types 1. High clouds (6-20km Height), 2. Middle clouds (2.5km-6km Height), 3. Low clouds (ground surface to 25 km height. These major types of clouds are further divided into different types on the basis of shape and structure.

High clouds

- **Cirrus:** Detached clouds in the form of white delicate fibrous silky filaments formed at the high sky (8000 meters to 12000 meters) are called Cirrus clouds. These clouds are dry and do not give rainfall.
- **Cirro-cumulus:** White patched, sheet or layer like clouds composed of ice crystals.
- **Cirro-stratus:** Smooth milky transparent whitish clouds composed of tiny ice crystals.

Middle clouds

- **Alto-stratus:** Thin sheets of grey or blue coloured clouds in uniform appearance. consisting of frozen water droplets
- **Alto-cumulus:** Clouds fitted closely together in parallel bands, called as 'Sheep clouds' or wool pack clouds.
- **Nimbo stratus:** These are clouds of dark colour very close to the ground surface associated with rain, snow or sleet.

Low clouds

- **Strato-cumulus:** Grey or whitish layer of non-fibrous low clouds found in rounded patches at an height of 2500 to 3000 metres, associated with fair or clear weather
- **Stratus:** Dense, low lying fog-like clouds associated with rain or snow
- **Cumulus:-** Dome-shaped with a flat base often resembling a cauliflower, associated with fair weather
- **Cumulo-nimbus:-** Fluffy thick towering thunderstorm cloud capable of producing heavy rain, snow, hailstorm or tornadoes

Precipitation

Falling down of condensed water vapour in different forms is called Precipitation. When the dew point is reached in the cloud water droplets become saturated and start to fall. Hence, they fall on the earth as Precipitation. The climatic conditions/ factors influencing the forms of precipitation mainly are:

- Temperature.
- Altitude
- Cloud type.
- Atmospheric conditions.
- Precipitation process.

The main forms of precipitation include drizzle, rain, sleet, snow, hail etc.

- **Drizzle:** Falling of numerous uniform minute droplets of water with diameter of less than 0.5 mm from low clouds. Sometimes drizzles are combined with fog and hence reduce visibility.
- **Rain:** Rain is the most widespread and important form of precipitation in places having temperature above the freezing point. It occurs only when there is abundant moisture in the air. The diameter of a rain drop is more than 5mm.
- **Sleet:** Sleet refers to a precipitation, in the form of pellets made up of transparent and translucent ice. This precipitation is a mixture of snow and rain
- **Snow:** Snow is formed when condensation occurs below freezing point. It is the precipitation of opaque and semi opaque ice crystals. When these ice crystals collide and stick together, it becomes snowflakes.
- **Hails:** Hails are chunks of ice (greater than 2cm in diameter) falling from the sky, during a rainstorm or thunderstorm. Hailstones are a form of solid precipitation where small pieces of ice fall downwards. These are destructive and dreaded forms of solid precipitation because they destroy agricultural crops and human lives.

Rainfall

Rainfall is the most predominant type of Precipitation. Moisture laden air masses rise upwards, forms clouds and bring rainfall. Based on the mechanisms of raising the air, there are three types of rainfall.

- Convictional rainfall
 - Frontal or cyclonic rainfall
 - Orographic rainfall.
- **Convictional rainfall:** Earth surface is intensely heated through solar radiation during the day time. When the air near the earth surface is heated, it rises and expands. This heating results in the formation of convectional air currents. Thus the ascending moist air cools, condenses and results in convectional rainfall. Convictional rainfall occurs regularly in the equatorial region in the evenings. It is also experienced in tropical, sub-tropical and temperate regions in the summer months and on warmer days.

- **Cyclonic rainfall:** Cyclonic precipitation occurs during cyclones when air masses are made to converge and move upward so that adiabatic cooling occurs. Cyclonic rainfall occurs in tropical as well as temperate regions. When warm and cold air masses converge, condensation and precipitation takes place on the boundary between warm and cold air masses called as Frontal rainfall.
- **Orographic rainfall** Orographic rainfall, also called relief rainfall, is caused when air is forced to rise against a high mountain. The mountain barriers lying across the direction of air flow, force the moisture laden air rise along the mountain slope. This results in the cooling of the air, which leads to the formation of clouds and rain. This rainfall is called Orographic rainfall. The side of the mountain facing the wind is called the windward side and receives heavy rainfall. It is called the rain fed region. The other side of the mountain that does not face the wind is called the leeward side and receives less rainfall becomes rain shadow region.

Humidity:

Humidity is an important aspect of the atmosphere because it affects both weather and climate. The amount of water vapour present in the atmosphere is referred to as humidity. Humidity of the atmosphere is high when it has large quantities of water vapour. The amount of water vapour in the atmosphere is called absolute humidity. The ratio between the amount of water vapour in the atmosphere and the amount of water vapour it can hold is relative humidity Hot air can hold more water vapour than cold air. Relative humidity increases when air gets cold and decreases when air gets heated up.

NOTE

- ❖ In 1772 CE Daniel Rutherford discovered Nitrogen in atmosphere. In 1774 Joseph Priestly discovered oxygen in atmosphere
- ❖ Magnetosphere lies beyond the exosphere. It is the earth's magnetic belt, where proton and electrons, coming out from the sun are trapped by the earth. The magnetic field extends to around 64,000 km above the Earth.
- ❖ Auroras are cosmic glowing lights produced by a stream of electrons discharged from the Sun's surface due to magnetic storms that are seen as unique multi-coloured fireworks hanging in the polar sky during midnight
- ❖ During the day, the land masses get heated more rapidly than the oceans. Heated air ascends and this causes low pressure on the adjoining ocean. Therefore, the wind blows from ocean to land in the afternoon. This is called sea breeze. **Sea breeze** helps in reducing the temperature of the

coastal region especially during the summer season. During the night, the land cools more rapidly than the ocean. Cool air sinks and forms high pressure. The wind blows from land to sea during the night, this is called **land breeze**.

- ❖ The windward is the side of a mountain which faces the prevailing wind. It receives heavy rainfall. The leeward side of the mountain is the side sheltered from the wind. It receives very less rainfall.
- ❖ Heat is the energy which makes objects hot, while temperature measures the intensity of heat.
- ❖ The amount of heat received from the sun in the form of short waves is called Insolation or Incoming Solar Radiation.
- ❖ The outgoing heat from the earth to space in the form of long waves is called terrestrial radiation. This is also called as re-radiation
- ❖ Albedo is the fraction of solar energy reflected from the earth back into space without reaching or heating the earth surface.
- ❖ There is a balance between insolation and radiation. This balance is termed as a heat budget of the earth.
- ❖ Isotherms are imaginary lines drawn on maps, connecting points that have equal temperatures. Temperature varies from place to place, season to season and continent to continent. The average global surface temperature is about 13 °C.
- ❖ **Conduction** is the transfer of heat from hot body to a cold body through contact.
- ❖ **Convection** is transfer of heat by movement or circulation of air in a mass.
- ❖ **Advection** is the transfer of heat through the horizontal movement of air.
- ❖ An isobar is an imaginary line drawn through places having equal atmospheric pressure reduced to sea level.
- ❖ At the top of Mount Everest (elevation 8848m), the air pressure is only about one third the pressure at sea level. When we fly in aircraft or travel fast on road to hill stations, our ears pop as they adjust to a rapid change in pressure when ascending or descending.
- ❖ **ITCZ and Doldrums:** The Inter Tropical Convergence Zone (ITCZ) is the belt of converging winds and rising air encircling Earth near the Equator. Doldrums (the zone of calm) lies in the equatorial region with calms, light unpredictable winds and sudden cyclones
- ❖ **HORSE LATITUDE:** In olden days vessels with cargo of horses passing through sub-tropical high pressure belts found difficulty in sailing under calm conditions. With little water and food left for the humans, sailors used to throw the horses in to the sea in order to make the vessels lighter. Henceforth these belts or latitudes are also called 'horse latitudes'.
- ❖ The rotation of the Earth causes deflection of winds from their original

path, called the "Coriolis effect". Winds are deflected to the right in the northern hemisphere and to the left in the southern hemisphere which is known as "Ferrel's law". This was profounded by William Ferrel. He used "Coriolis force" named after G.G Coriolis (1792-1843) for proving Ferrel's Law

- ❖ **Super Cyclone:** A violent cyclone that hit Odisha, on Friday, 29 October 1999, was one of the most devastating and strongest storm to hit the Indian coast. Winds of up to 260 kph raged for over 36 hours. The winds caused a seven-metre tidal wave that swept more than 20 km inland and brought massive destruction and death to a number of coastal districts in the state of Odisha. It is estimated that more than 10 million people in 12 coastal belt districts were affected by the cyclone. More than 10,000 people lost their lives.
- ❖ A front is the boundary separating warm and cold air masses. One type of airmass is usually denser than the other, with different temperatures and humidity. This meeting of airmass causes rain, snow, cold days, hot days, and windy days.
- ❖ Deliberations for naming cyclones in the Indian ocean region began in 2000 and a formula was agreed upon in 2004. Eight countries in the region Bangladesh, India, Maldives, Myanmar, Oman, Pakistan, Srilanka, and Thailand contributed a set of names which are assigned sequentially whenever a cyclonic storm develops.
- ❖ During sunset cirrus clouds look colourful hence they are called as "Mare's Tails".
- ❖ The only sphere which contains all clouds in the atmosphere is troposphere
- ❖ Any thunderstorm which is associated with fall of hail stones is known as hailstorm. Hailstorm is one of the most feared weather phenomenon because it has the potential to destroy plant, trees, crops, animals and human life.
- ❖ Mawsynram is the wettest place of India as it is located in the windward side of the Purvachal hills, whereas Shillong lies on the leeward side and thus receives less rainfall. This is the same, in the case of Mumbai and Pune.
- ❖ Absolute humidity is expressed in terms of grams of water vapour present per cubic metre of air. Relative humidity is expressed in percentage.
- ❖ When the relative humidity of the air is 100%, the air is said to be saturated. Saturated air will not absorb any more water vapour. The temperature at which air gets saturated is called dew point. Humidity of the atmosphere is measured by the wet and dry bulb thermometer also called the Hygrometer

4. Hydrosphere

One of the most indispensable natural resources on earth is water. The Earth is also called the Blue planet, as it holds water in abundance and thus stands unique among all other planets. Hydrosphere consists of water in various forms found on the earth. Over 97% of the water on the Earth's surface is confined to oceans. Less than 3% of water is held on land as glaciers, ice caps, groundwater, rivers, lakes, and also as the water vapour in air.

Hydrological Cycle

The Earth's water is not static. It is always in motion. This continuous movement of water on, above and below the earth's surface is called the Hydrological Cycle. The three major processes involved in the water cycle are evaporation, condensation and precipitation. Water changes its form constantly i.e. Ice, water and water vapour. This process happens in the blink of an eye or even over millions of years. Water resources of the Earth can be broadly divided into fresh water and salt water.

Fresh Water

Rain water is considered to be the purest form of water, as it contains very less proportion of salts when compared to the oceans and seas. Hence it is called fresh water. A major part of fresh water is found in the frozen state in the form of ice caps and glaciers. Around 1% of it is found in the liquid state as rivers, streams, lakes, ponds etc. Surface water may also penetrate through porous rocks and gets collected beneath the Earth's surface. This is called groundwater.

Oceans

The ocean is a continuous body of salt water that forms the major part of hydrosphere. Geoscientists believe that the oceans were formed on Earth nearly three billion years ago. It is difficult to believe that in the beginning there was no water on our planet. In due course of time, when the Earth started cooling, steam escaped from the interior and entered the atmosphere to form clouds. At first, the clouds brought incessant rains. The rain water filled the depressions for tens of thousands of years and eventually a super ocean was formed.

The continents and oceans are however, not evenly distributed in the northern and the southern hemispheres. The northern hemisphere holds 61% of land whereas the southern hemisphere holds 81% of water. It is because of this pattern of land and water distribution, the northern hemisphere is called as the land hemisphere and the southern hemisphere is called as the water hemisphere. Oceans and seas are considered as resource bowl of the earth because of the immense availability of food, minerals etc., Present distribution of the world's oceans and major seas are illustrated in the map.

Relief of the Ocean Floor

The ocean floor is not flat as it was believed to be in the earlier days. It comprises of many complex and varied relief as observed on the earth's surface. The ocean floor also has high mountains, deep trenches and large flat plains. These features are formed due to the tectonic, volcanic and depositional activities.

Comparative study of major oceans of the world

Ocean	Location	Average Depth (m)	Deepest Point (Below mean sea level)	Important Seas	Important Islands
Pacific Ocean	Bounded by North and South America on the east, Asia and Australia on the west and Antarctica on the South.	4,028	Challenger Deep in Mariana Trench (10,924 m)	Bering Sea, Sea of Japan , Okhotsk sea, yellow Sea, South china Sea, Coral sea	Hawali, Vancouver, Shakalin, Fiji
Atlantic Ocean	Extends from Greenland in the North to Antarctica in the South and located between North and South America in the west and Europe and Africa in the East.	3,926	Puerto Rico Trench (8,605 m)	Baltic sea, Black sea, Caribbean sea, North sea, Mediterranean sea, Norwegian sea	Canary island , New Found land, Azores, Greenland, Iceland,
Indian Ocean	Bounded by Asia in the north, Africa in the west, Australia in the east and Antarctica in the south.	3,963	Java Trench in Sunda Deep (7,258 m)	Red sea, Persian Gulf, Arabian sea, Andaman sea, bay of Bengal	Andaman and Nicobar, Islands, Lakshadweep Island, Sri Lanka, Pamban

					Islands
Southern Ocean	Found to the south of 60° South latitude and encircle Antarctica.	4,000 to 5,000	South Sandwich Trench (7,235 m)	Weddell sea, Amundsen sea, Davis sea, Ross sea	Trinity Islands, Barry Islands, Wednesday Islands, Saddle Islands, Tasmania
Arctic Ocean	Surrounded by Europe, Asia, North America, Greenland, and by several islands.	1,205	Fram Basin (4,665 m)	Beaufort sea, Hudson Bay, White sea,	Amsterdam Island, Monumental Islands, Hyde Parker Islands, Shoe Islands

The ocean basins are characterised by the following major relief features:

- | | |
|----------------------|------------------------------------|
| A. Continental shelf | D. Deep sea plain or Abyssal plain |
| B. Continental slope | E. Oceanic deep |
| C. Continental rise | F. Oceanic ridge |

A. Continental Shelf: A shallow and gently sloping platform extending out from the adjoining continental land mass into the sea is called Continental Shelf. It is almost a uniform zone of sea bed with a gentle gradient. The continental shelf is of great significance for the following reasons:

- ✓ They are shallower, thus enables sunlight to penetrate through the water. This encourages abundant growth of grass, sea weeds and plankton. Hence these zones become the richest fishing grounds in the world. Eg. The Grand Banks of Newfoundland.
- ✓ The continental shelves have extensive deposits of minerals and mineral fuels. Hence, this zone becomes accessible for oil drilling and mining activities. E.g. Mumbai High in Arabian Sea.

B. Continental Slope: A steep slope which descends from the edge of the continental shelf to the deep ocean-bed is called continental slope. It forms a boundary between the Continental Crust and the oceanic crust. This zone is free from deposits as they are steep. The most important characteristic of continental slope is the presence of deep canyons and trenches. Due to the low penetration of sunlight, the slope has nearly freezing temperature. Hence aquatic life has very slow rate of metabolism.

- C. Continental Rise:** At the base of the continental slope is a gently sloping layer of sediments which merge into the deep-sea floor. This underwater feature found between continental slope and abyssal plains is called the continental rise. It consists of submarine fans which are similar to the alluvial fans found on land.
- D. Deep Sea Plains or Abyssal Plains:** The deep sea plains or abyssal plains are underwater plains found on the deep ocean floor. These plains extend from continental rise to the mid oceanic ridges. The gradient of the slope is very gentle and it appears as a uniform flat and featureless plain. These plains are usually covered by the thick layer of sediments composed of clay, silt and sand, brought by the rivers. These are often characterized by features like abyssal hills, sea mounts, guyots, coral, atoll etc.
- E. Oceanic Deeps:** Trenches are the deepest part of the oceans and occupy about 7% of the total relief of the ocean floor. The ocean temperature in the trench is slightly cooler than the freezing temperature. As they are sediment free, most trenches are V-shaped with steep sides. Epicentre of the great earthquakes are all found in the trenches.
- F. Oceanic Ridge:** Oceanic ridge is a continuous submarine mountain chain. They are made of young basaltic rock formed when two tectonic plates moves apart. The mid-ocean ridge is probably the most extensive single feature of the earth's topography. Two of the most well known mid- ocean ridges are the Mid-Atlantic Ridge and the East Pacific Ridge. The Mid-Atlantic Ridge is the largest unbroken oceanic ridge.

Ocean Temperature and Salinity

Like land masses, ocean waters also vary in temperature from place to place, both at the surface and at its depths. As the warming and cooling of water is slower than the land, the annual range of temperature in any part of the ocean is very much lower. The mean annual temperature of the ocean water in equatorial regions is about 21° C and almost drops down to freezing point at the polar region.

The degree of concentration of salts in the sea water is called salinity. It is usually expressed in terms of parts per thousand (ppt or ‰). Salinity varies both horizontally and vertically. The influence of temperature on ocean salinity depends upon the heating up of the surface water, which varies from tropics to polar regions. When the sun heats up the surface layer of water in the tropics, the salt content is left out in the oceans after evaporation. Thus salinity is maximum at the tropics and lower at the equator and the poles.

Movement of the Ocean Water

The ocean water is dynamic. Temperature, salinity, density, external forces of the sun, moon and the winds keep the ocean waters in movement, both horizontally and vertically. Waves and currents are in horizontal motion while tides have vertical motion.

Waves:

Of all the movements of the oceans, sea waves are considered to be the strongest. Sea waves are ripples on water caused when winds blow over the sea. The height of these waves depends on the speed of wind, its duration and the direction from which they blow. Sometimes waves are also caused by tremors felt on the ocean floor. Such waves are quite destructive and called Tsunami.

Tides

- ✓ The periodic rise and fall of sea water due to the gravitational pull of the sun and moon on earth are called tides. They are classified broadly into Spring tides and Neap tides.
- ✓ When the Sun, Moon and Earth are aligned in the same line, the collective gravitation pull of the sun and moon on earth's water strengthens to form a high tide known as spring tide. Such tides always occur on full moon and new moon days.
- ✓ When the sun and the moon are at right angles, their gravitational forces work against each other, causing a low tide called neap tide. A neap tide occurs between two spring tides i.e., twice a month, when the first and last quarter moon appears.

Oceans Currents

The movement of oceanic water on the surface and at the depths in a definite direction is called ocean current. Ocean currents are in clockwise motion in the northern hemisphere and in the anti-clockwise motion in the southern hemisphere. The factors that generate ocean currents are: 1. Earth's rotation, 2. Prevailing winds and, 3. Differences in temperature and salinity of ocean water. On the basis of temperature, ocean currents are classified as warm currents and cold currents. The movement of ocean currents from the low latitudes (tropical zones) towards high latitudes (temperate and polar zones) is called warm current. Eg. Gulf Stream in Atlantic Ocean, North Equatorial Current in Pacific Ocean.

CASE STUDY Tides and Border Security Force (BSF).

The strategic role played by the Border Security Force (BSF) to guard the creek of Rann of Kutch is an enormous one. Firstly, most of the creek area gets submerged due to high tide and at times of low tide, the creek emerges out along with poisonous creatures like snakes, scorpions, etc. Even the landscape view differs in the morning and in the evening due to tidal effects twice a day. Secondly, the turbulence here in the creek area is more violent than the open sea. Thirdly, the salt marshy terrain and the humid weather conditions affect the health of the soldiers. Strong winds, scorching heat waves, high salinity of the coastal waters and mirages also affect the eyes of the soldiers. Natural factors like currents, tides, shifting sand bars and lack of permanent landmarks on the boundary, lead to great difficulty in safeguarding this sensitive area under military domain.

Distribution of Major Ocean Currents and Effects

Ocean	Name of the Current	Effects
South Atlantic Ocean	Benguela Current (Cold)	Leads to foggy conditions along the coast of Namibia. Helped in the development of Namibian & Kalahari deserts
	Canaries (Cold)	Influences the extension of Sahara Desert
North Atlantic Ocean	Gulf Stream (Warm)	Its confluence with the Labrador current produces heavy fog along the coast of Newfoundland, obstacles the navigation. Hence, Newfoundland is one of the major fishing grounds of the world.
	North Atlantic Drift (warm)	It keeps the ports at higher latitudes ice-free throughout the year. Eg. Port of Rorvik (Norway), Murmansk and Severodvinsk (Russia)
	Labrador (Cold)	Its confluence with Gulf Stream creates fog and hinders navigation.
South Pacific Ocean	Peruvian / Humboldt Current (Cold)	Helped in the desertification of the Atacama desert. EL-Nino effects the weather in western & S. America. It also affects timely arrival of Indian monsoon

North Pacific Ocean	Kuroshio Current (Warm)	It plays a vital role in carrying large amount of heat to the adjacent land areas and forms cloud cover that a use rainfall.
	Oyashio /Kurile Current (Cold)	Its confluence with the Kuroshio current produces heavy fogs around Hokkaido, which become potential hazards for navigation. Hence, Hokkaido acts as the major fishing ground of the world.
	Alaska Current (Warm)	Keeps the seaports of Alaska open throughout the year.
	California Current (Cold)	Leads to foggy Conditions along the coast of California. It helped in the development of Arizona & Sonata deserts.
India Ocean	West Australian Current (Cold)	Leads to foggy conditions along the western coast of Australia. It helped in the genesis of west Australian desert.

Marine Resources

The biotic and abiotic resources found in the oceanic water and at the bottoms are called marine resources. The ocean's resources play a vital role in sustaining the needs of society. A diverse array of marine organisms is used for food, medicine, cosmetics, and a wealth of industrial applications. The world's demand for energy, minerals and water have become increasingly dependent on non-living marine resources.

Marine Resources	Biological Resources: Eg. Fishes, Plankton, sea grass, Coral etc.
	Mineral Resources: Petroleum, Natural gas, Metallic minerals, Sand, Gravel etc.
	Energy resources: Eg. Energy fuels, Tidal energy, wave Energy etc.

Conservation of Marine Resources

Oceans are the life blood of planet earth and mankind. The humankind depends on the marine resources for its survival. They are also essential for the economic prosperity, social well-being and quality of life. Oceans have extensive deposits of oil reserves. Besides a major fishing ground, it helps in generating non-conventional energy, development of many ports and harbours for trade activities. Coastal tourism also attracts people around the world, thereby contributing to the economy of many countries.

The marine environment is faced with a number of increasingly severe threats. These include loss of biodiversity, loss of habitats, contamination through dangerous substances, and the impacts of climate change. Yet the marine resources are not deteriorating, it is necessary to find better ways of managing it.

NOTE

- ❖ Finland is known as the land of thousand lakes. There are 1,87,888 lakes in Finland.
- ❖ Water table is a level below the ground, where water is found collected beneath the Earth's surface. Aquifers are porous rock strata filled with water, found below the earth's surface.
- ❖ Sylvia Earle is a famous American oceanographer . She was named as the first, 'Hero for the Planet' by Time magazine for her efforts towards marine life protections.
- ❖ Jacques-Yves Cousteau (1910-1997) was a famous French Ocean explorer, who conducted extensive under-sea investigations.
- ❖ He belonged to the information service of the French Navy, and was sent on missions to Shanghai and Japan (1935- 1938) and in the USSR (1939).
- ❖ Honours: Cross of War 1939-1945 (1945), U.S. Presidential Medal of Freedom (1985)
- ❖ A Hypsometric Curve is a graphic representation which shows the height of a certain place found on land and the height of ocean features at sea. 'Hypso' means height in Greek.
- ❖ ONGC: Oil and Natural Gas Corporation is India's largest oil and gas exploration and production company. Its latest estimate is that about 20 million tons of oil reserves are found west of Mumbai High off shore.
- ❖ Abyssal plains in the Atlantic and Indian Oceans tend to be extensive than the Pacific Ocean because, majority of the world's largest rivers empty their sediments into either Atlantic or Indian Ocean. E.g. Amazon, Ganga and

Brahmaputra rivers.

- ❖ Dragon Hole is the deepest known underwater sink hole in the world. The local fishermen call it the 'eye' of the South China Sea.
- ❖ **Fathoms:** A nautical measurement of the depth of water in the ocean.
- ❖ **Isobath:** An imaginary line on a map joining the points of equal depths.
- ❖ **Isohaline:** An imaginary line on a map joining the points of equal salinity in oceans.
- ❖ The Bermuda Triangle, also called the Devil's Triangle, is a loosely defined region in the Western part of the North Atlantic Ocean, where a number of aircraft and ships are said to have disappeared. Collect recent news about this triangle and have a discussion about the same in your class room.
- ❖ The sea / ocean water does not contain calcium in great quantities. Many of the aquatic animals with shells use the dissolved calcium in the sea water to build their protective shells.
- ❖ The energy of the falling wave water is used to turn hydro turbines to generate power. Wave energy power plants have been installed at Vizhinjam in Kerala coast and Andaman and Nicobar islands of India.
- ❖ Potential tidal energy zones of India are the Gulf of Khambhat, Gulf of Kutch and Sundarbans.
- ❖ Maritime boundary of most the Countries is fixed to be 12 nautical miles from the baseline. This was fixed by the U.N. Convention on the Law of the sea 2013 where -as Jordan and Palau have 3 nautical miles as their maritime boundary and Benin, Republic of Congo, El Salvador, Peru and Somalia have 200 nautical miles.
- ❖ NIO (National Institute of Oceanography) was established in 1st January 1966. The headquarters of NIO is located at Dona Paula, Goa. It Conducts research and observations to understand oceanic features, Ocean engineering, marine Archaeology etc.
- ❖ The Gangetic Dolphin was declared the National Aquatic Animal in 2010. This has become an endangered species. Are the Dolphins really at risk? If so, list out the reasons.
- ❖ **The Great Barrier Reef:** The Great Barrier reef is the world's largest coral reef system composed of 2,900 individual reefs and 900 islands stretching for about 2,000 kilometres. It covers an area of about 3,50,000 km. The reef is located in the Coral sea, off the coast of Queensland, Australia. The Great Barrier Reef can be seen from the outer space. This sprawling coral reef system is one of the most biologically diverse places on the planet. Coral reefs are built by billions of tiny organisms, known as Coral polyps. CNN labelled it as one of the seven natural wonders of the world.

5. BIOSPHERE

Biosphere, the fourth sphere of the Earth, is a life supporting layer that exists on the earth's surface. This layer on earth encompasses the Lithosphere, Hydrosphere and Atmosphere. It includes flora and fauna that thrive on or near the earth's surface. The vertical range of the biosphere is approximately 20 km, which is measured from the ocean floor to the troposphere. However, most plants and animals live in a very narrow section for about 1 km above and below the Mean Sea Level (MSL). Biosphere is made up of different ecosystems and biomes. All living things, large or small, are grouped into species. The area in which an animal, plant or micro organism lives is called its habitat. A wide variety of plants and animals live in a particular habitat known as *biodiversity*.

Ecosystem

An ecosystem is a community, where all living organisms live and interact with one another and also with their non-living environment such as land, soil, air, water etc. Ecosystems range in size from the smallest units (Eg: bark of a tree) that can sustain life to the global ecosystem or ecosphere. (Eg: Cropland, Pond ecosystem, Forest ecosystem, Desert ecosystem etc.). Biosphere harbours all ecosystems on the earth and sustains life forms including mankind.

Components of ecosystem

An ecosystem consists of three basic components, namely

- a. Abiotic components
 - b. Biotic components and
 - c. Energy component
- a. **Abiotic Components:** Abiotic components include the non-living, inorganic, physical and chemical factors in the environment. Eg. Land, Air, Water, Calcium, Iron etc.
- b. **Biotic Components:** Biotic components include plants, animals and micro-organisms. Biotic components can be classified into three categories:
- **Producers** are self-nourishing components of the ecosystem. Hence they are called Autotrophs. They are found both on land and water. Eg. Plants, Algae, Bacteria etc.

- **Consumers** are those that depend on producers, directly or indirectly. Hence they are called Heterotrophs. The common category of consumers are:
 - ✓ **Primary consumers** depend on producers for their food. They are exclusively herbivores. Eg. zebra, goat etc.
 - ✓ **Secondary consumers** are small carnivores i.e., they consume herbivores. Eg. lion, snake etc.
 - ✓ **Tertiary consumers** are top carnivores that prey on both herbivores and carnivores. Eg. owl, crocodile etc.
- **Decomposers** are some organisms that are incapable of preparing its own food. They live on dead and decaying plants and animals. Hence they are called Saprotrophs. Eg. fungus, mushrooms etc.

c. **Energy Components:** All organisms in the biosphere use energy to work and convert one form of energy into another. The Sun is the ultimate source of energy for the biosphere as a whole. The solar energy gets transformed into other forms of energy through the various components in the ecosystem. The producers, consumers and the decomposers contribute a lot to the energy flow in an ecosystem.

Functions of an ecosystem

The living organisms form an interacting set of flora and fauna which are organized into trophic levels, food chains and food webs. The functioning of an ecosystem depends on the pattern of the energy flow, as it helps in the distribution and circulation of the organic and inorganic matter within an ecosystem. Energy flow generally takes place in a hierarchical order in an ecosystem through various levels. These levels are called trophic levels. The chain of transformation of energy from one group of organisms to another, through various trophic levels is called a food chain. A system of interlocking and interdependent food chains is called a food web.

Biodiversity

Biodiversity or biological diversity refers to a wide variety of living organisms (plants, animals and other micro-organisms) which live in a habitat. It is highly influenced by topography, climate as well as human activities. It represents the strength of the biological resources of a place on earth. In biodiversity, each species, no matter how big or small, has an important role to play in the ecosystem. It maintains the ecological balance and facilitates social benefits such as tourism, education, research etc. over an area.

Loss of biodiversity

The extinction of species (flora and fauna) due to human and natural influences is called loss of biodiversity. The biodiversity loss has a great impact on mankind and also affects land, water, air etc. Habitat destruction due to deforestation, population explosion, pollution and global warming are the major cause for loss of biodiversity. Sometimes, habitat loss is so severe or happens so quickly that it results in a species being eliminated from the planet. Scientists are still trying to decide what caused the mass extinction of dinosaurs. A healthy eco system provides clean water, pure water, enriched soil, food, raw materials, medicines etc. Hence stable biosphere has to be conserved.

Biomes

A biome is a geographically extensive ecosystem where all flora and fauna are found collectively. It is the total assemblage of plant and animal life interacting within the biosphere. Biomes are defined by abiotic factors like, relief, climate, soils and vegetation. They are classified into two broad categories, terrestrial biomes and aquatic biomes.

Terrestrial Biomes

Terrestrial biomes is a group of living organisms that live and interact with one another on land. They are mainly determined by temperature and rainfall. Some of the major terrestrial biomes of the world are A. Tropical Forest Biomes, B. Tropical Savanna Biomes, C. Desert Biomes, D. Temperate Grassland Biomes, E. Tundra Biomes

A. Tropical Forest Biomes

The tropical forest biome is comprised of several sub-biomes, including evergreen rainforest, seasonal deciduous forest etc. This biome extends between 10° N and 10° S of the Equator. Central and South America possess half of the world's tropical forests. The climate in these biomes shows little seasonal variation with high annual rainfall and relatively constant, high temperature. This unique weather condition favours thick vegetative cover. Tropical forests have the highest biodiversity and primary productivity of any of the terrestrial biomes.

The Amazon basin, Congo basin and Indonesian islands are the major regions of this biome. These regions have very dense forests and so have great economic importance. Human settlements are found scattered here. They sustain their livelihood through food gathering, fishing, lumbering and

shifting cultivation. Due to the humid nature of this biome, the people get afflicted to tropical diseases like malaria, yellow fever etc. The chief trees found here are rubber, bamboo, ebony, etc. Bats, pheasants, jaguars, elephants, monkeys etc. are the important birds and animals found here.

B. Tropical Savanna (Grasslands) Biomes

Tropical grasslands are generally found between tropical forests and deserts. Tropical Savanna biomes are found between 10° to 20° N and S latitudes. These grasslands are generally flat and are found in the Sahel, south of Sahara in East Africa and in Australia. This biome is generally hot and dry and experiences moderate to low rainfall. So, the grass which grow here are tall and sharp. Hence the chief occupation of the people found here is herding. The primitive people living here are nomadic. The common animals found here are the lion, leopard, tiger, deer, zebra, giraffe etc. Flora such as Rhodes grass, red oats grass, lemon grass etc. are found in this biome.

C. Desert Biomes

Deserts are usually found on the western margins of the continents between 20° and 30° N and S latitudes. The annual rainfall is less than 25 cm in these regions. Due to the lack of rainfall and arid conditions, these regions do not possess any vegetation but have special vegetation type called Xerophytes. As the soil is sandy and saline, deserts remain agriculturally unproductive. Drought resistant thorny scrubs and bushes, palms are found here.

Tribal people who live here practice food gathering and hunting. They move their temporary settlements frequently in search of pastures. Transportation becomes very difficult here and is carried on by camels. Reptiles like snakes, lizards, scorpions etc., are most commonly found here.

D. Temperate Grassland Biomes

Temperate Grasslands are usually found in the interior of the continents and are characterized by large seasonal temperature variations, with warm summer and cold winter. The type of grassland in these regions strongly depends upon precipitation. Higher precipitation leads to tall and soft grass and lower precipitation leads to short and soft grass. These regions favour wheat cultivation. Extensive mechanised agriculture is practised due to lack of farm labour. Pastoral industry becomes the main occupation, thereby facilitating slaughtering of animals, packing of raw and processed meat, dairy products etc. The common birds and animals are grass hopper, wolf, bison, prairie dog etc.

E. Tundra Biomes

These vast lowlands are found where the ground remains frozen. Greenland, Arctic and Antarctic regions and Northern parts of Asia, Canada and Europe fall in this biome. These regions are also called Barren lands. This biome experiences long severe winter and short cool summer. Due to the prevailing of low temperature and short growing seasons, the net primary productivity is very low in tundra. People are nomadic. Hunting and fishing are their major occupations. The population here is extremely sparse and the harsh environment makes them change their settlement frequently. They live in igloos in winter and in tents during summer. Arctic moss, Arctic willow, lichens etc. grow here. Fauna like the polar bear, wolverine, reindeer, snowy owl are found here.

Aquatic Biomes

Aquatic biome is a group of living organisms that live and interact with one another and its aquatic environment for nutrients and shelter. Like terrestrial biomes, aquatic biomes are influenced by a series of abiotic factors. It is broadly classified as fresh water biomes and marine biomes.

A. Fresh water Biomes: It comprises lakes, ponds, rivers, streams, wetlands etc. It is influenced by various abiotic components such as the volume of water, water flow, composition of oxygen, temperature, etc. Humans rely on freshwater biomes for drinking water, crop irrigation, sanitation and industry. Water lily, lotus, duck weeds etc. are the common plants found here. Trout, salmon, turtles, crocodiles etc. are the animals found here.

B. Marine Biomes: They are the largest aquatic biomes on earth. They are continuous bodies of salt water and provide a wide range of habitats for marine plants and animals. Coral reefs are a second kind of marine biomes within the ocean. Estuaries, coastal areas where salt water and fresh water mix, form a third unique marine biome. As water provides maximum mobility to marine organisms, nutrients are circulated more quickly and efficiently here than the terrestrial biomes.

Apart from animals, plants such as kelp, algae, phytoplankton etc. also grow in water. Aquatic biomes are not only important for plants and animals, but also for humans. Humans use aquatic biomes for water, food and leisure activities. Some of the threats and issues to aquatic biomes are overfishing, pollution and rise in sea level.

Difference between Aquatic and Terrestrial ecosystem

Aquatic Ecosystem	Terrestrial Ecosystem
Aquatic ecosystem exists on water covering 71% of the earth surface.	Terrestrial ecosystem exists on land covering 29% of the earth surface.
Aquatic animals use 20% of energy to obtain oxygen.	Terrestrial animals use only 1-2% of energy to obtain oxygen.
In this ecosystem there is abundant of water with limited oxygen supply.	In this ecosystem there is less availability of water, greater availability of gases and temperature fluctuation.
The small drifting photo synthetic organisms of the ocean called photo phytoplankton are regarded as the major primary producer.	The primary producer is the plants that produce food through photosynthetic process.
Aquatic environment is more stable with smaller fluctuation in temperature and other variable.	Terrestrial environment is quite unstable as the land surface is affected by great risks from external impacts.

Conservation

The biosphere extends from the deep ocean trenches to lush rain forests. People play an important role in maintaining the flow of energy in the biosphere. At the same time, the primary cause of today's loss of biodiversity is habitat alteration caused by human activities. The ever increasing population results in over exploitation of biological resources. This has an adverse impact on flora and fauna on earth. There are places on earth that are both biologically rich and deeply threatened. Hence it is man's duty to conserve and care for the earth and make it a better place to live in.

Case Study-Biosphere II

Scientists have created an artificial Biosphere called Biosphere-2, to understand the Earth which is referred as Biosphere-1.

Facts and Numbers

- ✓ Biosphere-2 covers 3.15 acres and is located in Arizona, America.
- ✓ It is 91 feet at its highest point.
- ✓ It is sealed off from earth below by 500 ton welded stainless steel liner.
- ✓ A host of instruments constantly monitors the air, soil and water.
- ✓ The 25 foot ocean contains a million gallons of salt water.
- ✓ Biosphere-2 contains five biomes - a rain forest, desert, savanna, marsh

and ocean.

- ✓ It has more than three thousand species of living organisms.
- ✓ The habitat is opened for public tours. (To visit biosphere-2 log on to www.biosphere2.org)

Gulf of Mannar - Marine Treasure

- ✓ **Location:** Lies between the southeastern tip of India and the west coast of Sri Lanka, in the Coromandel Coast region.
- ✓ **Marine National Park:** The gulf of Mannar Marine National Park is a protected area consisting of 21 Small Island and adjacent coral reefs in the Gulf of Mannar in the Indian Ocean.
- ✓ **History:** Gulf of Mannar was declared as National park in 1986. Later declared as a biosphere reserve in 1989.
- ✓ **Flora:** They consist of species belonging to the mangrove, *Rhizophora*, *Avicennia*, *Bruguiera*, *Ceriops* and *Lumnitzera* genus.
- ✓ **Fauna:** Indo - Pacific bottlenose dolphin, Common dolphin, Melon-headed whale, and critically endangered whale species.

NOTE

- ❖ The branch of science that deals about ecosystem is called *Ecology*.
- ❖ A person who studies ecology is referred to as an *Ecologist*.
- ❖ An ecological region that has lost more than 70% of its original habitat is considered a hotspot. Hotspots in India are the Himalayas, Western Ghats, Indo Burma Region and Sundaland.
- ❖ Of late, parts of the Savanna grasslands are being converted into farmlands, which pose a great threat to the wide range of fauna. For Eg. The population of the big cats like cheetah, lion etc. are dwindling drastically.
- ❖ The U.S. National Cancer Institute has identified about 70% of the plants used for treating cancer. Which are found only in rain forests. Eg. Lapacho.
- ❖ An oasis is a fertile fresh water source found in deserts and semi-arid regions. Oases are fed by springs. Crops like date palms, figs, citrus fruits, maize etc. are cultivated near these oases.
- ❖ Temperate grasslands are called differently in different parts of the world.
 - Prairies - North America
 - Steppes - Eurasia
 - Pampas - Argentina and Uruguay
 - Veld - South Africa
 - Downs - Australia and New Zealand
- ❖ A Biosphere Reserve is a special ecosystem or specialized environment with flora and fauna that require protection and nurturing. There are 18 Biosphere Reserves in India.

6. Man and Environment

Early man depended entirely on nature for food, clothing and shelter. Man has enjoyed a dominant position over the other living organisms around him because of his erect posture, hands and intelligence. From the paleolithic period to the neolithic period, man has invented and developed the wheel, fire, tools and patterns of agriculture and housing to his comfort, which led him to improve the standard of living making himself technologically advanced. Thus, modern man modified the environment where he multiplied in numbers to increase population and has always extended his territories, leading to the exploitation of natural resources.

Classification of Environment: Environment is generally classified as

- a. Natural environment
- b. Human environment and
- c. Man made environment

- a. **Natural environment:** Earlier, we have learnt about the natural components of environment such as lithosphere, atmosphere, hydrosphere and biosphere. In this chapter, we will study about the human and man-made components in a detailed manner.
- b. **Human Environment:** Human environment is defined as the interaction between man as an individual, with his family, occupation and society. It is also related to various cultural aspects such as education, religion, economics and politics.
- c. **Man-made environment:** Man-made environment has been created by man himself for the purpose of fulfilling his needs and to make his life more convenient and easy. For example, building, transport, park, industrie, monument, etc. To bring an equilibrium between man and the environment, man has to study the distribution of population, availability of resources, development in technology, alternate means of fulfilling the increasing demand created by the growing population and other man-made features.

Population

Can you imagine a world without human beings? Humanbeings are important to develop the economy and society. The Latin word 'populus' means 'people'. Population is the total number of people living together in a particular place at the given point of time.

Population Growth

‘It is easy to add but difficult to maintain’

Population is a dynamic phenomenon where the number, distribution and composition are constantly changing. Human population increases as babies are born and decreases as people die. For most of human history, births have only slightly exceeded deaths every year. As a result, human population grow slowly. About the time of Industrial Revolution, it began to increase rapidly.

Natural increase of population is the difference between the birth rate and death rate. In fact population is always increasing but only in very rare cases it may decrease through natural or man-made disasters such as famine, landslides, earthquakes, tsunami, epidemics, extreme weather conditions and war.

Population change refers to an increase or decrease in the population of an area influenced by the number of births, deaths and migration. The population of the world doubled from 500 million in 1650 to 1000 million in 1850. The projected population for 2025 and 2050 is about 8 billion and 9 billion respectively.

Population growth refers to an increase in the number of people who reside in a particular area during a particular period. Population increases when there are more births and immigration. It decreases when there are more deaths and emigration. Population growth, can be calculated as $\text{Population growth} = (\text{Birth rate} + \text{Immigration}) - (\text{Death rate} + \text{Emigration})$.

The important features associated with the population studies in Tamil Nadu are as follows:

S. No	Term	Definition	Data for Tamil Nadu
1.	Birth Rate	Indicates the number of live births per 1000 people in a year	15.4% (2014)
2.	Population Growth	The average annual growth of population	15.6% (2011)
3.	Population Density	The average number of people per square kilometer	555/ Km ² (2011)

4.	Total Fertility Rate	The average number of children born per woman during her child bearing years (usually ages 15 to 44)	1.6 Birth Per Woman (2016)
5.	Infant Mortality	The number of deaths under one year of age for every 1000 live births in a year	17 per 1000 live births (2016)
6.	Life Expectancy at Birth	The average number of years an individual is expected to live	70.6 years (2010-14)
7.	Literacy Rate	The percentage of people in a given population who can read and write a language	80.09% (2011)
8.	Sex Ratio	The number of females for 1000 males in a given population	996:1000 (2011)

Distribution of Population

Population distribution refers to the way in which people are spread out across the earth's surface. The world population is not uniformly distributed, owing to the following factors.

- A. Physical Factors:** Physical factors include temperature, rainfall, soil, relief, water, and natural vegetation, distribution of minerals and availability of energy resources.
- B. Historical Factors:** Regions with historical importance (river valley civilizations), war and constant invasions fall under historical factors responsible for population distribution.

Density of population

Density of population refers to the number of people living per square kilometer. An area is said to be sparsely populated when it has a large area with less number of people. Similarly, smaller the area with a large number of people, it is said to be densely populated.

$$\text{Population Density} = \frac{\text{Total Population}}{\text{Total land area}}$$

The world's population density is divided into three main groups.

- Areas of high density (above 50 people per sq.km) - East Asia, South Asia, North West Europe & Eastern North America.

- Areas of moderate density (10 to 50 people per sq.km) - The sub tropical regions like Angola, Congo, Nigeria and Zambia in Africa.
- Areas of low density (less than 10 people per sq.km) - Central Africa, Western Australia, Northern Russia, Canada, etc...

Migration

Migration is defined as the permanent or semi-permanent change of home of an individual or a group of people over a significant distance from their place of origin. The causes of migration may be physical (climate, drought, flood, earthquake, volcanic eruption, epidemics etc.), social inequalities, economic opportunities, technology, education, cultural clashes, war or political issues. There are two types of migration:

1. **Internal Migration:** The movement of people within a country i.e. between states, districts, villages, etc is called as Internal migration.
2. **International Migration:** The movement of people from one country to another, across international borders is called as International migration.

Push and pull factors of migration

Push factors are those factors which force people to move to new areas to live, while pull factors are those factors that attract migrants to a new location. Given below are some of the push and pull factors of migration.

Push Factors of migration	Pull factors of migration
• Insufficient jobs and few opportunities	• Better job opportunities
• Primitive conditions	• Better living conditions
• Desertification	• Fertile land
• Slavery or forced labour	• Socio economic independence
• Poor medical care	• Better health care
• Death threats	• Security
• Pollution	• Clean environment
• Poor infrastructural facilities	• Better infrastructural facilities
• Bullying	• Education
• Natural Disasters	• Living Stability
• War	• Industry
• Lack of political or religious freedom	• Political and religious freedom

Human settlements

A settlement can be described as any temporary or permanent unit area where people live, work and lead an organized life. It may be a city, town, village or other agglomeration of buildings. During the early days, man preferred tree branches, caves, pits or even rock cuts as his shelter. As days passed by, man slowly learnt the art of domesticating animals and cultivating food crops. The evolution of farming took place along four major river basins i.e. the Nile, Indus, Hwang Ho, Euphrates - Tigris. Man built huts and mud houses. Slowly settlements came into existence. A settlement generally consisted of a cluster of houses, places of worship and a place of burial. Later, small settlements developed into villages. Several villages together formed a town. Bigger towns developed into cities. Settlements were formed in different shapes, sizes and locations.

Classification of settlements

On the basis of occupation, settlements may be classified as rural and urban settlements.

Rural Settlements

Any settlement where most of the people are engaged in primary activities like agriculture, forestry, mining and fishery is known as a rural settlement. Most of the world's settlements are rural, that are mostly stable and permanent. The most important and unique feature of rural settlements is the vast, open spaces with green, pollution-free environment.

Patterns of rural settlements:

- **Rectangular pattern:** Rectangular pattern of settlements are found in plain areas or valleys. The roads are rectangular and cut each other at right angles.
- **Linear pattern:** In a linear pattern, the houses are located along a road, railway line and along the edge of the river valley or along a levee.
- **Circular or semicircular pattern:** The pattern of settlement that is found around the lakes, ponds and sea coasts are called circular or semi circular pattern.
- **Star like pattern:** Where several metalled or unmetalled roads converge, star shaped settlements develop. In the star shaped settlements, houses are spread out along the sides of roads in all directions.

- **Triangular pattern:** Triangular patterns of rural settlement generally develop at the confluence of rivers.
- **T-Shaped, Y-Shaped, Cross-Shaped or Cruciform settlements:** T-shaped settlements develop at tri-junctions of the roads (T), while Y-shaped settlements emerge as the places where two roads converge with the third one. Cruciform settlements develop on the cross-roads which extend in all four directions.
- **Nebular pattern:** The arrangement of roads is almost circular which ends at the central location or nucleus of the settlement around the house of the main landlord of the village or around a mosque, temple or church.

Urban Settlements

Urban is the term related to cities and towns where people are primarily engaged in non-agricultural activities, such as secondary, tertiary and quaternary activities. The common characteristic feature of an urban unit is that they are compact, congested and liable to a large number of population. They comprise of mostly man-made structures that fulfill the requirements of a society's administrative, cultural, residential and religious functions. The factors responsible for urbanization are better employment opportunities, suitable conditions for business, education, transport, etc.

Classification of Urban Settlements

Urban centres are classified as towns, cities, metropolitan cities, mega cities, conurbation, etc., depending on the size and services available and functions rendered to it.

- **Town:** A town is generally larger than a village, but smaller than a city. It has a population of less than 1 lakh. E.g.: Arakkonam near Chennai
- **City:** Cities are much larger than towns and have a greater number of economic functions. The population in cities are estimated to be more than 1 lakh. E.g.: Coimbatore
- **Metropolitan cities:** Cities accommodating population between 10 lakhs and 50 lakhs are metropolitan cities. E.g.: Madurai
- **Megacities:** Cities with more than 50 lakh population are called Megacities. E.g.: Greater Chennai

- **Conurbation:** A conurbation is a region comprising of a number of cities, large towns and other urban areas. E.g.: Delhi conurbation

Economic Activities

Economic activities are those efforts or actions that involve production, distribution and consumption of commodities and services at all levels within a region. Types of Economic Activities

Primary Activities: Primary Activities pertain to the extraction of raw materials from the earth's surface. For example: food gathering, hunting, lumbering, fishing, cattle rearing, mining and agriculture.

Secondary Activities: Secondary Activities transform raw materials into finished goods. For example: Iron and Steel industries, automobile manufacturing etc.

Tertiary Activities: Activities which by themselves do not produce goods, but support the process of production are called tertiary activities. For example: Transport, communication, banking, storage and trade.

Quaternary Activities: The activities related to Research and Development, as well as knowledge are called Quaternary activities. For e.g. Services like consultation, education and banking,

Quinary Activities: The activities that focus on the creation, rearrangement and interpretation of new and existing ideas are called quinary activities. It includes the highest levels of decision making in a society or economy. E.g.: Senior business executives, scientists and policy makers in the Government.

Environmental Issues: Environment is the basic life support system that provides air, water, food and land to all living organisms. But human beings degrade the environment through rapid industrialization.

Human life will be at risk if they don't live in harmony with the environment. Environmental problems are not limited to the local, regional and national level, but there are several global issues. Scientific and technological revolutions has given a lot of facilities to mankind, but at the same time it is responsible for the depletion of resources. Thus, several environmental problems have emerged. Some of the environmental issues that we are going to learn are:

1. Deforestation,
2. Pollution such as air, water ,noise, etc,
3. Urbanization,
4. Fracking,

5. Waste disposal

Deforestation: Deforestation is the cutting down of trees permanently by the people to clear forests in order to make the land available for other uses.

Effects of Deforestation: Deforestation results in many effects like floods and droughts, loss of soil fertility, air pollution, extinction of species, global warming, spread of deserts, depletion of water resource, melting of ice caps and glaciers, rise in sea level and depletion of ozone layer.

The United Nations Conference on Environment and Development (UNCED) by name Earth Summit Conference held at Rio de Janeiro, Brazil, on June 1992 concluded that all member countries should reduce their emission of carbon dioxide, methane and other green house gases thought to be responsible for global warming.

Conservation of forests

- i. Conservation of forests can be done through the regulation of cutting of trees.
- ii. **Control over forest fire:** Through regular monitoring and controlling the movement of the people forest fire can be prevented.
- iii. **Reforestation and afforestation:** Reforestation involves the replanting or regeneration of areas of forest which have previously been damaged or destroyed. Sometimes forests are able to regenerate naturally. Afforestation is the process of planting trees or sowing seeds on barren land devoid of any trees to create a forest. The term afforestation should not be confused with reforestation, which is the process of specifically planting native trees into a forest that has decreasing number of trees. While reforestation is increasing the number of trees of an existing forest, afforestation is the creation of a new forest.
- iv. **Proper use of forest products:** We depend on forests for our survival from the air we breathe, to the wood we use. Besides providing habitats for animals and livelihoods for humans, forest products are one of the most essential things in our day to day life. Therefore we must use forest products properly.
- v. **Sustainable forest management:** The use of forest and forest lands in a way and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill the global levels should not cause damage to other eco systems. Forest

Management seeks to achieve a balance between the society's increasing demands for forest products, its benefits and the preservation of forest health and diversity too. This balance is critical to the survival of forests and to the prosperity of forest dependent communities.

Pollution

Environmental pollution occurs when pollutants contaminate the natural surroundings. Pollution disturbs the balance of our eco system affecting our normal life styles and gives rise to human illnesses and global warming. The word 'pollute' means to degrade or to make dirty. Pollution is thus, an unfavourable modification of the natural world, caused entirely or partly due to direct or indirect actions of human beings. There are many types of pollution degrading the environment. They are

1. Air pollution
2. Water pollution
3. Land pollution
4. Noise pollution
5. Light pollution

A. Air pollution

Due to some human activities or natural processes, the amount of solid wastes or concentration of gases, other than oxygen increases in air. Air thus becomes polluted and this process is called air pollution. The pollutants are generally grouped as natural and manmade. The natural pollutants are volcanic eruptions, wind erosion, pollen disposal, evaporation of organic compounds and radioactive elements etc.,

Natural air pollution does not occur in abundance and also creates a little impact on the environment. But, manmade pollutants like vehicular emission, industrial wastes, smoke from thermal power plants and refineries badly affect the environment. The main pathological effects caused by air pollutants, particularly oxides of sulphur, nitrogen and carbon-di-oxide, include respiratory disorders, jaundice, irritation of eyes and throat, headache, cancer and even death.

Ozone Depletion: Ozone layer is depleted by the pollutants like CFCs, HFCs, methyle bromide, etc. Due to the depletion of ozone layer, UV rays fall on the earth's surface, warming the earth surface and leads to impervious diseases like skin cancer, blindness, loss of plankton etc.,

Ozone layer: Ozone is a poisonous gas made up of molecules consisting of three oxygen atoms (O₃). This gas is extremely rare in the atmosphere,

representing just three out of every 10 million molecules. The ozone layer is not really a layer at all, but has become known as such because most ozone particles are scattered between 19 and 30 kilometre up in the earth's atmosphere, in a region called the stratosphere. Ozone layer in the atmosphere absorbs most of the harmful ultraviolet radiation from the sun. It also screens out the deadly UV-C radiation the ozone shield is this essential to protect life.

B. Water Pollution:

Water pollution is any chemical, physical or biological change in the quality of water that has a harmful effect on any living thing that drinks or uses or lives in it. The water bodies including ponds, lakes, rivers, ground water and oceans are contaminated by the chemical wastes from industries, domestic wastes and sewage etc.

Major water pollutants

- a. The disease – Causing agents; bacteria, viruses, protozoa and parasitic worms that enter sewage – systems and untreated waste.
- b. Oxygen demanding bacteria: Wastes that can be decomposed by oxygen requiring bacteria.
- c. Water soluble inorganic pollutants: Acids, Salt and toxic metals.
- d. Organic compounds: Oil, plastics and pesticides in the water.

Our role in conserving water;

1. Do not dump in or around rivers. Clean up rivers that have a lot of trash in and around them.
2. Never dispose of cooking fats and oils by pouring them down the sink.
3. In the bathroom, take short showers and draw less water for baths. When you buy a new toilet, purchase a low flow model (1.6 gallons or less per flush). Check your toilet for "silent" leaks by placing a little food coloring in the tank and see if it leaks into the bowl.
4. Turn off water while brushing teeth, washing, gardening and shaving.
5. Keep a gallon of drinking water in the refrigerator, rather than running the tap for cold water. Run your washing machine with a full load of clothes. Wash with warm water instead of hot water, rinse with cold water instead of warm water.

Causes of Water Pollution: Main pathological problems caused due to water pollution include diarrhoea, liver cirrhosis, lung cancer, kidney diseases, paralysis, chronic pain, bone deformities, cancer and even death and so on.

C. Land Pollution

Land pollution is contaminating the land surface of the earth through dumping of urban waste matter. It arises from the breakage of underground storage tanks, application of pesticides and percolation of contaminated surface water, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil.

Preventive Measures

1. Things used for domestic purposes can be reused and recycled.
2. Organic waste matter should be disposed off far away from the settlements.
3. Inorganic wastes can be separated, reclaimed and recycled.

D. Noise Pollution

Noise pollution is basically a problem of urban areas, industrial areas, transport areas due to bombardment, traffic etc. It has an impact on the habitat of animals migration and health of inhabitants. E.g. Chandipur Missile Launching Centre has created migration of sea birds. Hearing loss, hypertension, stress and mental illness are the major health hazards that human beings face.

The control measures of noise pollution

1. Development of green belt vegetation.
2. Installation of decibel meters along highways and in places of public gatherings.
3. Planting trees along the compound wall to protect houses.

E. Light pollution

Light pollution is an unwanted consequence of outdoor lighting and includes such effects as sky glow, light trespass and glare. It is caused by streetlights, parking lot lights, floodlights, signs, sports field lighting decorative and landscape lights. It affects the environment, energy resources, wildlife, humans and astronomy research.

Urbanization

Urbanization refers to the process of increase in urban population and urban areas in a country.

Problems of urbanization

As the town expands, it mounts more pressure on transport system, water supplies, sewage and profuse disposal. The overall development creates problems like air pollution, water pollution, traffic congestion and noise pollution etc., This disturbed environment affects the human beings as mental illness, heart troubles, breathing problems etc.

Fracking:

The modern technology applied to extract oil and gas while fracturing the rocks artificially with the use of pressurized liquid is called fracking. Fracking fluid is a mixture of water, sand and thickening agents. The first successful implementation of the process was done in 1950. Methane is one of the most important chemicals used in fracking process. It is estimated that four percent of methane escapes into the atmosphere during extraction. Methane is 25 times stronger than carbon di-oxide in terms of trapping heat. The spills of this gas is detrimental to the air quality of the surrounding fracking sites. Pollutants decrease the availability of clean air for workers and local residents.

Other Environmental Concerns

Fracking not only pollutes water and air but also pollutes the soil. The oil spills during fracking can harm the soil and the surrounding vegetation. The use of high pressure at the time of oil extraction and the storage of waste water on site may cause earthquakes.

Waste disposal

Things become waste when their purpose of consumption is over. Wastes can be classified into five types, which are commonly found around the house. These include liquid waste, solid rubbish, organic waste, recyclable rubbish and hazardous waste like e-waste.

How to dispose of waste:

- Do not litter your surroundings. Use a proper waste bin to store your wastes.
- People should practise to segregate degradable and non-degradable wastes and should dispose them in proper coloured bins. Wastage is generally classified into three types. They are
 1. Wet Waste: Which comes from the kitchen/cooking/food, etc.
 2. Dry Recyclable Waste: Such as newspapers, cardboard, packing plastics, bottles, cans, etc., should go to a different bin.

3. Rejected Waste: Which does not belong to the above two categories, including bio waste like diapers and bandages, etc..

Sewage sludge is produced by waste water treatment processes. Due to rapid urbanization, there has been an increase in municipal waste water. Common disposal practices of sewage should be send to sewage treatment plant through proper drainage pipes.

Electronic Waste (e-waste):

It can be defined as any electrical goods, devices or components that you no longer want or have already thrown away. For example, computers, televisions, mobiles and fax machines. This waste can take many years to break down, if at all and can contain toxic chemicals such as mercury, lead and lithium that leach into the ground and cause illness. Even short-term exposure to high levels of lead can result in vomiting and diarrhea. Instead of sending e-waste to the dump, components from electronics can be reused to make new products.

Sustainable Development

Humans on earth are facing many problems, such as pollution, climatic changes, poverty, war and uneven distribution of resources. These problems directly affect the survival of mankind. Therefore to sustain mankind, we have to educate people on what sustainable development is. In 1987, the Brundtland Commission cited the definition of sustainability.

"Sustainable development is development that meets the needs of the present without compromising the ability of future generation to meet their own needs". For sustainable development to be achieved, it is crucial to harmonize three core elements: economic growth, social aspects and environmental protection. These elements are interconnected and are crucial for the well-being of individuals and societies. To achieve true sustainability, we need to balance the economic, social and environmental factors of sustainability in equal harmony.

Social Sustainability

The ability of a social system such as a country, family or organization to function at a defined level of social well-being and harmony is called social sustainability. Problems like war, endemic poverty, widespread injustice and low education rates are symptoms of a system in socially unsustainable. The balancing capacity of a government in maintaining peaceful existence towards

other countries and at the same time providing the requirements of its citizens without affecting the environment creates social sustainability.

Economic Sustainability

The people on earth consume far more than what is their fair share.

1. The economic sustainability is successfully implemented through strong Public Distribution System.
2. Economic sustainability ensures that our economic growth maintains a healthy balance with our ecosystem.

Environmental Sustainability

Environmental sustainability is the ability of the environment to support a defined level of environmental quality and natural resource extraction rates forever to mankind. Unnecessary disturbances to the environment should be avoided whenever possible.

Why is sustainability important?

The excessive usages of natural and manmade resources deplete its availability for the future generation. We need to look after our planet, our resources and our people to ensure that we can hand over our planet to our children to live in true sustainability. Hence conservation and awareness are the two important terms that can bring sustainability to our living. When we use the word sustainability to mean maintain, it means to maintain it forever. This is because our actions have a lasting effect on the environment and we should protect it for our future generations.

How to help the value of sustainability grow among students?

1. **Lifestyle:** Your lifestyle is your choice and you can change it. For example, when you go to the grocery store, make sure you always carry a cloth bag. This way the shopkeeper does not have to give you many plastic bags.
2. **Fixing:** If your watch or a toy or a camera is broken or not working, try getting it fixed before you buy yourself a new one.
3. **Recycle:** Try and be conscious about the things around you. When you consume something, see if you can re-use it later.

4. **Needs vs Wants :** Before you buy something, ask yourself the question- do I NEED this or do I WANT it? Remember sustainability begins with you. So act locally and think globally.

Case Study

The Mangroves of Palk Bay towards Sustainable Development

The sections above have discussed environmental degradation and climate change along with the concept of sustainable development. The connection between environment protection and restoration and sustainable development has also been presented. As an example, the case of the Mangroves of Palk Bay will help demonstrate these concepts in more practical terms.

Palk Bay is the area located roughly between Kodiakkarai or Point Calimere and Rameshwaram Island in Tamil Nadu on the southeastern coast of India. Palk Bay is home to mangrove ecosystems or tidal swamps. Characterised by plants and trees that can withstand high salinity, these swamps are rich in biodiversity. The Mangrove trees themselves, offer coastal protection by checking erosion. Erosion affects not just the coastline, but also coral reefs. The tangled roots of mangrove trees help retain and trap loose soil and thereby protect coral reefs and seaweed meadows from siltation. Coral reefs are important ecosystems in maintaining healthy fish population. Mangrove forests also help fish population by providing space which act as nurseries for juvenile fish.

In the recent decades, the mangroves of Palk Bay have been heavily degraded due to the Tsunami of 2004, land encroachment, rapid urbanisation, cattle grazing and agriculture. The degradation of mangroves resulted in the reduction of nursery space for juvenile fish, impacting fish populations in the region and as a result, the livelihood of the fishing communities of the region.

Given the scale of the problem, solutions needed to be multipronged and involve multiple stakeholders. Local communities, government and civic organisations all came together not just to conserve the remaining mangroves, but also to restore it. Saplings of native species of plants and trees are being grown, planted and cared for. Live colonies of coral from the Gulf of Mannar Biosphere Reserve are being transplanted to Palk Bay. The existing mangroves and the region are being mapped and the way land is used around the mangrove is being studied.

The local communities are actively involved in the conservation and

restoration of the mangroves. Education and awareness programmes about mangrove ecosystem are being undertaken.

Along with awareness programmes, the communities are also being provided with livelihood training, so they can earn an income in more ways than just fishing. All of these efforts are on-going. The health of the mangroves are improving and as it does, the fish population will improve in quality and quantity, improving the lives of the communities. As one can see, sustainable solutions take the needs of the people into consideration and the environment because both are interconnected.

NOTE

- ❖ Environment is a set of relationships between man and nature. Man has survived through the ages, dwelling within his surrounding called the environment. The word 'environment' is derived from the French word 'environ' meaning encircled or surrounded. Environment includes both living (biotic) and non-living (abiotic) components.
- ❖ The Stockholm Conference, 1972, declared man as both a creator and moulder of his environment. 'The Earth Summit', formally known as the United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro in 1992.
- ❖ In ancient Greek, 'demos' means people and 'graphis' means study of measurement. So, 'Demography' is the statistical study of human population.
- ❖ The black-death is estimated to have killed 30 - 60 percent of Europe's total population during the 14th century. The dominant explanation for black-death is attributed to the outbreak of plague.
- ❖ **Census:** Census is an official enumeration of population carried out periodically. It records information about the characteristics of population such as age, sex, literacy and occupation. Different countries of the world conduct census every 5 to 10 years as recommended by the United Nations. The first known census was undertaken nearly six thousand years ago by the Babylonians in 3800 BC (BCE). Denmark was the first country in the modern world to conduct a census. In India, the first census was carried out in the year 1872. Censuses have been conducted regularly every tenth year since 1881. The Indian Census is the most comprehensive source of demographic, social and economic data. Have you ever seen a census report? Check in your library.
- ❖ The World Population Day is observed on 11th July every year. It seeks to raise awareness of global population issues. The United Nations

Development Programme started celebrating this event from the year 1989.

- ❖ **Over population and Under Population:** Over population is a condition when a country has more people than its resources to sustain. Under Population is a condition where there are too few people to develop the economic potential of a nation fully.
- ❖ India has an official population policy implemented in 1952. India was the first country to announce such a policy. The main objective of this policy was to slow down the rate of population growth, through promotion of various birth control measures.
- ❖ **Emigration means moving out or to leave a place:** Immigration means to enter or come into a new country for the purpose of settling there.
- ❖ Damascus is widely believed to be the oldest, continuously inhabited city in the world, dating back to at least 11, 000 years.
- ❖ Tokyo is the world's largest city with the greater Tokyo area, housing about 38 million inhabitants.
- ❖ According to the Quality of Living Rankings by Consultancy Mercer, in 2016, the city offering the best quality of life was Vienna, with Zurich falling second. (Sources: United Nations, UNESCO, Mercer).
- ❖ Van Mahotsav is a weeklong festival celebrated in India. This is a festival of life and is usually celebrated between 1st July and 7 th July.
- ❖ **Green-house effect:** Global warming is caused by the increase of green house gases such as carbon dioxide, methane, water vapour and Chloro Fluoro Carbons(CFC), carbon monoxide, photo chemical oxidants and hydrocarbons, which are responsible for the heat retention ability of the atmosphere. Global warming causes climatic change, ozone layer depletion, rise in sea level and drowning of coastal inhabited land, melting of ice, etc., They are posing an even greater threat to human existence and so, man must start thinking of protecting the environment from pollution.
- ❖ **Acid Rain:** When pollutants combine with water vapour in the presence of sunlight and oxygen, they form dilute sulphuric and nitric acids in the atmosphere. When this mixture precipitates from the atmosphere, it is called acid rain. The gases that cause acid rain are sulphur-di-oxide, nitrogen oxides, carbon-di-oxide and other minute bio-products, caused by the burning of fossil fuels.
- ❖ **Smog:** A mixture of smoke, gases and chemicals causes a smoky dark atmosphere, especially over cities. It decreases visibility and creates haze throughout the area.
- ❖ Rural India has hardly any arrangement to dispose off liquid waste. Only 56.4% of the urban wards have a sewer network. According to estimates,

about 80% of the sewage in India flows into rivers, lakes and ponds. This sewage is untreated and pollutes water bodies.



7. Mapping Skills

Map as a Tool

A map is the basic tool of a geographer. It illustrates the earth's surface clearly and effectively through a combination of drawings, words and symbols. Thus, maps form an integral part of teaching geography. A map is a location guide.

History of Mapping

The ancient Babylonians, Romans, Greeks and Egyptians were the first people to create maps. For thousands of years, most people thought that the earth was flat.

For many centuries, hand-drawn flat maps and charts assembled from information collected visually by explorers were produced. As early as 300 BC(BCE), the ancient Greeks theorized that the earth was round and discarded maps of a flat earth. Herodotus, Anaximander, Pythagoras, Eratosthenes, Ptolemy and Al Idrisi were some of the major contributors who mapped the world.

The introduction of printing press during the 12th century in China and 15th century in Europe helped to produce more maps. Spanish adventurers made maps of North America as the continent was explored during the 15th century. Gerardus Mercator from Belgium was the leading cartographer of the mid-16th century, who developed projections in map making. The uses of aerial photographs and satellite imageries stimulated map-making in the nineteenth and twentieth centuries.

The foundation for map-making in India was laid during the Vedic period. Mahabharata conceived a round world surrounded by water. Surveying and map-making were an integral part of the revenue collection procedure in the medieval period. E.g.: Sher Shah Suri's revenue maps and Rajendra Chola's land survey techniques. Today, the Survey of India produces maps at different scales for the entire country.

Maps and Cartography

Maps are drawings of an area as seen from above. A map is defined as the miniature image of the 3 dimensional earth's surface on a paper/cloth or any flat surface. Maps can show a whole or part of the world. Maps are drawn to a scale and direction. Maps have legends to explain the meaning of symbols and colours used on it. The art of map - making is called Cartography.

Components of a map

A map should include the following components namely, the title, scale, direction, grid system, projection, legend, conventional signs and symbols.

A. Title: It indicates the purpose or theme of the map. Example: India - Physical, World - Political, Tamil Nadu - Transport.

B. Scale: Scale makes it possible to reduce the size of the whole earth to show it on a piece of paper. A scale is a ratio between the actual distance on the map to the actual distance on the ground. Scales can be represented in three methods. They are the Statement, Representative Fraction (R.F) and Linear or Graphical scale methods.

Statement scale

The statement scale describes the relationship of map distance to ground distance in words, such as one centimetre to ten kilometres. It is expressed as 1cm = 10 km.

The Representative Fraction (R.F)

It describes the proportion or ratio of the map distance to ground distance. It is usually abbreviated as R.F. It is stated as 1/100000 (or) 1:100000. This means that one unit on the map represents 100,000 of the same unit on the ground. This unit may be an inch or a centimetre or any other linear measurement unit. Thus,

$$\text{Representative Fraction (R.F.)} = \frac{\text{Distance on the map}}{\text{Distance on the ground}}$$

For example:

To find the RF when the scale is 1 cm to 1km. Here, 1 cm =1 km

According to the formula, R.F=

Convert the km to cm. Therefore, 1km =100000 cm. So, RF. is 1:100000.

Linear (or) Graphical scale

In a map, a linear scale is represented by a straight line divided into equal parts (Primary and secondary) to show what these markings represent on the actual ground. This scale helps in the direct measurement of distance on the map.

C. Direction: Maps are drawn normally with north orientation. North direction in a map is always towards the North Pole of the earth. If you

position yourself looking at the North Pole, on your right will be the east; your left will be the west; at your back will be south. These four main directions are called the cardinal directions. Direction is usually indicated on a map by a North-South line, with the North direction represented by an arrow head.

D. Grid System: The location of a place can be simply defined by its latitude and longitude. In normal practice, latitude is stated first and then comes the longitude. The latitude and longitude of a place can be expressed in units of degree, minutes and seconds. A grid is a set of lines with alphanumeric codes for defining a location on a map in many topographical sheets. The lines that run horizontally from left to right of the map are known as northings, whereas, the lines that run vertically from the top to the bottom of the map are called easting's. The points at which the vertical and horizontal lines of the grid intersect are called coordinates which are identified by numbers or letters.

E. Projection : A map projection is a way of showing the spherical shaped earth on a flat piece of paper. Where does the word 'projection' come from? Imagine a clear globe with latitude and longitude lines and the outlines of the landmasses on it. Suppose there was a light bulb inside the globe. If you wrapped a piece of paper around the globe and turned on the light bulb, the outlines of the grid and landmasses would be projected onto the paper. Map projection is defined as the transformation of spherical network of latitudes and longitudes on a plane surface. Projections are drawn to maintain the shape, area and directions.

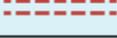
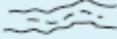
The three methods in widest use are as follows:

- Projection on the surface of a cylinder.
- Projection on to the surface of a cone.
- Projection directly onto a flat plane, called planar or zenithal or azimuthal projection

F. Legend: The legend of a map helps to understand the map details which are placed at the left or right corner at the bottom of the map

G. Conventional signs and symbols: A map is a global language and it needs to be drawn according to the international standards. Conventional signs and symbols are standard symbols used on a map and explained in the legend to convey a definite meaning. The topographic map contains a variety of information about physical and cultural features. These are shown by using signs and symbols in various colours so that the clarity of the map is maintained. There are three types of map symbols

- Point Symbols - buildings, dipping tanks, trigonometrical beacons
- Line Symbols - railways, roads, power lines, telephone lines
- Area Symbols - Cultivated lands, ponds, orchards and vineyards

Conventional Signs and Symbols	
 Fort	 Metalled Road
 Church	 Cart track
 Pagoda	 Pack-track
 Graveyard	 Foot-path with bridge
 Chhatri	 Aerodrome
 Mosque	 Light-house
 Temple	 Electric power Line
PO Post Office	 Perennial Stream
PS Police Station	 Dry Stream
RH Rest House	 Canal
CH Circuit House	 Dry River
IB Inspection Bungalow	 Dam with masonry work
 RS Railway station	 Dam with earth work
 Broad Gauge Railway	 Permanent Hut
 Level Crossing	 Temporary Hut
 Metalled Road	 Tower Antiquities

The following colour codes are used with map symbols

- 1. Brown:** Land or earth features - contour lines, eroded areas, prominent rock outcrops, sand areas and dunes, secondary or gravel roads
- 2. Light Blue:** Water features - canals, coastlines, dams, lakes marshes, Swamps and levees, ponds, rivers and water towers.
- 3. Dark Blue:** National waterways
- 4. Green:** Vegetation features - cultivated fields, golf courses, nature and game reserve boundaries, orchards and vineyards, recreation grounds, woodland
- 5. Black:** Construction features - roads, tracks, railways, buildings, bridges, cemeteries, communication towers,

- 6. **Red:** dam walls, excavations and mine dumps, telephone lines, power lines, wind pumps, boundaries
- 7. **Pink:** Construction features - national, arterial and main roads, lighthouses and marine lights
- 8. **Blue:** International boundaries

Classification of Maps

It is not possible to show all the data of an area on a map. The details that are to be shown may vary according to requirement. Therefore, it is essential to consider the scale and purpose while preparing maps.

Types of Maps

a. On the basis of scale, maps can be classified into:

- Large scale maps: Large amount of detail; can only show a small area.
- Small scale map: Small amount of detail; can show a large area.

b. On the basis of utility and purpose, they are classified as:

- General maps / Topographic Maps (physical and political maps)
- Thematic map (spatial variations of single phenomena)
- Special purpose maps (Braille maps for blind people, maps for neo literates, military maps, navigational charts, etc).

Weather station symbols

Symbols	Meaning
	Drizzle
	Rain
	Snow
	Shower(s)
	Thunderstorm (thunder is heard or lightning detected, even if no precipitation)
	Fog (with visibility < 5/8 statute mile)
	Sand Storm
	Dust Storm
	Drifting snow
	Blowing snow

Topographical maps and weather maps

Topographical maps show main features like landforms, water features, forests, settlements, agricultural fields, other land use, transportation and communication networks. These maps are general purpose maps and are drawn at quite large scales. The Survey of India prepares the topographical maps in India for the entire country. A weather map is the technique of meteorologists to display all the weather data recorded at various stations of a country at a particular point of time into a compact outline map using symbols and isolines. A weather map, otherwise called a synoptic chart, helps in weather analysis and weather forecast of the country/region for the next two to three days.

Survey

Surveying is done to measure the angle, direction, area, height and distance of an object or place on the surface of the earth using instruments. Surveying techniques are used to obtain the field data and to prepare maps. A knowledge of surveying helps one in map-making, particularly in the preparation of physical maps. Geographers mainly use Chain, Prismatic compass, Plane table, Dumpy level, Abney level, Clinometre, Theodolite, Total Station and GNSS to measure the distance, angle, altitude and position of the area of survey.

Remote Sensing as a Source of Map Data

Remote Sensing refers to the observation and measurement of earthly objects without touching them. 'Remote' means far away and 'Sensing' means observing or collecting information. Remote sensing means acquiring information of things/places from a distance, using a variety of tools and methods. Remote sensing has a long history, dating back from the use of cameras carried by balloons and pigeons in the 18th and 19th centuries. During the 20th century, airborne photographs and satellite remote sensing developed swiftly.

Aerial photography

Aerial photography refers to the technique of obtaining information about places or objects or phenomena with the help of photographs taken using cameras mounted on low flying birds, balloons, helicopters, aeroplanes and drones. The aerial photographs are captured continuously with a time gap of 10-30 seconds at a fixed height. Each photo will have a slight overlap of the area in the preceding photo. By making a mosaic of all the photos excluding the overlapping areas, a stereoscopic (3D) image of the study area can be

produced. Nowadays you might have seen drones being used for photography during grand occasions such as conferences, weddings, etc.

Satellite Remote Sensing

Satellite remote sensing is the science of collecting data about an object or area from artificial satellites orbiting the Earth. The term 'satellite imagery' refers to digitally transmitted images of the satellites.

Components of remote sensing

- Energy source
- Transmission path
- Target
- Sensor

Process of remote sensing

- A. The EMR (Electro Magnetic Radiation) or solar radiation is the primary source of energy for remote sensing.
- B. Sunlight travels from the sun through the atmosphere, before it reaches the earth surface. In the atmosphere, the sun's rays are not obstructed by any object.
- C. When solar radiation falls on the earth's surface, some of its energy is absorbed. While some is transmitted through the surface, the rest is reflected. Surfaces naturally emit radiation in the form of heat. The reflected energy travels from the earth surface back to space.
- D. Sensors in the satellite record the reflected and emitted radiation. Each surface/object possesses a characteristic spectral signature, a unique pattern of reflecting sunlight.
- E. The energy recorded by the sensor has to be transmitted to a ground station where the data are processed into an image.
- F. The processed image is interpreted either visually by human interpreters or by computer aided techniques called digital image processing to identify and distinguish between the different spectral signatures to get information about objects/places.
- G. Finally, we understand and apply the extracted information in mapping the area or assist in solving the particular problem.

Satellite remote sensing	Aerial Photography
<ul style="list-style-type: none"> • High cost of satellite systems. Takes at least 10 years to plan, construct, test and launch. 	<ul style="list-style-type: none"> • Surveying can be planned and executed in a shorter time economically.
<ul style="list-style-type: none"> • Satellites collect large amount of 	<ul style="list-style-type: none"> • Takes more time to capture and

data of the entire area in a short span.	area. Aircraft needs to fly back and forth.
<ul style="list-style-type: none"> • It allows global coverage and does not require permission. 	<ul style="list-style-type: none"> • It covers a small area and needs permission from authorities.
<ul style="list-style-type: none"> • Satellites circle the Earth: they can repeat and revisit easily. 	<ul style="list-style-type: none"> • Revisits or repeatability involves extra cost.
<ul style="list-style-type: none"> • Weather does not affect the functioning of satellites. 	<ul style="list-style-type: none"> • Adversely affected by bad weather
<ul style="list-style-type: none"> • All information is digital; it can be easily integrated with software for image improvement. 	<ul style="list-style-type: none"> • It is an analogue record, so no further improvement is possible after obtaining photographs.

Advantages of Remote sensing

- It is the only practical way to obtain data from inaccessible regions, e.g. Antarctica, Amazon forest.
- It helps in constructing cheap base maps in the absence of detailed land surveys.
- It detects the spread of natural calamities such as flood, forest fire and volcanic eruption, so that immediate rescue operations and planning can be carried out.

Disadvantages of Remote sensing

- It is difficult to prepare large scale maps from obtained satellite data.
- The technique is very expensive for small areas requiring one time analysis.

Remote sensing and Disaster Management

Remote sensing technology is highly used in disaster management to study the effects of earthquakes, tsunamis, cyclones, volcanic eruption, floods and wildfires.

Recent usage of Remote Sensing device in India and Malaysia

The whereabouts of the former Andhra Pradesh Chief Minister Y.S. Rajasekhara Reddy remained uncertain, after a helicopter carrying him went missing over a dense forest area prompting a continuing massive search operation on September 3rd, 2009. Low flying Air craft of the National Remote Sensing Agency has taken 41 imagery photographs of Nallamala forest area where the search operations were undergone to pick metal signals. ISRO processed the photographs in Hyderabad.

Overview of remote sensing application for search of missing Malaysia Airline MH370

This Boeing Commercial Airplane had disappeared on 8 March 2014 with 237 passengers onboard from Kuala Lumpur to Beijing. Numerous satellite images from diverse times, day and night, were used for the search for the missing flight. It became the most expensive search in aviation history, relying mostly on analysis of data from the Inmarsat (British satellite) to look into the airplane, flight data recorder and cockpit voice recorder, as well as the possible path. Search for oil slicks or debris or a piece of wing from MH370 with satellite image processing using ENVI software was done by thousands of volunteers.

After analyzing the 23 March 2014 satellite imagery, two weeks after MH370 disappeared, 12 objects in the ocean classifying as "probably man-made", were found to suspect the burst of the flight. The communications between Flight 370 and the satellite communication network relayed by the Inmarsat-3 F1 satellite provided significant clues to the location of Flight 370. The search goes on with no confirmed results yet. The preliminary data is retrieved from satellites like LANDSAT, CARTOSAT, OCEANSAT, etc. Fire and flood details can be extracted and delivered to relevant authorities within two hours of satellite image capture. E.g. major earthquakes in China and New Zealand, bushfire in Victoria and floods in Kerala. Dynamic phenomena such as flood, movement of wild animals, shoreline changes, finding lost ships and planes. Researchers use satellite imageries for these.

Global Navigation Satellite System (GNSS)

Have you ever booked a cab using a smart phone app? Did you see the map showing the route of your travel and movement of your vehicle on mobile phones? How is it possible to calculate the time duration of your travel?

In the 21st century, GNSS has become a part of our lives to promote the safety and convenience of transport. Global Navigation Satellite System (GNSS) is a satellite system connected with a small electronic receiver or tracker to locate, monitor and track a user's vehicle wherever in the world. It can also set up instant alerts when a driver of a vehicle speeds or deviates from a particular area. GNSS applications are used in tracking or mapping vehicles, ships and aircraft. A group of satellites (Space Segment) working with a network of ground stations (Control Segment) provide location data. The receiver (User Segment) converts satellite signals into location, speed and time data.

Examples of GNSS

- Europe's Galileo
- USA's NAVSTAR Global Positioning System (GPS)
- Russia's Global'naya Navigatsionnaya Sputnikovaya Sistema (GLONASS)
- China's BeiDou Navigation Satellite System
- India's NAVIC satellite system

a. Global Positioning System (GPS)

Without the Global Positioning System (GPS) on our vehicles and mobile phones, we would feel lost. GPS is the U.S. implementation of the world's first and currently the most used Global Navigation Satellite System (GNSS) created by the U. S. Department Of Defense (DOD). It became fully operational in 1995. NAVSTAR (Navigation Satellite Timing and Ranging) is a network of 24 U.S. satellites in six different orbits in space flying 20,350 km above the surface of the Earth; each one circles the planet twice a day to provide continuous, worldwide coverage. GPS receivers now come in all shapes and sizes, Most are the size of a cellular phone. Some are handheld, others are installed in ships, planes, trucks and cars.

Advantages of GPS

- GPS technology has tremendous applications in everything from mobile phones, watches, bulldozers, shipping containers and ATMs.
- The main purpose of GPS is to help in providing accurate transport data (distance, route and direction). It helps in military searches and rescue in wars. It can work as a reliable tourist guide.
- GPS helps during accident and rescue efforts, speeding the delivery of emergency services and disaster relief.
- Weather forecasting, earthquake monitoring and environmental protection can be done effectively by using GPS.

b. Geographic Information System (GIS)

Geographic Information System is a computer-based tool for managing a large amount of data collected for a given geographic region through remote sensing, GPS and other sources. The Geographic Information System is a combination of computer hardware, software, geographic data and the personnel.

G - Geographic - A particular area

I - Information - facts in order

S - System - arrangement

GIS was first recognised in the late 1950s by Waldo Tobler and Roger Tomlinson (Canada). Prime examples of importing GIS for public welfare are Google Maps, Yahoo Maps and Google Earth. The key ingredient is location. We must have a coordinate, an address or a distance from a known point that helps us to link the information to a location on a map. Each type of data of an area is stored as a separate 'layer' of the map. In GIS, layers may be used some times and removed according to need. Examples are hospitals, schools, water bodies, parks and ATMs. The computers can create maps showing any combination of data.

Advantages of GIS

- Maps produced by GIS analysis can be used to pinpoint problem areas.
- GIS finds its strongest use in resources management, telecommunications and urban and regional planning.
- GIS helps in planning the land-use requirements. The local government uses GIS for taxation and planning.

The hardware and software functions of a GIS include

- Data input and verification
- Compilation
- Storage
- Updating and changing
- Management and exchange
- Manipulation
- Retrieval and presentation
- Analysis and combination

BHUVAN

Bhuvan (Sanskrit for Earth) is a free internet based computer application launched by the Indian Space Research Organization (ISRO) on August 12th 2009. It enables visualization of Indian Remote Sensing (IRS) images taken over a year ago, by ISRO's seven satellites, including CartoSat-1 and CartoSat-2. Using Bhuvan connected to Internet, one can explore places of interest, scenes of events in the news or parts around the world they may never visit in person, by either entering the names of places or co-ordinates (latitudes and longitudes). Bhuvan has tremendous uses for scientists, academicians, policy makers and the general public.

Advantages

- Bhuvan, due to 3D rendering, gives the impression of moving through real space through the entire globe
- Students can use Bhuvan to understand subjects ranging from Sciences to History of places.
- It provides information on natural resources and timely information on disasters.
- Administrators use it for monitoring various developmental schemes.

Google Earth

Google Earth is a web based computer application. Google Earth is a virtual globe that renders a 3D representation of the Earth. It combines the power of Google Search with maps, satellite imageries, aerial photographs, GIS data and 3D buildings to visualize the world. Google Earth allows users to see cities and buildings looking perpendicularly down or at a tilted angle. Google Earth allows users to search for addresses of some countries, enter coordinates or simply use the mouse to browse a location. Google Earth also has Digital Elevation Model (DEM) data for many major cities. This means one can view Mount Everest or buildings in three dimensions, instead of 2D.

Do you want to locate your house using Google Earth? Follow the following steps

1. Start Google Earth by double-clicking on the Google Earth Icon or browse the icon in the 'Start' menu. This will start the program. The entire Earth (as a globe) will be shown by default.
2. Close Start-Up-Tip and start to explore and familiarize yourself with the Google Earth main menu on the top left on your screen,.
3. Windows-based: Click on 'Tools', select 'Options' and note the five tabs across the top of the 'Options' box. Mac-based: Under the Google Earth' main menu select 'Preferences'

In the '3D View' tab in the 'Terrain' box near the bottom, set 'Elevation Exaggeration' to '3'. Click 'Apply' to close the box. This will exaggerate the elevation relief by a factor of 3. Google Earth Options '3D View' tab with 'Terrain' Elevation Exaggeration circled in red. With development of such tools enabling flexible ways of viewing and interacting with geographic information, the ability of users to understand the information presented and the overall understanding of the world around us will surely progress.

NOTE

- ❖ More commonly known as the Babylonian Map of the World, the Imago Mundi is considered the oldest surviving world map. It is currently on display at the British Museum in London. It dates back to between 700 and 500 BC(BCE) and was found in a town called Sippar in Iraq. The carved map depicts Babylon at the centre. Nearby are places like Assyria and Elam, all surrounded by a “Salt Sea” forming a ring around the cities. Outside the ring, eight islands or regions are carved onto the tablet. The map is accompanied by a cuneiform text describing Babylonian mythology in the regions depicted on the stone.
- ❖ A cartographer is one who measures, analyzes and interprets geographical information to create maps and charts for political, cultural and educational purposes.
- ❖ Anaximander was the first ancient Greek to draw a map of the known world. It is for this reason that he is considered by many to be the first map maker (the first cartographer).
- ❖ Mnemonic device or memory technique to recall cardinal directions is the sentence "Never Eat Soggy Wheaties." (North, East, South and West)
- ❖ The mainland of India extends from 8°4'N to 37°6'N latitude and from 68°7' E to 97°25' E longitude. Here, (°) is degree and (') is minutes.
- ❖ The actual shape of the Earth is termed Geoid, which is an oblate spheroid. The “azimuthal” polar projection is depicted on the United Nations flag. North America was prominent on the initial 1945 UN flag (which had the longitude line 90 degrees west pointing upwards). The following year, the map on the flag was reoriented to be more neutral by having the International Date Line (180 degrees east, lying in the middle of the Pacific Ocean) pointing upwards. The map ends at 60 degrees South latitude, meaning Antarctica does not appear.
- ❖ We operate three remote sensing organs in our body.
 - Eyes -sense of sight
 - Nose - sense of smell
 - Ear - Sense of hearing
- ❖ Felix Nadar was a French photographer, journalist, novelist and balloonist. In 1858, he became the first person to take aerial photographs. He took his first photograph in 1853 and pioneered the use of artificial lighting in photography, working in the catacombs of Paris. Around 1863, Nadar built a huge (6000 m³) balloon named Le Géant ('The Giant').
- ❖ Remote sensing can be either passive or active. Active systems emit their own source of light energy such as RADAR, whereas passive systems depend on sunlight as energy source.
- ❖ People cannot be tracked generally by satellite or aerial photographs but they can be tracked by their mobile phone signals.

- ❖ Cyber cartography is a term that is used to define all the aspects of current state of Web and virtual mapping.
- ❖ Geographical objects in the real world are matched to program objects known as *geo objects*. Geo objects include placemarks, circles, polylines, rectangles, polygons and their collections. Place markers indicate a place on a map.



8. Disaster Management: Responding to Disasters

Case Study - Tsunami

Shortly before 8 am on 26 December 2004, the cicadas fell silent and the ground shook in dismay. The Moken, an isolated tribe on the Andaman Islands in the Indian Ocean, knew that the Laboon, the 'wave that eats people', had stirred from his ocean lair. The Moken also knew what was next: a towering wall of water washing over their island, cleansing it of all that was evil and impure. To heed the Laboon's warning signs, elders told their children, run to high ground. 'If the water recedes after an earthquake, run immediately to high ground' The tiny Andaman and Nicobar Islands were directly in the path of the tsunami generated by the magnitude 9.1 of earthquake off the coast of Sumatra. Final total put the islands' death toll at 1,879 alone with another 5,600 people missing. The islanders who had heard the stories about the Laboon or similar mythological figures survived the tsunami essentially unscathed.

Most of the casualties that occurred in the southern Nicobar Islands were outsiders, leaving them with no indigenous tsunami warning system to guide them to higher ground. So, humans have passed down stories through the ages that helped cultures to cope when disaster inevitably struck. These stories were fodder for anthropologists and social scientists, but in the past decade, geologists have begun to pay more attention to how indigenous people understood and prepared for disaster. These stories, which couched myth in metaphor, could ultimately help scientists prepare for cataclysms to come. In this lesson, you will learn about how to respond to certain disasters to become resilient. A disaster is "a catastrophe that causes great damage or loss of life and property".

Disaster Response

Disaster response entails restoring physical facilities, rehabilitation of affected population, restoration of lost livelihoods and reconstruction efforts to restore the infrastructure lost or damaged. The Response Phase focuses primarily on emergency relief: saving lives, providing first aid, restoring damaged systems (communications and transportation), meeting the basic life requirements of those impacted by disaster (food, water and shelter) and providing mental health and spiritual support and care.

Who are the first responders?

No matter how large or small, local communities are expected to provide immediate disaster response. On a daily basis, police officers, firefighters, and emergency medical technicians are a community's first responders, whether during fire, flood or acts of terrorism. Mental health professionals and the community's hospitals may also be activated in those early minutes and hours after disaster. Disaster management includes Prevention, Mitigation, Preparedness, Response and Recovery.

Disaster management involves all levels of government. Non-governmental and community based organizations play a vital role in the process. Modern disaster management goes beyond post-disaster assistance. It now includes pre-disaster planning and preparedness activities, organizational planning, training, information management, public relations and many other fields. Crisis management is important, but is only a part of the responsibility of a disaster manager. The traditional approach to disaster management has a number of phased sequences of action or a continuum. These can be represented as a disaster management cycle. We mainly focus on the way how the community should respond to disasters.

Earthquake

An earthquake is a sudden vibration of the part of the earth caused by plate movements. It occurs along the plate boundaries. The place inside the earth where an earthquake originates is focus. The point on the earth's surface above the called a focus is called an epicentre. The damage caused by the earthquake is the highest near the epicentre. The earthquake is measured by an instrument called a Seismograph. It is recorded in Richter scale. Let us now see how the communities can better respond to earthquakes.

What to do during an earthquake?

Be aware that some earthquakes are actually foreshocks and a larger earthquake might occur later. Minimize your movements to a few steps that reach a safe place nearby and stay indoors until the shaking has stopped and you are sure exiting is safe.

If indoors

1. DROP to the ground; take COVER by getting under a sturdy table or other piece of furniture and HOLD ON until the shaking stops. If there is no table or desk near you, cover your face and head with your arms and crouch in an inside corner of the building.

2. Protect yourself by staying under the lintel of an inner door, in the corner of a room, under a table or even under a bed.
3. Stay away from glass windows, outside doors and walls and anything that could fall (such as lighting fixtures or furniture).
4. Stay inside until the shaking stops and go outside.

If outdoors

1. Move away from buildings, trees, streetlights and utility wires.
2. If you are in open space, stay there until the shaking stops. The greatest danger exists directly outside buildings at exits and alongside exterior walls. Most earthquake-related casualties result due to collapsing walls, flying glass and falling objects.

If in a moving vehicle

1. Stop as quickly as safety permits. Avoid stopping near or under buildings, trees, overpasses and utility wires.
2. Proceed cautiously once the earthquake has stopped. Avoid roads, bridges or ramps that might have been damaged by the earthquake.

Tsunami

A tsunami can kill or injure people and damage or destroy buildings and infrastructure as waves come forth and recede. A tsunami is a series of enormous ocean waves caused by earthquakes, underwater landslides, volcanic eruptions or asteroids. Tsunamis can travel 700-800 km per hour, with waves 10-30 meter high. It causes flooding and disrupts transportation, power, communications, and water supply.

How to respond to Tsunami?

1. You should find out if your home, school, workplace or other frequently visited locations are in tsunami hazard areas along the sea-shore.
2. Plan evacuation routes from your home, school, workplace, or any other place you could be, where tsunamis poses a risk.
3. Use a weather radio or stay tuned to a local radio or television station to keep informed of local watches and warnings.
4. Discuss tsunamis with your family. Everyone should be aware of what to do when tsunami strikes. Discussing tsunamis ahead of time will help reduce fear and save precious time in an emergency. Review flood safety and precautionary measures with your family.

What to do after a Tsunami?

1. You should continue using a weather radio or staying tuned to a Coast Guard emergency frequency station or a local radio or television station for updated emergency information.
2. Check yourself for injuries and get first aid if necessary, before helping injured or trapped persons.
3. If someone needs to be rescued, call professionals with the right equipment to help.
4. Help people who require special assistance, like Infants, elderly people, those without transportation, large families who may need additional help in an emergency situation, people with disabilities, and the people who care for them.
5. Stay out of a building if water remains around it. Tsunami water, like floodwater, can undermine foundations, causing buildings to sink, floors to crack, or walls to collapse.
6. Check for gas leaks. If you smell gas or hear a blowing or hissing noise, open a window and get everyone outside quickly.

Riot

Though riot may seem dramatic, an angry mob can be just as dangerous and unpredictable as just about any natural disaster. Thousands of people are killed in riots all over the world each year, and these riots erupt from a number of racial, religious, economic, political, or social causes that cannot be predetermined. As per Pew Research Center analysis of 198 countries on April 11, 2015. Syria tops in riot in the world followed by Nigeria, Iraq and India. If you've found yourself in the middle of a riot, you may not be able to run away immediately, but you can take some measures to protect yourself from harm. If you want to know how to survive a riot, just follow these steps.

Surviving a Riot

At Travel Destination: What to Do

1. Keep abreast of the current news if you are in a volatile area.
2. If you come across a demonstration, don't become inquisitive, just leave the area and find another route to your intended destination.
3. Avoid any place where police or security forces action is in progress.

If caught in a riot:

1. If you find yourself caught up in a demonstration, keep to the edge of the crowd where it is safer. At the first opportunity, break away and seek refuge in a nearby building or find a suitable doorway or alley and stay there until the crowd passes.
2. When leaving the fringe of the demonstration, just walk away - don't run as this will draw attention to you.
3. In the event that you are arrested by the police/military, do not resist. Go along peacefully and contact your law advisor to help you resolve your predicament.
4. If you are caught up in the crowd, stay clear of glass shop fronts, moreover, move with the flow.
5. If shooting breaks out, drop to the ground and cover your head and neck, and lie as flat as you can.

Fire

1. Wildfires occur when vegetated areas are set alight and are particularly common during hot and dry periods. They can occur in forests, grasslands, bush and deserts, and with blowing wind, can spread rapidly.
2. Fires can lead to the destruction of buildings, wooden bridges and poles, power, transmission and telecommunication lines, warehouses containing oil products and other fuel. It causes injury to people and animals.
3. The most common causes of fires are lightning strikes, sparks during arid conditions, eruption of volcanoes and man-made fires arising from deliberate arson or accidents.
4. A side-effect of wildfires which also threatens inhabited areas is smoke. Fires create large quantities of smoke, which can be spread far by wind and poses a respiratory hazard.
5. On an average, in India, every year, about 25,000 persons die due to fires and related causes. Female accounts for about 66% of those killed in fire accidents. It is estimated that about 42 females and 21 males die every day in India due to fire.

Fire Safety Do's and Don'ts

1. Know your building's evacuation plan.
2. Evacuate calmly and quickly, whenever a fire alarm or carbon monoxide alarm sounds.
3. Before opening a door, feel it with the back of your hand. If the door is hot, do not open it.
4. If you encounter smoke during your evacuation, stay low to the floor.

5. Know the outside rally point for your building.
6. Know the locations of fire extinguishers, fire alarm pull stations and exits.

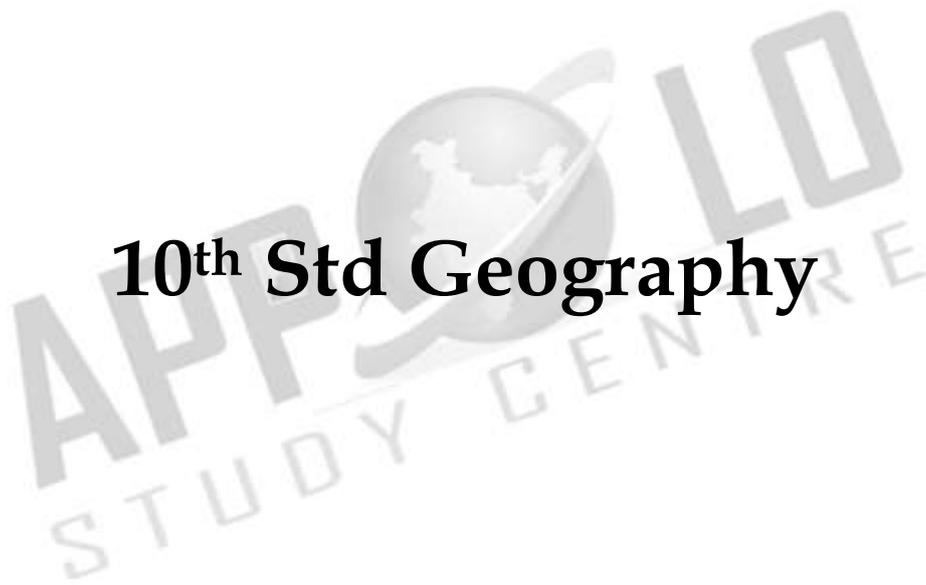
What you should do during a fire:

1. Stay calm.
2. Pull the nearest fire alarm or call 112.
3. Give your name and location of the fire. Do not hang up until the police dispatcher tells you to do so.
4. Leave the building immediately.
5. Inform others as you pass them to leave the building immediately.
6. Walk – don't run – to the nearest exit.
7. Never use elevators – an elevator may become a trap.

NOTE

- ❖ Japan is in a very active seismic area and it has the densest seismic network in the world.
- ❖ Which country actually has the most number of earthquakes? Indonesia is in a very active seismic zone also, but because it is larger than Japan, it has more earthquakes.
- ❖ Which country has the most earthquakes per unit area? This would probably be Tonga, Fiji or Indonesia, since they are all in extremely active seismic areas along subduction zones.

10th Std Geography



1 India - Location, Relief and Drainage

Introduction

India is the seventh largest country in the world and second largest country in Asia. It forms a part of south Asia and is separated by the Himalayas from the rest of the continent. India accounts for about 2.4 % of the total area of the world with an area of 32,87,263 sq.km. many of the India states are larger than several countries of the world.

India's Land and Water Frontiers

India shares its 15,200 km long land frontier with Pakistan in the west, Afghanistan in the north-west, China, Nepal and Bhutan in the north and Bangladesh and Myanmar in the east. India's longest border is with Bangladesh (4156 km) while the shortest border is with Afghanistan. (106 km) About 6,100 km long coastline of India is washed on three sides of the country by the Indian Ocean and its two arms namely the Arabian sea in the west and the Bay of Bengal in the east. The total length of the coast line of India including the islands is 7,516.6 km. India and Sri Lanka are separated by a narrow and shallow sea called Palk Strait.

India and the World

The Indian land mass has a central location between, the East and the West Asia. India and the southward extension of the Asian continent. The trans Indian ocean routes which connect the countries of Europe in the west and the countries of East Asia provide a strategic central location to India. Thus it helping India to establish close contact with West Asia, Africa and Europe from the western coast and with South East, east Asia from the eastern coast. India: A Subcontinent India along with the countries of Myanmar, Bangladesh, Pakistan, Nepal, Bhutan and Sri Lanka is called a subcontinent. This region is separated from the rest of Asia by a chain of mountains in the northwest, north and northeast and by seas in the south. This region also possesses a distinct continental characteristics in physiography, climate, natural vegetation, minerals, human resources etc. Hence India is known as 'subcontinent'.

Location and Extent

India extends from 8°4 'N to 37°6 'N latitudes and 68°7 'E to 97°25 'E longitudes. Hence India is located of the north Eastern hemisphere The southernmost point of the country is Pygmalion Point or Indira Point (6°45'N

latitude) located in the Andaman and Nicobar Islands. The southernmost point of main land of India is Cape Comorin (Kanyakumari). The north-south extent of India is 3,214 km and it extends from Indira Col in Jammu and Kashmir in the north to Kanyakumari in the south. The east-west extension is 2933 km and it stretches from Rann of Kutch (Gujarat) in the west to Arunachal Pradesh in the east. The Tropic of Cancer ($23^{\circ}30' N$) passes through the middle of the country dividing it into two halves as northern temperate and southern tropical lands. India has been politically divided into 29 states and 7 union territories for administrative convenience.

Indian Standard Time (IST)

The longitudinal difference between Gujarat in the west and Arunachal Pradesh in the east is about 30° . The Earth rotates through its axis around 360° in 24 hours. Thus, a difference of 1° longitude will make a difference of 4 minutes in time. The difference in longitude between Gujarat ($68^{\circ}7' E$) and Arunachal Pradesh ($97^{\circ}25' E$) is $29^{\circ}18'$. Hence the difference in local time between these two places is $29^{\circ}18' \times 4' \text{ (minutes)} = 1 \text{ hour } 57 \text{ minutes } 12 \text{ seconds}$ (approximately 2 hours). Since Arunachal Pradesh is towards east, it will have sunrise about two hours earlier than the sunrise at Gujarat which is in the west. In order to avoid these differences, Indian standard time is calculated. The local time of the central meridian of India is the standard time of India. India's central meridian is $82^{\circ}30' E$ longitude. It passes through Mirzapur and roughly bisects the country in terms of longitude. The IST is 5.30 hrs ahead of Greenwich Mean Time (GMT).

Major Physiographic Divisions of India

The majestic Himalayan peaks in the north, the beautiful beaches in the south, the great Indian desert in the west and the breath taking natural heritage in the east make India a geographically vibrant, colourful and truly incredible country. There is a varied nature of physiographic divisions in India. Though the country has many landforms based on the major differences, it is divided into the following five physiographic divisions:

1. The Himalayan Mountains
2. The Great Northern Plains
3. The Peninsular plateau
4. The Indian Desert
5. The Coastal Plains
6. The Islands

Himalayan Mountains

The Himalayan Mountains (Northern Mountains) consist of the youngest and the loftiest mountain chains in the world because they have been formed only few millions years ago and also they were formed because of the folding of the earth crust due to tectonic activity.

It stretches for a distance of 2,500 km from the Indus gorge in the west to Brahmaputra gorge in the east. The width of the Northern Mountains varies from 500 km in Kashmir to 200 km in Arunachal Pradesh. The Pamir Knot, popularly known as the "Roof of the World" is the connecting link between the Himalayas and the high ranges of Central Asia. From the Pamir, Himalayas extend eastward in the form of an arc shape. The term "Himalaya" is derived from Sanskrit. It means "The Abode of Snow". The Northern Mountains that function as a great wall is grouped into three divisions. 1) The Trans-Himalayas, 2) Himalayas, 3) Eastern or Purvanchal hills.

1. The Trans-Himalayas

It is also known as western Himalaya's. It lies to the north of the great Himalayan range. It lies in Jammu and Kashmir and Tibetan plateau. As its areal extent is more in Tibet, it is also known as Tibetan Himalayas. The Trans-Himalayas are about 40 km wide in its eastern and western extremities and about 225 km wide in its central part. They contain the Tethys sediments. The rocks of this region contain fossils bearing marine sediments which are underlain by 'Tertiary granite'. It has partly metamorphosed sediments and constitutes the core of the Himalayan axis. The prominent ranges of Trans Himalayas are Zaskar, Ladakh, Kailash, and Karakoram.

2. The Himalayas

Peak	Country	Height in Metres
Mt. Everest	Nepal	8848
Mt. K2 or Godwin Austen	India	8611
Kanchenjunga	India	8598
Makalu	Nepal	8481
Dhaulagiri	Nepal	8172
Nanga Parbat	India	8126
Annapurna	Nepal	8078
Nanda Devi	India	7817
Kamet	India	7756
Namcha Barwa	India	7756
Gurla Mandhata	Nepal	7728

It constitutes the core part of northern mountains. It is an young fold mountain. It was formed by the movement of Angara land mass in the north and Gondwana land mass in the south. The Tethys sea found between these two land masses was uplifted by the compression and the resultant landform was the Himalayas. It consists of many ranges. The main divisions of the Himalayas are the (i) Greater Himalayas,(ii) the Lesser Himalayas and (iii)the Siwaliks

The Greater Himalayas or the Himadri

The Greater Himalayas rise abruptly like a wall north of the Lesser Himalayas. The Greater Himalayas are about 25 km wide. Its average height is about 6,000 m. The Greater Himalayas receive lesser rainfall as compared to the Lesser Himalayas and the Siwaliks. Physical weathering is less effective over the Greater Himalayas as compared to the other ranges. Almost all the lofty peaks of Himalayas are located in this range. The notable ones are Mt. Everest (8,848 m) and Kanchenjunga (8,586 m). Mt. Everest is located in Nepal and Kanchenjunga is located between Nepal and Sikkim. This range is the most continuous of all ranges. It is region of permanent snow cover. So, it has many glaciers. Gangotri, Yamunothri and Siachen are some of them.

The Lesser Himalayas or the Himachal

It is the middle range of Himalayas. Height of this range varies from 3,700 to 4,500 m. Its width varies upto 80 km. The major rocks of this range are slate, limestone and quartzite. This region is subjected to extensive erosion due to heavy rainfall, deforestation and urbanization. Pir Panjal, Dhauladhar and Mahabharat are the mountain ranges found in this part. Major hill stations of the Himalayas are located in this range. Shimla, Mussourie, Nainital, Almora, Ranikhet and Darjeeling are the familiar ones.

The Siwaliks or Outer Himalayas

The Siwaliks extend from Jammu and Kashmir to Assam. It is partly made by the debris brought by the Himalayan rivers. The altitude varying between 900-1100 metres elevation of this range is 1300 m. The width of Siwaliks vary from 10 km in the east to 50 km in the west. It is the most discontinuous range. The longitudinal valleys found between the Siwaliks and the Lesser Himalayas are called Duns in the west and Duars in the east. These are the ideal sites for the development of settlements in this region.

Purvanchal Hills

These are the eastern off-shoot of Himalayas. It extended in the north-eastern states of India. Most of these hills are located along the border of India and Myanmar while others are inside India. Dafla Hills, Abor Hills, Mishmi Hills, Patkai Bum Hills, Naga Hills, Manipur Hills, Mizo Hills, Tripura Hills, Mikir Hills, Garo Hills, Khasi Hills and Jaintia Hills are the hills which are collectively known as purvanchal Hills.

Importance of Himalayas

- ✓ Himalayas blocks southwest monsoon winds and causes heavy rainfall to north
- ✓ India.
- ✓ It forms a natural barrier to the subcontinent.
- ✓ It is the source for many perennial rivers like Indus, Ganges, Brahmaputra etc.
- ✓ The Northern Mountains are described as the paradise of tourists due to its natural beauty.
- ✓ Many hill stations and pilgrim centres like Amarnath, Kedarnath, Badrinath and
- ✓ Vaishnavi devi temples are situated here.
- ✓ It provides raw material for many forest based industries.
- ✓ It prevents the cold winds blowing from the central Asia and protects India from severe cold.
- ✓ Himalayas are renowned for the rich biodiversity.

Longitudinal Divisions of Himalayas

1. The Kashmir Punjab Himachal Himalayas- Located between the rivers of Indus and Sutlej.
2. The Kumaun Himalayas- Located between the rivers of Sutlej and Kali.
3. The Central-Nepal Himalayas- Located between the rivers of Kali and Tista.
4. The Assam Eastern Himalayas- Located between rivers of Tista and Dihang.

The Great Northern Plains

The fertile land extending across seven north Indian states forms the Great Northern Plains. This extensive plain lies to the south of the northern

mountains. This plain is one of the most extensive stretches of the alluvium in the world and is deposited by the rivers Indus, Ganga, Brahmaputra and their tributaries. The length of the plain is about 2,400 km and the width varies from 240 to 320 km. Its width increases from east to west. It covers an area of over 7 lakh sq.km. The Great Plains of India is remarkably a homogeneous surface with an imperceptible slope. They are formed mostly by the depositional process of the Himalayan and Vindhyan rivers. These rivers deposit enormous quantity of sediments deposited along the foothills and flood plains. The important characteristics features of sediment deposition in the plains areas as follows.

The Bhabar Plain

This plain is made up of gravels and unsorted sediments deposited by the Himalayan rivers. The porosity of this plain is so high that most of the small streams flow over this region disappear. It lies to the south of the Siwalik from west to east (Jammu Division to Assam). Its width varies from 8 to 15 km. It is wider in the western plains (Jammu Division) than in the east (Assam). This plain is not suitable for cultivation, only big trees with large roots thrive in this region.

The Tarai Tract

It is a zone of excessive dampness, thick forests and rich wild life. This tract lies to the south of Bhabar plains. The width of this belt is 15-30 km. The Tarai is wider in the eastern parts of the Great Plains, especially in Brahmaputra Valley due to heavy rainfall. In many states, the Tarai forests have been cleared for cultivation.

The Bhangar Plains

The Bhangar represent the upland alluvial tracts of the Great Plains of India, formed by the older alluviums. The Bhangar land lies above the flood limits of the rivers. This soil is dark in colour, rich in humus content, well drained and useful for agriculture.

On the basis of deposition of sediments by various rivers and topographical characteristics, the Northern Plains of India is divided into the following four major regions:

- a. Rajasthan Plains: It is located to the west of Aravalli range. It covers an area of about 1,75,000 sq.km. Rajasthan plain is formed by the deposition of the river Luni and the long vanished river Saraswathi. There are several salt lakes in Rajasthan. The Sambhar salt lake (Pushkar Lake) near Jaipur is the

prominent one.

- b. Punjab - Haryana Plains: It lies to the north-east of the Great Indian Desert. This plain is found over an area of about 1.75 lakh sq.km. The Punjab - Haryana plains are formed by the deposition of the rivers Sutlej, Beas and Ravi. This plain acts as water - divide (doab). The two major watershed it divides are Yamuna - Sutlej and Ganga - Yamuna.
- c. Ganga Plains: It extends from the Yamuna River in the west to Bangladesh in the east. The total area covered by this plain is about 3.75 sq.km. River Ganga and its tributaries such as Ghaghra, Gandak, Kosi, Yamuna, Chambal, Betwa etc. constitute this plain by their sediments and make a great plain in India. It is the largest plain of India. The general slope of the entire plain (upper, middle and lower Ganga plains) is towards east and south-east.
- d. Brahmaputra Plains: It is located mainly in the state of Assam. It is a low - level plain located in the eastern part of the Great Plains of India and is formed by the deposits of river Brahmaputra. It covers an area of about 56,275 sq.km. These plains create alluvial fans and marshy tracts.

The Khadar Plains

The new alluvium tracts along the courses of the rivers are known as the 'Khadar' or 'Bet' lands. The Khadar tracts are enriched by fresh deposits of silt every year during rainy seasons. The Khadar land consists of sand, silt, clay and mud. It is highly fertile soil.

Delta Plains

The deltaic plain is an extension of the Khadar land. It covers about 1.9 lakh sq.km in the lower reaches of the Ganga River. It is an area of deposition as the river flows in this tract sluggishly. The deltaic plain consists mainly of old mud, new mud and marsh. In the delta region, the uplands are called 'Chars' while the marshy areas are called 'Bils'.

The Peninsular Plateaus

The plateau region lies to the south of the Great Northern Plains. This is the largest physiographic division of our country. It covers an area of about 16 lakh sq.km (about half of the total area of the country). It is an old rocky plateau region. The topography consists of a series of plateaus and hill ranges interspersed with river valleys. Aravalli hills mark the north-western

boundary of the plateau region. Its northern and north-eastern boundaries are marked by the Bundelkhand upland, Kaimur and Rajmahal hills.

The Western Ghats and the Eastern Ghats mark the western and eastern boundaries respectively. The altitude of a large portion of the plateau is more than 600 m from mean sea level. The peak of Anaimudi is the highest point in the plateau. Its height is 2,695 m and is located in Anaimalai. The general slope of this plateau is towards east. The Great Plateau is a part of the Gondwana (very ancient one) land mass. Due to the old age, the rivers in this region attained their base level and developed broad and shallow valleys.

The river Narmada divides the plateau region of India broadly into two parts. The region lying to the north of the Narmada is called the Central Highlands and the region lying to the south of Narmada is called the Deccan Plateau. All the major rivers (Mahanadi, Godavari, Krishna, Kaveri etc.) lying to the south of the Vindhyas flow eastwards and fall into the Bay of Bengal. Narmada and Tapti are the two rivers situated to the south of the Vindhyas flow westward. Their movement towards west is due to the presence of a rift valley in the region.

a. Central Highlands

The Central Highlands extend between the river Narmada and the Northern Great Plains. The Aravallis form the west and north-western edge of the Central Highlands. These hills extend from Gujarat, through Rajasthan to Delhi in the north-westerly direction for a distance of about 700 km. The height of these hills is about 1,500 m in southwest while near Delhi the height is hardly 400 m. Gurushikhar with 1,722 m is the highest peak of this range. The Western part of the Central Highland is known as the Malwa Plateau. It lies to the southeast of Aravallis and to the north of Vindhyachal Range.

The rivers Chambal, Betwa and Ken drain the Malwa Plateau before they join the river Yamuna. The part of the Central Highlands which extends to the east of Malwa Plateau is known as Bundelkhand and its further extension is known as Bagelkhand. The eastern part of the Central High lands which lies in the north-eastern part of the Indian Plateau is known as Chhota-Nagpur Plateau. It covers much of Jharkhand, adjacent parts of Odisha, West Bengal, Bihar and Chhattisgarh. This region is very rich in mineral resources particularly iron ore and coal.

b. Deccan Plateau

This physiographic division is the largest part of the plateau region of India. The shape of this plateau is roughly triangular. One of the sides of this

triangle is marked by the line joining Kanyakumari with Rajmahal Hills and this line passes through the Eastern Ghats. The second arm is marked by the Satpura Range, Mahadeo Hills, Maikal Range and the Rajmahal Hills. The third arm is marked by the Western Ghats. The area of this Plateau is about 7 lakh square km and the height ranges from 500 to 1000 m above sea level.

The Western Ghats forms the western edge of the Peninsular Plateau. It runs parallel to the Arabian Sea coast. The northern part of this range is called as Sahyadris. The height of the Sahyadris increases from north to south. Anaimudi is a sort of tri-junction of the Anaimalai Range, the Cardamom Hills and the Palani Hills. Kodaikanal is a beautiful hill resort situated on the Palani Hills. Eastern Ghats run from southwest to northeast form the eastern edge of this Plateau. This range is also called as Poorvadri. The Eastern Ghats join the Western Ghats at the Nilgiri hills, bordering Karnataka and Tamil Nadu. The Eastern Ghats are not continuous like the Western Ghats. The rivers of Mahanadi, Godavari, Krishna, Pennar and Kaveri have dissected this range at many places.

The Indian Desert

The Thar desert, also known as the Great Indian desert is a large arid region in the north western part of the Indian subcontinent that covers an area of 2,00,000 km² and forms a natural boundary between India and Pakistan. It is the world 7th largest desert, and world 9th largest sub tropical desert located in Western part of the India. The desert lies in the western part of the aravalli range and covers 2/3 of Rajasthan state. There are two major divisions in the Thar desert. They are known as the Actual desert region (Marusthali) and the semi desert region (Bhangar). Many different types of sand dunes and salt lakes (Dhands) are seen here.

The Coastal Plains

The Peninsula Plateau of India is flanked by narrow coastal plains of varied width from north to south, known as the Western Coastal Plains and the Eastern Coastal Plains. They were formed by the depositional action of the rivers and the erosional and depositional actions of the sea-waves. The Indian coastal plains are divided into the following two divisions: 1) The Western Coastal Plains and 2) The Eastern Coastal Plains.

1. The Western Coastal Plain

It lies between the Western Ghats and the Arabian Sea. It extends from Rann of kutch in the north to Kanyakumari in the south and its width varies

from 10 to 80 km. It is mainly characterised by sandy beaches, coastal sand dunes, mud flats, lagoons, estuary, laterite platforms and residual hills. The northern part of the West Coastal Plain is known as Konkan Plain. The middle part of this plain is known as Kanara. The southern part of the plain is known as Malabar coast which is about 550 km long and 20-100 km wide. This part of the coast is characterized by sand dunes. Along the coast, there are numerous shallow lagoons and backwaters called Kayals and Teris. Vembanad is a famous back water lake found in this region.

2. The Eastern Coastal Plain

It lies between the Eastern Ghats and the Bay of Bengal and, stretches along the states of West Bengal, Odisha, Andhra Pradesh and Tamil Nadu. These plains are formed by the alluvial fillings of the littoral zone by the east flowing rivers of India. The coastal plain consists mainly of the recent alluvial deposits. This coastal plain has a regular shoreline with well-defined beaches. The coastal plain between Mahanadi and Krishna river is known as the Northern Circars and the southern part lies between Krishna and Kaveri rivers is called Coromandal coast. The Marina beach on this coast in Chennai and it is the second longest beach in the world. Among the back water lakes of this coast, lake Chilka (Odisha) is the largest lake in India located to the southwest of the Mahanadi delta, the Kolleru Lake which lies between the deltas of Godavari and Krishna and the Pulicat Lake lies in the border of Andhra Pradesh and Tamil Nadu are the well known lakes in the east coastal plain.

The Islands

India has two major island groups namely Andaman and Nicobar and Lakshadweep. The former group consists of 572 islands and are located in Bay of Bengal, and the later one has 27 islands and are located in Arabian Sea. The islands of Andaman and Nicobar are largely tectonic and volcanic origin. India's only active volcano is found on Barren Island in Andaman and Nicobar group of Islands, while the islands of the Arabian Sea are mainly coral origin.

a) Andaman and Nicobar Islands

These islands are located in an elevated portion of the submarine mountains. Since these islands lie close to the equator, the climate remains hot and wet throughout the year and has dense forests. The area of the island group is about 8,249 sq.km. The entire group of islands is divided into two. They are Andaman in the north and the Nicobar in the south. These island groups are of great strategic importance for the country. Port Blair is the

administrative capital of the Andaman and Nicobar islands. The Ten Degree Channel separates Andaman from Nicobar group. The southernmost tip, the Indira Point is a part of Nicobar Island.

b) Lakshadweep Islands

This is a small group of coral islands located off the west coast of India. It covers an area of 32 sq. km. Kavaratti is its administrative capital. Lakshadweep islands are separated from the Maldivian Islands by the Eight Degree Channel. The uninhabited "Pitt Island" of this group has a bird sanctuary. Earlier, it had three divisions namely Laccadive, Minicoy and Amindivi. It was named as Lakshadweep in 1973.

c) Offshore Islands

Besides the two groups of islands, India has a number of islands along the Western Coast, Eastern Coast, in the delta region of Ganga and in the Gulf of Mannar. Many of these islands are uninhabited and are administered by the adjacent states.

Drainage System of India

A drainage system is an integrated system of tributaries and a trunk stream which collects and drains surface water into the sea, lake or some other body of water. The total area drained by a river and its tributaries is known as a drainage basin. The drainage pattern of an area is the result of the geological structure of the respective areas. The river system provides irrigation, drinking water, navigation, power as well as grant livelihoods for a large number of population. The drainage system of India is broadly divided into two major groups on the basis of their location. They are Himalayan rivers and the Peninsular rivers.

Himalayan Rivers

These rivers are found in north India and originate from Himalayas. So, they are also called

River	
Himalayan Rivers	Peninsular Rivers
> Indus	> Mahanadi > Cauvery
> Ganga	> Godavari > Narmada
> Brahmaputra	> Krishna > Tapti

a. The Indus River System

The Indus River is one of the largest rivers of the world. It originates from the northern slope of the Kailash range in Tibet near Manasarovar Lake at an elevation of about 5,150 m. Its length is about 2,880 km (Only 709 km is in India). The river has a total drainage area extending 11,65,500 sq km in which 321,289 sq km areas are drained in India. The river flows through the Ladakh and Zaskar ranges and creates deep gorges. The river runs through Jammu and Kashmir, turns south near Chillar and enters Pakistan. Its major tributaries are Jhelum, Chenab (Largest tributary of Indus), Ravi, Beas and Sutlej. It enters into with the Arabian Sea.

b. The Ganga River System

The Ganga River system is the largest drainage system of India it extend over an area of 8,61,404 sq km in India. The Ganga plain is the most densely populated place in India and many towns are developed on the banks of this river. The river Ganga originates as Bhagirathi from the Gangotri Glacier in Uttarakhand District of Uttarakhand state, at an elevation of 7,010 m. The length of the river Ganga is about 2,525 km. Its major tributaries from the north are Gomti, Gandak, Kosi and Ghaghra and from south, Yamuna (largest tributary of Ganga), Son, Chambal etc. The river Ganga is known as the River Padma in Bangladesh. The combined river of Ganga and Brahmaputra creates the World's largest delta known as Sundarbans in Bangladesh before joining the Bay of Bengal.

c. The Brahmaputra River System

The river Brahmaputra originates from the Chemayungdung Glacier of the Kailash range to the east of Lake Manasarovar in Tibet at an elevation of about 5,150 m. The total area is about 5,80,000 sq km but the drainage area lying in India is 1,94,413 sq km This river is known as Tsangpo (Purifier) in Tibet. The length of this river is about 2,900 km (900 km in India). It enters into India through a gorge in Arunachal Pradesh namely Dihang. It has many tributaries. Tista, Manas, Barak, Subansiri are some of them. This river is called as Jamuna in Bangladesh. After it joins with the river Ganga in Bangladesh, the river is called as Meghna. Characteristics of Himalayan Rivers

- ✓ Originate from Himalayas
- ✓ Long and wide
- ✓ Perennial in nature
- ✓ Unsuitable for hydro power generation
- ✓ Middle and lower courses are navigable

Peninsular Rivers

The rivers in south India are called the Peninsular rivers. Most of these rivers originate from the Western Ghats. These are seasonal rivers (non-perennial). They have a large seasonal fluctuation in volume of water as they are solely fed by rain. These rivers flow in valleys with steep gradients. Based on the direction of flow, the peninsular rivers are divided into the West flowing and East flowing rivers.

East Flowing Rivers

a. Mahanadi

The river Mahanadi originates near Sihawa in Raipur district of Chattisgarh and flows through Odisha. Its length is 851 km. Seonath, Telen, Sandur and Ib are its major tributaries. The main stream of Mahanadi gets divided into several distributaries such as Paika, Birupa, Chitartala, Genguti and Nun. All these distributaries form the Delta of Mahanadi which is one of the largest deltas in India. The Mahanadi empties its water in Bay of Bengal.

b. Godavari

Godavari is the longest river (1,465 km) with an area of 3.13 lakh km² among the Peninsular rivers. It is also called Vridha Ganga. It originates in Nasik district of Maharashtra, a portion of Western Ghats. It flows through the states of Telangana and Andhra Pradesh before joining Bay of Bengal. Purna, Penganga, Pranitha, Indravati, Tal and Salami are its major tributaries. The river near Rajahmundry gets divided into two Channels called Vasistha and Gautami and forms one of the largest deltas in India. Kolleru, a fresh water lake is located in the deltaic region of the Godavari.

c. Krishna

The river Krishna originates from a spring at a place called Mahabaleshwar in the Western Ghats of Maharashtra. Its length is 1,400 km and an area of 2.58 lakh sq km. It is the second longest Peninsular river. Bhima, Peddavagu, Musi, Koyna and Thungabhadra are the major tributaries of this river. It also flows through Andhra Pradesh and joins in Bay of Bengal, at Hamasaladeevi.

d. Kaveri

The river Kaveri originates at Talakaveri, Kudagu hills of Karnataka. Its length is 800 km. The river kaveri is called Dhakshin Ganga or Ganga of south. Harangi, Hemavati, Kabini, Bhavani, Arkavathy, Noyyal, Amaravathi etc are the main tributaries of the river Kaveri. In Karnataka the river bifurcates twice,

forming the sacred islands of Srirangapatnam and Sivasamudram. While entering Tamil Nadu, the Kaveri continues through a series of twisted wild gorges until it reaches Hogenakkal Falls and flows through a straight, narrow gorge near Salem. The Kaveri breaks at Srirangam Island with two channels, river Coleroon and Kaveri. At last, it empties into the Bay of Bengal at Poompuhar.

West Flowing Rivers

a. Narmada

This river rises in Amarkantak Plateau in Madhya Pradesh at an elevation of about 1057 m and flows for a distance of about 1,312 km it covers an area of 98,796 sq km and forms 27 km long estuary before out falling into the Arabian Sea through the Gulf of Cambay. It is the largest among the west flowing rivers of Peninsular India. Its principal tributaries are Burhner, Halon, Heran, Banjar, Dudhi, Shakkar, Tawa, Barna and Kolar.

b. Tapti

The Tapti is one of the major rivers of Peninsular India with the length of about 724 km. It covers an area of 65,145 sq km. Tapti river rises near Multai in the Betul district of Madhya Pradesh at an elevation of about 752 m. It is one of only the three rivers in Peninsular India that run from east to west - the others being the Narmada and the Mahi. The major tributaries are Vaki, Gomai, Arunavati, Aner, Nesu, Buray, Panjhra and Bori. It outfalls into the Arabian Sea through the Gulf of Cambay.

Characteristics of South Indian

Rivers

- Originate from Western Ghats
- Short and narrow
- Non perennial in nature
- Suitable for hydro power generation
- Not useful for navigation

NOTE

- ❖ Amaravati is the new capital of Andhra Pradesh But according to Andhra Pradesh
- ❖ Reorganization Act, Hyderabad will be the capital for both the states of Andhra Pradesh and Telungana till 2024 (For 10 years from the act passed).

- ❖ Aravalli range is the oldest fold mountain range in India.
- ❖ The major passes in the Himalayan are Karakoram pass (Jammu and Kashmir), Zojila pass, Shipkila pass (Himachal Pradesh), Bomdila pass (Arunachal Pradesh), Nathala pass (Sikkim) and Jhelepla pass (Sikkim). The Khyber pass which connects Pakistan and Afanisthan, and Bolan pass in Pakistan are important passes of the Indian subcontinent.
- ❖ Himalaya is the home of several high peaks. However, it holds the record of having the maximum number of highest peaks among any mountain range in world. Out of 14 heights peaks in this world, Himalayas holds 9.



2. Climate And Natural Vegetation Of India

Introduction

We drink more water during summer and do not drink the same amount of water during winter. Why do we wear cotton or lighter clothes during summer season and heavy woollen clothes during cold weather season in north India? Why do not we wear woollen clothes in south India? This is because of the prevalence of varying weather conditions between north and south India. In the previous chapter, you have learnt about the landforms and drainage of our country, which dealt with the natural environment. In this chapter, you will learn about the climate, rainfall distribution, natural vegetation and wildlife of our country.

The factors affecting the climate

Climate of India is affected by the factors of latitude, distance from the seas, monsoon wind, relief features and jet stream.

Latitude

Latitudinally, India lies between $8^{\circ}4'N$ and $37^{\circ}6'N$ latitudes. The Tropic of cancer divides the country into two equal halves. The area located to the south of Tropic of cancer experiences high temperature and no severe cold season throughout the year whereas, the areas to the north of this parallel enjoys subtropical climate. Here, summer temperature may rise above $40^{\circ}C$ and it is close to freezing point during winter.

Altitude

When the altitude increases, the temperatures decreases. Temperature decreases at the rate of $6.5^{\circ}C$ for every 1000 metres of ascent. It is called normal lapse rate. Hence, places in the mountains are cooler than the places on the plains. That is why the places located at higher altitudes even in south India have cool climate. Ooty and several other hill stations of south India and of the Himalayan ranges like Mussourie, Shimla etc., are much cooler than the places located on the Great Plains. Distance from the Sea Distance from the sea does not cause only temperature and pressure variations but also affects the amount of rainfall. A large area of India, especially the peninsular region, is not very far from the sea and this entire area has a clear maritime influence on climate. This part of the country does not have a very clearly marked winter

and the temperature is equable almost throughout the year. Areas of central and north India experience much seasonal variation in temperature due to the absence of influence of seas. Here, summers are hot and winters are cold. The annual temperature at Kochi does not exceed 30°C as its location is on the coast while it is as high as 40°C at Delhi, since it is located in the interior part. Air near the coast has more moisture and greater potential to produce precipitation. Due to this fact, the amount of rainfall at Kolkata located near the coast is 119 cm and it decreases to just 24 cm at Bikaner which is located in the interior part.

Monsoon Wind

The most dominant factor which affects the climate of India is the monsoon winds. These are seasonal reversal winds and India remains in the influence of these winds for a considerable part of a year. Though, the sun's rays are vertical over the central part of India during the mid-June, the summer season ends in India by the end of May. It is because the onset of southwest monsoon brings down the temperature of the entire India and causes moderate to heavy rainfall in many parts of the country. Similarly, the climate of southeast India is also influenced by northeast monsoon.

Relief

Relief of India has a great bearing on major elements of climate such as temperature, atmospheric pressure, direction of winds and the amount of rainfall. The Himalayas acts as a barrier to the freezing cold wind blows from central Asia and keep the Indian subcontinent warm. As such the north India experiences tropical climate even during winter. During southwest monsoon, areas on the western slope of the Western Ghats receive heavy rainfall. On the contrary, vast areas of Maharashtra, Karnataka, Telangana, Andhra Pradesh and Tamil Nadu lie in rain shadow or leeward side of the Western Ghats receive very little rainfall. During this season, Mangalore, located on the coast gets the rainfall of about 280 cm whereas the Bengaluru located on the leeward side receives only about 50 cm rainfall.

Jet Streams

Jet streams are the fast moving winds blowing in a narrow zone in the upper atmosphere. According to the Jet stream theory, the onset of southwest monsoon is driven by the shift of the sub-tropical westerly jet from the plains of India towards the Tibetan plateau. The easterly jet streams cause tropical depressions both during southwest monsoon and retreating monsoon.

Monsoon

The word 'monsoon' has been derived from the Arabic word 'Mausim' which means 'season'. Originally, the word 'monsoon' was used by Arab navigators several centuries ago, to describe a system of seasonal reversal of winds along the shores of the Indian Ocean, especially over the Arabian Sea. It blows from the south-west to north-east during summer and from the north-east to south-west during winter.

Monsoons are a complex meteorological phenomenon. Meteorologists have developed a number of concepts about the origin of monsoons. According to the Dynamic concept, Monsoon wind originates due to the seasonal migration of planetary winds and pressure belts following the position of the sun. During summer solstice, the sun's rays fall vertically over the Tropic of cancer. Therefore, all the pressure and wind belts of the globe shift northwards. At this time, Inter -Tropical Convergence Zone (ITCZ) also moves northward, and a major part of Indian landmass comes under the influence of southeast trade winds. While crossing equator this wind gets deflected and takes the direction of southwest and becomes southwest monsoon. During the winter season, the pressure and wind belts shift southward, thereby establishing the north-east monsoon (trade winds) over this region. Such systematic change in the direction of planetary winds is known as monsoon.

Seasons

The meteorologists recognize the four distinct seasons in India. They are;

1. Winter or cold weather season (January - February).
2. Pre Monsoon or summer or hot weather season (March - May).
3. Southwest monsoon or rainy season (June - September).
4. Northeast monsoon season (October - December).

Winter or cold weather season

During this period, the vertical rays of the sun falls over tropic of capricorn which is far away from India. Hence, India receives the slanting sun's rays which results in low temperature. The cold weather season is characterized by clear skies, fine weather, light northerly winds, low humidity and large day time variations of temperature. During this season a high pressure develops over north India and a north-westerly wind blows down the Indus and Ganges valleys. In south India, the general direction of wind is

from east to west. The mean temperature increases from north to south, the decrease being sharp as one moves northwards in the north-western part of the country.

The mean daily minimum temperatures range from 22°C in the extreme south, to 10°C in the northern plains and 6°C in Punjab. The rain during this season generally occurs over the Western Himalayas, Tamil Nadu and Kerala. Western disturbances and associated trough in westerlies are main rain bearing system in northern part of the country. The jet stream plays a dominant role in bringing these disturbances to India. These disturbances cause rainfall in Punjab, Haryana and Himachal Pradesh, and snowfall in the hills of Jammu and Kashmir. This rainfall is very useful for the cultivation of winter wheat.

2. Pre Monsoon or summer or hot weather season

During this season, the vertical rays of the sun falls over the peninsular India. Hence, there is a steady increase in temperature from south to north. It is practically hot and dry in the entire country in the initial part of this season. Weather over the land areas of the country is influenced by thunderstorms associated with rain and sometimes with hail mostly in the middle and later part. During this season, temperature starts increasing all over the country and by April, the interior parts of south India record mean daily temperatures of 30°C-35°C. Central Indian land mass becomes hot with day-time maximum temperature reaching about 40°C at many locations. Many stations in Gujarat, North Maharashtra, Rajasthan and North Madhya Pradesh exhibit high day-time and low night-time temperatures during this season.

Because of the atmospheric pressure conditions, the winds blow from southwest to northeast direction in Arabian Sea and Bay of Bengal. They bring pre monsoon showers to the west coast during the month of May. There are few thunder showers called "Mango Showers" which helps in quick ripening of mangoes along the coast of Kerala and Karnataka. "Norwesters" or "Kalbaisakhis" are the local severe storms or violent thunderstorms associated with strong winds and rain lasting for short durations. It occurs over the eastern and north eastern parts over Bihar, West Bengal and Assam during April and May. They approach the stations from the north-westerly direction.

3. Southwest monsoon or Rainy Season

The southwest monsoon is the most significant feature of the Indian climate. The onset of the southwest monsoon takes place normally over the southern tip of the country by the first week of June, advances along the Konkan coast in early June and covers the whole country by 15th July. The

monsoon is influenced by global phenomenon like ElNino. Prior to the onset of the southwest monsoon, the temperature in north India reaches upto 46°C. The sudden approach of monsoon wind over south India with lightning and thunder is termed as the 'break' or 'burst of monsoon'. It lowers the temperature of India to a large extent. The monsoon wind strikes against the southern tip of Indian land mass and gets divided into two branches. One branch starts from Arabian sea and the other from Bay of Bengal.

The Arabian sea branch of southwest monsoon gives heavy rainfall to the west coast of India as it is located in the windward side of the Western Ghats. The other part which advances towards north is obstructed by Himalayan Mountains and results in heavy rainfall in north. As Aravalli Mountain is located parallel to the wind direction, Rajasthan and western part do not get much rainfall from this branch. The wind from Bay of Bengal branch moves towards northeast India and Myanmar. This wind is trapped by a chain of mountains namely Garo, Khasi and Jaintia are mainly responsible for the heaviest rainfall caused at Mawsynram located in Meghalaya. Later on, this wind travel towards west which results in decrease in rainfall from east to west. Over all about 75% of Indian rainfall is received from this monsoon. Tamil Nadu which is located in the leeward side receives only a meagre rainfall.

4. Post monsoon or Retreating or Northeast monsoon season

The southwest monsoon begins to retreat from north India by the end of September due to the southward shifting pressure belts. The southwest monsoon wind returns from Indian landmass and blows towards Bay of Bengal. The coriolis force deflects this wind and makes it to blow from northeast. Hence, it is known as Northeast monsoon or Post-monsoon season. The season is associated with the establishment of the north-easterly wind system over the Indian subcontinent. Andhra Pradesh, Tamil Nadu, Kerala and south interior Karnataka receive good amount of rainfall accounted for 35% of their annual total. Many parts of Tamil Nadu and some parts of Andhra Pradesh and Karnataka receive rainfall during this season due to the storms forming in the Bay of Bengal. Large scale losses to life and property occur due to heavy rainfall, strong winds and storm surge in the coastal regions. The day time temperatures start falling sharply all over the country. The mean temperature over northwestern parts of the country shows a decline from about 38°C in October to 28°C in November.

Indian Monsoons

Distribution of rainfall

The average annual rainfall of India is 118 cm. However, spatial distribution of rainfall in the country is highly uneven. About 11% area receives over 200 cm of annual rainfall, 21% area receives 125 to 200 cm, 37% area receives 75 to 125 cm, 24% area gets 35 to 75 cm and 7% area gets less than 35 cm. The Western coast, Assam, South Meghalaya, Tripura, Nagaland and Arunachal Pradesh are the heavy rainfall areas which get more than 200 cm rainfall. The whole of Rajasthan, Punjab, Haryana, Western and South-western parts of Uttar Pradesh, Western Madhya Pradesh, the entire Deccan Trap or Plateau region east of Western Ghats except for a narrow strip along Tamil Nadu coast receive a low rainfall of less than 100 cm. The rest of the areas receive a rainfall ranging between 100 and 200 cm.

Natural Vegetation

Natural vegetation refers to a plant community unaffected by man either directly or indirectly. It has its existence in certain natural environment. Natural vegetation includes all plant life forms such as trees, bushes, herbs and forbs etc, that grow naturally in an area and have been left undisturbed by humans for a long time. Climate, soil and landform characteristics are the important environmental controls of natural vegetation. On the basis of the above factors the natural vegetation of India can be divided into the following types.

Tropical Evergreen Forest

These forests are found in areas with 200 cm or more annual rainfall. The annual temperature is about more than 22°C and the average annual humidity exceeds 70 percent in this region. Western Ghats in Maharashtra, Karnataka, Kerala, Andaman-Nicobar Islands, Assam, West Bengal, Nagaland, Tripura, Mizoram, Manipur and Meghalaya states have this type of forests. The most important trees are rubber, mahogany, ebony, rosewood, coconut, bamboo, cinchona, candel, palm, iron wood and cedar. These have not been fully exploited due to lack of transport facilities.

Tropical Deciduous Forest

These are found in the areas with 100 to 200cm. annual rainfall. These are called 'Monsoon Forests'. The mean annual temperature of this region is about 27°C and the average annual relative humidity is 60 to 70 percent. The trees of these forests drop their leaves during the spring and early summer.

(Sub Himalayan - Region from Punjab to Assam, Great Plains- Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal, Central India - Jharkhand, Madhya Pradesh, Chattisgarh, South India - Maharashtra, Karnataka, Telangana, Andhra Pradesh, Tamil Nadu and Kerala states are notable for this type of natural vegetation.) Teak and sal are the most important trees. Sandalwood, rosewood, kusum, mahua, palas, haldu, amla, padauk, bamboo and tendu are the other trees of economic importance. These forests also provide fragrant oil, varnish, sandal oil and perfumes.

Tropical Dry Forest

These are found in the areas with 50 to 100 cm. annual rainfall. They represent a transitional type of forests. These are found in east Rajasthan, Haryana, Punjab, Western Uttar Pradesh, Madhya Pradesh, Eastern Maharashtra, Telangana, West Karnataka and East Tamilnadu. The important species are mahua, banyan, amaltas, palas, haldu, kikar, bamboo, babool, khair etc., Desert and Semi-desert Vegetation).

These are also called as 'Tropical thorn forests'. These are found in the areas having annual rainfall of less than 50 cm. They have low humidity and high temperature. These forests are found in north-west India which includes west Rajasthan, south-west Haryana, north Gujarat and south-west Punjab. They are also found in the very dry parts of the Deccan plateau in Karnataka, Maharashtra and Andhra Pradesh. Babul, kikar and wild palms are common trees found here.

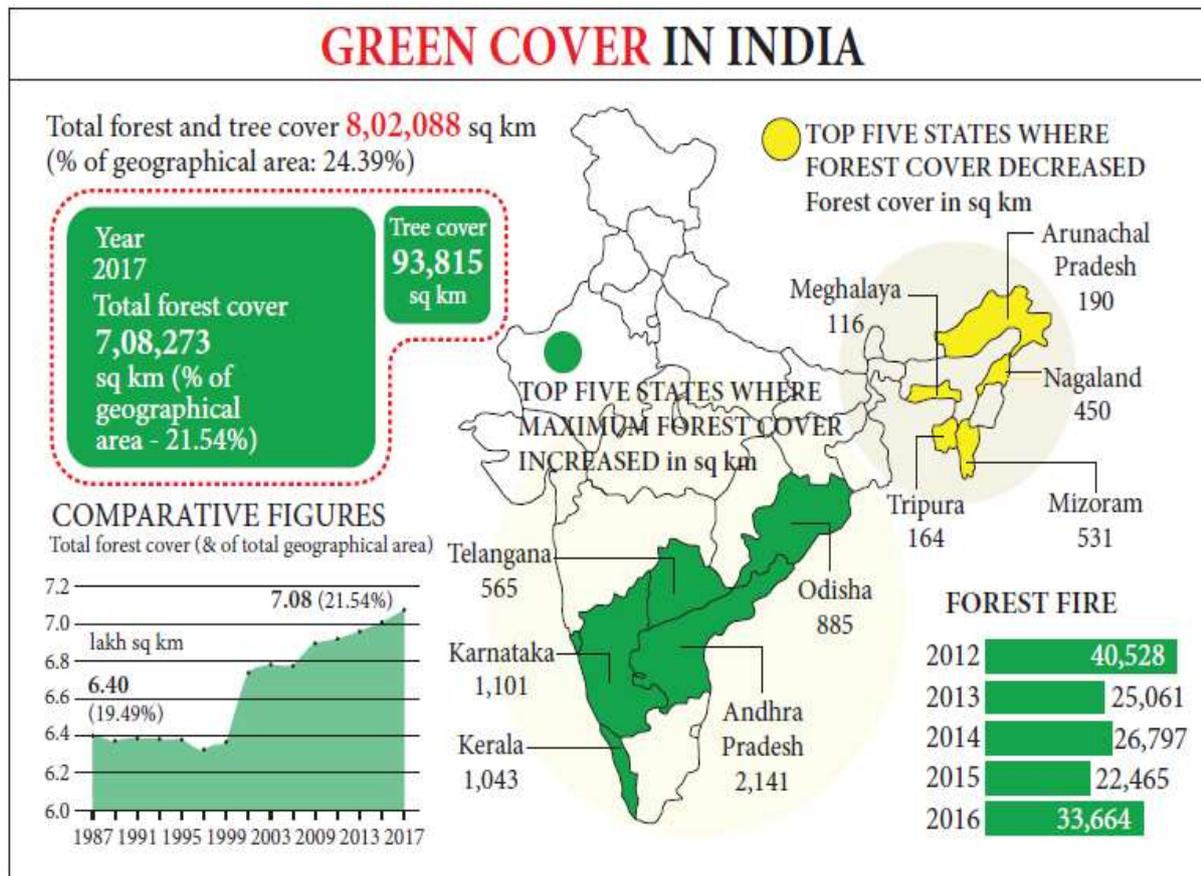
Mountain or Montane Forest

These forests are classified on the basis of altitude and amount of rainfall. Accordingly two different types of forests namely Eastern Himalayas Forests and Western Himalayas Forests.

i. Eastern Himalayan Forest: These are found on the slopes of the mountains in north-east states. These forests receive rainfall of more than 200 cm. The vegetation is of evergreen type. The Altitude between 1200-2400 m found in this type of forest sal, oak, laurel, amura, chestnut, cinnamon are the main trees from 1200 to 2400 m altitude oak, birch, silver, fir, pine, spruce and juniper are the major trees from 2400 to 3600 m height.

ii. Western Himalayan Forest: The rainfall of this region is moderate. These forests are found in the states of Jammu and Kashmir, Himachal Pradesh and Uttarakhand. Upto 900 m altitude semi desert vegetation is found and it is known for bushes and small trees. In altitude from 900 to 1800 m, chir tree is the most common tree. The other important trees of this region are sal,

semal, dhak, jamun and jujube. (height from 1800 to 3000 m is covered with semi temperate coniferous forests.) Chir, deodar, blue pine, poplar, birch and elder are the main trees of this region.



Alpine Forest: It occurs all along the Himalayas with above 2400 m altitude. These are purely having coniferous trees. Oak, silver fir, pine and juniper are the main trees of these forests. The eastern parts of Himalayas has large extent of these forests.

Tidal Forest: These forests occur in and around the deltas, estuaries and creeks prone to tidal influences and as such are also known as delta or swamp forests. The delta of the Ganga- Brahmaputra has the largest tidal forest. The deltas of Mahanadi, Godavari and Krishna rivers are also known for tidal forests. These are also known as mangrove forest.

Coastal Forest: These are littoral forests. Generally, coastal areas have these types of forests. Casurina, palm and coconut are the dominant trees. Both the eastern and western coasts have this type of forests. The coasts of Kerala and Goa are known for this type.

Riverine Forest: These forests are found along the rivers on Khadar areas. These are known for tamarisk and tamarind trees. The rivers of Great Plains are more prominent for this type of natural vegetation.

Wildlife

The term 'Wildlife' includes animals of any habitat in nature. Wild animals are non-domesticated animals and include both vertebrates (fish, amphibians, reptiles, birds and mammals) and invertebrates (bees, butterflies, moths etc.). India has a rich and diversified wildlife. The Indian fauna consists of about 81,251 species of animals out of the world's total of about 1.5 million species. The faunal diversity of the country consists of about 6500 invertebrates, 5000 molluscs, 2546 fishes, 1228 birds, 458 mammals, 446 reptiles, 204 amphibians, 4 panthers and about 60,000 species of insects. Our country is home to tigers, lions, leopards, snow leopards, pythons, wolves, foxes, bears, crocodiles, rhinoceroses, camels, wild dogs, monkeys, snakes, antelope species, deer species, varieties of bison and the mighty Asian elephant. Hunting, poaching, deforestation and other anthropogenic interferences in the natural habitats have caused extinction of some species and many are facing the danger of extinction. In view of this and the role of wild life in maintaining ecological balance, conservation and management of biodiversity of India is necessary at present situation.

The Indian Board for Wildlife (IBWL) was constituted in 1952 to suggest means of protection, conservation and management of wildlife to the government. The Government of India enacted Wildlife (Protection) Act in 1972 with the objective of effectively protecting the wild life of the country and to control poaching, smuggling and illegal trade in wildlife and its diversities. United Nations Convention on Biological Diversity (CBD) in 1992 recognizes the sovereign rights of states to use their own Biological Resources. To preserve the country's rich and diverse wildlife a network of 102 National Parks and about 515 Wildlife Sanctuaries across the country have been created.

Biosphere Reserves

Biosphere reserves are protected areas of land coastal environments wherein people are an integral component of the system. The Indian government has established 18 Biosphere Reserves in India which protect larger areas of natural habitat and often include one or more National Parks preserves along with buffer zones that are open to some economic uses. Eleven of the eighteen biosphere reserves (Gulf of Mannar, Nandadevi, the Nilgiris, Nokrek, Pachmarhi, Simlipal, Sundarbans Agasthiyamalai, Great Nicobar, Kanjanjunga and Amarkantak) of India fall under the list of Man and Biosphere programme of UNESCO.

S. No	Biosphere Reserves	State
1.	Achanakmar- Amarkantak (UNESCO)	Madhya Pradesh, Chattisgarh
2.	Agasthyamalai (UNESCO)	Kerala
3.	Dibru Saikhowa	Assam
4.	Dihang Dibang	Arunachal Pradesh
5.	Great Nicobar (UNESCO)	Andaman and Nicobar Islands
6.	Gulf of Mannar (UNESCO)	Tamil Nadu
7.	Kachch	Gujarat
8.	Kanchenjunga (UNESCO)	Sikkim
9.	Manas	Assam
10.	Nanda Devi (UNESCO)	Uttarkhand
11.	The Niligiris (UNESCO)	Tamil Nadu
12.	Nokrek (UNESCO)	Meghalaya
13.	Pachmarhi (UNESCO)	Madhya Pradesh
14.	Simlipal (UNESCO)	Odisha
15.	Sundarbans (UNESCO)	West Bengal
16.	Cold desert	Himachal Pradesh
17.	Sesahachalam hills	Andhra Pradesh
18.	Panna	Madhya Pradesh

NOTE

- ❖ Equable climate is also called as the British climate, Which is neither too hot nor too cold.
- ❖ Weather refers to the state of atmosphere of a place at a given point of time.
- ❖ Climate is the accumulation of daily and seasonal weather events of a given location over a period of 30-35 years.
- ❖ Atacama desert is the driest place on the earth.
- ❖ Mawsynram, the place which receives highest rainfall (1141 cm) in the world. It is located in Meghalaya.
- ❖ The Nilgiri Tahr is facing a major threat in the Western Ghats. Continuous poaching activities and Eucalyptus cultivation hampering its habitat, the Nilgiri Tahr population is continuously decreasing.
- ❖ The Black Buck is the state animal of Andhra Pradesh, Haryana and Punjab.
- ❖ Project Tiger was launched in April 1973 with the aim to conserve tiger population in specifically constituted "Tiger Reserves" in India. This project is benefited tremendously, with an increase of over 60% - the 1979 consensus put the population at 3,015 - while other equally disturbed

species like the barasingha (swamp deer), rhino and elephants also fought back from the brink of oblivion.



3. Components of Agriculture

Introduction

Soil is one of the most important natural resources. India's varied natural environments resulted in a great variety of soils compared to any other country of similar size in the world. The rich, deep and fertile soils support high density of population through agricultural prosperity

Soils

Soil is the uppermost layer of the land surface, usually composed of minerals, organic matter, living organisms, air and water. Grains in the soil are of three categories namely, clay, silt, and sand. Soils are generally formed by the weathering of rocks under different conditions. Some soils are formed by the deposition of agents of denudation. Soils can vary greatly from one region to the other.

Types of Soils:

The Indian Council of Agriculture Research (ICAR) set up in 1953 divides the soils of India into the following eight major groups.

Soils Type	Persentage
Saline & Alkaline Soil	1.29%
Peaty & Marshy Soil	2.17%
Laterite Soil	2.62%
Arid & Desert Soil	6.13%
Forest & Mountain Soil	7.94%
Alluvial Soil	22.16%
Red Soil	28%
Black soil	29.69%

Soil degradation

Soil degradation is an acute problem in India. According to a 2015 report of the Indian institute of remote sensing (IIRS). The estimated the amount of soil erosion that occurred in India was 147 million hectares. The main problems of the Indian soils are i) soil erosion (sheet erosion, Rill erosion, Gully erosion, Ravine and Bad land) ii) Degradation of Soil, iii) Water-logging, iv) Saline and Alkaline, and v) Salt Flats, types of soils are different erotion.

Methods of Conservation and Management of Soil

1. Afforestation
2. Constructing Dams and Barrages
3. Prevention of Overgrazing
4. Improved methods of Agricultural practices
 - ✓ Contour method
 - ✓ Rotation of crops
 - ✓ Contour bunding
 - ✓ Strip cropping
 - ✓ Planting of shelter belts
 - ✓ Adopting the techniques of sustainable agriculture are different conservation methods for better soil management.

Soil Type	Characteristics	Distribution	Crops Growing
Alluvial soil	<p>Khadar - light coloured, more siliceous. Bhangar - the older alluvium composed of lime nodules and has clayey composition. It is dark in colour. Formation - sediments deposited by streams and rivers when they slowly loose Chemical properties - rich in potash, phosphoric acid, lime and carbon compounds but poor in nitrogen. Nature - Sandly -loam-silt-clay profile shows no marked differentiation</p>	Ganga and Brahmaputra river valleys; plains of Uttar Pradesh, Uttaranchal, Punjab, Haryana, West Bengal and Bihar	Rice, Wheat, Sugarcane and Oilseeds
Black soils	<p>Formation - Derived from basalts of Deccan trap. Colour - black colour, due to presence of titanium, iron. Chemical properties - consist of calcium and magnesium carbonates, high quantities of iron, aluminium, lime and magnesia. Rich in potash lime, Aluminium calcium and magnesium poor in Nitrogen Phosphoric acid and humus Nature - Sticky when wet High degree of moisture retentively</p>	Maharashtra and Malwa plateaus, Kathiawar peninsula, Telangana and Rayalaseema region of Andhra Pradesh and northern part of Karnataka	Cotton, Millets, Tobacco and Sugarcane

Red soils	<p>Formation - decomposition of ancient crystalline rocks like granites and gneisses and from rock type</p> <p>Chemical properties - rich in minerals such as iron and magnesium. Deficient in nitrogen, humus, phosphoric acid and lime.</p> <p>Nature - Light texture, porous friable presence of limited soluble salts clay fraction of the red soils generally consists of Kaolinitic minerals.</p>	Eastern parts of Deccan plateau, southern states of kerala, Tamil Nadu, Karnataka and chota Nagpur plateau (Jharkhand)	Wheat, Rice, Cotton, Sugarcane and pulses
Laterite soils	<p>Formation - formed in the regions where alternate wet and hot dry conditions prevail. It is formed by the process of leaching.</p> <p>Chemical properties - Composed mainly of hydrated oxides of iron and aluminium,</p> <p>Nature - more acidic on higher areas poor in high level, cannot retain moisture while plains they consist of heavy loam and clay and easily retain moisture.</p>	Assam hills, hill summits of Kerala and Karnataka and eastern Ghats and region of Odisha	Coffee, Rubber, Cashew nut and Tapioca
Forest and mountain soils	<p>Differ from region to region depending on climate.</p> <p>Formation - due to mechanical weathering caused by snow, rain, temperature variation</p> <p>Chemical properties - are deficient in potash, Phosphorus and lime.</p> <p>Nature - light, sandy, thin and found with the pieces of rocks. Very rich in humus. slow decomposition makes it acidic</p>	Coniferous forest belts of Jammu and Kashmir, Himachal Pradesh, Uttarkhand and Sikkim. Eastern and Western Ghats	Coffee, tea, rice, maize, potato, barley, tropical fruits and various types of spices

Arid and desert soils	<p>Formation - due to prevalence of the dry climate, high temperature and accelerated evaporation, the soil is dry, it also lacks humus content due to the absence of vegetative cover</p> <p>Chemical properties - contain high percentages of soluble salts, alkaline with varying degree of calcium carbonate and are poor in organic matter; rich enough in phosphate though poor in nitrogen</p> <p>Nature - light in colour, low hums, friable structure, low in moisture</p>	Rajasthan, Northern Gujarat and Southern Punjab	Millets, barely, cotton, maize and pulses (with irrigation)
Saline and alkaline soils	<p>Formation - formed due to ill drainage which causes water logging, injurious salts are transferred from subsurface to the top soil by the capillary action, it causes the salinization of soils.</p> <p>Chemical properties - liberate sodium, magnesium and calcium salts and sulphurous acid.</p> <p>Nature - Consists of un decomposed rock and mineral fragments which on weathering.</p>	Andhra Pradesh and Karnataka. In the drier parts of Bihar, Uttar Pradesh, Haryana, Punjab, Rajasthan and Maharashtra	
Peaty and marshy soils	<p>Formation - formed in humid regions from the organic matter. It is found in the areas of heavy rainfall and high humidity peaty soils are black, heavy and highly acidic. Chemical properties - deficient in potash and phosphate. Contain considerable amount of soluble salts and 10 - 40 per cent of organic matter; and high proportion of vegetable matter.</p> <p>Nature - Contain considerable amount of Soluble salts and 10 - 40 per cent of organic matter; and high proportion of vegetable matter.</p>	Kottayam and Alappuzha districts of Kerala; and coastal areas of Odisha and Tamil Nadu, Sundarbans of West Bengal, in Bihar and Almora district of Uttarkhand	Paddy, jute

Irrigation

Watering of agricultural plants through artificial means is called irrigation. Being

a hot country with seasonal and irregular rainfall, it always needs irrigation to carry out agricultural activities during dry period. Beside erratic rainfall, prevalence of high temperature, cultivation of annual crops and hydrophytes, commercial farming and porous soil make irrigation an essential one for the agriculture of our country.

Sources of Irrigation

In India, different sources of irrigation are used depending upon the topography, soils, rainfall, availability of surface or groundwater, nature of river (whether perennial or non-perennial), requirements of crops etc. The main sources of irrigation used in different parts of the country are

- Canal irrigation
- Well irrigation and
- Tank irrigation

a. Canal Irrigation

It is the second most important source of irrigation in our country. Percentage of area under canal irrigation in our country is 24% (source: Statistical year book 2017 during 2013-2014) Canals are the effective source of irrigation in areas of low level relief, deep, fertile soils, perennial source of water and extensive command area. The canals are of two types:

Area Under Irrigation	
Tanks	3%
Other Sources	11%
Other wells	16%
Canals	24%
Tube wells	46%

1. **Inundation Canals:** In this, water is taken out directly from the rivers without making any kind of barrage or dam. Such canals are useful for the diversion of flood water from the rivers and remain operational during rainy season.
2. **Perennial Canals:** These are developed from perennial rivers by constructing barrage to regulate the flow of water. In our country, most of the canals fall under this category. These canals are useful for irrigation. In India the total area under canal irrigation is about 15.8 million hectares in 2014. About 60 percent of the canal irrigated area falls in the northern plains of India, particularly in Uttar Pradesh, Punjab, Haryana, Rajasthan, and Bihar. In south and central India, Andhra Pradesh, Maharashtra, Karnataka, Madhya Pradesh, Chattisgarh,

Odisha, and Tamil Nadu are the important states where canal irrigation is found.

b. Well Irrigation

A well is a hole or trough, usually vertical, excavated in the earth for bringing groundwater to the surface. Well irrigation is the most important source of irrigation as it contributes about 62 percent of net irrigated area in India. It is a cheap, dependable, and popular source of irrigation in the country. Well irrigation is unavoidable in the region of low rainfall and becomes an essential one where the canals and tank irrigation are not available. Wells are of two types: i) Open wells and ii) Tube wells

1. **Open Wells:** This type of irrigation is widely practiced in the areas where groundwater is sufficiently available. The areas are in Ganga Plains, the deltaic region of Mahanadi, Godavari, Krishna, Cauvery and parts of Narmada and Tapti valleys.
2. **Tube Wells:** Tube wells are developed in the areas of low water table, sufficient power supply and soft subsurface geological units. Tube wells are predominant in the states of Gujarat, Maharashtra, Punjab, Madhya Pradesh and Tamil Nadu.

As per the Irrigation - Statistical Year Book India - 2017, the following states are the top five with respect to the percentage of areas under well irrigation during 2013-14.

S. No	Name of the State	Area in %
1.	Uttar Pradesh	26.6
2.	Madhya Pradesh	14.6
3.	Rajasthan	13.1
4.	Gujarat	7.8
5.	Punjab	7.1

c. Tank Irrigation

A tank is a natural or man-made hollow on the surface developed by constructing a small bund around it across a stream. It is used to collect and store water for irrigation and other purposes. Irrigation by tanks is a very old system in India. It also includes irrigation from lakes and ponds. The tank irrigation is popular in the Peninsular India due to the following reasons:

- The undulating relief and hard rocks make difficult to dig canals and wells.
- Natural depressions serve as reservoirs.
- Absence of perennial rivers.
- Impermeable rock structure which do not permit percolation.
- The scattered nature of population and agricultural fields

The following table shows the five leading states in tank irrigation:

S. No	Name of the State	Area in Lakh Hectares (2013 - 14)
1.	Tamil Nadu	3.78
2.	Andhra Pradesh	3.40
3.	Madhya Pradesh	2.64
4.	Telangana	2.30
5.	Karnataka	1.54

Modern irrigation methods

There are many ways in Modern Irrigation among them mostly practiced and following in India are using drips, sprinklers and poly houses central pivot irrigation. Drip System is used to watering like drops at near the roots of plant. It will cover a tiny area at plant, but suitable for big trees and horticulture plants too which used to grow bigger

- **Rain Gun:** Rain gun used to spread water like rain as in name and used to serve for crops which used to grow upto 4 feet's or high also but we have to adjust sprinklers height as per crop size. typical usage of Rain guns are in sugarcane, maize crops.
- **Center:** Pivot irrigation (sometimes called central pivot irrigation), also called waterwheel and circle irrigation, is a method of crop irrigation in which equipment rotates around a pivot and crops are watered with sprinklers

Multipurpose River Valley Projects

It is a scientific management of water resources in our country. Construction of dam across rivers is aimed at many purposes. Hence, it is termed as multi-purpose river valley projects. The various purposes of a dam serves are irrigation, hydro power generation, water supply for drinking and industrial purpose, controlling floods, development of fisheries, navigation etc. Generally, majority of multipurpose projects are combination of irrigation and hydro-power which are the major aims of the projects.

Name of projects	River	Benefit States	Irrigation (sq km)	Hydropower (Megawatts)
Damodar Valley project	Damodar	Jharkhand, West Bengal	5,150	.260
Bhakra - Nangal Project (highest gravity dam in the world)	Sutlej	Punjab, Haryana and Rajasthan	52,609	1,500
Hirakud Project (longest dam in the world)	Mahanadi	Orissa	1,41,600	347.5
Kosi Project	Kosi '(Sorrow of Bihar'.)	Bihar & Nepal	8,750	19.2
Tungabhadra Project	Tungabhadra	Andhra Pradesh and Karnataka	1,968	35.
Tehri Dam:	Bhagirathi	Uttarkhand		1,000 MW
Chambal Valley Project	Chambal	Rajasthan and Madhya Pradesh	6000	-
Nagarjuna Sagar Project	Krishna	Andhra Pradesh	-	
Sardar Sarover Project	Narmada	Madhya Pradesh, Maharashtra, Rajasthan		250
Indira Gandhi Canal Project	Satlaj	Rajasthan, Punjab and Haryana	18,450	0
Mettur Dam	Kaveri	Tamil Nadu	-	40

Agriculture

Agriculture is the process of producing food for people, fodder for cattle, fibre and many other desired products by the cultivation of certain plants and the raising of domesticated animals (livestock). Though India is industrially a fast developing nation, still the agriculture in India employs more than 50 percent of the population of the country and accounts for about 25 percent of the national income.

Determinants of Agriculture

Agriculture in India is determined by a set of factors. Some of the important factors:

1. Physical factors: relief, climate and soil.
2. Institutional factors: Size of farm holdings, land tenure, and land reforms.
3. Infrastructural factors: Irrigation, power, transport, credit, market, insurance and storage facilities.
4. Technological factors: High yielding varieties of seeds, chemical fertilisers, insecticides and machinery.

Types of Farming

Owing to variations in the physical environment and culture, a variety of farming practices and cultivation systems have evolved in different parts of India.

a. Subsistence Farming

A considerable proportion of farmers in the country practice subsistence farming. In this, agricultural land holding is small. As the farmers are poor, they can't apply the modern inputs which cost more. They grow crops with the help of family members and consumes almost the entire farm produce with little surplus to sell in the market. Preference is given to food crops. In addition to the food crops, sugarcane, oilseeds, cotton, jute and tobacco are also cultivated. Traditional farming method results in low productivity. In Punjab, some parts of Rajasthan, Uttar Pradesh and Madhya Pradesh subsistence farming is practiced.

b. Shifting Agriculture

This type of agriculture is performed by tribal people in a piece of forest land after clearing the trees through felling and burning the trunks and branches. Once the land is cleared, crops are grown for two to three years and the land will get abandoned as the fertility of the soil decreases. The farmers then move to new areas and the process will be repeated. They cultivate some grains and vegetable crops using the manual labour. It is also called as "Slash and burn" cultivation.

c. Intensive Farming

Intensive farming is an agricultural intensification and mechanization system that aims to maximize yields from available land through various means, such as heavy use of pesticides and chemical fertilizers. This intensification and mechanization has also been applied to the raising of livestock with billions of animals, such as cows, pigs and chickens, being held indoors. They have become known as factory farms. Intensive farming is

practiced in Punjab, parts of Rajasthan, Uttar Pradesh, and Madhya Pradesh in India.

d. Dry Farming

This type of farming is practiced in arid areas where irrigation facilities are lacking. Crops cultivated in these areas can withstand dry conditions. The crops grown generally with the help of irrigation are also grown under dry farming. In such circumstances, the yields are generally low. Most of the areas under dry cultivation entertain only one crop per year. This is practiced in drier parts of Rajasthan, Gujarat, Madhya Pradesh etc.

e. Mixed Farming Agriculture

Mixed farming is defined as a system of farm which includes crop production, raising livestock, poultry, fisheries, bee keeping etc. to sustain and satisfy as many needs of the farmer as possible.

f. Terrace Cultivation

This type of cultivation is practiced specially in hilly areas, where lands are of sloping nature. The hill and mountain slopes are cut to form terraces and the land is used in the same way as in permanent agriculture. Since the availability of flat land is limited, terraces are made to provide small patches of level land. Soil erosion is also checked due to terrace formation on hill slopes. In our country, terrace cultivation takes place in the states of Punjab, Meghalaya, Haryana, Uttar Pradesh, Himachal Pradesh, and Uttarkhand.

Cropping Seasons in India		
Cropping Seasons	Major crops cultivated	
	Northern States	Southern States
Kharif Season: June - September	Rice, Cotton, Bajra, Maize, Jowar, Tur	Rice, Ragi, Maize, Jowar, Groundnut
Rabi Season: October - March	Wheat, Gram, Rapeseeds, Mustard, Barley	Rice, Maize, Ragi, Groundnut, Jowar
Zaid Season: April - June	Vegetables, Fruits, Fodder	Rice, Vegetables, Fodder

Major Crops Cultivated in India

The major crops of India are divided into four major categories as follows:

1. Food crops (wheat, maize, rice, millets, pulses etc.).
2. Cash crops (sugarcane, tobacco, cotton, jute, oilseeds etc.).

3. Plantation crops (tea, coffee and rubber).
4. Horticulture crops (fruits, flowers and vegetables).

1. Food Crops

Due to its large population, Indian agriculture is largely dominated by the food crops. Food crops include cereals and pulses, amongst which rice, wheat, jowar, bajra, maize, barley, ragi, gram and tur are important.

- ✓ **Rice:** Rice is an indigenous crop. India is the second largest producer of rice in the world after China. It is mainly a tropical crop, growing mainly with mean temperatures of 24°C and annual rainfall of 150 cm. Deep fertile clayey or loamy soils are suited well for rice cultivation. It also needs abundant supply of cheap labour. Rice in India is sown in three ways: i) Broadcasting, ii) Ploughing or drilling, and iii) Transplanting. Due to increased use of High Yielding Variety (HYV) seeds (CR Dhan 205, AR Dhan 306, CRR 451 etc.), many of the indigenous varieties were disappeared. In 2016, the first 10 leading rice producing states are West Bengal (First in India) Uttar Pradesh, Punjab, Tamil Nadu, Andhra Pradesh, Bihar, Chhattisgarh, Odisha, Assam, and Haryana.
- ✓ **Wheat:** Wheat is the second most important food crop of the country, after rice. It accounts for 22 percent of the total area and 34 percent of the total production of food grains in the country. It requires 10-15°C at the time of sowing and 20-25°C at the time of ripening of grains. Over 85% of the India's wheat production comes from 5 states namely Uttar Pradesh, Punjab, Haryana, Rajasthan and Madhya Pradesh. Apart from these regions, the black soil tract of the Deccan covering parts of Maharashtra and Gujarat also contribute a major wheat production.
- ✓ **Jowar:** Jowar is the third important food crop of our country. It is an indigenous plant of Africa. The plant has a tendency to grow in adverse climatic conditions. Its grains are rich in carbohydrates, protein, minerals, and vitamins. Hence, it provides cheap food to the large section of the poor population. It is also used as fodder in many parts of the country. Jowar is essentially a crop of the Peninsular India. Maharashtra, Karnataka, and Madhya Pradesh are the leading producers of Jowar.
- ✓ **Bajra:** Bajra is an indigenous plant of Africa. This forms the staple food for poor people. Its stalks are used as fodder for cattle and for thatching purposes. Bajra is a crop of dry region. Rajasthan is the largest producer of bajra followed by Uttar Pradesh, Haryana, Gujarat and Maharashtra.

- ✓ **Barley:** Barley is one of the important cereals of our country. Besides, being poor man's diet, it is used for making barley water, beer and whiskey. Rajasthan and Uttar Pradesh are the two leading producers of Barley.
- ✓ **Pulses:** Pulses include a large number of crops which are mostly leguminous and rich in vegetable protein. They are used as human food and feeding cattle. They fix atmospheric nitrogen in the soil and hence are usually rotated with other crops. India is the largest producer of pulses. The major pulse growing areas are Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra and Andhra Pradesh.

2. Cash Crops

The crops which are cultivated for commercial purpose are called cash crops. These crops include sugarcane, tobacco, fibre crops (cotton, jute, and mesta) and oilseeds.

- ✓ **Sugarcane:** Sugarcane is the most important cash crop of India and is the second largest producer in the world. This crop provides raw material for the sugar industry which is the second largest industrial category of our country. Besides providing sugar, gur and khandsari, it supplies molasses for alcohol industry and bagasse for paper industry.

India is ranked third in sugar production in the world after Cuba and Brazil. At the state level, Uttar Pradesh is the leading producer of sugarcane followed by Maharashtra, Karnataka, Tamil Nadu and Gujarat.

- ✓ **Cotton:** Cotton is the most important cash crop of India. It provides raw material to the largest industry of India. India ranks second next to China in the production of cotton. About 79% of the total area and production in the country were contributed by four states viz., Gujarat, Maharashtra, Andhra Pradesh and Punjab.
- ✓ **Jute:** It is a tropical fibre crops, grows well in the alluvial soil. It provides raw material for Jute industry. It is used for manufacturing of gunny bags, carpets, hessian, ropes and strings, rugs, clothes, tarpaulins, upholstery etc. West Bengal is the leading state both in cultivation and production of jute. The other cultivators of jute are Bihar, Assam and Meghalaya.
- ✓ **Oil Seeds:** Oil seeds, the premier source of fat in the Indian diet are derived from number of crops like groundnut, rapeseed, mustard, sesame, linseed, sunflower, castor seed, cotton seed, niger seed etc. These provide

oil and oilcake which are used for making lubricants, varnish, medicine, perfume, candles, soaps, manure and cattle feed. Gujarat is India's largest oilseeds producing state. Other major producers of oilseeds are followed by Rajasthan Madhya Pradesh, Maharashtra and Andhra Pradesh. In groundnut production, India is the second largest producer in the world after China.

Plantation Crops

Plantation crops are cultivated for the purpose of exports. These are cultivated in large estates on hilly slopes. Cultivation near the coast is preferable as it facilitates exports. Tea, coffee, rubber and spices are the major plantation crops of India.

- ✓ **Tea:** Tea is an evergreen plant that mainly grows in tropical and subtropical climates. Tea is a labour intensive and grows faster under light shade. Tea plants require high rainfall but its root cannot tolerate water logging. Two major varieties of tea are cultivated in India. They are i) Bohea originated from China and ii) Assamica from India. A number of hybrid varieties have been developed by mixing these two. India is the second largest producer of tea after China in the world. Assam is the larger producer of tea in India. Other states are Tamil Nadu, Kerala and West Bengal.
- ✓ **Coffee:** Coffee is grown in shade and it grows effectively in the altitudes between 1,000 and 1,500 m above mean sea level. There are two main varieties of coffee. They are i) Arabica (High quality-cultivated more in India) and ii) Robusta (Inferior quality). India is the 7th largest producer of coffee globally. Karnataka is the leading producer of coffee in India. It produces 71% in India, and 2.5 % in the world (source; coffee board of India-2018).
- ✓ **Rubber:** Rubber plantations were first established in Kerala in 1902. It needs hot and wet climatic conditions (temperature above 20°C and rainfall above 300cm). Most of the land under rubber belongs to small land holders. The major rubber growing areas are Tamil Nadu, Kerala, Karnataka and Andaman and Nicobar Islands.
- ✓ **Spices:** India has been world famous for its spices since ancient times. These spices mostly used for flavouring or tampering cooked food and for preparing medicines, dyes etc. Pepper, chillies, turmeric, ginger, cardamom, clove and areca nut are the major spices cultivated in India. Kerala is the leading producer of spices in India.

4. Horticulture Crops

It refers to the cultivation of fruits, flowers and vegetables. Fruits and vegetables are important supplement to the human diet, as they provide essential minerals, vitamins, and fibres required for maintaining health. India is in the second position in the production of fruits and vegetables. Apple is mostly produced in Himachal Pradesh, Jammu and Kashmir and Uttarkhand. Production of banana is concentrated in Tamil Nadu and Maharashtra. Orange is cultivated in Maharashtra, Uttarkhand, Himachal Pradesh, Jammu and Kashmir, Tamil Nadu and Karnataka. Grape is cultivated mainly in Uttarkhand, Himachal Pradesh, Jammu and Kashmir, Maharashtra, Andhra Pradesh, Tamil Nadu and Karnataka.

India contributes about 13% of the world's production of vegetables.

Livestock

Livestock is an integral component of the farming system in India. The livestock sector is socially and economically very significant due to its multi-functional outputs and contribution to socio-cultural security. It also helps to improve food and nutritional security by providing nutrient-rich food products, generate income and employment and act as a cushion against crop failure, provide draught power and manure inputs to the crop subsector.

Livestock sector contributes approximately 4 percent of national GDP (Gross Domestic Product) and 25.6 percent to agriculture GDP. As per 19th Livestock Census, conducted in 2012 (Government of India, 2014), India's livestock sector is one of the largest in the world with 11.6 percent of world livestock population, which consists of cattle (37.3 percent), goats (26.4 percent), buffaloes (21.2 percent), sheep (12.7 percent) and pigs (2.0 percent) etc.

Distribution of Livestock in India in 2012

Name of the State	Total No. of Livestock in Lakhs (2012)
Uttar Pradesh	687.2
Rajasthan	577.3
Andhra Pradesh	561.0
Madhya Pradesh	363.3
Bihar	329.4

Cattle

Cattle constitute 37.3 percent of livestock population in India. India has second largest cattle population after Brazil at World level. Among the states,

Madhya Pradesh leads with 10.3 percent followed by Uttar Pradesh (10.2 percent) and West Bengal (8.7 percent). Cattle population in India belongs to different breeds. These include: 1) Milch Breed, 2) Draught breed, and 3) Mixed or General breed.

The following table shows the Livestock population of India in 2012

Name of the Livestock	Population in Lakhs (2012)
Cattle	1.91
Goats	1.35
Buffaloes	1.09
Sheep	0.65
Pigs	0.10

Goats: The goat is the poor man's cow providing milk, meat, skin and hair. It is the main source of meat for the country. While looking at the current status of goat population among Indian states, Rajasthan records first with 16 percent followed by Uttar Pradesh and Bihar.

Buffaloes: Buffaloes are an important source of milk supply for India. Uttar Pradesh has the highest number of buffaloes (28.2%) followed by Rajasthan (9.6%) and Andhra Pradesh (7.9%).

Dairy, Meat and Wool Production

According to State / UT Animal Husbandry Department, during 2016-17, the total production of milk in our nation is 163.7 million tonnes. At this time, the leading producer was Uttar Pradesh with 27.6 million tonnes (16.8 percent) followed by Rajasthan with 19.4 million tonnes (11.8 percent) and Madhya Pradesh with 13.4 million tonnes (8.2 percent) in total milk production. While looking at the meat, the total production is 7.4 million tonnes. Uttar Pradesh is the leading producer with 1.3 million tonnes (18.2 percent), where Maharashtra and West Bengal are estimated with 0.8 million tonnes (11.4 percent) and 0.7 million tonnes (9.6 percent) respectively in the total country's production.

The total wool production of our nation is 43.5 million kilograms. The leading state in the wool production is Rajasthan with 14.3 million kilograms (32.9 percent) followed by Jammu and Kashmir with 7.3 million kilograms (16.7 percent) and Karnataka with 6.6 million kilograms (15.1 percent) in country's total wool production.

Fisheries

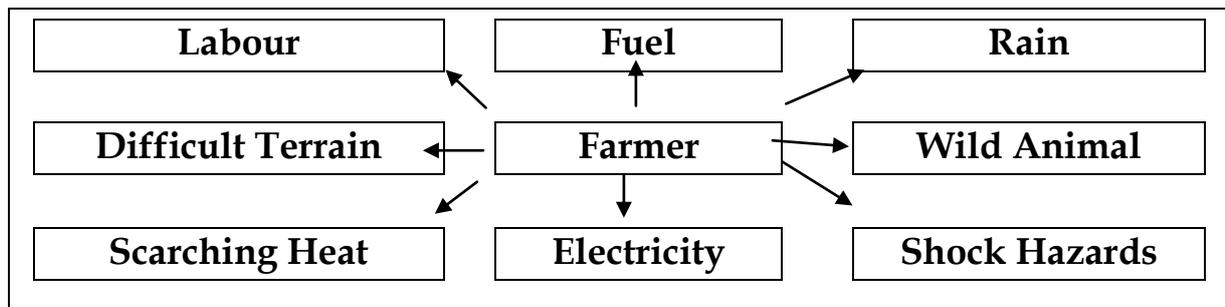
Fisheries in India are a very important economic activity and a flourishing sector with varied resources and potentials. Fishing in India is a major industry in its coastal states, employing over 14 million people. It produces about 3 percent of World's fish and occupies second place among the fish producing nations of the world after China. It also helps in augmenting food supply, generating employment, raising nutritional level and earning valuable foreign exchange. The length of Indian coastline is 7,517 km including the coastline of the islands; however the mainland's length is 6,100 km. In India, fishing is categorised into two types: they are Marine or Sea Fisheries: It includes coastal, off-shore and deep sea fisheries mainly on the continental shelf upto a depth of 200 m. Among the coastal states, Kerala leads in the marine fish production in India.

Inland or Fresh Water Fisheries: Rivers, lakes, canals, reservoirs, ponds, tanks etc. are the sources of fresh water and provide fresh water fisheries. About 50 percent of the country's total fish production comes from the inland fisheries and Andhra Pradesh is the leading producer in India. In India, the important varieties of fishes caught by the fisherman are Cat fish, Herrings, Mackerels, Perches, Eels, Mulletts etc. In 2014-15, the total inland or fresh water fish production was 65.77 lakh tonnes and the total marine fish production was 34.91 lakh tonnes. In India, the top five fish producing states are Andhra Pradesh, West Bengal, Gujarat, Kerala, and Tamil Nadu.

Major issues faced by farmers in India

Indian agriculture and Indian farmers are plagued by several problems; some of them are natural and some others are manmade.

- **Small and fragmented land-holdings:** The problem of small and fragmented holdings is more serious in densely populated and intensively cultivated states in India. About 67 percent of operational land holdings in India are marginal holdings (< 1 hectare).
- **High Costs of Inputs:** Seed is a critical and basic input for attaining higher crop yields and sustained growth in agricultural production. Unfortunately, good quality seeds are out of reach for many small and marginal farmers due to their high price.
- **Infertile Soil:** Indian soils have been used for growing crops over thousands of years without caring much for replenishing. This has led to depletion and exhaustion of soils resulting low productivity.



- **Lack of Irrigation:** Only one-third of the cropped area falls under irrigated area. To make agriculture reliable, irrigation facility has to be developed.
- **Lack of mechanization:** In spite of the large scale mechanization of agriculture in some parts of the country, most of the agricultural operations in larger parts are carried on by human hand using simple and conventional tools.
- **Soil erosion:** Large tracts of fertile land suffer from soil erosion by wind and water. Such kind of areas must be properly treated and restored to its original fertility.
- **Agricultural marketing:** In rural India, agricultural marketing continues in a bad shape. Due to the absence of sound marketing facility, the farmers have to depend on local traders and middlemen for the disposal of their farm products which is sold at low price. Besides, there is a fluctuation in the prices of agriculture products.
- **Inadequate storage facilities:** Storage facilities in the rural areas are either totally absent or grossly inadequate. Under such conditions the farmers are compelled to sell their products immediately after the harvest irrespective of the condition of market.
- **Inadequate transport:** One of the main handicaps with Indian agriculture is the lack of cheap and efficient means of transportation. Even at present there are lakhs of villages which are not well connected with main roads or with market centres.
- **Scarcity of capital:** Agriculture is an important industry which requires a huge capital. The role of capital plays a major role in the purchase of advanced farm machineries and equipment's.

List of important Agricultural Revolutions in India

Revolution	Related Product
Yellow Revolution	Oil seed Production (especially Mustard and Sunflower)
Blue Revolution	Leather / Cocoa / Non-Conventional Products
Brown Revolution	Jute Production
Golden Fibre Revolution	Fruits/ Honey Production / Horticulture Development
Golden Revolution	Fertilizers
Grey Revolution	Onion Production / Pharmaceuticals / Prawn Production
Pink Revolution	Overall production of Agriculture
Evergreen Revolution	Egg Production / Poultry Production
Silver Revolution	Cotton
Red Revolution	Meat Production / Tomato Production
Round Revolution	Potato
Green Revolution	Food Grains
White Revolution	Milk Grains

NOTE

- ❖ **Per Drop More Crop:** (Improving water use efficiency) - Pradhan Mantri Krishi Sinchayee Yojana (PMKSY). The Government of India has been implementing Centrally Sponsored Scheme on Micro Irrigation with the objective to enhance water use efficiency in the agriculture sector by promoting appropriate technological interventions like drip & sprinkler irrigation technologies and encourage the farmers to use water saving and conservation technologies. The following are the five leading states which account for 78% of the total progress under Micro Irrigation scheme: 1. Andhra Pradesh, 2. Karnataka, 3. Gujarat, 4. Maharashtra, and 5. Tamil Nadu.
- ❖ **Livestock Census:** First Livestock Census in India was conducted with the title of Dairy Cattle Census in 1919. Following this, the 19th Livestock census was conducted in October 2012 and it takes place at every five years.
- ❖ **How is livestock census conducted in Tamil Nadu?**
State Government is conducting Livestock Census with the help of Department of Animal Husbandry at state level and Regional Joint Director at District level under the guidelines of Government of India Ministry of Agriculture and farmers welfare, Department of Animal

Husbandry Dairying and Fisheries. The Livestock Census in the country started in the year 1919 - 1920. Since then it has been conducted once in every 5 years. So far 19 livestock census has been conducted and the last census was held in the year 2012. The 20th Live-stock Census - 2017 was scheduled to be conducted from 16th July and will end on 15th October 2017.



4. Resources and Industries

Introduction

Any matter or energy derived from the environment that is used by living things including humans is called a natural resource. Natural resources include air, water, soil, minerals, fossil fuels, plants, wild life etc. Many natural resources are used as raw materials. They play a vital role in the economic development of any region. Natural resources are classified on several basis. Based on continued availability, the resources are categorised into two types. Renewable Resources are those which have natural regeneration after their utilisation. Solar energy, wind energy, biogas, tidal energy, wave energy etc. are the renewable resources. Non- Renewable resources are the sources that cannot be replaced again after utilisation. Coal, petroleum, natural gas etc. fall under this category.

Minerals

Mineral is a natural substance of organic or inorganic origin with definite chemical and physical properties. The process of extracting mineral from the earth is known as mining. The mines near the earth crust are known as open pit mines while the deep mines are known as shaft mines.

Types of Minerals

On the basis of chemical and physical properties, minerals are broadly grouped under two categories. They are metallic and non-metallic minerals.

a. Metallic Minerals

Metallic minerals are the minerals which contain one or more metallic elements in them. Metallic minerals occur in rare, naturally formed concentrations known as mineral deposits. These deposits consist of a variety of valuable metals such as iron, manganese, copper, bauxite, nickel, zinc, lead, gold etc.

i. Iron ore

Iron ore is the most widely distributed elements of the earth crust, rarely occurs in a free state. It enters into the composition of many rocks and minerals especially from igneous and metamorphic rocks. The total recoverable reserves of iron ore in India are about 9602 million tons of haematite and 3408 million tons of magnetite. About 79% haematite deposits are found in Assam, Bihar, Chhattisgarh, Jharkhand, Odisha and Uttar Pradesh. About 93% magnetite deposits occur in Andhra Pradesh, Goa,

Karnataka, Kerala and Tamil Nadu. Karnataka alone contributes about 72% of magnetite deposits of India.

Iron ores are rocks and minerals from which metallic iron can be economically extracted. The ores are usually rich in iron oxides and vary in colour from dark grey, bright yellow, or deep purple to rusty red. The iron is usually found in following form.

Form of Iron ores	Iron Content (%)
Magnetite	72.4%
Hematite	69.9%
Goethite	62.9%
Limonite	55%
Siderite	48.2%

Jharkhand is the leading producer of iron ore with 25% the country's production. Singhbhum, Hazaribagh, Dhanbad and Ranchi districts are its major producers. Odisha with 21% production ranks second. Sundargarh, Mayurbhanj, Sambalpur and Keonjhar districts are its major producers. The magnetite production of Chhattisgarh is 18% (Rajgarh and Bilaspur are its leadings districts) and the Karnataka is 20% (Chikmangalur, Chitradurga, Shimoga and Dharwad districts are its major producers). Andhrapradesh and Karnataka produce about 5% each. Kurnool, Guntur, Cuddapah and Anantapur districts in Andhra Pradesh and Salem, Namakkal, Tiruvannamalai, Tiruchirappalli, Coimbatore, Madurai and Tirunelveli districts in Tamil Nadu are notable for the production of iron ore. SAIL (Steel Authority of India Limited): The Ministry of Steel is responsible for planning and development of iron and steel industry in India.

ii. Manganese

Manganese is a silvery grey element. It is very hard and brittle in nature. It is always available in combination with iron, laterite and other minerals. It is an important mineral used for making iron and steel and serves as basic raw material for alloying. It is the most important mineral for making iron and steel. Nearly 10 kg manganese is required for manufacturing one ton of steel. It is also used in the manufacturing of bleaching powder, insecticides, paints and batteries. Manganese deposits occur mainly as metamorphosed bedded sedimentary deposits. The largest deposits of manganese is found in Odisha(44%) followed by Karnataka (22%), Madhya Pradesh (12%), Maharashtra & Goa(7% each), Andhra Pradesh (4%) and Jharkhand (2%). Rajasthan, Gujarat, Telengana and West Bengal together constitute about 2% of the India's manganese resource. Nagpur, Bhandara and Ratnagiri districts

in Maharashtra and Balaghat and Chhindwara districts in Madhya Pradesh are the leading producers. Odisha is the third largest producer with 24% (Sundargarh, Kalahandi, Koraput and Bolangir districts are the major ones). Other producers are Andhra Pradesh (13%) and Karnataka (6%). Srikakulam, Visakhapatnam, Cuddapah and Guntur districts in Andhra Pradesh and the districts of Shimoga, Bellary, Chitradurga and Tumkur are the important districts of Karnataka. It is the most important mineral for making iron and steel. India is the fifth largest producer of manganese in the world.

iii. Copper

Copper is the first metal that prehistoric man has started using for many purposes. Being flexible, it can be made into utensils of any shape. Brass and Bronze are obtained when the copper alloys with zinc and tin respectively. Copper has been commonly used for making cooking utensils and other objects of common utility. In modern days, it is extensively used in vast variety of electrical machinery, wires and cables. Largest reserves of copper ore is in the state of Rajasthan (53.81%) followed by Jharkhand (19.54%) and Madhya Pradesh (18.75%). The states of Andhra Pradesh, Gujarat, Haryana, Karnataka, Maharashtra, Meghalaya, Nagaland, Odisha, Sikkim, Tamil Nadu, Telangana, Uttarkhand and West Bengal account for 7.9% of the total copper reserves of India.

Jharkhand is the largest producer of copper with 62% of India's production. Singhbhum and Hazaribagh districts are its leading producers of copper. Odisha is the other major producer with 50.2% production. Rajasthan ranks third with 28% production. The districts of Khetri, Alwar and Bhilwara are notables in this state. The states of Uttarkhand (Dehradun and Garhwal districts), Andhra Pradesh (Guntur, Kurnool and Nellore districts), Karnataka (Chitradurga and Hassan districts) and Tamil Nadu contributes about 7% of production each.

iv. Bauxite

Bauxite is an important ore from which aluminium is extracted. It is found in the rock consisting mainly of hydrated aluminium oxides. Bauxite is widely distributed as surface deposits in the areas of laterite soil. Being light in weight and tough, aluminium is used in the manufacture of aircrafts and automobile engines. Bauxite is also used in the manufacture of cement and chemicals. The main bauxite deposits occur in Odisha - 50.2%, Gujarat - 15.8% (Junagadh, Amreli and Bhavnagar districts), Jharkhand - 11.9% (Ranchi and Gumla districts), Maharashtra - 9.9% (Sindhu durg and Ratnagiri), Chhattisgarh - 6.2% (Ballarpur

and Durg districts), and Tamil nadu - 2.7%. Being light in weight and tough, aluminium is used in the manufacture of aircraft s and automobile engines. Bauxite is also used in the manufacture of cement and chemicals. Orissa is the largest producer of bauxite in India with approx. 1,370.5 million tonnes. India's State and Central Government is very supportive in production of Bauxite and other Industrial Minerals in Orissa, Jharkand, Tamil Nadu.

b. Non-Metallic Minerals

These minerals do not contain metal in them. Mica, limestone, gypsum, nitrate, potash, dolomite, coal, petroleum etc are the non- metallic minerals.

i. Mica

In ancient time, Mica was used in ayurvedic medicine. Mica became very popular with the development of electrical industry. Abhrak is a good quality mica. It is translucent, easily splittable into thin sheets, flat, colourless, elastic and incompressible. Mica is used in making of insulating properties, as it withstands high voltage and has low power loss factor. Since it is a non-conductor of electricity, it is exclusively used in electrical goods. It is also used in making of lubricants, medicines, paints and varnishes.

The major deposits of mica are found in Andhra Pradesh(41%) with Nellore, Visakhapatnam, West Godavari and Krishna are its major districts. Other important states in mica deposits are Rajasthan(21%) and Odisha(20%). Bhilwara, Jaipur and Ajmer are the notable districts in Rajasthan and, Rayagada, Bolangir and Sundargarh districts are the major producers in Odisha. Dhanbad, Palamu, Ranchi and Singhbhum districts are the major mica mines in Jharkhand state.

ii. Lime Stone

Limestone is associated with rocks composed of either calcium carbonate or the double carbonate of calcium and magnesium or mixture of both. Limestone also contains small quantities of silica, alumina, iron oxides, phosphorous and sulphur. Limestone is used in the industries of chemicals for soda ash, caustic soda, bleaching powder, paper, cement, iron and steel, glass and fertilizers. The major producing areas: Andhra Pradesh produces about 20% with major concentration in Cuddapah, Kurnool and Guntur districts. Telengana also accounts for about 20% of the country's production with the districts of Nalgonda, Adilabad, Warangal and Karimnagar as major producers. Rajasthan produces about 18% (Jodhpur, Ajmer, Bikhaner and Kota districts), Madhya Pradesh about 12% (Jabalpur and Satna districts) and Tamil Nadu about 8.4% (Salem, Kancheepuram, Tiruchirappalli, Thoothukkudi, Tirunelveli and Virudhunagar districts) of limestone production of India. In

terms of the reserves of limestone, the state of Karnataka leads with 27%, followed by Andhra Pradesh and Rajasthan (12% each), Gujarat (10%), Meghalaya (9%), Telangana (8%), Chhattisgarh and Madhya Pradesh (5% each) and the remaining by other states.

iii. Gypsum

Gypsum is a hydrated sulphate of calcium which occurs as white, opaque or transparent minerals in beds of sedimentary rocks such as limestone, sandstone and shale. Gypsum is used in the manufacture of cement, fertilizers, wall board, plaster of paris and in soil conditioning. The state of Rajasthan alone accounts for 81% of its reserves. 14% of its reserves is found in Jammu and Kashmir and 2% in Tamil Nadu. The remaining 3% resources are found in the states of Gujarat, Himachal Pradesh, Karnataka, Uttarakhand, Andhra Pradesh and Madhya Pradesh. Rajasthan produces 82% of the country's production. Jodhpur, Bikaner and Jaisalmer are notable districts. Jammu and Kashmir produces 14% of country's gypsum. Baramula, Doda and Uri districts are its major producers. The states of Gujarat (Bhavnagar and Jamnagar districts), Uttarkhand (Dehradun and Mussourie districts), Andhra Pradesh (Nellore, Guntur and Prakasam districts) and Tamil Nadu are the other producers with about 4% each.

Energy Resources

The resources from which the electricity generated are called energy resources. Electricity is an important component of our life. No day to day activity takes without the use of this energy. It is also the key factor for all economic activities and industrial development. Energy resources can be classified into renewable and non-renewable. Coal, petroleum, natural gas and nuclear minerals are the sources of non-renewable energy. Water, sun light, wind, bio gas, tides etc., are the sources of renewable energy.

Non-Renewable Energy

a. Coal

Coal is an inflammable organic substance composed mainly of hydrocarbons. Coal is available in the form of sedimentary rocks. It is used in the generation of thermal power. It has close association with the industrial development of any country. Since it is a valuable one, it is called as "Black Gold". Based on carbon content, it is classified in to the following types.

Anthracite:	contains 80 to 90% carbon
Bituminous:	contains 60 to 80% carbon

Lignite:	contains 40 to 60% carbon
Peat:	contains less than 40% carbon

Coal is an important source of energy in India with its varied and innumerable uses. It can be converted into gas, oil, electricity and thermal power. Besides, it forms a basic raw material for the production of chemicals, dyes, fertilizers, paints, synthetic and explosives. Indian coal is mostly associated with Gondwana series of rocks and is primarily found in Peninsular India. The states of Jharkhand, odisha, West Bengal and Madhya Pradesh alone account for nearly 90% of coal reserves of the country. About 2% of India's coal is of tertiary type and is found mostly in Assam and Jammu & Kashmir.

Jharkhand is the largest coal producing state in the country followed by odisha, Chhattisgarh, West Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra. The major coal fields of Jharkhand are Bokaro, North Karanpura, South Karanpura, Giridih, Ramgarh, Daltongunj and Rajmahal. Talcher and Ranapur in Odisha, Korba and Chirmiri in Chhattisgarh, Umaria and Singrauli in Madhya Pradesh, Tandur, Singareni, Kothagudem and Ramagundam in Andhra Pradesh, Wardha, Ballarpur, Chanda and Kampati in Maharashtra and, Raniganj, Asansol and Mejia in West Bengal are the other major coal fields of India.

Indian lignite (brown coal) deposits occur in the southern and western parts of Peninsular India particularly in Tamil Nadu, Pudhucherry and Kerala. The Ministry of coal has over-all responsibility of determining policies and strategies in respect of exploration and development of coal resource in India. Coal India Limited (CIL), NLC India Limited (NLCIL) and Singareni Collieries Company limited (SCCL) are its public sector undertakings.

b. Petroleum (or) Crude oil

The word petroleum has been derived from two Latin words petro (meaning - Rock) and oleum (meaning oil). Thus petroleum is oil obtained from rocks of the earth. Therefore, it is also called mineral oil. Petroleum is an inflammable liquid that is composed of hydrocarbons which constitute 90-95% of petroleum and the remaining is chiefly organic compounds containing oxygen, nitrogen, sulphur and traces of organ metallic compounds. Petroleum is used as a source of power and fuel for automobiles, aeroplanes, ships and locomotives. Lubricants, kerosene, vaseline, tar, soap, terylene and wax are its by-products. Oil in India is obtained from both from on-shore and off-shore areas. As of 2017, the total estimated crude oil reserves of the country is 604.10 million tons. From this, 324.24 million tons (54%) are found in onshore and

279.86 million tonnes (46%) are in offshore areas. The production of crude oil fluctuates from year to year from 2011-12 to 2017-18 but only with marginal variations. The change is invariably in negative. In natural gas production also the trend is negative except the last year. The change is high in the first three years and it is low to moderate in the remaining years.

Western coast offshore oil fields	Eastern coast offshore fields
Mumbai high oil fields (largest 65%)	Bharmaputra valley (Dibrugarh and Sibsagar districts of upper Assam.)
Gujarat coast (2 nd largest)	Digboi oil fields (oldest fields in country)
Basseim oil field, south of Mumbai high	Nahorkatiya oil fields (south west of digboi)
Aliabet oil field, south of Bhavanagar	Moran - Hugrijian oil fields (sibsagar districts of assam)
Ankleshwar	Rudrasagar - Lawa oil fields (sibsagar districts of assam)
Cambay - Luni Region	Surrma valley (Badarpur, Masimpur, Patharia)
Ahmedabad Kalol Region	Offshore of Andaman and Nicobar, Gulf of mannar, Baleshwar coast, Punjab, Haryana and Uttar Pradesh.

c. Natural Gas

Natural gas usually accompanies the petroleum accumulations. It is naturally occurring hydro carbon gas mixture consisting primarily of methane, but commonly includes varying amounts of other higher alkanes and sometimes a small percentage of carbon dioxide, nitrogen and hydrogen sulphides. It is formed when layers of decomposed plants and animals are exposed to intense heat and pressure over thousands of years. It is used as a source of energy for heating, cooking and electricity generation. It is also used as fuel for vehicles and as a chemical feedstock in the manufacture of plastics and other commercially important organic chemicals.

India has a very large proportion of tertiary rock and alluvial deposits particularly in the extra peninsular India. These sedimentary rocks, which were once under the shallow seas, hold the possibility of harbouring oil and gas deposits. The highest concentration of natural gas is found in the Bombay high and basseim oil fields. Jagatia and Gogha in Gujarat, Nahorkatiya and Moran in Assam, Neypaltur, Mangmadam in Thanjavur district in Tamil Nadu, Baranura and Atharnure ranges in Tripura, Barmer and Charaswala in Rajasthan, Miao Pung and Laptang areas in Arunachal Pradesh, Firozpur

district in Punjab, Mausar and Maradpur areas in Jammu and Kashmir and Medinipur in West Bengal are the other areas where natural gas reserves have been discovered. The Gas Authority of India Ltd [GAIL] is doing pioneer work in the field of natural gas exploration. Discovery of gas made rapid strides in the 1985. Oil strikes at Cauvery offshore, at Nanda in Cambay basin and Tarot in Jaisalmer basin in Rajasthan were major discoveries during 1988-89. Recently, it has been found that Krishna- Godavari delta has reserves of Natural gas.

Conventional Energy Sources

a. Thermal power

Thermal power is generated using fossil fuels like coal, diesel, petroleum and Natural gas. National Thermal Power Corporation [NTPC] was established in 1975. At present NTPC has 13 coal based super thermal power projects and 7 gas / liquid fuel based combined cycle projects in the states of Assam, Bihar, Jharkhand, Chhattisgarh, Mizoram and West Bengal. It accounts for over 90% of the installed capacity. Tamil Nadu produces about 5% of the total thermal electricity produced in India. Neyveli, Mettur, Thoothukudi and Ennore (Chennai) are the important thermal power stations in Tamil nadu.

b. Nuclear power

The energy released during nuclear fission or fusion is used to generate electricity. Nuclear energy is generated mainly from the minerals of Uranium and Thorium. Nuclear power programme in India was initiated in 1940's when 'Tata Atomic research commission was incorporated in August 1948. The first nuclear power station was setup at Tarapur near Mumbai in 1969 with the capacity of 320 mw. Later atomic reactors were installed at Rawatbhata (335 MW), near Kota in Rajasthan (100 MW), Kalpakkam (440 MW) and Kudankulam (2,000 MW) in Tamil Nadu and Narora (235 MW) in Uttar Pradesh, Kaiga in (235 MW) in Karnataka and Kakrapara (235 MW) in Gujarat.

Renewable or Non- Conventional Energy Resources

a. Hydro power

Power generated from water is termed as hydroelectricity. Hydro power is the energy harnessed from running water. Hydro power is considered as one of the most economic and non-polluting sources of energy. It contributes nearly 7% of global electricity production. The cost of production of hydroelectricity is relatively low, making it a competitive source of renewable

energy. It is also a flexible mode of power generation as the quantity of production can either be increased or decreased very quickly adapting to changing demands. India is fortunate to have a large potential of hydro-power potential. It is quite unevenly distributed in India. Of the total hydro-electric potential of the country, rivers of Assam, Arunachal Pradesh, Manipur, Nagaland and Tripura account for 30.4%, eastward flowing rivers of the peninsular India 20.9%, westward flowing rivers of the western Ghats (South of the Tapti) 10.5%, the Ganga Basin (excluding the potential of Nepal) 11.7%, the Indus Basin 16.0% and the rivers of central India 10.5%.

b. Solar Energy

Solar Power is the conversion of sunlight into electricity, either directly using photovoltaic (PV) or indirectly using concentrated solar power (CSP). Concentrated solar power systems use lenses or mirrors and tracking system to focus a large area of sunlight into a small beam. Photovoltaic convert light into an electric current using the photovoltaic effect. The mass objectives of the solar thermal energy programme, being implemented by the Ministry of Non-Conventional Energy Source (MNES) are market development, commercialisation and utilisation of heat energy requirement of different applications in domestic, institutional and industrial sectors. Solar power is used in water heaters, refrigerators, drying, street lighting, cooking, pumping, power generator, photovoltaic cells, salon parts etc. Andhra Pradesh, Gujarat, Rajasthan, Maharashtra and Madhya Pradesh are the major solar power producers.

c. Wind Energy

Wind energy is extracted from air flow using wind turbines. It is a cheap and pollution free source of energy. Power from wind mills are used for pumping water and to sail propel ships. Wind power is plentiful, renewable, widely distributed, clean and produces no greenhouse gas emissions during operation. These plants occupy only a less space. The development of wind power in India began in 1986 with first wind farms were set up in coastal areas of Gujarat (Okha), Maharashtra (Ratnagiri) and Tamil Nadu (Thoothukudi) with 55 KW Vestas wind turbines. The capacity has significantly increased in the last few years. India has the fourth largest installed wind power capacity in the world.

d. Biomass Energy

Bio energy may be obtained through bio-degradable materials like animal dung, kitchen wastes, water hyacinth, agricultural residues and city wastes etc. It is clean and cheap source of energy. India has a potential of

about 18 GW of energy from Biomass. Currently, about 32% of total primary energy used in India is derived from Biomass. Energy derived from biomass is mostly used for domestic purposes.

e. Tidal and wave Energy

There are two main sources of ocean energy. They are Ocean tides and Ocean waves. It is estimated that India possesses 8,000-9,000 MW of tidal energy potential. The Gulf of Cambay is the best suited area with about 7,000 mw potential of tidal energy. This is followed by Gulf of Kachch (1,000MW) and sunder bans (100MW). At present a 900mw tidal power plant is proposed to be set up in the Gulf of Kachch region. Wave energy potential in India is estimated to be 40,000 MW. An wave energy power plant of 150 KW(maximum) has been installed at vizhinjam near Thiruvananthapuram. An another plant of this kind has been set up near Andaman& Nicobar Islands.

Industries

It refers to the activities which converts the raw materials into finished products. This sector is called as the value addition sector. On the basis of the source of raw materials, Industries are classified into the Agro based industries, Forest based industries and Mineral based industries.

Agro based industries

These industries draw their raw materials from agricultural sector. The following part discusses the agro based industries in India.

a. Cotton Textile Industry

Textile is a broad term which includes cotton, jute, wool, silk and synthetic fibre textiles. This sector in India with 3400 textiles mills with installed capacity of more than 50 million spindles and 842000 rotors is the second largest in the world. Traditional sectors like hand loom, handicrafts and small power-loom units are the biggest source of employment for millions of people in rural and semi urban areas. The cotton textile industries contribute about 7% of industrial output, 2% of India's GDP and 15% of the country's export earnings. It is one of the largest sources of employment generation in the country. With over 45 million employees, the total employment in this industry is well over 25million worker. At present there are 1,719 textiles mills in the country. Out of which 188 mills are in public sector, 147 in cooperative sector and 1,284 in private sector. Currently, India is the third largest producer of cotton and has the largest loom arc and ring spindles in the world. At present, cotton textile industry is the largest organized modern industry of India. About 16% of the industrial capital, 14%

of industrial production and over 20% of the industrial labour of the country are engaged in this industry. The higher concentration of textile mills in and around Mumbai, makes it as “Manchester of India”. Presence of black cotton soil in Maharashtra, humid climate, presence of Mumbai port, availability of hydro power, good market and well developed transport facility favour the cotton textile industries in Mumbai. The major cotton textile industries are concentrated in the states of Maharashtra, Gujarat, West Bengal, Uttar Pradesh and Tamil Nadu. Coimbatore is the most important centre in Tamil Nadu with 200 mills out of its 435 and called as “Manchester of South India”. Erode, Tirupur, Karur, Chennai, Thirunelveli, Madurai, Thoothukudi, Salem and Virudhunagar are the other major cotton textiles centres in the state.

b. Jute Textiles

Jute is a low priced fibre used mainly for making package materials like gunny bags. Today jute is blended with cotton and wool to produce textiles. India is the largest producer of jute goods contributing 35% of the world’s total output. This is the second important textile industry in India after cotton textiles. Jute is the golden fibre which meets all the standards of goods packing with its natural, renewable, bio degradable and eco-friendly products. The first jute mill in India was established at Rishra near, Kolkata in 1854 by the English man George Auckland.

India tops in the production of raw jute and jute goods and second in the export of jute goods next to Bangladesh. Jute production includes gunny bags, canvas, pack sheets, jute web, carpets, cordage, hessians and twines. Now jute is also being used in plastic furniture and insulation bleached fibres to blend with wool. It is also mixed with cotton to make carpet and blankets. The major jute producing areas are in West Bengal and concentrated along the Hooghly river within the radius of six kilometre of Kolkata. Titagarh, Jagatdat, Budge-Budge, Haora and Bhadreswar are the chief centres of jute industry. Andhra Pradesh, Bihar, Uttar Pradesh, Assam, Chhattisgarh and Odisha are the other jute goods producing areas.

c. Silk Industry

India has been well known for the production of silk. Since the ancient times, India is the second largest producer of raw silk next only to China. Sericulture is a labour intensive industry and provides employment to 7.56 million people make to weaker and marginalised sections of society. Karnataka is the largest producer of silk with an average of 8200 metric tons every year which is about one third of the total silk production of India. Other major producers of silk are West Bengal, Jammu Kashmir, Bihar, Jharkhand,

Chhattisgarh, Uttar Pradesh, Punjab, Assam and Tamil Nadu states. India exports exclusively silk fabrics, silk scarves, dress material and sarees. It exports to the principal countries like Europe, U.S.A, U.K, Russia, Saudi Arabia, Kuwait and Singapore.

d. Sugar Industry

Sugar can be produced from sugar cane, sugar-beets or any other crop which have sugar content. In India, sugar cane is the main source of sugar. At present this is the second largest agro based industry of India after cotton textiles. India is the world's second largest producer of sugar cane after Brazil. This industry provides employment to 2.86 lakh workers. Sugar industry is decentralized and located near the sugarcane growing areas as they are weight loosing and bulky to transport. Uttar Pradesh is the largest producer of sugar, producing about 50% of the country's total. Other major producers are Maharashtra, Uttar Pradesh, Karnataka, Andhra Pradesh, Tamil Nadu, Bihar, Punjab, Gujarat, Haryana and Madhya Pradesh states. These states account for more than 90% of the sugar mills and sugar production.

Forest based industries

Forest provide us with different types of material which are used as raw material for certain industries like paper, lac, sports goods, plywood etc.

a. Paper industry

Paper Industry has emerged as a diversified and specialized industry in India that produces numerous types of papers that comes in various use such as sheet paper, paper boxes, tissues, paper bags, stationery, envelopes and printed-paper products such as books, periodicals, and newspapers. In India the Soft wood is the principal raw material used for making paper especially newsprint and high class printing papers. Paper is the pre-requisite for education and literacy and its use is an index of advancement in these two fields as well as the overall well-being of the society.

The first successful effort was made in 1867 with the setting up of the RoyalBengal paper mills at Ballyganj near Kolkata. Subsequent successful efforts were made at Lucknow in 1879, Titagarh in 1882, Pune in 1887, Raniganj in 1892, Kankinra in 1892 and Naihati in 1918. The raw materials for paper industry includes wood pulp, bamboo, salai and sabai grasses, waste paper and bagasse. West Bengal is the largest producer of paper in the country followed by Madhya Pradesh, Odisha and Tamil nadu states.

Mineral based industries

Mineral based industries use both metallic & non-metallic minerals as raw materials. The major mineral based industry of country is the iron steel industry

a. Iron and steel industries

Iron and steel industry is called a basic metallurgical industry as its finished product is used as raw material by host of other industries. Several industries like engineering, heavy machines and machine tools, automobile, locomotives and railway equipment industries use iron and steel as their primary raw material. Due to this, the steel producing capacity of a country is generally taken as an indicator of its level of industrial development. The modernization of the industry was started in 1907 with the establishment of Tata Iron and Steel Company at Sakchi, now called Jamshedpur. Iron and steel industry of India is mainly concentrated in the states of Jharkhand, West Bengal and Odisha. Proximity to the coal fields of Jharia, Raniganj, Bokaro and Karanpura and the iron ore mines of Mayurbhanj, Keonjar and Brona are responsible for this. This area also has sufficient deposits of limestone, dolomite, manganese, silicon and dolomite which are required for the industry.

S.N O	Name of Industry	Place	Establish ment year	Product
1.	Tata Iron and Steel Company (TISCO)	Jamshedpur, Jharkhand	1911	Pig Iron
2.	Indian Iron and steel Company (IISCO)	Burnpur, Hirapur, Kulti, West Bengal	1972	Pig Iron & Crude steel
3.	Visweshwaraya Iron Steel Ltd (VISL)	Bhadravati, Karnataka	1923	Alloy and Sponge steel
4.	Hisdustan Steel Ltd (HSL) Collaborated with Russia	Bhilai, Chattisgarh	1957	Railway Equipment's and Ship Building
5.	Hindustan Steel Ltd (HSL) Collaborated with Germany	Rourkela, Odisha	1965	Hot and Cold rolled sheets, Galvanized sheets and electrical plates
6.	Hindustal Steel Ltd (HSL) Collaborated with United Kingdom	Durgapur, west Bengal	1959	Alloy steel, Construction materials and

				railway equipment's
7.	Hisdustan Steel Ltd (HSL) Collaborated with Russia	Bokaro, Jharkhand	1972	Sludge and Slog
8.	Salem Steel Ltd	Salem, Tamil Nadu	1982	Stainless Steel
9.	Vijayanagar Steel Plant	Tornagal, Karnataka	1994	Flat steel and Long Steel
10.	Visakhapatnam Steel Plant (VSO)	Visakhapatnam, Andhra Pradesh	1981	Hot Metal

Automobile Industry

India is set to emerge not only as a large domestic market for automobile manufacturers, but also as a crucial link in the global automotive chain. It is one of the most dynamic industrial groups in India. The first automobile industry of India was started in 1947. The industry is the Premier Automobiles Ltd located at Kurla (Mumbai). It was followed by the Hindustan Motors Ltd at Uttarpara (Kolkata) in 1948. At present, India is the 7th largest producer of automobile manufacturers which include two wheelers, commercial vehicles, passenger car, jeep, scooty, scooters, motor cycles, mopeds and three wheelers. Major centres are at Mumbai, Chennai, Jamshedpur, Jabalpur, Kolkata, Pune, New Delhi, Kanpur, Bengaluru, Sadara, Lucknow and Mysuru. Tata Motors, Maruti Suzuki, Mahindra & Mahindra and Hindustan Motors are the largest passenger car manufacturers of Indian companies in the country. Presence of foreign car companies such as Mercedes Benz, Fiat, General Motors, Toyota and the recent entry of passenger car manufacturers BMW, Audi, Volkswagen and Volvo makes the Indian automobile sector a special one. Tata Motors, Ashok Leyland, Eicher Motors, Mahindra & Mahindra and Ford Motors are the major Indian companies which manufacture commercial vehicles. MAN, ITEC, Mercedes-Benz, Scania and Hyundai are the foreign companies engage in the manufacture of commercial vehicles. Two-wheeler manufacturing is dominated by Indian companies like Hero, Bajaj Auto and TVS.

The automobile industries are found in four clusters viz; Delhi, Gurgaon and Manesar in North India, Pune, Nasik, Halol and Aurangabad in West India, Chennai, Bengaluru and Hosur in South India and Jamshedpur and Kolkata in East India. Electrical and Electronic

Industries

Heavy electrical industries manufacture equipment used for power generation, transmission and utilization. Turbines for steam and hydro power plants, boilers for thermal power plants, generators, transformers, switch gears etc. are the chief products of this industry. The most important company in the field of heavy electrical is Bharat Heavy Electricals Ltd (BHEL). It has its plants at Hardwar, Bhopal, Hyderabad, Jammu, Bengaluru, Jhansi and Tiruchirappalli. This Industry covers a wide range of products including television sets, transistor sets, telephone exchanges, cellular telegram, computers and varied equipment's for post and railway, defence and meteorological department. Bengaluru is the largest producer of electronic goods in India, hence it is called as the "Electronic Capital of India". The other major producers of electronic goods centers are Hyderabad, Delhi, Mumbai, Chennai, Kolkata, Kanpur, Pune, Lucknow, Jaipur and Coimbatore.

Software Industry

India is home to some of the finest software companies in the world. The software companies in India are reputed across the globe for their efficient IT and business related solutions. The Indian Software Industry has brought about a tremendous success for the emerging economy. In India, software industry began in 1970 with the entry of Tata Consultancy Services (TCS). Along with this, L & T, InfoTech, i-Flex, Accenture, Cognizant, GalexE Solutions India Pvt Ltd and ITC InfoTech are the major software industries in the country. At present, there are more than 500 software companies all over India. It exports software service to nearly 95 countries in the world. The main centres of IT parks are located in Chennai, Coimbatore, Thiruvananthapuram, Bengaluru, Mysuru, Hyderabad, Visakhapatnam, Mumbai, Pune, Indore, Gandhi Nagar, Jaipur, Noida, Mohali and Srinagar.

Major challenges of Indian Industries

Industries in India face many problems. Some major problems are listed below.

- Shortage and fluctuation in Power Supply.
- Non- availability of large blocks of land.
- Poor access to credit.
- High rate of interest for borrowed loan.
- Non- availability of cheap labourers.
- Lack of technical and vocational training for employees.
- Inappropriate living conditions nearby industrial estates.

NOTE

- ❖ The organisations associated with minerals in India are the Geological Survey of India (Headquarter is at Kolkata), Indian Bureau of Mines (Headquarter at Nagpur) and Non-Ferrous Material Technology Development Centre (NFTDC), located at Hyderabad. The Ministry of Mines is responsible for the administration of all mines and minerals (Development and Regulation Act, 1957).
- ❖ MOIL- Manganese Ore India Limited state-owned manganese-ore mining company headquartered in Nagpur. With a market share of 50%, it was the largest producer of manganese ore in India.
- ❖ Hindustan Copper Ltd is a Government-owned corporation in the central public Enterprise under the Ministry of mines, India. HCL is the only vertically integrated copper producer in India engaged in a wide spectrum of activities ranging from Mining, Beneficiation, Smelting, Refining and Continuous Cast Rod manufacturer. Bauxite is an oxide of aluminium; the name has been derived after the French word Le Baux.
- ❖ National Aluminium Company Limited, abbreviated as NALCO, (incorporated 1981) has units in Odisha at places like Angul and Damanjodi. It was incorporated as a public sector enterprise of the Ministry of Mines, Government of India in 1981.
- ❖ Coal India Limited (CIL) is an Indian state-controlled coal mining company headquartered in Kolkata, West Bengal, its field offices are located at Dhanbad, Ranchi, Bilaspur, Nagpur, Sambalpur, Kothagudam and Asansol. It is the largest coal-producing company in the world.
- ❖ The Ministry of Petroleum and Natural Gas (MOP&NG) is a ministry of the Government of India. It is responsible for the exploration, production, refining, distribution, marketing, import, export, and conservation of petroleum, natural gas, petroleum products, and liquefied natural gas in India.
- ❖ Gail (India) Limited (GAIL) (formerly known as Gas Authority of India Limited) is the largest state-owned natural gas processing and distribution company in India. It is headquartered in New Delhi. It has the following business **segments**: natural gas, liquid hydrocarbon, liquefied petroleum gas transmission, petrochemical, city gas distribution, exploration and production, GAILTEL and electricity generation.
- ❖ Compressed natural gas (CNG) (methane stored at high pressure) is a fuel which can be used in place of gasoline, diesel fuel and propane/LPG. In comparison to other fuels, natural gas poses less of a threat in the event of a spill, because it is lighter than air and disperses quickly when released. Biomethane - cleaned-up biogas from anaerobic digestion or landfills - can be used. Natural gas vehicles are increasingly used in Delhi,

Ahmedabad, Mumbai, Pune, Kolkata Lucknow, Kanpur, Varanasi, etc.

- ❖ The Nuclear Power Corporation of India Limited (NPCIL) is an Indian public sector undertaking based in Mumbai, Maharashtra. It is wholly owned by the Government of India and is responsible for the generation of nuclear power for electricity. NPCIL is administered by the Department of Atomic Energy (DAE) is responsible for designing, and operating the nuclear power stations in India.
- ❖ NHPC Limited (National Hydroelectric Power Corporation) is located in Faridabad, India
- ❖ The first hydro-electric power station in India was established at “Darjeeling” in 1897.
- ❖ Solar Energy Corporation of India Limited (A Government of India Enterprise) head quarter is located at New Delhi.
- ❖ Tamil Nadu has the largest installation of wind turbines in the country in the
- ❖ Muppandal-Perungudi area near Kanniyakumari is the largest concentrations of wind farm capacity at a single location in the world.
- ❖ The National Institute of Wind Energy (NIWE), Chennai was established in Tamil Nadu in 1998 as an autonomous institution under the administrative control of the Ministry of New and Renewable Energy. NIWE main activities include resource assessment and testing & certification.
- ❖ The first cotton textile mill was established at Fort Gloster near Kolkata in 1818.
- ❖ Byssinosis, also called “brown lung disease” or “Monday fever”, is an occupational lung disease caused by exposure to cotton dust in inadequately ventilated working environments.
- ❖ National jute board is headquarter at Kolkata.
- ❖ Ginning is the process of cotton fibre is separated from the cotton seed.
- ❖ The first attempt to produce iron and steel unit was set up at Porto Novo in Tamil Nadu in 1830.
- ❖ CSTRI is the only research institute in the country dedicated to the Research & Developmental activities related to silk technology. CSTRI was established in the year 1983 by the Central Silk Board, Ministry of Textiles, Govt. of India having head quarter at Bangalore
- ❖ Development Commissioner for Handlooms was set up as an attached non-participating office on 20th November, 1975 under the Ministry of Commerce. At present it is functioning under the Ministry of Textiles having headquarters at Udyog Bhawan, New Delhi.
- ❖ The first paper mill of India was started in 1812 at Serampore in West Bengal.

- ❖ National Newsprint and Paper Mills (NEPA) is at Nepanagar in Burhanpur District of Madhya Pradesh.
- ❖ Chennai is nicknamed as the “Detroit of Asia” due to the presence of major automobile manufacturing units and allied industries around the city. Make in India program was launched in 2014 to put India on the world map as a major hub for global design and manufacturing.



5. India - Population, Transport, Communication & Trade

Introduction

The study on human population is one of the most important aspects in geography of any region. The human population has many components but the most fundamental are its number, composition, distribution and density. Therefore, it is essential to study these components. The study on these aspects also would reveal the workforce of the country. The population of India as per 2011 census is 1,210.19 million (1,21,01,93,422). It shows an increase of 19.31crores from the population of 2001. Population Census of India provides the detailed information about the demography of India. Along with population, we will study about the transport and communication of India in this chapter.

Population

The total number of people residing in a country at a specified period of time is called the 'Population' of that country. India is the second most populous country in the world next only to china. India covers only 2.4 percent of the land area of the world, but is the home of about 17.5 percent of the world's population. It shows that the proportion of population of India is far higher than the proportion of its area. Thus, a little more than one out of every six persons in the world is from India. Our population is almost equal to the combined population of the USA, Indonesia, Brazil, Pakistan, Bangladesh and Japan and total population of these six countries is 1214.3 million.

Census

Population census is the total process of collecting, compiling, analysing or otherwise disseminating demographic, economic and social data pertaining, at a specific time, of all persons in a country or a well-defined part of a country. It happens in an interval of ten years. The data collected through the census are used for administration, planning, policy making as well as management and evaluation of various programmes by the government.

Distribution and Density of Population

The term 'Population Distribution' refers to the way the people are spaced over the earth's surface. The distribution of population in India is quite uneven because of the vast variation in the availability of resources. Population is mostly concentrated in the regions of industrial centres and the good agricultural lands. On the other hand, the areas such as high mountains, arid lands, thickly forested areas and some remote corners are very thinly

populated and some areas are even uninhabited. Terrain, climate, soil, water bodies, mineral resources, industries, transport and urbanization are the major factors which affect the distribution of population in our country.

Uttar Pradesh is the most populous state in the country with a population of 199.5 million followed by Maharashtra (112.3 million), Bihar (103.8 million) West Bengal (91.3 million) and the combined Andhra Pradesh (84.6 million). These five states account for about half of the country's population. More than one fourth of the population live only in the two states of U.P and Maharashtra. Sikkim is the least populous state of India(0.61 million). Delhi with 16.75 million population tops among the Union territories.

The uneven distribution of population in the country is the result of several factors such as physical, socio-economic and historical ones. The physical factors include relief, climate, water, natural vegetation, minerals and energy resources. Socio-economic factors consists of the religion, culture, political issues, economy, human settlements, transport network, industrialization, urbanization, employment opportunity etc.

Density of population

Population density is a better measure of understanding the variation in distribution of population. It is expressed as number of persons per unit area usually per sq km. According to 2011, the average density of population of India is 382 persons per sq.km. India is one of the most thickly populated ten countries of the world. The most densely populated state of India is Bihar and the state with least population density is Arunachal Pradesh. Among the union territories, Delhi is the densely populated one with 11,297 per sq.km, while Andaman and Nicobar Islands have the lowest density of population.

Spatial pattern of population density	
Density	Places
Very Low density (less than 150 persons per sq.km)	Arunachal Pradesh (17), Andaman and Nicobar Islands (46), Mizoram (52), Sikkim (86) Nagaland (120), Manipur (122), Himachal Pradesh (123), Jammu and Kashmir (124) and Meghalaya (132)
Low Density (150 to 300 persons per sq.km)	Arunachal Pradesh (17), Andaman and Nicobar Islands (46), Mizoram (52), Sikkim (86) Nagaland (120), Manipur (122), Himachal Pradesh (123), Jammu and Kashmir (124) and Meghalaya (132)
Moderate Density	Gujarat (308), The combined Andhra Pradesh (308)

(300 to 500 persons per sq.km.)	Karnataka (319), Tripura (350), Maharashtra (365), Goa (394), Assam (397) and Jharkhand (414) are the states with moderate population density. Assam has tea estates, Andhra Pradesh, Karnataka and Jharkhand
High Density (500 to 1000 persons per sq.km)	Punjab (550), Tamil Nadu (555), Haryana (573), Uttar Pradesh (827) and Kerala (859) The union territory of Dadra and Nagar Haveli (698)
Very High Density (greater than 1000 persons per sq.km)	West Bengal (1029), Bihar (1102), Lakshadweep (2013), Daman and Diu (2169), Puducherry (2598), Chandigarh (9252) and Delhi (11.297).

Population Growth and Change

The growth rate of population is an important demographic feature. It not only helps in understanding the population change that a society has undergone in the past but also helps in predicting the future demographic characteristics of an area. Population growth refers to the change in the number of inhabitants of a country/territory during a specified period of time. The growth of population is expressed in percentage and is described as the growth rate of population. The following table shows the decadal growth rate of population from 1901 to 2011.

Growth of population in India has gone through the different phases. Population of the country in 1901 was 238 million and it grew to 1,210 million over a period of little more than a century. The following are the different stages of population growth of India.

The Period of Stagnant Population (1901-1921): During the first phase of 20 years (1901-1921), the population of India grew by 15 million. The year 1921 registered a negative growth rate of -0.31% which happened only once throughout the demographic history of India and is called the year of Great Demographic Divide.

The Period of Steady Growth (1921- 1951): During the second phase of 30 years (1921-1951), the population of India grew by 110 million.

The Period of Steady Growth (1951- 1981): During the third phase (1951-1981), the population of India grew from 361 million in 1951 to 683 million in 1981. Growth rate in this period is almost doubled when compared to the previous phase of growth rate. This period is often referred to as the period of population explosion.

The period of High Growth with Definite Signs of Slowing Down (1981-2011): Population of India increased from 685 million to 1210 million during this phase. The growth rate of population decreased from one census to other. This marks the beginning of a new era in the demographic history of India.

Population change refers to an increase or decrease of population of an area from one period to another period. Population growth is influenced by the birth rate, death rate and migration. These three make the changes in population. Birth rate refers to the number of live births per thousand people in a year and the

Death rate refers to the number of deaths per thousand people in a year. The rapid decline in death rate is the major cause of the rapid growth of population in India.

Migration

It is the movement of people across regions and territories. It can be internal (within a country) or international (between the countries). Internal migration does not change the size of population of a country but it influences the distribution of population in a nation. It plays an important role in changing the composition and distribution of population. In India, the mass migration is from rural to urban. Unemployment and under employment in the rural areas are the push factors and the employment opportunity and higher wages in the urban areas caused by the industrial development are the pull factors of migration in the country. 45 out of 121 crores of people in India are reported to be migrants as per 2011 census. Migrants constitute about 37% of population. Migrants are 48% from female and 52% from male.

Population composition

Population composition refers to the characteristics such as age, sex, marital status, caste, religion, language, education, occupation etc. The study of composition of population helps us to understand the social, economic and demographic structure of population.

Age composition

The age composition of population refers to the number of people in different age groups in a country. It is one of the most basic characteristics of a population. It helps us to understand the proportion of population in dependent and independent category. Population of a nation is generally grouped in to three broad categories. In India, the children who have less than 15 years of age constitute 29.5% and the people above 60 years constitute 8.0%.

So, the dependent population in India is 37.5% and the independent population (16- 59 yrs) is 62.5%. It shows that our country has enormous manpower.

Sex Ratio

Sex ratio is defined as the number of females per 1000 male population. This is an important social indicator to measure the extent of equality between males and females in a society at a given time. According to 2011 census, the sex ratio of the country is 940 females per 1000 males. This suggests that the size of female population is lower than males. Only in the state of Kerala and the union territory of Pondicherry the sex ratio is greater than 1000. It is 1084 in Kerala and 1038 in Puducherry. The lowest sex ratio is recorded in the union territory of Daman and Diu(618).

Literacy Rate

The people who are able to read and write are known as literates. It is an important indicator of quality of people. The percentage of literate people to the total population is termed as literacy rate. There has been a steady improvement in the literacy levels in India. India's literacy rate as per 2011 census is 74.04%. From this, the literacy rate of male is 82.14% and the female is 65.46%. It shows that still there is a vast gap (16.68%) between the male and female literacy rates. Kerala ranks first in the country with a literacy rate of 93.91% followed by union territory Lakshadweep with 92.28%. The lowest literacy rate is found in Bihar (63.82 %).

Occupational structure

The economically active part of a country's population is enumerated during the census operations and stated as workers. Workers are placed under three fold categories in census record. They are main workers, marginal workers and non-workers. According to the Census of India, all those who had worked for the major part of the preceding year (at least 6 months or 183 days) are recorded as main workers. Those who worked for less than six months are recorded as marginal workers and the people who have not worked at all comes under non- workers. Work participation rate denotes the percentage of total workers i.e., total main and marginal workers to the total population in an area. The work participation rate in India is 39.79% in 2011, out of which the work participation rate of male is 53.25% and the female is 25.51%. From the workers, main workers constitute 75.23% and the remaining 24.77% of the people belong to marginal workers.

Population Dynamics

Human population dynamics is a field that tracks factors related to changes in the size of population and its characteristics. Predicting population changes is an important aspect of population studies. The demographic trend affects the economic, social, and environmental systems. An increase in human population can affect the quality of natural resources like biodiversity, air, land, and water. The size of Population and characteristics undergoes changes constantly. These changes are reflected clearly in every other aspect of our country.

Problems of over Population

In India, growing pressure of Population on resource base, created many socioeconomic, cultural, political, ecological and environmental problems. The Population problems vary in space and time and differ from region to region. Some of the major issues created by the overpopulation in our country are overcrowding, unemployment and under employment, low standard of living, malnutrition, mismanagement of natural and agricultural resources, unhealthy environment etc.

Urbanization

The process of society's transformation from rural to urban is known as urbanization. The level of urbanization of a place is assessed based on the size of population of the towns and cities and the proportion of population engaged in non-agricultural sectors. These two are closely linked to the process of industrialization and expansion of the secondary and tertiary sectors of economy.

Urbanization in India

The level of urbanization is measured in terms of percentage of urban population. The level of urbanization in the country has increased more than three times from 1901 to 2011. The percentage of urban population of India was 27.82% in 2001 and it rose to 31.16% in 2011 shows an increase of 3 % in a decade. The level of urbanization varies widely among the states. Goa is the most urbanized state with 62.17% of urban population. Himachal Pradesh is the least urbanized state with 10.04% of urban population. Among the Union territories, Delhi is the most (97.50 %) urbanized region followed by Chandigarh (97.25%). Among the major states, Tamil Nadu continues to be the most urbanized state with 48.4% percent of urban population followed by Kerala (47.7%) and Maharashtra (45.2%).

S. No	Type of Towns /UAs/ OGs	2001 (in Numbers)	2011 (in Numbers)
1.	Statutory towns	3799	4041
2.	Census Towns	1362	3894
3.	Urban Agglomeration	384	475
4.	Out Growths	962	981

As per 2011 Census, there are 7,935 towns (statutory and census) in the country. The number of towns has increased to 2,774, from 2001 census. In 2011, 475 Urban agglomeration (UAs) with 981 outgrowths (OGs) have been identified as Urban Agglomerations as against 384 UAs with 962 OGs in 2001 Census. Out of 468 UAs belongs to Class I category, 53 UAs have the population of one million and above each and these urban centres are known as "Million Cities". These are the major urban centres in the country. Among the Million Cities, there are three major Urban Agglomerations with more than 10 million population each and are known as "Mega Cities". They are Greater Mumbai UA (18.4 million), Delhi UA (16.3 million) and Kolkata UA (14.1million).

Impact of Urbanization

Urbanization and population concentration go hand - in - hand and are closely related to each other. A rapid rate of urbanization in a society is taken as an indicator of its economic development. Urbanization is increasing rapidly in the developing countries including India. Rural to urban migration leads to population explosion in urban areas. Metropolitan cities like Mumbai, Kolkata and Delhi have more population than that can accommodate. The urban population of India had already crossed the 377million in 2011, which is more than the total population of USA. By 2030, more than 50% of India's population is Expected to live in urban areas. The following are the major problems of urbanization in India

- It creates urban sprawl.
- It makes overcrowding in urban centres.
- It leads to shortage of houses in urban areas.
- It leads to the formation of slums.
- It increases traffic congestion in cities.
- It creates water scarcity in cities.
- It creates drainage problem.
- It poses the problem of solid waste management.
- It increases the rate of crime.

Human Development

Dr. Mahabub-ul-haq defined as "it is a process of enlarging the range of people's choice, increasing their opportunities for education, health care, income and empowerment. It covers the full range of human choices from a sound physical environment to economic, social and political freedom".

Human Development Indicators: (as per UNDP) Population trends, health outcomes, education achievements, national income and composition of resources, work and employment, human security, human and capital mobility, supplementary indicators: perceptions of well-being and status of fundamental rights treaties are the human development indicators.

Measuring of Human Development

Human Development Index (HDI) is a composite index focusing on three basic dimensions of human development: i) Health - Life expectancy at birth ii) Education - Expected years of schooling for school age children and average years of schooling for the adult population. iii) Income - Measured by-gross national income and percapita income.

Human Development Classification

HDI classifications are based on HDI fixed cut off points, which are derived from the quartiles of distributions of the component indicators. The HDI of less than 0.550 is used for low human development, 0.550 - 0.699 stands for medium human development, 0.700 - 0.799 for high human development and 0.8 or greater for very high human development.

Transportation

Transport is a system in which passengers and goods are carried from one place to another. Transport system is considered as the lifeline of a country. Earlier man travelled on foot or used animals for transport. With the discovery of wheel, transport was made easier and gradually different means of transport were developed. There are three major means of transport in the world.

Means of Transport		
Land	Water	Air
<ul style="list-style-type: none">• Road ways• Railways• Pipelines	<ul style="list-style-type: none">• Inland• waterways• Ocean routes	<ul style="list-style-type: none">• Domestic airways• International Airways

Transport Network in India

Transport is one of the most important components of infrastructure and it is essential for economic development of a country, especially for a large country like India. India has a good transport network of roads, railways, airways and waterways providing necessary connectivity between different parts of the country.

Roadways

Roads play an important role in carrying goods and passengers for short, medium and long distances. It is highly suitable for short distance services. It is comparatively easy and cheap to construct and maintain roads. Road transport system can establish easy contact between farms, fields, factories and markets and can provide door to door transport services. Roads are the most universal mode of transport. Indian roads are cost efficient. It is used by all sections of people in the society. India has the second longest road network in the world with a total length of 56,03,293 km as of 2016. About 85% of passengers and 70 % of freight traffic are carried by roads every year. For the purpose of construction and maintenance, roads are classified into National Highways (NH), State Highways (SH), District Roads, Rural Roads (Village roads), Border Roads and International Highways.

1. Classification of Roads in India

a. National Highways (NH)

National Highways form the most important system of road transportation in India. These highways are running through length and breadth of the country connecting capitals of states, major Ports, rail junctions, industrial and tourist centres. Ministry of Road Transport and Highways of India, is responsible for the development and maintenance of National Highways in India. The total length of the National Highways (NHs) in India is 1,01,011 km which accounts for 1.8 % of the total road network length in 2016. The longest National highway is NH-7 which runs from Varanasi in Uttar Pradesh to Kanniyakumari in Tamil Nadu covering a distance of 2369 km. The shortest national highway is NH-47A, which runs from Ernakulum to Kochi port (Willington Island) covering a distance of 6 km.

b. State Highways

The state highways are usually roads that link important cities, towns and district headquarters within the state and connect them with national highways or highways of neighbouring states. These roads are administered

and financed by state governments. State Highway runs to the length of 1, 76,166 km as of 2016.

c. District Roads

District Roads provide connectivity between the district and taluk headquarters with the state highways and national highways. District Roads are constructed and maintained by the Public Works Department of the states. The total length of the road of this category is 5,61,940 km(16.81%) in 2016.

d. Rural Roads (Village Roads)

Rural roads connectivity is a key component of rural development. These roads are vital for providing links in the rural areas. It links the different villages with their neighbouring towns. They are maintained by Village Panchayats. The total length of rural roads in India is 39,35,337 km as of 2016. Rural roads consist of Panchayat roads, (Zilla Parishad, Panchayat Samiti, Gram Panchayat); roads of the Pradhan Mantri Gram Sadak Yojana (PMGSY) and those constructed by the State PWDs.

e. Border Roads

These are the roads of strategic importance in border areas. They are constructed and maintained by Border Roads Organization. It was established in 1960 for the development of the roads of strategic importance in the northern and north-eastern border areas. Border Roads Organization has constructed world's highest road joining Chandigarh and Leh in Ladakh. This road runs at an average altitude of 4,270 meters.

Golden Quadrilateral: 5,846 km long road of 4/6 lanes connecting, India's four metropolitan cities: Delhi-Kolkata-Chennai-Mumbai-Delhi. This project was launched in 1999. North-South and East-West Corridors: North-South corridor aims at connecting Srinagar in Jammu and Kashmir with Kanyakumari in Tamil Nadu (including Kochi-Salem Spur) with 4,076km long road. The East-West corridor has been planned to connect Silchar in Assam with the port town of Porbandar in Gujarat with 3,640km of road length. The two corridors intersect at Jhansi.

f. Expressways

These are multi-lane good quality highways for high speed traffic. Some of the important expressways are; (i)Mumbai-Pune Road, (ii) Kolkata-Dumdum Airport road (iii) Durgapur-Kolkata road and (iv) Yamuna expressway between Delhi and Agra.

g. International Highways

These are the roads that link India with neighbouring countries for promoting harmonious relationship with them. These highways have been constructed with an aid from world bank under an agreement with the Economic and Social Commission for Asia-Pacific (ESCAP). These roads connect important highways of India with those of the neighbouring countries such as Pakistan, Nepal, Bhutan, Bangladesh and Myanmar. In India the densest road network is found in the northern plains where it is relatively easy to construct roads. In mountainous area, it is quite difficult to construct roads. Road density is the highest in Kerala and lowest in Jammu & Kashmir.

Railways

Indian railway system is the main artery of the country's inland transport. Railways cater to the needs of large scale movement of traffic, both for freight and passenger, thereby contributing to economic growth. Railways are considered as the backbone of the surface transport system of India. It promotes national integration by bringing people together. It also promotes trade, tourism, education etc. Railways help in the commercialization of the agriculture sector by facilitating the quick movement of perishable goods. Its role in transporting raw materials to industries and finished goods to markets is invaluable. Indian railway network is the largest in Asia and second largest in the world.

The length of Indian railways network as of 2017 is 67,368 km with 7,349 railway stations. For operations and management, the Indian Railways is organized into 16 zones. 1) Northern Railway - Delhi 2) North- Western Railway - Jaipur 3) North-Central Railway- Allahabad 4) North-Eastern Railway - Gorakhpur 5) North-East Frontier Railway - Guwahati 6) Eastern Railway - Kolkata 7) East coast Railway - Bhubaneswar 8) East-Central Railway - Hazipur 9) West-Central Railway - Jabalpur 10) Central Railway - Mumbai (VT) 11) Western Railway - Mumbai (Churchgate) 12) Southern Railway - Chennai 13) South- Central Railway - Secunderabad 14) South Eastern Railway - Kolkata 15) South-Western Railway - Hubball and 16) South East Central Railway - Bilaspur.

The Northern Railway accounts for the longest route length, followed by the Western Railway. On the basis of width of the track, the Indian railways fall under four categories. Broad gauge with a width of 1.676 meter, Meter gauge with a width of 1 meter and Narrow gauge with a width of 0.762 meter and Light gauge with 0.610 meter. In recent times, many developments have taken place in the Indian railways. The arrival of Konkan Railway Corporation

(KRC), Mass Rapid Transit System (MRTS), Metro and Sub-Urban railways provide easy and efficient means of transport. These are very helpful in avoiding traffic congestion and overcrowding in urban areas.

a. Konkan railway

One of the important achievements of Indian Railways has been the construction of Konkan Railway in 1998. It connects Roha in Maharashtra to Mangaluru in Karnataka and the track measures 760 km. It is considered as an engineering marvel. On its routes, the railway crosses 146 rivers and streams, nearly 2000 bridges and 73 tunnels. Asia's longest tunnel nearly 6.44 km long is in this route. The states of Maharashtra, Goa and Karnataka are partners in this undertaking. The rail link between Banihal in Jammu region and Qazigund in Kashmir valley was opened in 2013. This rail line passes under the Pir Panjal Range through a 11.2 km long tunnel.

b. Metro Railways in India

There are 8 cities with metro rail connectivity in India. They are Kolkata (West Bengal), Chennai (Tamil Nadu), Delhi, Bengaluru (Karnataka), Gurgaon (Haryana), Mumbai (Maharashtra), Jaipur (Rajasthan) and Kochi (Kerala). The metro in Kolkata is the first one in India. It is also called as Mass Rapid Transit System (MRTS). As of September 2018, India has 507 km of operational metro lines and 381 stations.

Pipeline transport:

Pipelines provided a very convenient mode of transport to connect oil and natural gas fields, refineries and to the markets. In the past, these were used to transport water to cities and industries. Now solids can also be transported through a pipeline when converted into slurry. The initial cost of laying pipeline is high but subsequent running cost is minimum. It can be laid through difficult terrain as well as under water. It ensures steady supply of goods and reduces the transshipment losses and delays are the major advantages of pipeline transport. Oil field in upper Assam to Kanpur, from Salaya in Gujarat to Jalandhar in Punjab and gas pipeline from the Hazira in Gujarat to Jagadipur in Uttar Pradesh are the three important network large network of pipeline in the country.

Waterways

A waterway is an important mode of transport for both passenger and cargo traffic in India. It is the oldest and also the cheapest means of transport and most suitable for carrying heavy and bulky materials from one country to

another. It is a fuel-efficient and eco-friendly mode of transport. The water transport is of two types- Inland Waterways and Ocean water ways(sea routes).

a. Inland Waterways

India has an extensive network of inland waterways in the form of rivers, canals, lakes and backwaters. It depends upon the depth and width of the waterways and the continuity of the water flow. The total navigable length of our country is 14,500 km, out of which about 5,200 km length of rivers and 4,000 km length of canals can be used by mechanized crafts. The total cargo carried by inland waterways is just about 0.1% of the total inland traffic of India. For the development, maintenance and regulation of national waterways in the country, the Inland water ways Authority was setup in 1986.

The major national waterways are: National Waterway 1: It extends between Haldia and Allahabad, measures 1620 km and includes the stretches of the Ganga- Bhagirathi-Hooghly river system. National Waterway 2: This waterway includes the stretch of the Brahmaputra river between Dhubri and Sadiya a distance of 891 km. National Waterway 3: This waterway extends between Kollam and Kottapuram in the state of Kerala. It is the first national waterway in the country with 24 hour navigation facilities along its entire stretch of 205 km.

b. Oceanic Routes

Oceanic routes play an important role in the transport sector of India's economy. About 95% of India's foreign trade by volume and 70 percent by value moves through ocean routes. Coastal shipping plays an important role in transport of bulk goods in India. Shipping is not only the most economical mode of transport, it is also an environment friendly mode. The sea and oceanic routes are mainly used for international trade and are connected through ports. There are 13 major and 200 minor or intermediate ports in India. The major ports are administered by the Central Government and minor ports are managed and administered by various state governments.

The major ports on the east coast are Kolkata (including Haldia Dock), Paradip, Visakhapatnam, Chennai, Ennore and Tuticorin. The major ports on the west coast are Kandla, Mumbai, Nhava Seva (Jawaharlal Nehru Port), New Mangalore, Marmagao and Kochi. India has four major shipyards. Hindustan shipyard in Vishakhapatnam, Garden Reach workshop in Kolkata, Mazagaon Dock in Mumbai, Kochi Shipyard in Kochi. India is the second largest ship owning country in Asia and ranks 16th in the World.

Air Transport

Airways are the quickest, costliest, most modern and comfortable means of transport, Air transport facilitates connectivity on a national, regional and international scale. It has made accessibility easier by connecting difficult terrains like high mountains and sandy deserts. It carries passengers, freight and mail. Air transport plays a key role in times of emergency as well as in the event of natural and man-made calamities like floods, epidemics and wars.

Air transport in India made a beginning on 18th February, 1918 when Henry Piquet carried a mail from Allahabad to Naini. In 1953, eight different airlines which were in operation in the country were nationalised. Domestic Airways fly within the boundaries of a country and International Airways connect major cities of the world. The Indian Airlines and Air India are the two airline services run by the government of India. Indian Airlines provides the domestic air services and Air India provides international air services. Presently, there are 19 designated international airports available in the country.

These airports are managed by Airports Authority of India. Some of them are Netaji Subhash Chandra Bose International Airport, Kolkata, Chennai International Airport, Chennai, Indira Gandhi International Airport, Delhi, Chhatrapati Shivaji International Airport, Mumbai, Thiruvananthapuram International Airport, Thiruvananthapuram, Sardar Vallabh Bhai Patel International Airport, Ahmedabad, Bangalore International Airport, Bengaluru, Rajiv Gandhi International Airport, Hyderabad etc. Besides this, there are about 80 domestic airports and about 25 civil enclaves at defence air fields.

a. Pavan-Hans Helicopter Ltd

Pavan-Hans Helicopter Ltd has been providing Helicopter support services to the petroleum sector, including ONGC and oil India Ltd. It is a public sector company based in New Delhi. Its operations are based at the Juhu Aerodrome in Vile Parle (West) Mumbai. Pavan-Hans is a Mini Ratna-I category public sector undertaking. It often provides services to various state governments in India particularly north east India Inter Island, Ferry services in Andaman & Nicobar Islands, services to Lakshadweep Island etc.,

b. Airports Authority of India (AAI)

Airports Authority of India (AAI) was constituted in 1995. It provides security to Indian Airports. AAI under the ministry of Civil Aviation is

responsible for creating, upgrading, maintaining and managing civil aviation infrastructure in India.

Communication

Communication is a process that involves exchange of information, thoughts and ideas. Technology does wonders in communication fields. Communication is categorized in to personal and mass communications.

Personal Communication

The exchange of information between the individuals is called personal communication. It includes post and telegraph services, telephone, mobile phone, short message services, fax, internet, e-mail etc. Personal Communication system enables the user to establish direct contact. The Indian postal network is the largest in the world with 1,55,000 post offices. Of these more than 1,39,000 post offices are located in rural areas. The postal service was opened to the public in the country in 1837. The first Indian postal stamp was issued in 1852 in Karachi. Collecting and delivering mail is the primary function of the department of posts. It introduced the Quick Mail Service in 1975 and today it covers the entire country.

Them Quick Mail Service functions on the basis of the system of PIN (Postal Index Number) code which was introduced in 1972. The premium products include the Money order, e-money order, Speed Post, Express Parcel Post, Business Post, Media Post, Satellite Post, Retail Post, Greeting Post, Data Post, Speed Net and Speed Passport Services. Cards and envelopes are considered first class mail and are airlifted between stations covering both land and air. The second class mail includes book packets, registered newspapers and periodicals. They are carried by surface mail, covering land and water transport. To facilitate quick delivery of mails in large towns and cities, six mail channels have been introduced recently.

They are called Rajdhani Channel, Metro Channel, Green Channel, Business Channel, Bulk Mail Channel and Periodical Channel. India has one of the largest telecommunication networks in Asia. Apart from the urban areas more than two-thirds of the villages in India have already been covered with Subscriber Trunk Dialing (STD) telephone facility, while International communication can be made through ISD (International Subscriber Dialing). There is an uniform rate of STD facilities all over India. Telephone is a form of oral communication. It is considered very essential for the growth of commerce. It is the most preferred form as it provides instant communication. Mobile phone, fax and internet are the other personal communication used in the country.

Mass Communication Systems

Mass Communication enables millions of people to get the information at the same time. It is a great way to provide education as well as entertainment. It helps in creating awareness among the people regard in national policies and programmes. The Mass Communication Systems can provide the information to people in two methods. They are Print Media and Electronic Media.

Electronic Media: Radio broadcasting in India was started in 1923 by the Radio club of Bombay. Since then it gained immense popularity and changed the social and cultural life of people. It was named as All India Radio (AIR) in 1936 and again it was renamed as Akashwani in 1957. It broadcasts a variety of programs related to information, education and entertainment. Special news bulletins are also broadcasted on special occasions like session of parliament and state legislatures.

Television broadcasting has emerged as the most effective audio-visual medium for disseminating information and educating the masses. Television network in India is known as Doordarshan (DD) which started Common National Program (CNP) services and it is extended to the backward and remote rural areas. Internet (contraction of interconnected network) is the global system of interconnected computer networks that use the Internet protocol suite to link devices worldwide.

Social media are interactive computer-mediated technologies that facilitate the creation and sharing of information, ideas, career interests and other forms of expression via virtual communities and networks. With over 460 million internet users, India is the second largest online market, ranked only behind China. By 2021, there will be about 635.8 million internet users in India. Despite the large base of internet users in India, only 26 percent of the Indian population accessed the internet in 2015. This is a significant increase in comparison to the previous years, considering the internet penetration rate in India stood at about 10 percent in 2011. Furthermore, men dominated internet usage in India with 71 percent to women's 29 percent.

Print Media: Newspapers are the most common but powerful means of communication come under print media. India has many newspapers which carry information on local, national and international events to the people.

Satellite Communication

The use of Satellite in getting a continuous and synoptic view of larger area has made this communication system very vital for the country. Satellite images are used for weather forecasting, monitoring of natural calamities, surveillance of border areas etc. The communication through satellites emerged as a new era in communication in our country after the establishment of Indian Space Research Organization (ISRO) in 1969.

Satellite system in India can be grouped into two-the Indian National Satellite System (INSAT) and the Indian Remote Sensing Satellite System (IRS).The INSAT, established in 1983, is a multipurpose system for telecommunication, meteorological observation and for various other programs. The INSAT series are used for relaying signals to television, telephone, radio, mobile phone. It is also useful in weather detection, internet and military applications.

The INSAT series, GSAT series, KALPANA-1, HAMSAT, EDUSAT are the major communication satellite used for communication purpose. GSAT-7A is the recent launch (December 19, 2018) for communication programs. INSAT-1B launched on 30th August 1983 is the first communication satellite in INSAT series.

Trade

Trade is an important phenomenon that decides the economic growth of a country. Trade is an act (or) process of buying, selling or exchanging of goods and services. The primitive method of trade was known as the Barter system where goods were exchanged for goods. Later on, money was introduced as a medium of exchange in buying and selling of goods. The difference in value between the imports and exports is called balance of trade. The situation in which the value of exports exceeds the value of imports is termed as favourable balance of trade and the reverse position is termed as unfavourable balance of trade.

Types of Trade

Trade in general, is of two types. They are Internal and International. The trade carried on within the domestic territory of a country is termed as Internal trade. It is also called as Domestic trade or Local trade. Land transport (roadways and railways) plays a major role in this trade. Local currency is used in internal trade. It helps to promote a balanced regional growth in the country i.e, tea from Assam, coffee from Karnataka, Rubber and spices from Kerala, minerals from Jharkhand etc., are supplied to different parts of our

country. Trade carried on between two or more countries is called International trade. It is also called as external trade or foreign trade. Export and Import are two components of International trade. Export means goods and services sold for foreign currency. Import means goods and services bought from overseas producers. Waterways and Airways play a vital role in this type of trade. Foreign currency is involved in international trade. The trade between any two countries is called Bilateral trade. The trade between more than two countries is called Mutilateral Trade.

Exports

The major exports of India are tea, marine products, ores and minerals, leather products, gems and jewels, sports goods, chemicals and related products, plastics and rubber articles, articles of stones, plaster, cement, asbestos, mica, glass ware, paper and related products, base metals, optical, medical and surgical instruments, electronic items, machinery, office equipment's, textiles and allied products.

Imports

The major imports are petroleum products, pearls, precious stones and semi-precious stones, gold and telecom instruments. India's Trade Performance The volume of India's foreign trade has increased many fold since independence. During 2008 -2009, the volume of trade was 840755 crores and it rose to 1039797 crores in 2016-2017. The import during 2008-2009 was 1374436 crores and was with a deficit of 40679 crores. The import during 2016-2017 rose to 1396352 crores and was with the deficit of 356555 crores. It reveals that not only the balance of trade is unfavourable but also the increase in the level of deficit.

NOTE

- ❖ In India the first census was carried out in the year 1872. But the first complete and synchronous census was conducted in 1881. And the 2011 census represents the fifteenth census of India.
- ❖ The ratio between the economically active and economically inactive of population is termed as Dependency Ratio.
- ❖ Shershah suri built the shahi (Royal) road to strengthen and consolidate his empire from the Indus valley to the Sonar valley in Bengal. This road from Kolkata to Peshawar was renamed as Grand Trunk(GT) road during the British period. At present, it extends from Amristar to Kolkata. It is bifurcated into 2 segments: (a) (NH)-1 from Delhi to Amristar, and (b) NH-2 from Delhi to Kolkata.
- ❖ National Highways Authority of India (NHAI) was established in 1995.

It is an autonomous body under the Ministry of Surface Transport.

- ❖ The first train steamed off from Mumbai to Thane in 1853, covering a distance of 34 km. In 1951, the systems were nationalized as one unit "The Indian Railways". The headquarter of Indian Railways is New Delhi.
- ❖ The first sub-urban railway was started in 1925 in Mumbai.
- ❖ Chennai becomes the sixth Indian city with metro railway.
- ❖ Gatiman Express is the fastest operational train in India. This train connects New Delhi and Agra and touches 160 km/h. This train takes a travel time of 105minutes to cover 200km journey.
- ❖ The state of Meghalaya has no railway network.
- ❖ In 2007, the Government of India merged the Air India and Indian Airlines under National Aviation Corporation of India Limited (NACIL). In which NACIL (A) provides international services, NACIL (I) provides domestic services and services to neighbouring countries in south east Asia and middle East.

