CHAPTER-1
GEOGRAPHY AS A DISCIPLINE

TOPIC-1
Geography as an Integrated Discipline, Physical Geography and Natural Sciences, Geography and Social Sciences.

Revision Notes

- Geography should be studied as an independent subject as it helps us to gather knowledge about the physical environment of the Earth, human activities and their interactive relationships.
- As a student of geography, we should be curious to know about all the phenomena which vary over space. Through the study of geography, we get to know about the diverse lands and people. We also need to understand the changes that have taken place over time.
- Geography equips us to appreciate diversity and investigate into the causes responsible for creating such variations over time and space. We develop skills to understand the globe converted into maps and have a visual sense of the Earth's surface.
- We need to understand as to 'What is geography?'. In very simple words, it can be said that geography is the description of the Earth. The term 'geography' was first coined by **Eratosthenes**, a Greek scholar(276-194 BC). The word has been derived from two roots of Greek language geo (Earth) and graphos (description). Put together , they mean description of the Earth.
- Geography is different from other sciences in its subject matter and methodology but at the same time, it is closely related to other disciplines. Geography derives its data base from all the natural and social sciences and attempts their synthesis.
- Geography as a discipline is concerned with three sets of questions :
  - Some questions are concerned with the identification of the patterns of natural and cultural features over the surface of Earth. These are the questions about 'what'?
  - The second type of questions are concerned with the distribution of the natural and human/cultural features over the surface of the Earth. These are the questions about 'where'?
  - The third type of question is related to the explanation or the casual relationships between features and the processes and phenomena.
- As a social science discipline, geography studies the 'spatial organisation' and 'spatial integration.'
- Geography is a discipline of synthesis. It attempts spatial synthesis, and history attempts temporal synthesis. Its approach is holistic in nature. It recognises the fact that the world is a system of interdependencies.
- Every discipline, concerned with scientific knowledge is linked with geography as many of their elements vary over space.
- Geography helps in understanding the reality in its spatial perspective.

Know the Terms

- **Geography :** It can be defined as the description of the Earth.
- **Geographer :** An expert in the study of the Earth, the physical features of the Earth and its atmosphere and of human activities and its effects.
- **Spatial Synthesis :** It includes the formal techniques which study the entities using geographical properties.
- **Holistic Approach :** It means the overall approach that is taken up to study the subject.

TOPIC-2
Branches of Geography - Physical Geography, Human Geography, Biogeography, Branches of Geography Based on Regional Approach, Physical Geography and its Importance.

Revision Notes

- We all know that geography is an interdisciplinary subject of study.
- The major approach to the study of geography have been
  - Systematic
  - Regional
- The systematic geography was introduced by Alexander Von Humboldt, a German geographer and the regional geography was by a contemporary of Humboldt, Karl Ritter.
- In the systematic approach, a phenomenon is studied world-wide as a whole, and then the identification of typologies or spatial patterns is done.
- In the regional approach, the world is divided into regions at different hierarchical levels and then all the geographical phenomena in a particular region are studied. These regions may be natural, political or designated region.
- Branches of geography(based on systematic approach):
- **Physical Geography :**
  - Geomorphology : It is devoted to the study of landforms and their evolution.
  - Climatology : It is the study of the structure of atmosphere.
  - Hydrology : It studies the realm of water over the surface of the earth.
  - Soil Geography : It is the study of the processes of soil formation , types, etc.
- **Human Geography :**
  - Social/cultural Geography : It is the study of society and its spatial dynamics.
  - Population and Settlement Geography : It studies population growth, distribution, density , sex ratio, migration and occupational structure, etc.
  - Economic Geography : It studies the activities of the people.
  - Historical Geography : It studies the historical processes through which the space gets organised.
  - Political Geography : It looks at the space from the angle of political events and studies boundaries, etc., to understand the political behaviour of the population.
- **Biogeography :**
  - Plant Geography : It studies the spatial pattern of natural vegetation in their habitats.
  - Zoo Geography : It studies the spatial patterns and geographical characteristics of animals and their habitats.
  - Ecosystem : It deals with the scientific study of the habitats characteristics of species.
  - Environmental Geography : It studies the leading environmental problems such as land gradation, pollution and concerns for conservation of environment.
- **Branches of geography (based on regional approach) :**
  - Regional Studies/Area Studies : It comprises of Macro, Meso and Micro regional studies.
  - Regional Planning : It comprises of country/rural and town/urban planning.
  - Regional Development
  - Regional Analysis
- Physical geography includes the study of lithosphere (landforms, drainage, relief and physiography),atmosphere, hydrosphere and biosphere.
- Each element of the physical geography is important for human beings.
- Landforms provide the base on which the human activities are located.
- The climate influences our house types, clothing , food habits, vegetation, cropping pattern, location of industries, etc.
- The study of physical geography is emerging as a discipline of evaluating and managing natural resources.
- It is important to understand the intricate relationship between physical environment and human beings.

Know the Terms

- **Systematic Approach :** It is a phenomenon which is studied world-wide as a whole, and then the identification of typologies or spatial patterns is done.
- **Regional Approach :** In this approach the world is divided into regions at different hierarchical levels and then all the geographical phenomena in a particular region are studied. These regions may be natural, political or designated region.
- **Geomorphology :** It is concerned with the study of landforms, their evolution and related processes.
- **Hydrology :** It studies the realm of water over the surface of the earth including oceans, lakes, rivers and other water bodies and its effect on different life forms including human life and their activities.
- **Population Geography :** It studies population growth, distribution, density, sex ratio, migration and occupational structure, etc.
- **Ecology :** It is concerned with the scientific study of the habitats characteristics of species.

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PART-A : UNIT-II : THE EARTH

CHAPTER-2
THE ORIGIN AND EVOLUTION OF THE EARTH

TOPIC-1
Early Theories: Origin of the Earth, Modern Theories: Origin of the Universe, The Star Formation, Formation of the Planets.

Revision Notes

- A large number of hypotheses were put forth by different philosophers and scientists regarding the origin of the earth.
- One of the earlier and popular arguments was by German philosopher Immanuel Kant. Mathematician Laplace revised it in 1796. It is known as Nebular Hypothesis.
- The hypothesis considered that the planets were formed out of a cloud of material associated with a youthful sun, which was slowly rotating.
- Later in 1900, Chamberlain and Moulton considered that a wandering star approached the sun. As a result, a cigar-shaped extension of material was separated from the solar surface.
- Sir James Jeans and later Sir Harold Jeffrey supported this argument. These arguments are called the Binary Theories. In 1950, Otto Schmidt in Russia and Carl Weizascar in Germany somewhat revised the 'Nebular Hypothesis', though differing in details.
- However, scientists in later period took up the problems of origin of universe rather than that of just the earth or the planets.
- The most popular argument regarding the origin of the universe is the **Big Bang Theory**. It is also called 'Expanding Universe Hypothesis'.
- The Big Bang Theory considers the following stages in the development of the universe:
  - In the beginning, all matter forming the universe existed in one place in the form of a "tiny ball" (singular atom) with an unimaginably small volume, infinite temperature and infinite density.
  - At the Big Bang the "tiny ball" exploded violently. This led to a huge expansion. It is now generally accepted that the event of Big Bang took place 13.7 billion years before the present. The expansion continues even to the present day. As it grew, some energy was converted into matter. There was particularly rapid expansion within fractions of a second after the bang. Thereafter, the expansion has slowed down. Within first three minutes from the Big Bang event, the first atom began to form.
  - Within 300,000 years from the Big Bang, temperature dropped to 4,500 K and gave rise to atomic matter. The universe became transparent. The expansion of the universe means increase in space between the galaxies.

- A galaxy contains a large number of stars. Galaxies spread over vast distances that are measured in thousands of light years.
- The diameters of individual galaxies range from 80,000-150,000 light years. A galaxy starts to form by accumulation of hydrogen gas in the form of a very large cloud called nebula.
- Eventually, growing nebula develops localised clumps of gas. These clumps continue to grow into even denser gaseous bodies, giving rise to formation of stars. The formation of stars is believed to have taken place some 5-6 billion years ago.
- The following are considered to be the stages in the development of planets :
  - The stars are localised lumps of gas within a nebula. The gravitational force within the lumps leads to the formation of a core to the gas cloud and a huge rotating disc of gas and dust develops around the gas core.
  - In the next stage, the gas cloud starts getting condensed and the matter around the core develops into small-rounded objects. These small-rounded objects by the process of cohesion develop into what is called planetesimals. Larger bodies start forming by collision, and gravitational attraction causes the material to stick together. Planetesimals are a large number of smaller bodies.
  - In the final stage, these large number of small planetesimals accrete to form a fewer large bodies in the form of planets.

Know the Terms

- **Nebular Hypothesis :** Nebular Hypothesis considered that the planets were formed out of a cloud of material associated with a youthful sun, which was slowly rotating.
- **Nebula :** A galaxy starts to form by accumulation of hydrogen gas in the form of a very large cloud. This slow circular moving gaseous clouds are called nebula.
- **Big Bang Theory :** This theory is the most universally accepted theory regarding the formation of the earth.

TOPIC-2
Our Solar System, The Moon

Revision Notes

- Our solar system consists of eight planets. A Pluto like dwarf planet 2003 UB_{313} has also been recently sighted.
- Our solar system consists of the sun (the star), 8 planets, 63 moons, millions of smaller bodies like asteroids and comets and huge quantity of dust-grains and gases.
- Out of the eight planets, mercury, venus, earth and mars are called as the inner planets as they lie between the Sun and the belt of asteroids the other four planets are called the outer planets.
- Alternatively, the first four are called Terrestrial, meaning earth-like as they are made up of rock and metals, and have relatively high densities. The rest five are called Jovian or Gas Giant planets. Jovian means jupiter-like.
- All the planets were formed in the same period sometime about 4.6 billion years ago.
- The moon is the only natural satellite of the earth. Like the origin of the earth, there have been attempts to explain how the moon was formed.
- In 1838, Sir George Darwin suggested that initially, the earth and the moon formed a single rapidly rotating body.
- However, the present scientists do not accept either of the explanations. It is now generally believed that the formation of moon, as a satellite of the earth, is an outcome of 'giant impact' or what is described as "the big splat".
- A body of the size of one to three times that of mars collided into the earth sometime shortly after the earth was formed. It blasted a large part of the earth into space. This portion of blasted material then continued to orbit the earth and eventually formed into the present moon about 4.44 billion years ago.

Know the Terms

- **Planetesimals :** The gas cloud that starts getting condensed and the matter around the core develops into small-rounded objects. These small-rounded objects by the process of cohesion develop into what is called planetesimals.
- **Big Splat :** The origin of the moon as a satellite of the earth is the result of big collision which is called the Big Splat.
- **Galaxy :** It is a cluster of millions of stars and solar systems.
- **Outer planets :** Jupiter, Saturn ,Uranus and Neptune are called outer planets.
- **Inner planets :** Mercury, Venus, Earth and Mars are called inner planets.
- **Jovian planets :** Jupiter, Saturn, Uranus and Neptune are called Jovian or Gas Giant planets. Jovian means Jupiter-like. Most of them are much larger than the terrestrial planets and have thick atmosphere, mostly of helium and hydrogen.

TOPIC-3
Evolution of the Earth, Evolution of Lithosphere, Evolution of Atmosphere and Hydrosphere, Origin of Life.

Revision Notes

- The earth has a layered structure. From the outermost end of the atmosphere to the centre of the earth, the material that exists is not uniform.
- The atmospheric matter has the least density. From the surface to deeper depths, the earth's interior has different zones and each of these contains materials with different characteristics.
- The earth was mostly in a volatile state during its primordial stage. Due to gradual increase in density the temperature inside has increased.
- As a result, the material inside started getting separated depending on their densities. This allowed heavier materials (like iron) to sink towards the centre of the earth and the lighter ones to move towards the surface.
- With passage of time it cooled further and solidified and condensed into a smaller size. This later led to the development of the outer surface in the form of a crust.
- During the formation of the moon, due to the giant impact, the earth was further heated up. It is through the process of differentiation that the earth forming material got separated into different layers. Starting from the surface to the central parts, we have layers like the crust, mantle, outer core and inner core. From the crust to the core, the density of the material increases.
- There are three stages in the evolution of the present atmosphere. The first stage is marked by the loss of primordial atmosphere. In the second stage, the hot interior of the earth contributed to the evolution of the atmosphere. Finally, the composition of the atmosphere was modified by the living world through the process of photosynthesis.
- Sometime around 3,800 million years ago, life began to evolve. However, around 2,500-3,000 million years before the present, the process of photosynthesis got evolved. Life was confined to the oceans for a long time.
- Oceans began to have the contribution of oxygen through the process of photosynthesis. Eventually, oceans were saturated with oxygen, and 2,000 million years ago, oxygen began to flood the atmosphere.
- Modern scientists refer to the origin of life as a kind of chemical reaction, which first generated complex organic molecules and assembled them.
- It can be assumed that life began to evolve sometime 3,800 million years ago. The record of life that existed on this planet in different periods is found in rocks in the form of fossils.

Know the Terms

- **Differentiation :** The process through which the earth forming material got separated into different layers is called differentiation.
- **Volatile state :** State of being liable to change rapidly and unpredictably at normal temperatures.
- **Primordial stage :** The beginning or the basic stage.
- **Photosynthesis :** The process by which green plants and some other organisms use sunlight to synthesize nutrients from carbon dioxide and water.

CHAPTER-3
INTERIOR OF THE EARTH

TOPIC-1
Sources of Information about the Interior, Earthquake and its Effects

Rivision Notes

- The configuration of the surface of the earth is largely a product of the processes operating in the interior of the earth.
- To understand why the earth shakes or how a tsunami wave is generated, it is necessary that we know certain details of the interior of the Earth.
- It is interesting to know how scientists have gathered information about these layers and what are the characteristics of each of these layers.
- The earth's radius is 6,370 km. No one can reach the centre of the earth.
- Most of our knowledge about the interior of the earth is largely based on estimates and inferences. Yet, a part of the information is obtained through direct observations and analysis of materials.
- The most easily available solid earth material is surface rock or the rocks we get from mining areas.
- Besides mining, scientists have taken up a number of projects to penetrate deeper depths to explore the conditions in the crustal portions.
- Scientists world over are working on two major projects such as "Deep Ocean Drilling Project" and "Integrated Ocean Drilling Project".
- Volcanic eruption forms another source of obtaining direct information. As and when the molten material (magma) is thrown onto the surface of the earth, during volcanic eruption it becomes available for laboratory analysis.
- Analysis of properties of matter indirectly provides information about the interior.
- Another source of information are the meteors that at times reach the earth. However, it may be noted that the material that becomes available for analysis from meteors, is not from the interior of the earth.
- The material and the structure observed in the meteors are similar to that of the earth. They are solid bodies developed out of materials same as, or similar to, our planet. Hence, this becomes yet another source of information about the interior of the earth.
- The other indirect sources include gravitation, magnetic field, and seismic activity.
- An earthquake in simple words is shaking of the earth. It is a natural event. It is caused due to release of energy, which generates waves that travel in all directions.
- The point where the energy is released is called the focus of an earthquake, alternatively, it is called the hypocentre.
- The energy waves travelling in different directions reach the surface. The point on the surface, nearest to the focus, is called epicentre.
- An instrument called 'seismograph' records the waves reaching the surface.
- Earthquake waves are basically of two types — body waves and surface waves. Body waves are generated due to the release of energy at the focus and move in all directions travelling through the body of the earth.
- The body waves interact with the surface rocks and generate new set of waves called surface waves.
- There are two types of body waves. They are called P and S-waves. P-waves move faster and are the first to arrive at the surface.
- The P-waves are similar to sound waves. They travel through gaseous, liquid and solid materials. S-waves arrive at the surface with some time lag. These are called secondary waves.
- Reflection causes waves to rebound whereas refraction makes waves move in different directions. The variations in the direction of waves are inferred with the help of their record on seismograph.
- Different types of earthquake waves travel in different manners. As they move or propagate, they cause vibration in the body of the rocks through which they pass.
- Earthquake waves get recorded in seismographs located at far off locations. However, there exist some specific areas where the waves are not reported. Such a zone is called the 'shadow zone'.
- The most common type of earthquakes are the tectonic earthquakes. These are generated due to sliding of rocks along a fault plane.

- A special class of tectonic earthquake is sometimes recognised as volcanic earthquake. However, these are confined to areas of active volcanoes.
- In the areas of intense mining activity, sometimes the roofs of underground mines collapse causing minor tremors. These are called collapse earthquakes.
- Ground shaking may also occur due to the explosion of chemical or nuclear devices. Such tremors are called explosion earthquakes.
- The earthquakes that occur in the areas of large reservoirs are referred to as reservoir induced earthquakes.
- The earthquake events are scaled either according to the magnitude or intensity of the shock. The magnitude scale is known as the Richter Scale.
- Tsunamis are waves generated by the tremors and not an earthquake in itself. Though the actual quake activity lasts for a few seconds, its effects are devastating provided the magnitude of the quake is more than 5 on the Richter Scale.

Know the Terms

- **Earthquake :** An earthquake is the shaking of the earth. It is a natural event. It is caused due to the release of energy.
- **Gravity Anomalies :** The differences in readings from the expected values is called gravity anomaly. Gravity anomalies give us information about the distribution of mass of the material in the crust of the earth.
- **Richter Scale :** The earthquake events are scaled either according to the magnitude or intensity of the shock. The magnitude scale is known as the Richter Scale.
- **P-waves :** They are known as primary waves. They move faster and are the first to arrive at the surface.
- **S-waves :** They are known as secondary waves. They arrive at the surface with some time lag.
- **Shadow Zone :** There exists some specific areas where the waves are not reported. Such a zone is called the shadow zone.

TOPIC-2
Structure of the Earth, Volcanoes and Volcanic Landforms

Revision Notes

- The crust is the outermost solid part of the earth. It is brittle in nature. The thickness of the crust varies under the oceanic and continental areas. Oceanic crust is thinner as compared to the continental crust.
- The mean thickness of oceanic crust is 5 km whereas that of the continental is around 30 km.
- The portion of the interior beyond the crust is called the mantle.
- The upper portion of the mantle is called asthenosphere. The word 'astheno' means weak. It is considered to be extending upto 400 km.
- The crust and the uppermost part of the mantle are called lithosphere. Its thickness ranges from 10-200 km. The lower mantle extends beyond the asthenosphere. It is in solid state.
- The core-mantle boundary is located at the depth of 2,900 km. The outer core is in liquid state while the inner core is in solid state. The density of material at the mantle core boundary is around 5g and at the centre of the earth at 6,300 km, the density value is around 13g/cm^3.
- The core is made up of very heavy material mostly constituted by nickel and iron. It is sometimes referred to as the nife layer.
- A volcano is a place where gases, ashes and/or molten rock material – lava – escape to the ground.
- A volcano is called an active volcano if the materials mentioned are being released or have been released out in the recent past. The layer below the solid crust is mantle. It has higher density than that of the crust. The mantle contains a weaker zone called asthenosphere.
- The material in the upper mantle portion is called magma. Once it starts moving towards the crust or it reaches the surface, it is referred to as lava.
- Barring the basalt flows, the shield volcanoes are the largest of all the volcanoes on the earth. These volcanoes are mostly made up of basalt, a type of lava that is very fluid when erupted.

- Composite volcanoes are characterised by eruptions of cooler and more viscous lavas than basalt. These volcanoes often result in explosive eruptions.
- Caldera are the most explosive of the earth's volcanoes. They are usually so explosive that when they erupt, they tend to collapse on themselves rather than building any tall structure.
- Flood basalt provinces volcanoes outpour highly fluid lava that flows for long distances. Some parts of the world are covered by thousands of sq km of thick basalt lava flows.
- Mid-ocean ridge volcanoes occur in the oceanic areas. There is a system of mid-ocean ridges more than 70,000 km long that stretches through all the ocean basins.
- The lava that is released during volcanic eruptions on cooling develops into igneous rocks.
- Batholiths is a large body of magmatic material that cools in the deeper depth of the crust develops in the form of large domes. They appear on the surface only after the denudation processes remove the overlying materials.
- Lacoliths are large dome-shaped intrusive bodies with a level base and connected by a pipe-like conduit from below.
- The near horizontal bodies of the intrusive igneous rocks are called sill or sheet, depending on the thickness of the material.
- As and when the lava moves upwards, a portion of the same may tend to move in a horizontal direction wherever it finds a weak plane. It may get rested in different forms. In case it develops into a saucer shape, concave to the sky body, it is called lapolith.
- When the lava makes its way through cracks and the fissures developed in the land, it solidifies almost perpendicular to the ground. It gets cooled in the same position to develop a wall-like structure. Such structures are called dykes.

Know the Terms

- **Magma :** Magma is a mixture of molten or semi-molten rock, volatiles and solids that is found beneath the surface of the earth.
- **Volcano :** A volcano is a place where gases, ashes and molten rock materials lava escape to the ground.
- **Lava :** When magma reaches the crust of the earth, it is called lava.
- **Batholiths :** A large body of magmatic material that cools in the deeper depth of the crust develops in the form of large domes.
- **Lacoliths :** These are large dome-shaped intrusive bodies with a level base and connected by a pipe-like plane.
- **Phacolith :** A wavy mass of intrusive rocks, at times, is found at the base of synclines or at the top of anticline in folded igneous country. Such wavy materials have a definite conduit to source beneath in the form of magma chambers (subsequently developed as batholiths). These are called the phacoliths.
- **Asthenosphere :** The upper portion of the mantle is called asthenosphere.

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CHAPTER-4
DISTRIBUTION OF OCEANS AND CONTINENTS

TOPIC-1
Continental Drift

Revision Notes

- The position of the continents and the ocean bodies, as we see them in the map, have not been the same in the past. Moreover, it is now a well-accepted fact that oceans and continents will not continue to enjoy their present positions in times to come.
- Observe the shape of the coastline of the Atlantic Ocean. You will be surprised by the symmetry of the coastlines on either side of the ocean.

- Many scientists thought of this similarity and considered the possibility of the two Americas, Europe and Africa, to be once joined together.
- From the known records of the history of science, it was Abraham Ortelius, a Dutch map maker, who first proposed such a possibility as early as 1596. Antonio Pellegrini drew a map showing the three continents together.
- However, it was Alfred Wegener, a German meteorologist, who put forth a comprehensive argument in the form of the "Continental Drift Theory " in 1912.
- According to Wegener, all the continents formed a single continental mass, a mega ocean surrounded by the same. The super continent was named PANGAEA, which meant all earth. The mega-ocean was called PANTHALASSA, meaning all water.
- He argued that, around 200 million years ago, the super continent, Pangaea, began to split. Pangaea first broke into two large continental masses as Laurasia and Gondwanaland forming the northern and southern components respectively.
- The shorelines of Africa and South America facing each other have a remarkable and unmistakable match.
- The radiometric dating methods developed in the recent period have facilitated correlating the rock formation from different continents across the vast ocean.
- It is the sedimentary rock formed out of deposits of glaciers. The Gondawana System of sediments from India is known to have its counter parts in six different landmasses of the Southern Hemisphere.
- The occurrence of rich placer deposits of gold in the Ghana coast and the absolute absence of source rock in the region is an amazing fact.
- The observations that Lemurs occur in India, Madagascar and Africa led some to consider a contiguous landmass "Lemuria" linking these three landmasses. Mesosaurus was a small reptile adapted to shallow brackish water. The skeletons of these are found only in two localities : The Southern Cape province of South Africa and Iraver formations of Brazil. The two localities presently are 4,800 km apart with an ocean in between them.
- Wegener suggested that the movement responsible for the drifting of the continents was caused by pole-fleeing force and tidal force.
- The polar-fleeing force relates to the rotation of the earth. The second force that was suggested by Wegener, the tidal force which is due to the attraction of the moon and the sun that develops tides in oceanic waters.
- It is interesting to note that for continental drift, most of the evidence was collected from the continental areas in the form of distribution of flora and fauna or deposits like tillite.
- Arthur Holmes in 1930s discussed the possibility of convection currents operating in the mantle portion.
- Detailed research of the ocean configuration revealed that the ocean floor is not just a vast plain but it is full of relief.

Know the Terms

- **Tillite :** Tillite is the sedimentary rock formed out of the deposits of glaciers.
- **Pangaea :** According to Wegener, all the continents formed a single continental mass, a mega ocean surrounded by the same. The super continent was named PANGAEA, which meant all earth.
- **Panthalassa :** The mega-ocean was known as Panthalassa, meaning all water.

TOPIC-2
Ocean Floor Configuration

Revision Notes

- The ocean floor configuration help us in the understanding of the distribution of continents and oceans.
- The ocean floor may be segmented into three major divisions based on the depth as well as the forms of relief. These divisions are continental margins, deep-sea basins and mid-ocean ridges.
- Continental Margins form the transition between continental shores and deep-sea basins. They include continental shelf, continental slope, continental rise and deep-oceanic trenches.
- Abyssal Plains are extensive plains that lie between the continental margins and mid-oceanic ridges. The Abyssal Plains are the areas where the continental sediments that move beyond the margins get deposited.
- Mid-Oceanic Ridges form an interconnected chain of mountain system within the ocean. It is the longest mountain-chain on the surface of the earth though submerged under the oceanic waters.
- The mapping of the ocean floor and paleomagnetic studies of rocks from oceanic regions revealed the following facts about the sea floor spreading :

- It was realised that all along the mid-oceanic ridges, volcanic eruptions are common and they bring huge amounts of lava to the surface in this area.
- Rocks closer to the mid-oceanic ridges are normal polarity and are the youngest. The age of the rocks increases as one moves away from the crest.
- The ocean crust rocks are much younger than the continental rocks.
- The sediments on the ocean floor are unexpectedly very thin. However, nowhere was the sediment column found to be older than 200 million years.
- The deep trenches have deep-seated earthquake occurrences while in the midoceanic ridge areas, the quake foci have shallow depths.

➢ Hess argued that constant eruptions at the crest of oceanic ridges cause the rupture of the oceanic crust and the new lava wedges into it, pushing the oceanic crust on either side. The ocean floor, thus spreads.

Know the Terms

➢ **Abyssal Plains :** The abyssal plains are the areas where the continental sediments that move beyond the margins get deposited.

➢ **Continental Margins :** These form the transition between continental shores and deep-sea basins.

➢ **Sea-floor spreading :** Hess argued that constant eruptions at the crest of oceanic ridges cause the rupture of the oceanic crust and the new lava wedges into it, pushing the oceanic crust on either side. The ocean floor, thus spreads.

TOPIC-3
Plate Tectonics

Revision Notes

➢ It was in 1967, McKenzie and Parker and also Morgan, independently collected the available ideas and came out with another concept termed Plate Tectonics.

➢ A tectonic plate (also called lithospheric plate) is a massive, irregularly-shaped slab of solid rock, generally composed of both continental and oceanic lithosphere.

➢ A plate may be referred to as the continental plate or oceanic plate depending on which of the two occupy a larger portion of the plate. Pacific plate is largely an oceanic plate whereas the Eurasian plate may be called a continental plate.

➢ The Theory of Plate Tectonics proposes that the earth's lithosphere is divided into seven major and some minor plates.

➢ The major plates are :
- Antarctica and the surrounding oceanic plate
- North American (with western Atlantic floor separated from the South American plate along the Caribbean islands) plate
- South American (with western Atlantic floor separated from the North American plate along the Caribbean islands) plate
- Pacific plate
- India-Australia-New Zealand plate
- Africa with the eastern Atlantic floor plate
- Eurasia and the adjacent oceanic plate

➢ Some important minor plates are :
- **Cocos plate :** Between Central America and Pacific plate
- **Nazca plate :** Between South America and Pacific plate
- **Arabian plate :** Mostly the Saudi Arabian landmass
- **Philippine plate :** Between the Asiatic and Pacific plate
- **Caroline plate :** Between the Philippine and Indian plate (North of New Guinea)
- **Fuji plate :** North-east of Australia

➢ These plates have been constantly moving over the globe throughout the history of the earth. It is not the continent that moves as believed by Wegener. Continents are part of a plate and what moves is the plate.

➢ Wegener had thought of all the continents to have initially existed as a super continent in the form of Pangaea.

➢ Scientists using the paleomagnetic data have determined the positions held by each of the present continental landmass in different geological periods.

- Where new crust is generated as the plates pull away from each other. The sites where the plates move away from each other are called spreading sites.
- Where the crust is destroyed as one plate dived under another. The location where sinking of a plate occurs is called a **Subduction Zone**.
- Transform faults are the planes of separation generally perpendicular to the mid-oceanic ridges.
- The strips of normal and reverse magnetic field that parallel the mid-oceanic ridges help scientists determine the rates of plate movement.
- The Arctic Ridge has the slowest rate (less than 2.5 cm/yr), and the East Pacific Rise near Easter Island, in the South Pacific about 3,400 km west of Chile, has the fastest rate (more than 15 cm/yr).
- The fact that the plates move is now a well-accepted fact. The mobile rock beneath the rigid plates is believed to be moving in a circular manner. The heated material rises to the surface, spreads and begins to cool, and then sinks back into deeper depths. This cycle is repeated over and over to generate what scientists call a convection cell or convective flow.
- The Indian plate includes Peninsular India and the Australian continental portions.
- India was a large island situated off the Australian coast, in a vast ocean. The Tethys Sea separated it from the Asian continent till about 225 million years ago. India is supposed to have started her northward journey about 200 million years ago at the time when Pangaea broke.
- India collided with Asia about 40-50 million years ago causing rapid uplift of the Himalayas.
- The two major plates were separated by the Tethys Sea and the Tibetan block was closer to the Asiatic landmass. During the movement of the Indian plate towards the Asiatic plate, a major event that occurred was the outpouring of lava and formation of the Deccan Traps.
- This started somewhere around 60 million years ago and continued for a long period of time.
- Scientists believe that the process is still continuing and the height of the Himalayas is rising even to this date

Know the Terms

- **Paleomagnetic data :** It is the data used by scientist that has helped them determine the positions held by each of the present continental landmass in different geological periods.
- **Spreading sites :** Where new crust is generated as the plates pull away from each other. The sites where the plates move away from each other are called spreading sites.
- **Subduction zone :** It is the location where the sinking of the plates occurs.
- **Convergent Boundaries :** When the crust is neither produced nor destroyed as the plates slide horizontally past each other is known as convergent boundaries.
- **Transform faults :** They are the planes of separation generally perpendicular to the mid-oceanic ridges.
- **Divergent boundaries :** They are those where new crust is generated as the plates pull away from each other.
- **Tectonic plate :** A tectonic plate (also called lithospheric plate) is a massive, irregularly-shaped slab of solid rock, generally composed of both continental and oceanic lithosphere.

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CHAPTER-5
MINERALS AND ROCKS

TOPIC-1
Some Major Minerals and their Characteristics

Rivision Notes

- The earth is composed of various kinds of elements. These elements are in solid form in the outer layer of the Earth and in hot and molten form in the interior.
- The elements in the earth's crust are rarely found exclusively but are usually combined with other elements to make various substances.
- These substances are recognised as minerals. Thus, a mineral is a naturally occurring inorganic substance, having an orderly atomic structure and a definite chemical composition and physical properties.

- Though the number of elements making up the lithosphere are limited they are combined in many different ways to make up many varieties of minerals.
- Almost all the commonly occurring ones are related to six major mineral groups that are known as major rock forming minerals.
- The basic source of all minerals is the hot magma in the interior of the earth. When magma cools, crystals of minerals appear and a systematic series of minerals are formed in sequence to solidify so as to form rocks.
- Minerals such as coal, petroleum and natural gas are organic substances found in solid, liquid and gaseous forms respectively.
- Some important characteristics of the minerals are :
  - **External crystal form :** Determined by internal arrangement of the molecules — cubes, octahedrons, hexagonal prisms, etc.
  - **Cleavage :** Tendency to break in given directions producing relatively plane surfaces.
  - **Fracture :** Internal molecular arrangement so complex the crystal will break in an irregular manner.
  - **Lustre :** Appearance of a material without regard to colour; each mineral has a distinctive lustre like metallic, silky, glossy ,etc.
  - **Colour :** Some minerals have characteristic colour determined by their molecular structure.
  - **Streak :** Colour of the ground powder of any mineral. It may be of the same colour as the mineral or may differ.
  - **Transparency :** Some minerals might be transparent, translucent or opaque.
  - **Structure :** Particular arrangement of the individual crystals; fine, medium or coarse grained; fibrous — separable, divergent, radiating.
  - **Hardness :** Some minerals are measured on the basis of their hardness.
  - **Specific gravity :** The ratio between the weight of a given object and the weight of an equal volume of water.
- Some major minerals and their characteristics are as follows :
  - **Feldspar :** Half of the earth's crust is composed of feldspar. It has light cream to salmon pink colour. It is used in ceramics and glass making.
  - **Quartz :** It is one of the most important components of sand and granite. It is white or colourless and used in radio and radar.
  - **Pyroxene :** It forms 10 per cent of the earth's crust. It is commonly found in meteorites. It is in green or black colour.
  - **Amphibole :** They form 7 per cent of the earth's crust. It is in green or black colour and is used in asbestos industry.
  - **Mica :** It is commonly found in igneous and metamorphic rocks. It is used in electrical instruments.
  - **Olivine :** It is used in jewellery. It is usually a greenish crystal, often found in basaltic rocks.
- **Metallic Minerals :** These minerals contain metal content and can be sub-divided into three types:
  - **Precious metals :** Gold, silver, platinum, etc.
  - **Ferrous metals :** Iron and other metals often mixed with iron to form various kinds of steel.
  - **Non-ferrous metals :** Include metals like copper, lead, zinc, tin, aluminium, etc.
- **Non-Metallic Minerals :** These minerals do not contain metal content. Sulphur, phosphates and nitrates are examples of non-metallic minerals. Cement is a mixture of non-metallic minerals.

Know the Terms

- **Mineral :** A mineral is a naturally occurring inorganic substance, having an orderly atomic structure and a definite chemical composition and physical properties.
- **Cleavage :** The tendency to break the crystal in given directions producing relatively plane surfaces is known as cleavage.
- **Metallic minerals :** These are minerals which contain metal in the raw form.
- **Non-metallic minerals :** These are the minerals which do not contain metal content.

TOPIC-2
Rocks and Rock Cycle

Revision Notes

- The earth's crust is composed of rocks. A rock is an aggregate of one or more minerals. Rocks may be hard or soft and in varied colours.
- Rocks do not have definite composition of mineral constituents. Feldspar and quartz are the most common minerals found in rocks.
- As there is a close relation between rocks and landforms, rocks and soils; a geographer requires basic knowledge of rocks.
- There are many different kinds of rocks which are grouped under three families on the basis of their mode of formation. They are :
  - **Igneous Rocks :** Solidified from magma and lava.
  - **Sedimentary Rocks :** The result of deposition of fragments of rocks by exogenous processes.
  - **Metamorphic Rocks :** Formed out of existing rocks undergoing recrystallisation.
- As igneous rocks form out of magma and lava from the interior of the earth, they are known as primary rocks.
- The igneous rocks are formed when magma cools and solidifies. When magma in its upward movement cools and turns into solid form it is called igneous rock.
- Granite, gabbro, pegmatite, basalt, volcanic breccia and tuff are some of the examples of igneous rocks.
- The word 'sedimentary' is derived from the Latin word sedimentum, which means settling.
- Rocks (igneous, sedimentary and metamorphic) of the earth's surface are exposed to denudation agents, and are broken up into various sizes of fragments. Such fragments are transported by different exogenous agencies and deposited. These deposits through compaction turn into rocks. This process is called **lithification**.
- Depending upon the mode of formation, sedimentary rocks are classified into three major groups:
  - **Mechanically formed :** Sandstone, conglomerate, limestone, shale, loess, etc., are examples.
  - **Organically formed :** Geyserite, chalk, limestone, coal, etc., are some examples.
  - **Chemically formed :** Chert, limestone, halite, potash, etc., are some examples.
- The word metamorphic means 'change of form'. These rocks form under the action of pressure, volume and temperature (PVT) changes.
- Metamorphism is a process by which already consolidated rocks undergo recrystallisation and reorganisation of materials within original rocks.
- Mechanical disruption and reorganisation of the original minerals within rocks due to breaking and crushing without any appreciable chemical changes is called **dynamic metamorphism.**
- The materials of rocks chemically alter and recrystallise due to thermal metamorphism.
- In regional metamorphism, rocks undergo recrystallisation due to deformation caused by tectonic shearing together with high temperature or pressure or both.
- In the process of metamorphism in some rocks grains or minerals get arranged in layers or lines. Such an arrangement of minerals or grains in metamorphic rocks is called **foliation or lineation.**
- Sometimes minerals or materials of different groups are arranged into alternating thin to thick layers appearing in light and dark shades. Such a structure in metamorphic rocks is called banding and rocks displaying banding are called banded rocks.
- Metamorphic rocks are classified into two major groups: foliated rocks and non-foliated rocks.
- Rocks do not remain in their original form for long but may undergo transformation. Rock cycle is a continuous process through which old rocks are transformed into new ones.
- Igneous rocks are primary rocks and other rocks (sedimentary and metamorphic) form from these primary rocks. Igneous rocks can be changed into metamorphic rocks. The fragments derived out of igneous and metamorphic rocks form into sedimentary rocks.
- Sedimentary rocks themselves can turn into fragments and the fragments can be a source for formation of sedimentary rocks.
- The crustal rocks (igneous, metamorphic and sedimentary) once formed may be carried down into the mantle (interior of the earth) through subduction process (parts or whole of crustal plates going down under another plate in zones of plate convergence) and the same melt down due to increase in temperature in the interior and turn into molten magma, the original source for igneous rocks.

Know the Terms

- **Rock :** A rock is the solid mineral material forming part of the surface of the earth.
- **Rock cycle :** Rock cycle is a continuous process through which old rocks are transformed into new ones.
- **Petrology :** Petrology is science of rocks.
- **Petrologist :** A petrologist studies rocks in all their aspects viz., mineral composition, texture, structure, origin, occurrence, alteration and relationship with other rocks.
- **Igneous rocks :** Igneous rocks are those rocks which are formed through the cooling and solidification of magma or lava.
- **Sedimentary rocks :** Sedimentary rocks are those rocks which are formed by the deposition and subsequent cementation of that material at the earth's surface and within the bodies of water.
- **Metamorphic rocks :** Metamorphic rocks are those rocks which are formed under the action of pressure.
- **Lithification :** It is a process in which unconsolidated sediments are converted into solid stone or rock.
- **Metamorphism :** It is the process by which the rocks are changed in composition, texture or structure by extreme heat and pressure.
- **Foliation :** It refers to repetitive layering in metamorphic rocks.
- **Dynamic metamorphism :** Mechanical disruption and reorganisation of the original minerals within rocks due to breaking and crushing without any appreciable chemical changes is called dynamic metamorphism.
- **Contact metamorphism :** In contact metamorphism the rocks come in contact with hot intruding magma and lava and the rock materials recrystallise under high temperatures.
- **Banding :** Sometimes minerals or materials of different groups are arranged into alternating thin to thick layers appearing in light and dark shades. Such a structure in metamorphic rocks is called banding.
- **Banding rocks :** Rocks displaying banding are called banded rocks.

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CHAPTER-6
GEOMORPHIC PROCESSES

TOPIC-1
Geomorphic Processes : Endogenic Processes, Diastrophism and Volcanism

Revision Notes

- Now it is time to know in detail about the surface of the earth on which we live. The differences in the internal forces operating from within the earth which built up the crust have been responsible for the variations in the outer surface of the crust.
- The earth's surface is being continuously subjected to external forces induced basically by energy (sunlight). That means, the earth's surface is being continuously subjected to by external forces originating within the earth's atmosphere and by internal forces from within the earth.
- The external forces are known as exogenic forces and the internal forces are known as endogenic forces.
- The actions of exogenic forces result in wearing down (degradation) of relief/elevations and filling up (aggradation) of basins/depressions, on the earth's surface. The phenomenon of wearing down of relief variations of the surface of the earth through erosion is known as gradation.
- The endogenic forces continuously elevate or build up parts of the earth's surface and hence the exogenic processes fail to even out the relief variations of the surface of the earth.
- In general terms, the endogenic forces are mainly land building forces and the exogenic processes are mainly land wearing forces.
- Most of the surface of the earth had and has been shaped over very long periods of time (hundreds and thousands of years) and because of its use and misuse by humans its potential is being diminished at a fast rate.
- The endogenic and exogenic forces causing physical stresses and chemical actions on earth materials and bringing about changes in the configuration of the surface of the earth are known as geomorphic processes.
- Weathering, mass wasting, erosion and deposition are exogenic geomorphic processes.
- Any exogenic element of nature (like water, ice, wind, etc.) capable of acquiring and transporting earth materials can be called a geomorphic agent.
- Geomorphic processes and geomorphic agents especially exogenic, unless stated separately, are one and the same.

- Gravity besides being a directional force activating all downslope movements of matter also causes stresses on the earth's materials. Indirect gravitational stresses activate wave and tide induced currents and winds. Without gravity and gradients there would be no mobility and hence no erosion, transportation and deposition are possible.
- Gravity is the force that is keeping us in contact with the surface and it is the force that switches on the movement of all surface material on earth.
- The energy emanating from within the earth is the main force behind endogenic geomorphic processes. This energy is mostly generated by radioactivity, rotational and tidal friction and primordial heat from the origin of the earth.
- All processes that move, elevate or build up portions of the earth's crust come under diastrophism.
- They include :
  - Orogenic processes involving mountain building through severe folding and affecting long and narrow belts of the Earth's crust.
  - Epeirogenic processes involving uplift or warping of large parts of the earth's crust.
  - Earthquakes involving local relatively minor movements.
  - Plate tectonics involving horizontal movements of crustal plates.
- Volcanism includes the movement of molten rock (magma) onto or toward the earth's surface and also formation of many intrusive and extrusive volcanic forms.

Know the Terms

- **Gradation :** The phenomenon of wearing down of relief variations of the surface of the earth through erosion is known as gradation.
- **Exogenic forces :** The external forces are known as exogenic forces.
- **Geomorphic processes :** The endogenic and exogenic forces causing physical stresses and chemical actions on earth materials and bringing about changes in the configuration of the surface of the earth are known as geomorphic processes.
- **Geomorphic agents :** An agent is a mobile medium (like running water, moving ice masses, wind, waves and currents, etc.) which removes, transports and deposits earth materials. Running water, groundwater, glaciers, wind, waves and currents, etc., can be called geomorphic agents.
- **Diastrophism :** All processes that move, elevate or build up portions of the earth's crust come under diastrophism.
- **Volcanism :** It is the phenomenon of eruption of molten rock onto the surface of the earth where lava and volcanic gases erupt through a break in the surface called vent.

TOPIC-2
Exogenic Processes and Weathering

Revision Notes

- The exogenic processes derive their energy from atmosphere determined by the ultimate energy from the sun and also the gradients created by tectonic factors.
- Gravitational force acts upon all earth materials having a sloping surface and tend to produce movement of matter in downslope direction. Force applied per unit area is called stress.
- Stress is produced in a solid by pushing or pulling. Forces acting along the faces of earth materials are shear stresses (separating forces). The shear stresses result in angular displacement or slippage.
- As there are different climatic regions on the earth's surface, the exogenic geomorphic processes vary from region to region. Temperature and precipitation are the two important climatic elements that control various processes.
- All the exogenic geomorphic processes are covered under a general term, denudation. The word 'denude' means to strip off or to uncover. Weathering, mass wasting/movements, erosion and transportation are included in denudation.
- The effects of most of the exogenic geomorphic processes are small and slow and may be imperceptible in a short time span, but will in the long run affect the rocks severely due to continued fatigue.
- Weathering is defined as mechanical disintegration and chemical decomposition of rocks through the actions of various elements of weather and climate.
- There are three major groups of weathering processes :
  - Chemical
  - Physical or mechanical
  - Biological

- A group of weathering processes viz; solution, carbonation, hydration, oxidation and reduction acts on the rocks to decompose, dissolve or reduce them to a fine clastic state through chemical reactions by oxygen, surface and/or soil water and other acids.
  - When something is dissolved in water or acids, the water or acid with dissolved contents is called solution. This process involves removal of solids in solution and depends upon solubility of a mineral in water or weak acids.
  - Carbonation is the reaction of carbonate and bicarbonate with minerals and is a common process helping the breaking down of feldspars and carbonate minerals.
  - Hydration is the chemical addition of water. Minerals take up water and expand; this expansion causes an increase in the volume of the material itself or rock.
  - In weathering, oxidation means a combination of a mineral with oxygen to form oxides or hydroxides. Oxidation occurs where there is ready access to the atmosphere and oxygenated waters.
- Physical or mechanical weathering processes depend on some applied forces. Most of the physical weathering processes are caused by thermal expansion and pressure release.
- Biological weathering is contribution to or removal of minerals and ions from the weathering environment and physical changes due to growth or movement of organisms. Burrowing and wedging by organisms like earthworms, termites, rodents etc., help in exposing the new surfaces to chemical attack and assists in the penetration of moisture and air.
- Decaying plant and animal matter help in the production of humic, carbonic and other acids which enhance decay and solubility of some elements. Algae utilise mineral nutrients for growth and help in concentration of iron and manganese oxides. Plant roots exert a tremendous pressure on the earth materials mechanically breaking them apart.
- Significance of weathering is that weathering of rocks and deposits helps in the enrichment and concentrations of certain valuable ores of iron, manganese, aluminium, copper, etc., which are of great importance for the national economy.
- Weathering is an important process in the formation of soils.

Know the Terms

- **Endogenic forces :** The internal forces are known as endogenic forces.
- **Stress :** Gravitational force acts upon all earth materials having a sloping surface and tend to produce movement of matter in downslope direction. Force applied per unit area is called stress.
- **Weathering :** Weathering is defined as mechanical disintegration and chemical decomposition of rocks through the actions of various elements of weather and climate.
- **Shear stress :** Forces acting along the faces of earth materials are shear stresses (separating forces).
- **Denudation :** All the exogenic geomorphic processes are covered under a general term, denudation. The word 'denude' means to strip off or to uncover. Weathering, mass wasting/movements, erosion and transportation are included in denudation.
- **Solution :** When something is dissolved in water or acids, the water or acid with dissolved contents is called solution.
- **Carbonation :** Carbonation is the reaction of carbonate and bicarbonate with minerals and is a common process helping the breaking down of feldspar and carbonate minerals.
- **Hydration :** Hydration is the chemical addition of water.
- **Oxidation :** Oxidation means combination of a mineral with oxygen to form oxides or hydroxides.
- **Enrichment :** When rocks undergo weathering, some materials are removed through chemical or physical leaching by groundwater and thereby the concentration of remaining (valuable) materials increases. Without such a weathering taking place, the concentration of the same valuable material may not be sufficient and economically viable to exploit, process and refine. This is what is called enrichment.
- **Reduction :** When oxidised minerals are placed in an environment where oxygen is absent, reduction takes place.
- **Tors :** In rocks like granites, smooth surfaced and rounded small to big boulders form due to exfoliation. It is called tors.

TOPIC-3
Mass Movements

Revision Notes

- Mass movements transfer the mass of rock debris down the slopes under the direct influence of gravity. That means, air, water or ice do not carry debris with them from place to place but on the other hand the debris may carry with it air, water or ice.
- The movements of mass may range from slow to rapid, affecting shallow to deep columns of materials and include creep, flow, slide and fall.
- Mass movements are aided by gravity and no geomorphic agent like running water, glaciers, wind, waves and currents participate in the process of mass movement.
- Weak unconsolidated materials, thinly bedded rocks, faults, steeply dipping beds, vertical cliffs or steep slopes, abundant precipitation and torrential rains and scarcity of vegetation etc., favour mass movements.
- Several activating causes precede mass movements. They are :
  - Removal of support from below to materials above through natural or artificial means
  - Increase in gradient and height of slopes
  - Overloading through addition of materials naturally or by artificial filling
  - Overloading due to heavy rainfall, saturation and lubrication of slope materials
  - Removal of material or load from over the original slope surfaces
  - Occurrence of earthquakes, explosions or machinery
  - Excessive natural seepage
  - Heavy drawdown of water from lakes, reservoirs and rivers leading to slow outflow of water from under the slopes or river banks
  - Indiscriminate removal of natural vegetation.
- Mass movements can be grouped under three major classes :
  - Slow movements
  - Rapid movements
  - Landslides
  - **Slow Movements :** Creep is one type under this category which can occur on moderately steep, soil covered slopes. Movement of materials is extremely slow and imperceptible except through extended observation. Materials involved also included in this group is solifluction which involves slow downslope flowing soil mass or fine grained rock debris saturated or lubricated with water. This process is quite common in moist temperate areas where surface melting of deeply frozen ground and long continued rain respectively, occur frequently can be soil or rock debris.
  - **Rapid Movements :** These movements are mostly prevalent in humid climatic regions and occur over gentle to steep slopes. Movement of water-saturated clayey or silty earth materials down low-angle terraces or hillsides is known as earthflow.

    Another type in this category is mudflow. In the absence of vegetation cover and with heavy rainfall, thick layers of weathered materials get saturated with water and either slowly or rapidly flow down along definite channels.

    A third type is the debris avalanche, which is more characteristic of humid regions with or without vegetation cover and occurs in narrow tracks on steep slopes. This debris avalanche can be much faster than the mudflow. Debris avalanche is similar to snow avalanche.
  - **Landslides :** These are known as relatively rapid and perceptible movements. Slump is slipping of one or several units of rock debris with a backward rotation with respect to the slope over which the movement takes place. Rapid rolling or sliding of earth debris without backward rotation of mass is known as debris slide.

    Sliding of individual rock masses down bedding, joint or fault surfaces is rockslide.
- Erosion involves acquisition and transportation of rock debris. When massive rocks break into smaller fragments through weathering and any other process, erosional geomorphic agents like running water, groundwater, glaciers, wind and waves remove and transport it to other places depending upon the dynamics of each of these agents.

- It is erosion that is largely responsible for continuous changes that the earth's surface is undergoing.
- The erosion and transportation of earth materials is brought about by wind, running water, glaciers, waves and groundwater.
- The erosion can be defined as "application of the kinetic energy associated with the agent to the surface of the land along which it moves".
- The work of the other two agents of erosion waves and groundwater is not controlled by climate.
- Deposition is a consequence of erosion. The erosional agents lose their velocity and hence energy on gentler slopes and the materials carried by them start to settle themselves.

Know the Terms

- **Solifluction :** Solifluction can defined as the gradual mass movement of wet soil or other material down a slope affected by alternate freezing and thawing.
- **Earthflow :** Movement of water-saturated clayey or silty earth materials down low-angle terraces or hillsides is known as earthflow.
- **Mudflow :** In the absence of vegetation cover and with heavy rainfall, thick layers of weathered materials get saturated with water and either slowly or rapidly flow down along definite channels.
- **Rockslide :** Sliding of individual rock masses down bedding, joint or fault surfaces is rockslide.
- **Slump :** Slump is slipping of one or several units of rock debris with a backward rotation with respect to the slope over which the movement takes place.

TOPIC-4
Soil Formation

Revision Notes

- A pedologist who studies soils, defines soil as a collection of natural bodies on the earth's surface containing living matter and supporting or capable of supporting plants.
- Soil is a dynamic medium in which many chemical, physical and biological activities go on constantly. Soil is a result of decay, it is also the medium for growth.
- It is a changing and developing body. It has many characteristics that fluctuate with the seasons. It may be alternatively cold and warm or dry and moist.
- The soil chemistry, the amount of organic matter, the soil flora and fauna, the temperature and the moisture, all change with the seasons as well as with more extended periods of time.
- Soil formation or pedogenesis depends first on weathering. First, the weathered material or transported deposits are colonised by bacteria and other inferior plant bodies like mosses and lichens. Also, several minor organisms may take shelter within the mantle and deposits. The dead remains of organisms and plants help in humus accumulation.
- Five basic factors control the formation of soils :
  - **Parent material :** Parent material is a passive control factor in soil formation. Parent materials can be any insitu or on-site weathered rock debris (residual soils) or transported deposits (transported soils).
    Nature and rate of weathering and depth of weathering mantle are important consideration under parent materials. Also, in case of some limestone areas, where the weathering processes are specific and peculiar, soils will show clear relation with the parent rock.
  - **Topography :** Topography like parent materials is another passive control factor. The influence of topography is felt through the amount of exposure of a surface covered by parent materials to sunlight and the amount of surface and sub-surface drainage over and through the parent materials.
  - **Climate :** Climate is an important active factor in soil formation. The climatic elements involved in soil development are : **(i)** moisture in terms of its intensity, frequency and duration of precipitation — evaporation and humidity; **(ii)** temperature in terms of seasonal and diurnal variations. Precipitation gives soil its moisture content which makes the chemical and biological activities possible. Excess of water helps in the downward transportation of soil components through the soil (eluviation) and deposits the same down below (illuviation).
    In climates like wet equatorial rainy areas with high rainfall, not only calcium, sodium, magnesium, potassium etc., but also a major part of silica is removed from the soil. Removal of silica from the soil is known as desilication.

- **Biological activity :** The vegetative cover and organisms that occupy the parent materials from the beginning and also at later stages help in adding organic matter, moisture retention, nitrogen, etc. Dead plants provide humus, the finely divided organic matter of the soil. Some organic acids which form during humification aid in decomposing the minerals of the soil parent materials. The influence of large animals like ants, termites, earthworms, rodents, etc., is mechanical, but, it is nevertheless important in soil formation as they rework the soil up and down.
- **Time :** Time is the third important controlling factor in soil formation. The length of time the soil forming processes operate, determines maturation of soils and profile development. A soil becomes mature when all soil-forming processes act for a sufficiently long time developing a profile.

Know the Terms

- **Soil :** Soil can be defined as a collection of natural bodies on the earth's surface containing living and non-living organisms.
- **Desilication:** Removal of silica from the soil is termed as desilication.
- **Hardpans :** In dry climates, because of high temperature, evaporation exceeds precipitation and hence ground-water is brought up to the surface by capillary action and in the process the water evaporates leaving behind salts in the soil. Such salts form into a crust in the soil known as hardpans.
- **Precipitation :** It can defined as ran, snow, sleet or hail—any kind of weather condition where something's falling from the sky.

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CHAPTER-7
LANDFORMS AND THEIR EVOLUTION

TOPIC-1
Running Water, Erosional Landforms, Depositional Landforms

Revision Notes

- After weathering processes have had their actions on the earth materials making up the surface of the earth, the geomorphic agents like running water, groundwater, wind, glaciers, waves perform erosion.
- What is a landform? In simple words, small to medium tracts or parcels of the earth's surface are called landforms.
- Several related landforms together make up landscapes, (large tracts of earth's surface). Each landform has its own physical shape, size, materials and is a result of the action of certain geomorphic processes and agent(s).
- Actions of most of the geomorphic processes and agents are slow, and hence the results take a long time to take shape. Every landform has a beginning. Landforms once formed may change in their shape, size and nature slowly or fast due to continued action of geomorphic processes and agents. A landmass passes through stages of development somewhat comparable to the stages of life — youth, mature and old age.
- Geomorphology deals with the reconstruction of the history of the surface of the earth through a study of its forms, the materials of which it is made up of and the processes that shape it.
- In humid regions, which receive heavy rainfall running water is considered the most important of the geomorphic agents in bringing about the degradation of the land surface.
- There are two components of running water. One is overland flow on general land surface as a sheet. Another is linear flow as streams and rivers in the valleys.
- With time, stream channels over steep gradients turn gentler due to continued erosion, and as a consequence, lose their velocity, facilitating active deposition.
- When the stream beds turn gentler due to continued erosion, downward cutting becomes less dominant and lateral erosion of banks increases and as a consequence the hills and valleys are reduced to plains.
- Overland flow causes sheet erosion. Depending upon irregularities of the land surface, the overland flow may concentrate into narrow to wide paths.
- In the early stages, Streams are few during this stage with poor integration and flow over original slopes showing shallow V-shaped valleys with no floodplains or with very narrow floodplains along trunk streams. Waterfalls and rapids may exist where local hard rock bodies are exposed.

- During the middle stage streams are plenty with good integration. The valleys are still V-shaped but deep; trunk streams are broad enough to have wider floodplains within which streams may flow in meanders confined within the valley. Waterfalls and rapids disappear.
- Smaller tributaries during old age are few with gentle gradients. Streams meander freely over vast floodplains showing natural levees, ox-bow lakes, etc. Most of the landscape is at or slightly above sea level.
- **Erosional Landforms :**
  - Valleys : They start as small and narrow rills; the rills will gradually develop into long and wide gullies; the gullies will further deepen, widen and lengthen to give rise to valleys. Depending upon dimensions and shape, many types of valleys like V-shaped valley, gorge, canyon, etc., can be recognised. A gorge is almost equal in width at its top as well as its bottom. Valley types depend upon the type and structure of rocks in which they form.
  - Potholes and Plunge Pools : Over the rocky beds of hill-streams more or less circular depressions called potholes form because of stream erosion aided by the abrasion of rock fragments. Once a small and shallow depression forms, pebbles and boulders get collected in those depressions and get rotated by flowing water and consequently the depressions grow in dimensions. A series of such depressions eventually join and the stream valley gets deepened.
  - Incised or Entrenched Meanders : In streams that flow rapidly over steep gradients, normally erosion is concentrated on the bottom of the stream channel. Also, in the case of steep gradient streams, lateral erosion on the sides of the valleys is not much when compared to the streams flowing on low and gentle slopes. Because of active lateral erosion, streams flowing over gentle slopes, develop sinuous or meandering courses.
  - River terraces : They are surfaces marking old valley floor or floodplain levels. They may be bedrock surfaces without any alluvial cover or alluvial terraces consisting of stream deposits. River terraces are basically products of erosion as they result due to vertical erosion by the stream into its own depositional floodplain.
- **Depositional Landforms :**
  - Alluvial fans : They are formed when streams flowing from higher levels break into foot slope plains of low gradient. Normally very coarse load is carried by streams flowing over mountain slopes. This load becomes too heavy for the streams to be carried over gentler gradients and gets dumped and spread as a broad low to high cone shaped deposit called alluvial fan.
  - Deltas : Deltas are like alluvial fans but develop at a different location. The load carried by the rivers is dumped and spread into the sea. If this load is not carried away far into the sea or distributed along the coast, it spreads and accumulates as a low cone. Unlike in alluvial fans, the deposits making up deltas are very well sorted with clear stratification. As the delta grows, the river distributaries continue to increase in length and delta continues to build up into the sea.
  - Floodplains, Natural Levees and Point Bars : Deposition develops a floodplain just as erosion makes valleys. Floodplain is a major landform of river deposition. The floodplain above the bank is inactive floodplain. Inactive floodplain above the banks basically contain two types of deposits — flood deposits and channel deposits. Natural levees are found along the banks of large rivers . The levee deposits are coarser than the deposits spread by flood waters away from the river. When rivers shift laterally, a series of natural levees can form. Point bars are also known as meander bars.
  - Meanders : In large flood and delta plains, rivers rarely flow in straight courses. Loop-like channel patterns called meanders develop over flood and delta plains. Meander is not a landform but is only a type of channel pattern. Normally, in meanders of large rivers, there is active deposition along the convex bank and undercutting along the concave bank.
  - Braided Channels : When rivers carry coarse material, there can be selective deposition of coarser materials causing formation of a central bar which diverts the flow towards the banks; and this flow increases lateral erosion on the banks. Deposition and lateral erosion of banks are essential for the formation of braided pattern.

Know the Terms

- **Landforms :** A small to medium tracts or parcels of the earth's surface are called landforms.
- **Landscape :** Several related landforms together make up landscapes.
- **Evolution :** Evolution implies stages of transformation of either a part of the earth's surface from one landform into another or transformation of individual landforms after they are once formed
- **Geomorphology :** Geomorphology deals with the reconstruction of the history of the surface of the earth through a study of its forms, the materials of which it is made up of and the processes that shape it.

- **Monadnocks :** The divides between drainage basins are likewise lowered until they are almost completely flattened leaving finally, a lowland of faint relief with some low resistant remnants called monadnocks.
- **Peneplain :** The plain formed as a result of stream erosion is called a peneplain.
- **Gorge :** A gorge is a deep valley with very steep to straight sides.
- **Canyon :** A canyon is characterised by steep step-like side slopes and may be as deep as a gorge.
- **Plunge pools :** At the foot of waterfalls also, large potholes, quite deep and wide, form because of the sheer impact of water and rotation of boulders. Such large and deep holes at the base of waterfalls are called plunge pools.
- **Plunge tools :** A series of depressions eventually join and the stream valley gets deepened. At the foot of waterfalls also, large potholes, quite deep and wide, form because of the sheer impact of fwater and rotation of boulders. Such large and deep holes at the base of waterfalls are called potholes.
- **Incised or entrenched meanders :** They are very deep and wide meanders that can be found cut in hard rocks.
- **Paired terraces :** The river terraces may occur at the same elevation on either side of the rivers, these are called paired terraces.
- **Lunpaired terraces :** When a terrace is present only on one side of the stream and with none on the other side or one at quite a different elevation on the other side, the terraces are called lunpaired terraces.
- **Delta plains :** The floodplains in a delta are called delta plains.
- **Natural levees :** Natural levees are found along the banks of large rivers. They are low, linear and parallel ridges of coarse deposits along the banks of rivers, quite often cut into individual mounds.
- **Meanders :** In large flood and delta plains, rivers rarely flow in straight courses. Loop-like channel patterns are formed they are called meanders.
- **Ox-bow lakes :** As meanders grow into deep loops, the same may get cut-off due to erosion at the inflection points and are left as ox-bow lakes.

TOPIC-2
Groundwater, Erosional Landforms, Depositional Landforms

Revision Notes

- The surface water percolates well when the rocks are permeable, thinly bedded and highly jointed and cracked. After vertically going down to some depth, the water under the ground flows horizontally through the bedding planes, joints or through the materials themselves.
- Physical or mechanical removal of materials by moving groundwater is insignificant in developing landforms. That is why, the results of the work of groundwater cannot be seen in all types of rocks.
- Any limestone or dolomitic region showing typical landforms produced by the action of groundwater through the processes of solution and deposition is called Karst topography after the typical topography developed in limestone rocks of Karst region in the Balkans adjacent to Adriatic Sea.
- **Erosional Landforms :**
  - Pools, Sinkholes, Lapies and Limestone Pavements : Small to medium sized round to sub-rounded shallow depressions called swallow holes form on the surface of limestones through solution. Sinkholes are very common in limestone/karst areas. A sinkhole is an opening more or less circular at the top and funnel-shapped towards the bottom with sizes varying in area from a few sq m to a hectare and with depth from a less than half a metre to thirty metres or more. Gradually, most of the surface of the limestone is eaten away by these pits and trenches, leaving it extremely irregular with a maze of points, grooves and ridges or lapies. Especially, these ridges or lapies form due to differential solution activity along parallel to sub-parallel joints. The lapie field may eventually turn into somewhat smooth limestone pavements.
  - Caves : In areas where there are alternating beds of rocks (shales, sandstones, quartzites) with limestones or dolomites in between or in areas where limestones are dense, massive and occurring as thick beds, cave formation is prominent. Caves normally have an opening through which cave streams are discharged. Caves having openings at both the ends are called tunnels.

- **Depositional Landforms :**
  - Stalactites, Stalagmites and Pillars : Stalactites hang as icicles of different diameters. Normally they are broad at their bases and taper towards the free ends showing up in a variety of forms. Stalagmites rise up from the floor of the caves. In fact, stalagmites form due to dripping water from the surface or through the thin pipe, of the stalactite, immediately below it. Stalagmites may take the shape of a column, a disc, with either a smooth, rounded bulging end or a miniature crater like depression. The stalagmites and stalactites eventually fuse to give rise to columns and pillars of different diameters.

Know the Terms

- **Karst topography :** Any limestone or dolomitic region showing typical landforms produced by the action of groundwater through the processes of solution and deposition is called Karst topography.
- **Sinkhole :** A sinkhole is an opening more or less circular at the top and funnel-shapped towards the bottom with sizes varying in area from a few sq m to a hectare and with depth from a less than half a metre to thirty metres or more.
- **Doline :** It is a shallow usually funnel-shaped depression of the ground surface formed by solution in limestone regions.
- **Valley sinks or Uvalas :** A closed karst depression, a terrain form usually of elongated or compound structure and of larger size than a sinkhole.
- **Ridges or lapies :** It is the grooved , fluted features in an open limestone field.
- **Stalactites :** A tapering structure hanging like an icicle from the roof of a cave, formed of calcium salts deposited by dripping water.
- **Stalagmites :** A mound or tapering column rising from the floor of a cave, formed of calcium salts deposited by dripping water and often uniting with a stalactite.

TOPIC-3
Glaciers, Erosional Landforms, Depositional Landforms, Waves and Currents, Erosional Landforms, Depositional Landforms

Revision Notes

- Masses of ice moving as sheets over the land (continental glacier or piedmont glacier if a vast sheet of ice is spread over the plains at the foot of mountains) or as linear flows down the slopes of mountains in broad trough-like valleys (mountain and valley glaciers) are called glaciers. Glaciers move basically because of the force of gravity.
- Erosion by glaciers is tremendous because of friction caused by sheer weight of the ice.
- Glaciers can cause significant damage to even un-weathered rocks and can reduce high mountains into low hills and plains.
- **Erosional Landforms :**
  - Cirques : They are the most common of landforms in glaciated mountains. The cirques quite often are found at the heads of glacial valleys. The accumulated ice cuts these cirques while moving down the mountain tops. They are deep, long and wide troughs or basins with very steep concave to vertically dropping high walls at its head as well as sides.
  - Horns and Serrated Ridges : Horns form through headward erosion of the cirque walls. If three or more radiating glaciers cut headward until their cirques meet, high, sharp pointed and steep-sided peaks called horns form.
  - Glacial Valleys/Troughs : Glaciated valleys are trough-like and U-shaped with broad floors and relatively smooth, and steep sides. The valleys may contain littered debris or debris shaped as moraines with swampy appearance. Very deep glacial troughs filled with sea water and making up shorelines (in high latitudes) are called fjords/fiords.
- **Depositional Landforms :**
  - Moraines : They are long ridges of deposits of glacial till. Terminal moraines are long ridges of debris deposited at the end (toe) of the glaciers. Lateral moraines form along the sides parallel to the glacial valleys. Many valley glaciers retreating rapidly leave an irregular sheet of till over their valley floors. Such deposits varying greatly in thickness and in surface topography are called ground moraines.

- Eskers : When glaciers melt in summer, the water flows on the surface of the ice or seeps down along the margins or even moves through holes in the ice. These waters accumulate beneath the glacier and flow like streams in a channel beneath the ice.
- Outwash Plains : The plains at the foot of the glacial mountains or beyond the limits of continental ice sheets are covered with glacio-fluvial deposits in the form of broad flat alluvial fans which may join to form outwash plains of gravel, silt, sand and clay.
- Drumlins : It are smooth oval shaped ridge-like features composed mainly of glacial till with some masses of gravel and sand. The long axes of drumlins are parallel to the direction of ice move.
- One end of the drumlins facing the glacier called the stoss end is blunter and steeper than the other end called tail. Drumlins give an indication of direction of glacier movement.

➢ Most of the changes along the coasts are accomplished by waves. When waves break, the water is thrown with great force onto the shore, and simultaneously, there is a great churning of sediments on the sea bottom.

➢ Constant impact of breaking waves drastically affects the coasts. As wave environment changes, the intensity of the force of breaking waves changes.

➢ Along the high rocky coasts, the rivers appear to have been drowned with highly irregular coastline. The coastline appears highly indented with extension of water into the land where glacial valleys (fjords) are present.

➢ Along high rocky coasts, waves break with great force against the land shaping the hill sides into cliffs. Waves gradually minimise the irregularities along the shore.

➢ When waves break over a gently sloping sedimentary coast, the bottom sediments get churned and move readily building bars, barrier bars, spits and lagoons. The maintenance of these depositional features depends upon the steady supply of materials.

➢ **Erosional Landforms :**

- **Cliffs, Terraces, Caves and Stacks :** Wave-cut cliffs and terraces are two forms usually found where erosion is the dominant shore process. Almost all sea cliffs are steep and may range from a few m to 30 m or even more. The lashing of waves against the base of the cliff and the rock debris that gets smashed against the cliff along with lashing waves create hollows and these hollows get widened and deepened to form sea caves. Retreat of the cliff may leave some remnants of rock standing isolated as small islands just off the shore. Such resistant masses of rock, originally parts of a cliff or hill are called sea stacks.

➢ **Depositional Landforms :**

- **Beaches and Dunes :** Beaches are characteristic of shorelines that are dominated by deposition, but may occur as patches along even the rugged shores. Most of the sediment making up the beaches comes from land carried by the streams and rivers or from wave erosion. Most of the beaches are made up of sand sized materials. Beaches called shingle beaches contain excessively small pebbles and even cobbles.
- **Bars, Barriers and Spits :** A ridge of sand and shingle formed in the sea in the off-shore zone (from the position of low tide waterline to seaward) lying approximately parallel to the coast is called an off-shore bar. An off-shore bar which is exposed due to further addition of sand is termed a barrier bar. Sometimes such barrier bars get keyed up to one end of the bay when they are called spits.

Know the Terms

➢ **Fjords :** Very deep glacial troughs filled with sea water and making up shorelines (in high latitudes) are called fjords/fiords.

➢ **Glacier :** Masses of ice moving as sheets over the land or as linear flows down the slopes of mountains in broad trough-like valleys are called glaciers.

➢ **Glacier till :** The unassorted coarse and fine debris dropped by the melting glaciers is called glacial till.

➢ **Outwash deposits :** Some amount of rock debris small enough to be carried by such melt-water streams is washed down and deposited. Such glacio-fluvial deposits are called outwash deposits.

➢ **Moraines :** They are long ridges of deposits of glacial till.

➢ **Tarn lakes :** A lake of water can be seen quite often within the cirques after the glacier disappears. Such lakes are called cirque or tarn lakes.

➢ **Drumlins :** They are smooth oval shaped ridge-like features composed mainly of glacial till with some masses of gravel and sand.

➢ **Wave cut terrace :** At the foot of such cliffs there may be a flat or gently sloping platform covered by rock debris derived from the sea cliff behind. Such platforms occurring at elevations above the average height of waves is called a wave-cut terrace.

- **Barrier bar :** Bars are submerged features and when bars show up above water, they are called barrier bars.
- **Wave cut terrace :** The gently sloping platform occurring at elevations above the average height of waves is called a wave-cut terrace.
- **Sea stacks :** The resistant masses of rock, originally parts of a cliff or hill are called sea stacks.
- **Spits :** Sometimes the barrier bars get keyed up to one end of the bay when they are called spits.

TOPIC-4
Winds, Erosional Landforms, Depositional Landforms

Revision Notes

- Wind is one of the two dominant agents in hot deserts. The desert floors get heated up too much and too quickly because of being dry and barren.
- Winds also move along the desert floors with great speed and the obstructions in their path create turbulence.
- Winds cause deflation, abrasion and impact. Deflation includes lifting and removal of dust and smaller particles from the surface of rocks. In the transportation process sand and silt act as effective tools to abrade the land surface.
- The wind action creates a number of interesting erosional and depositional features in the deserts. The wind moves fine materials and general mass erosion is accomplished mainly through sheet floods or sheet wash.
- **Erosional Landforms :**
  - Pediments and Pediplains : Landscape evolution in deserts is primarily concerned with the formation and extension of pediments. Gently inclined rocky floors close to the mountains at their foot with or without a thin cover of debris, are called pediments. Erosion starts along the steep margins of the landmass or the steep sides of the tectonically controlled steep incision features over the landmass.
  - Playas : Plains are by far the most prominent landforms in the deserts. In times of sufficient water, these plains are covered up by a shallow water body. Such types of shallow lakes are called as playas where water is retained only for short duration due to evaporation and quite often the playas contain good deposition of salts.
  - Deflation Hollows and Caves : Weathered mantle from over the rocks or bare soil, gets blown out by persistent movement of wind currents in one direction. This process may create shallow depressions called deflation hollows. Deflation also creates numerous small pits or cavities over rock surfaces. The rock faces suffer impact and abrasion of wind-borne sand and first shallow depressures called blow outs are created, and some of the blow outs become deeper and wides fit to be called cares.
  - Mushroom, Table and Pedestal Rocks : Many rock-outcrops in the deserts easily susceptible to wind deflation and abrasion are worn out quickly leaving some remnants of resistant rocks polished beautifully in the shape of mushroom with a slender stalk and a broad and rounded pear shaped cap above. Sometimes, the top surface is broad like a table top and quite often, the remnants stand out like pedesta.
- **Depositional Landforms :**
  - Sand Dunes : Dry hot deserts are good places for sand dune formation. Obstacles to initiate dune formation are equally important. There can be a great variety of dune forms.
  - Barchans : Crescent shaped dunes called barchans with the points or wings directed away from wind direction i.e., downwind, form where the wind direction is constant and moderate and where the original surface over which sand is moving is almost uniform. Parabolic dunes form when sandy surfaces are partially covered with vegetation. Seif is similar to barchan with a small difference. Seif has only one wing or point. This happens when there is shift in wind conditions. The lone wings of seifs can grow very long and high. When sand is plenty, quite often, the regular shaped dunes coalesce and lose their individual characteristics. Most of the dunes in the deserts shift and a few of them will get stabilised especially near human habitations.

Know the Terms

- **Wind :** The perceptible natural movement of the air, especially in the form of a current of air blowing from a particular direction.

- **Pediments :** Gently inclined rocky floors close to the mountains at their foot with or without a thin cover of debris, are called pediments.
- **Pediplain :** It is an extensive plain formed in a desert by the coalescence of neighbouring pediments.
- **Inselberg :** It is an isolated rock hill, knob, ridge or small mountain that rises abruptly from a gently sloping or virtually level surrounding plain.
- **Alkali Flats :** The playa plain covered up by salts is called alkali flats.
- **Deflation hollows :** Weathered mantle from over the rocks or bare soil, gets blown out by persistent movement of wind currents in one direction. This process may create shallow depressions called deflation hollows.
- **Barchans :** Crescent shaped dunes called barchans.
- **Parabolic Dunes :** Parabolic dunes form when sandy surfaces are partially covered with vegetation.
- **Seif :** Seif is similar to barchan with a small difference. Seif has only one wing or point. This happens when there is shift in wind conditions.
- **Longitudinal dunes :** They are formed when supply of sand is poor and wind direction is constant. They appear as long ridges of considerable length but low in height.
- **Transverse dunes :** They are aligned perpendicular to wind direction. These dunes form when the wind direction is constant and the source of sand is an elongated feature at right angles to the wind direction.

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UNIT-IV : CLIMATE

CHAPTER-8
COMPOSITION AND STRUCTURE OF ATMOSPHERE

TOPIC-1
Atmosphere, composition of Atmosphere

Revision Notes

- Air is essential to the survival of all organisms. Some organisms like humans may survive for some time without food and water but can't survive even a few minutes without breathing air.
- Atmosphere is a mixture of different gases and it envelopes the earth all round. It contains life-giving gases like oxygen for humans and animals and carbon dioxide for plants.
- The air is an integral part of the earth's mass and 99 per cent of the total mass of the atmosphere is confined to the height of 32 km from the earth's surface.
- The atmosphere is composed of gases, water vapour and dust particles.
- The proportion of gases changes in the higher layers of the atmosphere in such a way that oxygen will be almost in negligible quantity at the height of 120 km.
- Carbon dioxide is meteorologically a very important gas as it is transparent to the incoming solar radiation but opaque to the outgoing terrestrial radiation.
- It absorbs a part of terrestrial radiation and reflects back some part of it towards the earth's surface. It is largely responsible for the green house effect.
- Ozone is another important component of the atmosphere found between 10 and 50 km above the earth's surface and acts as a filter and absorbs the ultraviolet rays radiating from the sun and prevents them from reaching the surface of the earth.
- Water vapour is also a variable gas in the atmosphere, which decreases with altitude. It acts like a blanket allowing the earth neither to become too cold nor too hot. Water vapour also contributes to the stability and instability in the air.
- Atmosphere has a sufficient capacity to keep small solid particles, which may originate from different sources and include sea salts, fine soil, smoke-soot, ash, pollen, dust and disintegrated particles of meteors.
- Dust particles are generally concentrated in the lower layers of the atmosphere; yet, convectional air currents may transport them to great heights.
- Dust and salt particles act as hygroscopic nuclei around which water vapour condenses to produce clouds.

Know the Terms

- **Atmosphere :** An atmosphere is layer of gases surrounding a planet or other material body.
- **Ozone :** It is a region of earth's stratosphere that absorbs most of the sun's ultraviolet radiations.

TOPIC-2
Structure of the Atmosphere

Revision Notes

- The atmosphere consists of different layers with varying density and temperature.
- Density is highest near the surface of the earth and decreases with increasing altitude.
- Atmosphere is divided into five different layers depending upon the temperature condition. They are: troposphere, stratosphere, mesosphere, ionosphere and exosphere.
- The troposphere is the lowermost layer of the atmosphere. Its average height is 13 km and extends roughly to a height of 8 km near the poles and about 18 km at the equator.
- Thickness of the troposphere is greatest at the equator because heat is transported to great heights by strong convectional currents.
- All changes in climate and weather take place in this layer. The temperature in this layer decreases at the rate of 1°C for every 165 m of height.
- This is the most important layer for all biological activity.
- The zone separating the troposphere from stratosphere is known as the tropopause.
- The air temperature at the tropopause is about minus 80°C over the equator and about minus 45°C over the poles.
- The stratosphere is found above the tropopause and extends up to a height of 50 km.
- One important feature of the stratosphere is that it contains the ozone layer. This layer absorbs ultraviolet radiation and shields life on the earth from intense, harmful form of energy.
- The mesosphere lies above the stratosphere, which extends up to a height of 80 km. In this layer, once again, temperature starts decreasing with the increase in altitude and reaches up to minus 100°C at the height of 80 km.
- The upper limit of mesosphere is known as the mesopause.
- The ionosphere is located between 80 and 400 km above the mesopause. It contains electrically charged particles known as ions, and hence, it is known as ionosphere.
- The uppermost layer of the atmosphere above the ionosphere is known as the exosphere. This is the highest layer but very little is known about it.
- Whatever contents are there, these are extremely rarefied in this layer, and it gradually merges with the outer space.

Know the Terms

- **Ion :** Ion are the electrically charged particles.
- **Tropopause :** The zone that separates the troposphere from stratosphere is known as the tropopause.
- **Mesopause :** The upper limit of mesosphere is known as mesopause.

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CHAPTER-9
SOLAR RADIATION, HEAT BALANCE AND TEMPERATURE

TOPIC-1
Solar Radiation, Variability of Insolation at the Surface of the Earth, Heating and Cooling of Atmosphere, Terrestrial Radiation

Revision Notes

- The earth receives almost all of its energy from the sun. The earth in turn radiates back to space the energy received from the sun. As a result, the earth neither warms up nor does it get cooled over a period of time.
- Thus, the amount of heat received by different parts of the earth is not the same. This variation causes pressure differences in the atmosphere. This leads to transfer of heat from one region to the other by winds.
- The earth's surface receives most of its energy in short wavelengths. The energy received by the earth is known as incoming solar radiation which in short is termed as insolation.
- As the earth is a geoid resembling a sphere, the sun's rays fall obliquely at the top of the atmosphere and the earth intercepts a very small portion of the sun's energy.
- The solar output received at the top of the atmosphere varies slightly in a year due to the variations in the distance between the earth and the sun.
- During its revolution around the sun, the earth is farthest from the sun (152 million km on 4th July). This position of the earth is called aphelion.
- On 3rd January, the earth is the nearest to the sun (147 million km). This position is called perihelion.
- The variation in the solar output does not have great effect on daily weather changes on the surface of the earth.
- The amount and the intensity of insolation vary during a day, in a season and in a year. The factors that cause these variations in insolation are :
  - the rotation of earth on its axis;
  - the angle of inclination of the sun's rays;
  - the length of the day;
  - the transparency of the atmosphere;
  - the configuration of land in terms of its aspect.

  The last two however, have less influence.
- The atmosphere is largely transparent to short wave solar radiation. The incoming solar radiation passes through the atmosphere before striking the earth's surface.
- The insolation received at the surface varies from about 320 Watt/m^2 in the tropics to about 70 Watt/m^2 in the poles. Maximum insolation is received over the subtropical deserts, where the cloudiness is the least.
- Equator receives comparatively less insolation than the tropics.
- The Earth after being heated by insolation transmits the heat to the atmospheric layers near to the earth in long wave form.
- The air in contact with the land gets heated slowly and the upper layers in contact with the lower layers also get heated. This process is called conduction.
- Conduction takes place when two bodies of unequal temperature are in contact with one another, there is a flow of energy from the warmer to cooler body.
- The air in contact with the earth rises vertically on heating in the form of currents and further transmits the heat of the atmosphere. This process of vertical heating of the atmosphere is known as convection.
- The transfer of heat through horizontal movement of air is called advection.
- In tropical regions particularly in northern India during summer season local winds called 'loo' is the outcome of advection process.
- The insolation received by the earth is in short waves forms and heats up its surface. The earth after being heated itself becomes a radiating body and it radiates energy to the atmosphere in long wave form. This energy heats up the atmosphere from below. This process is known as terrestrial radiation.
- The long wave radiation is absorbed by the atmospheric gases particularly by carbon dioxide and the other green house gases. Thus, the atmosphere is indirectly heated by the earth's radiation.

Know the Terms

- **Insolation :** The energy received by the earth is known as incoming solar radiation which in short is termed as insolation.
- **Aphelion :** During its revolution around the sun, the earth is farthest from the sun (152 million km on 4th July). This position of the earth is called aphelion.
- **Perihelion :** On 3rd January, the earth is the nearest to the sun (147 million km). This position is called perihelion.
- **Incoming Solar Radiation :** The earth's surface receives most of its energy in short wavelengths. The energy received by the earth is known as incoming solar radiation**.**
- **Conduction :** The air in contact with the land gets heated slowly and the upper layers in contact with the lower layers also get heated. This process is called conduction.
- **Convection :** The air in contact with the earth rises vertically on heating in the form of currents and further transmits the heat of the atmosphere. This process of vertical heating of the atmosphere is known as convection.
- **Advection :** The transfer of heat through horizontal movement of air is called advection.
- **Terrestrial Radiation :** The insolation received by the earth is in short waves forms and heats up its surface. The earth after being heated itself becomes a radiating body and it radiates energy to the atmosphere in long wave form. This energy heats up the atmosphere from below. This process is known as terrestrial radiation.

TOPIC-2
Heat Budget of the Planet Earth, Temperature, Factors Controlling Temperature Distribution, Inversion of Temperature

Revision Notes

- The earth as a whole does not accumulate or loose heat. It maintains its temperature. This can happen only if the amount of heat received in the form of insolation equals the amount lost by the earth through **terrestrial radiation.**
- Consider that the insolation received at the top of the atmosphere is 100 per cent. While passing through the atmosphere some amount of energy is reflected, scattered and absorbed. Only the remaining part reaches the earth's surface.
- Roughly 35 units are reflected back to space even before reaching the earth's surface. Of these, 27 units are reflected back from the top of the clouds and 2 units from the snow and ice-covered areas of the earth. The reflected amount of radiation is called the albedo of the earth.
- Some part of the earth has surplus radiation balance while the other part has deficit.
- The surplus heat energy from the tropics is redistributed pole wards and as a result the tropics do not get progressively heated up due to the accumulation of excess heat or the high latitudes get permanently frozen due to excess deficit.
- The interaction of insolation with the atmosphere and the earth's surface creates heat which is measured in terms of temperature.
- While heat represents the molecular movement of particles comprising a substance, the temperature is the measurement in degrees of how hot (or cold) a thing (or a place) is.
- The various factors controlling temperature distribution are :
  - **The Latitude :** The temperature of a place depends on the insolation received. It has been explained earlier that the insolation varies according to the latitude hence the temperature also varies accordingly.
  - **The Altitude :** The temperature generally decreases with increasing height. The rate of decrease of temperature with height is termed as the normal lapse rate. It is 6.5°C per 1,000 m.
  - **Distance for the Sea :** As compared to land, the sea gets heated slowly and loses heat slowly. Land heats up and cools down quickly. Therefore, the variation in temperature over the sea is less compared to land.
  - **Air mass and Ocean Currents :** The places, which come under the influence of warm air masses experience higher temperature and the places that come under the influence of cold air masses experience low temperature. Similarly, the places located on the coast where the warm ocean currents flow record higher temperature than the places located on the coast where the cold currents flow.

- **Distribution of Temperature :** The temperature distribution is generally shown on the map with the help of isotherms. The isotherms are lines joining places having equal temperature. The global distribution of temperature can well be understood by studying the temperature distribution in January and July.

➢ The temperature decreases with increase in elevation. It is called normal lapse rate. At times, the situations are reversed and the normal lapse rate is inverted. It is called inversion of temperature. Inversion is usually of short duration but quite common nonetheless.

➢ A long winter night with clear skies and still air is ideal situation for inversion. Over polar areas, temperature inversion is normal throughout the year.

➢ The inversion takes place in hills and mountains due to air drainage. Cold air at hills and mountains ,produced during night , flow under the influence of gravity . Being heavy and dense , the cold air acts almost like water and moves down the slopes to pile up deeply in pockets and valley bottoms with warm air above. This is called drainage. It protects plants from frost damages.

Know the Terms

➢ **Albedo of the earth :** While passing through the atmosphere some amount of energy is reflected , scattered and absorbed. Only the remaining part reached the earth surface. The reflected amount of radiation is called the albedo of the earth.

➢ **Heat budget :** The balance between incoming and outgoing solar radiation is termed as heat budget.

➢ **Normal lapse time :** The temperature generally decreases with increasing height. The rate of decrease of temperature with height is termed as the normal lapse time.

➢ **Loo :** It is the strong , gusty , hot and dry summer wind which blows in the summer season.

➢ **Isotherms :** They are lines joining places having equal temperature.

➢ **Inversion of temperature :** A reversal in the normal behaviour of temperature in the troposphere in which a layer of cool air at the surface is overlain by a layer of warmer air.

➢ **Planck's Law :** This law states that hotter a body, the more energy it radiates and shorter the wavelength of that radiation.

➢ **Air drainage :** The downslope flow of relatively cold air .

➢ **Specific heat :** It is the energy needed to raise the temperature of one gram of substance by one Celsius.

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CHAPTER-10
ATMOSPHERIC CIRCULATION AND WEATHER SYSTEMS

TOPIC-1
Atmospheric Pressure, Vertical Variation of Pressure, Horizontal Distribution of Pressure, World Distribution of Sea Level Pressure, Forces Affecting the Velocity and Direction of Wind.

Revision Notes

➢ Air expands when heated and gets compressed when cooled. This results in variations in the atmospheric pressure. The result is that it causes the movement of air from high pressure to low pressure, setting the air in motion.

➢ Atmospheric pressure also determines when the air will rise or sink. The wind redistributes the heat and moisture across the planet, thereby, maintaining a constant temperature for the planet as a whole. The vertical rising of moist air cools it down to form the clouds and bring precipitation.

➢ The weight of a column of air contained in a unit area from the mean sea level to the top of the atmosphere is called the atmospheric pressure.

➢ The atmospheric pressure is expressed in units of milibar (mb). Air pressure is measured with the help of a mercury barometer or the aneroid barometer.

- The pressure decreases with height. At any elevation it varies from place to place and its variation is the primary cause of air motion, i.e. wind which moves from high pressure areas to low pressure areas.
- The vertical pressure gradient force is much larger than that of the horizontal pressure gradient.
- Horizontal distribution of pressure is studied by drawing isobars at constant levels. Isobars are lines connecting places having equal pressure.
- Near the equator the sea level pressure is low and the area is known as **equatorial low**.
- Along 30° N and 30° S are found the high-pressure areas known as the subtropical highs.
- Further pole wards along 60 °N and 60° S, the low-pressure belts are termed as the sub polar lows.
- Near the poles the pressure is high and it is known as the polar high.
- These pressure belts are not permanent in nature. They oscillate with the apparent movement of the Sun. In the Northern Hemisphere in winter they move southwards and in the summer northwards.
- The air in motion is called wind. The wind blows from high pressure to low pressure.
- The wind at the surface experiences friction. In addition, rotation of the earth also affects the wind movement.
- The force exerted by the rotation of the earth is known as the Coriolis Force.
- Thus, the horizontal winds near the Earth surface respond to the combined effect of three forces – the pressure gradient force, the frictional force and the Coriolis Force.
  - **Pressure Gradient Force :** The differences in atmospheric pressure produces a force. The rate of change of pressure with respect to distance is the pressure gradient.
  - **Frictional Force :** It affects the speed of the wind. It is greatest at the surface and its influence generally extends upto an elevation of 1 - 3 km. Over the sea surface the friction is minimal.
  - **Coriolis Force :** The rotation of the earth about its axis affects the direction of the wind. This force is called the Coriolis Force. The Coriolis Force is directly proportional to the angle of latitude. It is maximum at the poles and is absent at the Equator.
  - **Pressure and Wind :** The velocity and direction of the wind are the net result of the wind generating forces. The winds in the upper atmosphere, 2 - 3 km above the surface, are free from frictional effect of the surface and are controlled by the pressure gradient and the Coriolis Force. Coriolis Force and the resultant wind blows parallel to the isobar. This wind is known as the geostrophic wind.
- The wind circulation around a low is called cyclonic circulation. Around a high it is called anti cyclonic circulation. The direction of winds around such systems changes according to their location in different hemispheres.

Know the Terms

- **Atmospheric Pressure :** The pressure exerted by the Earth's atmosphere at any given point of time, being the product of the mass of the atmospheric column of the unit area above the given point and of the gravitational acceleration at the given point.
- **Isobars :** They are lines connecting places having equal pressure.
- **Vertical pressure force:** The force that counteracts gravity and keeps the air up in the atmosphere is called the vertical pressure gradient force.
- **Horizontal pressure force :** The horizontal pressure forces are forces that are directed from higher towards lower pressure.
- **Equatorial low :** Near the Equator the sea level pressure is low and the area is known as equatorial low.
- **Polar high :** Near the poles the pressure is high and it is known as the polar high.
- **Sub-polar low :** The low-pressure belts are termed as the sub-polar lows.
- **Wind :** A natural movement of air of any velocity.
- **Pressure Gradient Force :** The differences in atmospheric pressure produces a force. The rate of change of pressure with respect to distance is the pressure gradient.
- **Frictional force :** It is the force resisting the relative motion of solid surfaces, fluid layers and material elements sliding against each other.
- **Coriolis force :** The rotation of the earth about its axis affects the direction of the wind. This force is called the Coriolis force.
- **Geostrophic wind :** These winds result from an exact balance between the Coriolis force and the pressure gradient force.
- **Cyclonic circulation :** The wind circulation around a low pressure condition is known as cyclonic circulation.
- **Anti-cyclonic circulation :** The wind circulation around the high pressure condition is known as anti-cyclonic circulation.

TOPIC-2
General Circulation of the Atmosphere

Revision Notes

- The pattern of planetary winds largely depends on :
  - Latitudinal variation of atmospheric heating
  - Emergence of pressure belts
  - The migration of belts following apparent path of the sun
  - The distribution of continents and oceans
  - The rotation of Earth.
- The pattern of the movement of the planetary winds is called the **general circulation of the atmosphere.**
- The general circulation of the atmosphere also sets in motion the ocean water circulation which influences the Earth's climate.
- The air at the **Inter Tropical Convergence Zone** (ITCZ) rises because of convection caused by high insolation and a low pressure is created.
- The winds from the tropics converge at this low pressure zone. The converged air rises along with the convective cell. It reaches the top of the troposphere up to an altitude of 14 km. and moves towards the poles.
- This causes accumulation of air at about 30° N and S. Part of the accumulated air sinks to the ground and forms a subtropical high. Another reason for sinking is the cooling of air when it reaches 30° N and S latitudes.
- Down below near the land surface the air flows towards the Equator as the easterlies. The easterlies from either side of the Equator converge in the Inter Tropical Convergence Zone (ITCZ).
- Such circulations from the surface upwards and vice-versa are called cells. Such a cell in the tropics is called **Hadley Cell**.
- In the middle latitudes the circulation is that of sinking cold air that comes from the poles and the rising warm air that blows from the subtropical high. At the surface these winds are called westerlies and the cell is known as the **Ferrel Cell.**
- At polar latitudes the cold dense air subsides near the poles and blows towards middle latitudes as the polar easterlies. This cell is called the polar cell. These three cells set the pattern for the general circulation of the atmosphere.
- The local deviations from the general circulation system are as follows.
  - Seasonal Wind : The pattern of wind circulation is modified in different seasons due to the shifting of regions of maximum heating, pressure and wind belts. The most pronounced effect of such a shift is noticed in the monsoons, especially over southeast Asia.
  - Local Winds : Differences in the heating and cooling of Earth surfaces and the cycles those develop daily or annually can create several common, local or regional winds.
  - Land and Sea breeze : The land and sea absorb and transfer heat differently. During the day the land heats up faster and becomes warmer than the sea. Therefore, over the land the air rises giving rise to a low pressure area, whereas the sea is relatively cool and the pressure over sea is relatively high. In the night the reversal of condition takes place. The land loses heat faster and is cooler than the sea. The pressure gradient is from the land to the sea and hence land breeze results.
  - Mountain and Valley Winds : In mountainous regions, during the day the slopes get heated up and air moves upslope and to fill the resulting gap the air from the valley blows up the valley. This wind is known as the valley breeze. The cool air, of the high plateaus and ice fields draining into the valley is called katabatic wind.
  - Air Masses : The air with distinctive characteristics in terms of temperature and humidity is called an airmass. It is defined as a large body of air having little horizontal variation in temperature and moisture.
  - Fronts : When two different air masses meet, the boundary zone between them is called a front. The process of formation of the fronts is known as frontogenesis. When the front remains stationary, it is called a stationary front. When the cold air moves towards the warm air mass, its contact zone is called the cold front, whereas if the warm air mass moves towards the cold air mass, the contact zone is a warm front. If an air mass is fully lifted above the land surface, it is called the occluded front.

- Extra Tropical Cyclones : The systems developing in the mid and high latitude, beyond the tropics are called the middle latitude or extra tropical cyclones. The passage of front causes abrupt changes in the weather conditions over the area in the middle and high latitudes. Extra tropical cyclones form along the polar front. Initially, the front is stationary. In the Northern Hemisphere, warm air blows from the South and cold air from the North of the front.

  The extra tropical cyclone differs from the tropical cyclone in number of ways. The extra tropical cyclones have a clear frontal system which is not present in the tropical cyclones. They cover a larger area and can originate over the land and sea. Whereas the tropical cyclones originate only over the seas and on reaching the land they dissipate. The extra tropical cyclone affects a much larger area as compared to the tropical cyclone. The wind velocity in a tropical cyclone is much higher and it is more destructive. The extra tropical cyclones move from west to east but tropical cyclones, move from East to West.
- Tropical Cyclones : Tropical cyclones are violent storms that originate over oceans in tropical areas and move over to the coastal areas bringing about large scale destruction caused by violent winds, very heavy rainfall and storm surges. This is one of the most devastating natural calamities. Tropical cyclones originate and intensify over warm tropical oceans.
- The conditions favourable for the formation and intensification of tropical storms are : (i) Large sea surface with temperature higher than 27° C; (ii) Presence of the Coriolis force; (iii) Small variations in the vertical wind speed; (iv) A pre-existing weaklow-pressure area or low-level-cyclonic circulation; (v) Upper divergence above the sea level system.
- The place where a tropical cyclone crosses the coast is called the landfall of the cyclone. The cyclones, which cross 20° N latitude generally, recurve and they are more destructive.
- A mature tropical cyclone is characterised by the strong spirally circulating wind around the centre, called the eye. The diameter of the circulating system can vary between 150 and 250 km.
- Thunderstorms and Tornadoes : Other severe local storms are thunderstorms and tornadoes. They are of short duration, occurring over a small area but are violent. Thunderstorms are caused by intense convection on moist hot days. A thunderstorm is a well-grown cumulonimbus cloud producing thunder and lightening.
- A thunderstorm is characterised by intense updraft of rising warm air, which causes the clouds to grow bigger and rise to greater height. This causes precipitation. Later, downdraft brings down to earth the cool air and the rain. From severe thunderstorms sometimes spiralling wind descends like a trunk of an elephant with great force, with very low pressure at the centre, causing massive destruction on its way. Such a phenomenon is called a tornado. Tornadoes generally occur in middle latitudes. The tornado over the sea is called water sprouts.

Know the Terms

- **General circulation of the atmosphere :** The pattern of the movement of the planetary winds is called the general circulation of the atmosphere.
- **Hadley cell :** A cell in the tropics is called the Hadley Cell.
- **Ferrel cell :** In the middle latitudes the circulation is that of sinking cold air that comes from the poles and the rising warm air that blows from the subtropical high. At the surface these winds are called westerlies and the cell is known as the Ferrel Cell**.**
- **Polar cell :** At polar latitudes the cold dense air subsides near the poles and blows towards middle latitudes as the polar easterlies. This cell is called the Polar Cell.
- **Cell :** The easterlies from either side of the Equator converge in the Inter Tropical Convergence Zone(ITCZ). Such circulations from the surface upwards and vice-versa are called cells.
- **El Nino :** The warm water of the central Pacific Ocean slowly drifts towards South American coast and replaces the cool Peruvian current. Such appearance of warm water off the coast of Peru is known as the El Nino.
- **Southern Oscillation :** The change in pressure condition over Pacific is known as the southern oscillation.
- **Westerlies :** They are the prevailing winds from the West towards the East in the middle latitudes between 30° and 60° degrees respectively**.**
- **Easterlies :** They are the winds which blow from the East towards the West .
- **Polar easterlies :** They are the dry, cold prevailing winds that blow from the high-pressure areas of polar highs at the North and South Poles towards low-pressure areas within the Westerlies at high latitudes. They blow from the pole to Equator.
- **ENSO :** The combined phenomenon of southern oscillation and El Nino is known as ENSO.

- **Katabatic winds :** The cool air, of the high plateaus and ice fields draining into the valley is called katabatic wind.
- **Adiabatic process :** It is the process which occurs without transfer of heat or matter between a thermodynamic system and its surroundings.
- **Airmass :** It is a volume of air defined by its temperature and water vapour content.
- **Source regions :** The homogenous surfaces, over which air masses form, are called the source regions.
- **Front :** When two different air masses meet, the boundary zone between them is called a front.
- **Frontogenesis :** The process of formation of the fronts is known as frontogenesis.
- **Stationary front :** When the front remains stationary, it is called a stationary front.
- **Cold front :** When the cold air moves towards the warm air mass, its contact zone is called the cold front.
- **Warm front :** If the warm air mass moves towards the cold air mass, the contact zone is a warm front.
- **Occluded front :** If an air mass is fully lifted above the land surface, it is called the occluded front.
- **Cyclone :** A cyclone is a large scale air mass that rotates around a strong centre of low atmospheric pressure.
- **Extra tropical cyclones :** The systems developing in the mid and high latitude, beyond the tropics are called the middle latitude or extra tropical cyclones.
- **Hurricane :** It is a large swirling storms which form over tropical or subtropical waters.
- **Landfall of the cyclone :** The place where a tropical cyclone crosses the coast is called the landfall of the cyclone.
- **Cumulous cloud :** They are the clouds which have flat bases and are often described as puffy , cotton-like or fluffy in appearance.
- **Cumulonimbus cloud :** They are dense, towering vertical cloud associated with thunderstorms and atmospheric instability , forming water vapour carried by powerful upward air currents.
- **Tornado :** They are rapidly rotating violent column of air that is in contact with both the surface of the Earth and the cumulonimbus cloud.
- **Water spouts :** The tornado over the sea is called water sprouts.
- **The eye :** It is a region of calm with subsiding air.
- **Eye Wall :** Around the eye is the eye wall, where there is a strong spiralling ascent of air to greater height reaching the tropopause.

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CHAPTER-11
WATER IN THE ATMOSPHERE

TOPIC-1
Evaporation and Condensation, Clouds

Revision Notes

- The air contains water vapour. It varies from zero to four per cent by volume of the atmosphere and plays an important role in the weather phenomena.
- Water is present in the atmosphere in three forms namely – gaseous, liquid and solid.
- Water vapour present in the air is known as humidity. It is expressed quantitatively in different ways. The actual amount of the water vapour present in the atmosphere is known as the absolute humidity.
- The absolute humidity differs from place to place on the surface of the earth. The percentage of moisture present in the atmosphere as compared to its full capacity at a given temperature is known as the relative humidity.
- It is the weight of water vapour per unit volume of air and is expressed in terms of grams per cubic metre.
- The air containing moisture to its full capacity at a given temperature is said to be saturated.
- The temperature at which saturation occurs in a given sample of air is known as dew point.
- Evaporation is a process by which water is transformed from liquid to gaseous state. Heat is the main cause for evaporation. The temperature at which the water starts evaporating is referred to as the latent heat of vapourisation.

- The transformation of water vapour into water is called condensation. Condensation is caused by the loss of heat. When moist air is cooled, it may reach a level when its capacity to hold water vapour ceases. Then, the excess water vapour condenses into liquid form. If it directly condenses into solid form, it is known as sublimation.
- Condensation also takes place when the moist air comes in contact with some colder object and it may also take place when the temperature is close to the dew point. Condensation, therefore, depends upon the amount of cooling and the relative humidity of the air.
- Condensation is influenced by the volume of air, temperature, pressure and humidity.
- Condensation takes place:
  - When the temperature of the air is reduced to dew point with its volume remaining constant;
  - When both the volume and the temperature are reduced;
  - When moisture is added to the air through evaporation. However, the most favourable condition for condensation is the decrease in air temperature.
- Condensation takes place when the dew point is lower than the freezing point as well as higher than the freezing point.
- After condensation the water vapour or the moisture in the atmosphere takes one of the following forms such as dew, frost, fog and clouds.
- When the moisture is deposited in the form of water droplets on cooler surfaces of solid objects (rather than nuclei in air above the surface) such as stones, grass blades and plant leaves, it is known as dew.
- Frost forms on cold surfaces when condensation takes place below freezing point (0^0C), i.e. the dew point is at or below the freezing point.
- The ideal conditions for the formation of white frost are the same as those for the formation of dew, except that the air temperature must be at or below the freezing point.
- When the temperature of an air mass containing a large quantity of water vapour falls all of a sudden, condensation takes place within itself on fine dust particles. So, the fog is a cloud with its base at or very near to the ground. Because of the fog and mist, the visibility becomes poor to zero.
- In urban and industrial centres smoke provides plenty of nuclei which help the formation of fog and mist. Such a condition when fog is mixed with smoke, is described as smog.
- In mist each nuclei contains a thicker layer of moisture. Mists are frequent over mountains as the rising warm air up the slopes meets a cold surface.
- Cloud is a mass of minute water droplets or tiny crystals of ice formed by the condensation of the water vapour in free air at considerable elevations.
- According to their height, expanse, density and transparency or opaqueness clouds are grouped under four types :
  - Cirrus : Cirrus clouds are formed at high altitudes (8,000 - 12,000m). They are thin and detached clouds having a feathery appearance. They are always white in colour.
  - Cumulus : Cumulus clouds look like cotton wool. They are generally formed at a height of 4,000 7,000 m. They exist in patches and can be seen scattered here and there. They have a flat base.
  - Stratus : As their name implies, these are layered clouds covering large portions of the sky. These clouds are generally formed either due to loss of heat or the mixing of air masses with different temperatures.
  - Nimbus : Nimbus clouds are black or dark grey. They form at middle levels or very near to the surface of the earth. These are extremely dense and opaque to the rays of the sun. Sometimes, the clouds are so low that they seem to touch the ground. Nimbus clouds are shapeless masses of thick vapour.

Know the Terms

- **Humidity :** Water vapour present in the air is known as humidity.
- **Absolute humidity :** The actual amount of the water vapour present in the atmosphere is known as the absolute humidity.
- **Relative humidity :** The percentage of moisture present in the atmosphere as compared to its full capacity at a given temperature is known as the relative humidity.
- **Dew point :** The temperature at which saturation occurs in a given sample of air is known as dew point.
- **Latent heat of Vaporisation :** The temperature at which the water starts evaporating is referred to as the latent heat of vapourisation.
- **Condensation :** The transformation of water vapour into water is called condensation.
- **Sublimation :** The change from solid to gas without passing through the liquid phase is known as sublimation.
- **Dew :** When the moisture is deposited in the form of water droplets on cooler surfaces of solid objects such as stones, grass blades and plant leaves, it is known as dew.

- **Frost :** It is the coating or deposit of ice that may form in humid air in cold conditions, usually overnight.
- **Fog :** A weather condition in which very small drops of water come together to form a thick cloud close to the land or sea , ocean making it difficult to see.
- **Mist :** A cloud of tiny water droplets suspended in the atmosphere at or near the Earth's surface limiting visibility.
- **Smog :** It is combination of smoke and fog.
- **Cloud :** Cloud is a mass of minute water droplets or tiny crystals of ice formed by the condensation of the water vapour in free air at considerable elevations.

TOPIC-2
Precipitation, Types of Rainfall, World Distribution of Rainfall

Revision Notes

- The process of continuous condensation in free air helps the condensed particles to grow in size. When the resistance of the air fails to hold them against the force of gravity, they fall on to the earth's surface. So after the condensation of water vapour, the release of moisture is known as precipitation.
- The precipitation in the form of water is called rainfall, when the temperature is lower than the 00C, precipitation takes place in the form of fine flakes of snow and is called snowfall.
- Besides rain and snow, other forms of precipitation are sleet and hail.
- Sleet is frozen raindrops and refrozen melted snow-water. When a layer of air with the temperature above freezing point overlies a subfreezing layer near the ground, precipitation takes place in the form of sleet.
- Sometimes, drops of rain after being released by the clouds become solidified into small rounded solid pieces of ice and which reach the surface of the earth are called hailstones.
- On the basis of origin, rainfall may be classified into three main types – the convectional, orographic or relief and the cyclonic or frontal.
  - Conventional Rain : The, air on being heated, becomes light and rises up in convection currents. As it rises, it expands and loses heat and consequently, condensation takes place and cumulous clouds are formed. With thunder and lightening, heavy rainfall takes place but this does not last. It is very common in the equatorial regions and interior parts of the continents, particularly in the northern hemisphere.
  - Orographic Rain : When the saturated air mass comes across a mountain, it is forced to ascend and as it rises, it expands; the temperature falls, and the moisture is condensed. The chief characteristic of this sort of rain is that the windward slopes receive greater rainfall. The area situated on the leeward side, which gets less rainfall is known as the rain-shadow area. It is also known as the relief rain.
  - Cyclonic Rain : The rain caused by cyclonic activity is called cyclonic rain. It occurs along the fronts of the cyclone. It is formed when two masses of air of different temperature , humidity and density meets.
- Different places on the earth's surface receive different amounts of rainfall in a year and that too in different seasons.
- The coastal areas of the world receive greater amounts of rainfall than the interior of the continents. The rainfall is more over the oceans than on the landmasses of the world because of being great sources of water. Between the latitudes 35^0 and 40^0 N and S of the Equator, the rain is heavier on the eastern coasts and goes on decreasing towards the west. But, between 45^0 and 65^0 N and S of Equator, due to the westerlies, the rainfall is first received on the western margins of the continents and it goes on decreasing towards the east.
- Wherever mountains run parallel to the coast, the rain is greater on the coastal plain, on the windward side and it decreases towards the leeward side.
- The equatorial belt, the windward slopes of the mountains along the western coasts in the cool temperate zone and the coastal areas of the monsoon land receive heavy rainfall of over 200 cm per annum.
- Interior continental areas receive moderate rainfall varying from 100 - 200 cm per annum. The coastal areas of the continents receive moderate amount of rainfall. The central parts of the tropical land and the eastern and interior parts of the temperate lands receive rainfall varying between 50-100 cm per annum.
- Areas lying in the rain shadow zone of the interior of the continents and high latitudes receive very low rainfall-less than 50 cm per annum. Seasonal distribution of rainfall provides an important aspect to judge its effectiveness.
- In some regions rainfall is distributed evenly throughout the year such as in the equatorial belt and in the western parts of cool temperate regions.

Know the Terms

- **Precipitation :** After the condensation of water vapour, the release of moisture is known as precipitation.
- **Rainfall :** The precipitation in the form of water is called rainfall.
- **Snowfall :** When the temperature is lower than the 0°C, precipitation takes place in the form of fine flakes of snow and is called snowfall.
- **Orographic rain :** Orographic rainfall is caused when masses of air pushed by wind are forced up the side of elevated land formations, such as large mountains.
- **Cyclonic rain :** The rain caused by cyclonic activity is called cyclonic rain.
- **Hailstones :** The drops of rain after being released by the clouds become solidified into small rounded solid pieces of ice and which reach the surface of the earth are called hailstones.
- **Sleet :** Sleet is frozen raindrops and refrozen melted snow-water. When a layer of air with the temperature above freezing point overlies a subfreezing layer near the ground, precipitation takes place in the form of sleet.
- **Conventional rain :** Conventional rain occurs when the energy of the Sun heats the Earth's surface and causes water to evaporate changing to water vapour.
- **Rain shadow area :** The area situated on the leeward side, which gets less rainfall is known as the rain-shadow area.

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CHAPTER-12
WORLD CLIMATE AND CLIMATE CHANGE

TOPIC-1
Koeppen's Scheme of Classification of Climate, Tropical Humid Climates, Dry Climates, Cold Snow Forest Climates, Polar Climates, Highland Climates.

Revision Notes

- The most widely used classification of climate is the empirical climate classification scheme developed by V. Koeppen.
- Koeppen identified a close relationship between the distribution of vegetation and climate.
- He selected certain values of temperature and precipitation and related them to the distribution of vegetation and used these values for classifying the climates.
- He introduced the use of capital and small letters to designate climatic groups and types. Although developed in 1918 and modified over a period of time, Koeppen's scheme is still popular and in use.
- Koeppen recognised five major climatic groups, four of them are based on temperature and one on precipitation.
- The climatic groups are subdivided into types, designated by small letters, based on seaonality of precipitation and temperature characteristics. The seasons of dryness are indicated by the small letters namely - f, m, w and s, where f corresponds to no dry season, m - monsoon climate, w - winter dry season and s - summer dry season. The small letters a, b, c and d refer to the degree of severity of temperature.
- The english capital letters such as A, B, C, D and E present the Koeppen climate groups in which A, C, D and E delineate humid climates and B dry climates. later he added new climate zone called H types.
- **Tropical Humid Climates A :** Tropical humid climates exist between Tropic of Cancer and Tropic of Capricorn. The Sun being overhead throughout the year and the presence of Inter Tropical Convergence Zone (ITCZ) make the climate hot and humid. The tropical group is divided into three types, namely:
  - Af-Tropical wet climate : Tropical wet climate is found near the Equator. The major areas are the Amazon Basin in South America, western equatorial Africa and the islands of East Indies. The maximum temperature on any day is around 30°C while the minimum temperature is around 20°C.
  - Am-Tropical monsoon climate : These type of climate are found over the Indian sub-continent, North Eastern part of South America and Northern Australia.
  - Aw-Tropical wet and dry climate : This type of climate occurs North and South of Af type climate regions. It borders with dry climate on the western part of the continent and Cf or Cw on the eastern part. The annual rainfall in this climate is considerably less than that in Af and Am climate types and is variable also. Temperature is high throughout the year and diurnal ranges of temperature are the greatest in the dry season. Deciduous forest and tree-shredded grasslands occur in this climate.
- **Dry Climates B :** Dry climates are characterised by very low rainfall that is not adequate for the growth of plants. These climates cover a very large area of the planet extending over large latitudes from 15° - 60° North and South

of the Equator. At low latitudes, from 15° - 30°, they occur in the area of subtropical high where subsidence and inversion of temperature do not produce rainfall. In middle latitudes, from 35° - 60° North and South of the Equator, they are confined to the interior of continents where maritime-humid winds do not reach and to areas often surrounded by mountains.

- Dry climates are divided into steppe or semi-arid climate (BS) and desert climate (BW).
  - Subtropical Steppe (BSh) and Subtropical Desert (BWh) Climates : Subtropical steppe (BSh) and subtropical desert (BWh) have common precipitation and temperature characteristics. Located in the transition zone between humid and dry climates, subtropical steppe receives slightly more rainfall than the desert, adequate enough for the growth of sparse grasslands. Fog is common in coastal deserts bordering cold currents. Maximum temperature in the summer is very high. The annual and diurnal ranges of temperature are also high.
- **Warm Temperate (Mid-Latitude) Climates-C :** This type of climates extend from 30° - 50° of latitude mainly on the eastern and western margins of continents. They are grouped into four types:

  (a) Humid Subtropical Climate (Cwa) : Humid subtropical climate occurs poleward of Tropic of Cancer and Capricorn, mainly in North Indian plains and South China interior plains. The climate is similar to Aw climate except that the temperature in winter is warm.

  (b) Mediterranean Climate (Cs) : As the name suggests, Mediterranean climate occurs around the Mediterranean Sea, along the west coast of continents in subtropical latitudes between 30° - 40° latitudes *e.g.*, Central California, Central Chile, along the coast in south eastern and south western Australia. Monthly average temperature in summer is around 25° C and in winter below 10°C. The annual precipitation ranges between 35 - 90 cm.

  (c) Humid Subtropical (Cfa) Climate : Humid subtropical climate lies on the eastern parts of the continent in subtropical latitudes. In this region the air masses are generally unstable and cause rainfall throughout the year. They occur in eastern United States of America, southern and eastern China, southern Japan, North-eastern Argentina, coastal south Africa and eastern coast of Australia. Thunderstorms in summer and frontal precipitation in winter are common.

  (d) Marine West Coast Climate (Cfb) : Marine west coast climate is located poleward from the Mediterranean climate on the west coast of the continents. The main areas are: Northwestern Europe, west coast of North America, north of California, southern Chile, southeastern Australia and New Zealand. The annual and daily ranges of temperature are small. Precipitation occurs throughout the year. Precipitation varies greatly from 50-250cm.
- **Cold Snow Forest Climates (D) :** Cold snow forest climates occur in the large continental area in the northern hemisphere between 40°-70° north latitudes in Europe, Asia and North America. The severity of winter is more pronounced in higher latitudes. Cold snow forest climates are divided into two types:

  (a) Cold Climate with Humid Winters (Df) : Cold climate with humid winter occurs poleward of marine west coast climate and mid latitude steppe. The frost free season is short. The annual ranges of temperature are large. The weather changes are abrupt and short. Poleward, the winters are more severe.

  (b) Cold Climate with Dry Winters (Dw) : Cold climate with dry winter occurs mainly over Northeastern Asia. The development of pronounced winter anti- cyclone and its weakening in summer sets in monsoon like reversal of wind in this region. The annual precipitation is low from 12-15 cm.
- **Polar Climates (E) :** Polar climates exist poleward beyond 70° latitude. Polar climates consist of two types:

  (a) Tundra Climate (ET) : The tundra climate (ET) is so called after the types of vegetation, like low growing mosses, lichens and flowering plants. This is the region of permafrost where the sub soil is permanently frozen. During summer, the tundra regions have very long duration of day light.

  (b) Ice Cap Climate (EF) : The ice cap climate (EF) occurs over interior Greenland and Antartica. Even in summer, the temperature is below freezing point. This area receives very little precipitation. The snow and ice get accumulated and the mounting pressure causes the deformation of the ice sheets and they break.
- **Highland Climates (H) :** Highland climates are governed by topography. In high mountains, large changes in mean temperature occur over short distances. Precipitation types and intensity also vary spatially across high lands. There is vertical zonation of layering of climatic types with elevation in the mountain environment.

Know the Terms

- **Koeppen's scheme of classification of climate :** It is scheme developed by Koeppen. Koeppen identified a close relationship between the distribution of vegetation and climate.
- **Empirical Classification :** This classification is based on observed data, particularly on temperature and precipitation.
- **Genetic Classification :** This classification attempts to organise climates according to their causes.
- **Applied Classification :** This is used when classification is done for specific purpose.
- **Frontal precipitation :** It results when the leading edge of a warm, moist air mass meets a cool and dry air mass.
- **Annual rainfall :** It is the total accumulated rainfall in a year.
- **Diurnal ranges of temperature :** It is the difference between the daily maximum and minimum temperature.
- **Icebergs :** It is a large piece of freshwater ice that has broken off a glacier or an ice shelf and is floating freely in open water.

TOPIC-2
Climate Change, Climate in the Past, Causes of Climate Change ,Global Warming.

Revision Notes

- The type of climate we experience now might be prevailing over the last 10,000 years with minor and occasionally wide fluctuations.
- The planet earth has witnessed many variations in climate since the beginning. Geological records show alteration of glacial and inter-glacial periods.
- The geomorphological features, especially in high altitudes and high latitudes, exhibit traces of advances and retreats of glaciers.
- The sediment deposits in glacial lakes also reveal the occurrence of warm and cold periods.
- The rings in the trees provide clues about wet and dry periods. Historical records describe the vagaries in climate. All these evidences indicate that change in climate is a natural and continuous process.
- India also witnessed alternate wet and dry periods. Archaeological findings show that the Rajasthan desert experienced wet and cool climate around 8,000 B.C.
- The period 3,0001,700 B.C. had higher rainfall. From about 2,000-1,700 B.C., this region was the centre of the Harappan Civilization. Dry conditions accentuated since then.
- In the geological past, the earth was warm some 500-300 million years ago, through the Cambrian, Ordovician and Silurian periods.
- During the Pleistocene Epoch, glacial and inter-glacial periods occurred, the last major peak glacial period was about 18,000 years ago. The present inter-glacial period started 10,000 years ago.
- Variability in climate occurs all the time. The nineties decade of the last century witnessed extreme weather events.
- The 1990s recorded the warmest temperature of the century and some of the worst floods around the world.
- The worst devastating drought in the Sahel region, south of the Sahara Desert, from 1967-1977 is one such variability. During the 1930s, severe drought occurred in southwestern Great Plains of the United States, described as the dust bowl.
- A number of times Europe witnessed warm, wet, cold and dry periods, the significant episodes were the warm and dry conditions in the tenth and eleventh centuries, when the Vikings settled in Greenland.
- Europe witnessed "Little Ice Age" from 1550 to about 1850. From about 1885-1940 world temperature showed an upward trend. After 1940, the rate of increase in temperature slowed down.
- The causes for climate change are many. They can be grouped into astronomical and terrestrial causes.
- The astronomical causes are the changes in solar output associated with sunspot activities. Sunspots are dark and cooler patches on the sun which increase and decrease in a cyclical manner.
- According to some meteorologists, when the number of sunspots increase, cooler and wetter weather and greater storminess occur. A decrease in sunspot numbers is associated with warm and drier conditions. Yet, these findings are not statistically significant.
- An another astronomical theory is Millankovitch Oscillations, which infer cycles in the variations in the earth's orbital characteristics around the sun, the wobbling of the earth and the changes in the earth's axial tilt.
- All these alter the amount of insolation received from the sun, which in turn, might have a bearing on the climate.
- Volcanism is considered as another cause for climate change. Volcanic eruption throws up lots of aerosols into the atmosphere. These aerosols remain in the atmosphere for a considerable period of time reducing the sun's radiation reaching the Earth's surface.
- The most important anthropogenic effect on the climate is the increasing trend in the concentration of greenhouse gases in the atmosphere which is likely to cause global warming.
- Due to the presence of greenhouse gases, the atmosphere is behaving like a greenhouse. The atmosphere also transmits the incoming solar radiation but absorbs the vast majority of long wave radiation emitted upwards by the earth's surface.
- The gases that absorb long wave radiation are called greenhouse gases. The processes that warm the atmosphere are often collectively referred to as the greenhouse effect.
- The primary GHGs of concern today are carbon dioxide (CO_2), Chlorofluorocarbons (CFCs), methane (CH_4), nitrous oxide (N_2O) and ozone (O_3). Some other gases such as nitric oxide (NO) and carbon monoxide (CO) easily react with GHGs and affect their concentration in the atmosphere.
- The effectiveness of any given GHG molecule will depend on the magnitude of the increase in its concentration, its life time in the atmosphere and the wavelength of radiation that it absorbs.
- The chlorofluorocarbons (CFCs) are highly effective. Ozone which absorbs ultra violet radiation in the stratosphere is very effective in absorbing terrestrial radiation when it is present in the lower troposphere.

- Another important point to be noted is that the more time the GHG molecule remains in the atmosphere, the longer it take for Earth's atmospheric system to recover from any change brought about by the latter.
- The largest concentration of GHGs in the atmosphere is carbon dioxide. The emission of CO_2 comes mainly from fossil fuel combustion (oil, gas and coal). Forests and oceans are the sinks for the carbon dioxide.
- Doubling of concentration of CO_2 over pre-industrial level is used as an index for estimating the changes in climate in climatic models.
- Ozone occurs in the stratosphere where ultra-violet rays convert oxygen into ozone. Thus, ultra violet rays do not reach the earth's surface.
- The depletion of ozone concentration in the stratosphere is called the ozone hole. This allows the ultra violet rays to pass through the troposphere.
- International efforts have been initiated for reducing the emission of GHGs into the atmosphere. The most important one is the Kyoto protocol proclaimed in 1997.
- Kyoto protocol bounds the 35 industrialised countries to reduce their emissions by the year 2012 to 5 per cent less than the levels prevalent in the year 1990.
- The increasing trend in the concentration of GHGs in the atmosphere may, in the long run, warm up the earth. Once the global warming sets in, it will be difficult to reverse it.
- Rise in the sea level due to melting of glaciers and ice-caps and thermal expansion of the sea may inundate large parts of the coastal area and islands.
- One of the major concerns of the world today is global warming. An increasing trend in temperature was discernible in the 20th century. The greatest warming of the 20th century was during the two periods, 1901-44 and 1977-99.
- Over each of these two periods, global temperatures rose by about 0.4°C.
- The globally averaged annual mean temperature at the end of the 20th century was about 0.6°C above that recorded at the end of the 19th century. The seven warmest years during the 1856-2000 were recorded in the last decade.
- The year 1998 was the warmest year, probably not only for the 20th century but also for the whole millennium.

Know the Terms

- **Ozone hole :** A severe depletion of ozone in a region of the ozone layer, particularly over Antarctica and over the Arctic.
- **Sediment deposits :** It is the geological process in which sediments, soil and rocks are added to a landform or land mass.
- **Cambrian period :** It was the first geological period of the Paleozoic Era.
- **Ordovician periods :** It is a geologic period and system , the second of six periods of the Paleozoic Era.
- **Silurian periods :** It is a geologic period and system spanning 24.6 million years from the end of Ordovician Period.
- **Dust bowl :** During the 1930s, severe drought occurred in south western Great Plains of the United States. These are described as the 'Dust Bowl'.
- **Milllankovitch oscillations :** It infers cycles in the variations in the Earth's orbital characteristics around the Sun, the wobbling of the earth and the changes in the Earth's axial tilt. All these alter the amount of insolation received from the Sun, which in turn, might have a bearing on the climate.
- **Aerosols :** It is a colloidal system of solid or liquid particles in a gas.
- **Ozone :** It is a colourless unstable toxin gas with a pungent odour and powerful oxidizing properties, formed from oxygen by electrical discharges or ultraviolet light.
- **Ozone hole :** The depletion of ozone concentration in the stratosphere is called the ozone hole.
- **Kyoto protocol :** It is the name given to the protocol which was held for reducing the emission of GHGs into the atmosphere in 1997.
- **Global warming :** The increasing trend in the concentration of GHGs in the atmosphere may in the long run warm up the Earth. This is called global warming.
- **Greenhouse gases :** They are the gases in an atmosphere that absorbs and emits radiant energy within the thermal infrared range.
- **Greenhouse effect :** The processes that warm the atmosphere are often collectively referred to as the green house effect.
- **Greenhouse :** The term greenhouse is derived from the analogy to a greenhouse used in cold areas for preserving heat. A greenhouse is made up of glass. The glass which is transparent to incoming short wave solar radiation is opaque to outgoing long wave radiation.
- **Sunspots :** They are dark and cooler patches on the Sun which increase and decrease in a cyclic manner.
- **Daily range of temperature :** The differences between the highest and the lowest temperature of a place in a day is called daily range of temperature.

CHAPTER-13
WATER (OCEANS)

TOPIC-1
Hydrological Cycle, Relief of the Ocean Floor, Divisions of the Ocean Floor, Minor Relief Features.

Revision Notes

- Water is a rare commodity in our solar system. There is no water on the sun or anywhere else in the solar system.
- The earth, fortunately has an abundant supply of water on its surface. Hence, our planet is called the **'Blue Planet'.**
- Water is a cyclic resource. It can be used and re-used. Water also undergoes a cycle from the ocean to land and land to ocean.
- The water cycle has been working for billions of years and all the life on earth depends on it.
- The distribution of water on earth is quite uneven. The hydrological cycle, is the circulation of water within the earth's hydrosphere in different forms i.e. the liquid, solid and the gaseous phases.
- Nearly 59 per cent of the water that falls on land returns to the atmosphere through evaporation from over the oceans as well as from other places.
- It is to be noted that the renewable water on the earth is constant while the demand is increasing tremendously.
- The oceans are confined to the great depressions of the earth's outer layer.
- The geographers have divided the oceanic part of the earth into four oceans, namely the Pacific, the Atlantic, the Indian and the Arctic. The various seas, bays, gulfs and other inlets are parts of these four large oceans.
- A major portion of the ocean floor is found between 3-6 km below the sea level.
- The floors of the oceans are rugged with the world's largest mountain ranges, deepest trenches and the largest plains.
- The ocean floors can be divided into four major divisions:
  - The Continental Shelf : The continental shelf is the extended margin of each continent occupied by relatively shallow seas and gulfs. It is the shallowest part of the ocean showing an average gradient of 1° or even less. The shelf typically ends at a very steep slope, called the shelf break.

    The continental shelves are covered with variable thicknesses of sediments brought down by rivers, glaciers, wind, from the land and distributed by waves and currents.
  - The Continental Slope : The continental slope connects the continental shelf and the ocean basins. It begins where the bottom of the continental shelf sharply drops off into a steep slope. The depth of the slope region varies between 200 and 3,000 m. The slope boundary indicates the end of the continents. Canyons and trenches are observed in this region.
  - The Deep Sea Plain : Deep sea plains are gently sloping areas of the ocean basins. These are the flattest and smoothest regions of the world. These plains are covered with fine-grained sediments like clay and silt.
  - The Oceanic Deeps : These areas are the deepest parts of the oceans. The trenches are relatively steep sided, narrow basins. They are some 3-5 km deeper than the surrounding ocean floor. As many as 57 deeps have been explored so far; of which 32 are in the Pacific Ocean; 19 in the Atlantic Ocean and 6 in the Indian Ocean.
- Some of the minor relief features are :
  - Mid-Oceanic Ridges : A mid-oceanic ridge is composed of two chains of mountains separated by a large depression. The mountain ranges can have peaks as high as 2,500 m and some even reach above the ocean's surface.
  - Seamount : It is a mountain with pointed summits, rising from the seafloor that does not reach the surface of the ocean. Seamounts are volcanic in origin. These can be 3,000-4,500 m tall.
  - Submarine Canyons : These are deep valleys, some comparable to the Grand Canyon of the Colorado river. They are sometimes found cutting across the continental shelves and slopes, often extending from the mouths of large rivers.
  - Guyots : It is a flat topped seamount. It is estimated that more than 10,000 seamounts and guyots exist in the Pacific Ocean alone.
  - Atoll : These are low islands found in the tropical oceans consisting of coral reefs surrounding a central depression.

Know the Terms

- **Blue planet :** The earth, has an abundant supply of water on its surface. Hence, our planet is called the 'Blue Planet'.
- **Hydrological cycle :** It is the circulation of water within the earth's hydrosphere in different forms i.e. the liquid, solid and the gaseous phases.
- **Continental shelf :** The continental shelf is the extended margin of each continent occupied by relatively shallow seas and gulfs.
- **Continental slope :** The continental slope connects the continental shelf and the ocean basins.
- **Deep sea plains :** They are gently sloping areas of the ocean basins.
- **Oceanic Deeps or Trenches :** These areas are the deepest parts of the oceans .
- **Shelf break :** The shelf typically ends at a very steep slope, called the shelf break.
- **Seamount :** It is a mountain with pointed summits, rising from the seafloor that does not reach the surface of the ocean.
- **Submarine Canyons :** These are deep valleys, some comparable to the Grand Canyon of the Colorado river.
- **Guyots :** It is a flat topped seamount.

TOPIC-2
Temperature of Ocean Waters, Factors Affecting Temperature Distribution, Horizontal and Vertical Distribution of Temperature

Revision Notes

- Ocean waters get heated up by the solar energy just as land. The process of heating and cooling of the oceanic water is slower than land.
- The factors which affect the distribution of temperature of ocean water are :
  - **Latitude :** The temperature of surface water decreases from the Equator towards the poles because the amount of insolation decreases poleward.
  - **Unequal distribution of land and water :** The oceans in the Northern Hemisphere receive more heat due to their contact with larger extent of land than the oceans in the Southern Hemisphere.
  - **Prevailing wind :** The winds blowing from the land towards the oceans drive warm surface water away from the coast resulting in the upwelling of cold water from below.
  - **Ocean currents :** Warm ocean currents raise the temperature in cold areas while the cold currents decrease the temperature in warm ocean areas.
- The temperature-depth profile for the ocean water shows how the temperature decreases with the increasing depth.
- This boundary region, from where there is a rapid decrease of temperature, is called the thermocline.
- About 90 per cent of the total volume of water is found below the thermocline in the deep ocean. In this zone, temperatures approach 0° C.
- The temperature structure of oceans over middle and low latitudes can be described as a three-layer system from surface to the bottom.
- The first layer represents the top layer of warm oceanic water and it is about 500m thick with temperatures ranging between 20° and 25° C .
- The second layer called the thermocline layer lies below the first layer and is characterised by rapid decrease in temperature with increasing depth.
- The highest temperature is not recorded at the equator but slightly towards north of it. The average annual temperatures for the Northern and Southern Hemisphere are around 19° C and 16° C respectively.
- It is a well known fact that the maximum temperature of the oceans is always at their surfaces because they directly receive the heat from the sun and the heat is transmitted to the lower sections of the oceans through the process of conduction.
- The temperature falls very rapidly up to the depth of 200 m and thereafter, the rate of decrease of temperature is slowed down.

Know the Terms

- **Latitude :** It is the angular distance of a place north or south of the Earth's Equator.
- **Ocean currents :** It is the steady flow of surface ocean water in a prevailing direction.
- **Thermocline :** The boundary region, from where there is a rapid decrease of temperature, is called the thermocline.
- **The process of conduction :** It is the process in which the energy is transferred from the Earth's atmosphere to the air.

TOPIC-3
Salinity of Ocean Waters, Horizontal Distribution of Salinity,Vertical Distribution of Salinity

Revision Notes

- All waters in nature, whether rain water or ocean water, contain dissolved mineral salts.
- Salinity is the term used to define the total content of dissolved salts in sea water.
- It is calculated as the amount of salt (in gm) dissolved in 1,000 gm (1 kg) of seawater.
- Salinity of 24.7 $\%_0$ has been considered as the upper limit to demarcate *'brackish water'*.
- Factors affecting ocean salinity are mentioned below :
  - The salinity of water in the surface layer of oceans depend mainly on evaporation and precipitation.
  - Surface salinity is greatly influenced in coastal regions by the fresh water flow from rivers, and in polar regions by the processes of freezing and thawing of ice.
  - Wind, also influences salinity of an area by transferring water to other areas.
  - The ocean currents contribute to the salinity variations. Salinity, temperature and density of water are interrelated.
- The salinity for normal open ocean ranges between 33$\%_0$ and 37 $\%_0$. In hot and dry regions, where evaporation is high, the salinity sometimes reaches to 70 $\%_0$.
- The average salinity of the Atlantic Ocean is around 36$\%_0$. The highest salinity is recorded between 15° and 20° latitudes. Maximum salinity (37 $\%_0$) is observed between 20° N and 30° N and 20° W – 60.
- The North Sea, in spite of its location in higher latitudes, records higher salinity due to more saline water brought by the North Atlantic Drift.
- The Baltic Sea records low salinity due to influx of river waters in large quantity.
- The average salinity of the Indian Ocean is 35 $\%_0$. The low salinity trend is observed in the Bay of Bengal due to influx of river water by the River Ganga.
- Salinity changes with depth, but the way it changes depends upon the location of the sea.
- Salinity at depth is very much fixed, because there is no way that water is 'lost', or the salt is 'added.'
- The lower salinity water rests above the higher salinity dense water.
- Salinity, generally, increases with depth and there is a distinct zone called the halocline, where salinity increases sharply.
- High salinity seawater, generally, sinks below the lower salinity water. This leads to stratification by salinity.

Know the Terms

- **Salinity :** Salinity is the term used to define the total content of dissolved salts in sea water.
- **Halocline :** Salinity, generally, increases with depth and there is a distinct zone called the halocline, where salinity increases sharply.

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CHAPTER-14
MOVEMENTS OF OCEAN WATER

TOPIC-1
Waves, Tides, Types of Tides, Importance of Tides

Revision Notes

- The ocean water is dynamic. Its physical characteristics like temperature, salinity, density and the external forces like of the sun, moon and the winds influence the movement of ocean water.
- The horizontal motion refers to the ocean currents and waves.

- The vertical motion refers to tides. The vertical motion refers to the rise and fall of water in the oceans and seas.
- Ocean currents are the continuous flow of huge amount of water in a definite direction while the waves are the horizontal motion of water.
- Water moves ahead from one place to another through ocean currents while the water in the waves does not move, but the wave trains move ahead.
- Due to attraction of the sun and the moon, the ocean water is raised up and falls down twice a day.
- Waves are actually the energy, not the water as such, which moves across the ocean surface.
- Wind provides energy to the waves. Wind causes waves to travel in the ocean and the energy is released on shorelines.
- As a wave approaches the beach, it slows down. This is due to the friction occurring between the dynamic water and the sea floor.
- Most of the waves are caused by the wind driving against water.
- Waves may travel thousands of km before rolling ashore, breaking and dissolving as surf.
- A wave's size and shape reveal its origin.
- Steep waves are fairly young ones and are probably formed by local wind. Slow and steady waves originate from far away places, possibly from another hemisphere.
- Waves travel because wind pushes the water body in its course while gravity pulls the crests of the waves downward.
- The periodical rise and fall of the sea level, once or twice a day, mainly due to the attraction of the sun and the moon, is called a tide.
- Movement of water caused by meteorological effects (winds and atmospheric pressure changes) are called surges.
- The study of tides is very complex, spatially and temporally, as it has great variations in frequency, magnitude and height.
- The moon's gravitational pull to a great extent and to a lesser extent the sun's gravitational pull, are the major causes for the occurrence of tides.
- Another factor is centrifugal force, which is the force that acts to counter the balance the gravity.
- On the side of the earth facing the moon, a tidal bulge occurs while on the opposite side though the gravitational attraction of the moon is less as it is farther away, the centrifugal force causes tidal bulge on the other side.
- The 'tide-generating' force is the difference between these two forces; *i.e.*, the gravitational attraction of the moon and the centrifugal force.
- On the surface of the earth, nearest the moon, pull or the attractive force of the moon is greater than the centrifugal force, and so there is a net force causing a bulge towards the moon.
- On the opposite side of the earth, the attractive force is less, as it is farther away from the moon, the centrifugal force is dominant. Hence, there is a net force away from the moon. It creates the second bulge away from the moon.
- When the tide is channelled between islands or into bays and estuaries they are called tidal currents.
- Tides may be grouped into various types based on their frequency of occurrence in one day or 24 hours or based on their height.

- **Tides based on Frequency :**
  - **Semi-diurnal tide :** The most common tidal pattern, featuring two high tides and two low tides each day. The successive high or low tides are approximately of the same height.
  - **Diurnal tide :** There is only one high tide and one low tide during each day. The successive high and low tides are approximately of the same height.
  - **Mixed tide :** Tides having variations in height are known as mixed tides. These tides generally occur along the west coast of North America and on many islands of the Pacific Ocean.
  - **Tides based on the Sun, Moon and the Earth Positions:**
  - **Spring tides :** The position of both the sun and the moon in relation to the earth has direct bearing on tide height.
  - **Neap tides :** Normally, there is a seven day interval between the spring tides and neap tides. At this time the sun and moon are at right angles to each other and the forces of the sun and moon tend to counteract one another.
- Once in a month, when the moon's orbit is closest to the earth (perigee), unusually high and low tides occur. During this time the tidal range is greater than normal.
- Two weeks later, when the moon is farthest from earth (apogee), the moon's gravitational force is limited and the tidal ranges are less than their average heights.
- The time between the high tide and low tide, when the water level is falling, is called the ebb. The time between the low tide and high tide, when the tide is rising, is called the flow or flood.
- Since tides are caused by the earth-moon-sun positions which are known accurately, the tides can be predicted well in advance. This helps the navigators and fishermen plan their activities.

- Tidal flows are of great importance in navigation.
- Tidal heights are very important, especially harbours near rivers and within estuaries having shallow 'bars' at the entrance, which prevent ships and boats from entering into the harbour.
- Tides are also helpful in desilting the sediments and in removing polluted water from river estuaries.
- Tides are used to generate electrical power (in Canada, France, Russia, and China). A 3 MW tidal power project at Durgaduani in Sunderbans of West Bengal is under way.

Know the Terms

- **Waves :** Waves are actually the energy, not the water as such, which moves across the ocean surface.
- **Wave height :** It is the vertical distance from the bottom of a trough to the top of a crest of a wave.
- **Crest :** The highest point of a wave is called the crest.
- **Trough:** The lowest point of a wave is called trough.
- **Wave amplitude :** It is one-half of the wave height.
- **Wave period :** It is merely the time interval between two successive wave crests or troughs as they pass a fixed point.
- **Wavelength : I**t is the horizontal distance between two successive crests.
- **Tides :** The periodical rise and fall of the sea level, once or twice a day, mainly due to the attraction of the sun and the moon, is called a tide.
- **Tidal currents :** When the tide is channelled between islands or into bays and estuaries they are called tidal currents.
- **Semi-diurnal tide :** The most common tidal pattern, featuring two high tides and two low tides each day.
- **Diurnal tide :** An area has diurnal tide if it experiences one high and one low tide every lunar day.
- **Mixed tide :** It is tidal cycle which consists of two unequal high tides and two unequal low tides in approximately a 24 hour period.
- **Spring tide :** When the sun, the moon and the earth are in a straight line, the height of the tide will be higher. These are called spring tides**.**
- **Neap tide :** A tide just after the first or third quarters of the moon when there is least difference between high and low water**.**
- **Perigee :** Once in a month, when the moon's orbit is closest to the earth , unusually high and low tides occur , it is called perigee**.**
- **Apogee :** When the moon is farthest from earth, the moon's gravitational force is limited and the tidal ranges are less than their average heights, it is called apogee.
- **Perihelion :** When the earth is closest to the sun.
- **Aphelion :** When the earth is farthest from the sun.
- **Flow :** The time between the low tide and high tide, when the tide is rising, is called the flow or flood.
- **Ebb :** The time between the high tide and low tide, when the water level is falling, is called the ebb.

TOPIC-2
Ocean Currents, Types of Ocean Currents

Revision Notes

- Ocean currents are like river flow in oceans. They represent a regular volume of water in a definite path and direction.
- **Ocean currents are influenced by two types of forces namely :**
  - The primary forces that influence the currents are :
  - **Heating by solar energy :** Heating by solar energy causes the water to expand. That is why, near the equator the ocean water is about 8 cm higher in level than in the middle latitudes.
  - **Wind :** Wind blowing on the surface of the ocean pushes the water to move. Friction between the wind and the water surface affects the movement of the water body in its course.
  - **Gravity :** Gravity tends to pull the water down to pile and create gradient variation.
  - **Coriolis force :** The coriolis force intervenes and causes the water to move to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.
- **The secondary forces that influence the currents to flow :**
- Water with high salinity is denser than water with low salinity and in the same way cold water is denser than warm water.
- Denser water tends to sink, while relatively lighter water tends to rise. Cold-water ocean currents occur when the cold water at the poles sinks and slowly moves towards the equator.

- **The ocean currents may be classified based on their depth as surface currents and deep water currents :**
  - **Surface currents :** Constitute about 10 per cent of all the water in the ocean, these waters are the upper 400 m of the ocean.
  - **Deep water currents :** Make up the other 90 per cent of the ocean water. These waters move around the ocean basins due to variations in the density and gravity.
- **Ocean currents can also be classified based on temperature : As cold currents and warm currents :**
  - **Cold currents :** Bring cold water into warm water areas. These currents are usually found on the west coast of the continents in the low and middle latitudes (true in both hemispheres) and on the east coast in the higher latitudes in the Northern Hemisphere.
  - **Warm currents :** Bring warm water into cold water areas and are usually observed on the east coast of continents in the low and middle latitudes (true in both hemispheres). In the Northern Hemisphere they are found on the west coasts of continents in high latitudes.
- Major ocean currents are greatly influenced by the stresses exerted by the prevailing winds and Coriolis Force.
- Due to the coriolis force, the warm currents from low latitudes tend to move to the right in the Northern Hemisphere and to their left in the Southern Hemisphere.
- The oceanic circulation transports heat from one latitude belt to another in a manner similar to the heat transported by the general circulation of the atmosphere.
- Ocean currents have a number of direct and indirect influences on human activities.
- Their average temperatures are relatively low with a narrow diurnal and annual ranges.
- Warm currents flow parallel to the east coasts of the continents in tropical and subtropical latitudes. This results in warm and rainy climates.
- The mixing of warm and cold currents helps to replenish the oxygen and favour the growth of planktons, the primary food for fish population. The best fishing grounds of the world exist mainly in these mixing zones.

Know the Terms

- **Ocean currents :** It is a seasonal directed movement of sea water generated by forces acting upon this mean flow.
- **Coriolis force :** It is an inertial force described by the 19th century French engineer-mathematician. Gaspart-Gustave de coridis, in connection with the theory of water wheels.
- **Gravity :** It is the natural phenomenon by which all things with mass are brought towards one another.
- **Drift :** At depths, currents are generally slow with speeds less than 0.5 knots. We refer to the speed of a current as its "drift.
- **Surface current :** The movement of the water at the surface of the ocean is known as surface currents.
- **Deep water current :** Deep water currents move very slowly, usually around 0.8-1.2 in per second.
- **Cold currents :** Cold currents bring cold water into warm water areas.
- **Warm currents :** Warm currents bring warm water into cold water areas.
- **Gyres :** It is any large system of circulating ocean currents, particularly those involved with large wind movements

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UNIT-VI : LIFE ON THE EARTH

CHAPTER-15
LIFE ON THE EARTH

TOPIC-1
Ecology, Types of Ecosystems, Structure and Functions of Ecosystems.

Revision Notes

- There are three major realms of the environment, that is, the lithosphere, the atmosphere and the hydrosphere.
- The living organisms of the earth, constituting the biosphere, interact with other environmental realms.
- The biosphere includes all the living components of the earth. It consists of all plants and animals, including all the micro-organisms that live on the planet earth and their interactions with the surrounding environment.
- The biosphere and its components are very significant elements of the environment. These elements interact with other components of the natural landscape such as land, water and soil.

- The interactions of biosphere with land, air and water are important to the growth.
- The interactions of a particular group of organisms with abiotic factors within a particular habitat resulting in clearly defined energy flows and material cycles on land, water and air, are called ecological systems.
- The term ecology is derived from the Greek word 'oikos' meaning 'house', combined with the word 'logy' meaning the 'science of' or 'the study of'. Literally, ecology is the study of the earth as a 'household', of plants, human beings, animals and micro-organisms.
- A habitat in the ecological sense is the totality of the physical and chemical factors that constitute the general environment.
- A system consisting of biotic and abiotic components is known as ecosystem. All these components in ecosystem are inter related and interact with each other.
- Different types of ecosystems exist with varying ranges of environmental conditions where various plants and animal species have got adapted through evolution. This phenomenon is known as ecological adaptation.
- Ecosystems are of **two** major types : terrestrial and aquatic.
- Terrestrial ecosystem can be further be classified into 'biomes'. A biome is a plant and animal community that covers a large geographical area.
- A biome can be defined as the total assemblage of plant and animal species interacting within specific conditions. These include rainfall, temperature, humidity and soil conditions.
- Some of the major biomes of the world are: forest, grassland, desert and tundra biomes.
- Aquatic ecosystems can be classed as marine and freshwater ecosystems. Marine ecosystem includes the oceans, coastal estuaries and coral reefs. Freshwater ecosystem includes lakes, ponds, streams, marshes and bogs.
- From a structural point of view, all ecosystems consist of abiotic and biotic factors.
- Abiotic factors include rainfall, temperature, sunlight, atmospheric humidity, soil conditions, inorganic substances (carbon dioxide, water, nitrogen, calcium, phosphorus, potassium, etc.).
- Biotic factors include the producers, (primary, secondary, tertiary) the consumers and the decomposers. The producers include all the green plants, which manufacture their own food through photosynthesis.
- The primary consumers include herbivorous animals like deer, goats, mice and all plant-eating animals.
- The secondary consumers *i.e.,* carnivores include all the flesh-eating animals like snakes, tigers and lions.
- Decomposers are those that feed on dead organisms (for example, scavengers like vultures and crows), and further breaking down of the dead matter by other decomposing agents like bacteria and various microorganisms.
- Organisms of an ecosystem are linked together through a food chain.
- For example, a plant eating beetle feeding on a paddy stalk is eaten by a frog, which is, in turn, eaten by a snake, which is then consumed by a hawk. This sequence of eating and being eaten and the resultant transfer of energy from one level to another is known as the food-chain.
- Transfer of energy that occurs during the process of a foodchain from one level to another is known as flow of energy.
- The food- chains get interlocked with one another. This interconnecting network of species is known as food web. Generally, two types of food-chains are recognised : grazing food-chain and detritus food-chain.
- In a grazing food-chain, the first level starts with plants as producers and ends with carnivores as consumers as the last level, with the herbivores being at the intermediate level. There is a loss of energy at each level which may be through respiration, excretion or decomposition.
- A detritus food-chain is based on autotrophs energy capture initiated by grazing animals and involves the decomposition or breaking down of organic wastes and dead matter derived from the grazing food-chain.

Know the Terms

- **Biosphere :** The biosphere includes all the living components of the earth.
- **Ecological systems :** The interactions of a particular group of organisms with abiotic factors within a particular habitat resulting in clearly defined energy flows and material cycles on land, water and air, are called ecological systems.
- **Ecology :** Ecology can be defined as a scientific study of the interactions of organisms with their physical environment and with each other.
- **Science of ecology :** The study of interactions between life forms (biotic) and the physical environment (abiotic) is the science of ecology.
- **Habitat :** A habitat in the ecological sense is the totality of the physical and chemical factors that constitute the general environment.
- **Ecological adaptation :** Different types of ecosystems exist with varying ranges of environmental conditions where various plants and animal species have got adapted through evolution. This phenomenon is known as ecological adaptation**.**
- **Biomes :** A biome is a plant and animal community that covers a large geographical area.

- **Abiotic factors :** They are the non living condition or thing such as climate or habitat , that influences or affects an ecosystem and the organisms in it.
- **Biotic factors :** Biotic factors can be described as any living component that affects another organism, or shapes the ecosystem.
- **Marine ecosystem :** Marine ecosystems are among the largest of Earth's aquatic ecosystems.
- **Freshwater ecosystem :** Freshwater ecosystem: Freshwater ecosystems are a subset of Earth's aquatic ecosystems. They include lakes , rivers, ponds, streams, etc.
- **Primary consumers :** The primary consumers include herbivorous animals like deer, goats, mice and all plant-eating animals.
- **Carnivores :** The carnivores include all the flesh-eating animals like snakes, tigers and lions.
- **Decomposers :** They are those that feed on dead organisms.
- **Food chain :** The sequence of eating and being eaten and the resultant transfer of energy from one level to another is known as the food-chain.
- **Flow of energy :** Transfer of energy that occurs during the process of a food-chain from one level to another is known as flow of energy.
- **Food web :** The interconnecting network of species is known as food web.
- **Grazing food chain :** In a grazing food-chain, the first level starts with plants as producers and ends with carnivores as consumers as the last level, with the herbivores being at the intermediate level.
- **Detritus food-chain :** A detritus food-chain is based on autotrophs energy capture initiated by grazing animals and involves the decomposition or breaking down of organic wastes and dead matter derived from the grazing food-chain.

TOPIC-2
Types of Biomes, Biogeochemical Cycles, Ecological Balance.

Revision Notes

- There are five major biomes — forest, desert, grassland , aquatic and attitudinal biomes.
- The Sun is the basic source of energy on which all life depends.
- During photosynthesis, carbon dioxide is converted into organic compounds and oxygen. Out of the total solar insolation that reaches the earth's surface, only a very small fraction (0.1 per cent) is fixed in photosynthesis.
- More than half are used for plant respiration and the remaining part is temporarily stored or is shifted to other portions of the plant.
- Studies have shown that for the last one billion years, the atmosphere and hydrosphere have been composed of approximately the same balance of chemical components.
- This balance of the chemical elements is maintained by a cyclic passage through the tissues of plants and animals.
- These cyclic movements of chemical elements of the biosphere between the organism and the environment are referred to as biogeochemical cycles. 'Bio' refers to living organisms and 'geo' to rocks, soil, air and water of the earth.
- There are two types of biogeochemical cycles : the gaseous and the sedimentary cycle.
- In the gaseous cycle, the main reservoir of nutrients is the atmosphere and the ocean. In the sedimentary cycle, the main reservoir is the soil and the sedimentary and other rocks of the earth's crust.
- All living organisms, the atmosphere and the lithosphere maintain between them a circulation of water in solid, liquid or gaseous form referred to as the water or hydrologic cycle.
- The carbon cycle is mainly the conversion of carbon dioxide. This conversion is initiated by the fixation of carbon dioxide from the atmosphere through photosynthesis.
- During this process, more carbon dioxide is generated and is released through its leaves or roots during the day. The remaining carbohydrates not being utilised by the plant become part of the plant tissue.
- Oxygen is the main by-product of photosynthesis. It is involved in the oxidation of carbohydrates with the release of energy, carbon dioxide and water. The cycling of oxygen is a highly complex process. Oxygen occurs in a number of chemical forms and combination.
- Much of oxygen is produced from the decomposition of water molecules by sunlight during photosynthesis and is released in the atmosphere through transpiration and respiration processes of plants.
- Nitrogen is a major constituent of the atmosphere comprising about seventy-nine per cent of the atmospheric gases.

- Only a few types of organisms like certain species of soil bacteria and blue green algae are capable of utilising it directly in its gaseous form. Generally, nitrogen is usable only after it is fixed. Ninety per cent of fixed nitrogen is biological.
- Nitrogen can also be fixed in the atmosphere by lightning and cosmic radiation.
- Dead plants and animals, excretion of nitrogenous wastes are converted into nitrites by the action of bacteria present in the soil.
- There are still other types of bacteria capable of converting nitrates into free nitrogen, a process known as denitrification.
- Other than carbon, oxygen, nitrogen and hydrogen being the principal geochemical components of the biosphere, many other minerals also occur as critical nutrients for plant and animal life.
- All living organisms fulfil their mineral requirements from mineral solutions in their environments.
- Ecological balance is a state of dynamic equilibrium within a community of organisms in a habitat or ecosystem.
- It can happen when the diversity of the living organisms remains relatively stable.
- This occurs through competition and cooperation between different organisms where population remains stable.
- This balance is also attained by the fact that some species depend on others for their food and sustenance.
- In the plants, any disturbance in the native forests such as clearing the forest for shifting cultivation usually brings about a change in the species distribution.
- This change is due to competition where the secondary forest species such as grasses, bamboos or pines overtakes the native species changing the original forest structure. This is called succession.
- Ecological balance may be disturbed due to the introduction of new species, natural hazards or human causes.
- Human pressure on the earth's resources has put a heavy toll on the ecosystem.
- Ecological imbalances have brought many natural calamities like floods, landslides, diseases, erratic climatic occurrences, etc.

Know the Terms

- **Biogeochemical cycles :** The cyclic movements of chemical elements of the biosphere between the organism and the environment are referred to as biogeochemical cycles.
- **Gaseous cycle :** In the gaseous cycle, the main reservoir of nutrients is the atmosphere and the ocean.
- **Sedimentary cycle :** In the sedimentary cycle, the main reservoir is the soil and the sedimentary and other rocks of the earth's crust.
- **Photosynthesis :** The process by which green plants and some other organisms use sunlight to synthesize nutrients from carbon dioxide and water.
- **Water cycle :** All living organisms, the atmosphere and the lithosphere maintain between them a circulation of water in solid, liquid or gaseous form. This is known as the water or hydrologic cycle.
- **Oxygen cycle :** Oxygen is the main by-product of photosynthesis. It is involved in the oxidation of carbohydrates with the release of energy, carbon dioxide and water. The cycling of oxygen is a highly complex process.
- **Biogeochemical cycle :** The cyclic movements of chemical elements of the biosphere between the organism and the environment are referred to as biogeochemical cycles. Bio refers to living organisms and geo to rocks, soil, air and water of the earth.
- **Denitrification :** Some bacteria can even convert nitrites into nitrates that can be used again by green plants. There are still other types of bacteria capable of converting nitrates into free nitrogen, a process known as denitrification.

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CHAPTER-16
BIODIVERSITY AND CONSERVATION

Revision Notes

- Biodiversity as we have today is the result of 2.5-3.5 billion years of evolution. Before the advent of humans, our earth supported more biodiversity than in any other period.
- The number of species globally vary from 2 million to 100 million, with 10 million being the best estimate. New species are regularly discovered most of which are yet to be classified (an estimate states that about 40 per cent of fresh water fishes from South America are not classified yet). Tropical forests are very rich in bio-diversity.

- Biodiversity is a system in constant evolution, from a view point of species, as well as from view point of an individual organism.
- Biodiversity is not found evenly on the earth. It is consistently richer in the tropics. As one approaches the polar regions, one finds larger and larger populations of fewer and fewer species.
- Biodiversity is our living wealth. It is a result of hundreds of millions of years of evolutionary history.
- **Genetic biodiversity :** It refers to the variation of genes within species. Groups of individual organisms having certain similarities in their physical characteristics are called species. The genetic diversity is essential for a healthy breeding of population of species.
- **Species Diversity :** This refers to the variety of species. It relates to the number of species in a defined area. The diversity of species can be measured through its richness, abundance and types.
- **Ecosystem diversity :** The broad differences between ecosystem types and the diversity of habitats and ecological processes occurring within each ecosystem type constitute the ecosystem diversity.
- Biodiversity plays the following roles :
  - Ecological role : The more diverse an ecosystem, better are the chances for the species to survive through adversities and attacks, and consequently, is more productive. Hence, the loss of species would decrease the ability of the system to maintain itself. Just like a species with a high genetic diversity, an ecosystem with high biodiversity may have a greater chance of adapting to environmental change. In other words, the more the variety of species in an ecosystem, the more stable the ecosystem is likely to be.
  - Economic role : Some of the important economic commodities that biodiversity supplies to humankind are: food crops, livestock, forestry, fish, medicinal resources, etc.
  - Scientific role : Biodiversity also helps in understanding how life functions and the role of each species in sustaining ecosystems of which we are also a species. This fact must be drawn upon every one of us so that we live and let other species also live their lives.
- Since the last few decades, growth in human population has increased the rate of consumption of natural resources.
- It has accelerated the loss of species and habitation in different parts of the world. Tropical regions which occupy only about one-fourth of the total area of the world, contain about three fourth of the world human population.
- Overexploitation of resources and deforestation have become rampant to fulfil the needs of large population.
- Natural calamities such as earthquakes, floods, volcanic eruptions, forest fires, droughts, etc. cause damage to the flora and fauna of the earth, bringing change the biodiversity of respective affected regions.
- Pesticides and other pollutants such as hydrocarbons and toxic heavy metals destroy the weak and sensitive species.
- During the last few decades, some animals like tigers, elephants, rhinoceros, crocodiles, minks and birds were hunted mercilessly by poachers for their horn, tusks, hides, etc. It has resulted in the rendering of certain types of organisms as endangered category.
- The International Union of Conservation of Nature and Natural Resources (IUCN) has classified the threatened species of plants and animals into **three** categories for the purpose of their conservation.
  - Endangered Species : It includes those species which are in danger of extinction.
  - Vulnerable Species : This includes the species which are likely to be in danger of extinction in near future if the factors threatening to their extinction continue.
  - Rare Species : Population of these species is very small in the world; they are confined to limited areas or thinly scattered over a wider area.
- There is an urgent need to educate people to adopt environment-friendly practices and reorient their activities in such a way that our development is harmonious with other life forms and is sustainable.
- The critical problem is not merely the conservation of species nor the habitat but the continuation of process of conservation.
- The Government of India along with 155 other nations have signed the Convention of Biodiversity at the Earth Summit held at Rio-de Janeiro, Brazil in June 1992.
- The world conservation strategy has suggested the following steps for biodiversity conservation :
  - Efforts should be made to preserve the species that are endangered.
  - Prevention of extinction requires proper planning and management.
  - Varieties of food crops, forage plants, timber trees, livestock, animals and their wild relatives should be preserved.

- Each country should identify habitats of wild relatives and ensure their protection.
- Habitats where species feed, breed, rest and nurse their young should be safeguarded and protected.
- International trade in wild plants and animals be regulated.

➢ There are some countries which are situated in the tropical region; they possess a large number of the world's species diversity.

➢ They are called mega diversity centres. There are 12 such countries, namely Mexico, Columbia, Ecuador, Peru, Brazil, Zaire, Madagascar, China, India, Malaysia, Indonesia and Australia in which these centres are located.

➢ In order to concentrate resources on those areas that are most vulnerable, the International Union for the Conservation of Nature and Natural Resources (IUCN) has identified certain areas as biodiversity hotspots.

➢ Hotspots are defined according to their vegetation. Plants are important because these determine the primary productivity of an ecosystem. Most, but not all, of the hotspots rely on species rich ecosystems for food, firewood, cropland, and income from timber.

➢ In Madagascar about 85 percent of the plants and animals are found nowhere else in the world. Other hotspots in wealthy countries are facing different types of pressure.

➢ The Islands of Hawaii have many unique plants and animals that are threatened by introduces species and land development.

Know the Terms

➢ **Biodiversity :** Biodiversity is the number and variety of organisms found within a specified geographic region. It refers to the varieties of plants, animals and micro-organisms, the genes they contain and the ecosystems they form.

➢ **Genetic biodiversity :** Genetic biodiversity refers to the variation of genes within Species

➢ **Species :** Groups of individual organisms having certain similarities in their physical characteristics are called species

➢ **Species diversity :** It refers to the variety of species. It relates to the number of species in a defined area.

➢ **Ecosystem diversity :** The broad differences between ecosystem types and the diversity of habitats and ecological processes occurring within each ecosystem type constitute the ecosystem diversity.

➢ **Hotspots :** Areas rich in species diversity are called hotspots of diversity.

➢ **Crop diversity/agro biodiversity :** It includes all components of biological diversity of relevance to food and agriculture.

➢ **Exotic species :** Species which are not the natural inhabitants of the local habitat but are introduced into the system, are called exotic species.

➢ **Sensitive species :** Pesticides and other pollutants such as hydrocarbons and toxic heavy metals destroy the weak species. These are called sensitive species.

➢ **Mega diversity centre :** There are some countries which are situated in the tropical region; they possess a large number of world's species diversity. They are called mega diversity centre.

➢ **IUCN :** The International Union of Conservation of Nature and Natural Resources.

➢ **Endangered species :** It includes the species which are likely to be in danger of extinction.

➢ **Rare species :** They are those species whose population is very small in the world and they are confined to limited areas or thinly scattered over a wider area.

➢ **Vulnerable species :** It includes those species which are likely to be in danger of extinction in near future if the factors threatening to their extinction continue.

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PART-B : UNIT-VII : INTRODUCTION

CHAPTER-1
INDIA-LOCATION

Revision Notes

➢ The mainland of India, extends from Kashmir in the North to Kanyakumari in the South and Arunachal Pradesh in the East to Gujarat in the West.

➢ India's territorial limit further extends towards the sea upto 12 nautical miles (about 21.9 km) from the coast.

- Our southern boundary extends upto 6°45' N latitude in the Bay of Bengal.
- If you work out the latitudinal and longitudinal extent of India, they are roughly about 30 degrees, whereas the actual distance measured from North to South extremity is 3,214 km and that from east to west only 2,933 km.
- From the values of latitude, it is understood that the southern part of the country lies within the tropics and the northern part lies in the sub-tropical zone or the warm temperate zone.
- From the values of longitude, it is quite discernible that there is a variation of nearly 30 degrees, which causes a time difference of nearly two hours between the easternmost and the westernmost parts of our country.
- There is a general understanding among the countries of the world to select the standard meridian in multiples of 7°30' of longitude. That is why 82°30' E has been selected as the 'Standard Meridian' of India. Indian Standard Time is ahead of Greenwich Mean Time by 5 hours and 30 minutes.
- India with its area of 3.28 million sq. km accounts for 2.4 per cent of the world's land surface area and stands as the seventh largest country in the world.
- The size of India has endowed her with great physical diversity.
- India has the presence of lofty mountains in the North; large rivers such as Ganga, Brahmaputra, Mahanadi, Krishna, Godavari and Kaveri; green forested hills in North East and South India; and the vast sandy expanse of Marusthali.
- Bounded by the Himalayas in the North, Hindukush and Sulaiman ranges in the North West, Purvachal hills in the North-East and by the large expanse of the Indian ocean in the South, it forms a great geographic entity known as the Indian subcontinent. It includes the countries — Pakistan, Nepal, Bhutan, Bangladesh and India.
- The Himalayas, together with other ranges, have acted as a formidable physical barrier in the past.
- Except for a few mountain passes such as the Khyber, the Bolan, the Shipkila, the Nathula, the Bomdila, etc., it was difficult to cross it.
- Peninsular part of India extends towards the Indian Ocean. This has provided the country with a coastline of 6,100 km in the mainland and 7,517 km in the entire geographical coast of the mainland plus the island groups Andaman and Nicobar located in the Bay of Bengal and the Lakshadweep in the Arabian Sea.
- India is located in the south-central part of the continent of Asia, bordering the Indian ocean and its two arms extending in the form of Bay of Bengal and the Arabian Sea. This maritime location of Peninsular India has provided links to its neighbouring regions through the sea and air routes.
- Sri Lanka and Maldives are the two island countries located in the Indian Ocean, which are our neighbours. Sri Lanka is separated from India by the Gulf of Mannar and Palk Strait.

Know the Terms

- **Indira point :** It is the southernmost point of India.
- **Subcontinent :** A subcontinent is part of a larger continent , made up of a number of countries that form a large mass of land.

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UNIT-VIII : PHYSIOGRAPHY

CHAPTER-2
STRUCTURE AND PHYSIOGRAPHY

TOPIC-1
The Peninsular Block, The Northern and North-Eastern Mountains

Revision Notes

- Do you know that the Indian plate was to the South of the Equator millions of years ago?
- Over millions of years, this plate broke into many parts and the Australian plate moved towards the South Eastern direction and the Indian plate to the North.
- This northward movement of the Indian plate is still continuing and it has significant consequences on the physical environment of the Indian subcontinent.

- It is primarily through the interplay of these endogenic and exogenic forces and lateral movements of the plates that the present geological structure and geomorphologic processes active in the Indian subcontinent came into existence.
- The Peninsula is formed essentially by a great complex of very ancient gneisses and granites, which constitutes a major part of it.
- As a part of the Indo-Australian Plate, it has been subjected to various vertical movements and block faulting.
- **The Himalayas and Other Peninsular Mountains :** The Himalayas along with other Peninsular mountains are young, weak and flexible in their geological structure unlike the rigid and stable Peninsular Block.
- These mountains are tectonic in origin, dissected by fast-flowing rivers which are in their youthful stage. Various landforms like gorges, V-shaped valleys, rapids, waterfalls, etc., are indicative of this stage.
- **Indo-Ganga-Brahmaputra Plain :** The third geological division of India comprises the plains formed by the river Indus, the Ganga and the Brahmaputra. Originally, it was a geo-synclinal depression which attained its maximum development during the third phase of the Himalayan mountain formation approximately about 64 million years ago.
- **The North and North eastern Mountains :** The North and North eastern Mountains consist of the Himalayas and the North eastern hills . The Himalayas consist of a series of parallel mountain ranges. Some of the important ranges are the Greater Himalayan range, which includes the Great Himalayas and the Trans Himalayan range, the Middle Himalayas and the Shiwalik.
- The approximate length of the Great Himalayan range, also known as the central axial range, is 2,500 km from East to West, and their width varies between 160-400 km from North to South.
- Himalayas are not only the physical barrier, they are also a climatic, drainage and cultural divide. There are large-scale regional variations within the Himalayas. On the basis of relief, alignment of ranges and other geomorphological features, the Himalayas can be divided into the following sub-divisions :
  - Kashmir or Northwestern Himalayas : It comprise a series of ranges such as the Karakoram, Ladakh, Zaskar and Pir Panjal. The northeastern part of the Kashmir Himalayas is a cold desert, which lies between the Greater Himalayas and the Karakoram ranges. Between the Great Himalayas and the Pir Panjal range, lies the world famous valley of Kashmir and the famous Dal Lake. The Kashmir Himalayas are also famous for Karewa formations, which are useful for the cultivation of Zafran, a local variety of saffron.
- Some of the important passes of the region are Zoji La on the Great Himalayas, Banihal on the Pir Panjal, Photu La on the Zaskar and Khardung La on the Ladakh range.
- Srinagar, capital city of the state of Jammu and Kashmir is located on the banks of Jhelum river.
- Jhelum in the valley of Kashmir is still in its youth stage and yet forms meanders – a typical feature associated with the mature stage in the evolution of fluvial land form.
  - The Himachal and Uttarakhand Himalayas : This part lies approximately between the Ravi in the West and the Kali (a tributary of Ghaghara) in the East. It is drained by two major river systems of India, i.e., the Indus and the Ganga. Tributaries of the Indus include the river Ravi, the Beas and the Satluj, and the tributaries of Ganga flowing through this region include the Yamuna and the Ghaghara.
- The three ranges of Himalayas are prominent in this section also. These are the Great Himalayan range, the Lesser Himalayas (which is locally known as Dhaoladhar in Himachal Pradesh and Nagtibha in Uttaranchal) and the Shiwalik range from the North to the South.
- The two distinguishing features of this region from the point of view of physiography are the 'Shiwalik' and 'Dun formations'.
- Dehra Dun is the largest of all the duns with an approximate length of 35-45 km and a width of 22-25 km.
  - The Darjiling and Sikkim Himalayas : They are flanked by Nepal Himalayas in the west and Bhutan Himalayas in the East. It is relatively small but is a most significant part of the Himalayas.
- The higher reaches of this region are inhabited by Lepcha tribes while the southern part, particularly the Darjiling Himalayas, has a mixed population of Nepalis, Bengalis and tribals from Central India.
- As compared to the other sections of the Himalayas, these along with the Arunachal Himalayas are conspicuous by the absence of the Shiwalik formations.
  - The Arunachal Himalayas : These extend from the east of the Bhutan Himalayas up to the Diphu pass in the East. The general direction of the mountain range is from South West to North East. Some of the important mountain peaks of the region are Kangtu and Namcha Barwa. Bhramaputra flows through a deep gorge after crossing Namcha Barwa.
- An important aspect of the Arunachal Himalayas is the numerous ethnic tribal community inhabiting in these areas. Some of the prominent ones from west to east are the Monpa, Daffla, Abor, Mishmi, Nishi and the Nagas.
- Most of these communities practise Jhumming. It is also known as shifting or slash and burn cultivation. Due to rugged terrain inter-valley transportation linkages are nominal. Hence, most of the interactions are carried through the duar region along the Arunachal-Assam border.

- The Eastern Hills and Mountains : These are part of the Himalayan mountain system having their general alignment from the north to the south direction. They are known by different local names. In the north, they are known as Patkai Bum, Naga hills, the Manipur hills and in the south as Mizo or Lushai hills.

- The Barak is an important river in Manipur and Mizoram. The physiography of Manipur is unique by the presence of a large lake known as 'Loktak' lake at the centre, surrounded by mountains from all sides.
- Mizoram which is also known as the 'Molassis basin' which is made up of soft unconsolidated deposits. Most of the rivers in Nagaland form the tributary of the Brahmaputra.
- While two rivers of Mizoram and Manipur are the tributaries of the Barak river, which in turn is the tributary of Meghna; the rivers in the eastern part of Manipur are the tributaries of Chindwin, which in turn is a tributary of the Irrawady of Myanmar.

Know the Terms

- **Physiography :** Physiography of an area is the outcome of structure, process and the stage of development.
- **Geomorphological processes :** The internal and external forces causing changes in the configuration of the surface of the earth are known as geomorphological processes.
- **Geo-synclinal depression :** It is a water depression characterized by sedimentation.
- **Karewas :** Karewas are the thick deposits of glacial clay and other materials embedded with moraines.
- **Central Axial Range :** The approximate length of the Great Himalayas range is known as the central axial range. It is 2,500 km from East to West.
- **Dhaoladhar :** The Lesser Himalayas is locally known as the Himachal Pradesh.
- **Nagtibha :** The Lesser Himalayas are known as the Nagtibha in Himachal Pradesh.

TOPIC-2
The Northern Plains

Revision Notes

- The Northern Plains are formed by the alluvial deposits brought by the rivers – the Indus, the Ganga and the Brahmaputra.
- These plains extend approximately 3,200 km from the East to the West. The average width of these plains varies between 150-300 km.
- The maximum depth of alluvium deposits varies between 1,000-2,000 m. From the North to the South, these can be divided into three major zones : the Bhabar, the Tarai and the alluvial plains. The alluvial plains can be further divided into the Khadar and the Bhangar.
- Bhabar is a narrow belt ranging between 8-10 km parallel to the Shiwalik foothills at the break-up of the slope.
- South of the Bhabar is the Tarai belt, with an approximate width of 10-20 km where most of the streams and rivers re-emerge without having any properly demarcated channel, thereby, creating marshy and swampy conditions known as the Tarai.
- The Brahmaputra plains are known for their riverine islands and sand bars. Most of these areas are subjected to periodic floods and shifting river courses forming braided streams.
- Otherwise, this is a featureless plain with a general elevation of 50-150 m above the mean sea level. The states of Haryana and Delhi form a water divide between the Indus and the Ganga river systems.
- The river valley plains have a fertile alluvial soil cover which supports a variety of crops like wheat, rice, sugarcane and jute, and hence, supports a large population.

Know the Terms

- **Indo-Ganga-Brahmaputra Plain :** It is a geological division of India that comprises the plains formed by the river Indus, the Ganga and the Brahmaputra.
- **Bhabar :** It is a narrow belt ranging between 8-10 km parallel to the Shiwalik foothills at the break-up of the slope.
- **Khadar :** The South of Tarai is a belt consisting of new alluvial deposits is known as khadar.
- **Tarai :** South of the Bhabar is the Tarai belt, with an approximate width of 10-20 km where most of the streams and rivers re-emerge without having any properly demarcated channel, thereby, creating marshy and swampy conditions known as the Tarai.

TOPIC-3
The Peninsular Plateau

Revision Notes

- Rising from the height of 150 m above the river plains up to an elevation of 600-900 m is the irregular triangle known as the Peninsular Plateau.
- The Peninsular India is made up of a series of patland plateaus such as the Hazaribagh plateau, the Palamu plateau, the Ranchi plateau, the Malwa plateau, the Coimbatore plateau and the Karnataka plateau, etc.
- This is one of the oldest and the most stable landmass of India. The general elevation of the plateau is from the West to the East, which is also proved by the pattern of the flow of rivers.
- Some of the important physiographic features of this region are tors, block mountains, rift valleys, spurs, bare rocky structures, series of hummocky hills and wall-like quartzite dykes offering natural sites for water storage. The western and northwestern part of the plateau has an emphatic presence of black soil.
- On the basis of the prominent relief features, the Peninsular Plateau can be divided into three broad groups :
  - The Deccan Plateau : This is bordered by the Western Ghats in the West, Eastern Ghats in the East and the Satpura, Maikal range and Mahadeo hills in the North. Western Ghats are locally known by different names such as Sahyadri in Maharashtra, Nilgiri hills in Karnataka and Tamil Nadu and Anaimalai hills and Cardamom hills in Kerala.
- Western Ghats are comparatively higher in elevation and more continuous than the Eastern Ghats.
- Their average elevation is about 1,500 m with the height increasing from North to South.
- Most of the Peninsular rivers have their origin in the Western Ghats. Eastern Ghats comprising the discontinuous and low hills are highly eroded by the rivers such as the Mahanadi, the Godavari, the Krishna, the Kaveri, etc.
- Some of the important ranges include the Javadi Hills, the Palconda Range, the Nallamala Hills, the Mahendragiri Hills, etc. The Eastern and the Western Ghats meet each other at the Nilgiri hills.
  - The Central Highlands : They are bounded to the west by the Aravali range. The Satpura range is formed by a series of scarped plateaus on the South, generally at an elevation varying between 600-900 m above the mean sea level.
- The extension of the Peninsular Plateau can be seen as far as Jaisalmer in the West, where it has been covered by the longitudinal sand ridges and crescent-shaped sand dunes called barchans.
- This region has undergone metamorphic processes in its geological history, which can be corroborated by the presence of metamorphic rocks such as marble, slate, gneiss, etc.
- The general elevation of the Central Highlands ranges between 700-1,000 m above the mean sea level and it slopes towards the North and northeastern directions.
- Banas is the only significant tributary of the river Chambal that originates from the Aravalli in the West. An eastern extension of the Central Highland is formed by the Rajmahal Hills, to the South of which lies a large reserve of mineral resources in the Chotanagpur Plateau.
  - The Northeastern Plateau : In fact it is an extension of the main Peninsular Plateau. It is believed that due to the force exerted by the northeastward movement of the Indian Plate at the time of the Himalayan origin, a huge fault was created between the Rajmahal Hills and the Meghalaya Plateau.
- Today, the Meghalaya and Karbi Anglong Plateau stand detached from the main Peninsular Block.
- The Meghalaya Plateau is further sub-divided into three : **(i)** The Garo Hills; **(ii)** The Khasi Hills; **(iii)** The Jaintia Hills, named after the tribal groups inhabiting this region.
- An extension of this is also seen in the Karbi Anglong Hills of Assam.
- The Meghalaya Plateau has a highly eroded surface. Cherrapunji displays a bare rocky surface devoid of any permanent vegetation cover.

Know the Terms

- **Peninsular Plateau :** Rising from the height of 150 m above the river plains up to an elevation of 600-900 m is the irregular triangle known as the Peninsular Plateau.
- **Central highlands :** They are bound to the West by the Aravali Range.
- **Satpura range :** They are formed by a series of scraped plateaus on the South , generally at an elevation varying between 600-900m above the mean sea level.

TOPIC-4
The Indian Desert, The Coastal Plains, The Islands

Revision Notes

- To the Northwest of the Aravali Hills lies the Great Indian Desert.
- It is a land of undulating topography dotted with longitudinal dunes and barchans.
- This region receives low rainfall below 150 mm per year; hence, it has arid climate with low vegetation cover. It is because of these characteristic features that this is also known as Marusthali.
- Though the underlying rock structure of the desert is an extension of the Peninsular Plateau, yet, due to extreme arid conditions, its surface features have been carved by physical weathering and wind actions.
- On the basis of the orientation, the desert can be divided into two parts: the northern part is sloping towards Sindh and the southern towards the Rann of Kachchh.
- Most of the rivers in this region are ephemeral. The Luni river flowing in the southern part of the desert is of some significance.
- Low precipitation and high evaporation makes it a water deficit region.
- The lakes and the playas have brackish water which is the main source of obtaining salt.
- On the basis of the location and active geomorphological processes, the coastal plains can be broadly divided into two :
  - The western coastal plains : The western coastal plains are an example of submerged coastal plain. It is believed that the city of Dwarka which was once a part of the Indian mainland situated along the West coast is submerged under water.
- Because of this submergence it is a narrow belt and provides natural conditions for the development of ports and harbours.
- Kandla, Mazagaon, JLN port Navha Sheva, Marmagao, Mangalore, Cochin, etc., are some of the important natural ports located along the West coast.
- The the western Coast may be divided into following divisions – the Kachchh and Kathiawar coast in Gujarat, Konkan Coast in Maharashtra, Goan Coast and Malabar Coast in Karnataka and Kerala respectively.
  - The eastern coastal plains : As compared to the western coastal plain, the eastern coastal plain is broader and is an example of an emergent coast.
- There are well developed deltas here, formed by the rivers flowing eastward in to the Bay of Bengal.
- The continental shelf extends up to 500 km into the sea, which makes it difficult for the development of good ports and harbours. Name some ports on the eastern coast.
- There are **two** major island groups in India – one in the Bay of Bengal and the other in the Arabian Sea.
- The Bay of Bengal island groups consist of about 572 islands/islets. These are situated roughly between 6°N-14°N and 92°E -94°E.
- The two principal groups of islets include the Ritchie's Archipelago and the Labrynth Island.
- The entire group of island is divided into two broad categories – the Andaman in the North and the Nicobar in the South.
- They are separated by a water body which is called the Ten Degree Channel.
- It is believed that these islands are an elevated portion of submarine mountains. However, some smaller islands are volcanic in origin. The Barren Island, the only active volcano in India is also situated in the Nicobar Islands.
- The islands of the Arabian Sea include Lakshadweep and Minicoy. These are scattered between 8°N-12°N and 71°E -74°E longitude.
- The entire island group is built of coral deposits.
- There are approximately 36 islands of which 11 are inhabited. Minicoy is the largest island with an area of 453 sq. km.
- The islands of this archipelago have storm beaches consisting of unconsolidated pebbles, shingles, cobbles and boulders on the eastern seaboard.

Know the Terms

- **11° Channel :** It is the water body which separates the Andaman from the Nicobar.
- **Barren Island :** Barren island, the only active volcano in India is also situated in the Nicobar islands.

CHAPTER-3
DRAINAGE SYSTEM

TOPIC-1
The Himalayan Drainage System : Evolution of the Himalayan Drainage System, The River Systems of the Himalayan Drainage System

Revision Notes

- The flow of water through well-defined channels is known as 'drainage' and the network of such channels is called a 'drainage system'.
- The drainage pattern of an area is the outcome of the geological time period, nature and structure of rocks, topography, slope, amount of water flowing and the periodicity of the flow.
- A river drains the water collected from a specific area, which is called its 'catchment area'. An area drained by a river and its tributaries is called a drainage basin. The boundary line separating one drainage basin from the other is known as the watershed. The catchments of large rivers are called river basins while those of small rivulets and rills are often referred to as watersheds.
- Indian Drainage System may be divided on various bases. On the basis of discharge of water (orientations to the sea), it may be grouped into : **(i)** the Arabian Sea Drainage; and **(ii)** the Bay of Bengal Drainage.
- Nearly 77 per cent of the drainage area consisting of the Ganga, the Brahmaputra, the Mahanadi, the Krishna, etc., is oriented towards the Bay of Bengal while 23 per cent comprising the Indus, the Narmada, the Tapi, the Mahi and the Periyar systems discharge their waters in the Arabian Sea.
- On the basis of the size of the watershed, the drainage basins of India are grouped into three categories : **(i)** Major river basins with more than 20,000 sq. km of catchment area. **(ii)** Medium river basins with catchment area between 2,000-20,000 sq. km.
- On the basis of the mode of origin, nature and characteristics, the Indian drainage may also be classified into the Himalayan drainage and the Peninsular drainage.
- **The Himalayan Drainage :** The Himalayan drainage system has evolved through a long geological history. It mainly includes the Ganga, the Indus and the Brahmaputra river basins. Since these are fed both by melting of snow and precipitation, rivers of this system are perennial.
- These rivers pass through the giant gorges carved out by the erosional activity carried on simultaneously with the uplift of the Himalayas.
- In the Himalayan reaches, the course of these rivers is highly tortuous, but over the plains they display a strong meandering tendency and shift their courses frequently.
- River Kosi, also know as the 'sorrow of Bihar', has been notorious for frequently changing its course.
- There are difference of opinion about the evolution of the Himalayan rivers. However, geologists believe that a mighty river called Shiwalik or Indo-Brahma traversed the entire longitudinal extent of the Himalaya from Assam to Punjab and onwards to Sind, and finally discharged into the Gulf of Sind near lower Punjab during the Miocene period some 5-24 million years ago.
- It is opined that in due course of time Indo– Brahma river was dismembered into three main drainage systems : **(i)** the Indus and its five tributaries in the western part; **(ii)** the Ganga and its Himalayan tributaries in the central part; and **(iii)** the stretch of the Brahmaputra in Assam and its Himalayan tributaries in the eastern part.
- The Himalayan drainage consists of several river systems but the following are the major river systems:
- **The Indus System :** It is one of the largest river basins of the world, covering an area of 11,65,000 sq. km (in India it is 321, 289 sq. km and a total length of 2,880 km (in India 1,114 km). It originates from a glacier near Bokhar Chu (31°15' N latitude and 81°40' E longitude) in the Tibetan region at an altitude of 4,164 m in the Kailash Mountain range.
- The Indus receives a number of Himalayan tributaries such as the Shyok, the Gilgit, the Zaskar, the Hunza, the Nubra, the Shigar, the Gasting and the Dras.
- The other important tributaries joining the right bank of the Indus are the Khurram, the Tochi, the Gomal, the Viboa and the Sangar. They all originate in the Sulaiman ranges. The river flows southward and receives 'Panjnad' a little above Mithankot. The Panjnad is the name given to the five rivers of Punjab, namely the Satluj, the Beas, the Ravi, the Chenab and the Jhelum.

- The Indus flows in India only through the Leh district in Jammu and Kashmir.
- The Jhelum, an important tributary of the Indus, rises from a spring at Verinag situated at the foot of the Pir Panjal in the south-eastern part of the valley of Kashmir.
- The Chenab is the largest tributary of the Indus. It is formed by two streams, the Chandra and the Bhaga, which join at Tandi near Keylong in Himachal Pradesh.
- The Ravi is another important tributary of the Indus. It rises west of the Rohtang Pass in the Kullu hills of Himachal Pradesh and flows through the Chamba Valley of the state.
- The Beas is another important tributary of the Indus, originating from the Beas Kund near the Rohtang Pass at an elevation of 4,000 m above the mean sea level.
- The Satluj originates in the Rakas lake near Mansarovar at an altitude of 4,555 m in Tibet where it is known as Langchen Khambab.

- **The Ganga System :** The Ganga is the most important river of India both from the point of view of its basin and cultural significance . The Ganga basin covers about 8.6 lakh sq. km area in India alone. The Ganga river system is the largest in India having a number of perennial and non-perennial rivers originating in the Himalayas in the north and the Peninsula in the south, respectively.
- The Yamuna, the western most and the longest tributary of the Ganga, has its source in the Yamunotri Glacier on the western slopes of Banderpunch range (6,316 km).
- The Chambal rises near Mhow in the Malwa Plateau of Madhya Pradesh and flows northwards through a gorge up wards of Kota in Rajasthan, where the Gandhisagar Dam has been constructed.
- The Gandak comprises two streams, namely Kaligandak and Trishulganga. It rises in the Nepal Himalayas between the Dhaulagiri and Mount Everest and drains the central part of Nepal.
- The Ghaghara originates in the glaciers of Mapchachungo. After collecting the waters of its tributaries – Tila, Seti and Beri, it comes out of the mountain, cutting a deep gorge at Shishapani.
- The Kosi is an antecedent river with its source to the north of Mount Everest in Tibet, where its main stream Arun rises.
- The Ramganga is comparatively a small river rising in the Garhwal Hills near Gairsain.
- The Damodar occupies the eastern margins of the Chotanagpur Plateau where it flows through a rift valley and finally joins the Hugli. The Barakar is its main tributary.
- The Sarda or Saryu river rises in the Milan Glacier in the Nepal Himalayas where it is known as the Goriganga.
- The Mahananda is another important tributary of the Ganga rising in the Darjiling Hill.
- The Son is a large south bank tributary of the Ganga, originating in the Amarkantak Plateau.

- **The Brahmaputra System :** The Brahmaputra, one of the largest rivers of the world, has its origin in the Chemayungdung Glacier of the Kailash range near the Mansarovar Lake.
- The Brahmaputra receives numerous tributaries in its 750 km long journey through the Assam valley.
- The Brahmaputra enters into Bangladesh near Dhubri and flows southward. In Bangladesh, the Tista joins it on its right bank from where the river is known as the Yamuna.

Know the Terms

- **Drainage :** The flow of water through well-defined channels is known as 'drainage'.
- **Drainage system :** The network of drainage channels is called a 'drainage system'.
- **Dendritic drainage pattern :** The drainage pattern resembling the branches of a tree is known as "dendritic" the examples of which are the rivers of northern plain.
- **Radial drainage pattern :** When the rivers originate from a hill and flow in all directions, the drainage pattern is known as 'radial'.
- **Trellis drainage pattern :** When the primary tributaries of rivers flow parallel to each other and secondary tributaries join them at right angles, the pattern is known as 'trellis'.
- **Centripetal drainage pattern :** When the rivers discharge their waters from all directions in a lake or depression, the pattern is known as 'centripetal'.
- **Catchment area :** A river drains the water collected from a specific area, which is called its 'catchment area'.
- **Drainage basin :** An area drained by a river and its tributaries is called a drainage basin.
- **Watershed :** The boundary line separating one drainage basin from the other is known as the watershed.
- **River basins :** The catchments of large rivers are called river basins.
- **River system :** A river or a river system is a body of water flowing in a channel through the surface of the Earth. It consists of four important parts; river course, river source, tributaries and river mouth.

TOPIC-2

The Peninsular Drainage System : The Evolution of the Peninsular Drainage System, River Systems of the Peninsular Drainage, River Regimes.

Revision Notes

- The Peninsular Drainage System is older than the Himalayan one.
- The Western Ghats running close to the western coast act as the water divide between the major Peninsular rivers, discharging their water in the Bay of Bengal and as small rivulets joining the Arabian Sea.
- Most of the major Peninsular rivers except Narmada and Tapi flow from west to East.
- The other major river systems of the Peninsular drainage are – the Mahanadi the Godavari, the Krishna and the Kaveri. Peninsular rivers are characterised by fixed course, absence of meanders and non perennial flow of water.
- Three major geological events in the distant past have shaped the present drainage systems of Peninsular India :
  - Subsidence of the western flank of the Peninsula leading to its submergence below the sea during the early tertiary period.
  - Upheaval of the Himalayas when the northern flank of the Peninsular block was subjected to subsidence and the consequent trough faulting. Slight tilting of the Peninsular block from northwest to the southeastern direction gave orientation to the entire drainage system towards the Bay of Bengal during the same period.
- The Mahanadi rises near Sihawa in Raipur district of Chhattisgarh and runs through Odisha to discharge its water into the Bay of Bengal. It is 851 km long and its catchment area spreads over 1.42 lakh sq.km.
- The Godavari is the largest Peninsular river system. It is also called the Dakshin Ganga. It rises in the Nasik district of Maharashtra and discharges its water into the Bay of Bengal.
- The Krishna is the second largest eastflowing Peninsular river which rises near Mahabaleshwar in Sahyadri.
- The Kaveri rises in Brahmagiri hills (1,341m) of Kogadu district in Karnataka. Its length is 800 km and it drains an area of 81,155 sq. km.
- The Narmada originates on the western flank of the Amarkantak plateau at a height of about 1,057 m.
- The Tapi is the other important westward flowing river. It originates from Multai in the Betul district of Madhya Pradesh.
- Luni is the largest river system of Rajasthan, west of Aravali. It originates near Pushkar in two branches, i.e. the Saraswati and the Sabarmati, which join with each other at Govindgarh.
- Goa has two important rivers which are Mandovi and Jauri.
- Kerala has a narrow coastline. The longest river of Kerala, Bharathapuzha rises near Annamalai hills. It is also known as Ponnani.
- The Periyar is the second largest river of Kerala.
- The pattern of flow of water in a river channel over a year is known as its regime. The north Indian rivers originating from the Himalayas are perennial as they are fed by glaciers through snow melt and also receive rainfall water during rainy season.
- The discharge is the volume of water flowing in a river measured over time. It is measured either in cusecs (cubic feet per second) or cumecs (cubic metres per second).
- The two Peninsular rivers display interesting differences in their regimes compared to the Himalayan rivers.
- The rivers of India carry huge volumes of water per year but it is unevenly distributed both in time and space.
- There are perennial rivers carrying water throughout the year while the non-perennial rivers have very little water during the dry season.

Know the Terms

- **Meanders :** It is a series of regular sinuous curves, bends, loops , turns or windings in the channel of a river or a stream.
- **Cusecs :** It means cubic feet per second.
- **Cumecs :** It stands for cubic meters per second.

UNIT-IX : CLIMATE, VEGETATION AND SOIl

CHAPTER-4
CLIMATE

TOPIC-1
Unity and Diversity in the Monsoon Climate, Factors Determining the Climate of India

Revision Notes

- Weather is the momentary state of the atmosphere while climate refers to the average of the weather conditions over a longer period of time.
- There are variations in weather conditions during different seasons. These changes occur due to the changes in the elements of weather (temperature, pressure, wind direction and velocity, humidity and precipitation, etc.).
- Weather changes quickly, may be within a day or week but climate changes imperceptivity and may be noted after 50 years or even more.
- Monsoon connotes the climate associated with seasonal reversal in the direction of winds. India has hot monsoonal climate which is the prevalent climate in south and southeast Asia.
- The climate of India has many regional variations expressed in the pattern of winds, temperature and rainfall, rhythm of seasons and the degree of wetness or dryness.
- India's climate is controlled by a number of factors which can be broadly divided into two groups —
- **Factors related to location and relief :**
  - Latitude : The Tropic of Cancer passes through the central part of India in east-west direction. Thus, northern part of the India lies in sub-tropical and temperate zone and the part lying south of the Tropic of Cancer falls in the tropical zone. The tropical zone being nearer to the equator, experiences high temperatures throughout the year with small daily and annual range.
  - The Himalayan Mountains : The lofty Himalayas in the north along with its extensions act as an effective climatic divide. The towering mountain chain provides an invincible shield to protect the subcontinent from the cold northern winds . The Himalayas also trap the monsoon winds, forcing them to shed their moisture within the subcontinent.
  - Distribution of Land and Water : India is flanked by the Indian Ocean on three sides in the south and girdled by a high and continuous mountain-wall in the north. As compared to the landmass, water heats up or cools down slowly. This differential heating of land and sea creates different air pressure zones in different seasons in and around the Indian subcontinent.
  - Distance from the Sea : Areas in the interior of India are far away from the moderating influence of the sea. Such areas have extremes of climate. Whereas, the coastal areas hardly have any idea of extremes of temperature and the seasonal rhythm of weather.
  - Altitude : Temperature decreases with height. Due to thin air, places in the mountains are cooler than places on the plains.
  - Relief : The physiography or relief of India also affects the temperature, air pressure, direction and speed of wind and the amount and distribution of rainfall.
- **Factors related to air pressure and winds :**
  - To understand the differences in local climates of India, we need to understand the mechanism of the following three factors :
- Distribution of air pressure and winds on the surface of the earth.
- Upper air circulation caused by factors controlling global weather and the inflow of different air masses and jet streams.
- Inflow of western cyclones generally known as disturbances during the winter season and tropical depressions during the south-west monsoon period into India, creating weather conditions favourable to rainfall. The mechanism of these three factors can be understood with reference to winter and summer seasons of the year separately.
- **Mechanism of weather in the winter season :**
  - Surface Pressure and Winds : In winter months, the weather conditions over India are generally influenced by the distribution of pressure in Central and Western Asia.

- A high pressure centre in the region lying to the north of the Himalayas develops during winter. This centre of high pressure gives rise to the flow of air at the low level from the north towards the Indian subcontinent, south of the mountain range.
- The surface winds blowing out of the high pressure centre over Central Asia reach India in the form of a dry continental air mass. These continental winds come in contact with trade winds over northwestern India. The position of this contact zone is not, however, stable.
- Jet Stream and Upper Air Circulation : In the lower troposphere about 3 km above the surface of the earth, a different pattern of air circulation is observed. All of Western and Central Asia remains under the influence of westerly winds along the altitude of 9-13 km from West to East. These winds blow across the Asian continent at latitudes north of the Himalayas roughly parallel to the Tibetan highlands . These are known as jet streams.
- Western Cyclonic Disturbance and Tropical Cyclones : The western cyclonic disturbances originate over the Mediterranean Sea and are brought into India by the westerly jet stream. An increase in the prevailing night temperature generally indicates an advance in the arrival of these cyclones disturbances. Most of these cyclones are very destructive due to high wind velocity and torrential rain that accompanies.

➢ **Mechanism of Weather in the Summer Season :**

- Surface Pressure and Winds : By the middle of July, the low pressure belt nearer the surface [termed as Inter Tropical Convergence Zone (ITCZ) shifts northwards, roughly parallel to the Himalayas between 20° N and 25° N. By this time, the westerly jet stream withdraws from the Indian region. The maritime tropical airmass (mT) from the Southern Hemisphere, after crossing the Equator, rushes to the low pressure area in the general southwesterly direction. It is this moist air current which is popularly known as the southwest monsoon.
- Jet Streams and Upper Air Circulation : An easterly jet stream flows over the southern part of the Peninsula in June, and has a maximum speed of 90 km per hour . In August, it is confined to 15oN latitude, and in September up to 22o N latitudes. The easterlies normally do not extend to the north of 30o N latitude in the upper atmosphere.
- Easterly Jet Stream and Tropical Cyclones : The easterly jet stream steers the tropical depressions into India. These depressions play a significant role in the distribution of monsoon rainfall over the Indian subcontinent. The frequency at which these depressions visit India, their direction and intensity, all go a long way in determining the rainfall pattern during the southwest monsoon period.

Know the Terms

➢ **Weather :** Weather is the momentary state of the atmosphere.

➢ **Climate :** Climate refers to the average of the weather conditions over a longer period of time.

➢ **Monsoon :** It is traditionally defined as a seasonal reversing wind accompanied by corresponding changes in precipitation .

➢ **Break in the monsoon :** During the south-west monsoon period after having rains for a few days, if rain fails to occur for one or more weeks, it is known as break in the monsoon.

➢ **Jet Streams :** Winds blow across the Asian continent at latitudes north of the Himalayas roughly parallel to the Tibetan highlands are known as jet streams.

➢ **ITCZ :** The Inter Tropical Convergence Zone (ITCZ) is a low pressure zone located at the Equator where trade winds converge, and so, it is a zone where air tends to ascend.

➢ **Monsoon Trough :** In July, the ITCZ is located around 20° N-25°N latitudes over the Gangetic plain.

TOPIC-2

The Nature of the Indian Monsoon, The Rhythm of Seasons, Distribution of Rainfall, Climatic Regions of India, Monsoon and the Economic Life in India

Revision Notes

➢ Systematic studies of the causes of rainfall in the South Asian region help to understand the causes and salient features of the monsoon, particularly some of its important aspects, such as :

- **The onset of the monsoon :** The differential heating of land and sea during the summer months is the mechanism which sets the stage for the monsoon winds to drift towards the subcontinent. During April and May when the

sun shines vertically over the Tropic of Cancer, the large landmass in the north of Indian ocean gets intensely heated. This causes the formation of an intense low pressure in the northwestern part of the subcontinent.
The southwest monsoon sets in over the Kerala coast by 1st June and moves swiftly to reach Mumbai and Kolkata between 10th and 13th June. By mid July, southwest monsoon engulfs the entire subcontinent.

- **Rain bearing Systems and Rainfall Distribution :** There seem to be two rain-bearing systems in India. First originate in the Bay of Bengal causing rainfall over the plains of north India. Second is the Arabian Sea current of the southwest monsoon which brings rain to the west coast of India. The intensity of rainfall over the west coast of India is, however, related to two factors:
- The offshore meteorological conditions
- The position of the equatorial jet stream along the eastern coast of Africa
The rain which comes in spells, displays a declining trend from west to east over the west coast, and from the southeast towards the northwest over the North Indian Plain and the northern part of the Peninsula.
- **Break in the Monsoon :** During the south-west monsoon period after having rains for a few days, if rain fails to occur for one or more weeks, it is known as break in the monsoon. These dry spells are quite common during the rainy season. These breaks in the different regions are due to different reasons.
- In northern India rains are likely to fail if the rain-bearing storms are not very frequent along the monsoon trough or the ITCZ over this region.
- Over the west coast the dry spells are associated with days when winds blow parallel to the coast.

➢ The meteorologists recognise the following four seasons :

➢ **The Cold Weather Season :**

- **Temperature :** Usually, the cold weather season sets in by mid-November in northern India. December and January are the coldest months in the northern plain. The mean daily temperature remains below 21°C over most parts of northern India. There are three main reasons for the excessive cold in north India during this season :

➢ States like Punjab, Haryana and Rajasthan being far away from the moderating influence of sea experience continental climate.

➢ The snowfall in the nearby Himalayan ranges creates cold wave situation; and

➢ Around February, the cold winds coming from the Caspian Sea and Turkmenistan bring cold wave along with frost and fog over the north-western parts of India.

➢ There is hardly any seasonal change in the distribution pattern of the temperature in coastal areas because of moderating influence of the sea and the proximity to equator.

- **Pressure and Winds :** Due to low pressure gradient, the light winds with a low velocity of about 3-5 km per hour begin to blow outwards. By and large, the topography of the region influences the wind direction.

➢ During the winters, the weather in India is pleasant. The pleasant weather conditions, however, at intervals, get disturbed by shallow cyclonic depressions originating over the east Mediterranean Sea and travelling eastwards across West Asia, Iran, Afghanistan and Pakistan before they reach the north western parts of India.

- **Rainfall :** Winter monsoons do not cause rainfall as they move from land to the sea. It is because firstly, they have little humidity; and secondly, due to anti cyclonic circulation on land, the possibility of rainfall from them reduces. During October and November, northeast monsoon while crossing over the Bay of Bengal, picks up moisture and causes torrential rainfall over the Tamil Nadu coast, southern Andhra Pradesh, southeast Karnataka and southeast Kerala.

➢ **The Hot Weather Season :**

- **Temperature :** With the apparent northward movement of the sun towards the Tropic of Cancer in March, temperatures start rising in North India. April, May and June are the months of summer in north India. The hot weather season in South India is mild and not so intense as found in North India. Due to altitude, the temperatures in the hills of Western Ghats remain below 25°C. The mean daily minimum temperature during the summer months also remains quite high and rarely goes below 26°C.
- **Pressure and Winds :** The summer months are a period of excessive heat and falling air pressure in the northern half of the country. Because of the heating of the subcontinent, the ITCZ moves northwards occupying a position centred at 25°N in July. In the heart of the ITCZ in the northwest, the dry and hot winds known as 'Loo', blow in the afternoon, and very often, they continue to well into midnight. Dust storms in the evening are very common during May in Punjab, Haryana, Eastern Rajasthan and Uttar Pradesh.

➢ **The South West Monsoon Season** :

➢ The rain in the southwest monsoon season begins rather abruptly. One result of the first rain is that it brings down the temperature substantially.

➢ This sudden onset of the moisture-laden winds associated with violent thunder and lightening, is often termed as the "break" or "burst" of the monsoons. The monsoon may burst in the first week of June in the coastal areas of Kerala, Karnataka, Goa and Maharashtra while in the interior parts of the country, it may be delayed to the first week of July.

- **The monsoon approaches the landmass in two branches :**
- **The Arabian Sea branch :** The monsoon winds originating over the Arabian Sea further split into three branches:
- It's one branch is obstructed by the Western Ghats. These winds climb the slopes of the Western Ghats from 900-1200 m. Soon, they become cool, and as a result, the windward side of the Sahyadris and Western Coastal Plain receive very heavy rainfall ranging between 250 cm and 400 cm.
- Another branch of the Arabian sea monsoon strikes the coast north of Mumbai. Moving along the Narmada and Tapi river valleys, these winds cause rainfall in extensive areas of central India.
- A third branch of this monsoon wind strikes the Saurashtra Peninsula and the Kachchh. It then passes over west Rajasthan and along the Aravallis, causing only scanty rainfall.
- **The Bay of Bengal branch :** The Bay of Bengal branch strikes the coast of Myanmar and part of southeast Bangladesh. But the Arakan Hills along the coast of Myanmar deflect a big portion of this branch towards the Indian subcontinent. The other branch moves up the Brahmaputra Valley in the north and the northeast, causing widespread rains. Its sub-branch strikes the Garo and Khasi hills of Meghalaya. Mawsynram, located on the crest of Khasi hills, receives the highest average annual rainfall in the world.
- **Season of Retreating Monsoon :**
- The months of October and November are known for retreating monsoons.
- The monsoon retreats from the western Rajasthan by the first week of September. It withdraws from Rajasthan, Gujarat, Western Ganga plain and the Central Highlands by the end of the month. By the beginning of October, the low pressure covers northern parts of the Bay of Bengal and by early November, it moves over Karnataka and Tamil Nadu. By the middle of December, the centre of low pressure is completely removed from the Peninsula.
- The weather in the retreating monsoon is dry in north India but it is associated with rain in the eastern part of the Peninsula. Here, October and November are the rainiest months of the year.
- The widespread rain in this season is associated with the passage of cyclonic depressions which originate over the Andaman Sea and manage to cross the eastern coast of the southern Peninsula.
- A bulk of the rainfall of the Coromandal Coast is derived from these depressions and cyclones. Such cyclonic storms are less frequent in the Arabian Sea.
- The average annual rainfall in India is about 125 cm, but it has great spatial variations.
- The highest rainfall occurs along the west coast, on the Western Ghats, as well as in the sub-Himalayan areas is the northeast and the hills of Meghalaya. In some parts of Khasi and Jaintia hills, the rainfall exceeds 1,000 cm.
- Rainfall between 100-200 cm is received in the southern parts of Gujarat, east Tamil Nadu, north eastern Peninsula covering Odisha, Jharkhand, Bihar, eastern Madhya Pradesh, northern Ganga plain along the sub-Himalayas and the Cachar Valley and Manipur.
- Western Uttar Pradesh, Delhi, Haryana, Punjab, Jammu and Kashmir, eastern Rajasthan, Gujarat and Deccan Plateau receive rainfall between 50-100 cm.
- Parts of the Peninsula, especially in Andhra Pradesh, Karnataka and Maharashtra, Ladakh and most of western Rajasthan receive rainfall below 50 cm.
- A climatic region has a homogeneous climatic condition which is the result of a combination of factors.
- Temperature and rainfall are two important elements which are considered to be decisive in all the schemes of climatic classification.
- **Major climatic types of India based on Koeppen's scheme have been described below :**
- Tropical climates, where mean monthly temperature throughout the year is over 18°C.
- Dry climates, where precipitation is very low in comparison to temperature, and hence, dry.
- Warm temperate climates, where mean temperature of the coldest month is between 18°C and minus 3°C.
- Cool temperate climates, where mean temperature of the warmest month is over 10°C, and mean temperature of the coldest month is under minus 3°C.
- Ice climates, where mean temperature of the warmest month is under 10°C.
- Regional variations in monsoon climate help in growing various types of crop.
- Sudden monsoon burst creates problem of soil erosion over large areas in India.
- Besides the natural causes, human activities such as large scale industrialisation and presence of polluting gas in the atmosphere are also important factors responsible for global warming.
- The mean annual surface temperature of the earth in the past 150 years has increased. It is projected that by the year 2,100, global temperature will warm about 2°C.
- According to the current prediction, on an average, the sea level will rise 48 cm by the end of twenty first century.

Know the Terms

- **Mango Shower :** Towards the end of summer, there are pre-monsoon showers which are a common phenomena in Kerala and coastal areas of Karnataka. Locally, they are known as mango showers since they help in the early ripening of mangoes.

- **Nor Westers :** These are dreaded evening thunderstorms in Bengal and Assam. Their notorious nature can be understood from the local nomenclature of 'Kalbaisakhi', a calamity of the month of Baisakh. These showers are useful for tea, jute and rice cultivation. In Assam, these storms are known as "Bardoli Chheerha".
- **Loo :** Hot, dry and oppressing winds blowing in the Northern plains from Punjab to Bihar with higher intensity between Delhi and Patna.
- **Dust storms :** A strong turbulent wind which carriers clouds of fine dust, soil and sand over a large area.
- **Northeast Monsoon :** In winters, the ITCZ moves southward, and so the reversal of winds from the northeast to south and southwest, takes place. They are called northeast monsoons.
- **Tropical Depression :** Inflow of western cyclones is generally known as tropical depressions.
- **Bardoli Chheerha :** In Assam, North Western storms are known as 'Bardoli Chheerha'**.**
- **Bursting of the monsoon :** High velocity winds with extreme thundering and lightening cause sudden rainfall, which is called bursting of the monsoon.
- **Western cyclone :** It is the extratropical storm originating in the Mediterranean region that brings sudden winter rain to India.
- **Tropical cyclone :** It is a rapidly rotating storm system characterised by a low-pressure centre, a closed low-level atmospheric circulation , strong winds and a spiral arrangement of thunderstorms that produce heavy rains.
- **October heat :** Owing to the condition of high temperature and humidity, the weather becomes rather oppressive and this is known as October heat.
- **Blossom showers :** With this shower, coffee flowers blossom in Kerala and nearby areas.

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CHAPTER-5
NATURAL VEGETATION

TOPIC-1
Types of Forests, Forest Cover in India

Revision Notes

- Natural vegetation refers to a plant community that has been left undisturbed over a long time, so as to allow its individual species to adjust themselves to climate and soil conditions as fully as possible.
- India is a land of great variety of natural vegetation.
- Depending upon the variations in the climate and the soil, the vegetation of India changes from one region to another.
- Indian forests can be divided into the following groups :
  - Tropical Evergreen and Semi Evergreen Forests : These forests are found in the western slope of the Western Ghats, hills of the north eastern region and the Andaman and Nicobar Islands. They are found in warm and humid areas with an annual precipitation of over 200 cm and mean annual temperature above 22°C.
- Tropical evergreen forests are well stratified, with layers closer to the ground and are covered with shrubs and creepers, with short structured trees followed by tall variety of trees.
- The trees reach great heights up to 60 m or above.
- There is no definite time for trees to shed their leaves, flowering and fruition.
- As such these forests appear green all the year round. Species found in these forests include rosewood, mahogony, aini, ebony, etc
- The semi evergreen forests are found in the less rainy parts of these regions.
- The undergrowing climbers provide an evergreen character to these forests. Main species are white cedar, hollock and kail.
  - Tropical Deciduous Forests : These are the most widespread forests in India. They are also called the monsoon forests.
- They spread over regions which receive rainfall between 70-200 cm.

- **On the basis of the availability of water, these forests are further divided into :**
  - The Moist deciduous forests : They are more pronounced in the regions which record rainfall between 100-200 cm. Teak, sal, shisham, hurra, mahua, amla, semul, kusum, and sandalwood etc. are the main species of these forests.
- **Dry deciduous forest :** It covers vast areas of the country, where rainfall ranges between 70 -100 cm. Tendu, palas, amaltas, bel, khair, axlewood, etc. are the common trees of these forests.
  - Tropical thorn forests : It occur in the areas which receive rainfall less than 50 cm. These consist of a variety of grasses and shrubs. It includes semi-arid areas of south west Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh.
- Important species found are babool, ber, and wild date palm, khair, neem, khejri, palas, etc.
  - Montane Forests : In mountainous areas, the decrease in temperature with increasing altitude leads to a corresponding change in natural vegetation. Mountain forests can be classified into two types :
- **The northern mountain forests :** Deciduous forests are found in the foothills of the Himalayas. Deodar, a highly valued endemic species grows mainly in the western part of the Himalayan range. The southern slopes of the Himalayas carry a thicker vegetation cover because of relatively higher precipitation than the drier north-facing slopes.
- **The southern mountain forests :** These forests are found in the Western Ghats, the Vindhyas and the Nilgiris. Some of the other trees of this forest of economic significance include, magnolia, laurel, cinchona and wattle. Such forests are also found in the Satpura and the Maikal ranges.
  - Littoral and Swamp Forests : India has a rich variety of wetland habitats. About 70 per cent of this comprises areas under paddy cultivation. The total area of wet land is 3.9 million hectares. Crisscrossed by creeks of stagnant water and tidal flows, these forests give shelter to a wide variety of birds. In India, the mangrove forests spread over 6,740 sq. km which is 7 per cent of the world's mangrove forests. They are highly developed in the Andaman and Nicobar Islands and the Sunderbans of West Bengal.
- According to state records, the forest area covers 23.28 per cent of the total land area of the country. The forest area is the area notified and recorded as the forest land irrespective of the existence of trees, while the actual forest cover is the area occupied by forests with canopy.
- In 2011, the actual forest cover was only 21.05 per cent. Of the forest cover, the share of dense and open forests was 12.29 per cent and 8.75 per cent respectively.
- Both forest area and forest cover vary from state to state. Lakshadweep has zero per cent. Andaman and Nicobar Icelands have 83.93 percent.
- Most of the states with less than 10 per cent of the forest area lie in the north and north western part of the country. These are Rajasthan, Gujarat, Punjab, Haryana and Delhi.
- States with 10-20 per cent forest area are Tamil Nadu and West Bengal. In Peninsular India, excluding Tamil Nadu, Dadra and Nagar Haveli and Goa, the area under forest cover is 20-30 per cent.
- There is a lot of variation in actual forest cover, which ranges from 9.56 per cent in Jammu and Kashmir to 84.01 per cent in Andaman and Nicobar Islands.

Know the Terms

- **Natural vegetation :** It refers to a plant community that has been left undisturbed over a long time, so as to allow its individual species to adjust themselves to climate and soil conditions as fully as possible.
- **Planted vegetation :** It refers to planting of trees under human supervision.
- **Tropical evergreen forests :** They occur in areas receiving more than 200 cm of rainfall and having a temperature of 15 to 30 degree Celsius.
- **Tropical Deciduous forests :** In these types of forests biome is dominated by deciduous trees which lose their leaves seasonally.
- **Tropical thorn forests :** They are found in semi-arid area with seasonal rainfall averaging 250 to 500 millimetres.
- **Montane forest :** These forests are found in the mountains.
- **Littoral and swamp forest :** They are forests which are inundated with freshwater, either permanently or seasonally.
- **Forest Area :** The forest area is the area notified and recorded as the forest land irrespective of the existence of trees.
- **Forest cover :** The forest cover is the area occupied by forests with canopy.

TOPIC-2
Forest Conservation, Social Forestry, Farm Forestry, Wildlife Conservation in India, Biosphere Reserves.

Revision Notes

- Forests have an intricate interrelationship with life and environment. These provide numerous direct and indirect advantages to our economy and society.
- Hence, conservation of forest is of vital importance to the survival and prosperity of humankind.
- Accordingly, the Government of India proposed to have a nation-wide forest conservation policy, and adopted a forest policy in 1952, which was further modified in 1988.
- The forest policy aimed at :
  - Bringing 33 per cent of the geographical areas under forest cover;
  - Maintaining environmental stability and to restore forests where ecological balance was disturbed;
  - Conserving the natural heritage of the country, its biological diversity and genetic pool;
  - Checks soil erosion, extension of the desert lands and reduction of floods and droughts;
  - Increasing the forest cover through social forestry and afforestation on degraded land;
  - Increasing the productivity of forests to make timber, fuel, fodder and food available to rural population dependant on forests, and encourage the substitution of wood;
  - Creating of a massive peoples movement involving women to encourage planting of trees, stop felling of trees and thus, reduce pressure on the existing forest .
- Forest and tribals are very closely related. The age-old knowledge of tribals regarding forestry can be used in the development of forests. Rather than treating tribals as minor forest produce collectors they should be made growers of minor forest produce and encouraged to participate in conservation.
- Social forestry means the management and protection of forests and afforestation on barren lands with the purpose of helping in the environmental, social and rural development.
- The National Commission on Agriculture (1976) has classified social forestry into three categories :
  - Urban forestry : It pertains to the raising and management of trees on public and privately owned lands in and around urban centres such as green belts, parks, roadside avenues, industrial and commercial green belts, etc.
  - Rural forestry : It lays emphasis on promotion of agro-forestry and community-forestry.
  - Agro-forestry : It is the raising of trees and agriculture crops on the same land inclusive of the waste patches. It combines forestry with agriculture, thus, altering the simultaneous production of food, fodder, fuel, timber and fruit.
- Community forestry involves the raising of trees on public or community land such as the village pasture and temple land, roadside, canal bank, strips along railway lines, and schools etc. Community forestry programme aims at providing benefits to the community as a whole.
- Forest departments of various states distribute seedlings of trees free of cost to small and medium farmers. Several lands such as the margins of agricultural fields, grasslands and pastures, land around homes and cow sheds may be used for raising trees under non-commercial farm forestry.
- Wildlife of India is a great natural heritage. It is estimated that about 4-5 per cent of all known plant and animal species on the earth are found in India.
- Over the years, their habitat has been disturbed by human activities and as a result, their numbers have dwindled significantly. There are certain species that are at the brink of extinction.
- Some of the important reasons of the declining of wildlife are as follows :
  - Industrial and technological advancement brought about a rapid increase in the exploitation of forest resources.
  - More and more lands were cleared for agriculture, human settlement, roads, mining, reservoirs, etc.
  - Pressure on forests mounted due to lopping for fodder and fuelwood and removal of small timber by the local people.
  - Grazing by domestic cattle caused an adverse effect on wildlife and its habitat.
  - Hunting was taken up as a sport by the elite and hundreds of wild animals were killed in a single hunt. Now commercial poaching is rampant.
  - Incidence of forest fire.
- In 1972, comprehensive Wildlife Act was enacted, which provides the main legal framework for conservation and protection of wildlife in India.

- The two main objectives of the Act are; to provide protection to the endangered species listed in the schedule of the Act and to provide legal support to the conservation areas of the country classified as National parks, sanctuaries and closed areas.
- There are 103 National parks and 535 wildlife sanctuaries covering an area of 15.67 million hectares in the country.
- For the purpose of effective conservation of flora and fauna, special steps have been initiated by the Government of India in collaboration with UNESCO's 'Man and Biosphere Programme'.
- Special schemes like Project Tiger (1973) and Project Elephant (1992) have been launched to conserve these species and their habitat in a sustainable manner.
- Initially, the Project Tiger was launched in nine tiger reserves, covering an area of 16,339 sq. km, which has now increased to 44 tiger reserves, encompassing 36,988.28sq. km of tiger habitats distributed in 17 states. The tiger population in the country has registered an increase from 1,411 in 2006 to 1,706 in 2010.
- Project Elephant was launched in 1992 to assist states having free ranging population of wild elephants.
- Apart from this, some other projects such as Crocodile Breeding Project, Project Hangul and conservation of Himalayan Musk deer have also been launched by the Government of India.
- A **Biosphere Reserve** is a unique and representative ecosystem of terrestrial and coastal areas which are internationally recognised within the framework of UNESCO's Man and Biosphere (MAB) Programme.
- There are 18 Biosphere Reserves, in India. Ten Biosphere Reserves have been recognized by UNESCO on World Network of Biosphere Reserves.
  - Nilgiri Biosphere Reserve : The Nilgiri Biosphere Reserve (NBR), the first of the fourteen biosphere reserves of India, was established in September 1986. The Nilgiri Biosphere Reserve possesses different habitat types, unspoilt areas of natural vegetation types with several dry scrubs, dry and moist deciduous, semievergreen and wet evergreen forests, evergreen sholas, grasslands and swamps. The largest south Indian population of elephant, tiger, gaur, sambar and chital as well as a good number of endemic and endangered plants are also found in this reserve.
  - Nanda Devi Biosphere Reserve : The Nanda Devi Biosphere Reserve situated in Uttaranchal includes parts of Chamoli, Almora, Pithoragarh and Bageshwar districts. The biosphere reserve has a rich fauna, for example the snow leopard, black bear, brown bear, musk deer, snowcock, golden eagle and black eagle.
  - Sunderbans Biosphere Reserve : It is located in the swampy delta of the river Ganga in West Bengal. It extends over a vast area of 9,630 sq. km and consists of mangrove forests, swamps and forested islands. Sunderbans is the home of nearly 200 Royal Bengal tigers. Adapting itself to the saline and fresh water environment, the tigers at the park are good swimmers, and they hunt scarce preys such as chital deer, barking deer, wild pig and even macaques.
  - Gulf of Mannar Biosphere Reserve : The Gulf of Mannar Biosphere Reserve covers an area of 105,000 hectares on the southeast coast of India. The biosphere reserve comprises 21 islands with estuaries, beaches, forests of the nearshore environment, sea grasses, coral reefs, salt marshes and mangroves.

Know the Terms

- **Social forestry :** It means the management and protection of forests and afforestation on barren lands with the purpose of helping in the environmental, social and rural development.
- **Urban forestry :** It pertains to the raising and management of trees on public and privately owned lands in and around urban centres such as green belts, parks, roadside avenues, industrial and commercial green belts, etc.
- **Rural forestry :** It lays emphasis on promotion of agro-forestry and community-forestry.
- **Agro-forestry :** It is the raising of trees and agriculture crops on the same land inclusive of the waste patches.
- **Community forestry :** It involves the raising of trees on public or community land such as the village pasture and temple land, roadside, canal bank, strips along railway lines, and schools etc.
- **Community forestry programme :** It aims at providing benefits to the community as a whole.
- **Farm forestry :** It is a term applied to the process under which farmers grow trees for commercial and non-commercial purposes on their farm lands.
- **Biosphere reserve :** It is a unique and representative ecosystem of terrestrial and coastal areas which are internationally recognised within the framework of UNESCO's Man and Biosphere(MAB) Programme.
- **National Park :** It is an area which is strictly reserved for the protection of the wildlife and where activities such as forestry, grazing or cultivation are not allowed.
- **Reserved forest :** An area notified under the provisions of Indian Forest Acts having full degree of protection. In protected forests, all activities are permitted unless prohibited.
- **Sanctuary :** It is an area which is reserved for the conservation of animals only and operations such as harvesting of timber, collection of minor forest products are allowed as long as that do not affect the animals adversely.

CHAPTER-6
SOILS

TOPIC-1
Classification of Soils

Revision Notes

- Soil is the most important layer of the earth's crust. It is a valuable resource. The bulk of our food and much of our clothing is derived from land-based crops that grow in the soil.
- The soil on which we depend so much for our day-to-day needs has evolved over thousands of years.
- Soil is the mixture of rock debris and organic materials which develop on the earth's surface. The major factors affecting the formation of soil are relief, parent material, climate, vegetation and other life-forms and time.
- Components of the soil are mineral particles, humus, water and air.
- Some soils are deficient in one or more of these, while there are some others that have varied combinations.
- India has varied relief features, landforms, climatic realms and vegetation types. These have contributed in the development of various types of soils in India.
- **On the basis of genesis, colour, composition and location, the soils of India have been classified into :**
  - Alluvial Soils : Alluvial soils are widespread in the Northern Plains and the river valleys. Through a narrow corridor in Rajasthan, they extend into the plains of Gujarat. In the Peninsular region, they are found in deltas of the east coast and in the river valleys.
- The colour of the alluvial soils varies from the light grey to ash grey. Its shades depend on the depth of the deposition, the texture of the materials, and the time taken for attaining maturity. Alluvial soils are intensively cultivated.
  - Black Soil : Black soil covers most of the Deccan Plateau which includes parts of Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh and some parts of Tamil Nadu.
- These soils are also known as the 'Regur Soil' or the 'Black Cotton Soil'.
- The black soils are generally clayey, deep and impermeable. They swell and become sticky when wet and shrink when dried.
- Chemically, the black soils are rich in lime, iron, magnesia and alumina. They also contain potash. But they lack in phosphorous, nitrogen and organic matter.
- The colour of the soil ranges from deep black to grey.
  - Red and Yellow soil : It develops on crystalline igneous rocks in areas of low rainfall in the eastern and southern part of the Deccan Plateau.
- Yellow and red soils are also found in parts of Odisha and Chhattisgarh and in the southern parts of the middle Ganga plain.
- The fine-grained red and yellow soils are normally fertile, whereas coarse-grained soils found in dry upland areas are poor in fertility.
- They are generally poor in nitrogen, phosphorous and humus.
  - Laterite soil : The word 'Laterite' has been derived from the Latin word 'Later' which means brick. The laterite soils develop in areas with high temperature and high rainfall.
- These soils are poor in organic matter, nitrogen, phosphate and calcium, while iron oxide and potash are in excess.
- Red laterite soils in Tamil Nadu, Andhra Pradesh and Kerala are more suitable for tree crops like cashewnut.
- Laterite soils are widely cut as bricks for use in house construction.
- The laterite soils are commonly found in Karnataka, Kerala, Tamil Nadu, Madhya Pradesh and the hilly areas of Odisha and Assam.
  - Arid soils : It ranges from red to brown in colour. In some areas, the salt content is so high that common salt is obtained by evaporating the saline water.
- Lower horizons of the soil are occupied by 'kankar' layers because of the increasing calcium content downwards.

- Arid soils are characteristically developed in western Rajasthan, which exhibit characteristic arid topography. These soils are poor and contain little humus and organic matter.
  - Saline Soils : They are also known as Usara soils. Saline soils contain a larger proportion of sodium, potassium and magnesium, and thus, they are infertile, and do not support any vegetative growth.
- They have more salts, largely because of dry climate and poor drainage.
- Excessive irrigation with dry climatic conditions promotes capillary action, which results in the deposition of salt on the top layer of the soil.
- They are more widespread in western Gujarat, deltas of the eastern coat and in suderban areas of West Bengal.
  - Peaty Soils : They are found in the areas of heavy rainfall and high humidity, where there is a good growth of vegetation.
- Organic matter in these soils may go even up to 40-50 per cent.
- This soil is black in colour.
- At many places, they are alkaline also. It occurs widely in the northern part of Bihar, southern part of Uttarakhand and the coastal areas of West Bengal, Odisha and Tamil.
  - Forest soil : forest soils are formed in the forest areas where sufficient rainfall is available. The soils vary in structure and texture depending on the mountain environment where they are formed.
- They are loamy and silty on valley sides and coarse-grained in the upper slopes.
- The soils found in the lower valleys are fertile.

Know the Terms

- **Soil :** Soil is the mixture of rock debris and organic materials which develop on the earth's surface.
- **Horizons :** If we dig a pit on land and look at the soil, we find that it consists of three layers which are called horizons.
- **Horizon A' :** It is the topmost zone, where organic materials have got incorporated with the mineral matter, nutrients and water, which are necessary for the growth of plants.
- **Horizon B' :** It is a transition zone between the 'horizon A' and 'horizon C', and contains matter derived from below as well as from above. It has some organic matter in it, although the mineral matter is noticeably weathered.
- **Horizon C' :** It is composed of the loose parent material. This layer is the first stage in the soil formation process and eventually forms the above two layers.
- **Soil profile :** The arrangement of layers in the three horizons is known as the soil profile.
- **Parent rock :** Underneath the three horizons there is the rock which is known as the parent rock or the bedrock.
- **Khadar :** Khadar is the new alluvium and is deposited by floods annually, which enriches the soil by depositing fine silt.
- **Bhangar :** It represents a system of older alluvium, deposited away from the flood plains.
- **Alluvial soil :** They are depositional soils, transported and deposited by the rivers and streams.
- **Laterite soil :** This soil develops in areas with high temperature and high rainfall.
- **Black soil :** These soils are made out of volcanic eruption.

TOPIC-2
Soil Degradation, Soil Erosion, Soil Conservation

Revision Notes

- Like any other organism, they too develop and decay, get degraded, respond to proper treatment if administered in time.
- **Soil degradation** can be defined as the decline in soil fertility, when the nutritional status declines and depth of the soil goes down due to erosion and misuse.
- The degree of soil degradation varies from place to place according to the topography, wind velocity and amount of the rainfall.

- The destruction of the soil cover is described as soil erosion. The soil forming processes and the erosional processes of running water and wind go on simultaneously.
- Human activities too are responsible for soil erosion to a great extent.
- Forest and other natural vegetation is removed for human settlement, for cultivation, for grazing animals and for various other needs.
- Wind and water are powerful agents of soil erosion because of their ability to remove soil and transport it. Wind erosion is significant in arid and semi-arid regions. In regions with heavy rainfall and steep slopes, erosion by running water is more significant.
- Sheet erosion takes place on level lands after a heavy shower and the soil removal is not easily noticeable.
- Gully erosion is common on steep slopes. Gullies deepen with rainfall, cut the agricultural lands into small fragments and make them unfit for cultivation.
- A region with a large number of deep gullies or ravines is called a badland topography.
- Besides this, they are also found in Tamil Nadu and West Bengal. The country is losing about 8,000 hectares of land to ravines every year.
- Soil erosion is a serious problem for Indian agriculture and its negative effects are seen in other spheres also.
- Eroded materials are carried down to rivers and they lower down their carrying capacity, and cause frequent floods and damage to agricultural lands.
- Deforestation is one of the major causes of soil erosion. Plants keep soils bound in locks of roots, and thus, prevent erosion.
- Chemical fertilisers in the absence of organic manures are also harmful to the soil. Unless the soil gets enough humus, chemicals harden it and reduce its fertility in the long run.
- According to estimates, about half of the total land of India is under some degree of degradation.
- If soil erosion and exhaustion are caused by humans; by corollary, they can also be prevented by humans.
- Soil conservation is a methodology to maintain soil fertility, prevent soil erosion and exhaustion, and improve the degraded condition of the soil.
- The first step in any rational solution is to check open cultivable lands on slopes from farming.
- Lands with a slope gradient of 15 - 25 per cent should not be used for cultivation.
- Over-grazing and shifting cultivation in many parts of India have affected the natural cover of land and given rise to extensive erosion.
- Contour terracing, regulated forestry, controlled grazing, cover cropping, mixed farming and crop rotation are some of the remedial measures which are often adopted to reduce soil erosion.
- Efforts should be made to prevent gully erosion and control their formation. Finger gullies can be eliminated by terracing.
- Special attention should be made to control headward extension of gullies. This can be done by gully plugging, terracing or by planting cover vegetation.
- Lands not suitable for cultivation should be converted into pastures for grazing. Experiments have been made to stabilise sand dunes in western Rajasthan by the Central Arid Zone Research Institute (CAZRI).
- The Central Soil Conservation Board, set up by the Government of India, has prepared a number of plans for soil conservation in different parts of the country.
- Integrated land use planning, therefore, seems to be the best technique for proper soil conservation.
- The final responsibility for achieving the conservation of land will rest on the people who operate on it and receive the benefits.

Know the Terms

- **Bad land topography :** A region with a large number of deep gullies or ravines is called a bad land topography.
- **Gully erosion :** It is the erosion of the soil and rock by the concentration of runoff into gullies.
- **Sheet erosion :** It is the uniform removal of soil in thin layers by the forces of raindrops and overland flow.
- **Soil erosion :** The destruction of the soil cover is described as soil erosion.
- **Soil degradation :** It is the decline in soil fertility when the nutritional status declines and depth of the soil goes down due to erosion and misuse.
- **Soil conservation :** It is a methodology to maintain soil fertility , prevent soil erosion and exhaustion and improve the degraded condition of the soil.

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UNIT-X : NATURAL HAZARDS AND DISASTERS: CAUSES, CONSEQUENCES AND MANAGEMENT

CHAPTER-7
NATURAL HAZARDS AND DISASTERS

TOPIC-1
Classification of Natural Disasters

Revision Notes

- Change is the law of nature. It is a continuous process that goes on uninterruptedly involving phenomena, big and small, material and nonmaterial that make our physical and sociocultural environment.
- Change can be a gradual or slow process like the evolution of landforms and organisms and it can be as sudden and swift as volcanic eruptions, tsunamis, earthquakes and lightening, etc.
- Disasters in general and natural disasters in particular, are some such changes that are always disliked and feared by humankind.
- "Disaster is an undesirable occurrence resulting from forces that are largely outside human control, strikes quickly with little or no warning, which causes or threatens serious disruption of life and property including death and injury to a large number of people, and requires therefore, mobilisation of efforts in excess of that which are normally provided by statutory emergency services."
- For a long time, geographical literature viewed disasters as a consequence of natural forces; and human beings were treated as innocent and helpless victims in front of the mighty forces of nature.
- Disasters are also caused by some human activities. There are some activities carried by human beings that are directly responsible for disasters.
- Bhopal Gas tragedy, Chernobyl Nuclear Disaster, wars, release of CFCs (Chlorofluorocarbons) and increase of green house gases, environmental pollutions like noise, air, water and soil are some of the disasters which are caused directly by human actions.
- Landslides and floods due to deforestation, unscientific land use and construction activities in fragile areas are some of the disasters that are the results of indirect human actions.
- Natural Hazards are elements of circumstances in the Natural environment that have the potential to cause harm to people or property or both.
- These may be swift or permanent aspects of the respective environmental settings like currents in the oceans, steep slope and unstable structural features in the Himalayas or extreme climatic conditions in deserts or glaciated areas.
- As compared to natural hazards, natural disasters are relatively sudden and cause large scale, widespread death, loss of property and disturbance to social systems and life over which people have a little or no control.
- Every disaster is unique in terms of the local socio-environmental factors that control it, the social response it generates, and the way each social group negotiates with it.
- Natural disasters have caused widespread loss of life and property. Concerted efforts are on at various levels to take appropriate measures to deal with the situation. It is also being felt that the damages caused by natural disasters have global repercussions that are beyond the means and capabilities of individual nation-states to cope up with.
- Identification and classification of disasters is being considered as an effective and scientific step to deal promptly and efficiently with the disasters.
- India is one of those countries which has experienced most of the natural disasters.
- Every year it loses thousands of lives and property worth millions of rupees due to these natural calamities.

Know the Terms

- **Disaster :** Disasters in general and natural disasters in particular, are some such changes that are always disliked and feared by humankind.
- **Natural Hazards :** They are elements of circumstances in the natural environment that have the potential to cause harm to people or property or both.

TOPIC-2
Natural Disasters and Hazards in India, Disaster Management

Revision Notes

- Let us focus on the major natural disasters in India.
  - Earthquakes : Earthquakes are by far the most unpredictable and highly destructive of all the natural disasters. Earthquakes that are of tectonic origin have proved to be the most devastating and their area of influence is also quite large.
- These earthquakes result from a series of earth movements brought about by a sudden release of energy during the tectonic activities in the earth's crust.
- Some of the most vulnerable states are Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and the Darjeeling and subdivision of West Bengal and all the seven states of the northeast.
- Earth scientists have found it difficult to explain the occurrence of earthquakes in one of the oldest, most stable and mature landmass of Peninsular block for a long time.
- National Institute of Disaster Management, have made an intensive analysis of more than 1,200 earthquakes that have occurred in India in different years in the past, and based on these, they divided India into the following five earthquake zones :
  - Very high damage risk
  - High damage risk zone
  - Moderate damage risk zone
  - Low damage risk zone
  - Very low damage risk zone
- Out of these, the first two zones had experienced some of the most devastating earthquakes in India.
- **Socio-Environmental Consequences of Earthquakes :**
- It becomes a calamity when it strikes the areas of high density of population. It not only damages and destroys the settlements, infrastructure, transport and communication network, industries and other developmental activities but also robs the population of their material and socio-cultural gains that they have preserved over generations.
- It renders them homeless, which puts an extra-pressure and stress, particularly on the weak economy of the developing countries.
- **Effects of Earthquakes :**
- Surface seismic waves produce fissures on the upper layers of the earth's crust through which water and other volatile materials gush out, inundating the neighbouring areas.
- Earthquakes are also responsible for landslides and often these cause obstructions in the flow of rivers and channels resulting in the formation of reservoirs.
- Sometimes, rivers also change their course causing floods and other calamities in the affected areas.
- **Earthquake Hazard Mitigation :**
- The next best option is to emphasis on disaster preparedness and mitigation rather than curative measures such as :
  - Establishing earthquake monitoring centres (seismological centres) for regular monitoring and fast dissemination of information among the people in the vulnerable areas.
  - Use of Geographical Positioning System (GPS) can be of great help in monitoring the movement of tectonic plates.
  - Preparing a vulnerability map of the country and dissemination of vulnerability risk information among the people and educating them about the ways and means minimising the adverse impacts of disasters.
  - Modifying the house types and building designs in the vulnerable areas.
  - Finally, making it mandatory to adopt earthquake-resistant designs and use light materials in major construction activities in the vulnerable areas.
  - Tsunami : Earthquakes and volcanic eruptions that cause the sea-floor to move abruptly resulting in sudden displacement of ocean water in the form of high vertical waves are called tsunamis (harbour waves) or seismic sea waves.

- As a result of this, the impact of tsunami is less over the ocean and more near the coast where they cause large-scale devastations.
- Therefore, a ship at sea is not much affected by tsunami and it is difficult to detect a tsunami in the deeper parts of sea.
- Tsunamis are frequently observed along the Pacific ring of fire, particularly along the coast of Alaska, Japan, Philippines, and other islands of Southeast Asia, Indonesia, Malaysia, Myanmar, Sri Lanka, and India etc.
- After reaching the coast, the tsunami waves release enormous energy stored in them and water flows turbulently onto the land destroying port-cities and towns, structures, buildings and other settlements.
- Unlike other natural hazards, the mitigation of hazards created by tsunami is difficult, mainly because of the fact that losses are on a much larger scale.
  - Tropical cyclones : These are intense low-pressure areas confined to the area lying between 30° N and 30° S latitudes, in the atmosphere around which high velocity winds blow.
- Horizontally, it extends up to 500-1,000 km and vertically from surface to 12-14 km.
- A tropical cyclone or hurricane is like a heat engine that is energised by the release of latent heat on account of the condensation of moisture that the wind gathers after moving over the oceans and seas.
- Some initial conditions for the emergence of a tropical cyclone are :
  - Large and continuous supply of warm and moist air that can release enormous latent heat.
  - Strong Coriolis force that can prevent filling of low pressure at the centre (absence of Coriolis force near the equator prohibits the formation of tropical cyclone between 0°-5° latitude).
  - Unstable condition through the troposphere that creates local disturbances around which a cyclone develops.
  - Finally, absence of strong vertical wind wedge, which disturbs the vertical transport of latent heat.
- **Structure of Tropical Cyclone :**
- The centre of the cyclone is mostly a warm and low-pressure, cloudless core known as eye of the storm.
- Normally, it varies between 14-17mb/100 km, but sometimes it can be as high as 60mb/100km. Expansion of the wind belt is about 10-150 km from the centre.
- **Spatio-temporal Distribution of Tropical Cyclone in India :**
- Though most of the cyclones originate between 10°-15° north latitudes during the monsoon season, yet in case of the Bay of Bengal, cyclones mostly develop during the months of October and November. Here, They originate between 16^0 - 2^0 N Latitudes and to the west of 92^0 E.
- **Consequences of Tropical Cyclones :**
- With the increase in distance from the sea, the force of the cyclone decreases.
- In India, the force of the cyclone decreases with increase in distance from the Bay of Bengal and the Arabian Sea.
- So, the coastal areas are often struck by severe cyclonic storms with an average velocity of 180 km/h. Often, this results in abnormal rise in the sea level known as Storm Surge.
  - Floods : Floods are relatively slow in occurrences and often, occur in well-identified regions and within expected time in a year.
- Floods occur commonly when water in the form of surface run-off exceeds the carrying capacity of the river channels and streams and flows into the neighbouring low-lying flood plains.
- Floods can also be caused due to a storm surge (in the coastal areas), high intensity rainfall for a considerably longer time period, melting of ice and snow, reduction in the infiltration rate and presence of eroded material in the water due to higher rate of soil erosion.
- Floods in the South, Southeast and East Asian countries, particularly in China, India and Bangladesh, are frequent and equally disastrous.
- It has been noticed that states like Rajasthan, Gujarat, Haryana and Punjab are also getting inundated in recent decades due to flash floods.
- Sometimes, Tamil Nadu experiences flooding during November -January due to the retreating monsoon.
- **Consequence and Control of Floods :**
- Floods do not only destroy valuable crops every year but these also damage physical infrastructure such as roads, rails, bridges and human settlements.

- Millions of people are rendered homeless and are also washed down along with their cattle in the floods.
- Spread of diseases like cholera, gastro-enteritis, hepatitis and other water-borne diseases spread in the flood-affected areas.
- However, floods also make a few positive contributions. Every year, floods deposit fertile silt over agricultural fields which is good for the crops.
  - Droughts : The term 'drought' is applied to an extended period when there is a shortage of water availability due to inadequate precipitation, excessive rate of evaporation and over-utilisation of water from the reservoirs and other storages, including the ground water.
- Drought is a complex phenomenon as it involves elements of meteorology like precipitation, evaporation, evapotranspiration, ground water, soil moisture, storage and surface run-off, agricultural practices, particularly the types of crops grown, socio-economic practices and ecological conditions.
- **Types of Droughts :**
- **Meteorological Drought :** It is a situation when there is a prolonged period of inadequate rainfall marked with mal-distribution of the same over time and space.
- **Agricultural Drought :** It is also known as soil moisture drought, characterised by low soil moisture that is necessary to support the crops, thereby resulting in crop failures.
- **Hydrological Drought :** It results when the availability of water in different storages and reservoirs like aquifers, lakes, reservoirs, etc.
- **Ecological Drought :** When the productivity of a natural ecosystem fails due to shortage of water and as a consequence of ecological distress, damages are induced in the ecosystem.
- **Drought Prone Areas in India :**
- Droughts and floods are the two accompanying features of Indian climate.
- About 30 per cent of the country's total area is identified as drought prone affecting around 50 million people.
- Drought is mainly because of the large-scale variations and unpredictability in the behaviour of the monsoon in India.
- Thus, droughts are widespread and common phenomena in most parts of the country, but these are most recurrent and severe in some and not so in others.
- **Consequences of Drought :**
- Crop failure leading to scarcity of food grains (akal), fodder (trikal), inadequate rainfall, resulting in shortage of water (jalkal), and often shortage in all the three (trikal) is most devastating.
- Large-scale death of cattle and other animals, migration of humans and livestock are the most common sight to be seen in the drought-affected areas.
- Scarcity of water compels people to consume contaminated water resulting in spread of many waterborne diseases like gastro-enteritis, cholera, hepatitis, etc.
- Droughts have both immediate as well as long-term disastrous consequences on the social and physical environments.
  - Landslides : Disasters due to landslides, are in general, far less dramatic than due to earthquakes, volcanic eruptions, tsunamis and cyclones but their impact on the natural environment and national economy is in no way less severe.
- Landslides are largely controlled by highly localised factors.
- Frequency and certain causal relationships with the controlling factors like geology, geomorphic agents, slope, land-use, vegetation cover and human activities are the major reasons for the landslides to occur.
- **Landslide Vulnerability Zones :**
  - Very High Vulnerability Zone : Highly unstable, relatively young mountainous areas in the Himalayas and Andaman and Nicobar, high rainfall regions with steep slopes in the Western Ghats and Nilgiris, the north-eastern regions.
  - High Vulnerability Zone : All the Himalayan states and the states from the north-eastern regions except the plains of Assam are included in the high vulnerability zones.
  - Moderate to Low Vulnerability Zone : Areas that receive less precipitation such as Trans-Himalayan areas of Ladakh and Spiti (Himachal Pradesh), rain shadow areas in the Western and Eastern Ghats and Deccan plateau also experience occasional landslides.
  - Other Areas : The remaining parts of India, particularly states like Rajasthan, Haryana, Uttar Pradesh, Bihar, West Bengal (except district Darjiling), Assam (except district Karbi Anglong) and Coastal regions of the southern States are safe as far as landslides are concerned.

- **Consequences of Landslides :**
- Landslides have relatively small and localised area of direct influence, but roadblock, destruction of railway lines and channel blocking due to rock-falls have far-reaching consequences.
- Diversion of river courses due to landslides can also lead to flood and loss of life and property.
- **Mitigation :**
- Restriction on the construction and other developmental activities such as roads and dams, limiting agriculture to valleys and areas with moderate slopes, and control on the development of large settlements in the high vulnerability zones, should be enforced.
- Terrace farming should be encouraged in the north-eastern hill states where Jhumming (Slash and Burn/Shifting Cultivation) is still prevalent.
- Construction of cyclone shelters , embankments, dykes, reservoirs and afforestation to reduce the speed of the winds are some of the steps that can help in minimising the damages .
- **There are three stages involved in disaster mitigation and management :**
  - Pre-disaster management involves generating data and information about the disasters, preparing vulnerability zoning maps and spreading awareness among the people about these.
  - During disasters, rescue and relief operations such as evacuation, construction of shelters and relief camps, supplying of water, food, clothing and medical aids etc. should be done on an emergency basis.
  - Post-disaster operations should involve rehabilitation and recovery of victims.
- Introduction of the Disaster Management Bill, 2005 and establishment of National Institute of Disaster Management are some examples of the positive steps taken by the Government of India.

Know the Terms

- **Drought :** It can be defined as the extended period when there is a shortage of water availability due to inadequate precipitation, excessive rate of evaporation and over-utilisation of water from the reservoirs and other shortages, including ground water.
- **Landslide :** It is a form of mass movement on which rock and debris moves rapidly downslope under the influence of gravity as a result of failure along a sheer plane.
- **Tsunamis :** Earthquakes and volcanic eruptions that cause the sea-floor to move abruptly resulting in sudden displacement of ocean water in the form of high vertical waves are called tsunamis.
- **Flood :** When a river bursts its banks and water spills out onto the floodplain , it is called floods.
- **Meteorological drought :** It is a situation when there is a prolonged period of inadequate rainfall marked with mal-distribution of the same over time and space.
- **Agricultural drought :** When there is low soil moisture that is necessary to support the crops, thereby resulting in crop failures it is termed as agricultural drought.
- **A tropical cyclone :** It is like a heat engine that is energised by the release of latent heat on account of the condensation of moisture that the wind gathers after moving over the oceans and seas.
- **Hydrological drought :** It results when the availability of water in different storages and reservoirs like aquifers, lakes, reservoirs, etc.
- **Ecological drought :** When the productivity of a natural ecosystem fails due to shortage of water and as a consequence of ecological distress, it is termed as ecological drought.
- **Eye of the storm :** The centre of the cyclone is mostly a warm and low-pressure, cloudless core. It is known as eye of the storm.
- **Storm surge :** Abnormal rise in the sea level is known as storm surge.
- **Famine :** Extreme scarcity of food as a result of drought is called famine.
- **Earthquake :** Earthquakes result from a series of earth movements brought about by a sudden release of energy during the tectonic activities in the earth's crust.
- **Seismicity :** It refers to the frequency , type and size of earthquake experienced over a period of time. It is also called as seismism or seismic activity.

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PART-C
UNIT-I : FUNDAMENTALS OF MAPS

CHAPTER-1
INTRODUCTION TO MAPS

Revision Notes

- A map is a simplified depiction of whole or part of the earth on a piece of paper. In other words, it is a two-dimensional form of the three-dimensional earth.
- A map is, therefore, defined as selective, symbolised and generalised representation of whole or apart of the earth's surface on a plane surface at a reduced scale.
- Cartography, being an art and science of map-making, does include a series of processes that are common to all the maps.
- The certain essential features of map are:
  - Scale : The first decision that a map-maker has to take is about the scale of the map. The choice of scale is of utmost importance. The scale of a map sets limits of information contents and the degree of reality with which it can be delineated on the map.
  - Projection : The transformation of all-side-curved-geoidal surface into a plane surface is another important aspect of the cartographic process. We should know that such a radical transformation introduces some unavoidable changes in directions, distances, areas and shapes from the way they appear on a geoid. Hence, the choice, utilisation and construction of projections is of prime importance in map-making.
  - Generalisation : Every map is drawn with a definite objective. For example, a general purpose map is drawn to show information of a general nature such as relief, drainage, vegetation, settlements, means of transportation, etc. Similarly, a special purpose map exhibits information pertaining to one or more selected themes like population density, soil types or location of industries. It is, therefore, necessary to carefully plan the map contents while the purpose of the map must be kept in the forefront.
  - Map Design : The fourth important task of a cartographer is the map design. It involves the planning of graphic characteristics of maps including the selection of appropriate symbols, their size and form, style of lettering, specifying the width of lines, selection of colours and shades, arrangement of various elements of map design within a map and design for map legend.
  - Map Construction and Production : The drawing of maps and their reproduction is the fifth major task in the cartographic process. However, the map construction and reproduction has been revolutionalised with the addition of computer assisted mapping and photo-printing techniques in the recent past.
- The history of map making is as old as the history of mankind itself. The oldest map was found in Mesopotamia drawn on a clay tablet that belongs to 2,500 B.C.
- The measurement of the circumference of the Earth and the use of the system of geographical coordinates in map-making are some of the significant contributions of the Greeks and the Arabs.
- The foundation of map-making in India was laid during the Vedic period when the expressions of astronomical truths and cosmological revelations were made.
- Ancient Indian scholars divided the known world into seven 'dwipas'. Mahabharata conceived a round world surrounded by water surveying and map-making as an integral part of the revenue collection procedure. Besides, Sher Shah Suri's revenue maps further enriched the mapping techniques during the medieval period.
- The Survey of India was set up in 1767. Today, the Survey of India produces maps at different scales for the entire country.
- On the basis of scale, maps may be classified into large-scale and small-scale.
  - Large scale maps : Large scale maps are drawn to show small areas at a relatively large-scale. For example, the topographical maps drawn at a scale of 1: 250,000, 1:50,000 or 1:25,000 and the village maps, the zonal plans of the cities and house plans prepared on a scale of 1:4,000, 1:2,000 and 1:500 are large scale maps. Large-scale maps are further divided into the following types :

  (a) Cadastral Maps : These maps are drawn to show the ownership of landed property by demarcating field boundaries of agricultural land and the plan of individual houses in urban areas. The cadastral maps are prepared by the government agencies to realise revenue and taxes, along with keeping a record of ownership.

(b) Topographic Maps : The topographical maps are based on precise surveys and are prepared in the form of series of maps made by the national mapping agencies of almost all countries of the world .These maps follow uniform colours and symbols to show topographic details such as relief, drainage, agricultural land, forest, settlements, means of communication, location of schools, post offices and other services and facilities.

- Small scale maps : The small-scale maps are drawn to show large areas. For example, atlas maps, wall maps, etc. Small-scale maps are further divided into the following types:

(a) Wall Maps : These maps are generally drawn on large size paper or on plastic base for use in classrooms or lecture halls.

(b) Atlas Maps : Atlas maps are very small-scale maps. These maps represent fairly large areas and present highly generalised picture of the physical or cultural features. Even so, an atlas map serves as a graphic encyclopaedia of the geographical information about the world, continents, countries or regions.

- The maps may also be classified on the basis of their functions :
  - Physical Maps : Physical maps show natural features such as relief, geology, soils, drainage, elements of weather, climate and vegetation, etc.

(a) Relief Maps : Relief maps show general topography of an area like mountains and valleys, plains, plateaus and drainage.

(b) Geological Maps : These maps are drawn to show geological structures, rock types, etc.

(c) Climatic Maps : These maps depict climatic regions of an area. Besides, maps are also drawn to show the distribution of temperature,rainfall, cloudiness, relative humidity, direction and velocity of winds and other elements of weather.

(d) Soil Maps : Maps are also drawn to show the distribution of different types of soil(s) and their properties.

- Cultural Maps : Cultural maps show man-made features. These include a variety of maps showing population distribution and growth, sex and age, social and religious composition, literacy, levels of educational attainment, occupational structure, location of settlements, facilities and services, transportation lines and production, distribution and flow of different commodities.

(a) Political Maps : These maps show the administrative divisions of an area such as country, state or district.

(b) Population Maps : The population maps are drawn to show the distribution, density and growth of population, age and sex composition,distribution of religious, linguistic and social groups, occupational structure of the population, etc.

(c) Economic Maps : Economic maps depict production and distribution of different types of crops and minerals, location of industries and markets, routes for trade and flow of commodities.

(d) Transportation Maps : These maps show roads, railway lines and the location of railway stations and airports.

- The maps are very useful for various purposes :
  - Measurement of Distance : The linear features shown on the maps fall into two broad categories, i.e. straight lines and erratic or zigzag lines. The measurement of straight line features like roads, railway lines and canals is simple.However, distances are required, more often, along erratic paths, i.e. the coastlines, rivers and streams. The distances along all such features can be measured by placing a thread at the starting point and carrying it along the line up to the end point.
  - Measurement of direction : Direction is defined as an imaginary straight line on the map showing the angular position to a common base direction. A map always shows the north direction. All other directions are determined in to this relation. The north direction enables the map user to locate different features with respect to each other. The four commonly known directions are North, South, East and West. These are also called the cardinal points. In between the cardinal points, one may have several intermediate directions.
  - Measurement of Area : There are different methods in which areas can be determined. One of the simplest but not very accurate method to determine the area is by means of regular pattern of squares. In this method, the area to be measured is covered by squares by placing a sheet of graph paper beneath the map on an illuminated tracing table or by tracing the area onto the square sheet.

Know the Terms

- **Maps :** A map, is a simplified depiction of whole or part of the earth on a piece of paper.
- **Geoid :** An oblate spheroid whose shape resembles the actual shape of the Earth.
- **Cadastral map :** It is a large scale map drawn at a scale of 1:500 to 1:4000 to show property boundaries, designating each parcel of land with a number.
- **Cardinal Points :** North (N), South (S), East (E) and West (W).

- **Cartography :** Art, science and technology of making maps, charts, plans and other modes of graphical expression as well as their study and use.
- **Generalisation-Map :** A simplified representation of the features on the map, appropriate to its scale or purpose, without affecting their visual form.
- **Map series :** A group of maps produced at same scale, style and specifications for a country or a region**.**
- **Projection-Map :** The system of the transformation of the spherical surface onto a plane surface. Scale : The ratio between the distances of two points on the map, plan or photograph and the actual distance between the same two points on the ground.
- **Sketch Map :** A simplified map drawn freehand which fails to preserve the true scale or orientation.
- **Scale :** The ratio between the distances of two points on the map, plan or photograph and the actual distance between the same two points on the ground is called scale.
- **Zero direction :** The line pointing to the north is zero direction .
- **Ratometer :** It is an instrument which is used to measure distance on a map.
- **Large scale map :** Large scale maps are drawn to show small areas at a relatively large-scale.
- **Small scale map :** Small-scale maps are drawn to show large areas. For example, atlas maps, wall maps, etc.
- **Planimeter :** It is an instrument used to measure area on a map.

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CHAPTER-2
MAP SCALE

Revision Notes

- A map scale provides the relationship between the map and the whole or a part of the earth's surface shown on it. We can also express this relationship as a ratio of distances between two points on the map and the corresponding distance between the same two points on the ground.
- There are at least three ways in which this relationship can be expressed. These are: 1. Statement of Scale 2. Representative Fraction (R. F.) 3. Graphical Scale.
- There are two different systems of measurement of the distances used in different countries of the world. Whereas the former system is referred to as the Metric System of Measurement and presently used in India and many other countries of the world, the latter system is known as the English System of Measurement and is prevalent in both the United States and the United Kingdom. India also used this system for measuring/showing linear distances before 1957.
- The scale of the map may be expressed using one or a combination of more than one **methods of scale**. Let us see how these methods are used and what are their advantages and limitations.

- **Statement of Scale :** The scale of a map may be indicated in the form of a written statement. For example, if on a map a written statement appears stating 1 cm represents 10 km, it means that on that map a distance of 1 cm is representing 10 km of the corresponding ground distance. It may also be expressed in any other system of measurement, i.e. 1 inch represents 10 miles.

- It is the simplest of the three methods. However, it may be noted that the people who are familiar with one system may not understand the statement of scale given in another system of measurement. Another limitation of this method is that if the map is reduced or enlarged, the scale will become redundant and a new scale is to be worked out.

- **Graphical or Bar Scale :** The second type of scale shows map distances and the corresponding ground distances using a line bar with primary and secondary divisions marked on it. This is referred to as the graphical scale or bar scale. n yet another bar scale the readings may be shown in miles and furlongs. Hence, like the statement of scale method, this method also finds restricted use for only those who can understand it.
- **Representative Fraction (R. F.) :** The third type of scale is R. F. It shows the relationship between the map distance and the corresponding ground distance in units of length. The use of units to express the scale makes it the most versatile method.

Know the Terms

- **Map scale :** A map scale provides the relationship between the map and the whole or a part of the earth's surface shown on.
- **Scale :** The ratio between the distances of two points on the map, plan or photograph and the actual distance between the same two points on the ground is called scale.
- **Denominator :** The number below the line in a fraction. For example, in a fraction of 1 : 50,000, 50,000 is the denominator.
- **Numerator :** The number above the line in a fraction. For example, in a fraction of 1 : 50,000, 1 is the numerator.
- **Representative Fraction :** A method of scale of a map or plan expressed as a fraction showing the ratio between a unit distance on the map or plan, and the distance measured in the same units on the ground.
- **Statement of scale :** The scale of a map may be indicated in the form of a written statement. For example, if on a map a written statement appears stating 1 cm represents 10 km, it means that on that map a distance of 1 cm is representing 10 km of the corresponding ground distance.
- **Graphical or Bar Scale :** The type of scale showing map distances and the corresponding ground distances using a line bar with primary and secondary divisions marked on it is known as the graphical scale or bar scale.
- **Representative Fraction (R. F.) :** It shows the relationship between the map distance and the corresponding ground distance in units of length. The use of units to express the scale makes it the most versatile method.

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CHAPTER-3
LATITUDE, LONGITUDE AND TIME

Revision Notes

- The Earth is nearly a sphere. It is because of the fact that the equatorial radius and the polar radius of the earth is not the same.
- The shape of the earth presents some difficulties in positioning its surface features, as there is no point of reference from which to measure the relative positions of other points. Hence, a network of imaginary lines is drawn on a globe or a map to locate various places.
- The spinning of the earth on its axis from west to east provides two natural points of reference, i.e. North and South Poles. They form the basis for the geographical grid.
- A network of intersecting lines is drawn for the purpose of fixing the locations of different features. The grid consists of two sets of horizontal and vertical lines, which are called parallels of latitudes and the meridians of longitudes.
- Horizontal lines are drawn parallel to each other in East-West direction. The line drawn midway between the North Pole and the South Pole is called the Equator.
- It is the largest circle and divides the globe into two equal halves. It is also called a great circle. All the other parallels get smaller in size, in proportion to their distance from the Equator towards the poles and divide the earth into two unequal halves, also referred to as the small circles.
- These imaginary lines running East-West are commonly known as the parallels of latitude.
- The vertical lines running North-South, join the two poles. They are called the meridians of longitude.
- The latitudes and longitudes are commonly referred to as geographical coordinates as they provide systematic network of lines upon which the position of various surface features of the earth, can be represented.
- Although an infinite number of parallels and meridians may be drawn on a globe, only a selected number of them are usually drawn on a map.
- Latitudes and longitudes are measured in degrees (°) because they represent angular distances. Each degree is further divided into 60 minutes (') and each minute into 60 seconds (").

- The latitude of a place on the earth's surface is its distance north or south of the equator, measured along the meridian of that place as an angle from the centre of the earth.
- Lines joining places with the same latitudes are called parallels.
- If parallels of latitude are drawn at an interval of one degree, there will be 89 parallels in the Northern and the Southern Hemispheres each. The total number of parallels thus drawn, including the Equator, will be 179.
- Unlike the parallels of latitude which are circles, the meridians of longitude are semi-circles that converge at the poles.
- The meridians intersect the Equator at right angles. Unlike the parallels of latitude, they are all equal in length.
- For convenience of numbering, the meridian of longitude passing through the Greenwich observatory (near London) has been adopted as the Prime Meridian by an international agreement and has been given the value of 0°.
- The longitude of a place is its angular distance east or west of the Prime Meridian. It is also measured in degrees.
- The part of the earth east of the Prime Meridian is called the Eastern Hemisphere and in its west referred to as the Western Hemisphere.
- The Sun traverses 15^0 of longitudes per hour or one degree of longitude in every four minutes of time. It may further be noted that the time decreases when we move from west to east and increases with our westward movement.
- The rate of the time at which the sun traverses over certain degrees of longitudes is used to determine the local time of an area with respect to the time at the Prime Meridian (0°Longitude).
- In order to maintain uniformity of time as far as possible within the territorial limits of a country, the time at the central meridian of the country is taken as the Standard Meridian and its local time is taken as the standard time for the whole country.
- The Indian Standard Time is calculated from 82°30'E meridian passing through Mirzapur. Therefore, IST is plus 5.30 hours from the GMT ((82°30' × 4) (60 minutes = 5 hours 30 minutes).
- Similarly, all countries of the world choose the standard meridian within their territory to determine the time within their administrative boundaries.
- The countries with large east west span may choose more than one standard meridian to get more than one time zone such as Russia, Canada and the United States of America. The world is divided into 24 major time zones.
- While the world is divided into 24 time zones, the 180° line of longitude is approximately where the International Date Line passes. The time at this longitude is exactly 12 hours from the 0° longitude, irrespective of one travels westward or eastward from the Prime Meridian.

Know the Terms

- **Parallels of Latitude :** The parallels of latitude refer to the angular distance, in degrees, minutes and seconds of a point North or South of the Equator. Lines of latitude are often referred to as parallels.
- **Meridians of Longitude :** The meridians of longitude refer to the angular distance, in degrees, minutes, and seconds, of a point East or West of the Prime (Greenwich) Meridian. Lines of longitude are often referred to as meridians.
- **Equator :** Imaginary line drawn midway between the North Pole and the South Pole is called the Equator.
- **International Date Line :** The 180° line of longitude is taken as international date line.
- **Prime Meridian :** It is a meridian in a geographic coordinate system at which longitude is defined to be 0°.
- **Great circle :** Equator is also known as Great Circle.
- **Eastern Hemisphere :** It refers to the part of the Earth East of the Prime Meridian .
- **Western Hemisphere :** It refers to the part of the Earth West of the Prime Meridian.
- **Parallel :** It refers to the lines joining places with the same latitudes.
- **Geographical grid :** The spinning of the earth on its axis from west to east provides two natural points of reference, *i.e.,* North and South Poles. They form the basis for the geographical grid.

CHAPTER-4
MAP PROJECTIONS

TOPIC-1
Map Projection, Need for Map Projection, Elements of Map Projection

Quick Review

- Map projection is the method of transferring the graticule of latitude and longitude on a plane surface. It can also be defined as the transformation of spherical network of parallels and meridians on a plane surface.
- The globe is divided into various segments by the lines of latitude and longitude. The horizontal lines represent the parallels of latitude and the vertical lines represent the meridians of the longitude. The network of parallels and meridians is called graticule. This network facilitates drawing of maps. Drawing of the graticule on a flat surface is called projection.
- The need for a map projection mainly arises to have a detailed study of a region, which is not possible to do from a globe.
- In map projection we try to represent a good model of any part of the earth in its true shape and dimension.
- But distortion in some form or the other is inevitable. To avoid this distortion, various methods have been devised and many types of projections are drawn.
- Due to this reason, map projection is also defined as the study of different methods which have been tried for transferring the lines of graticule from the globe to a flat sheet of paper.
- The various elements of map projection are:
  - Reduced Earth : A model of the earth is represented by the help of a reduced scale on a flat sheet of paper. This model is called the "reduced earth".
  - Parallels of Latitude : These are the circles running round the globe parallel to the equator and maintaining uniform distance from the poles. Each parallel lies wholly in its plane which is at right angle to the axis of the earth. They are not of equal length.
  - Meridians of Longitude : These are semi-circles drawn in north-south direction from one pole to the other, and the two opposite meridians make a complete circle, i.e. circumference of the globe. Each meridian lies wholly in its plane, but all intersect at right angle along the axis of the globe.
  - Global Property : In preparing a map projection the following basic properties of the global surface are to be preserved by using one or the other methods:

(a) Distance between any given points of a region;
(b) Shape of the region;
(c) Size or area of the region in accuracy;
(d) Direction of any one point of the region bearing to another point.

Know the Terms

- **Map projection :** It is the system of transformation of the spherical surface onto a plane surface. It is carried out by an orderly and systematic representation of the parallels of latitude and the meridians of longitude of the spherical earth or part of it on a plane surface on a conveniently chosen scale.
- **The Great Circle :** It represents the shortest route between two points, which is often used both in air and ocean navigation.
- **Graticule :** The horizontal lines represent the parallels of latitude and the vertical lines represent the meridians of the longitude. The network of parallels and meridians is called graticule.

TOPIC-2
Classification of Map Projections, Construction of some Selected Projections.

Revision Notes

- Map projections may be classified on the following bases :
  - Drawing Techniques : On the basis of method of construction, projections are generally classified into perspective, non-perspective and conventional or mathematical.
  - **(a)** Perspective projections can be drawn taking the help of a source of light by projecting the image of a network of parallels and meridians of a globe on developable surface.
  - **(b)** Non–perspective projections are developed without the help of a source of light or casting shadow on surfaces, which can be flattened.
  - **(c)** Mathematical or conventional projections are those, which are derived by mathematical computation, and formulae and have little relations with the projected image.
  - Developable Surface : A developable surface is one, which can be flattened, and on which, a network of latitude and longitude can be projected. A non-developable surface is one, which cannot be flattened without shrinking, breaking or creasing.
  - Global Properties : As mentioned above, the correctness of area, shape, direction and distances are the four major global properties to be preserved in a map. But none of the projections can maintain all these properties simultaneously. Therefore, according to specific need, a projection can be drawn so that the desired quality may be retained. Thus, on the basis of global properties, projections are classified into equal area, orthomorphic, azimuthal and equi-distant projections.
  - **(a) Equal Area Projection :** It is also called homolographic projection. It is that projection in which areas of various parts of the earth are represented correctly.
  - **(b) Orthomorphic or True-Shape projection :** It is one in which shapes of various areas are portrayed correctly. The shape is generally maintained at the cost of the correctness of area.
  - **(c) Azimuthal or True-Bearing projection :** It is one on which the direction of all points from the centre is correctly represented.
  - **(d) Equi-distant or True Scale projection :** It is that where the distance or scale is correctly maintained. However, there is no such projection, which maintains the scale correctly throughout.
  - Source of Light : On the basis of location of source of light, projections may be classified as gnomonic, stereographic and orthographic.
  - **(a) Gnomonic projection :** It is obtained by putting the light at the centre of the globe.
  - **(b) Stereographic projection :** It is drawn when the source of light is placed at the periphery of the globe at a point diametrically opposite to the point at which the plane surface touches the globe.
  - **(c) Orthographic projection :** It is drawn when the source of light is placed at infinity from the globe, opposite to the point at which the plane surface touches the globe.
- A conical projection is one, which is drawn by projecting the image of the graticule of a globe on a developable cone, which touches the globe along a parallel of latitude called the standard parallel. As the cone touches the globe located along AB, the position of this parallel on the globe coinciding with that on the cone is taken as the standard parallel. The length of other parallels on either side of this parallel are distorted.
- **The properties of the conical projection are :**
  - All the parallels are arcs of concentric circle and are equally spaced.
  - All meridians are straight lines merging at the pole. The meridians intersect the parallels at right angles.
  - The scale along all meridians is true, i.e. distances along the meridians are accurate.
  - An arc of a circle represents the pole.
  - The scale is true along the standard parallel but exaggerated away from the standard parallel.
  - Meridians become closer to each other towards the pole.
  - This projection is neither equal area nor orthomorphic.
- **The limitations of conical projection are :**
  - It is not suitable for a world map due to extreme distortions in the hemisphere opposite the one in which the standard parallel is selected.
  - Even within the hemisphere, it is not suitable for representing larger areas as the distortion along the pole and near the equator is larger.

- **The uses of conical projection are :**
  - This projection is commonly used for showing areas of mid-latitudes with limited latitudinal and larger longitudinal extent.
  - A long narrow strip of land running parallel to the standard parallel and having east-west stretch is correctly shown on this projection.
  - Direction along standard parallel is used to show railways, roads, narrow river valleys and international boundaries.
  - This projection is suitable for showing the Canadian Pacific Railways, Trans-Siberian Railways, international boundaries between USA and Canada and the Narmada Valley.
- The cylindrical equal area projection, also known as the Lambert's projection, has been derived by projecting the surface of the globe with parallel rays on a cylinder touching it at the equator.
- Both the parallels and meridians are projected as straight lines intersecting one another at right angles. The pole is shown with a parallel equal to the equator; hence, the shape of the area gets highly distorted at the higher latitude.
- **The properties of cylindrical equal area projection are :**
  - All parallels and meridians are straight lines intersecting each other at right angle.
  - Polar parallel is also equal to the equator.
  - Scale is true only along the equator.
- **The limitations of cylindrical equal area projection are :**
  - Distortion increases as we move towards the pole.
  - The projection is non-orthomorphic.
  - Equality of area is maintained at the cost of distortion in shape.
- **The uses of the cylindrical equal area projection are :**
  - The projection is most suitable for the area lying between 45º N and S latitudes.
  - It is suitable to show the distribution of tropical crops like rice, tea, coffee, rubber and sugarcane.
- A Dutch cartographer Mercator Gerardus Karmer developed the Mercator projection in 1569. The projection is based on mathematical formulae. So, it is an orthomorphic projection in which the correct shape is maintained. The distance between parallels increases towards the pole.
- Like cylindrical projection, the parallels and meridians intersect each other at right angle. It has the characteristics of showing correct directions. A straight line joining any two points on this projection gives a constant bearing, which is called a Laxodrome or Rhumb line.
- **The properties of the Mercator projection are :**
  - All parallels and meridians are straight lines and they intersect each other at right angles.
  - All parallels have the same length which is equal to the length of equator.
  - All meridians have the same length and equal spacing. But they are longer than the corresponding meridian on the globe.
  - Spacing between parallels increases towards the pole.
  - Scale along the equator is correct as it is equal to the length of the equator on the globe; but other parallels are longer than the corresponding parallel on the globe; hence the scale is not correct along them. For example, the 30º parallel is 1.154 times longer than the corresponding parallel on the globe.
  - Shape of the area is maintained, but at the higher latitudes distortion takes place.
- **The limitations of this projection are :**
  - There is greater exaggeration of scale along the parallels and meridians in high latitudes. As a result, size of the countries near the pole is highly exaggerated. For example, the size of Greenland equals to the size of USA, whereas it is 1/10th of USA.
  - Poles in this projection cannot be shown as 90º parallel and meridian touching them are infinite.
- **The uses of this projection are :**
  - More suitable for a world map and widely used in preparing atlas maps.
  - Very useful for navigation purposes showing sea routes and air routes.
  - Drainage pattern, ocean currents, temperature, winds and their directions, distribution of worldwide rainfall and other weather elements are appropriately shown on this map.

Know the Terms

- **Lexodrome or Rhumb Line :** It is a straight line drawn on Mercator's Projection joining any two points having a constant bearing. It is very useful in determining the directions during navigation.
- **Homolograhic Projection :** A projection in which the network of latitudes and longitudes is developed in such a way that every graticule on the map is equal in area to the corresponding graticule on the globe. It is also known as the equal-area projection.

- **Orthomorphic Projection :** A projection in which the correct shape of a given area of the earth's surface is preserved.
- **Perspective projections :** They can be drawn taking the help of a source of light by projecting the image of a network of parallels and meridians of a globe on developable surface.
- **Non–perspective projections :** They are developed without the help of a source of light or casting shadow on surfaces, which can be flattened.
- **Mathematical or conventional projections :** They are those, which are derived by mathematical computation, and formulae and have little relations with the projected image.
- **Cylindrical projections :** They are made through the use of cylindrical developable surface. A paper-made cylinder covers the globe, and the parallels and meridians are projected on it.
- **Normal projections :** If the developmental surface touches the globe at the Equator, it is called the equatorial or normal projections.
- **A Conical projection :** It is drawn by wrapping a cone round the globe and the shadow of graticule network is projected on it. When the cone is cut open, a projection is obtained on a flat sheet.
- **Zenithal projection :** It is directly obtained on a plane surface when plane touches the globe at a point and the graticule is projected on it.

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UNIT-II : TOPOGRAPHIC AND WEATHER MAPS

CHAPTER-5
TOPOGRAPHICAL MAPS

TOPIC-1
Topographical Maps, Methods of Relief Representation, Contours, Basic Features of Contour Lines, Types of Slope.

Revision Notes

- The topographical maps are of utmost importance to geographers. They serve the purpose of base maps and are used to draw all the other maps.
- Topographical maps, also known as general purpose maps, are drawn at relatively large scales. These maps show important natural and cultural features such as relief, vegetation, water bodies, cultivated land, settlements, and transportation networks, etc. These maps are prepared and published by the National Mapping Organisation of each country.
- For example, the Survey of India prepares the topographical maps in India for the entire country.
- The topographical maps in India are prepared in two series, i.e. India and Adjacent Countries Series and The International Map Series of the World.
  - India and Adjacent Countries Series : The topographical maps of India are prepared on 1 : 10,00,000, 1 : 250,000, 1 : 1,25,000, 1 : 50,000 and 1: 25,000 scale providing a latitudinal and longitudinal coverage of 4° x 4°, 1° x 1°, 30' x 30', 15' x 15' and 5' x 7' 30", respectively.
  - International Map Series of the World : Topographical Maps under International Map Series of the World are designed to produce standardised maps for the entire World on a scale of 1: 10,00,000 and 1:250,000.
  - Reading of Topographical Maps : The study of topographical maps is simple. It requires the reader to get acquainted with the legend, conventional sign and the colours shown on the sheets.
  - Methods of Relief Representation :
- The elevation and depressions of the earth's surface are known as physical features or relief features of the earth. The map showing these features is called a relief map.
- A number of methods have been used to show the relief features of the Earth's surface on maps, over the years. These methods include hachure, hill shading, layer tints, benchmarks and spot heights and contours.
- Contours are imaginary lines joining places having the same elevation above mean sea level. A map showing the landform of an area by contours is called a contour map.
- The contour lines on a map provide a useful insight into the topography of an area.
- Contours are drawn at different vertical intervals (VI), like 20, 50, 100 metres above the mean sea level. It is known as contour interval.
- **Some of the basic features of contour lines are :**

- A contour line is drawn to show places of equal heights.
- Contour lines and their shapes represent the height and slope or gradient of the landform.
- Closely spaced contours represent steep slopes while widely spaced contours represent gentle slope.
- When two or more contour lines merge with each other, they represent features of vertical slopes such as cliffs or waterfalls.
- Two contours of different elevation usually do not cross each other.

➢ The slopes can broadly be classified into gentle, steep, concave, convex and irregular or undulating.
- Gentle Slope : When the degree or angle of slope of a feature is very low, the slope will be gentle. The contours representing this type of slope are far apart.
- Steep Slope : When the degree or angle of slope of a feature is high and the contours are closely spaced, they indicate steep slope.
- Concave Slope : A slope with a gentle gradient in the lower parts of a relief feature and steep in its upper parts is called the concave slope. Contours in this type of slope are widely spaced in the lower parts and are closely spaced in the upper parts.
- Convex Slope : Unlike concave slope, the convex slope is fairly gentle in the upper part and steep in the lower part. As a result, the contours are widely spaced in the upper parts and are closely spaced in the lower parts.

➢ **The various types of landforms are :**
- Conical Hill : It rises almost uniformly from the surrounding land. A conical hill with uniform slope and narrow top is represented by concentric contours spaced almost at regular intervals.
- Plateau : A widely stretched flat–topped high land, with relatively steeper slopes, rising above the adjoining plain or sea is called a plateau.

➢ A geomorphic feature lying between two hills or ridges and formed as a result of the lateral erosion by a river or a glacier is called a valley. The various types of valleys are:
- 'V'-shaped Valley : It resembles the letter V. A V-shaped valley occurs in mountainous areas .The lowermost part of the V–shaped valley is shown by the innermost contour line with very small gap between its two sides and the lowest value of the contour is assigned to it. The contour value increases with uniform intervals for all other contour lines outward.
- 'U' – shaped Valley : A U–shaped valley is formed by strong lateral erosion of glaciers at high altitudes. The flat wide bottom and steep sides makes it resemble the letter 'U'. The contour value increases with uniform intervals for all other contour lines outward.
- Gorges : In high altitudes, gorges form in the areas where the vertical erosion by river is more prominent than the lateral erosion. A gorge is represented by very closely-spaced contour lines on a map with the innermost contour showing small gap between its two sides.
- Spur : A tongue of land, projecting from higher ground into the lower is called a spur. It is also represented by Vshaped contours but in the reverse manner.
- Cliff : It is a very steep or almost perpendicular face of landform. On a map, a cliff may be identified by the way the contours run very close to one another, ultimately merging into one.
- Waterfalls and Rapids : A sudden and more or less perpendicular descent of water from a considerable height in the bed of a river is called a waterfall. Sometimes, a waterfall succeeds or precedes with a cascading stream forming rapids upstream or downstream of a waterfall. The contours representing a waterfall merge into one another while crossing a river stream and the rapids are shown by relatively distant contour lines on a map.

Know the Terms

➢ **Contours :** Imaginary lines joining all the points of equal elevation or altitude above mean sea level. They are also called "level lines".

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

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

➢ **Hachures :** Small straight lines drawn on the map along the direction of maximum slope, running across the contours. They give an idea about the differences in the slope of the ground.

➢ **Topographic Map :** A map of a small area drawn on a large scale depicting detailed surface features both natural and man made. Relief in this map is shown by contours.

➢ **Relief map :** The elevation and depressions of the earth's surface are known as physical features or relief features of the earth. The map showing these features is called a relief map.

➢ **Contour map :** A map showing the landform of an area by contours is called a contour map.

➢ **Concave slope :** A slope with a gentle gradient in the lower parts of a relief feature and steep in its upper parts is called concave slope.

- **Convex slope :** It is fairly gentle in the upper part and steep in the lower part. As a result, the contours are widely spaced in the upper parts and are closely spaced in the lower parts.
- **Conical hills :** It rises almost uniformly from the surrounding land. A conical hill with uniform slope and narrow top is represented by concentric contours spaced almost at regular.

TOPIC-2
Identification of Cultural Features from Topographical Sheets, Interpretation of Topographical Maps, Map Interpretation Procedure

Revision Notes

- Settlements, buildings, roads and railways are important cultural features shown on topographical sheets through conventional signs, symbols and colours.
  - Distribution of settlements:
- Four types of rural settlements may be identified on the map
  - Compact
  - Scattered
  - Linear
  - Circular
- Similarly, urban centres may also be distinguished as
  - Cross-road town
  - Nodal point
  - Market centre
  - Hill station
  - Coastal resort centre
  - Port
  - Manufacturing centre with suburban villages or satellite towns
  - Capital town
  - Religious centre
- Various factors determine the site of settlements like
  - Source of water
  - Provision of food
  - Nature of relief
  - Nature and character of occupation
  - Defence
- Density of settlement is directly related to food supply. Sometimes, village settlements form alignments, *i.e.*, they are spread along a river valley, road, embankment, coastline – these are called linear settlements.
  - Transport and Communication Pattern: Relief, population, size and resource development pattern of an area directly influence the means of transport and communication and their density. Means of transport and communication provide useful information about the area shown on the map.
- Knowledge of map language and sense of direction are essential in reading and interpreting topo-sheets.
- You must first look for the north line and the scale of the map and orient yourself accordingly.
- You must have a thorough knowledge of the legends / key given in the map depicting various features. All topo-sheets contain a table showing conventional signs and symbols used in the map.
- Conventional signs and symbols are internationally accepted; so, anyone can read any map anywhere in the world without knowing the language of that particular country.
- A topographic sheet is usually interpreted under the following heads :
  - Marginal Information : It includes the topographical sheet number, its location, grid references, its extent in degrees and minutes, scale, the districts covered, etc.

- Relief of the Area : The general topography of the area is studied to identify the plains, plateaus, hills or mountains along with peaks, ridges, spur and the general direction of the slope.
- Drainage of the Area : The important rivers and their tributaries and the type and extent of valleys formed by them, the types of drainage pattern, i.e. dendritic, radial, ring, trellis, internal, etc.
- Land use : It includes the use of land under different categories like natural vegetation and forest, agricultural, orchard, wasteland, industrial, etc. Facilities and services such as schools, colleges, hospitals, parks, airports, electric substations, etc.
- Transport and Communication : The means of transportation include national or state highways, district roads, cart tracks, camel tracks, footpaths, railways, waterways, major communication lines, post offices, etc.
- Settlement : Settlements are studied are rural settlement and urban settlement.
- Occupation : The general occupation of the people of the area may be identified with the help of land use and the type of settlement. For example, in rural areas the main occupation of majority of the people is agriculture; in tribal regions, lumbering and primitive agriculture dominates and in coastal areas, fishing is practised. Similarly, in cities and towns, services and business appear to be the major occupations of the people.

➢ Map interpretation involves the study of factors that explain the causal relationship among several features shown on the map.

➢ **The following steps will help in map interpretation :**

- Find out from the index number of the topographical sheet, the location of the area in India. Note the scale of the map and the contour interval, which will give the extent and general landform of the area.
- Trace out the following features on tracing sheets: major landforms, drainage and water features, land use, settlement and transport pattern.

➢ Describe the distributional pattern of each of the features separately drawing attention to the most important aspect.

➢ Superimpose pairs of these maps and note down the relationship, if any, between the two patterns. For example, if a contour map is superimposed over a land use map, it provides the relationship between the degree of slope and the type of the land used.

Know the Terms

➢ **Linear settlements :** Sometimes, village settlements form alignments, i.e. they are spread along a river valley, road, embankment, coastline – these are called linear settlements.

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CHAPTER-6
INTRODUCTION TO AERIAL PHOTOGRAPHS

TOPIC-1
Uses of Aerial Photographs, Advantages of Aerial Photographs, Types of Aerial Photographs

Quick Review

➢ The photographs taken from an aircraft or helicopter using a precision camera are termed aerial photographs.

➢ The photographs so obtained have been found to be indispensable tools in the topographical mapping and interpretation of the images of the objects.

➢ Aerial photographs are used in topographical mapping and interpretation. These two different uses have led to the development of photogrammetry and photo/image interpretation as two independent but related sciences.

- Photogrammetry : It refers to the science and technology of making reliable measurements from aerial photographs. The principles used in photogrammetry facilitate precise measurements related to the length, breadth and height from such photographs. Hence, they are used as the data source for creating and updating topographic maps.

- Image Interpretation : It is an art of identifying images of objects and judging their relative significance. The principles of image interpretation are applied to obtain qualitative information from the aerial photographs such as land use/land cover, topographical forms, soil types, etc.

➢ The basic advantages that aerial photographs offer over ground based observation are:
- Improved vantage point : Aerial photography provides a bird's eye view of large areas, enabling us to see features of the earth surface in their spatial context.
- Time freezing ability : An aerial photograph is a record of the surface features at an instance of exposure.
- Broadened Sensitivity : Our eyes perceive only in the visible region of the electromagnetic spectrum, i.e. 0.4 to 0.7 μm whereas the sensitivity of the film ranges from 0.3 to 0.9 μm.
- Three Dimensional Perspective : Aerial photographs are normally taken with uniform exposure interval that enables us in obtaining stereo pair of photographs.

➢ The types of the aerial photographs based on the position of optical axis and the scale are given below :
- Types of Aerial Photographs Based on the Position of the Camera Axis : On the basis of the position of the camera axis, aerial photographs are classified into the following types :

(a) Vertical Photographs : While taking aerial photographs, two distinct axes are formed from the camera lens centre, one towards the ground plane and the other towards the photo plane. When the photo plane is kept parallel to the ground plane, the two axes also coincide with each other. The photograph so obtained is known as vertical aerial photograph.

(b) Low Oblique : An aerial photograph taken with an intentional deviation of 15° to 30° in the camera axis from the vertical axis is referred to as the low oblique photograph.

(c) High Oblique : The high oblique are photographs obtained when the camera axis is intentionally inclined about 60° from the vertical axis.

- Types of Aerial Photographs Based on Scale : The aerial photographs may also be classified on the basis of the scale of photograph into three types :

(a) Large Scale Photographs : When the scale of an aerial photograph is 1 : 15,000 and larger, the photography is classified as large-scale photograph.

(b) Medium Scale Photographs : The aerial photographs with a scale ranging between 1 : 15,000 and 1 : 30,000 are usually treated as medium scale photographs.

(c) Small Scale Photographs : The photographs with the scale being smaller than 1 : 30,000, are referred to as small scale photographs.

Know the Terms

➢ **Aerial photographs :** The photographs taken from an aircraft or helicopter using a precision camera are termed aerial photographs.

➢ **Aerial perspective :** The bird's eye view which we get in aerial photographs, is termed as aerial perspective.

➢ **Aerial camera :** A precision camera specifically designed for use in aircrafts.

➢ **Aerial Film :** A roll film with high sensitivity, high intrinsic resolution power and dimensionally stable emulsion support.

➢ **Aerial photography :** Art, science and technology of taking aerial photographs from an air-borne platform.

➢ **Vertical aerial photography :** When the photo plane is kept parallel to the ground plane, the two axes also coincide with each other. The photograph so obtained is known as vertical aerial photograph.

➢ **Tilted photography :** Any photography with an unintentional deviation of more than 3o in the optical axis from the vertical axis is known as a tilted photograph.

TOPIC-2
Geometry of an Aerial Photography, Difference between a Map and an Aerial Photography

Revision Notes

➢ To understand the geometry of an aerial photograph, it is important to appreciate the orientation of the photograph with respect to the ground, *i.e.*, the way the rays connect or 'project' onto the ground in relation to the ground representation. The following three examples of such projection would be useful in understanding the problem :

- Parallel Projection : In this projection, the projecting rays are parallel but not necessarily perpendicular.
  - Orthogonal Projection : This is a special case of parallel projections. The advantage of this projection is that the distances, angles or areas on the plane are independent of the elevation differences of the objects.
  - Central Projection : This is a case in which a projection of one plane onto a second plane such that a point on the first plane and its image on the second plane lie on a straight line through a fixed point not on either plane. the central projection is characterised by the fact that all straight lines joining corresponding points, i.e., straight lines joining object points to their corresponding image points pass through one point.

➢ **The main differences between aerial photograph and map are as follows :**
  - An aerial photograph is geometrically incorrect. The distortion in the geometry is minimum at the centre and increase towards the edges of the photographs. Whereas, a map is a geometrically correct representation of the part of the Earth projected.
  - In aerial photography, the scale of photograph is not uniform. Whereas, in the map the scale of map is uniform throughout the map extent.
  - Aerial photograph is a central projection, whereas, map is an orthogonal projection.
  - Aerial photograph holds good for inaccessible and inhospitable areas. Whereas, the mapping of inaccessible and inhospitable area is very difficult and sometimes it becomes impossible.

➢ The concept of scale for aerial photographs is much the same as that of a map. Scale is the ratio of a distance on an aerial photograph the distance between the same two places on the ground in the real world.

➢ **There are three methods to compute the scale of an aerial photograph using different sets of information :**
  - By Establishing Relationship Between Photo Distance and Ground Distance: If additional information like ground distances of two identifiable points in an aerial photograph is available, it is fairly simple to work out the scale of a vertical photograph. Provided that the corresponding ground distances (Dg) are known for which the distances on an aerial photograph (Dp) are measured. In such cases, the scale of an aerial photograph will be measured as a ratio of the two, i.e., Dp/ Dg.
  - By Establishing Relationship Between Photo Distance and Map Distance: In other words, the distances between two points identifiable both on a map and the aerial photograph enable us to compute the scale of the aerial photograph (Sp).
  - By Establishing Relationship Between Focal Length (f) and Flying Height (H) of the Aircraft : If no additional information is available about the relative distances on photograph and ground/map, we can determine the photo-scale provided the information about the focal length of the camera (f) and the flying height of the aircraft (H) are known.

Know the Terms

➢ **Orthogonal projection :** This is a special case of parallel projections. Map are orthogonal projections of the ground.

➢ **Principal point :** It is the foot of the perpendicular drawn from the camera lens centre on the photo plane.

➢ **Principal distance :** It is the perpendicular distance from the perspective centre to the plane of the photograph.

➢ **Focal length :** The perpendicular distance between the camera lens and the negative plane is known as the focal length.

➢ **Flying height :** The perpendicular distance between the camera lens and the ground photographed is known as the flying height.

➢ **Perspective centre :** The point of origin(perspective point) of the bundle of light rays.

➢ **Nadir points :** The foot of the perpendicular drawn from the camera lens centre on the ground plane.

➢ **Orthophotos :** Aerial photographs need to be transformed from perspective view to the planimetric view before they can be used as map substitute. Such transformed photographs are known as orthophotos.

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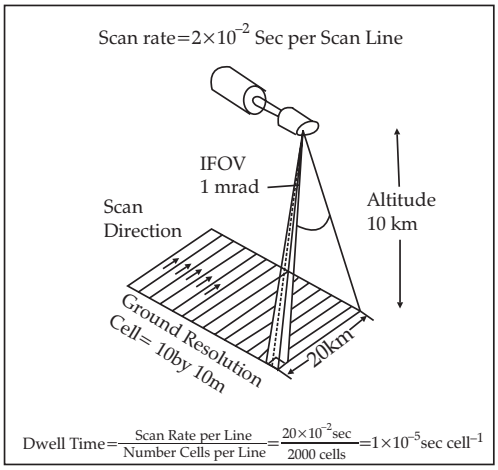
CHAPTER-7
INTRODUCTION TO REMOTE SENSING

TOPIC-1
Stages in Remote Sensing, Sensors, Resolving Powers of the Satellites, Sensor Resolutions

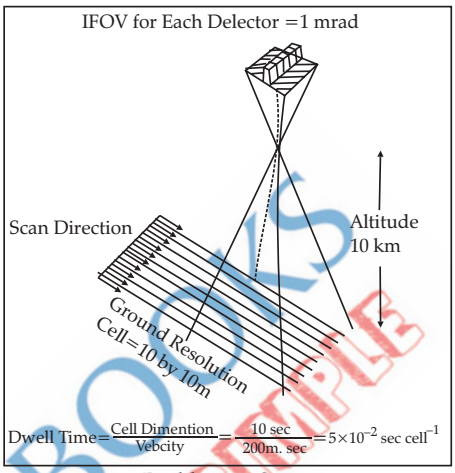
Revision Notes

- The term remote sensing was first used in the early 1960s. Later, it was defined as the total processes used to acquire and measure the information of some property of objects and phenomena by a recording device (sensor) that is not in physical contact with the objects and phenomena in study.
- The stages in remote sensing involve the following steps :
  - Source of Energy : Sun is the most important source of energy used in remote sensing.
  - Transmission of Energy from the Source to the Surface of the Earth : The energy that emanates from a source propagates between the source and the object surface in the form of the waves of energy at a speed of light (300,000 km per second). Such energy propagation is called the Electromagnetic Radiation (EMR).
  - Interaction of Energy with the Earth's Surface : The propagating energy finally interacts with the objects of the surface of the earth. This leads to absorption, transmission, reflection or emission of energy from the objects. The objects' responses to the energy they receive are also not uniform. Besides, one particular object also responds differently to the energy it receives in different regions of the spectrum.
  - Propagation of Reflected/Emitted Energy through Atmosphere : When energy is reflected from objects of the earth's surface, it re–enters into the atmosphere. The energy reflected from the objects comes in contact with the atmospheric constituents and the properties of the original energy get modified.
  - Detection of Reflected/Emitted Energy by the Sensor : The sensors recording the energy that they receive are placed in a near– polar sun synchronous orbit at an altitude of 700 – 900 km. These satellites are known as remote sensing satellites. Remote sensing satellites are deployed with sensors which are capable of collecting the EMR reflected by the objects. The sensors used in remote sensing satellites possess a mechanism that is different from photographic camera in collecting and recording the information.
  - Conversion of Energy Received into Photographic/ Digital Form of Data : The radiations received by the sensor are electronically converted into a digital image. It comprises digital numbers that are arranged in rows and columns. These numbers may also be converted into an analogue (picture) form of data product.
  - Extraction of Information Contents from Data Products : After the image data is received at the earth station, it is processed for elimination of errors caused during image data collection. Once the image is corrected, information extraction is carried out from digital images using digital image processing techniques and from analogue form of data products by applying visual interpretation methods.
  - Conversion of Information into Map/Tabular Forms : The interpreted information is finally delineated and converted into different layers of thematic maps. Besides, quantitative measures are also taken to generate a tabular data.
- A sensor is a device that gathers electromagnetic radiations, converts it into a signal and presents it in a form suitable for obtaining information about the objects under investigation.
- Based upon the form of the data output, the sensors are classified into photographic (analogue) and non–photographic (digital) sensors.
- A photographic sensor (camera) records the images of the objects at an instance of exposure. On the other hand, a non–photographic sensor obtains the images of the objects in bit-by-bit form.
- In satellite remote sensing, the Multi-Spectral Scanners (MSS) are used as sensors. These sensors are designed to obtain images of the objects while sweeping across the field of view.
- A scanning sensor constructs the scene by recording a series of scan lines. The oscillation of the scanning mirror across the scene directs the received energy to the detectors, where it is converted into electrical signals. These signals are further converted into numerical values called Digital Number (DN Values) for recording on a magnetic tape. The Multi-Spectral Scanners are divided into the following types :

- Whiskbroom Scanners : The whiskbroom scanners are made up of a rotating mirror and a single detector. The mirror is so oriented that when it completes a rotation, the detector sweeps across the field of view between 90° and 120° to obtain images in a large number of narrow spectral bands ranging from visible to middle infrared regions of the spectrum.
- Push broom Scanners : The push broom scanners consist of a number of detectors which are equivalent to the number obtained by dividing the swath of the sensor by the size of the spatial resolution. In push broom scanner, all detectors are linearly arrayed and each detector collects the energy reflected by the ground cell (pixel) dimensions of 20 metres at a nadir's view.



7.1 Whiskbroom Scanners



7.2 Pushbroom Scanners

- In satellite remote sensing, the sun-synchronous polar orbit enables the collection of images after a pre-determined periodical interval referred to as the temporal resolution or the revisit time of the satellite over the same area of the earth surface.
- Remote sensors are characterised by spatial, spectral and radiometric resolutions that enable the extraction of useful information pertaining to different terrain conditions:
  - Spatial Resolution : In remote sensing, the spatial resolution of the sensors refers to the same phenomena. It is the capability of the sensor to distinguish two closed spaced object surfaces as two different object surfaces. As a rule, with an increasing resolution the identification of even smaller object surfaces become possible.
  - Spectral Resolution : It refers to the sensing and recording power of the sensor in different bands of EMR (Electromagnetic radiation). Multi-spectral images are acquired by using a device that disperses the radiation received by the sensor and recording it by deploying detectors sensitive to specific spectral ranges.
  - Radiometric Resolution : It is the capability of the sensor to discriminate between two targets. Higher the radiometric resolution, smaller the radiance differences that can be detected between two targets.

Know the Terms

- **Sensor :** Any imaging or non–imaging device that receives EMR and converts it into a signal that can be recorded and displayed as photographic or digital image.
- **Remote sensing :** It can be defined as the total processes used to acquire and measure the information of some property of objects and phenomena by a recording device (sensor) that is not in physical contact with the objects and phenomena in study.
- **Electromagnetic Radiation (EMR) :** The energy propagated through a space or a medium at a speed of light.
- **Electromagnetic Spectrum :** The continuum of EMR that ranges from short wave high frequency cosmic radiations to long wavelength low frequency radio waves.
- **Sensor :** A sensor is a device that gathers electromagnetic radiations, converts it into a signal and presents it in a form suitable for obtaining information about the objects under investigation.
- **Digital image :** An array of digital numbers (DN) arranged in rows and columns, having the property of an intensity value and their locations.
- **Band :** The specific wavelength interval in the electromagnetic spectrum.
- **Swath :** The motor device which oscillates the scanning mirror through the angular field of view of the sensor, which determines the length of scan lines and is called swath.

TOPIC-2
Data Products, Interpretation of Satellite Imageries, Elements of Visual Interpretation.

Revision Notes

- We have seen that the electromagnetic energy may be detected either photographically or electronically.
- An image refers to pictorial representation, regardless of what regions of energy have been used to detect and record it. A photograph refers specifically to images that have been recorded on photographic film. Hence, it can be said that all photographs are images, but all images are not photographs.
- Based upon the mechanism used in detecting and recording, the remotely sensed data products may be broadly classified into two types :
  - Photographic Images : Photographs are acquired in the optical regions of electromagnetic spectrum, i.e., 0.3 – 0.9 μm. Four different types of light sensitive film emulsion bases are used to obtain photographs. These are black and white, colour, black and white infrared and colour infrared. Photographs may be enlarged to any extent without loosing information contents or the contrast.
  - Digital Images : A digital image consists of discrete picture elements called pixels. Each one of the pixels in an image has an intensity value and an address in two-dimensional image space. In a digital image, the reproduction of the details pertaining to the images of the objects is affected by the size of the pixel. A smaller size pixel is generally useful in the preservation of the scene details and digital representation.
- The data obtained from the sensors is used for information extraction related to the forms, and patterns of the objects and phenomena of the earth's surface.
- The visual interpretation is a manual exercise. It involves reading of the images of objects for the purpose of their identification.
- Whether we are conscious of it or not we use the form, size, location of the objects and their relationships with the surrounding objects to identify them in our day-to-day life. These characteristics of objects are termed as elements of visual interpretation.
- We can further group the characteristics of the objects into two broad categories, i.e. image characteristics and terrain characteristics. The image characteristics include:
  - Tone or Colour : We know that all objects receive energy in all regions of spectrum. The interaction of EMR with the object surface leads to the absorption, transmittance and reflection of energy. The variations in the tone or the colour depend upon the orientation of incoming radiations, surface properties and the composition of the objects. In other words, smooth and dry object surfaces reflect more energy in comparison to the rough and moist surfaces.
  - Texture : The texture refers to the minor variations in tones of grey or hues of colour. These variations are primarily caused by an aggregation of smaller unit features that fail to be discerned individually such as high density and low density residential areas; slums and squatter settlements; garbage and other forms of solid waste; and different types of crops and plants. The textural differences in the images of certain objects vary from smooth to coarse textures.
  - Size : The size of an object as discerned from the resolution or scale of an image is another important characteristic of individual objects.
  - Shape : The general form and configuration or an outline of an individual object provides important clues in the interpretation of remote sensing images. The shape of some of the objects is so distinctive that make them easy to identify.
  - Shadow : The shape of some of the objects is so typical that they could not be identified without finding out the length of the shadow they cast. For example, the Qutub Minar located in Delhi. It may , however, be noted that the shadow as an element of image interpretation is of less use in satellite images. However, it serves a useful purpose in large-scale aerial photography.
  - Pattern : The spatial arrangements of many natural and man–made features show repetitive appearance of forms and relationships.
  - Association : The association refers to the relationship between the objects and their surroundings along with their geographical location. For example, an educational institution always finds its association with its location in or near a residential area as well as the location of a playground within the same premises.

Know the Terms

- **Absorbance :** The ratio of the radiant energy absorbed by a substance to the energy it receives is called absorbance.
- **Digital number :** An intensity value of a pixel in a digital image.
- **Grey scale :** A medium to calibrate the variations in the brightness of an image that ranges from black to white with intermediate grey values is called grey scale.
- **Image :** It is the permanent record of a scene comprising of natural and man-made features and activities, produced by photographic and non-photographic means.
- **False Colour Composite (FCC) : An artificially generated colour image in which blue, green and red colours are assigned to the wavelength regions to which they do not belong in nature.**

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CHAPTER-8

WEATHER INSTRUMENTS, MAPS AND CHARTS

Revision Notes

- Weather denotes the atmospheric conditions of weather elements at a particular place and time. The weather elements include temperature, pressure, wind, humidity and cloudiness.
- In India, weather-related information is collected and published under the auspices of the Indian Meteorological Department, New Delhi, which is also responsible for weather forecasting.
- Weather forecasts help in taking safety measures in advance in case of the likelihood of bad weather. Predicting weather a few days in advance may prove very useful to farmers and to the crew of ships, pilots, fishermen, defence personnel, etc.
- Globally, meteorological observations are recorded at three levels:
  - Surface Observatories : A typical surface observatory has instruments for measuring and recording weather elements like temperature (maximum and minimum), air pressure, humidity, clouds, wind and rainfall. Specialised observatories also record elements like radiation, ozone atmospheric trace gases, pollution and atmospheric electricity.
- These observations are taken all over the globe at fixed times of the day as decided by the WMO and the use of instruments are made conforming to international standards, thus making observations globally compatible.
- In India, meteorological observations are normally classified into five categories depending upon their instruments and the number of daily observations taken.
- Typical instrumental facility available in a Class-I observatory consists of the following :
  (a) Maximum and minimum thermometers
  (b) Anemometer and wind vane
  (c) Dry and Wet bulb thermometer
  (d) Rain gauge
  (e) Barometer
  - Space Based Observations : Weather satellites make comprehensive and large-scale observations of different meteorological elements at the ground level as well in the upper layers of the atmosphere.
- The geo-stationary satellites provide space-based observations about weather conditions.
- The Indian National Satellite (INSAT) provides valuable observations of temperature, cloud cover, wind and associated weather phenomena.

- Various instruments are used for measuring different weather phenomena :
  - Thermometer : Thermometer is used to measure air temperature. Most thermometers are in the form of a narrow-closed glass tube with an expanded bulb at one end.
- The bulb of the thermometer in contact with the air gets heated or cooled, as the case may be, as a result of which the mercury in the bulb rises or falls.
- A scale is marked on the glass tube and readings are taken from there.
- The two most common scales used in thermometers are Centigrade and the Fahrenheit.
- The maximum thermometer is designed to record the highest temperature during a day. As the temperature increases, the mercury moves up into the tube; however, as the mercury cools, it cannot move downwards because of a constriction in the tube.
- The minimum thermometer records the lowest reading in a day. In this thermometer, alcohol is used in place of mercury. When the temperature decreases, the metal pin in the tube goes down and strikes at the minimum temperature.
- The dry bulb and wet bulb thermometers are used for measuring humidity in the air. The dry bulb and wet bulb thermometers are two identical thermometers fixed to a wooden frame. The bulb of the dry thermometer is kept uncovered and is exposed to the air while the bulb of the wet bulb thermometer is wrapped up with a piece of wet muslin, which is kept continuously moist by dipping a strand of it into a small vessel of distilled water.
- The difference of the readings of the dry bulb and the wet bulb thermometers determines the state of the atmosphere with regard to its humidity. The larger the difference, the more arid is the air.
  - Barometer : The instrument used to measure atmospheric pressure is called a barometer.
- The most commonly used barometers are the mercury barometer, aneroid barometer and barographs.
- The unit of measurement is in the millibar. Mercury barometer is an accurate instrument and is used as a standard.
- Aneroid barometer gets its name from the Greek work, aneros (a- 'not', neros – 'moisture', meaning without liquid). It is a compact and portable instrument. It consists of a corrugated metal box made up of a thin alloy, sealed completely and made airtight after partial exhaustion of air. It has a thin flexible lid, which is sensitive to changes of pressure.
- Barograph works on the principle of aneroid barometer. There are a number of vacuum boxes placed one above the other so that the displacement is large.
  - Wind Vane : Wind vane is a device used to measure the direction of the wind. The wind vane is a lightweight revolving plate with an arrowhead on one end and two metal plates attached to the other end at the same angle.
- This revolving plate is mounted on a rod in such a manner that it is free to rotate on a horizontal plane.
- The arrow always points towards the direction from which the wind blows.
  - Rain Gauge : The amount of rainfall is measured with the help of a rain gauge. The rain gauge consists of a metal cylinder on which a circular funnel is fitted. The diameter of the funnel's rim is normally 20 cm.
- The rain drops are collected and measured in a measuring glass. Normally, rainfall is measured in the units of millimetres or centimetres.
- A weather map is the representation of weather phenomena of the earth or a part of it on a flat surface. It depicts conditions associated with different weather elements such as temperature, rainfall, sunshine and cloudiness, direction and velocity of winds, etc. on a particular day.
- The central office keeps a record of the observations, which forms the basis for making a weather map.
- Since the inception of the Indian Meteorological Department, the weather maps and charts are prepared regularly. Meteorological observatories transmit the data to the Central Observatory at Pune twice a day.
- A good progress has been made in the field of weather forecasting and observation with the establishment of weather observatories in Antarctica, the International Indian Ocean Expedition, and the launching of rockets and weather satellites.
- Weather charts provide the primary tools for weather forecasting. They help in locating and identifying different air masses, pressure systems, fronts and areas of precipitation.
- The messages received from all the observatories are plotted on the map using weather symbols standardised by the World Meteorological Organisation and the National Weather Bureaus.
- Much of the climatic data is represented by line symbols. The most common of these are the isometric lines. These lines are depicted on the map as isopleths.
- The Isopleth can be interpolated for places having the same mean values of temperature, rainfall, pressure, sunshine, clouds, etc.

Know the Terms

- **Weather :** The condition of the atmosphere at a given place and time with respect to atmospheric pressure, temperature, humidity, precipitation, cloudiness and wind. These factors are known as weather elements.
- **Weather Forecast :** Prediction with a reasonable amount of certainty about the conditions of weather that would prevail in the coming 12 to 48 hours in a certain area.
- **Weather elements :** Pressure, temperature, humidity , precipitation, cloudiness and wind are known as weather elements.
- **Weather forecast :** It is the weather prediction with a reasonable amount of certainty about the conditions of weather that would prevail in the coming 12 to 48 hours in a certain area.
- **Weather satellites :** These satellites make comprehensive and large-scale observations of different meteorological elements at the ground level as well in the upper layers of the atmosphere.
- **The geo-stationary satellites :** These satellites provide space-based observations about weather conditions.
- **Thermometer :** It is an instrument used to measure air temperature**.**
- **Wind vane :** It is a device used to measure the direction of the wind.
- **Rain gauge :** The amount of rainfall is measured with the help of a rain gauge.
- **Weather map :** A weather map is the representation of weather phenomena of the earth or a part of it on a flat surface. It depicts conditions associated with different weather elements such as temperature, rainfall, sunshine and cloudiness, direction and velocity of winds, etc. on a particular day.
- **Isobars :** Lines connecting places of equal air pressure**.**
- **Isotherms :** Lines connecting places of equal temperature.
- **Isohyets :** Lines connecting places of equal amount of rainfall over a given period of time.
- **Isohels :** Lines connecting places of same mean daily duration of sunshine.
- **Isonephs :** Lines connecting places of same mean value of cloud cover.

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