

**Post-Graduate Degree Programme (CBCS)**  
**in**  
**GEOGRAPHY**

**Semester-I**

**Paper: GEO101T**

**Self-Learning Material**



**DIRECTORATE OF OPEN AND DISTANCE LEARNING**

**UNIVERSITY OF KALYANI**

**Kalyani, Nadia**  
**West Bengal, India**

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**COURSE MATERIAL COMPILED BY**

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Utmost care has been taken to develop the SLMs useful to the learners and to avoid errors as far as possible. Further suggestions from the learners' end would be gracefully admitted and to be appreciated.

During the academic productions of the SLMs, the team continuously received positive stimulations and feedback from Professor (Dr.) Sankar Kumar Ghosh, Hon'ble Vice- Chancellor, University of Kalyani, who kindly accorded directions, encouragements and suggestions, offered constructive criticism to develop it within proper requirements. We gracefully, acknowledge his inspiration and guidance.

Due sincere thanks are being expressed to all the Members of PGBOS (DODL), University of Kalyani, Course Writers- who are serving subject experts serving at University Post Graduate departments and also to the authors and academicians whose academic contributions have been utilized to develop these SLMs. We humbly acknowledge their valuable academic contributions. I would like to convey thanks to all other University dignitaries and personnel who have been involved either at a conceptual level or at the operational level of the DODL of University of Kalyani.

Their concerted efforts have culminated in the compilation of comprehensive, learner-friendly, flexible texts that meet the curriculum requirements of the Post Graduate Programme through Distance Mode.

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Director  
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# **SYLLABUS**

## **Paper–GEO101T**

**(Total Credit–4; Total Marks–100: Internal Evaluation–20,  
Semester-end Examination-80)**

### **GROUP–GEO101T.1: GEOTECTONICS**

**(Credit–1; Marks-25: Internal Evaluation–5, Semester-end Examination-20)**

- Unit-1: Internal structure of the earth;
- Unit-2: Palaeomagnetism and Sea floor spreading;
- Unit-3: Theories of mountain building; Geosynclines;
- Unit-4: Earthquake and Vulcanicity: mechanism and distribution

### **GROUP–GEO101T.2: GEOMORPHOLOGY**

**(Credit–2; Marks-50: Internal Evaluation–10, Semester-end Examination-40)**

- Unit-5: Fundamental concepts in Geomorphology;
- Unit-6: Evolution of topography in fluvial landscapes–Cyclic and Non-cyclic concepts
- Unit-7: Coastal landscapes–Cyclic and Non-cyclic concepts
- Unit-8: Arid landscapes–Cyclic and Non-cyclic concepts
- Unit-9: Karst landscapes–Cyclic and Non-cyclic concepts;
- Unit-10: Elements of slope and different approaches of slope development;
- Unit-11: Concept of Fluvial morphometry–linear, areal and relief aspects;
- Unit-12: Periglacial processes and landforms

### **GROUP–GEO101T.3: HYDROLOGY**

**(Credit–1; Marks-25: Internal Evaluation–5, Semester-end Examination-20)**

- Unit-13: Significance of Global Hydrological Cycle;
- Unit-14: Aquifers: types and issues related to over utilization; Importance of Piezometric level;
- Unit-15: Basin hydrology; Run off cycle; Unit hydrograph and its application;
- Unit-16: Fresh water crisis: issues and management; Rain water harvesting; Significance of water-shed management



# Content

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	<b>Page No.</b>
1.1 Introduction	9
1.2 Learning Objectives	9
1.3 Assessment of Prior Knowledge	9
1.4 Learning Activities	10
1.5 Feedback of Learning Activities	10
1.6 Examples and Illustrations	10
<b>Unit-1</b>	
1.6.1 Internal Structure of the Earth	10
Crust	12
Mantle	12
Core	13
<b>Unit-2</b>	
1.6.2 Palaeomagnetism	13
1.6.3 Sea-floor Spreading	14
<b>Unit-3</b>	
1.6.4 Theories of Mountain Building	16
1.6.5 Geosynclines	18
<b>Unit-4</b>	
1.6.6 Earthquake: Mechanism and Distribution	19
• Shaking and ground rupture	20
• Landslides and avalanches	20
• Fires	20
• Soil liquefaction	20
• Tsunami	20
• Floods	20
1.6.7 Vulcanicity: Mechanism and Distribution	21
1.7 Self-assessment test	23
1.8 Summaries and Key Points	23
1.9 Study Tips	23
2.1 Introduction	25
2.2 Learning Objectives	25
2.3 Assessment of prior knowledge	25
2.4 Learning activities	26
2.5 Feedback of Learning Activities	26
2.6 Examples and Illustrations	26
<b>Unit-5</b>	
2.6.1 Fundamental Concepts in Geomorphology	26
<b>Unit-6</b>	
2.6.2 Fluvial Processes and Landforms	27

<b>Unit-7</b>	
2.6.3	Processes and Landforms of Coast or Coastal Geomorphology 30
<b>Unit-8</b>	
2.6.4	Processes and Landforms of Arid Region or Aeolian Geomorphology 31
<b>Unit-9</b>	
2.6.5	Geomorphology of Karst Topography 33
2.6.6	Concept of Cyclic and Non-Cyclic Theories in Geomorphology 34
<b>Unit-10</b>	
2.6.7	Slope 36
<b>Unit-11</b>	
2.6.8	Concept of Fluvial Morphometry – linear, areal and relief aspects 38
<b>Unit-12</b>	
2.6.9	Periglacial Processes and landforms 39
2.7	Self-assessment test 40
2.8	Summaries and Key Points 40
2.9	Study trips 41
3.1	Introduction 42
3.2	Learning objectives 42
3.3	Assessment of prior knowledge 42
3.4	Learning Activities 43
3.5	Feedback of Learning Activities 43
<b>Unit-13</b>	
3.6.1	Significance of Global Hydrological Cycle 43
<b>Unit-14</b>	
3.6.2	Aquifer: Types and Utilization 45
3.6.3	Importance of Piezometric Level 47
<b>Unit-15</b>	
3.6.4	Basin Hydrology 47
3.6.5	Runoff: a key element of basin hydrology 48
3.6.6	Unit Hydrograph and Its Application 49
<b>Unit-16</b>	
3.6.7	Fresh Water Crisis: Issues and Management 50
3.6.8	Rain Water Harvesting 52
3.6.9	Significance of Watershed Management 53
3.7	Self-assessment test 55
3.8	Summaries and key points 55
3.9	Study trips 56

## **Group – GEO101T.1: GEOTECTONICS**

**(Credit – 1; Marks – 25; Internal Evaluation – 5 + Semester-end Examination - 20)**

### **1.1 Introduction**

Earth Science is a complete discipline to know the different aspects of the Earth as a Planet of Solar System. The aspects are all individually known as a science of specific field *viz.* geophysics, geochemistry, geology, climatology, hydrology, biology, pedology, geomorphology, and others. Name of all sub-fields of Earth Science denotes characteristic of the respective aspect of the planet. However, none of them could exist independently. Therefore, the Earth Scientists need a broad perspective to understand entire Earth and its operating systems. Among them, '*Geotectonic*' is a sub-field of *geology* deals with the form, arrangement, and structure of rock masses of the earth's crust resulting from folding or faulting. *Geotectonics* specially focus on the general and regional tectonics, structural geology, geodynamics, and experimental tectonics and considers the relation of tectonics to the deep structure of the earth, magmatism, metamorphism, and mineral resources.

### **1.2 Learning Objectives**

Present subject module is a basic introduction about the Earth's physical processes, specially endogenic processes and picture of underlying surface. The major aims of the module are:

- To enrich the student's knowledge about the interiors of the Earth, which is not visual.
- To understand the magnetism of the Earth, and its dynamics.
- Developing the concept of Earth's broken and moving crust, in the name of Plate Tectonic.
- Understanding about the processes of mountain building and their types.
- To understand the importance of a geosynclines for a Himalaya like folded mountain.
- To clarify the idea about earthquake and volcanoes, with their internal mechanism and world-wide distribution.

### **1.3 Assessment of Prior Knowledge**

- The basic knowledge about the Earth as a part of solar system is very essential to understand the physical processes within the planet.

- A proper knowledge about the history of the Earth since 4.6 billion years through the '*Geological Time Scale*' is very important to understand the processes of plate tectonic and mountain buildings.
- The prior knowledge of magnetic behaviour and why our Earth behave like a magnet are also important to study palaeomagnetism.

## 1.4 Learning Activities

- An audio-visual teaching method using smart-classes could be helpful for the teachers to explain and students to understand the internal processes of the Earth, specially the processes of plate motion and their mechanism.
- The detail study on this field could scientifically solve the mysterious questions regarding the Earth since the study of geography.

## 1.5 Feedback of Learning Activities

- Models on the major and minor plates of the Earth will be helpful to understand the 'Plate Tectonic'.
- Poster and charts of '*Geological Time Scale*' is very essential to study the geotectonic of the Earth.
- Model on the internal structure of the Earth is also important.

## 1.6 Examples and Illustrations

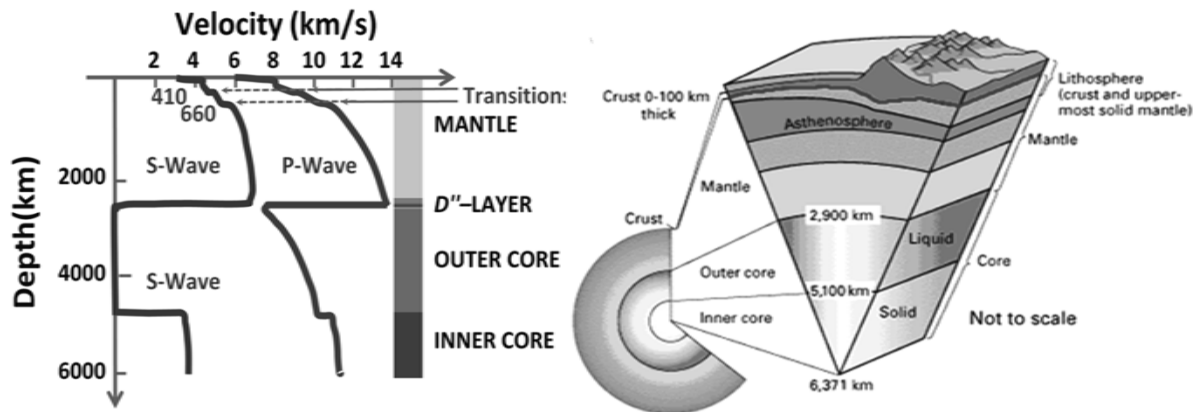
### 1.6.1 Internal Structure of the Earth

Geoscientists are still actively engaging to update the scientific information about the internal structure of the Earth. At present the most advanced drilling techniques make possible to know the detail information of Earth's interiors up to the 10 km only, whereas the radius of our planet is about 6371 km. There are three major sources to provide the evidences of the internal structure of the Earth, which are (i) *meteorites*, (ii) *seismic waves*, and (iii) *volcanoes*. *Meteorites* are fragmented extraterrestrial debris fall on the Earth with the influence of its gravity field. It seems that the meteorites that they were all formed at about the same time as the solar system developed and carrying the evidences of the Earth's formation history. *Seismic waves* are shock waves produced as an earthquake and they travel differently through

different types of material. The internal structures of the earth are mainly developed by studying seismic waves that travel through the earth and are measured at seismometer stations.

The site at which seismic waves are generated is termed the *focus* of the earthquake and the point on the Earth's surface directly above the focus is the *epicenter*. Seismic waves are mainly three types known as *Primary (P) waves* and *Secondary (S) waves*, and *Surface (L) waves*. Primary waves travel through both solids and liquids at a speed which is proportional to the density of the material. By determining the speed of the wave it is then possible to learn something of the density and state of the materials through which the wave has travelled. Secondary waves can only travel through solids, so if they meet a liquid layer within the Earth they are stopped. The variation in the velocity graphs of P and S waves are mainly used to study the interiors of the Earth. Based on that, the interior of the Earth has been divided into several sections. *Volcanoes* are also useful indicators of the internal structure of the crust mainly because they are sites at which rock from the lower part of the lithosphere is brought to the surface.

Basically, the Earth is built with three major concentric layers with varying density, thickness, and temperature. The names of these three layers are ***Crust, Mantle, and Core***, respectively from the outer part to the centre of the Earth. The density and temperature rise with increasing depth. Each layer is also classified into two parts based on the differentiation in their compositions. The imaginary line of differentiation between two layers is called '***line of discontinuity***'. The surface layer of the Earth is *crust* with an average thickness of 35 km for continents and 5 – 10 km for oceanic crust. The layer below of the crust is known as mantle and the distinction line between these two layers is called ***Mohorovicic discontinuity*** or ***Moho***, after the Serbian seismologist who discovered it in 1909.



**Fig. 1: Variation in the velocity of P and S waves towards the core of the Earth and schematic reorientations of the internal layers of the Earth (Source: Wikipedia.org, 2018)**

### Crust

- It is the outermost solid part of the earth, normally about 8-40 kms thick.
- It is brittle in nature.
- Nearly 1% of the earth's volume and 0.5% of earth's mass are made of the crust.
- The thicknesses of the crust under the oceanic and continental areas are different. Oceanic crust is thinner (about 5kms) as compared to the continental crust (about 30 kms).
- Major constituent elements of crust are Silica (Si) and Aluminium (Al) and thus, it is often termed as **SIAL**.
- The major constituent elements of the mantle are Silicon (Si) and Magnesium (Ma) and hence it is also termed as **SIMA**.
- The mean density of the materials in the crust is 3 g/cm<sup>3</sup>.
- The discontinuity between the **SIAL** and **SIMA** is termed as the **Conrad Discontinuity**.

### Mantle

- The portion of the interior beyond the crust is called as the mantle.
- The discontinuity between the **crust and mantle** is called as the **Mohorovicic Discontinuity or Moho discontinuity**.
- The mantle is about 2900 km in thickness.
- Nearly 84% of the earth's volume and 67% of the earth's mass is occupied by the mantle.
- The density of the layer is higher than the crust and varies from 3.3 – 5.4 g/cm<sup>3</sup>.

- The uppermost solid part of the mantle and the entire crust constitute the **Lithosphere**.
- The **asthenosphere** (in between 80-200 km) is a highly viscous, mechanically weak and ductile, deforming region of the upper mantle which lies just below the lithosphere.
- The asthenosphere is the main source of magma and it is the layer over which the lithospheric plates/ continental plates move (plate tectonics).
- The discontinuity between the **upper mantle and the lower mantle** is known as **Repetti Discontinuity**.

### **Core**

- It is the innermost layer surrounding the earth's centre.
- The **core is separated from the mantle by Guttenberg's Discontinuity**.
- It is composed mainly of iron (Fe) and nickel (Ni) and hence it is also called as **NIFE**.
- The core constitutes nearly 15% of earth's volume and 32.5% of earth's mass.
- The core is the densest layer of the earth with its density ranges between 9.5-14.5 g/cm<sup>3</sup>.
- The Core consists of two sub-layers: the inner core and the outer core.
- The inner core is in solid state and the outer core is in the liquid state (or semi-liquid).
- The discontinuity between the upper core and the lower core is called as **Lehmann Discontinuity**.

### **1.6.2 Palaeomagnetism**

Palaeomagnetism is a record of the Earth's *past magnetic field*. When lava is erupted at the surface, magnetic minerals, such as iron, in the lava align parallel with the Earth's magnetic field. The magnetic minerals have a declination that points towards the magnetic north pole and an inclination related directly to latitude (at the equator inclination is 0 and at the North Pole inclination is 90°). By looking at magnetized rocks we can work out. This is used to tell where the continents were in the past and how they have moved. This is used to construct apparent polar wander paths for continents.

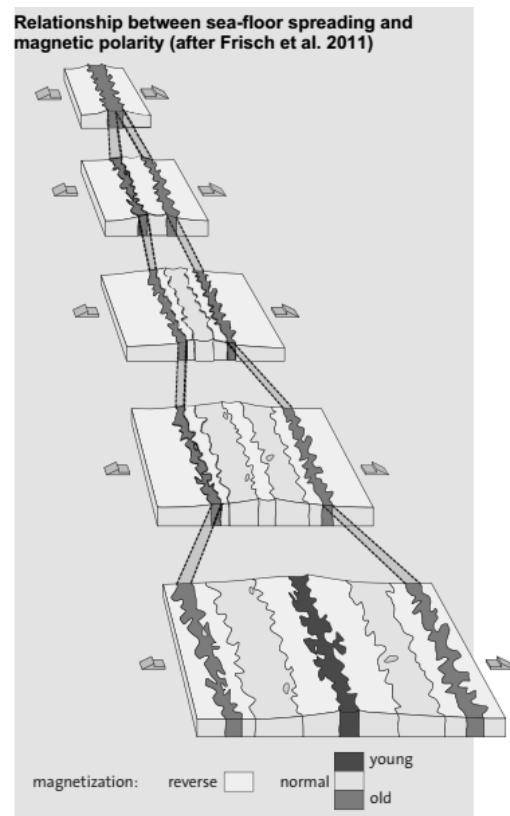
The basic aim to study the palaeomagnetism is providing scientific evidences to the Alfred Wegener's Continental drift theory, published at 1912. The geophysical survey for the world-wide palaeomagnetism was started during mid-1950s, by S.K. Runcorn and his team in Britain. The team has observed significant anomalies in the samples. It was found that the

palaeomagnetism of younger rock are closely associated with the present Earth's magnetic field, however older rocks are deviated from it. Therefore, it was assumed that the magnetic field of the Earth is not static and having a tendency of shifting, which can be correlated with the age of the sample rock and their location. Hence, the results of the palaeomagnetic survey have been helped to discover the concept of *polar wandering*. Runcorn and his team have demonstrated an apparent movement of the magnetic pole over the past 500 Ma (million years). The detail result shows the average duration of 'normal' fields (like the present one) had been about 420 ka (thousand year) and the 'reversed' field had been little longer about 480 ka. The period of a particular polarity are termed *epochs* and within an epoch the shorter phase of opposite magnetization called *events*.

### 1.6.3 Sea-floor Spreading

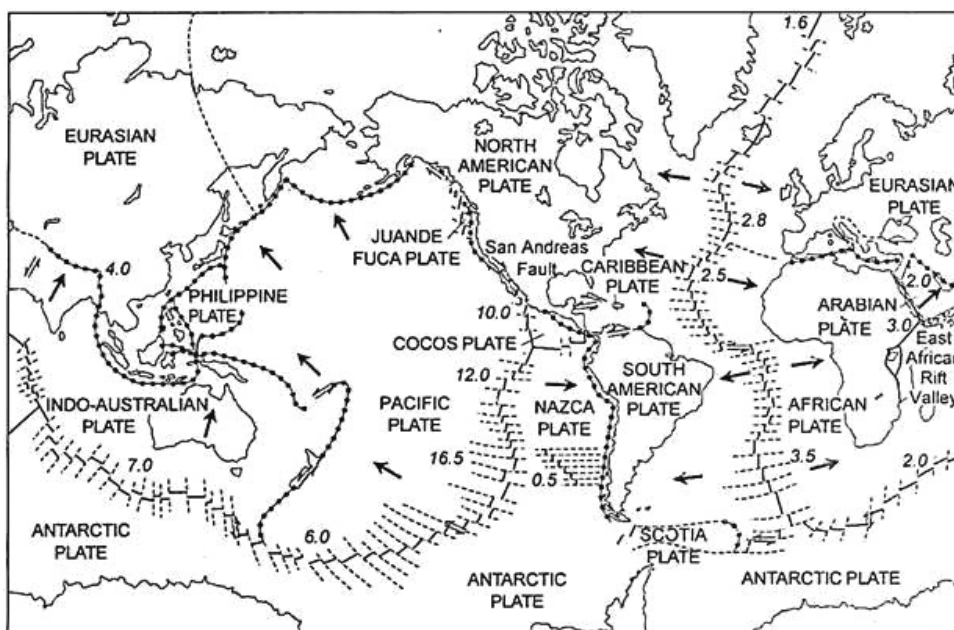
Sea-floor spreading is a significant geotectonic process to generate new crust along the mid-oceanic ridges (MOR) through volcanic activity then moves away from the ridge. The great Runcorn's geophysical survey of the Earth's palaeomagnetism, specially the detail magnetic characteristic of the crust of oceanic floor indicates the presence of anomalies in a linear pattern. Therefore, alternative bands of normal and reverse magnetized rock have been observed either side of the MOR.

In 1962 **H.H. Hess**, of Princeton University in the USA, initially proposed that mid-oceanic ridges represent the regions where new crust is being generated by the upwelling of hot magma and this new crust spreads laterally away from the ridges until it reaches at a subduction zone. The term '*sea-floor spreading*' was given by **Dietz**, an American geologist. It was **Vine and Matthews (1963)**, two Cambridge geophysicists, have linked the idea of sea-floor spreading and palaeomagnetic data observed at the MOR and established the fact of geotectonic process operated at the MOR in the name of sea-floor spreading. It was a radical explanation to understand the continental drift theory and helps to develop the theory of **Plate Tectonic**.



In the late 1960s, Plate Tectonic is a result of incorporation of different ideas like continental drift, palaeomagnetism, sea-floor spreading, mid-oceanic ridges, subduction zone, conveyor belt etc. of number of workers around the world. The theory of plate tectonic proposes that the Earth's surface is not a continuous object. It comprises seven major and number of minor parts of lithospheric plates, which are composed of crust and upper most rigid mass of the mantle. The plates are in continuous motion in respect to each other in different direction at different rate. The rate of movement ranges up to 100 mm/year with an average of 70 mm/year. The study of plate tectonic deals with the mechanism and movement different plates, in addition with the geomorphological and geotectonic features and processes in and around of the plates.

There are three major types of plate boundary. **Divergent or Constructive or Accreting** plate boundary, where two plates are moving away from each other and new crust is formed, such as Mid-Atlantic Ridge. **Convergent or Destructive or Consuming** plate boundary, where two plates move towards each other (face to face) and collide along a line and the heavy plate slipping down below the lighter plate, e.g. the boundary of pacific plate. **Transform boundary**, where two plates move laterally past each other along a transform fault, e.g. San Andreas Fault System in California, USA. However, at some places three plates may come into contact, which is known as **Triple junction**, e.g. junction of the Pacific, Nazca, and Cocos plates.



**Fig. 3: Major and Minor Tectonic Plates and their relative movement**  
(after USGS,2018)

### 1.6.4 Theories of Mountain Building

Mountains are the important second order relief feature on the earth surface. The highest mountain on Earth is Mount Everest in the Himalayas of Asia, whose summit is 8,850 m (29,035 ft) above mean sea level. Mountains can be classified in different types based on height, location, mode of origin, period of origin.

- A) Types based on height: (i) Low mountain (height between 700 – 1000 m); (ii) Rough mountain (1000 – 1500 m); (iii) Rugged mountain (1500 – 2000 m); and (iv) High mountain (>1500 m).
- B) Types based on location: (i) Continental mountain and (ii) Oceanic mountain.
- C) Types based on mode of origin: (i) Folded mountain; (ii) Block mountain; (iii) Dome mountain; (iv) Mountain of accumulation.
- D) Types based on period of origin: (i) Pre-Cambrian mountains; (ii) Caledonian mountains; (iii) Hercynian mountains; and (iv) Alpine mountains (Rockies, Andes, Alpine, Pamir, Himalaya mountain system come under this category).

The process of mountain building is basically deformation of earth crust due to the interaction between intrinsic and extrinsic forces of the Earth, as part of endogenetic processes. Therefore, the process of mountain building is very complex and long lasting. A number of hypotheses and theories have been presented to explain the process of mountain building by number of geoscientists since very past. The major theories are as follows:

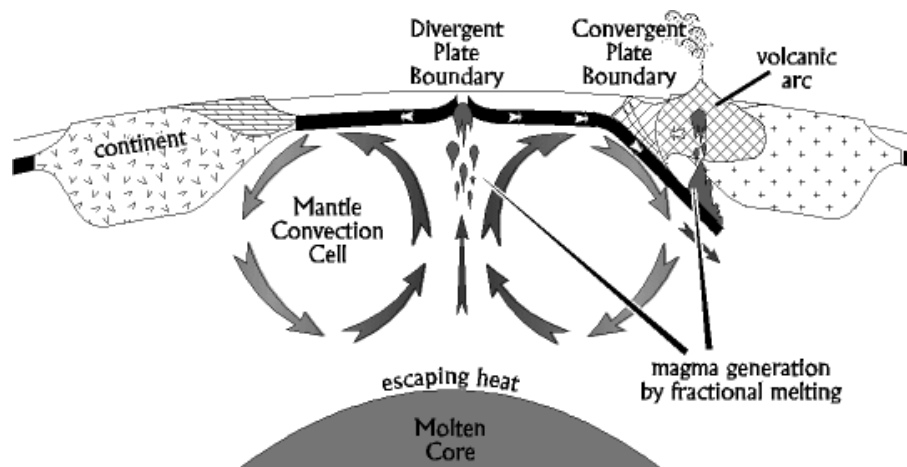
1. Geosynclinal Orogen Theory of Kober: According to Kober, a German geologist, the present mountains are the result of interaction between mobile zones of water as geosynclines or '**orogen**' (place of mountain building) and rigid masses or '**kartogen**' in the surrounding of orogen. The major kartogens are Canadian Shield, Baltic Shield, Siberian Shield, Chinese Massif, Peninsular India, African Shield, Brazilian Mass, Australian, and Antarctic masses.

2. Thermal Contraction Theory of Jeffreys: The theory is based on the cooling process from initial phase of planet earth to present form. According to Jeffreys, the earth began to shrink because of contraction caused by gradual cooling of the earth due to loss of heat through radiation from the very beginning of its origin. The process of mountain building depends on the nature and strength of rocks. The soft and elastic rocks are most affected by contraction and easily developed folded mountain.

3. Sliding Continent Theory of Daly: Gravitational force of Earth is the key element of this theory. The gravity influenced to the continental masses for downhill sliding. The collapse

part of the continent makes anomalies in temperature in the interior of the Earth and influenced surface geosynclines for folding or warping.

4. Thermal Convection Current Theory of Holmes: Arthur Holmes believed on the presence of two layers below the Earth surface, i.e. the *crust* and molten layer of *substratum* below of it. The convection current basically indicates the circular flow of magma within the layer of *substratum* layer. The current is significantly influenced the movement of crust and consequently helps to developed Earth's major relief features, such as folded mountain. Convection currents rise and diverge below the mid-oceanic ridges and converge and descend along the subduction zone. The causes behind the origin of convection current below the crust depend on the presence of radioactive elements in the rocks. The disintegration of radioactive elements generates the heat which caused the convection current.

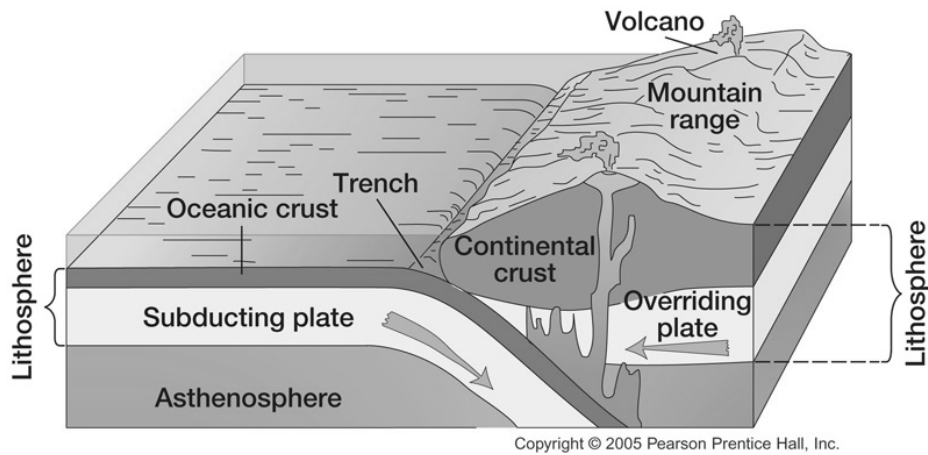


**Fig. 4: Convection current theory and adjacent geotectonic events** (Source: <http://mrrudgegeography.weebly.com/continental-drift.html>)

5. Radioactivity Theory of Joly: The theory also known as 'thermal cycle theory', mainly based on the heat generated by the radioactive minerals in the substratum. According to Joly, the driving force of mountain building is provided by expansion and contraction of the substratum of the earth.

6. Plate Tectonic Theory: The most fundamental theory was developed in the late 1960s, which is able to explain all the tectonic events and relief features on the Earth surface using the concept of plate movements. In the aspect of mountain building, the theory explains that majority of mountains are developed due to the collision of two plates or at the convergent plate boundary. The collision might happen between two oceanic plates, between two continental plates, or between one oceanic and one continental plate. For example, the Himalaya is a

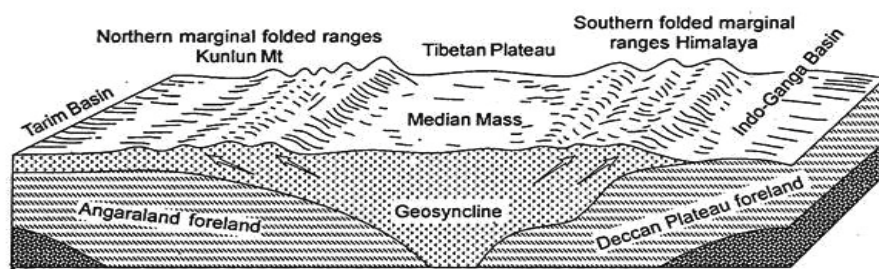
result of collision between Eurasian Plate and Indo-Australian Plate, a collision of two continental plain, Rockies and Andes are examples of the collision between one continent and one oceanic plate.



**Fig. 5: Subduction zone and associated relief features through the process of plate tectonic** (Source: <https://infogram.com/o-c-subduction-zone-1g957pr5g90vm01>)

### 1.6.5 Geosynclines

Geosynclines is an important ancient relief feature characterised by long, narrow and shallow depression and accumulated with very thick sediments and are sometime results of earth subsidence. Erath scientists are believed that it was an ancient feature, started to develop since the origin of our planet surrounding the rigid masses. The concept of the geosyncline was introduced by the American geologist James Hall and Dana in 1859, but it was elaborate by J.A. Steers (1932). The geosynclines are blue-print of the folded mountain and its sediments are the source of material need for the formation of mountain ranges. The Himalaya is the result of Tethys geosyncline by the compressional force generated between Angaraland foreland and Deccan Plateau foreland.



**Fig. 6: Formation of Himalaya, Tibetan Plateau, Kunlun Mt. from the underling geosynclines (Tethys)** (after Kober)

The history of geosyncline formation has been divided into three main stages.

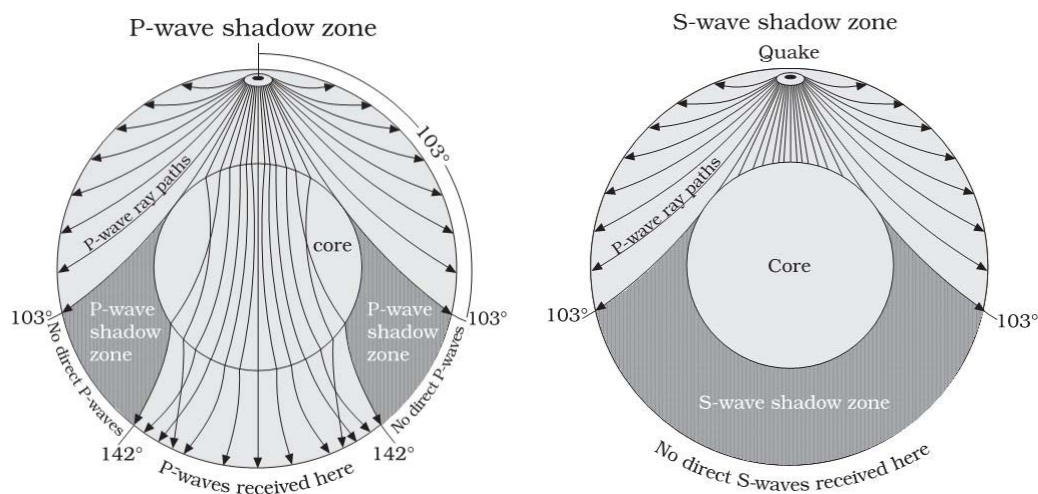
1. Lithogenesis: the stage of formation with huge sedimentation and subsidence of beds of geosynclines.
2. Orogenesis: the stage of mountain building by squeezing and folding of accumulated sediments by the compression force from the foreland on the both side.
3. Gliptogenesis: the stage of gradual rising of mountain, and their denudation and associated reducing the height of the mountains.

### 1.6.6 Earthquake: Mechanism and Distribution

The event of earthquake is a result of seismic wave movements generated beneath the earth surface due to the sudden release of epirogenic energy. The magnitude of the earthquake depends on the nature of seismic waves. There are three types of seismic waves, i. Primary or P-wave, ii. Secondary or S-wave, and iii. Surface or L-wave.

#### P-wave

- High frequency, shorter wavelength, and longitudinal wave.
- Travelling within the Earth through the both liquid and solid masses.
- Speed ranges from 5 – 7 km/s.
- It produces relatively small displacement of the ground.
- Their velocity depends on shear strength or elasticity of the material.
- The shadow zone for 'P' waves is an area that corresponds to an angle between  $103^{\circ}$  and  $142^{\circ}$



#### S-wave

- More slow than P-wave, speed range from 3 – 4 km/s.

- Low frequency, long wavelength, and transverse vibration.
- They cause displacement of rocks, and hence, the collapse of structures occurs.
- These waves are responsible for most the destructive force of earthquake.
- Travel only solid mass, so the entire zone beyond 105 ° does not receive S-waves.

### **L-wave**

- L Waves or Surface Waves travel near the earth's surface and within a depth of 30-32 kilometers from the surface.
- These are also called Rayleigh waves after Lord Rayleigh.
- This wave created close to the epicenter and can only travel through the outer part of the crust.
- Together with secondary effects such as landslides, fires and tsunami are account for the loss of approximately 10000 lives and over \$100 million annually.

### **Major causes of earthquakes are:**

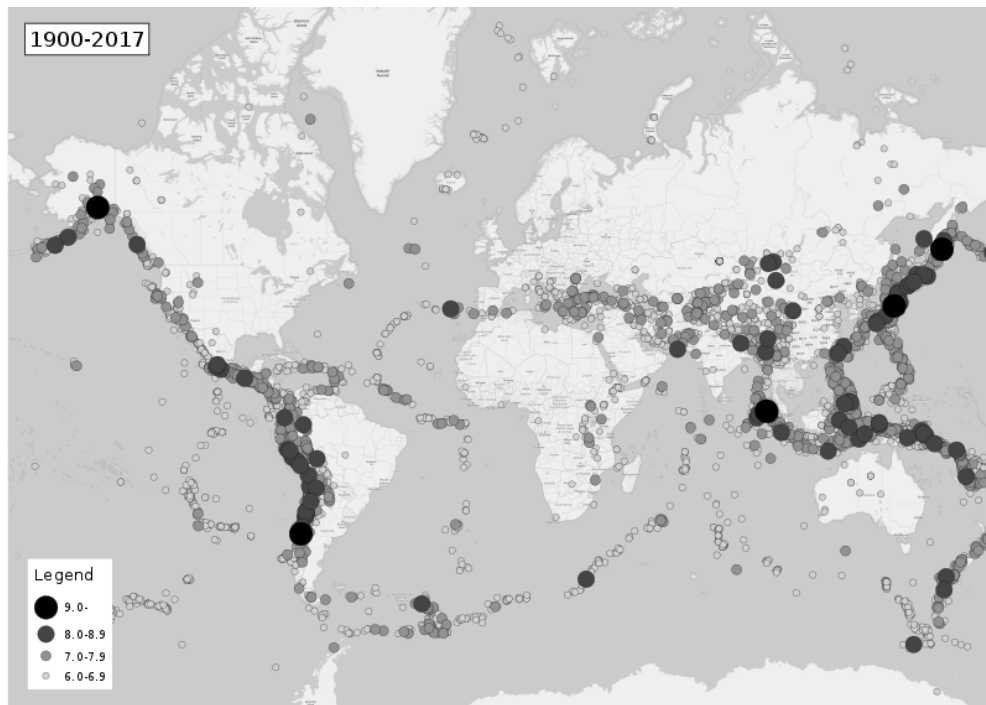
- Plate tectonic
- Volcanic activity
- Folding and faulting
- Human interference with nature (e.g. dam, dynamite blasting for mining etc.)

### **Major effects of earthquakes are:**

- Shaking and ground rupture
- Landslides and avalanches
- Fires
- Soil liquefaction
- Tsunami
- Floods
- Effect on human life and property.

### **Distribution of Earthquakes**

Earthquake can be event in ant part of the earth surface. However, the major allocation of the earthquake is direly correlated with the plate boundary, especially along the convergent boundaries. The distribution map can helps to correlate the world's plate boundaries and major earthquake events. There are five example of very high magnitude (>9.0) earthquake especially at the edge of pacific plate. Worldwide major earthquake prone areas are: i) around the Pacific Ocean, ii) Along the Indo-Australian plate boundary, iii) Eastern side of Eurasian plate, iv) western side of the North American plate.



**Fig. 8: Distribution map of the major earthquake (>6.0 magnitudes) over the world of last 117 years (Source: USGS, 2018)**

### **1.6.7 Volcanicity: Mechanism and Distribution**

The term volcano refers the point of eruption or outlet of magma or highly heated gases, ashes, or pyroclastic materials from the below of crust. The form the volcano is usually circular or nearly circular, however it varying widely over the world. Whereas, volcanicity includes all the processes of magma, gases and pyroclastic material eruption into the crust through volcanoes and thereafter way of solidify as a crystalline or semi-crystalline rock. The major components of a volcano are volcanic vent, volcanic crater, volcanic pipe, and volcanic cone.

The volcanic event basically associated with the weaker zone of the earth surface, represented by the mountain building areas or along the convergent or destructive plate boundaries. A wide range of variation has been observed in the mode of volcanic eruption and their periodicity. Therefore, volcanoes are classified into several types as follows.

#### **A. Based on the Mode of Eruption**

- i) Central eruption types or explosive eruption type: a. Hawaiiin, b. Strombolian, c. Vulcanian, d. Peleean, e. Visuvius
- ii) Fisser eruption type or quite eruption type: a. Lava flow, b. Mud flow, c. Fumaroles

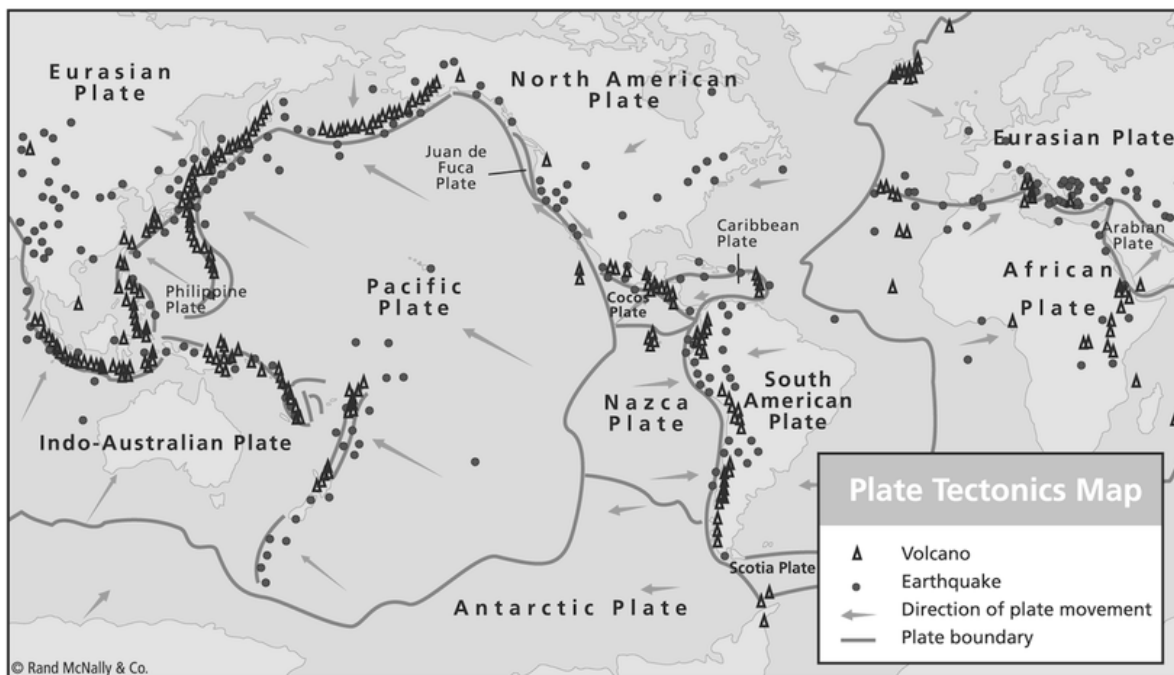
B. Based on the Periodicity

- i) Active volcanoes
- ii) Dormant volcanoes
- iii) Extinct volcanoes

**Distribution of the Volcanoes**

The major volcanic belts of the earth are:

1. Circum-Pacific Belt (Fire Girdle of the Pacific or the fire ring of the Pacific) Island arcs and Festoons E.g. Sakhalin, Kamchatka, Japan, Philippines, Aleutian Island, Hawaii, some Highest volcanic Peaks -Cotopaxi (S.America), Fujiyama (Japan), Shasta, Rainier and Hood (W. Cordillera of N. America), Valley of ten thousand smokes (Alaska), Mt. St. Helens (USA), Kilavea (Hawaii), Mt. Taral, Pinatubo and Mayon (Philippines).
2. Mid-Continental Belt (Volcanic Zones of convergent continental plate margins) Volcanes of Alpine Mt. Chains, Mediterranean Sea, Aegean Sea, Fault zone of Africa (Kilimanjaro, Mem, Elgon, Birunga, Rungwe etc.)
3. Mid-Atlantic Belt- Hekla (Iceland) , Lesser Antilles, Southern Antilles, Azores, St. Helena, Mt. Pelee (Martinique) in Caribbean Sea.



**Fig. 9: Location of major volcanoes and point of earthquake across the world, which are directly corresponding with the convergent plate boundary (Source: USGS, 2018)**

## 1.7 Self-assessment Test

1. What is the importance of seismology to define the internal structure of the Earth?
2. Describe the internal structure of the Earth with suitable diagrams.
3. Describe the concept of plate tectonic and compare the effects different types of plate boundary on landform development.
4. Define palaeomagnetism and correlate it with sea-floor spreading.
5. What are the major processes of fold mountain building?
6. Explain the different stages of geosynclines and what is the role a geosyncline on folded mountain building?
7. What is earthquake? What are the major type of seismic waves and their characteristic?
8. Correlate the distribution of worldwide volcanoes and location plate boundary.
9. Describe the “Thermal Convection Current Theory” of Holmes.
10. Explain the term “Ring of Fire”?

## 1.8 Summaries and Key Points

The understanding of the Earth as a planet of solar system, especially the internal ongoing processes, is very important for everyone to correlate with other physical and socio-economic condition of our environment. The brief knowledge about the above topics might be helpful to understand the movement of Earth surface and different natural calamities, specially earthquake and volcanic activities. The causes behind the mountain structure and types can be understood from this study material. With the knowledge of plate tectonic, the student can explain any type of crustal deformation and related landforms.

## 1.9 Study Tips

- Singh, S. 2010: GEOMORPHOLOGY. Prayag Pustak Bhawan, Allahabad.
- Kale, V.S. and Gupta, A. 2001: Introduction to Geomorphology. Orient Longman, Hyderabad.
- Selby, M.J. 2005: Earth’s Changing Surface. Indian Edition, Oxford University Press.
- Summerfield, M.A. 1991: Global Geomorphology: An introduction to the study of landforms. Pearson Prentice Hall, London.

- Frisch, W., Meschede, M., Blakey, R. 2011. Plate Tectonics: Continental Drift and Mountain Building. Springer Heidelberg Dordrecht London New York

**Online Sources of Information**

<https://earthquake.usgs.gov/earthquakes/map/>

<https://www.wikipedia.org/>

<https://volcanoes.usgs.gov/index.html>

## **GROUP – GEO101T.2: GEOMORPHOLOGY**

**(Credit – 2; Marks - 50: Internal Evaluation – 10, Semester-end Examination - 40)**

### **2.1 Introduction**

Geomorphology, a science of landscape, deals with the form and processes involved to create it. The science helps to identify the topographical variation over the earth surface with a specific ordering of landforms and explain the geomorphic processes in temporal and spatial frameworks. In the beginning, the subjects was a description of topography by the travelers, which becoming quantitative during 1960s, and at present it becomes highly scientific and model building discipline to understand the dynamics of Earth's processes and predict for the future.

### **2.2 Learning Objectives**

- The module helps the student to understand the basic geomorphological processes happening around them.
- To identify different relief feature over the Earth surface and can explain their basic causes of origin.
- To know the processes of landscape evolution and role of different parameters on it.
- To understand the interaction between intrinsic and extrinsic forces to developed and landform.
- For detail understanding about the fluvial system of the Earth surface for further understanding of hydrology.
- To understand the difference between glacial and periglacial environment.

### **2.3 Assessment of Prior Knowledge**

- Real-life experience of river, desert, any cave in karst region, glaciated mountain could help to understand the theoretical knowledge of geomorphology very easily.
- Should have interest to observe and query about the physical landscape surrounding by trainees.

## 2.4 Learning Activities

- An audio-visual teaching method using smart-classes could help for the teachers to explain and students to understand the different geomorphic processes and related landforms through the original colour photographs.
- Field visit of any river or any other geomorphic landscape is very helpful and essential for the proper knowledge of geomorphology.

## 2.5 Feedback of Learning Activities

- Models on different landforms developed by actions of fluvial, glacial, wind, and calcium solution can help to visualize and explain them properly.
- Preparation of charts and poster on the mechanism of erosion, transportation and deposition of different geomorphic agents can help to summarize them all at a glance.

## 2.6 Examples and Illustrations

### 2.6.1 Fundamental Concepts in Geomorphology

The term geomorphology first used to describe the morphology of the Earth's surface in the 1870s and 1880s (e.g. de Margerie 1886, p. 315). However, the development of geomorphological thought comes through a long history. For example, Herodotus (484 – 420 B.C.) was conceptualized the formation of lower part of Egypt is the process of sedimentation by Nile River and was saying '*Egypt is a gift of Nile river*'. The concept of geomorphology deals with the landforms on the earth surface and ongoing and historical processes behind their formation. The chief aspects of study in geomorphology are *form*, *process*, and *time*.

During the middle of the 20th century **W.D. Thornbury (1954)** has synthesized different aspect of geomorphology and presented ten fundamental concepts in geomorphology with the entitle of "Principal of Geomorphology", New York: Wiley.

1. "The same physical processes and laws that operate today, operated throughout geological time, although not necessarily always with the same intensity as now".
2. "Geological structure is a dominant control factor in the evolution of landforms and is reflected in them".

3. "To a large degree the Earth's surface processes relief because the geomorphic processes operate at different rates".
4. "Geomorphic processes leave their distinctive imprint upon landforms, and each geomorphic process develops its own characteristic assemblage of landforms".
5. "As the different erosional agents act upon the Earth's surface there is produced an orderly sequence of land forms".
6. "Complexity of geomorphic evolution is more common than simplicity".
7. "Little of the Earth's topography is older than Tertiary and most of it no older than Pleistocene".
8. "Proper interpretation of present-day landscapes is impossible without a full appreciation of the manifold influences of the geologic and climatic changes during the Pleistocene".
9. "An appreciation of world climates is necessary for a proper understanding of the varying importance of the different geomorphic processes".
10. "Geomorphology, although concerned primarily with present-day landscapes, attains its maximum usefulness by historical extension".

## 2.6.2 Fluvial Processes and Landforms

Except the frigid (dominated by ice) and dry regions, action of running water is present all around the world, which is geomorphologically known as fluvial action and the assemblage of landforms associated with these processes is called fluvial landscape. The term fluvial is derived from the Latin word '*fluvius*', meaning river.

### Major Drainage System and Pattern

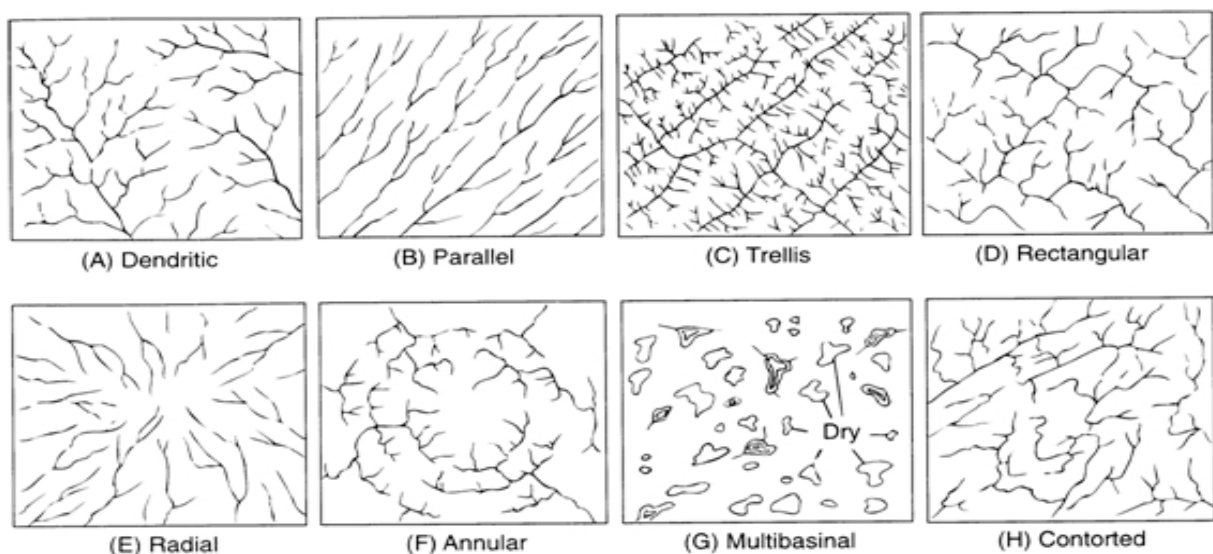
Drainage system refers the origin and development of stream over a part of earth surface through time, however, Drainage Pattern means the spatial arrangement of the streams on that particular part of earth surface. The origin of drainage system and pattern is significantly influenced by nature of underlying geology, surface slope, rainfall, land use land cover etc. The major **drainage systems** are two types.

1. **Sequent Drainage System**
  - a. *Consequent Streams*: Streams following initial slope direction of a region
  - b. *Subsequent Streams*: Streams developed after the master consequent stream
  - c. *Obsequent Streams*: Streams flowing in the opposite direction of the master consequent stream

- d. *Resequent Streams*: Streams developed in the last stage of fluvial landscape and flowing in the same direction with master consequent stream, while the bed height level is below the master consequent.
2. In-sequent Drainage System
    - a. *Antecedent Drainage System*: When a stream maintains its flow direction instead of upliftment of land across the channel path through deep vertical erosion.
    - b. *Superimposed Drainage System*: Not adjust the regional slope and overcome all problems related to topography to maintain its palaeo-path.

**Major Drainage Patterns**

1. Dendritic Pattern
2. Trellised Pattern
3. Rectangular Pattern
4. Radial Drainage Pattern
5. Centripetal Drainage Pattern
6. Annular Drainage Pattern
7. Barbed Drainage Pattern
8. Pinnate Drainage Pattern
9. Herringbone Drainage Pattern
10. Parallel Drainage Pattern



**Fig. 10: Major drainage patterns(after Singh, 2010)**

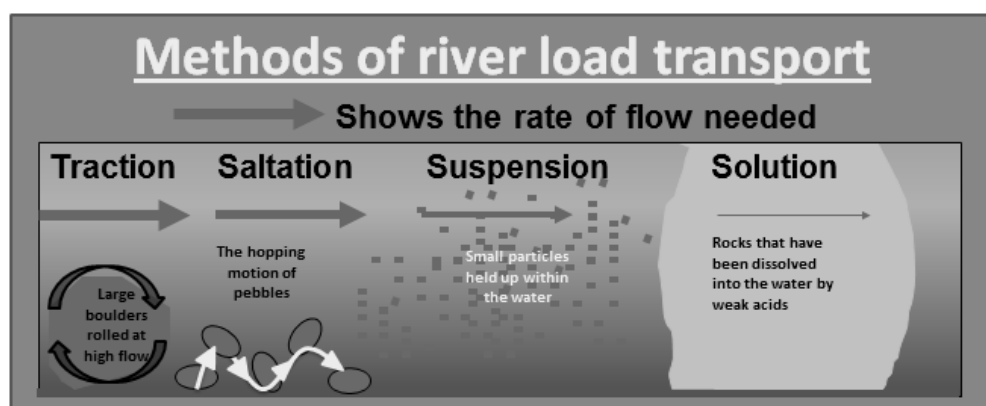
### Major Erosional Processes

1. Abrasion or corrasion: This process means removing of loosened materials from the channel bed. The level of abrasion depends on the amount of erosional tool presence in the running water such as boulders, cobbles, pebbles, sands etc., which are working as drilling tools of river bed and bank.
2. Corrosion: This is a chemical process of erosion through the dissolution of soluble materials (carbonate rock mainly).
3. Hydraulic Action: It refers breakdown of channel materials due to the pressure created by water current.
4. Attrition: Tear and wear of erosional tools suffered by themselves.
5. Cavitation: Erosion produced by the water bubbles generated by the sudden dropping in flow.

### Mode of Fluvial Sediment Transportation

Transportation of a river means the carrying of eroded materials from its catchment and channel through the flowing water in the name of sediments. The major sources of sediments are weathering and mass wasting over river basin, which are input in the river system through the sub-channels. In a channel sediments are transported in following ways.

1. Bed-load Transportation or Traction: sediment moves with the contact of channel bed.
2. Transportation through Saltation
3. Suspended Sediment Transportation,
4. In form of Solution



**Fig. 11: Mode of sediment transport in fluvial system** (Source: Wikipedia.org, 2018)

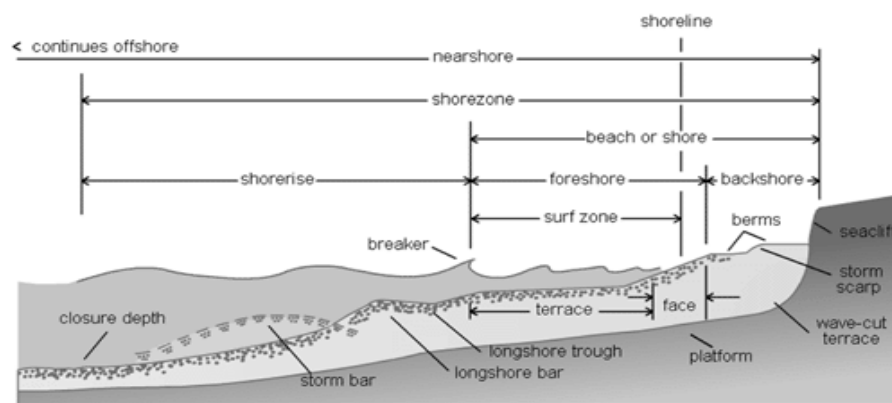
### Major Fluvial Landforms

A variety of landforms developed within a fluvial system, which are classified as erosional, depositional or some are the combination of erosion and deposition (Table).

Erosional Landforms	Depositional Landforms
1. River Valley: Gorges and Canyons	
2. Waterfall	1. Alluvial Fans and Cones
3. Pot Holes	2. Natural Levees
4. Structural Bench	3. Delta
5. River Terraces: Paired and Un-paired	4. Floodplain
6. River Meander	5. In-stream Bars
7. Ox-bow Lake	
8. Peneplains	

### 2.6.3 Processes and Landforms of Coast or Coastal Geomorphology

Coastal geomorphology means primarily the action of sea water through wave action, tidal current, tsunamis etc. The contact zone between land and water usually describe by two terms, e.g. shore and coast. Shore is the part of land-sea interaction zone delineated by extreme high and extreme low tide level. Coast denotes the adjacent land mass including the shore. The land mass is characterised with sea cliff and sand dunes. The zone of seashore has been classified into different section based on the tide level as in figure.



**Fig. 12: Different terminology of coastal geomorphology** (Source:

[http://www.coastalwiki.org/wiki/Definitions\\_of\\_coastal\\_terms](http://www.coastalwiki.org/wiki/Definitions_of_coastal_terms))

**Major Erosional Processes and Landforms**

The erosional processes are active at the coastal zone and backshore region through the processes of hydraulic action, corration or abrasion, attrition, corrosion or solution and water pressure. The nature and magnitude of erosion depends on the wavelength, wave velocity, wave frequency, structure and composition of bedrocks of the coast land, longshore current, rip current, tides.

<b>Erosional Landforms</b>	<b>Depositional Landforms</b>
1. Sea Cliffs	1. Sea beaches
2. Wave-cut Platform	2. Offshore and Longshore bars
3. Sea stacks	3. Spits
4. Sea Arches	4. Hooks
5. Blow holes	5. Loops
6. Geo	6. Tombolo
7. Caves	7. Connecting Bars

**2.6.4 Processes and Landforms of Arid Region or Aeolian Geomorphology**

Arid region means a region with severally lack of water and usually characterised by desert area and the active geomorphic agent is wind. The geomorphic processes by wind action are known as aeolian activity. Although, wind action is not as much effective of river and sea waves, still a significant role played by wind with desert sand and create number of erosional and depositional landforms.

**Erosional Work of Wind**

The wind erosion depends on the wind velocity, nature and amount of sand, erosional tools present in the wind, nature of vegetation, and humidity, rainfall amount and temperature. Maximum wind erosion occurs at the short distance above the ground (20 - 25 cm) because wind velocity and sediment movement are high. The major erosional processes are (i) deflation (process of removing, lifting and blowing sand from the ground and to the long outward), (ii) abrasion or sandblasting, and (iii) attrition. The major transportation works are suspension, saltation, and traction.

### **Major Erosional Landforms**

1. Deflation basin also known as buffalo wallows, pang kiang for large depression
2. Mushroom rocks
3. Inselbergs or bornhardts
4. Demoisells
5. Zeugen
6. Yardangs
7. Dreikanter and Ventifacts
8. Stone latties
9. Wind bride and windows

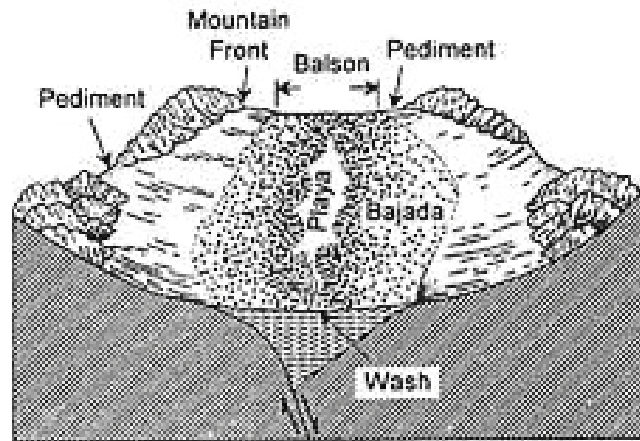
### **Major Depositional Landforms**

1. Formation of sand dunes
  - a. Longitudinal sand dunes
  - b. Transverse sand dune
  - c. Brachan
  - d. Parabolic
  - e. Other forms of sand dune: star dunes, reversing dunes, whalebacks
2. Loess: the accumulation of wind-blown silt, typically in the 20–50 micrometer size range, twenty percent or less clay and the balance equal parts sand and silt that are loosely cemented by calcium carbonate.

### **Fluvio-Aeolian Landforms**

Some region are characterised by the combine work of fluvial and aeolian and developed some typical landforms as follows:

1. Pediment
2. Bolsons and Playas
3. Bajada



**Fig. 13: Fluvio-aeolian landforms** (after Singh, 2010)

Pediment is a bare rocky surface in the front in arid mountain, with a general gradient of  $1^{\circ}$  -  $7^{\circ}$ , situated in between mountain and bajada. The term first coined by G.K. Gilbert (1882). A number of theories are developed to explain the process of its generation.

- a. Lawson's Recession Theory (1915)
- b. Sheet-flood Theory of McGee (1897)
- c. Lateral Erosion Theory of Johnson (1932)
- d. Composite Theory

### **2.6.5 Geomorphology of Karst Topography**

A typical region, where the landforms are generated by the chemical weathering or by chemical erosion of carbonate rocks through the surface and subsurface water known as Karst Topography. The major dominated rock type is limestone; therefore the alternative name of karst is Limestone Topography.

#### **Favourable condition for Karst Topography**

- a. The limestone area must be well extended vertically as well as horizontally with a significant amount of thickness.
- b. The limestone bed should be characterized with number joints and fracture, which support the good permeability of the bed and helps to the interaction between water and carbonate rock.
- c. The area should be situated above the local ground water.
- d. There must be enough rainfall to supply the required water for solution.

### Distribution of Karst Topography

Yugoslavia: extended about 480 km in length and 80 km in width; Causes Region of southern France; Spanish Andalusia; Northern Puertorico; Western Cuba; Jamaica; Southern Indiana; Virginia; Tennessee; central Florida etc.

In India, especially at Guptadham Cave in Rohtas plateau; some patches in western and eastern Himalaya, Rovers Cave and Tapkeshwar temple near Dehra Dun; Pachmarhi (M.P.); Baster district (M.P.); coastal area near Visakhapatnam etc.

### Major Erosional and Depositional Landforms

Erosional	Depositional
a. Lapias/Karren b. Terra rosa c. Solution holes: sink hole, swallow hole, dolines, Ovals d. Solution pan e. Karst Window f. Poljes g. Blind valley h. Caves i. Ponores j. Natural Bridge	a. Stalactite b. Stalagmite c. Cave pillars d. Helictite and helicmites e. Tufa

### **2.6.6 Concept of Cyclic and Non-Cyclic Theories in Geomorphology**

Geomorphology, the discipline generally deals with the development of landscape over the Earth's Surface. A number of theories have been presented this concept. All these theories have been divided into two major categories: (a) Cyclic and (b) Non-cyclic.

**William Morris Davis**, an American geomorphologist, was first scholar to present the general theory of landscape development. His theory was published by three major research works in the name of 'complete cycle of river life' (1889), 'geographical cycle' (1899) and 'slope evolution'. Through these research works, he was first presented the concept of cyclic nature of landscape evolution. According to him, the landscape is developed progressively through different geomorphological processes within a time-frame. He has divided the progressive time of landscape development into three stages e.g. **Youth, Mature and Old**.

According to Davis, 'the geographical cycle is a period of time during which an uplifted landmass undergoes its transformation by the process of landculpture ending into low featureless plain or peneplain'.

To define landscape, he said "Landscape is a function of structure, process and time". Structure means the lithological and structural characteristic of rocks, Process includes all the denudational processes e.g. weathering, mass wasting etc. and Time refers the temporal context as well as the progressive development.

### **Basic Characteristics of Landscape during the Stages of Youth, Mature, and Old**

#### **Youth**

- i. Erosion starts after complete of landmass upliftment.
- ii. The summits of the water divides are not affected.
- iii. Initiations of small consequent streams along the general slope.
- iv. Major channel processes are stream lengthening by headwater erosion and deep vertical erosion.
- v. Channel gradient is very high and channel bank slope is very steep, some time  $>70^\circ$ .
- vi. The relative relief continues to increase and at the end of youth it reached maximum relief condition.
- vii. Erosional and Transportation work are high in river water with high flow velocity.

#### **Mature**

- i. Reduced the width of river divides.
- ii. Lateral erosion is more active than vertical erosion.
- iii. Channel widening process is actively started.
- iv. Substantial decrease in channel gradient and bank slope, flow velocity, transporting capacity.

#### **Old**

- i. Total absence of valley incision but lateral erosion and valley widening are still active.
- ii. Water divides are rapidly eroded and at the last stage they are vanished.
- iii. A period towards maximum entropy in fluvial system.
- iv. River started to deposit sediments within the channel due to over load than transport capacity.
- v. At the end, the entire landscape is transformed into peneplain with number of monadnocks.

### **Some other theories on Landscape Development**

1. Theory of W. Penck (1924): 'Morphological System' or 'Morphological Analysis'
2. Theory of L.C. King (1948): 'Cyclic model of Pediplanation'
3. Dynamic Equilibrium theory of J.T. Hack (1960).
4. Tectono-Geomorphic Model of M. Morisawa (1975)
5. Episodic Erosion model of S.A. Schumm (1965)

### **Non-Cyclic Theory by J.T. Hack (1960)**

J.T. Hack, another American geomorphologist, have opposed the cyclic nature of landscape development and presented a new advanced concept of landscape development i.e. *dynamic equilibrium model* on 1960. According to him, it is not a model only this is a reality about landscape. The concept implies that landscape is result of energy balance between exogenic and endogenic forces. The model was a serious attempt to fill the gap developed by Davis and Penck with no explanation about the poly-cyclic landscape. The basic views of this model are:

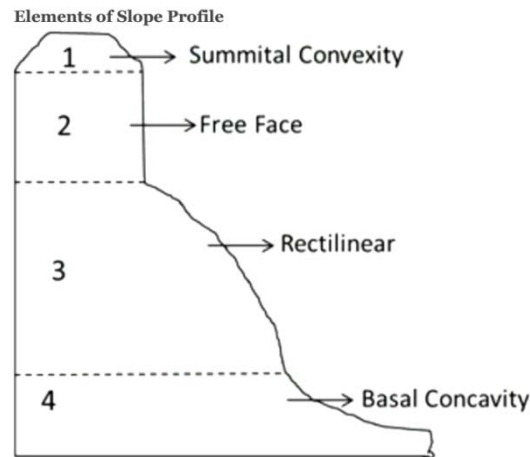
- i. The landscape evolution is an open system and time independent process.
- ii. The processes are largely depending on the lithological adjustment to landforms.
- iii. The landscape is result of balance between erosion and deposition.
- iv. Base level of erosion plays significant role in the landscape development.

### **2.6.7 Slope**

Slope is a key element to understand the geomorphology. Slope is basically the angular inclination of terrain between hill top to hill bottom. According to Singh (2010), 'slope is upward or downward inclination of surface between hills and valleys and form most significant aspect in landscape assemblages'.

### **Major Elements of Slope**

In consideration of a longitudinal slope from the hill top to bottom, four major parts can be observed.



- a. Summit Convexity: The convex segment at the top of the hill. The slope of this region also called ‘waxing slope’ or ‘upper wash slope’.
- b. Free Face: The wall-like vertical bare slope segment.
- c. Rectilinear: The nearly straight or linear segment of a hillslope profile.
- d. Basal Concavity: This part is also known as valley floor segment and slope is called waving slope.

### Classification of Slope

#### A. Genetic Classification

- a. Tectonic Slope: formed by tensional and compressional forces.
- b. Erosional Slope: formed due to erosion by fluvial, aeolian, glacial, sea wave actions
- c. Slope of Accumulation: formed by the deposition of eroded materials.

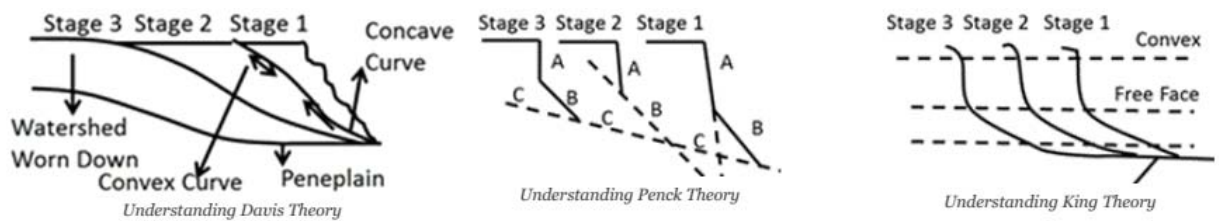
#### B. Quantitative Classification

- a. Level to gentle slope ( $0^{\circ}$  -  $2^{\circ}$ )
- b. Gentle Slope ( $2^{\circ}$  -  $5^{\circ}$ )
- c. Moderate Slope ( $5^{\circ}$  -  $10^{\circ}$ )
- d. Moderately Steep Slope ( $10^{\circ}$  -  $18^{\circ}$ )
- e. Steep Slope ( $18^{\circ}$  -  $30^{\circ}$ )
- f. Very Steep Slope ( $30^{\circ}$  -  $45^{\circ}$ )
- g. Precipitous to Vertical Slope ( $>45^{\circ}$ )

### Model of Slope Evolution

The study of slope evolution is done through three main approaches: (i) theoretically; (ii) experimentally, and (iii) empirically. There are a number of theories developed to study this geomorphological process, which is grouped into three main categories by A. Young (1972).

1. Slope Decline Theory by W.M. Davis
2. Slope Replacement Theory by W. Penck
3. Parallel Retreat Theory by L.C. King



**Fig. 15: Different Slope Models** (Source: Singh, 2010)

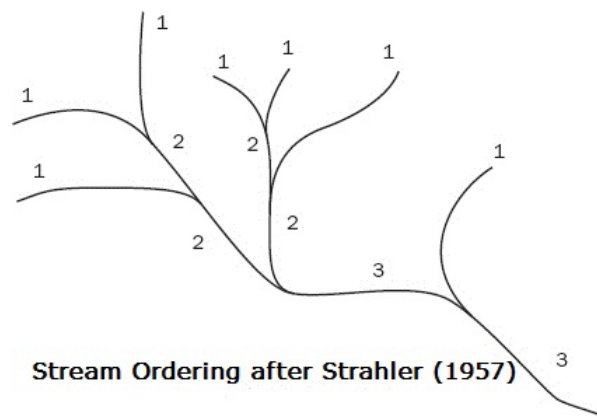
### 2.6.8 Concept of Fluvial Morphometry – linear, areal and relief aspects

The concept of fluvial morphometry is a result of quantitative revolution during 1960s in the field of research, especially on the physical geography. The term ‘morphometry’ in geomorphology refers the quantitative measure and mathematical analysis the configuration of relief features of on the Erath surface.

In particular, the fluvial morphometry includes the consideration of linear, areal, and relief aspects of fluvial originated drainage basin.

#### The Linear Aspects of the Basin

1. **Stream Ordering:** refers the determination of hierarchical position of streams within a drainage basin. The first attempt was made by Gravelius on 1914, thereafter, number of researcher have done the same job with different ways. Among them, the ordering of A.N. Strahler (1957) is widely accepted by the world geomorphologists.



2. Bifurcation Ratio
3. Law of Stream Number

4. Stream Length Ratio and Law of Stream Number
5. Sinuosity Index: to study the shape geometry of a stream line with the help of ratio between original stream length and air length from source to confluence of that stream.
6. Meandering Pattern
7. Length of Overland Flow
8. Stream Junction Angles

#### **The Areal Aspects of the Basin**

1. Geometry of Basin's Shape
2. Area Ratio and law of basin area
3. Stream Frequency: to study the number of stream within a unit area
4. Drainage Density: the ration between total stream length and area of a unit of study
5. Drainage Texture

#### **The Relief Aspects of the Basin**

1. Hypsometric Curve: to know the distribution of area within a specific relief values
2. Average Slope of the Basin
3. Relative Reliefs
4. Dissection Index
5. Ruggedness Index
6. Law of Channel Slope and Profile Analysis

### **2.6.9 Periglacial Processes and Landforms**

The term 'periglacial' defer from the term 'glacial' in terms of the nature of glaciations and climatic characteristic. The term periglacial was first used by Polish geomorphologist *Walery von Lozinzki* in 1909. The periglacial environments experienced with intense frost action during winter and snow-free ground during summer. The climate of these regions is characterised by mean annual temperature ranging between  $-1^{\circ}\text{C}$  to  $-15^{\circ}\text{C}$ , and mean annual precipitation mostly in form of snow is 120 mm to 1400 mm.

**Permafrost** is a most important feature of periglacial region. Permafrost means continuous and discontinuous zones of permanently frozen ground, currently 25% of the Erath comes

under this type of land surface. In permafrost the soil or rocks have to remain frozen for at least two year or more consecutive years.

The *fluvial activity* is a main *process of periglacial* region in addition with the continuous 'freezing and thawing' of water. A verity of typical landforms has been observed over the periglacial regions, such as:

1. Ice and sand wedges
2. Frost mounds
3. Pingos
4. Bugors
5. Palsas, peat plateau, and string bogs
6. Thermokarst and oriented lakes
7. Pattern Ground

## **2.7 Self-assessment Test**

1. What is geomorphology? What are the major principles of geomorphology?
2. Classify the rivers. What are the major type of drainage patterns and their characteristics?
3. Describe the major erosional and depositional landforms of fluvial/Aeolian/glacial/coastal activities.
4. Difference between cyclic and non-cyclic concept of landscape evolution.
5. Landscape is a function of structure, process and time. ---- Explain.
6. What are the major elements of slope? Describe the importance of slope in geomorphological investigation.
7. Explain the role of morphometry to understand a drainage basin.
8. What is Pingo? How does it form?

## **2.8 Summaries and Key Points**

The geomorphological knowledge from the above discussion might help to understand the processes over the earth surface, which cumulatively helps to configure the landscape. Geomorphology, a science of landscape reveals the evolution of topographical features created by physical, chemical or biological processes operating at the Earth's surface. In addition with the surface features, the subject also deals with the bathymetric characteristic of

the planet. Practical application of the geomorphological principal will help for hazard assessment (landslide, flood) and river control and restoration, coastal protection etc.

## **2.9 Study tips**

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## **GROUP – GEO101T.3: HYDROLOGY**

**(Credit – 1; Marks - 25: Internal Evaluation – 5, Semester-end Examination - 20)**

### **3.1 Introduction**

Water is the essential and demanding natural resource on the Earth. There will be no life without it. Hydrology deals with this valuable resource to understand the complex water system of the Earth. Being a hydrologist, the researchers are working on the all three forms of water, their distribution, temporal and spatial changes; try to solve the water related problem in society. The surface and sub-surface water quality and quantity are alarmingly deteriorating. At this stage, it is essential to understand the hydrology of earth for sustainable use and proper managements.

### **3.2 Learning Objectives**

- To understand the importance of water on the Earth.
- To understand the occurrence process of groundwater and sources of groundwater.
- To know the importance of basin hydrology and basin's regime for planners and researches.
- For the understanding about the flood characteristic of a river basin.
- To know the rising problems in society, especially about the fresh drinking water.
- To know the processes of water resource management through rainwater harvesting, watershed analysis.

### **3.3 Assessment of Prior Knowledge**

- Basic knowledge about the river system from fluvial geomorphology is important to understand the process of runoff and basin hydrology.
- The relationship between climatic type and the distribution of rainfall.
- Use of water in different sector of our society.

### 3.4 Learning Activities

- With the theoretical knowledge of the hydrology, the teacher should correlate their learning with the current affairs on the rising problem of water at global level, which makes the study more interesting.
- An audio-visual teaching method using smart-classes could be helpful for the teachers to explain and students to understand the different hydrological processes and related problem and their solution.
- Field experiment of the theoretical knowledge is also important to understand hydrology properly.

### 3.5 Feedback of Learning Activities

- Preparation of models on the 'Elements of River Basin' and 'Global Hydrological Cycle'.
- Increasing social awareness to 'SAVE WATER' through poster and campaign.
- Rainwater Harvesting model making.
- River water management plan.
- Model on the Aquifer system and Groundwater table.

### 3.6 Examples and Illustrations

#### 3.6.1 Significance of Global Hydrological Cycle

*Hydrology* is a science which deals with all type of water on the Earth, their occurrences, distribution and circulation, its physical and chemical properties, its effects on the environment and life of all forms. Water presents on the Earth in three different forms: gaseous, liquid and solid. The solar and planetary forces help to circulate it between lithosphere, atmosphere, and hydrosphere. The presence of water extends from about 1 km depth of lithosphere to 15 km high of atmosphere. Therefore, '*Global Hydrological Cycle*' means continuous circulation water in different state between atmosphere, the land, and rivers, oceans, lakes. It is a *closed system* globally; however, hydrological cycle of drainage basin is an example of *open system*.

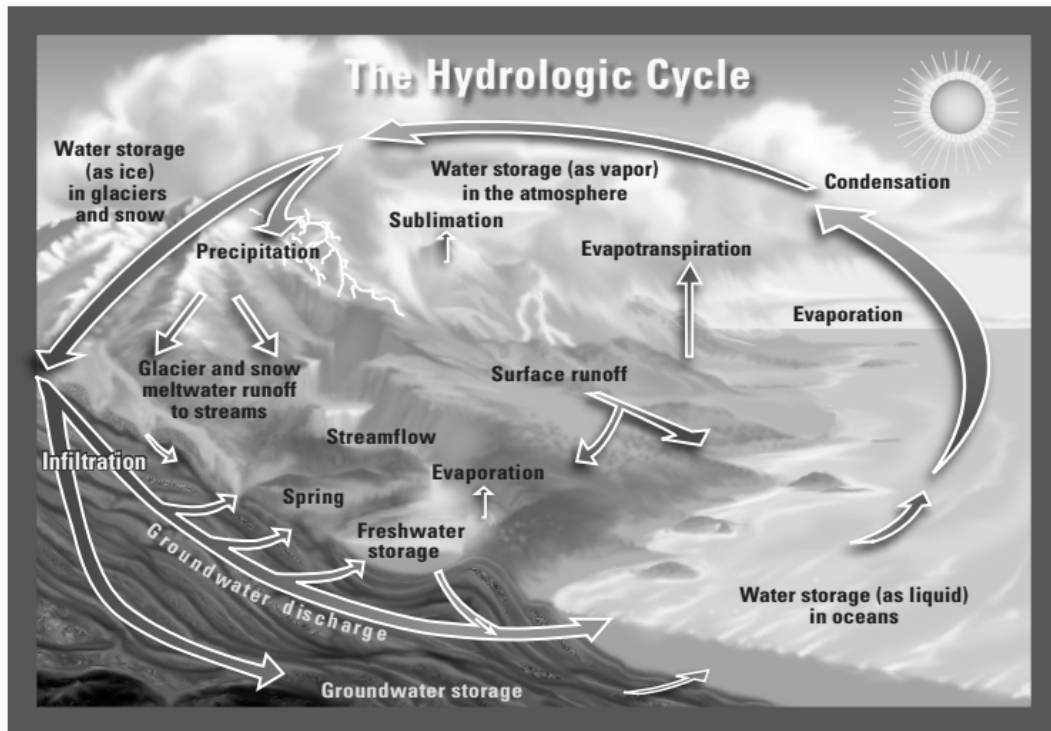


Fig. 17: Global Hydrological Cycle (after USGS, 2012)

### Major Components of Global Hydrological Cycle

Components of hydrological cycle help to make possible the continuous flow of all forms of water.

1. Evaporation
2. Condensation
3. Precipitation
4. Transpiration
5. Interception
6. Infiltration
7. Percolation
8. Groundwater Flow
9. Soil Water Storage

### Distribution of Global Hydrology

**Peter H. Gleick (1993)** makes a quantitative distribution of world water in his famous work “*Water in Crisis: A Guide to the World Fresh Water Resource*”. Suppose the global water (all forms) is sum of 100%, then the distribution is as follows:

1. Oceans: 96.5%
2. Ice and Glacial: 1.74%

3. Soil Moisture: 0.001%
4. River Water: 0.0002%
5. Salt Lake: 0.006%
6. Sweet Lake: 0.007%
7. Atmosphere: 0.001%
8. Groundwater: 1.69% (Saline: 0.93 and Sweet: 0.76)
9. Swampy Water: 0.008%
10. Biological Water: 0.0001%

### Global Water Balance through Hydrological Cycle

Globally the annual turnover of water on the Earth is 577000 km<sup>3</sup>. These huge amounts of water circulate from land to ocean and ocean to land by the processes of runoff, evaporation and precipitation mainly. The diagram makes clear the transformation in global hydrological cycle.

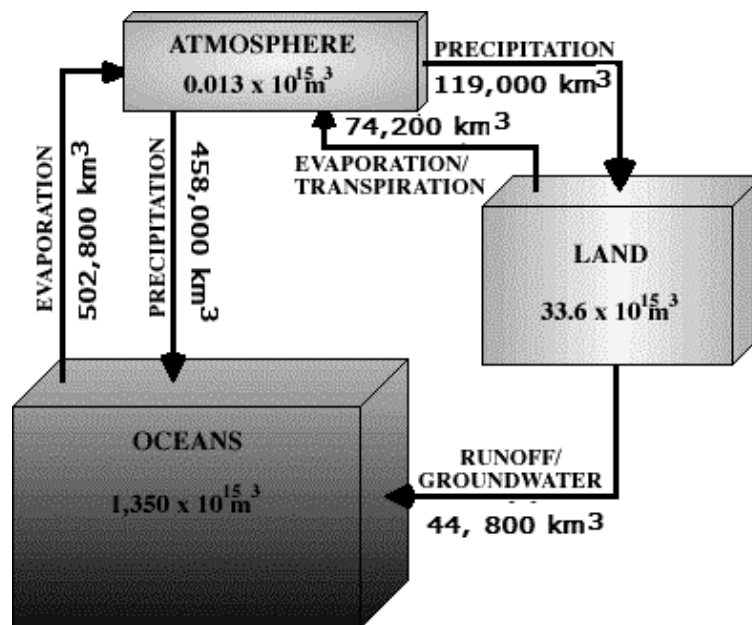


Fig. 18: Global Hydrological Balance (Source: Gleick, 1993)

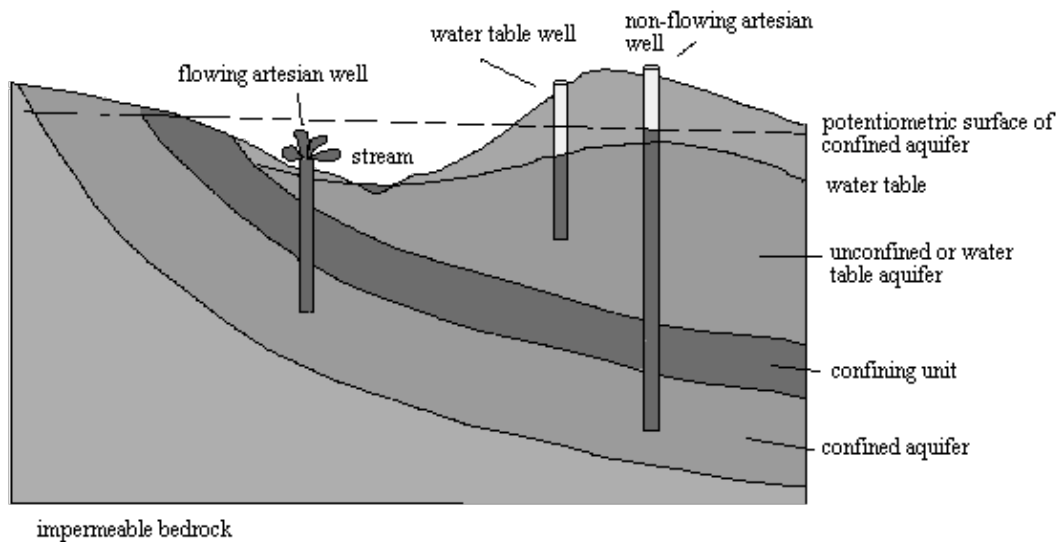
### 3.6.2 Aquifer: Types and Utilization

For groundwater hydrology, aquifer is most significant concept to study in detail. Terminologically, *aquifer* is a soil or geological formations which contain groundwater, which also have sufficient permeability to transmit and yield water in usable quantities. Based on the allocation and nature of bedding plans, aquifer is mainly two types:

1. Confined Aquifer: When groundwater is trapped between two impermeable layers, which may also pressurize is called confined aquifer. For example, one sandy layer between two clay layers. The term '*piezometric surface*' is connected with this aquifer.
2. Un-confined aquifer: When only one side of an aquifer is protected by impermeable layer is called unconfined aquifer. The term water table is linked with this type of aquifer.

Based on some unique characteristic, there are some other types of aquifers as follows:

3. Aquiclude: A geological formation with plenty of water with high porosity, however, due to less to negligible permeability it has no transmit capacity and behave like a impermeable layer. A clay layer is best example of this aquifer.
4. Aquitard: A saturated geological formation which is poorly permeable and hence it does not yield water freely to wells. Sandy Clay is the example of it.
5. Aquifuge: An impervious geological formation, which neither contains water not transmit water. Soil granite rock is an example.
6. Leaky Aquifer: An aquifer bound by one or two aquitard is called a leaky aquifer or a semi-confined aquifer.



**Fig. 19: Aquifer and its different components**

(after Michigan Environmental Education, 2018)

**Some Important Terminology of Aquifer**

**Porosity**: The ratio of volume of pore space to the volume of the formation. In unconsolidated materials porosity depends on the shape and size distribution of the particles

and their packing arrangement. Higher porosity denotes higher capacity to hold water. Clay material has maximum porosity.

**Permeability:** The capacity to transmit water through aquifer is called Permeability. Maximum permeability is observed in granular to sandy aquifer.

**Specific Yield:** the specific yield of an aquifer is the ratio of the volume of water which will drain freely from the material to the volume of the formation.

**Specific Retention:** A ratio between the volumes of water retain in the formation to the total volume of the formation.

**Hydraulic Conductivity:** It is a rate of groundwater flow under a unit hydraulic gradient.

**Darcy's Law:** A model to measure the velocity of groundwater. According to the model, the rate of flow of groundwater per unit area of aquifer is proportional to the gradient of the potential head measured in the direction of flow.

**Hydraulic Gradient:** It is a vector gradient between two or more hydraulic heads measured over the length of the flow path.

### 3.6.3 Importance of Piezometric Level

An imaginary or hypothetical surface of the piezometric pressure or hydraulic head throughout all or part of a confined or semi-confined aquifer. The piezometric surface provides an indication of the direction of groundwater flow and is used to determine hydraulic gradients. Whereas, groundwater table refers the depth of groundwater within the unconfined aquifer. The difference in the height between water table and piezometric is known as potentiometric. When several piezometric surface measurements are available, a hydrogeologist can determine recharge and discharge rates and most importantly groundwater-flow direction and rates.

### 3.6.4 Basin Hydrology

A drainage basin is well accepted hydrological unit to study the dynamics of water within a watershed. In hydrology, basin as a unit helps to measure quantitatively all the major parameters of hydrological cycle with a specific amount of precipitation input. The concept of 'Basin Hydrology was formed in 1994 by Mark Oliver, a surface water hydrologist, to provide a diverse client base with a variety of process-based hydrologic, hydraulic and restoration services'.

### ***Factor affecting hydrological response of a basin***

1. Soil and Geology
2. Vegetation and land use
3. Physiographical characteristic
4. Channel Characteristic
5. Meteorological Factors
6. Morphometry of Drainage Basin

### **3.6.5 Runoff: a key element of basin hydrology**

Runoff is the channelized flow (perennial or intermittent nature) of excess water from precipitations after fulfills the demand of surface infiltration. Runoff is major output of a drainage basin system. Runoff is usually expressed as volume per unit time and denotes by  $m^3/s$  or cumec. In hydrology, runoff at the specific outlet of a basin is also known as ‘*river discharge*’.

#### **Types of Runoff**

1. **Surface Runoff:** Runoff through the channels and as overland flow or sheet flow
2. **Sub-surface Runoff:** Flow through the immediate below of surface soil
3. **Groundwater Flow:** Flow of groundwater as per the hydraulic gradient

#### **Factor affecting Runoff**

The runoff of a basin is influenced by number of factors. The major categories are climatic factor and physiographic factors.

##### **A. Climatic Factors**

- a. Type of precipitation
- b. Intensity of rainfall
- c. Duration of rainfall
- d. Areal distribution of rainfall
- e. Direction of storm movement
- f. Other climatic factors that affect evaporation and transpiration

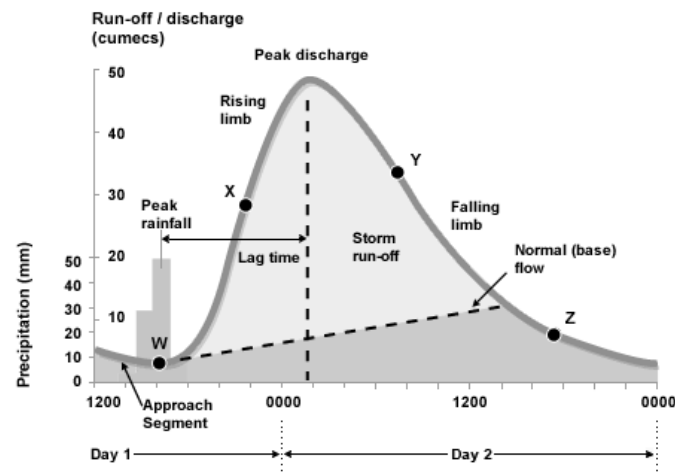
##### **B. Physiographical Factors**

- a. Land use
- b. Type of soil
- c. Area of the basin
- d. Shape of the basin
- e. Elevation

- f. Slope
- g. Orientation
- h. Type of drainage networks
- i. Indirect drainage
- j. Artificial drainage or source of water

### 3.6.6 Unit Hydrograph and Its Application

Hydrograph is a curve of discharge plotted against the time (daily, monthly, annual, year wise). A unit hydrograph of a drainage basin is defined as a hydrograph of direct runoff resulting from a unit amount of effective rainfall applied uniformly over the basin area at a uniform rate during a specified period of time. A hydrograph includes graphs of base flow and direct runoff, a rising limb, a peak, and a falling limb.



**Fig. 20: Different component of a hydrograph** (Source: BBC Web Page on Hydrograph, 2018)

#### Terminology of Hydrograph

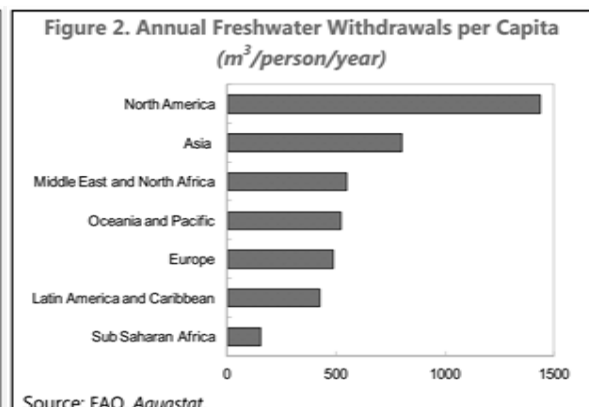
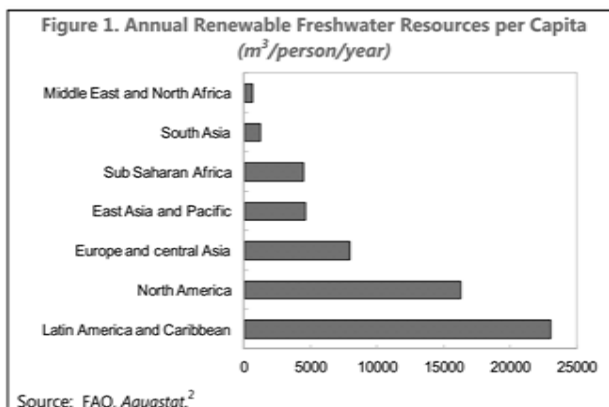
- a. Discharge: the rate of flow (volume per unit time) passing a specific cross-section of a channel.
- b. Rising Limb: Rising limb indicates the nature and rate of runoff concentration to that particular measure site.
- c. Peak: Highest point of the hydrograph, demote the maximum amount of discharge
- d. Falling limb: part of hydrograph from peak point to the end, represents the rate of output of water from the basin
- e. Lag-time: Time interval between peak rainfall amount and peak discharge amount.

## Major Application of Hydrograph

1. Flood frequency analysis and flood forecasting with return period calculation.
2. Understand of basin hydrology, temporally as well as spatially.
3. Estimation of groundwater potentiality and basin runoff.

### 3.6.7 Fresh Water Crisis: Issues and Management

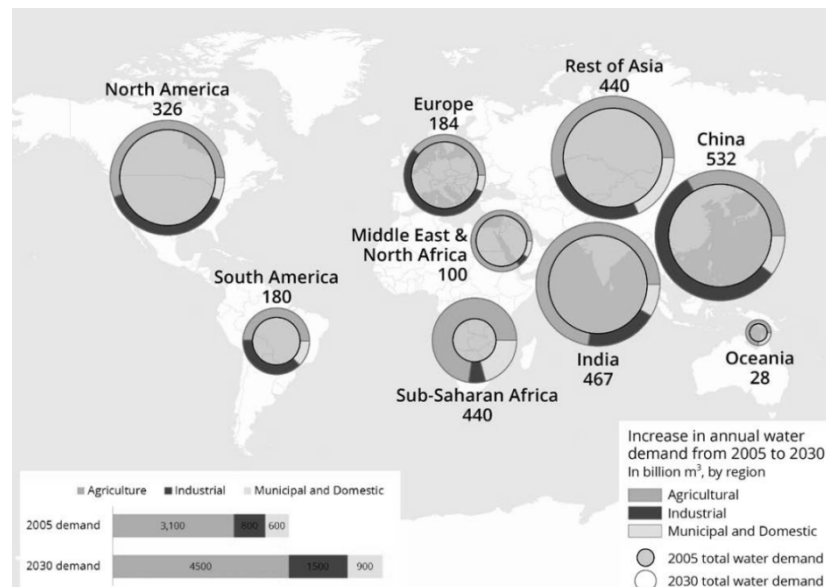
New research says over the past 32 years, between 1984 and 2015 permanent surface water has disappeared from an area of almost 90,000 square kilometres, roughly equivalent to that of Lake Superior (Pekel et al. 2016; Nature: 540, pp. 418 – 422). Freshwater scarcity is one of the most significant natural resource challenges of our generation, posing an enormous threat to global health and security. The World Economic Forum's 2014 top ten list of global risks ranks water crises as the number three global threat, behind a fiscal crisis in a major economy and structurally high unemployment (CEA, 2014). The report of Food and Agricultural Organization (FAO) shows a negative correlation between continent scale water supply and demand. About 70% of the Earth's surface is covered with water and 3% of it is actually fresh water that is fit for human consumption. Around two-thirds of that is tucked in frozen glaciers and unavailable for our use. According to WWF, some 1.1 billion people worldwide lack access to water, and a total of 2.7 billion find water scarce for at least one month of the year.



### Major causes of Freshwater Crisis

1. Exponential growth of world population and associated increase of water demand
2. Climate Change and Global Warming
3. Overuse of Water
4. Pollution of water

5. Political Conflict
6. Increasing drought
7. Destruction of Watershed by anthropogenic pressure



**Fig. 22: Projected increase in annual water demand over the world** (Sources: Addams et al. 2009; and report of California Environmental Associates or CEA (2014) on “Global Freshwater Challenges and Opportunities”

### Major Effects of Water Scarcity

1. Lack of drinking water
2. Lack of food security
3. Sanitation Problem
4. Loss of vegetation
5. Increasing temperature
6. Diseases and Parasites

### Major Solution and Way of Management

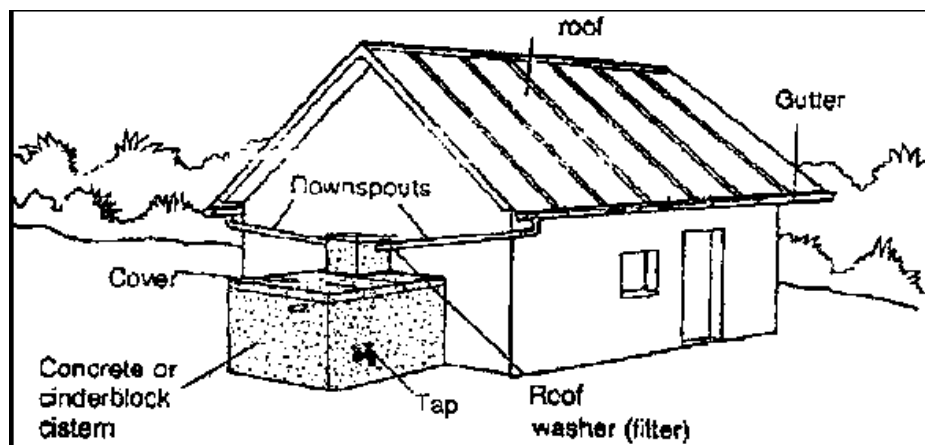
- People should be educated on the benefits of conserving water.
- Laws should be enacted to prevent water pollution. Those found polluting water should pay a fine or face imprisonment.
- People should be encouraged to recycle rain water.
- Farmers should be encouraged to adopt farming practices that use less water.
- Water catchment areas should be preserved.
- People should contribute funds to support clean water initiatives especially in areas that face water shortage.

### 3.6.8 Rain Water Harvesting

Rain water harvesting is one of the best reasonable methods of water resource management. The major aim of this method is to collect rain water and store for the future use.

A rainwater harvesting system consists of the three basic elements show in Figure:

- 1. A collection area.** In most cases this is the roof of a house or a building. The effective roof area and the material used in constructing the roof influence the efficiency of collection and the water quality.
- 2. A conveyance system.** This usually consists of gutters or pipes that deliver rainwater falling on the rooftop to cisterns or other storage vessels. Both drainpipes and roof surfaces should be constructed of chemically inert materials such as wood, plastic, aluminum, or fiberglass, in order to avoid adverse effects on water quality.
- 3. A storage system.** The water ultimately is stored in a storage tank or cistern, which should also be constructed of an inert material. Reinforced concrete, fiberglass, or stainless steel are suitable materials. Storage tanks may be constructed as part of the building, or may be built as a separate unit located some distance away from the building.



**Fig. 23: Process of rain water harvesting** (Source:

<http://www.dadychery.org/2011/11/05/rainwater-harvesting-reasonable-for-haiti/>)

#### Major Advantages

- Rainwater harvesting provides a source of water at the point where it is needed. It is owner operated and managed.
- It provides an essential reserve in times of emergency and/or breakdown of public water supply systems, particularly during natural disasters.

- The construction of a rooftop rainwater catchment system is simple, and local people can easily be trained to build one, minimizing its cost.
- The technology is flexible. The systems can be built to meet almost any requirements. Poor households can start with a single small tank and add more when they can afford them.
- It can improve the engineering of building foundations when cisterns are built as part of the substructure of the buildings, as in the case of mandatory cisterns.
- The physical and chemical properties of rainwater may be superior to those of groundwater or surface waters that may have been subjected to pollution, sometimes from unknown sources.
- Running costs are low.
- Construction, operation, and maintenance are not labor-intensive.

### **3.6.9 Significance of Watershed Management**

‘Watershed’ is basically an applied term of drainage basin in terms of water resource management. Watershed is the major geomorphic as well as hydrological unit to study. Watershed, as a unit of measure helps to estimate the potentiality of water resource over the surface to use water in different purposes, such as irrigation, domestic use, groundwater recharge etc.

#### **Type of Watershed**

Watershed is classified depending upon the size, drainage, shape and land use pattern.

- a. Macro watershed: 1000 -10,000 ha
- b. Micro watershed: 100 -1000 ha
- c. Mini watershed: 10 -100 ha
- d. Mille watershed: 1 -10 ha

#### **Importance to Manage Watershed**

1. Drought Mitigation
2. To reduce over exploitation of groundwater
3. To reduce extending desertification
4. To stop deforestation
5. Manage the problem of water scarcity
6. To ensure the food security

7. Reduce the effect of Climate Change and Global Warming
8. To reduce the soil erosion by protecting bank erosion, overland flow, increasing the area of infiltration
9. Protection of Riverine Ecology and Wild life Protection
10. Flood Management

### **Watershed Management Programmes**

1. Drought Prone Area Programme (DPAP)
2. Desert Development Programme (DDP)
3. National Watershed Development Programme for Rainfed Agriculture (NWDPA)
4. Control of Shifting Cultivation
5. World Bank Assisted Integrated Watershed Development Project

### **Watershed Management Practices:**

#### A. In Terms of Purpose

- (i) To increase infiltration
- (ii) To increase water holding capacity
- (iii) To prevent soil erosion

#### B. Method and Accomplishment:

- (i) Vegetative measures/Agronomical measures:
  - (a) Strip cropping
  - (b) Pasture cropping
  - (c) Grass land farming
  - (d) Woodlands
- (ii) Engineering measures/Structural practices:
  - (a) Contour bunding
  - (b) Terracing
  - (c) Construction of earthen embankment
  - (d) Construction of check dams
  - (e) Construction of farm ponds
  - (f) Construction of diversion
  - (g) Gully controlling structure
  - (h) Rock dam
  - (i) Establishment of permanent grass and vegetation
  - (j) Providing vegetative and stone barriers

### 3.7 Self-assessment Test

1. What is global hydrological cycle? What are major parameters involved in global hydrological cycle? Explain the water balance of the Earth.
2. What is the role of aquifer in the development of groundwater?
3. What drainage basin treated as a major hydrological unit to study?
4. Write a note on runoff. Role of land use land cover on the runoff.
5. Define hydrograph. Importance of hydrograph in flood management.
6. What are major causes of fresh water crisis over the world?
7. What is watershed? What is the importance of watershed management?
8. Describe the importance of rainwater harvesting at present day scenario.

### 3.8 Summaries and Key Points

In the present time, the subject like hydrology is very essential to study and research than any other field due to the increasing important to manage water, specially the quality and quantity of drinking water. A short and brief knowledge provided in this study material can help the students to understand the basic of our hydrosphere and rising problem and way to solve them. A major focus has been given to the crisis and management of water, where quantitative data base can help to understand it properly. The rainwater harvesting model also explains in detail, which one is the best ongoing process of water management in the developed and developing counties. Importance of river basin hydrology is essential to know everyone. The information regarding this issue is provided here in detail.

### 3.9 Study tips

- i. Hydrology: Principles, Analysis, Design” by H M Raghunath
- ii. “A Textbook of Hydrology” by P Jaya Rami Reddy
- iii. “Soil and Water Conservation Engineering” by Suresh

#### **Disclaimer**

This self-learning material is based on different books, journals and web-sources.

**Post-Graduate Degree Programme (CBCS)**  
**in**  
**GEOGRAPHY**

**Semester-I**

**Paper: GEO102T**

**Self-Learning Material**



**DIRECTORATE OF OPEN AND DISTANCE LEARNING**  
**UNIVERSITY OF KALYANI**

**Kalyani, Nadia**  
**West Bengal, India**

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## **Director's Note**

Open and Distance Learning (ODL) systems play a threefold role- satisfying distance learners' needs of varying kinds and magnitudes, overcoming the hurdle of distance and reaching the unreached. Nevertheless, this robustness places challenges in front of the ODL systems managers, curriculum designers, Self Learning Materials (SLMs) writers, editors, production professionals and other personnel involved in them. A dedicated team of the University of Kalyani under the leadership of Hon'ble Vice-Chancellor has put its best efforts, professionally and in unison to promote Post Graduate Programmes in distance mode offered by the University of Kalyani. Developing quality printed SLMs for students under DODL within a limited time to cater to the academic requirements of the Course as per standards set by Distance Education Bureau of the University Grants Commission, New Delhi, India under Open and Distance Mode UGC Regulations, 2017 had been our endeavour and we are happy to have achieved our goal.

Utmost care has been taken to develop the SLMs useful to the learners and to avoid errors as far as possible. Further suggestions from the learners' end would be gracefully admitted and to be appreciated.

During the academic productions of the SLMs, the team continuously received positive stimulations and feedback from Professor (Dr.) Sankar Kumar Ghosh, Hon'ble Vice- Chancellor, University of Kalyani, who kindly accorded directions, encouragements and suggestions, offered constructive criticism to develop it within proper requirements. We gracefully, acknowledge his inspiration and guidance.

Due sincere thanks are being expressed to all the Members of PGBOS (DODL), University of Kalyani, Course Writers- who are serving subject experts serving at University Post Graduate departments and also to the authors and academicians whose academic contributions have been utilized to develop these SLMs. We humbly acknowledge their valuable academic contributions. I would like to convey thanks to all other University dignitaries and personnel who have been involved either at a conceptual level or at the operational level of the DODL of University of Kalyani.

Their concerted efforts have culminated in the compilation of comprehensive, learner-friendly, flexible texts that meet the curriculum requirements of the Post Graduate Programme through Distance Mode.

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Director  
Directorate of Open & Distance Learning  
University of Kalyani



March, 2018

## **SYLLABUS**

### **Paper–GEO102T**

**Semester-I;**

**Paper–GEO102T: (Total Credit-4, Total Marks–100)**

#### **Group–GEO102T.1: Climatology (Total Credit–2)**

- Unit-1:** Nature and scope of Climatology
- Unit-2:** Air-masses and atmospheric stability and instability
- Unit-3:** Adiabatic processes
- Unit-4:** Tri-cellular model
- Unit-5:** Monsoon: Recent theories of its origin
- Unit-6:** El Nino, Southern Oscillation and La Nina
- Unit-7:** Weather forecasting: short, medium and long range
- Unit-8:** Global warming and climate change

#### **Group–GEO102T.2: Soil Geography (Total Credit–1)**

- Unit-9:** Soil taxonomy and world pattern of soils
- Unit-10:** Soil nutrients; soil organisms; Micro-organisms and their relation with soil fertility
- Unit-11:** Soil pollution and soil degradation
- Unit-12:** Concept of integrated management of soil

#### **Group–GEO102T.3: Biogeography (Total Credit–1)**

- Unit-13:** Nature, scope and significance of Biogeography; Plant ecology: Concept of Adaptation, Succession and Climax
- Unit-14:** Impact of climate and soil on distribution of plants
- Unit-15:** Means and barriers of dispersal and migration of animals
- Unit-16:** Biodiversity and related issues; International Biological Programme; Man and Biosphere Programme



# Content

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	<b>Page No.</b>
<b>CLIMATOLOGY</b>	
1.1 Introduction	9
1.2 Learning Objectives	9
1.3 Assessment of Prior Knowledge	9
1.4 Learning Activities	9
1.5 Feedback of Learning Activities	9
1.6 Examples and Illustrations	10
<b>Unit-1</b>	
1.6.1 Nature and Scope of Climatology	10
<b>Unit-2</b>	
1.6.2 Air-masses and atmospheric stability and instability	13
<b>Unit-3</b>	
1.6.3 Adiabatic processes	21
<b>Unit-4</b>	
1.6.4 Tri-cellular model	21
<b>Unit-5</b>	
1.6.5 Monsoon: Recent theories of its origin	22
<b>Unit-6</b>	
1.6.6 El Nino, Southern Oscillation and La Nina	24
<b>Unit-7</b>	
1.6.7 Weather forecasting: short, medium and long range	25
<b>Unit-8</b>	
1.6.8 Global warming and climate change	28
<b>SOIL GEOGRAPHY</b>	
2.1 Introduction	32
2.2 Learning Objectives	32
2.3 Assessment of Prior Knowledge	32
2.4 Learning Activities	33
2.5 Feedback of Learning Activities	33
2.6 Examples and Illustrations	33
<b>Unit-9</b>	
2.6.1 Soil taxonomy and world pattern of soils	33
2.6.1.1 Concept of Soil Taxonomy	33
2.6.1.2 Soil classification system	34
2.6.1.3 Soil orders	37
<b>Unit-10</b>	
2.6.2. Soil nutrients and soil organisms	39
2.6.2.1 Concept of soil nutrients	39
2.6.2.2 Functions of soil nutrients	39

2.6.2.3	Sources of soil nutrients	41
2.6.2.4	Soil organisms	42
2.6.2.5	Role of soil organisms	43
2.6.3	Micro-organisms and their relation with soil fertility	44
2.6.3.1	Classification of micro-organisms	44
2.6.3.2	Role of micro-organisms in soil fertility	44
<b>Unit-11</b>		
2.6.4	Soil pollution and soil degradation	45
2.6.4.1	Soil pollution	45
2.6.4.2	Types of soil pollution	46
2.6.4.3	Sources of soil pollution	46
2.6.4.4	Effects of soil pollution	47
2.6.4.5	Controlling measures of soil pollution	48
2.6.4.6	Soil degradation	48
2.6.4.7	Types of soil degradation	48
2.6.4.8	Effects of soil degradation	49
2.6.4.9	Strategies to mitigate soil degradation	50
<b>Unit-12</b>		
2.6.5	Concept of integrated management of soil	50
2.6.5.1	Principles of the integrated soil management approaches	50
2.7	Self assessment test	51
2.8	Summaries and key points	52
<b>BIOGEOGRAPHY</b>		
3.1	Introduction	55
3.2	Learning Objectives	55
3.3	Assessment of Prior Knowledge	56
3.4	Learning Activities	56
3.5	Feedback of Learning Activities	56
3.6	Examples and Illustrations	57
<b>Unit-13</b>		
3.6.1	Nature, scope and significance of Biogeography	57
3.6.2	Plant ecology: Concept of Adaptation, Succession and Climax	59
<b>Unit-14</b>		
3.6.3	Impact of climate and soil on distribution of plants	65
<b>Unit-15</b>		
3.6.4	Means and barriers of dispersal and migration of animals	69
<b>Unit-16</b>		
3.6.5	Biodiversity and related issues	73
3.6.6	International Biological Programme	76
3.6.7	Man and Biosphere Programme	77

**SEMESTER-I; PAPER – GEO102T; GROUP – GEO102T.1: CLIMATOLOGY**  
**(Credit – 2; Marks - 50: Internal Evaluation – 10, Semester-end Examination - 40)**

### **1.1 Introduction**

In this lesson, different aspects of climatology and climate will be discussed. By subdividing the branches of climatology, the content and scope is elaborated. Air masses and related aspects like adiabatic lapse rate, stability and instability, their relationship and resultant influence on climate is discussed. Atmospheric circulation and origin of monsoon are explained with help of few models and theories and brief overview of weather forecasting is incorporated in this lesson. Some abnormalities like El Nino, La Nina, global warming, climate change are discussed.

### **1.2 Learning Objectives**

After going through this unit, the learners will able to

- Describe the content of the climatology
- Elucidate the concept of air mass, adiabatic lapse rate, stability and instability.
- Explain the mechanism of atmospheric circulation, monsoon, ENSO
- Write overview of the global warming and climate change

### **1.3 Assessment of prior knowledge**

1. What do you mean by climate?
2. Highlight the major components of weather.
3. Differentiate the climate from weather.
4. State the relationship between pressure belts and planetary winds.

### **1.4 Learning Activities**

Climatology deals with the climate, its elements, regional variations and influence on plants, animal and human activities. Going through the different climatic aspects, learners will be able to assess different climatic phenomena, their dynamics and cause-effects relationships of atmospheric conditions. In this regard, learners may collect the temporal and spatial data on different elements of climate and thereby, examine the trend of temperature, rainfall, humidity etc. as well as their spatial distribution. Besides, synoptic charts and different statistical simulation are to be prepared based on climatic data to predict the future weather conditions, climate change etc.

### **1.5 Feedback of Learning Activities**

As feedback of learning activities, learners will consult with the groups and instructors regarding their objectives, methods and other related problems of the climate related projects and acquire

necessary instructions and solutions. From the completion of these activities, they will be able to endow their knowhow both from theoretical and practical backgrounds.

## **1.6 Examples and Illustrations (Subject content)**

### **1.6.1 Nature and Scope of Climatology**

#### **1.6.1.1 Definition of climatology**

Critchfield define that ‘climatology is the science that seeks to describe and explain the nature of climate, how it differs from place to place and how it is related to man’s activities’. Thornthwaite broadens the scope of climatology and suggest that ‘it is the study of the atmosphere as well as the Earth’s surface’. According to Bryson ‘climatology is the thermodynamic/hydrodynamic status of the global boundary conditions that determine the concurrent array of weather patterns’. Lamb's definition of climatology, however, reveals most about his own approach to the study of climate: ‘Climatology, the study of climate, the long-term aspects and total effects of meteorological processes, is (like meteorology) a branch of Earth physics (geophysics). It is concerned with the various conditions of the atmosphere that occur and with everything that, habitually or occasionally, influences the condition of the atmosphere, either locally or over great regions of the Earth’.

Therefore, the focus of climatology is to explain the atmospheric phenomenon over a period of time in local, regional and global level. Thus, climatology encompasses the themes in its study are structure and composition of the atmosphere, elements of weather and climate, insolation and energy balance, atmospheric temperature, pressure, motion and circulation, atmospheric humidity, condensation, precipitation, climatic classification and climate change, effects of climate on plants, animal and human being and also the modification of climate by human activities.

#### **1.6.1.2 Subdivision of climatology**

Climatology evolves the versatile contents in its study. So, based on nature of study, method and principles of the study, climatology has some subdivisions. These are physical climatology, dynamic climatology, regional climatology, applied climatology, satellite climatology etc.

Physical climatology- It deals with the physical properties of atmosphere i.e. mechanism, process and factors of different weather and climatic conditions. It explains temporal and spatial variation of atmospheric phenomena and applies the methods and principles of meteorology and physical sciences to explain this variation. Insolation, air temperature, air pressure, humidity, condensation, precipitation etc. are studied in this branch of climatology. As it concern with the general circulation of atmosphere and dynamic relation of earth and atmosphere, it is also known as *dynamic climatology*.

Regional climatology- It study the climate on regional basis i.e. it includes study of micro climate, meso climate and macro climate. Macro level climatology refers to the largest areal unit of climatic studies. It may vary from a country, continent to whole globe. World climatic classification, global atmospheric circulation studies are included in this level. As larger spatial scale is concern with this level, generalization is more common than detailing. For analyzing climatic condition vividly, macro level subdivided into different meso level. Initially, physical characteristics were used to identify the meso climatic region but recently, developed technology of data collection and analysis (satellite, radio sound, radar, computer etc.) has been strengthening the different meso climatic atmospheric phenomena identifications. Different extreme cyclonic conditions such as tornado, hurricane, precipitation pattern etc. are studied in this regional scale. For further vivid study of climate, micro climatic analysis has got wide emphasis and it refers to the smallest unit of climatic studies. It is totally rely on the data collected from field work. M.M. Yoshino has identified four levels of climatic studies in regional climatology i.e. micro, local, meso and macro clima

#### Level of Regional Climatology after Yoshino

Level	Horizontal Extension	Vertical Extension	Example
Micro	Less than one meter to 100 m.	Ground surface to 100 m.	Single crop field
Local	100-1000 m.	Ground surface to 1000 m.	Forest cover, urban area
Meso	100 m. to 20 km	Ground surface to 6 km.	Ganga plain
Macro	More than 20 km	Ground surface to more than 6 km	Country, continent

Applied climatology-It is mainly concerned with the application of climatic principles and knowledge to solve the specific problems faced by human being and betterment of human life on the earth. Applied climatology studies the symbiotic relationship of climate and biosphere i.e. it studies the influence of climate on plants, animals and man as well as stresses the modification and changes of climate by human activities. Now, applied climatology has flourished with numerous specialized branches such as agro-climatology, bio climatology, urban climatology, architectural climatology, medical climatology etc. to address specialized field like climate and agriculture, climate and urban planning, climate and transport communication, climate and comfort and health, postdiction and prediction of climate etc.

Satellite climatology is another subdivision of climatology and it is associated with the climatic observation through satellites. Mainly two types of satellite geosynchronous (equatorial orbit and high altitude) and Sunsynchronous (polar orbit and low altitude) with various sensing system collect weather information of every hour and provides a updated data about the weather conditions.

### **1.6.1.3 Approaches of climatology**

Climatology in its content, incorporates a vast and versatile subject matter ranging from study of climatic phenomena to the relationship of climate and biotic elements. Different ways of thinking, ideas, principles, philosophy, methods are followed in climatology such as descriptive approach, synoptic approach, interdisciplinary approach etc.

Descriptive approach deals with the description of climatic characteristics in various spatial scales. It involves the study of world climatic classification based on air temperature, air pressure, humidity, precipitation etc.

Synoptic approach refers to the analysis of climatic variation of the earth and it involves genetic methods i.e. cause effect analysis, empirical study i.e. field based analysis and numerical analysis i.e. statistical analysis of the climatic phenomena. This approach is very meaningful in the investigation of palaeoclimate (past climate) and their reconstruction and prediction of future climate (forecasting).

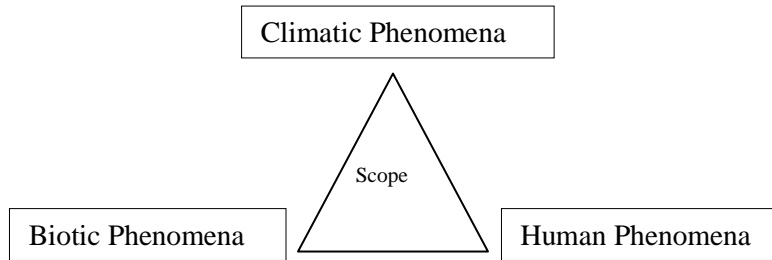
Interdisciplinary approach grew out from the symbiotic interaction of different disciplines to study the human problems. It means climatology borrow different aspects of knowledge, principles, methods etc. to study its contents and on the other hands, climatic knowledge and principles are used in different other disciplines for better understanding of human life. Such interdisciplinary approach gives birth agroclimatology, architectural climatology, urban climatology, tourism climatology, medical climatology etc.

### **1.6.1.4 Scope of climatology**

Broadly, climatology involves three major objectives in its scope-

- i. Study of climatic phenomena
- ii. Relationship between climatic phenomena and biotic phenomena
- iii. Relationship between climatic phenomena and human being

The first objective deals with the identification, description, analysis, interpretation of different climatic types, their distribution, variation, causes, factors, process studies i.e. the it includes the description and analysis of elements of weather and climate like insolation, temperature, air pressure, atmospheric circulation, humidity, precipitation and characteristics of different climatic types. The second and third objectives indicate the applied aspects of climatology which study the influence of climate on plants and animals including man as well as modification and changes of climate by human activities. Climatic region and biome, climate and civilization, climate change and modification are the focus arena of this aspect.



Therefore, scope of the climatology can be studied through the study of its major branches and approaches such as physical climatology, regional climatology, applied climatology etc. Therefore, scope of climatology evolves round the following themes-

1. Elements of weather and climate
2. Structure and composition of the atmosphere
3. Insolation and energy balance
4. Atmospheric temperature, pressure, motion and circulation
5. Local and seasonal winds
6. Atmospheric humidity and condensation
7. Fogs, clouds and precipitation
8. Air masses
9. Atmospheric disturbances
10. Classification of climates and their salient characteristics
11. Factors in variation climatic characteristics
12. Influence of climate on flora and fauna
13. Influence of climate on human being and climatic modification by human being
14. Climate change and weather forecasting

## **1.6.2 Air masses**

### **1.6.2.1 Definition of air masses**

According to Barry and Chorley (1968) an air mass may be defined as a large body of air whose physical properties, especially temperature and moisture content and lapse rate (of temperature) are more or less uniform horizontally for hundreds of kilometers. A.N. Strahler and A.H. Strahler (1978) define air mass as a body of air in which the upward gradients of temperature and moisture are fairly uniform over a large area is known as air mass. According to Oliver and Hidore (2003) air mass is a large, horizontal, homogeneous body of air that may cover thousands of square kilometers and extend upward for thousands of meters. Its uniformity is principally one of temperature and humidity. So, an air mass is an extremely large body of air having more or less homogeneity properties of temperature and moisture content (humidity) both horizontally and vertically.

## Characteristics of Air masses

1. An air mass originates when atmospheric condition remain stable and uniform over a extensive area for fairly long period.
2. An air mass is seldom stationary over the source region rather it travels to other regions.
3. Contrasting air masses tend to remain separate by distinct sloping boundary surface, called front.
4. Air mass is modified by path, time and destination region.

Source Regions of Air mass: Source Regions are simply geographic areas where an air mass originates. Extensive and uniform surface and stable atmospheric condition etc. are some required characteristics of source region. Source region may be classified as equatorial, tropical, polar, arctic on the basis of latitude and continental and maritime on the basis of nature of surface.

### 1.6.2.2 Modification of air masses

Air mass modification broadly classified into two viz. *thermodynamic modification* by exchange of heat with underlying surface or by changes in moisture content due to changing evaporation or by increase of moisture content from precipitation of overlying moist air and *mechanical modification* by the process of uplift or subsidence, divergence or convergence of air or by turbulent mixing. Thermodynamic modification of an air mass depends on initial temperature and moisture character of the air mass, nature of land or water surface, path of movement and time of travel. On the other hand, mechanical modification depends on convection, advection, cyclonic, anticyclonic condition etc.

### 1.6.2.3 Classification of air masses

Air masses are classified on the basis of source region and their subsequent modification as moves away from source regions. Systematically, the classification of air masses can be organized as follows-

1. Geographical Classification (based on source region)
  2. Thermodynamic Classification (based on modification)
  3. Composite Classification (based on combination)
1. Geographical Classification: Petterssen has identified five types of air masses on the basis of the source region viz. *tropical air mass*, *polar air mass*, *arctic*, *antartic* and *equatorial*. But, Trewartha, on the basis of geographical location of air masses, has classified into two groups i.e. *polar air mass* (formed pole-ward of 60°) which is denoted by capital 'P' and *tropical air mass* (formed within 30° of the equator), denoted by capital

'T'. He also opined that Arctic, Anterctic and Equatorial air masses are considered to be modified form of Tropical and Polar air masses.

These two types of air masses have been further subdivided on the basis of nature of surface of their source region i.e. land or water surface- continental air mass (c)- formed over large land masses and maritime (m) -formed over the oceans. So, on the basis of source region as well as the nature of surface, the principal types of air masses are-

- cP – continental polar air mass
- mP- maritime polar air mass
- cT – continental Tropical air mass
- mT – maritime tropical air mass

Continental polar (cP) air masses:

*Origin:* North America and Eurasia in the sub -Arctic zone i.e. Siberia, northern Canada, Greenland and Antarctica.

*Characteristics:*

- Low specific humidity
- Very cold in winter
- The depth of these air mass is almost 3km for heavy coldness
- Due to coldness, cPWs type of air mass is formed at the centre of the source region.
- cP lost its characteristics when passes over the ocean because it takes both heat and moisture from the ocean and turn into mPKu air mass.

Maritime poplar (mP) air masses:

*Origin:* mid latitude oceans

*Characteristics:*

- Consist of cool moist air with steep laps rate
- Orographic type of precipitation.

Continental tropical (cT) air masses:

*Origin:* Subtropical deserts

*Characteristics:*

- less water vapour content

- Low relative humidity
- At summer time temperature is 50 ° -55°C
- Hottest air mass at the surface
- cT changes into mT air mass when cT leaves its source region and begins to hold moisture.
- cT air mass dominates over North America in winter and South Africa in summer.

Maritime tropical (mT) air masses:

*Origin:* warm oceans in the tropical and subtropical zones

*Characteristics:*

- high specific humidity
- Heavy precipitation
- Cumulus and cumulonimbus type of cloud

2. Thermodynamic Classification: on the basis of under the Influence of Underlying Surface air mass may be warm air mass-warmer than underlying surface (W) and cold air mass-colder than underlying surface (K) and on the basis of heat exchange between air mass and underlying surface air mass may be stable (s) and unstable (u)

3. Composite Classification: Based on the geographical and thermodynamic classifications combinedly, 16 types of air masses are classified.

#### A. Tropical Air masses

1. cTWs – Continental Tropical Warm Stable
2. cTWu – Continental Tropical Warm Unstable
3. cTKs – Continental Tropical Cold Stable
4. cTKu – Continental Tropical Cold Unstable
5. mTWs – Maritime Tropical Warm Stable
6. mTWu – Maritime Tropical Warm Unstable
7. mTKs – Maritime Tropical Cold Stable
8. mTKu – Maritime Tropical Cold Unstable

#### B. Polar Air masses

1. cPWs– Continental Polar Warm Stable

2. cPWu– Continental Polar Warm Unstable
3. cPKs – Continental Polar Cold Stable
4. cPKu– Continental Polar Cold Unstable
5. mPWs– Maritime Polar Warm Stable
6. mPWu– Maritime Polar Warm Unstable
7. mPKs– Maritime Polar Cold Stable
8. mPKu– Maritime Polar Cold Unstable

#### **1.6.2.4 Front**

When two contrasting air masses (mainly temperature and moisture contrast) moves towards each other, they converge in a zone with distinct sloping boundary, called front. It may be called as the zone of transition or line of discontinuity between two contrasting air masses and their associated weather condition. Along the front, warm air mass ascends or push upward and cold air mass settles downwards. The process of front formation is called frontogenesis and decaying of front is called frontolysis.

#### **1.6.2.5 Types of front**

On the basis of dynamic characteristics and invading (aggressive) air mass, four types of front have identified. These are - warm, cold, occluded and stationary fronts.

**Warm front:** When warm air mass is active and aggressive, warm air mass slowly overrides the cold air mass along a gentle slope and form warm front. The gentler slope of this front results from the retreatment and friction of cold air mass which slows down the advances of surface position of front.

As warm air mass ascends over cold air mass, it expands and cools by adiabatic rate to produce clouds and precipitation which is determined by the nature of stability and instability of the warm air mass. When the air mass is stable with low moisture content, it condense at greater distance from the surface point of the front and form stratified clouds which produce moderate to low precipitation for a longer time over a larger region. In winter seasons, it may caused fog and drizzle. Though occasional, when warm air mass is inherently unstable with high moisture content, it associates with cumulonimbus clouds and violent thunderstorms. After the passage of warm front, pressure beings to decrease, sky become clear and wind shift from easterly to southerly direction.

**Cold front:**When cold air mass active and aggressive, it advances towards region of warm air mass and push the warm air mass upwards and denser and heavier cold air mass remain at

ground. This type of front is known as cold front. Due to the free movement of air mass above the surface, cold front becomes steeper than warm front.

As cold front associates with rapid vertical movement of warm air, it results into thick clouds, heavy downpour with thunderstorm, lightening of shorter duration. After the passage of cold front, sky becomes rapidly clear and weather improves.

Occluded front: When cold front and warm front combine into one, occluded front formed and warm air completely displaced from ground. Occluded front is of two types- cold front occlusion when cold front overtakes the warm front and warm front occlusion when warm front overtakes the cold.

Weather condition associates occluded front is very complex and reveals a combination of warm and cold front weather. Cooling, condensation, precipitation are common phenomena along occlusion and it is the decaying stage of cyclone as the warm air displaced from its source of energy.

Stationary front: When neither warm air mass nor cold air mass overtakes each other rather they move parallel along a boundary which forms stationary front. Both the air masses remain at surface level.

Stationary front usually characterized by unpredictable weather. Sometimes, warm front types precipitation may occur when warm air overruns the cold air.

### **1.6.2.6 Stability and Instability**

Stability and instability are two atmospheric conditions based on the vertical motion of air parcel. The nature of vertical motion depends upon the relationship of normal lapse rate ( $6.5^{\circ}\text{C}/\text{km}$ ) and adiabatic lapse rate.

Stability is that atmospheric conditions in which vertical motion of air parcel is restricted. If ascending air parcel is colder than surrounding environment, uprising of air is restricted and it starts to descend. When dry adiabatic lapse (DALR) rate is greater than environmental lapse rate (ELR), stability prevails in the atmosphere. For example, the temperatures of ascending air parcel and environment on ground are  $30^{\circ}\text{C}$  and  $25^{\circ}\text{C}$  respectively. At the elevation of 2km, the former gets  $10^{\circ}\text{C}$  temperature due to adiabatic cooling ( $10^{\circ}\text{C}/\text{km}$ ) and latter's temperature is  $15^{\circ}\text{C}$  as it cools by normal lapse rate ( $5^{\circ}\text{C}/\text{km}$ ). Thus, at this height, rising air parcel is colder than surrounding environment and tends to move downwards.

Sometimes, rising air still bound to sink down even after condensation at dew point when wet adiabatic rate (WALR) is greater than environmental lapse rate. Such stability is called *absolute stability*.

### Absolute stability (ELR<WALR<DALR)

Height (Mts.)	Temperature of environment (ELR-5 <sup>0</sup> C/km)	Temperature of air parcel (DALR-10 <sup>0</sup> C/Km and WALR-6 <sup>0</sup> C/Km)	Remarks
<b>Surface</b>	20 <sup>0</sup> C	20 <sup>0</sup> C	Dry adiabatic lapse rate
<b>1000</b>	15 <sup>0</sup> C	10 <sup>0</sup> C	
<b>2000</b>	10 <sup>0</sup> C	0 <sup>0</sup> C	Condensation level
<b>3000</b>	5 <sup>0</sup> C	-6 <sup>0</sup> C	Wet adiabatic lapse rate
<b>4000</b>	0 <sup>0</sup> C	-12 <sup>0</sup> C	

On the other hand, continuous vertical movement of air parcel having higher temperature than its surroundings is called atmospheric *instability*. Instability or rising of air parcel ceased when temperature of rising air parcel coincides with the temperature of the surrounding environment. When dry adiabatic rate is lower than environmental lapse rate, the ascending air parcel always remains warmer than surrounding and continues to rise upward. Such continued vertical movement is termed as *absolute instability*.

When moist air has a environmental lapse rate between dry and wet adiabatic rate, instability occurs only after attaining the condensation level and it is called *conditional instability*. ‘Condition’ is used because only if the air parcel is forced to attain condensation level, it becomes unstable and convergence, turbulence, orographic lifting help the air parcel to attain such level.

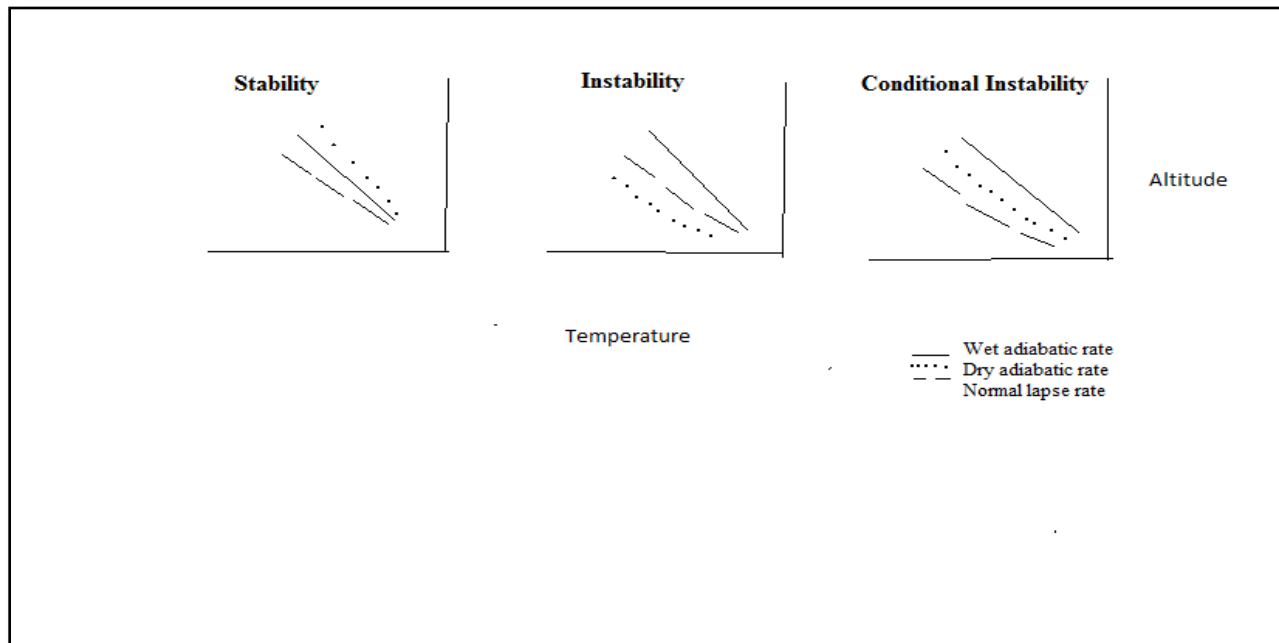
Various weather phenomena are associated with atmospheric stability and instability. Stable condition leads to subsistence and formation of inversion of temperature, fog, anticyclone etc. while instability helps to form vertically thickened clouds and heavy downpours.

Though the causes of these phenomena are still mysterious, the impact of these are very prominent both in tropical and subtropical region. Rhythm of Indian monsoon is also influenced by these shifting conditions of atmosphere.

## Absolute and Conditional Instability

	<b>Absolute (ELR&gt;DALR&gt;WALR)</b>	<b>Instability</b>	<b>Conditional (DALR&gt;ELR&gt;WALR)</b>	<b>Instability</b>	<b>Remarks</b>
<b>Height (Mts.)</b>	Temperature of environment (ELR-12 <sup>0</sup> C/km)	Temperature of air parcel (DALR-10 <sup>0</sup> C/Km and WALR-5 <sup>0</sup> C/Km)	Temperature of environment (ELR-8 <sup>0</sup> C/km)	Temperature of air parcel (DALR-10 <sup>0</sup> C/Km and WALR-6 <sup>0</sup> C/Km)	
<b>Surface</b>	40 <sup>0</sup> C	40 <sup>0</sup> C	40 <sup>0</sup> C	40 <sup>0</sup> C	Dry adiabatic lapse rate
<b>1000</b>	28 <sup>0</sup> C	30 <sup>0</sup> C	32 <sup>0</sup> C	30 <sup>0</sup> C	
<b>2000</b>	16 <sup>0</sup> C	20 <sup>0</sup> C	24 <sup>0</sup> C	20 <sup>0</sup> C	
<b>3000</b>	4 <sup>0</sup> C	15 <sup>0</sup> C	16 <sup>0</sup> C	14 <sup>0</sup> C	Condensation level
<b>4000</b>	-8 <sup>0</sup> C	10 <sup>0</sup> C	8 <sup>0</sup> C	8 <sup>0</sup> C	Wet adiabatic lapse rate
<b>5000</b>	-20 <sup>0</sup> C	5 <sup>0</sup> C	0 <sup>0</sup> C	2 <sup>0</sup> C	
<b>6000</b>	-32 <sup>0</sup> C	0 <sup>0</sup> C	-8 <sup>0</sup> C	-4 <sup>0</sup> C	

## Comparison of Stability, instability and conditional instability of atmosphere



### 1.6.3 Adiabatic lapse rate

For condensation process, one of the pre requisite conditions is cooling of air. Cooling of air may occur in diabatic process and adiabatic process. In adiabatic process of cooling there is no addition or subtraction of heat is involved, only expansion of air due to decrease of pressure leads to cooling of air. Adiabatic change of temperature is of two types-

i. Dry adiabatic change

ii. Wet adiabatic change

**Dry adiabatic change:** When a parcel of air ascends, it passes through the successive lower pressure region. So the air parcel expands and cools. Conversely, descending air parcel heats up. This type of change of temperature of unsaturated air (dry air) is called dry adiabatic lapse rate. The average rate of this change of temperature is  $10^{\circ}\text{C}$  per km.

**Wet adiabatic change:** The rate of temperature change of ascending air beyond the condensation level (saturated air) is lowered down due to release of latent heat of condensation. This type of change of temperature of saturated air is called wet adiabatic lapse rate. It varies from  $3^{\circ}\text{C}$  to  $6^{\circ}\text{C}$  per km depending on the temperature and moisture content of air.

### 1.6.4 Tri cellular model

Apart from the surface and horizontal flows, winds have vertical and upper surface flows also. Such surface and upper surface flows combinedly form convective cell. Initially, assuming non rotating earth, unicellular convection of global atmospheric circulation extending equatorial to polar region was postulated but considering earth rotation, the atmospheric circulation is explained with the help of tricellur model. According to this model there is three cells circulation in both hemispheres. These are -

- (a) Hadley cell or low latitude cell
- (b) Ferrel cell or middle latitude cell
- (c) Polar cell or high latitude cell

Hadley and polar cells are thermally induced cells while ferrel cell is directed by these two cells.

**Hadley cell or low latitude cell:** When north eastern and south eastern trade reach equator, particularly the ITCZ (Inter-tropical convergence zone), the winds rise to upward due to convergence and convection. After a certain height (about 14 km i.e. tropopause), the winds start to flow poleward horizontally and due to deflection by coriolis force, the wind flows in opposite direction of trade winds in upper atmosphere. Sometimes, these winds are called anti-trade winds. At about  $30^{\circ}$  latitude, the accumulated air in upper atmosphere sinks back to compensate the surface flows. Thus, surface trade winds and upper air anti-trades complete the convection cell, known as *Hadley cell* after G. Hadley (1735).

Polar cell or high latitude cell: The convection process of *Polar cell* is similar as Hadley cell. In this case, at 60<sup>th</sup> parallel, two contrasting air masses i.e. cold polar easterlies and warm westerlies converge and move upward up to the limit of tropopause (about 8 km) and defect towards equator and poles in both hemisphere and denser and colder poleward upper air (anti-polar) descends in pole areas to energize the polar high and again this mass of air, flow as surface flow from polar high to subpolar low areas to complete the polar cell.

Ferrel cell or middle latitude cell: In Ferrel cell circulation, surface flows comes from 30<sup>th</sup> latitude (subtropical) to 60<sup>th</sup> latitude (subpolar) i.e. westerly winds or westerlies. Due to rotation of the earth, the wind ascends near subpolar region and in tropopause height, wind diverge polewards and equatorwards. The equatorwards branch descends near horse latitude to strengthen the subtropical high and again flow polewards to complete the cell. But, recent study reveals the facts that regularity and continuity of surface westerlies is frequently disturbed by various meteorological extreme events and also the upper flow is not well defined and associates with jet streams. So, recent studies want to refute the existence of ferrel cell.

Numerous criticisms are raised regarding this concept of tricellar model of atmospheric circulation. Such as thermal gradient is not the sole factor of circulation, various other factors influence the circulation; upper air anti-trades are not uniformly present over all meridians, upper air become parallel to isobar or geostrophic flow etc.

### **1.6.5 Monsoon: Theories of its origin**

Monsoon means (Arabic word 'mausim' or Malayan word 'monsin' means season) seasonal reversality of winds at least twice in a year. Monsoon may be true (directional reversality along at 180<sup>o</sup> axis) or pseudo monsoon (no definite 180<sup>o</sup> reversal direction). The origin of monsoon is explained in the light of different theories. Such as-

#### Thermal theory

Origin of monsoon is explained by the unequal heating and cooling of land and water by Hailey in 1686. He explained that in summer during summer solstice there is high pressure over Indian Ocean and low pressure in Central Asia. As a result, moisture laden air blows from sea to land i.e. called south west monsoon or summer monsoon. But in winter (winter solstice), the situation become reverse as high pressure develop over Central Asia and low over the ocean and that's why, wind start to blow from land to sea and it is called north eastern or winter monsoon.

#### Air Mass Theory

H. Flohn, German meteorologist opined(1951) that monsoon is nothing but the modified trade winds and the modification is caused by the shifting of pressure and wind belts due to seasonal migration of the sun. Tropical convergence is formed due to convergence of southeast trade winds in the southern hemisphere and the northeast trade winds in the northern hemisphere. The meeting place of these winds is known as the Inter-Tropical Convergence Zone (ITCZ). The

location of ITCZ shifts north and south of equator with the shift of pressure belts. In the summer season, the sun shines vertically over the Tropic of Cancer and the ITCZ shifts northwards. The southeast trade winds of the southern hemisphere cross the equator and start flowing from southwest to northeast direction under the influence of coriolis force. These displaced trade winds are called south-west monsoons when they blow over the Indian sub-continent. The front where the south-west monsoons meet the north-east trade winds is known as the Monsoon Front. Due to southward shifting of pressure and wind belts during winter, north east trades reestablished to its original position and become winter or north east monsoon (Cited in Singh, 2005).

Apart from the unequal heating and shifting winds, monsoon also influenced by other factors like shape of continent, orography, surface and upper air circulation. Therefore, other theories are put forwarded to explain the origin of monsoon. M.T. Yin (1949), P. Koteswaram (1952), Pierre Pedelaborde (1963) opined that monsoon has a relationship with Tibet plateau, upper air circulation, El Nino and southern oscillation etc.

Effects of Jet Stream on Monsoon:

Jet stream is upper air, fast moving strong westerly wind, blows from west to east in middle latitude.

In winter, the subtropical jet stream is bifurcated by the Himalayan ranges and Tibetan Plateau and southern branch positioned to the south of the Himalayan ranges and create an upper air anti-cyclonic situation. So, the surface high pressure (thermally originated in winter) and upper high pressure strongly obstructs the invasion of monsoon. But, in summer, the subtropical jet stream shifted to the north of Himalaya and creates vacuum at the upper atmosphere. Ground level low pressure develops due to thermal causes. These combined low pressures invite the landward invasion of moisture laden air mass as south west monsoon.

Besides, the subtropical westerly jet to the north of the Himalayas, there is the tropical easterly jet stream (June to September) over the peninsular India. This jet exert the Bay of Bengal branch of monsoon towards west and thereby monsoon forced to penetrate over the northern part of the sub-continent.

Effects of Tibet plateau:

Dr. P. Koteswaram, the director general of Indian Observatories when attended an international seminar on 'The Monsoon of the World' opined that summer time heating of Tibetan plateau is responsible for the origin of monsoon. Approximately 4000m high Tibetan plateau acts as a high level of heat source and physical barrier. During summer, sensible heat and latent heat released from remnants of pre-monsoon thunderstorms make the plateau into an elevated heat island and this heat transfer to the upper air. The rising air parcel diverges southwards and sinks in the

equatorial part of Indian Ocean and energises the high pressure of Indian Ocean and onset of summer monsoon.

Effects of El Nino and Southern Oscillation (OS):

During non El Nino period, high pressure in Peru coast and low pressure in Australian coast and wind flows from east to west (for details see 1.4.7) and moisture laden remnants air moves towards Indian ocean and energise Indian summer monsoon .

But, during El Nino period pressure cells transpose i.e. low pressure in Peru coast and high pressure in Australian coast leads to eastward movement of wind. As a result, Australian coast suffers from moisture supply and there is no supply of moisture to Indian subcontinent and Indian summer monsoon weakens. It is also the fact that during El Nino period, warm El Nino current in Peru coast move further southwards and crossing its normal limit 36°S latitude, it merge with west wind drift and raises the temperature of southern ocean. Hence, increasing temperature weakens the high pressure formation of Indian Ocean as well as summer monsoon. This situation in winter energizes the low pressure of Indian Ocean and thereby north eastern monsoon gets momentum.

But, weakness and scanty rainfall of Indian summer monsoon not only for El Nino rather there are other factors also. This statesman comes from the instances that the monsoon reveals weakness and scanty rainfall in non El Nino periods also.

### **1.6.6 El Nino, Southern Oscillation and La Nina**

Both sea surface temperature and atmospheric circulation strongly influenced by each other and the result of this interaction is Walker circulation and Southern oscillation.

In normal situation, there is surface high pressure in Peruvian coast i.e. in equatorial eastern Pacific Ocean and low pressure in eastern Australian and Indonesia coast i.e. in equatorial western pacific coast and trade wind strongly blows from east to west and drive the surface warm water westwards and it help in upwelling of cold water along the equator in the eastern Pacific Ocean and piling up warm water in west pacific coast. Warm water heats the atmosphere, upward limb of air over western coast and subsidence limb over Peru coast. Such ocean atmospheric circulation is known as *Walker circulation* after the Sir Gilbert Walker.

But, when the walker circulation become weak that means transposition of high and low pressure between eastern and western pacific is created, a reversal situation is observed. In this situation, trade winds are weakened which allows the warmer western pacific waters to move east and reach the Peru coast and increases the temperature of the eastern pacific coast, sea level rises up, makes the thermocline (layer between surface water and deep water) deeper and convection cell shift towards eastern Pacific Ocean and a band of warm water flow southward which replaces the northward cold Peruvian current-such phenomena is called *El Nino*.

Such periodic transposition of pressure cell as well as the transposition of ocean and atmospheric circulation is known as southern oscillation (SO) as it brings turbulence in meteorological phenomena in southern ocean. Entire event of El Nino and related southern oscillation is known as *ENSO or El Nino Southern Oscillation*.

La Nina is the opposite phenomena of El Nino. In La Nina episode easterly trade winds again strengthen, convection cell shift far westward and upwelling of cold water increases in Peru coast and represent a below average sea surface temperature. Such reversal situation is known as *Non ENSO or Non El Nino Southern Oscillation*.

### **1.6.7 Weather forecasting**

#### **1.6.7.1 Definition of Weather forecasting**

Weather forecasting is very much important for aviation, navigation, economic activities specially agriculture even for socio-cultural activities and daily work. Simply, it refers to prediction of weather conditions i.e. temperature, humidity, cloudiness, wind circulation, precipitation and other atmospheric condition of different spatial scale (Local, regional etc.) in different temporal scale (hourly, daily, weekly, monthly, yearly). So, the atmospheric state in a given time and the physical laws that govern the changes of the state are two key concern of weather forecasting. However, three sequential procedures i.e. observation of weather conditions, collection, compilation and analysis of data and forecasting and different methods like synoptic, numerical and statistical as well as entomogenic methods are used to predict the weather.

#### **1.6.7.2 Types of Weather forecasting**

On the basis of temporal range or periodicity forecasting may be short range, medium range and long range-

Weather forecasting	Duration (Validity)	Level of accuracy
Short range	Part or whole of a 24 hours period with a further outlook for the following 24 hours.	Satisfactory
Medium range	Period of two to five days	Helpful for general public specially farmers but accuracy level is relatively less than short range.
Long range	Period longer than five days, vary from a fortnight to a month, season or year.	Less than former two

On the basis of the purpose of the society, weather forecasting can be grouped as aviation forecasting, shipping forecasting, agricultural forecasting, local forecasting etc.

Aviation forecasting refers to the prediction of weather for different aspects of aviation like take off, climbing, flying, descent and landing of the aircrafts. Temperature, air pressure, winds, visibility, clouds, atmospheric storm, jet stream etc. are included in this prediction.

Shipping forecasting is for navigation and it includes both the atmospheric conditions as well as temperature of sea water, nature and ferocity of sea waves and issue of warning about sea condition.

Agricultural forecasting is mainly for farmers and includes information and warning about sky conditions, precipitation, frosts, fogs, dry spells etc. which are very useful for sowing, growing and harvesting of different crops.

Local forecasting is area-specific daily forecast of weather condition for general public and administrators.

### **1.6.7.3 Methods of Weather forecasting**

Weather and climate have intense influence on physical, economic, social, cultural life and that's why weather forecasting is very much necessary in various purposes in our life. The forecaster predict future tendency of weather considering atmospheric status in a given time and the physical process that govern the state and its changes. Though weather forecasting is based on the theory of probability, but, for a more accurate and obvious forecasting different methods are adopted for different types of forecasting such as – Synoptic methods numerical methods, statistical methods, biological methods, folklore methods etc. The first here methods are mainly used by professional weather forecasters who observe and collect weather data through different tools and techniques and analyse to predict weather condition.

i. Synoptic methods are one of the most important weather forecasting methods. It means the observation of different weather elements in a specific time in a particular spatial unit i.e. the overall generalization of weather condition of an area a given time. Atkinson (1968) defined that 'synoptic forecasting entails the diagrammatical representation of weather system through time and the extrapolation of developments of such system into future'. These methods related to the preparation of synoptic chart of the present weather condition and on the basis of these chart future projections of the weather elements are prepared. It has two aspects viz. prognostic or prebatic chart which predict the surface weather conditions and it is for upper atmosphere is known as proutour chart.

Synoptic models, sometimes, are used to predict weather mainly cyclone and anticyclone. It is an ideal synoptic situation and it is used keeping the facts that weather does not change in a

complete random fashion rather follow a fairly ordered system. As it is a simplified ordered situation of weather, it may deviate from the actual.

Analogue method is another technique under synoptic methods. It depicts the future based on past occurrences. Though infinite variety of analogue pattern is possible for atmospheric circulation, based on the surface and upper surface atmospheric data and interactive situation future inference can be prostrulated.

Synoptic process extrapolates the past and current occurrences but any future changes do not possible to include in the study. Besides, skill and experience of the forecaster influence the forecasting. However, these methods are widely used for short range weather forecasting and satellite imagery and computer techniques enhance the utility of the methods.

ii. Numerical methods are the application of mathematical equations, laws, models etc. in the prediction process of weather. It is based on the belief that atmosphere is a fluid and flow the physical laws and accordingly subsequent state develop from preceding ones. Historically, it stress back its origin into 1920s after V. Bjerkness and L.F. Richardson but got momentum after 1950s with the introduction of computer simulations that reduce the computation time to less than the forecast period itself.

In this method, manipulation and articulation of voluminous database and huge mathematical calculations are necessary and it requires most powerful supercomputer. Over the area of interest, grid are developed to feed the weather data and future condition of atmosphere are predicted using supercomputer and following physical laws that govern the motion of atmosphere and prepare the prognostic chart. This methods widely used in long range weather forecasting such as the preparation of simulated model of climate change and it also used in medium and short range forecasting like air quality modeling, ocean surface modeling, tropical cyclone forecasting etc.

Collection of prerequisite numerous data and billion of arithmetic operation for a model is very hectic process and changing of atmospheric conditions could not be included in ongoing calculations and so, when forecasting report comes to reality, large scale change within atmosphere may be occurred. Besides, physical assumptions and simplification of reality into model deviate from the reality.

iii. Statistical methods often supplement the numerical method and uses the past records of weather data based on the conception that future will be the repetition of past. In this method, data relating to temperature, air pressure, wind velocity, cloudiness, rainfall etc. are compiled and statistical analysis such correlation, regression, factor analysis etc. are used to depict the relationship, trends of the present weather condition. But, it is the drawback that it provides the average pictures of weather element.

Though completely accurate forecasting is impossible and it is mainly follow the law of probability but now a day, due to the advancement of tools, techniques and database and ensemble methods, weather forecasting has become more accurate and reliable.

### 1.6.8 Global warming and Climate change

Global warming has now become a matter of most serious concern for the humanity. Global warming is defined as the increase in the average temperature of earth’s surface, atmosphere and oceans. The United Nations Framework convention on Climate Change defines global warming as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods”. Global warming is largely caused by the emission of carbon dioxide. According to Inter-governmental Panel on Climate Change (IPCC) climate change refers to ‘any change of climate over time weather due to natural cause or as a result of human activity’. In 2013, the Inter-governmental Panel on Climate Change (IPCC) Fifth Assessment Report state that human influence is the dominant cause of warming since the mid 20<sup>th</sup> century.

The major causes are burning of fossil fuels in industry and automobile, emission of methane from animal and agriculture, use of chemical fertilizers, volcanic eruptions, deforestation, ozone layer depletion etc. have been increasing the concentration of green house gases in atmosphere and increasing effects of green house effects. At present Global Warming potential (GWP) is used to measure the warming level of the globe due to increasing level of green house effects.

Major sources of green house gases

Name of the Gases	Major sources
Carbon Dioxide (CO <sub>2</sub> )	Burning of fossil fuel, deforestation, industrialization, auto mobiles, volcanoes, hot spring etc.
Methane(CH <sub>4</sub> )	Wet lands, volcanoes, paddy field and other organic substances etc.
Nitrous Oxide (N <sub>2</sub> O)	Blazing of fossil fuel, manufacturing centre, and agricultural fertilizer.
Dichlorodifluoromethane Chlorodifluoromethane Tetrafluoromethane Hexafluoroethane	Most of electronic equipments like refrigerator, air conditioner and various industrial sources
Water Vapour (H <sub>2</sub> O)	Water vapour directly not produced from human activity

	but human action accelerating the evaporation from water bodies.
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Carbon dioxide is the most significant green house gas and minor gases like halogenated gases (chlorofluorocarbons), halons, methane, nitrous oxide and ozone etc. also have increase the green house mechanism of atmosphere and increase the temperature of earth and atmosphere gradually. These gases are released from different sources both from human activities and natural sources. Some of the major sources of the green house gases are listed in the chart-

The increasing trend of temperature may cause reduction of ice covers in Arctic region, glacial retreatment, rise in sea level, breaching of coral reefs, crop failures, increases the frequency of severe storms like hurricanes, cyclones etc. and some of these effects are evident in the present earth.

According to Inter-governmental Panel on Climate Change (IPCC) climate change refers to ‘any change of climate over time weather due to natural cause or as a result of human activity’. From past to present the evidences which are used to indicate climate change phenomena are- biological indicators: Floral and faunal remain in fossils, geological indicators: sedimentary deposits, cryogenic indicators: change of sea level, geomorphologic indicators, migration of man and animals due to drought and flood etc. Earth’s elliptical orbit, variation of solar radiant, increasing green house effects, combustion of fossil fuels, industrialization, urbanization, deforestation, changes of consumer behavior etc, facilitate the change of climate. Global warming, heat island, ice melting, acid rain, desertification, changes in moisture budget, loss of biodiversity, increasing frequency of natural disasters etc. are some major effects of climate change. Efficient and wise use of resources and energy, proper landuse, green technology, afforestation, management, laws, policy making regarding resource use and conservation and human awareness and consciousness are necessary to combat, minimize, mitigate and prevent the harmful effects of climate change.

### 1.9 Summary

- Climatology is the study of climatic phenomena over different spatial and temporal scales.
- Cooling or heating of air through the expansion or contraction of air is called adiabatic process.
- Retarded upward movement or tendency of downward sinking of air parcel is called stability while continuous vertical movement of air parcel is known as instability.
- Vertically and horizontally extensive body of air with homogeneous properties (temperature, moisture, lapse rate etc.) is called air mass and two contrasting air masses form front.

- Surface and upper surface flows form convective cells and three cells circulation exist in both hemispheres.
- Origin of monsoon can be explained in the light of thermal factor, air mass modification, jet stream etc.
- In southern Pacific Ocean, the normal circulation is Walker circulation, warmer than average is El Niño and Colder than average is La Niña Situation.
- Weather forecasting is the future prediction of weather phenomena with the help of different surface and upper surface atmospheric data and different tools and techniques.
- Gradual rise of earth and atmospheric temperature is called as global warming and alteration of climatic element due to natural or human causes is known as climate change.

### 1.10 Self assessment tests

#### Short type questions

- Define climatology.
- What is adiabatic lapse rate?
- What is short, medium and long range weather forecasting?
- Differentiate the stability from instability.

#### Descriptive type questions

- Discuss the scope of climatology
- Account for the classification of air masses on the basis of source region.
- Explain the theories relating to the origin of monsoon.
- Elucidate the atmospheric circulation with reference to tricellular model.

### 1.11 Study Tips and References

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**SEMESTER- I; PAPER – GEO102T; GROUP – GEO102T.2: SOIL GEOGRAPHY**  
**(Credit – 1; Marks - 25: Internal Evaluation – 5, Semester-end Examination - 20)**

## **2.1 Introduction**

Soil is an inevitable component of the environment that supports all the living organisms on the earth viz. plants, animals and micro-organisms. Agriculture, the dominant primary economic activity all over the world largely depends on the nature of soil. Soil plays an active role in the biogeochemical cycles. Therefore, an in-depth knowledge of soil is essential to maintain environmental sustainability.

## **2.2 Learning objectives**

1. To highlight soil taxonomy and world pattern of soils.
2. To learn the concept of soil nutrients and soil organisms.
3. To examine the relation of soil nutrients with soil organisms and micro-organisms.
4. To study the concept of soil pollution and soil degradation.
5. To understand the concept of integrated management of soil.

## **2.3 Assessment of prior knowledge**

General idea on soil profiles and horizons, chemical, physical and biological properties of soil and major soil forming processes will be considered to assess prior knowledge of the learners.

The following questions will be asked to assess the prior knowledge in this field:

1. What is soil?
2. Define soil profile and soil horizon.
3. What is soil forming process?
4. What are the main components of soil?
5. What do you mean by properties of soil?
6. Is soil renewable or non-renewable resource?
7. What types of soil do you observe in your locality?

## **2.4 Learning activities**

Concept of soil taxonomy and the nature of world pattern of soils will be learned. Soil classifications in the Higher Categories (Thorp & Smith, USDA, 1949) and major soil groups and orders of India will be explained. Concept of soil nutrients and soil organisms will be discussed and their relationship will be learned. The concept of soil pollution and soil degradation along with causes, consequences and controlling measures will be studied. The concept of integrated management of soil will be learned.

## **2.5 Feedback of learning activities**

- Making chart on Soil Taxonomy
- Preparation of maps showing distribution of soil
- Preparation of model on soil conservation
- Class test

## **2.6 Examples and illustrations (Subject content)**

### **2.6.1 Soil taxonomy and world pattern of soils**

#### **2.6.1.1 Concept of Soil Taxonomy (ST):**

According to Brady (2002), soil taxonomy is ‘the science of classification of soils; laws and principles governing the classifying of the soil’ (p. 596).

Bockheim (2014) stated that ‘Soil Taxonomy is a hierarchical system that is based primarily on diagnostic surface horizons (epipedons) and subsurface horizons that appear in the system at different taxonomic levels’ (p. v).

Arnold and Eswaran (2002) mentioned, ‘Soil Taxonomy is structured as a nested hierarchy, in which classes of the lower levels are an integral part of and confined by the defining properties of the classes at higher levels’ (p.31).

According to Foth (1990), ‘diagnostic surface and subsurface horizons, together with other diagnostic features, are used to classify soils in Soil Taxonomy’ (p. 284). He also mentioned six categories of soil taxonomy; from highest to lowest category as ‘order, suborder, great group, subgroup, family, and series’ (Foth, 1990, p. 279).

Soil Survey Staff.(1999) identified the following two objectives of soil taxonomy:

- ‘To establish hierarchies of classes that permit us to understand, as fully as possible, the relationship among soils and between soils and the factors responsible for their character’ (p. 15).
- ‘To provide a means of communication for the discipline of soil science’ (p. 15).

The term soil taxonomy bears a narrow concept compared to the term soil classification. According to Soil Survey Staff.(1999), ‘classification includes taxonomy, but it also includes the grouping of soils according to limitations that affect specific practical purposes’ (p. 15), whereas, the term ‘taxonomy is the part of classification’ (p. 15).

### **2.6.1.2 Soil classification system**

#### **The USDA (United States Department of Agriculture) soil classification system**

Curtis Fletcher Marbut, Director of the Soil Survey Division in USA presented a comprehensive soil classification scheme for the United States in 1935. Marbut’s system was modified by Mark Baldwin, Charles Kellogg, and James Thorp in 1938. This soil system was further modified by James Thorp and Guy D. Smith in 1949. The modified system is widely known as USDA Soil Classification System 1949 (Table No. 2). In this USDA soil system (1949), soils are divided into three orders as follow (Table No.1):

**Table No. 1: Soil orders (USDA Soil Classification System 1949)**

Soil orders	Major characteristics
A. Zonal soils	i) Mature soils and develop over sufficient time. ii) Well defined soil profiles and distinct soil horizons. iii) Soils formation and development are largely controlled by the nature of climate, vegetation and organism. iv) Soils develop over well drained surface.
B. Intrazonal soils	i) Thesesoils are found within zonal soils. ii) On an average, these soils reflect well developed and distinct features. iii) Soil formation and development largely depend on local factors, viz. nature of terrain, parent materials, surface and subsurface drainage.

C. Azonal soils	<p>i) Immature soils and develop over short period of time.</p> <p>ii) Lack of time, distinct nature of terrain and parent materials impede the proper development of soil profile.</p> <p>iii) ‘They do not have profile development and structure developed from the soil-forming processes (Fang and Chaney, 2017, p. 56).</p>
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**Table No. 2: Soil Classifications in the Higher Categories (Thorp & Smith, USDA, 1949)**

Order	Suborder	Great Soil Groups
A. Zonal soils	1. Soils of the cold zone	Tundra soils
	2. Light-colored soils of the arid regions	Desert soils Red desert soils Sierozem Brown soils Reddish-brown soils
	3. Dark-colored soils of semi-arid, sub-humid and humid grasslands	Chestnut soils Reddish Chestnut soils Chernozem soils Prairie soils Reddish Prairie soils
	4. Soils of the forest-grassland transition	Degraded Chernozem Noncalcic Brown or Shantung Brown soils
	5. Light-colored podzolized soils of the timbered regions	Podzol soils Gray wooded or Gray Podzolic soils Brown Podzolic soils Gray-Brown Podzolic soils Red-Yellow Podzolic soils
	6. Lateritic soils of forested warm-temperature and tropical regions	Reddish-Brown Lateritic soils Yellowish-Brown Lateritic soils Laterite soils
B. Intrazonal soils	1. Halomorphic (saline and alkali) soils of imperfectly drained arid regions and littoral deposits	Solonchak, or Saline soils Solonetz soils Soloth soils
	2. Hydromorphic soils of marshes, swamps, seep areas, and flats	Humic-Glei soils (includes Wiesenboden) Alpine Meadow soils Bog soils

		Half-Bog soils Low-Humic-Glei soils Planosols Ground-Water Podzol soils Ground-Water Laterite soils
	3. Calcimorphic soils	Brown Forest soils (Braunerde) Rendzina soils
C. Azonal soils		Lithosols Regosols (includes Dry Sands) Alluvial soils

Source: Thorp and Smith (1949, p. 118)

Biswas and Mukherjee (1994, pp. 379-380) presented soil groups in India, adapted from Soils of India by Raychaudhuri and GovindaRajan, 1971 and Studies on Soils of India by GovindaRajan and GopalaRao, 1978 (Table No. 3).

**Table No. 3: Soil Group and Soil Order of India (Biswas and Mukherjee, 1994)**

Soil group	Soil Order (Soil Taxonomy)
1. Red loamy	Alfisols
2. Red sandy	Alfisols
3. Laterite	Ultisols, Oxisols
4. Red and yellow	Ultisols
5. Shallow black	Entisols, Inceptisols
6. Medium black	Vertisols
7. Deep black	Vertisols
8. Mixed red and black	Association of Alfisols and Vertisols
9. Coastal alluvium	Entisols
10. Coastal sands	Entisols
11. Deltaic alluvium	Entisols, Alfisols
12. Alluvial Khadar (recent) Bhangar (old)	Entisols Inceptisols Alfisols
13. Alluvial (Highly calcareous)	Entisols
14. Calcareous sierozemic	Aridisols
15. Grey brown	Aridisols
16. Desert - Regosolic	Aridisols Entisols
17. Desert - Lithosolic	Entisols
18. Tarai	Mollisols

19. Brown hill	Ultisols
20. Sub-montane (Podzolic)	Alfisols
21. Mountain meadow	Mollisols
22. Saline and alkali	Aridisols, Entisols, Vertisols
23. Peaty and saline peaty	Histosols
24. Skeletal	Entisols
25. Glaciers and eternal snow	

Source: Biswas&Mukherjee (1994, pp. 379-380)

### 2.6.1.3 Soil orders

Soil order is the largest category in Soil Taxonomy. According to Brady (2002), ‘the order category is based largely on soil forming processes as indicated by the presence or absence of major diagnostic horizons. A given order includes soils whose properties suggest that they are not too dissimilar in their genesis’ (p. 63). In general, the following eleven soil orders have been identified in Soil Taxonomy (Brady, 2002).

- Alfisols: ‘Alfisols are moist mineral soils having no mollicepedon on oxic or spodic horizons. They have gray to brown surface horizons (commonly an ochricepedon), medium- to high- base status, and contain an alluvial horizon in which silicate clays have accumulated’ (Brady, 2002, p. 69).
- Andisols (Andosols): Andisols are found around the volcanoes and formed by the materials (e.g. tephra) ejected from volcanic eruptions. Andosols are characterized with high amount of ‘active Al and Fe materials, and the lowest bulk density among mineral soils’ (FAO & ITPS, 2015, p. 559).
- Aridisols: Aridisols are found mainly in arid regions. ‘Aridisols are dry soils characterized by an ochricepedon generally light in color and low in organic matter. They may have a horizon of accumulation of calcium carbonate (calcic), gypsum (gypsic), soluble salts (salic) or sodium (natric)’ (Brady, 2002, p. 74).
- Entisols: These soils are mostly the ‘weakly developed mineral soils without natural genetic (subsurface) horizons or with only the beginnings of such horizons’ (Brady, 2002,

p. 66). Most of the Entisols have ‘an orchicepedon and a few have man-made anthropic or agricepedons’ (Brady, 2002, p. 66).

- Histosols: Histosols soils contain high percentage of organic matter. These soils are generally referred as ‘bogs, moors or peats and mucks’ (Biswas& Mukherjee, 1994, p. 328). Four subdivisions of Histosols, viz. Folists, Fibrists, Hemists and Saprists are mentioned in USA Soil Taxonomy.
- Inceptisols: ‘The horizons of Inceptisols are thought to form quickly and result mostly from the alteration of parent materials. Inceptisols have ochric or umbricepedons and/or cambic subsurface horizons’ (Brady, 2002, p. 67).
- Mollisols: Mollisols are the base-rich dark coloured soils observed in steppes regions (Biswas& Mukherjee, 1994). ‘Mollisols are characterized by a mollicepedon or surface horizon which is thick, dark and dominated by base-forming cations’ (Brady, 2002, p. 67).
- Oxisols: These soils are infertile with ‘reddish, yellowish or grayish’ colour formed in tropical and subtropical climatic conditions (Biswas& Mukherjee, 1994). ‘The unique properties of Oxisols are extreme weathering of most minerals other than quartz to kaolin and free oxides; very low activity of the clay fraction and loamy or clayey texture’ (Biswas& Mukherjee, 1994, p. 329).
- Spodosols: ‘Spodosols are mineral soils that have a spodic horizon, a subsurface horizon with an accumulation of organic matter and of oxides of aluminum with or without iron oxides’ (Brady, 2002, p. 74).
- Ultisols: These soils are commonly found in warm and humid climatic regions with seasonal shortage of rainfall (Biswas& Mukherjee, 1994). Ultisols are characterized by ‘argillic horizon, low supply of bases, particularly in lower horizons and mean annual soil temperature higher than 8°C’ (Biswas& Mukherjee, 1994, p. 330).

- Vertisols: ‘The Vertisols order of mineral soils is characterized by a high content (>30%) of sticky or swelling and shrinking-type clays to a depth of 1 m, which in dry seasons causes the soils to develop deep, wide cracks’ (Brady, 2002, p. 73). These soils are mostly found in sub-humid to semiarid regions with average soil temperature more than 8°C (Brady, 2002).

## **2.6.2 Soil nutrients and soil organisms**

### **2.6.2.1 Concept of soil nutrients**

Soil nutrients largely determine soil fertility. Soil nutrients are essential for plant growth.

Essential elements for plants nutrients are divided into two broad categories i.e.

A). Macronutrients

B) Micronutrients.

A. Macronutrients - ‘A chemical element necessary in large amounts (usually 50mg/kg in plant) for the growth of plants’ (Brady, 2002, p. 589). Macronutrients are classified into three categories i.e.

(i) Structural nutrients e.g. Carbon (C), Hydrogen (H) and Oxygen (O);

(ii) Primary nutrients e.g. Nitrogen (N), Phosphorus (P) and Potassium (K);

(iii) Secondary nutrients e.g. Calcium (Ca), Magnesium (Mg) and Sulfur (S).

B. Micronutrients - ‘A chemical element necessary in only extremely small amounts (<50mg/kg in the plant) for the growth of plants’ (Brady, 2002, p. 589). Examples are Boron (B), Copper (Co), Iron (Fe), Manganese (Mn), Zinc (Zn), Molybdenum (Mo), Chlorine (Cl), Cobalt (Co) and Nickel (Ni).

### **2.6.2.2 Functions of soil nutrients**

‘As a precondition for growth, health and the production of nutritious food, plants require essential nutrients (macro and micronutrients) in sufficient quantities (IFA, WFO & GACSA, 2016, p.1). According to Biswas and Mukherjee (1994) ‘the essential elements exist as structural components of a cell, maintain cellular organizations, functions in energy transformation and in enzyme reactions’ (p. 224) (Table Nos. 4 and 5).

**Table No. 4: Functions of Macronutrients**

<b>Macronutrients</b>	<b>Functions</b>
Carbon (C),	‘Constituent of carbohydrates; necessary for photosynthesis’ (Jones & Olson-Rutz, <b>2016, p. 2</b> ).
Hydrogen (H)	‘Maintains osmotic balance; important in numerous biochemical reactions; constituent of carbohydrates’ (Jones & Olson-Rutz, <b>2016, p. 2</b> ).
Oxygen (O)	‘Constituent of carbohydrates, necessary for respiration’ (Jones & Olson-Rutz, <b>2016, p. 2</b> ).
Nitrogen (N)	‘Nitrogen is needed by plants for the production of proteins, nucleic acids (DNA and RNA) and chlorophyll’ (McCauley et al., 2011, p. 5).
Phosphorus (P)	‘Constituent of many proteins, coenzymes, nucleic acids and metabolic substrates; important in energy’ (Jones & Olson-Rutz, <b>2016, p. 2</b> ).
Potassium (K)	‘Potassium is utilized by plants in the activation of enzymes, photosynthesis, protein formation and sugar transport’ (McCauley, et al., 2011, p. 9).
Calcium (Ca)	Activates plant enzymes, forms the constituent of cell wall and helps in maintaining cell membrane stability (Biswas& Mukherjee, 1994).
Magnesium (Mg)	‘Enzyme activator, component of chlorophyll’(Jones & Olson-Rutz, <b>2016, p. 2</b> ).
Sulphur (S)	‘Essential constituent of certain amino acids and proteins, S deficiency results in the inhibition of protein and chlorophyll synthesis’ (McCauley et al., 2011, p. 10).

Sources: Biswas& Mukherjee (1994); McCauley et al. (2011); Jones & Olson-Rutz (**2016**)

**Table No. 5: Functions of Micronutrients**

<b>Micronutrients</b>	<b>Functions</b>
Zinc (Zn)	‘Involved with enzyme systems that regulate various metabolic activities (Jones & Olson-Rutz, 2016, p. 2).
Iron (Fe)	‘Present in several peroxides, catalase, and cytochrome oxidase enzymes’ (Brady, 2002, p. 383); takes part in oxidation-reduction reactions and plays an active role in the formation of chlorophyll (Brady, 2002).
Copper (Co)	‘Copper is needed for chlorophyll production, respiration and protein synthesis’ (McCauley et al. 2011, p. 12).
Manganese (Mn)	‘Activates decarboxylase, dehydrogenase and oxidase enzymes’ (Brady, 2002, p. 383); actively involves in the processes of photosynthesis as well as metabolism and assimilation of nitrogen (Brady, 2002).
Boron (B)	‘Believed to be important in sugar translocation and carbohydrate metabolism’(Jones & Olson-Rutz, 2016, p. 2).
Molybdenum (Mo)	‘Involved with nitrogen fixation and transforming nitrate to ammonium’ (Jones & Olson-Rutz, 2016, p. 2).
Cobalt (Co)	Cobalt plays a significant role in nitrogen fixation (Brady, 2002).

Sources: Brady (2002); McCauley et al. (2011); Jones & Olson-Rutz (2016)

### **2.6.2.3. Sources of soil nutrients**

Major sources of soil nutrients (IFA, WFO & GACSA, 2016):

- a) Weathering of rocks is the primary source of soil nutrients. This process releases nutrients in small amount into the soil.
- b) Nutrients applied for crop production are not totally used. Residual nutrients are retained in the soil.
- c) A significant amount of nutrients (e.g. nitrogen and sulphur) is added into the soil through atmospheric deposition process.
- d) Crop residues are the important sources of soil nutrients. Mainly nitrogen (N), phosphorus (P) and sulphur (S) are mixed with the soil from decomposition of crop residues.
- e) Compost is also a source of soil nutrients.

- f) Livestock manure is a significant source of soil nutrients. Nitrogen, phosphorus, potassium, calcium, magnesium and sulphur are mainly added to soil from livestock manures.
- g) Biosolids derived from urban waste water treatment are a source of soil nutrients.
- h) By the process of Biological Nitrogen Fixation (BNF), mainly atmospheric nitrogen is converted to ammonia and then to nitrates. This is the main process of converting atmospheric nitrogen to soil nutrients.
- i) Fertilizers are manufactured in industry and farmers apply fertilizers to the soil to raise crops.

#### **2.6.2.4 Soil organisms**

Soil organisms play an active role in the availability, transformation and supply of soil nutrients. According to Hesammi et al. (2014), 'soil biodiversity reflects the mix of living organisms in the soil. These organisms interact with one another and with plants and small animals forming a web of biological activity (p. 10328). He also stated that 'soil organisms contribute a wide range of essential services to the sustainable function of all ecosystems' (Hesammi et al., 2014, p. 10328). Classification of soil organisms (Brady, 2002, p.254; Biswas& Mukherjee, 1994, p. 46):

1. Soil flora (plants): Soil flora is divided into two broad categories i.e.
  - a) Soil macroflora: Roots of higher plants.
  - b) Soil microflora: (i) Bacteria (ii) Fungi (iii) Algae (iv) Actinomycetes
2. Soil fauna (animals): Soil fauna is also divided into two broad categories, i.e.
  - a) Soil macrofauna: (i) Largely herbivores and detritivores (ii) Largely predators
  - b) Soil microfauna: (i) Largely detritivores, predators and parasites

### **2.6.2.5 Role of soil organisms**

The role and function of soil flora and fauna are indispensable in their influence on crop production 'through a number of processes such as decomposition, synthesis and transformation' (Biswas& Mukherjee, 1994, p. 70). 'During decomposition, soil organisms release essential plant nutrients in inorganic forms that can be absorbed by plant roots or leached from the soil (Brady, 2002, p. 276).

Hesammi et al. (2014) summarized the three key roles of soil organisms:

- j) 'Decompose organic residues'
- ii) 'Re-cycle nutrients from organic residues'
- iii) 'Enhance soil structure' (p. 10331).

Soil organisms improve physical properties of the soil. Organisms play an active role for the formation of better soil structure. According to Hesammi et al. (2014), 'soil with good structure has many beneficial effects including enhanced water transmission into and through soil, lower bulk density and lower potential for soil erosion' (p. 10331).

Soil organisms degrade soil pollutants through biodegradation process. Micro-organisms help to degrade specific soil contaminants by bioremediation process.

Soil organisms decompose various organic residues and significant amount of nutrients are added to the soil in this way.

Organisms are the vital factor in soil formation. Organisms control the process of biomass formation and the process of biological weathering in creation of parent materials that are essential part of soil formation.

Aislabie and Deslippe (2013) mentioned that 'microbes contribute to soil formation through nutrient cycling and organic matter production. Microbial products are critical to soil aggregation, improved soil structure making soil more habitable for plants (p. 144).

Brady (2002) stated that 'organically bound forms of nitrogen, sulfur, and phosphorous are converted by the microbes into plant available forms' (p.275).

According to Aislabie and Deslippe (2013), microbes determine the process of mineralization of soil carbon and nutrients and consequently 'the carbon storage capacity of soils'. 'Denitrifying bacteria and fungi and methane producing and consuming bacteria regulate nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>) (Aislabie&Deslippe, 2013, p. 144).

## **2.6.3 Micro-organisms and their relation with soil fertility**

According to Powlson et al. (2001), 'the soil micro-organisms (collectively the soil microbial biomass) are the agents of transformation of soil organic matter, nutrients and of most key soil processes. Their activities are much influenced by soil physico-chemical and ecological interactions (p. 41).

### **2.6.3.1 Classification of microorganisms**

Soil microorganisms are classified into two broad categories i.e. (a) Soil microflora and (b) Soil microfauna.

- Soil microflora (Brady, 2002, p.254; Biswas& Mukherjee, 1994, p.46): Algae (eg. Blue-green Algae, Yellow-green Algae and Diatoms), Fungi (eg. Mushrooms, Yeasts and Moulds), Actinomycetes (eg. Actinomycetaceae and Streptomycetaceae) and Bacteria (eg. Aerobic, Anaerobic, Autotropic and Heterotrophic).
- Soil microfauna (Protozoa, Nematodes and Rotifers).

### **2.6.3.2 Role of micro-organisms in soil fertility**

To know the role of micro-organism in soil fertility, it is essential to understand the concept of soil fertility.

Foth (1990) defined soil fertility 'as the ability of a soil to supply essential elements for plant growth without a toxic concentration of any element' (p. 9-10). The term soil fertility is defined as 'the inherent capacity of soil to provide nutrients, in adequate amounts and in proper balance, for the growth of specified plants when other growth factors such as light, water and temperature, and the physical condition of the soil are favourable' (Biswas& Mukherjee, 1994, p. 222).

Bollen (1959) mentioned two types of soil fertility: active and potential. According to him, 'active fertility is immediately available; potential fertility becomes available by chemical or microbial action on minerals and organic matter. The function of soil microorganisms is to render potential fertility available' (p.1).

Micro-organisms play a significant role in Biological Nitrogen Fixation (BNF). Plants cannot absorb elementary nitrogen from the atmosphere directly. 'The nodule organisms, especially those of legumes, free-fixing bacteria of several kinds, and some actinomycetes are most noted for their ability to fix nitrogen' (Brady, 2002, p.275). Hence, Biological Nitrogen Fixation is the most significant natural way to maintain soil fertility.

Biofertilizers are the important sources of soil nutrients. 'Biofertilizers are the cultures of micro-organisms used for inoculating seed or soil or both under ideal conditions to increase the availability of plant nutrients' (Biswas & Mukherjee, 1994, p. 84). Biofertilizers are broadly classified into two sub groups 'inoculants of specific organisms such as Rhizobia, Azotobacter, blue-green algae, phosphate solubilizers, cellulolytic microorganisms; and biomass producing organisms, e.g. Azolla' (Biswas & Mukherjee, 1994, p. 84).

Micro-organisms make the soil nutrients available to plants through various microbial activities. 'Organically bound forms of nitrogen, sulfur, and phosphorus are converted by the microbes into plant-available forms' (Brady, 2002, p. 275).

Decomposition of organic matters and humus formation are the significant processes to enrich soil nutrients and to maintain nutrient cycle. Moreover in order to obtain energy 'soil organisms break down organic matter, aid in the production of humus, and leave behind compounds that are useful to higher plants' (Brady, 2002, p. 275).

Micro-organisms are actively involved in 'synthesis of microbial cell substance, oxidation and reduction of soil constituents' (Waksman & Starkey, 1931, p. 243) that enhance soil fertility.

## **2.6.4 Soil pollution and soil degradation**

### **2.6.4.1 Soil pollution**

Soil pollution is defined as the accumulation or contamination of toxic elements in soil caused by human activities or natural phenomenon that poses harmful effects on human beings and other living organisms.

*Rodríguez-Eugenio et al. (2018) defined soil pollution as ‘the presence of a chemical or substance out of place and/or present at higher than normal concentration that has adverse effects on any non-targeted organism’ (p. viii).*

Though most of the ‘pollutants have anthropogenic origins, some contaminants can occur naturally in soils as components of minerals and can be toxic at high concentrations. Soil pollution often cannot be directly assessed or visually perceived making it a hidden danger’ (*Rodríguez-Eugenio et al., 2018, p. 1*).

#### **2.6.4.2 Types of soil pollution**

Soil pollution is categorized into (a) Point source pollution and (b) Diffuse source pollution (*Rodríguez-Eugenio et al., 2018, p. 3*).

- Point source pollution: ‘Anthropogenic activities represent the main sources of point-source pollution. Examples include former factory sites, inadequate waste and wastewater disposal, uncontrolled landfills, excessive application of agrochemicals, spills of many types, and many others’ (*Rodríguez-Eugenio et al., 2018, p. 3*).
- Diffuse source pollution: ‘Diffuse pollution is pollution that is spread over very wide areas, accumulates in soil, and does not have a single or easily identified source’ (*Rodríguez-Eugenio et al., 2018, p. 4*) and this pollution includes ‘the transport of pollutants via air-soil-water systems’ (p. 4).

#### **2.6.4.3 Sources of soil pollution**

Sources of soil pollution are divided into two broad categories:

- Natural sources:
  - Heavy metals (e.g. lead, cadmium, mercury, copper, tin, zinc etc.) and other toxic elements which are available in the soil from the parent materials itself.
  - Volcanic eruptions and forest fires lead to soil pollution with pollutants.
  - Cosmic dusts pollute soil.
  - Radon diffusion from natural sources and contamination of ‘*Naturally Occurring Asbestos* (NOA)’ pollute soil.
- Anthropogenic Sources
  - Industrial wastes: Industrial wastes are the major sources of various toxic elements and heavy metals (e.g. lead, copper, mercury, cadmium, Chromium, Polychlorinated Bi-

phenyl (PCB) including Polychlorinated etc.). These pollutants play key role in destroying soil organisms and altering the chemical properties of soil.

- Mining activities: Mining activities releases toxic elements and heavy metals e.g. arsenic, chromium, asbestos, nickel etc. Extraction of crude oil also acts as the point-source pollution of soil with radioactive and toxic trace elements.
- Urban wastes: Urban wastes are mainly of three types – commercial, domestic and biomedical wastes. Dried sludge and sewage are the main pollutants. Apart from these, plastics, fuel residues, old medicines, lead-based paints, metallic cans, batteries, e-wastes and various organic wastes pollute soil to a large extent.
- Agricultural activities: Use of chemical fertilizers, pesticides, insecticides, herbicides and fungicides in agriculture are responsible for severe soil pollution.
- Radioactive wastes: Testing and explosion of nuclear bombs and hydrogen bombs, nuclear waste generated from nuclear power stations and nuclear testing laboratories and accidents in such stations contaminate soil with radioactive elements.

#### **2.6.4.4 Effects of soil pollution**

- Loss of soil fertility: Soil fertility reduces due to soil pollution. Soil pollutants alter the physical and chemical properties of the soil adversely.
- Loss of soil organisms: Soil organisms which are essential for plant growth, maintaining the bio-geochemical cycles and soil fertility are lost due to soil pollution.
- Decrease in agricultural output: Soil pollution decreases agricultural productivity in all sectors e.g. crops, fishes and livestock.
- Contamination of surface and ground water: Polluted soil acts as a source of surface and ground water contamination.
- Damage of human health and life: Soil pollution directly and indirectly affects human health and life. Heavy metals and toxic elements of contaminated soil are transferred into human body through crops, fishes and livestock. Direct contact with the polluted soils also damages human health.
- Decrease in Net Primary Production (NPP) and Gross Primary Production (GPP): If soil pollution continues, the NPP and GPP of the global ecosystem gradually will decline. As a result, ecological balance and environmental sustainability will be disrupted.

#### **2.6.4.5 Controlling measures of soil pollution**

The following controlling measures are essential to check soil pollution:

- Recycling and reuse of urban, industrial, medical and domestic wastes
- Safe and effective disposal of nuclear wastes in scientific way
- Promotion of organic farming and reduction in the use of agro-chemicals
- Introduction of Integrated Pest Management (IPM) and Integrated Plant Nutrient Management (IPNM)
- Proper disposal and treatment of polluting materials
- Imposing ban on the use of non-degradable plastics (made of synthetic polymers) and promotion of the use of degradable plastics (derived from plants)
- Afforestation including social forestry, agro-forestry, joint forest management and community forestry
- Emphasis on the plantation of indigenous trees
- Generation of public awareness on soil pollution and its prevention
- Development of a comprehensive plan to prevent soil pollution and its effective implementation

#### **2.6.4.6 Soil degradation**

‘Soil degradation inherently reduces or eliminates soil functions and their ability to support ecosystem services essential for human well-being’ (FAO & ITPS, 2015, p. 180).

According to Jie et al. (2002), ‘soil degradation, defined as lowering and losing of soil functions, is becoming more and more serious worldwide in recent decades, and poses a threat to agricultural production and terrestrial ecosystem’ (p. 1).

Young et al. (2015) stated that ‘soil degradation occurs through the deterioration of the physical, chemical and biological properties of soil that results in soil compaction, salinisation, acidification and soil loss from wind and water erosion (p. 2).

#### **2.6.4.7 Types of soil degradation**

Soil degradation takes place through wind and water erosion as well as physical and chemical degradation (Table No. 6).

**Table No. 6: Types of soil degradation for Global Assessment of Soil Deterioration (GLASOD), (after Oldeman, 1992)**

Type (code)	Subtype (code)
1. Water erosion (W)	i. Loss of Topsoil (Wt)
	ii. Terrain deformation (Wd).
2. Wind erosion (E)	i. Loss of topsoil by wind erosion (Et),
	ii. Terrain deformation (Ed)
	iii. Overblowing (Eo)
3. Chemical degradation (C)	i. Loss of nutrients and/or organic matter (Cn).
	ii. Salinization (Cs)
	iii. Acidification (Ca)
	iv. Pollution (Cp).
4. Physical degradation (P)	i. Compaction, crusting and sealing (Pc)
	ii. Waterlogging (Pw)
	iii. Subsidence of organic soils (Ps)

Source: Oldeman (1992, pp. 19-36).

#### **2.6.4.8 Effects of soil degradation**

The major effects of soil degradation include -

- Soil erosion leads to removal of top fertile soils and soil fertility is reduced.
- Contaminated soil with heavy metal and toxic elements destroys soil microorganisms which maintain the soil fertility and bio-geochemical cycles.
- Agricultural productivity decreases as result of the loss of soil nutrients.
- Soil degradation increases desertification that adversely affects the existing ecosystem.
- Soil degradation leads to increase in soil salinity and soil alkalinity.
- Soil degradation increases water-logging conditions and desertification.
- Soil degradation threatens the biodiversity.
- Soil degradation ultimately reduces the amount of arable lands. This situation accelerate food crisis.

#### **2.6.4.9 Strategies to mitigate soil degradation**

Effective strategies to mitigate soil degradation are as follow:

- Afforestation and reforestation are the most effective strategies to reduce soil degradation.
- Mulching, contour farming and terracing, strip farming, shelter belts and intercropping are to be introduced.
- Crop rotation is the most important farming technique to maintain soil fertility naturally.
- Integrated Pest Management and Integrated Soil Fertility Management have to be implemented.
- Diversified cropping and integrated farming systems have the potential to counter soil degradation.
- Effective measures should be taken to prevention all sorts of soil contamination and pollution.
- Specific measures have to be taken for reclaiming acidic and saline soils.
- Awareness generation about the causes, effects and preventive measures of soil pollution.

#### **2.6.5 Concept of integrated management of soil**

The term integrated management of soil is a set of integrated management approaches to protect soil from degradation, to maintain soil health and quality, to enhance agricultural productivity in particular and to sustain soil ecosystem in general. Integrated Soil Management (ISM) is a strategy that ensures sustainable agricultural production and to optimise social and economic benefits and to maintain environmental sustainability.

##### **2.6.5.1 Principles of the integrated soil management approaches**

Integrated management of soil is based on the principles of the following integrated management approaches:

- Integrated Soil and Nutrient Management (ISNM): ‘ISNM aims to optimize the condition of the soil, with regard to its physical, chemical, biological and hydrological properties, for the purpose of enhancing farm productivity, whilst minimizing land degradation’ (FAO, 2000, p.5).

- Integrated Soil Fertility Management (ISFM): ‘ISFM is defined as a set of soil fertility management practices that include the integrated use of mineral fertilizers, organic inputs and improved germplasms’ (Fairhurst, 2012, p.vii). These management practices are too ‘combined with the knowledge on how to adapt these practices to local conditions which are aimed at optimizing efficient agronomic use of the applied nutrients and thereby improving crop productivity’ (Fairhurst, 2012, p.vii).
- Integrated Pest Management (IPM): ‘Integrated Pest Management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified’ (FAO & WHO, 2014, p.4). These managements also ‘reduce or minimize risks to human and animal health and/or the environment’ (FAO & WHO, 2014, p.4).
- Integrated Management of Soil Conservation (IMSC): Integrated Management of Soil Conservation (IMSC) primarily protects soil from all sorts of degradation, improves soil fertility and environmental stability.
- Integrated Farming System (IFS): Integrated Farming System (IFS) is the integration of crop, livestock and fish production and sustainable use of farm resources.

## **2.7 Self assessment tests**

1. Define soil taxonomy?
2. Discuss the major world patterns of soils with suitable diagrams.
3. What is meant by soil nutrient?
4. Specify the relationship between soil nutrients and soil organisms.
5. Analyse the role of micro-organisms in soil fertility with specific examples.
6. Give the concept of soil pollution and soil degradation.
7. Illustrate the concept of integrated management of soil.

## 2.8 Summaries and Key points

- Soil is the essential component of ecosystem and its characteristics vary across the world.
- Soil Taxonomy helps to understand the variations of the soil characteristics over the earth.
- Plant growth depends on the availability of soil nutrients.
- Soil organisms are important component of soil. Soil organisms play crucial role in maintaining soil fertility.
- Soil degradation and soil pollution are two major concerns of soil geography.
- Soil degradation and soil pollution are caused by mainly anthropogenic factors.
- Soil degradation and soil pollution reduce soil fertility, decline agricultural productivity, deteriorate human health and pose threat on sustainability of the ecosystem.
- Introduction of integrated management of soil is utmost need of the hour.

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**SEMESTER- I; PAPER – GEO102T; GROUP – GEO102T.3 BIOGEOGRAPHY  
(Credit – 1; Marks - 25: Internal Evaluation – 5, Semester-end Examination - 20)**

### **3.1 Introduction**

Biogeography is a sub-field of the discipline of geography. Geography is a spatial science. Biogeography studies the spatial patterns on distributions and differentiations of various biological forms, starting from a single species to the entire biosphere, over the earth's surface. Thus, it studies both the physical components of the earth's surface, such as land, soil, water etc. as well as the organisms of an area in a holistic way. In this sense, it is a synthesis of the disciplines of ecology, botany, zoology, geography, geology, climatology etc. This self-learning material will help you to understand the nature, scope, content and significance of biogeography; different aspects related to plant ecology; impact of climate and soil on the distribution of plants, and also to understand the biodiversity and different measures taken to keep the balance between human beings and environment.

### **3.2 Learning objectives**

The major objectives of this self-learning material are:

- To study the intrinsic characteristics of biogeography through interdisciplinary study of knowledge.
- To study the organisms and their complex environmental relationships.
- To know the spatial and temporal distribution of plants and animals kingdom and factors those influencing them.
- To evaluate the anthropogenic impact on environment and interactions.
- To study the present environmental degradation and survival questions of organisms.
- To know the present management strategies which have been taken for restoration of fragile environment.

### **3.3 Assessment of prior knowledge**

Knowledge of biogeography as a sub-discipline of geography is very much inter-linked with the knowledge of environment. Biogeography in many ways contains same elements of the environment. For the purpose of assessment of prior knowledge on biogeography of the students the following questions may be asked:

- i. What do you mean by 'bio'?
- ii. What is meant by 'biogeography'?
- iii. What is 'biome'?
- iv. How does climate control the distribution of plants over the earth surface?
- v. Distinguish between 'ecology' and 'biogeography'.

### **3.4 Learning activities**

Knowledge of biogeography is based on distribution of plants and animals kingdom over the earth surface. To understand the theoretical backgrounds behind spatial distribution and differentiation of organisms, controlling factors, growth and development, threats and future conservation strategies, a practical documentation of the existing plants and animals on local as well as regional level may be done. Students may prepare a notebook mentioning existing names and numbers of the plants and animals considering a selected study area with physical descriptions like topography, climate, soil, landuse/ landcover, etc. of the study area. For better understanding of the present situation of biodiversity and its related threats along with management strategies, different governmental and non-governmental websites, films, reports, pictures, etc. are to be observed.

### **3.5 Feedback of learning activities**

For the purpose of feedback from students on their learning activities group discussions can be arranged. An internal assessment may be taken. During feedback, problem areas would be identified and necessary steps would be taken up to resolve them.

### **3.6 Examples and illustrations**

The following discussion explores examples and illustrations on different aspects of biogeography.

#### **3.6.1. Nature, Scope and Significance of Biogeography:**

Biogeography is one of the important branches of physical geography. The study of organisms in a life supporting layer called biosphere is the core of biogeography. It is the study of organisms concerning their habitats. According to Lincoln, Boxshall and Clark (1982), biogeography is the study of geographical distribution of organisms, their habitats (ecological biogeography), and the historical and biological factors which produced them (historical biogeography).

Biogeography is a scientific discourse. It is the study of all plants, animals and microorganisms along with their surroundings i.e. environment. It is associated with documentation and understanding of distributions and variations of all organisms spatially and temporally. Biogeography is concerned with variety of organisms and their habitats; adaptation to the local environment; dispersal and migration of organisms; biological diversity over the earth surface and the processes behind distribution changes with time. Biogeography studies the heterogeneous distribution of organisms in space and time, and their relationship with surrounding environment. It deals with environmental conditions, environmental resources, use and misuse of environmental resources, relationships, environmental degradations, and environmental management.

The study of biogeography has a long history from the pre 13<sup>th</sup> Century to today. The knowledge of biogeography enriched by the distribution information from the Age of Exploration, Theory of Evolution, Plate Tectonics Theory, Island Biogeography of 1967, Biodiversity, Conservation, etc.

Biogeography has been enriched by several branches of natural science. It is further subdivided into: (i) plant geography, (ii) zoo geography, (iii) human ecology, and (iv) environmental geography. The basic unit of biogeography is biosphere. It lies at the interaction zone of lithosphere, atmosphere and hydrosphere. It is very important realm and it contains all forms of life including human. Plant geography deals with the distribution of plants and zoo geography

deals with the distribution of animals and microorganisms. Human ecology basically focused on human-nature relationship and consequences. Environmental geography studies both physical environment and human environment. Biogeography mainly focused on environmental problems and human life. Biogeography is not only the study of distribution of organisms with spatial variation of environment but it also studies the pattern of human interaction to natural environment. It also incorporates the explanation of changing environmental components and consequences.

All elements and factors which act as function of habitats of the organisms of the biosphere have been included in the study. And, the complete understanding of biogeography needs an integrated knowledge from different disciplines like, physical geography, atmospheric science, concept of hydrology, biology, etc.

Biogeography, an integrated sub-field of geography, combines the knowledge from environmental science, life science and fundamental rules of geography. According to F.N. Joseph, the scope of biogeography deals with the study of interactions between ecological factors and human beings. The scope of biogeography is principally concentrated in biosphere. Biosphere is life supporting layer where life exists, an integrated part of lithosphere, atmosphere and hydrosphere. All organisms of biosphere, their habitats and all environment controlling factors (which are directly and indirectly influencing life) are included in the nature of biogeography study. The scope and significance of biogeography contain the analysis of complex interaction between living elements (biotic elements) and physical world or surroundings (abiotic elements) and interpreting the spatial distribution of plants, animals and microorganisms. The nature and scope of biogeography enriched from different disciplines like geology, meteorology, pedology, botany, zoology, geomorphology, etc. Main scopes of biogeography are description of spatial variation of species diversification, adaptation with habitat environment through mutual interaction, and complex interaction between human and environment. Being the superior species humans have greater efficiency of resource utilisation. The human activities strongly modify the environmental compositions that change the abiotic worlds of organisms and ultimately those disrupt the biological succession.

### **3.6.2. Plant ecology: Concept of Adaptation, Succession and Climax:**

The word 'ecology' during mid of 19<sup>th</sup> century evolved to interpret the fact of dynamic interaction between organisms and their surroundings. Literally, it is the study of organism at home. There are lots of controversies about who coined the term but it is consensus that German biologist Ernest Haeckel used and gave definition of this term. Ecology has four basic concepts: a) Holism, b) ecosystem, c) succession, and d) conservation.

Plants play an important role as primary producer and provide food for all other living organisms in biosphere. Plant ecology is the study of plant species in their natural environment. It is considered as a sub-discipline of ecology. It studies the distribution and abundance of plants over the surface of the earth, the effects of environmental factors upon the abundance of plants, and the interactions among and between plants and other organisms. One of the early classic books on plant ecology was written by J.E. Weaver and F.E. Clements in 1938. It describes broadly about plant communities and particularly competition forces and processes like succession. Plant ecology is an important branch of geography and it is commonly known as plant geography. Basic contents of plant geography are origin and development, classification of plants, spatial distribution, dispersal, extinction and function. Spatial distribution of plant species has been discussed as plant community which is defined as association of population of different plant species in a given habitat. Plant community consists of more than one plant species. Plants grow in a particular habitat after adopting with regional environment.

There are four types of major habitats for plants. These are: i) terrestrial, ii) freshwater, iii) estuarine, and iv) marine. Adaptation, succession and climax of plant community depend on habitat environment.

Plant ecology deals with the study of plant ecophysiology, plant population ecology, community ecology, ecosystem ecology, landscape ecology and biosphere ecology.

Carl Ludwig Willdenow noted that similar climates produced similar types of vegetation, even when they were located in different parts of the world. Willdenow's student Alexander von Humboldt described vegetation types and noted that the distribution of vegetation depends on environmental factors. Plant distributions are controlled by a combination of historical factors, ecophysiology and biotic interactions. A species must either have evolved in an area or dispersed through natural processes or through human agency. Physiological adaptation is

very much significant for survival of a plant species. Plant communities are broadly distributed into biomes based on the present dominant plant species. Biomes are determined by regional climates (mostly temperature and precipitation) and they have general latitudinal trends.

### **3.6.2.1. Concept of Adaptation in Plant Ecology:**

Adaptation of organisms is an important concept in ecology. Adaptation is the fit of organisms to their environment. For organisms it is the process of adopting better solutions of problems created by environment. Adaptation is the process by which an organism enables to exist under existing conditions of a habitat as well as environment. Adaptation process is ultimate outcome of evolution. Through adaptation organisms modified themselves according to alternation of environmental condition and make them as potential climax community. Life forms are very much divers and complex. This diversity is the also nothing but the adaptation of organisms to their respective habitat. Organisms when faced environmental problems and these problems need to solve then they guided by the complex mechanism of evolution through natural selection. Evolution process provides to organisms better solution for adaptation. So adaptation is relative rather than absolute. Slow or moderate change of environment is accompanied by adaptation of organisms but rapid changes are cause of extinction of organisms. Through the dynamic evolutionary process of adaptation, organisms enhance their fitness with slow but steady changing environment.

In general adaptation of organisms with their changing environment can be grouped into:

- i) Structural adaptations,
- ii) Protective adaptations,
- iii) Animal association adaptations,
- iv) Physiological adaptations, and
- v) Biochemical adaptation.

Warming classified plants on the basis of soils into the following groups concerning theirgrowing (Shukla and Chandel, 1994):

- i) Oxylophytes – plants of acidic soil,
- ii) Halophytes – plants of saline soil,
- iii) Psammophytes – plants on sands,
- iv) Lithophytes – plants on surface of rocks, and
- v) Chasmophytes – plants in rocks fractures.

Warming (1909) again classified plants on the basis of available water for growing (Shukla and Chandel, 1994). These are:

- i) Hydrophytes - plants in or near water.
- ii) Xerophytes – plants in very poor supply of available water.
- iii) Mesophytes - .plants in an environment neither very dry nor very wet.

#### **3.6.2.1.1. Hydrophytes:**

As described by Shukla and Chandel (1994), hydrophytes are plants which grow in wet places or in water. These are called aquatic plants. Plants remain submerged either partly or wholly under water. Hydrophytes are classified as: (a) submerged hydrophytes, (b) floating hydrophytes, and (c) amphibious hydrophytes. The controlling factors behind the growth of hydrophytes in the aquatic environment are: (a) temperature of water, (b) water quality (nature of dissolved chemicals), (c) surrounding environmental factors, etc. Hydrophytic adaptations characterised by morphological adaptations like roots, stem, leaves modification; anatomical modifications, physiological modifications, etc.

#### **3.6.2.1.2. Xerophytes:**

As described by Shukla and Chandel (1994), xerophytes are plants which grow in dry environment. These types of plants are found in the desert areas. These plants are characterised by dry conditions, low humidity and high temperature. Xerophytes are grouped into several types based on their drought resisting power. There are like hydrophytes certain morphological adaptations like roots, stem, leaves modification; anatomical modifications, physiological modifications, etc.

#### **3.6.2.1.3. Mesophytes:**

As described by Shukla and Chandel (1994), this community is intermediate community between hydrophytes and xerophytes. They cannot grow in waterlogged or in dry areas. These are classified into two main groups. These are: (a) grasses and herbs communities, and (b) woody plants communities. Mesophytic adaptation characterised by tropical rain forest biome, sub-tropical forests, deciduous forests, meadows, etc.

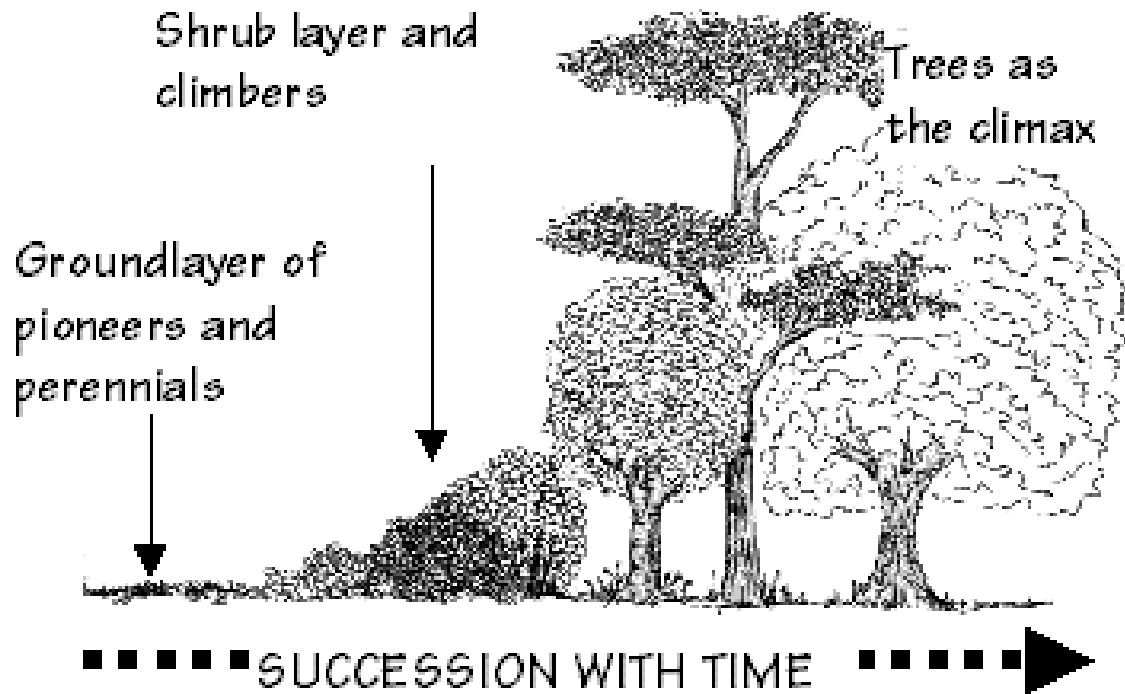
### **3.6.2.2. Concept of Succession in Plant Ecology:**

The plant community developed in a habitat through series of stages with time. Some typical plant communities try to maintain equilibrium. But, generally one community is replaced by another concerning ecological complexity of an area. Communities are dynamic. They are changing over space and time. Colonisation of species as well as progress of community is a continuous process of ecosystem development. Environment always changes over a period of time and that influences on existing community. It is cause of modification of existing community or replaced by another community. When species composition changes then community structure and function continue to successive development one after another community until the final community reaches again in more or less stable for a specific period. This relative occurrence of species over a specific area is known as succession or ecological succession. E. P. Odum opined that plant succession is an orderly process of community change in an area under consideration. According to Clements, succession is a natural process by which the same area becomes successively colonised by different groups or communities. Ecological succession is a sequential process of community progress and changes in species structure. Succession is the result of modification of physical environment. It ends in a stabilised ecosystem. Succession is characterised by continuous changes in animals and plants. It is also characterised by increasing diversity of species.

#### **3.6.2.2.1. Causes of succession:**

Succession of community is a complex process and the causes are:

- a) **Initiating causes:** Climatic causes, topographic causes and biotic causes.
- b) **Continuing causes:** Migration, aggregation, competition, reaction etc.
- c) **Stabilising causes:** Stabilisation of community.



(Source: <http://www.self-willed-land.org.uk>)

**Figure 1: Succession of plant with time**

### 3.6.2.2.2. Types of succession:

On the basis of different aspects basic types of succession are as follow:

- a) **Primary succession** - starts from primitive substratum.
- b) **Secondary succession** - new succession starts on previously built up substrata.
- c) **Autogenic succession** - community modification with changing environmental conditions.
- d) **Allogenic succession** - community modification due to external condition.
- e) **Autotrophic succession** - characterised by early and continued dominance of autotrophic organisms.
- f) **Heterotrophic succession** - characterised by early and continued dominance of heterotrophic organisms.

### 3.6.2.2.3. Processes of succession:

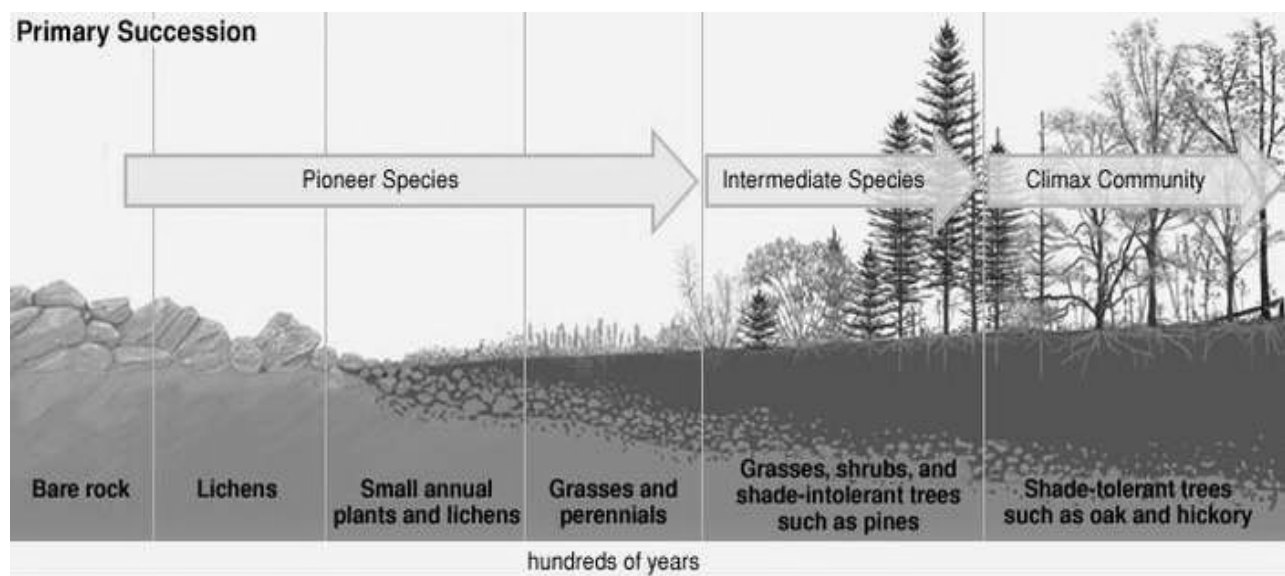
a) **Nudation** – first stage of succession where a bare land developed.

b) **Invasion** - species successfully established in a bare land. This process completed through three successive stages: i) dispersal (migration), ii) establishment, and iii) aggregation.

c) **Competition and Coaction** - after invasion species competition develops basically for nutrition and space.

d) **Reaction** – modification happened by the influence of living organisms and when modified environment unsuitable for existing community then it will be replaced by other community.

e) **Stabilisation** - the stage of climax of vegetation.



(Source: Encyclopedia Britannica, 2006)

**Figure 2: Process of succession and Climax community**

### 3.6.2.3. Concept of Climax in Plant Ecology:

The end point or final stage of succession is referred to as stabilisation. In this stage, final community becomes more or less stabilised for a longer period of time by process of equilibrium with the environment. This ultimate community is known as climax community and the stage is defined as climax stage. Here populations reach to an equilibrium condition which is stable and

self-replicating community with the surrounding environment. A specific type of climax developed largely depending on the climatic condition of an area. Climax vegetation is characterized by dynamic equilibrium stage and self-sustaining. Small scale environmental changes are unable to alter the climax species and species are smoothly adopted with this modification. Sometimes a climax community is seen as more stable in condition for a considerable time period, called arrested climax. The climax concept in ecology has been discussed by different approaches. These are: i) Monoclimax theory, ii) Polyclimax theory, and iii) Climax pattern theory.

### **3.6.3. Impact of Climate and Soil on Distribution of Plant:**

Etymologically, the meaning of environment is surroundings. Environmental system as well as ecosystem characterised by a set of different organic and inorganic substances functioned together through their interconnections as well as interrelationships forming a structure. All organic and inorganic substances are interconnected in our environment. The life of plants and their distributions are deeply controlled by surrounding outer world. This outer world is nothing but our environment i.e. organic and inorganic conditions. Any external factor which surrounds and affects the organisms (plants and animals) has been defined as environmental factor or ecological factor. Environmental factors those control plants growth and development, distribution and variation, etc. have been categorized as: (i) climatic or aerial factors, and (ii) topographic or physiographic factors.

i) **Climatic or aerial factors:** These factors include -

- Light
- Temperature of air
- Precipitation
- Humidity of air
- Atmospheric other elements

ii) **Topographic or physiographic factors:** These factors are -

- Altitude
- Direction of mountain chains and valleys
- Soil, etc.

All these factors are mutually interrelated and changes. One factor affects the other. During a specific period of time and in a specific place, impact on plants is the effect of these interrelated factors. Environment itself is very complex and dynamic in character acting, reacting and interacting with all organisms. The environment and organisms in an ecosystem (taken as a whole) are in a state of constant evolution. Here, we are going only to understand the impact of climatic factors and soil on the distribution of plants over the earth surface.

### **3.6.3.1. Climatic factors:**

Climatic factors, among all the environmental conditions, dominantly control the life and development, distribution and variation of plants. The important climate factors include: (i) light, (ii) temperature, (iii) precipitation and atmospheric humidity, and (iv) air.

Light is the key abiotic component without which life is impossible. Major source of light is sunlight. Major environmental phenomena like wind flow, rainfall, atmospheric temperature, chemical reactions, etc. are controlled by the energy of sunlight. Light controls many physiological activities of plants. These effects are: (i) photosynthesis, (ii) respiration, (iii) opening and closing of stomata, (iv) transpiration, (v) flowering of plants, (vi) growth, etc. Duration of sunlight is also impotent for plants life. It controls the growth and varieties of plants. It is known as photoperiodicity. Plants have been classified based on this characteristic into three categories: (i) long day plant, (ii) short day plant, and (iii) day neutral plant.

Temperature is another variable that strongly controls the activities of plants by time, season, latitude, and altitude. The distribution patterns of plants over the earth surface are more similar to the distribution of temperature. The temperature affects the plants directly and indirectly. Temperature affects the physiological processes and accordingly growth and size of plants. The range of temperature determines the survival of species in a particular habitat. This range of tolerance of temperature differs from one plant species to another species, which is called optimum temperature. This is why when temperature varies with changing places, vertically or horizontally, plant species are also changing. Based on temperature requirement, plant species are grouped into: (i) megatherms, (ii) mesotherms, (iii) microtherms, and (iv) hekistotherms.

Precipitation and atmospheric humidity are most influencing climatic factors behind plants growth and distribution. Precipitation, mainly in the form of rainfall, is the source of water over the surface of the earth. There are surface water and groundwater available for plants growth and distribution. It is the comprehensive agent makes available nutrients for plants and affects the physiology and morphology of plants. Where rainfall is very high there evergreen forests are found. The places with decreasing rainfall and amount of surface water varieties of plants grow from deciduous to herbs, grasses, and xerophytes. Water requirements by plants differ considerably from species to species. Some species need very little amount of water and some species grow in water as well.

#### **3.6.3.2. Soil:**

Soil is another most dominating ecological factor called edaphic factor for plants growth and distribution. Soil is the base for plants mechanical support and source of nutrients for plant kingdoms of terrestrial environment. It is very essential element for any living organisms. The outermost part of earth's surface covered by a thin layer of soil, a mixture of weathered rock particles and decomposed organic matters. Soil minerals, soil moisture, soil air and soil organisms constitute the soil properties as well as soil for use that controls plant growth, development, distribution and variation. Soil properties are considerably controlled by surface composition of the earth and climatic conditions. As different parts of the earth surface have been evolved through complex processes, surface compositions vary from one part to another. And, climate also differs from one place to another. Thus soil has been developed with wide varieties. With changing latitudinal zones, from equator to pole, and with increasing height horizontal and vertical distribution of soils are very prominent with environmental diversity of soil forming factors. As soil is the home and store house of nutrient, with variation of soils from one place to another the composition and characteristics of plant species changes.

#### **3.6.3.3. Biome:**

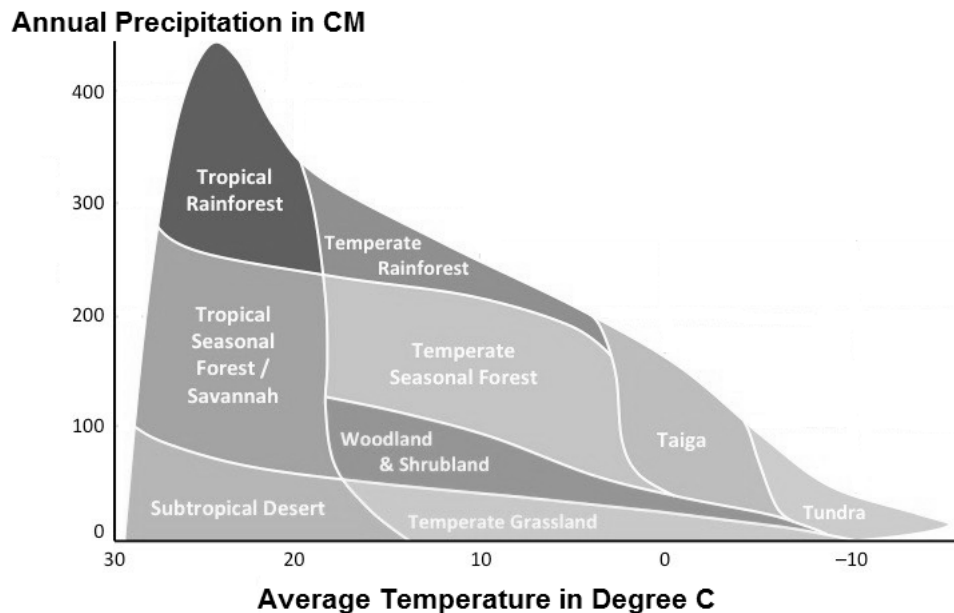
Impact of climate and soil on the distribution of plants is very much understood with changing biomes over the earth surface. Biomes i.e. principle plant communities are very much interconnected with prevailing climatic condition and soil characteristics of the region. It is because biome has passed through a series of developmental stage. Biome has distinctive

combination of plants and animals. Biome has attained an approximate condition of equilibrium with regional environment. The major biomes are:

- i. Tropical evergreen rainforest.
- ii. Tropical Savanna.
- iii. Mixed hot and moist evergreen and deciduous forest.
- iv. Tropical desert.
- v. Temperate grassland.
- vi. Broad leaved evergreen forest.
- vii. Temperate deciduous forest.
- viii. Mixed sub-tropical forest.
- ix. Coniferous forest.
- x. Tundra.

Equatorial or tropical evergreen rainforest biome is characterised by high temperature and high rainfall with tropical soils. High temperature and high rainfall create high and dense evergreen type of plants here. Tropical rainforests cover a wide range of precipitation but are stenothermic. In the central part of the continents, rainfall is moderate therefore over the tropical region tropical savanna and over the temperate part temperate grasslands are found. Chernozem soil, chestnut soil, grey soil, etc. are interlinked with the characteristics of grasslands. Tropical grasslands are stretched over a wide variety of temperature conditions but are delimited by moisture. Deserts with xerophytes and desert soils are observed on the western part of the continents in the tropical region where temperature is very high and rainfall is very low. Deciduous forest with mostly brown earth type of soil is found on the eastern part of the continents both in tropical and temperate regions. The deciduous forests grow in median temperature and rainfall regimes. In the tropical region where rainfall is much better due to monsoon type of climate than temperate region there mixed forests of hot and moist evergreen and deciduous forests are found particularly in India and China. The evergreen broad leaved forests having sclerophyllous vegetation lie on the western margins of the mid-latitudes marked by winter rainfall due to shift of the westerly winds. Taiga or Boreal or Coniferous forests with acidic litter of conifers with some podzol type of soils are characterised by low temperature and low rainfall. The tundra biome, north of the coniferous forest, lies over the tundra zone where most part of the year characterised by permanent snow due to very low temperature and the

ground is frozen up to a depth of more than 30 cm. causing permafrost condition and providing a very short period of optimal climate to plants growth. North of the tundra, there is permanent ice where no vegetation can survive.



(Based on <http://ib.bioninja.com.au>)

**Figure 3: Relationship between biomes, precipitation and temperature characteristics**

### 3.6.4. Means and barriers of dispersal and migration of animals:

The geographical (distribution) study of animals is called zoo geography. The distribution of animals over the earth surface is the result of migration of animals over time into ecologically suitable region. In biogeography, there are several fundamental processes by which organisms respond to changes in the geographic template. These are:

- (i) Evolution.
- (ii) Speciation.
- (iii) Extinction.
- (iv) Dispersal.

Simply, dispersal is the movement of organisms away from their birthplace. The spreading of animals from the place of their origin to other areas is called animal dispersal. Dispersal is an ecological process that plays an adaptive role in the life history of the organisms

which are involved. Dispersal and migration of animals or biological dispersal of animals refers to the movement of individuals or groups from their native habitat to another place due to different reasons. The fitness of the organism is increased in some way through the process of dispersal. In biogeography, it is an interesting topic since dispersal events related with species spatial movement and change their range by dispersing over long distances. Thus, it is the moving of organisms from their habitat to another region and it is also the consequences of individual fitness, population dynamics and genetics and species variation. To understand dispersal and its dynamic characteristics from evolutionary strategies at different level of ecosystem requires understanding on dispersal types and range of a given species and mechanisms involved in it.

The early dispersalists are Darwin, Alfred Russel Wallace and Asa Gray. According to them disjunctions (a situation in which two closely related populations are separated by a wide geographic distance) could be best explained as the result of long distance dispersal. The continental drift theory is considered as a means for dispersal. Some animals are percipient in dispersal throughout their lives and some others are limited phases of their life cycles. The strategies of animal's dispersal are predicted based on habitat nature and circumstances. Organisms can disperse either actively or passively. As for example: Monarch butterflies migrate great distances. They fly from southern Canada to the southern United States and central Mexico. Many organisms depend on other organisms for their long distance migration. Parasites are a good example. Many insects, spiders, and mites disperse through the atmosphere residing upon aerial planktons.

During dispersal as well as range expansion, organisms must be able to reach in a new area. They must survive against the harsh conditions occurring during the passage. They also survive and reproduce in the new area for the establishment of a new population.

#### **3.6.4.1. Types of Dispersal of Animals:**

(i) **Gradual dispersal:** It involves longer period of time and very slow rate of migration. It covers larger area and results in widespread distribution of animals over time.

(ii) **Rapid dispersal:** Here organisms are dispersed or migrated rapidly in the new areas from one area due to harsh environmental condition or human discourage.

(iii) **Seasonal dispersal:** Due to seasonal extreme weather conditions every year animals migrated to a favourable area. Here migratory animals again return to their native places.

(iv) **Forced dispersal:** Animals are forced to leave their native place or habitat due to sudden and catastrophic events like prolonged droughts, recurrent floods, forest fires, volcanic eruption, etc.

(v) **Dispersal for breeding place:** Animals migrated from their native place to find sufficient and suitable breeding places to avoid harsh condition.

(vi) **Anthropogenic dispersal:** In this type of dispersal, humans are largely involved in dispersal of animals through their deliberate efforts. It has caused several environmental and ecological problems.

Considering the process of dispersal, dispersal events broadly are grouped as: (i) Jump dispersal or sweepstakes, (ii) Diffusion, and (iii) Secular migration. Jump dispersal refers to the colonization over a long distance in a new area of animals, birds, etc. from their birth place. Bats are often through this process became island inhabitants. Diffusion denotes gradual spread of organisms outward from the boundaries of the range of their distribution. It is a slower form of dispersal. It involves not just individuals, but populations. As for example: Red fox in Australia, American muskrat in Europe, etc. Secular migration happens much more slowly. In fact, it is so slow that organisms can evolve during the process.

#### **3.6.4.2. Means of Dispersal and Migration of Animals:**

The dispersal routes allow movement of organisms from one region to another. It is characterised by allowing a balanced assemblage of plants and animals to cross them without any selective discrimination. At the two ends of a dispersal route as well as corridor, there are fairly similar assemblages of organisms. A 'filter' is a dispersal route that cannot allow all the passing organisms to cross it rather it selects to pass through it. The Arabian subcontinent acts as a filter. It only permits certain mammals, reptiles, etc. to disperse between northern Africa and central Asia. Lastly, 'sweepstakes' routes refer to the crossing of barriers by rare chance events. From south-east Asia different land snails dispersed to the eastward and southward.

Taking all natural and human factors together, in general, the common means of animal dispersal are as follow:

(i) **Corridor bridge:** It is like a corridor for dispersal and migration.

(ii) **Land bridge:** These are barrier to aquatic animals and serve as good passage for land animals and plant population.

(iii) **Filter bridge:** It is like a filter for dispersal and migration.

(iv) **Natural rafts and driftwood:** Animals take long journey upon the natural rafts of vegetation in marine waters. Driftwood acts as means for migration of animals in oceanic islands from main lands. Majority of animals are exterminated during such journey but a few may survive to reach other island.

(v) **Sweepstakes:** It is like a sweepstakes for dispersal and migration.

(vi) **Winds and storms:** Transportation by winds and storms is one of the important means of dispersal of animals and plants.

(vii) **Transportation by animals capable of flight:** Migratory birds transported small animals, insects, plant seeds, plants, etc. long distance to oceanic islands and others.

(viii) **Human agency:** Involving transportation and introducing a number of animals to places where these were not found.

#### **3.6.4.3. Barriers of Animals:**

Barrier in dispersal is the dispersal range of a species. Barriers are that type of environment or features in nature which are hostile to the organisms those are under long distance dispersal. The effectiveness barriers to prevent dispersal depend on the nature of the barriers and also on the organisms dispersing. Mostly, barriers are species-specific phenomena. There are different types of barriers. These are:

(i) Physical barriers.

(ii) Climatic barriers.

(iii) Physiological barrier.

(iv) Seasonal barrier.

(v) Sedentary habit.

(vi) Home range or territoriality.

Physical barriers of dispersal are (a) topographic barriers: mountain ranges, deserts, etc.; (b) large bodies of water and land masses: oceans, continents, etc.; (c) vegetative barrier: forests; (d) lack of salinity in sea water. Here, the barriers in migration are physical factors which prevent organisms for crossing to a new region. Climatic barriers like temperature, moisture, amount of

light, etc. All animals are not able to cross all types of barriers. Therefore, the dispersal and migration of animals also related with their psychology, body size, locomotive organs, physiological endurance, etc. These are physiological barriers. Physiological barriers are accomplished by environmental conditions to survive long enough for dispersal. Such barriers are salt (or fresh) water or unfavorable temperatures. In some areas, the nature of barriers may change with season. In temperate regions of North America, water bodies serve as barriers to the movement of many terrestrial species in summer, but during winter these waters may freeze and allow movement across them. Sedentary habit of animals makes them to aggregate in particular area only. Home range or territoriality involved with choice of animals for not migration to other areas from their native land.

### **3.6.5. Biodiversity and Related Issues:**

When we look at the geological history of evolution of both flora and fauna it is found that a gradual change of them occurred. With the emergence of different species some species extinct in parallel due to different causes. In this regard at present human activity is very important.

The term 'biodiversity' is a contraction of 'biological diversity'. In 1985, Waler G. Rosen coined the term 'Biodiversity'. But, long before, wildlife scientist Raymond F. Dasmann used 'Biological Diversity' in the year of 1968. Biodiversity denotes the variety of all life forms on earth and the essential interdependence of all living things. In the convention on Biological Diversity at Rio De Jenerio (Brazil) in 1992 by 154 countries, the term 'biodiversity' was defined as 'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic eco-systems and the ecological complexes of which the area part, this include diversity within species, between species and of ecosystem.' According to IUCN (1998), biodiversity refers to 'the variety and variability of species of their population, the variety of species of their life forms, the diversity of the complex association with species with their interaction and their ecological process which influences perform.' Biodiversity has intrinsic value. Biodiversity has also utilitarian value. Biodiversity is dynamic.

### **3.6.5.1. Factors influencing biodiversity:**

There are different factors responsible for variety of species over the earth surface. These are: (i) Spatial heterogeneity factor, (ii) Climatic factor, (iii) Time factor, (iv) Competition factor, (v) Predation factor, (vi) Productivity factor, and (vii) Environmental stability factor.

### **3.6.5.2. Types of biodiversity:**

Biodiversity is observed in terms of genes, species and ecosystem. There are three types of biodiversity. These are: (a) Genetic diversity, (b) Species diversity, and (c) Ecosystem diversity. Genetic diversity represents the heritable variation within and between populations of organisms. Species diversity refers to different kinds of organisms, relationships among species. It represents different types of plants, animals and other types of life forms within a region. 'Species richness' means the number of species in a site or habitat. Species diversity is an indicator to understand the biological richness/ stress of an ecosystem. Biodiversity is determined by species richness, species evenness, species composition, species interaction, etc. Ecosystem diversity represents the variety of different habitats/ ecosystems in a particular area (e.g. wetland, grassland, forest, etc.). The world ecosystems are maintained by their biodiversity.

### **3.6.5.3. Significance and benefits of biodiversity:**

Biodiversity has wider significance and value in all level to support the life on earth.

- (i) Biodiversity is the sum of all life forms on earth and it includes genetic, species, and ecosystem diversity.
- (ii) Biodiversity shows the health of the ecosystems on earth.
- (iii) Biodiversity helps human life through oxygen, food, clean water, medicine, aesthetics, ideas, etc.
- (iv) Biodiversity regulates climate, biogeochemical cycles and hydrological functions.
- (v) Biodiversity helps soil protection.
- (vi) Biodiversity helps crop pollination.
- (vii) Biodiversity supports recreation and ecotourism.
- (viii) Biodiversity supports ecological services.
- (ix) Biodiversity gives traditionally free benefits to society or public goods.
- (x) Biodiversity supports aesthetic and cultural benefits.

(xi) Biodiversity supports various local to global benefits involving commodity value, amenity value, ecological integrity value, ethical value and other values.

#### **3.6.5.4. Biodiversity issues and management:**

Biodiversity i.e. flora and fauna distributions depend on climatic elements, physiographic characteristics, availability of water, soil characteristics, presence of other organisms, human behavior and interaction, etc. In the tropical region over the earth surface maximum biodiversity is concentrated. Current worldwide landuse practices as well as activities related to economic development of countries lead to the degradation of biodiversity. Different reports, websites, papers, etc. show that by the end of the 21<sup>st</sup> century, two-thirds of the species on earth may extinct. Till date, about 50 percent of the natural habitats on earth have been cleared due to human uses like agricultural field generation, urbanisation, industrialisation, infrastructural development, etc., and another 0.5 to 1.5 percent of nature is lost each year. Nearly 75 percent of the genetic diversity of crops has been lost in the past century. Direct and indirect human activities have altered the terrestrial, freshwater and marine ecosystems throughout history. According to the principle, the rate of extinction should be one mammal and two bird species in every 400 years. But, recorded extinction of past nearly 400 years shows that 58 mammals and 115 bird species have disappeared. According to an estimation made by scientists that as many as three species per hour are going extinct and 20,000 extinctions occur each year. Extinction may be caused by natural reasons (e.g. droughts, fires, floods, etc.). Rich biodiversity regions are now destroying and the major causes of diversity loss are:

- a) Catastrophic processes.
- b) Habitat destruction and reduction.
- c) Huge hunting of wildlife.
- d) International trade of biotic resources.
- e) Introduction of new species.
- f) Pollution of habitats.
- g) Other causes.

According to the Millennium Ecosystem Assessment, there five main causes of biodiversity loss are: (i) Habitat change, (ii) Climate change, (iii) Invasive alien species, (iv) Overexploitation, and (v) Pollution.

Habitat loss is the largest current threat to biodiversity. Based on relative threat of species extinction, IUCN categorised species into six threatened classes and incorporated in Red Data Book. This categorisation was made to restrict the extinction of threatened species. To protect the biodiversity, different strategies and measurements have been taken. Biodiversity has immense value to maintain the human and ecosystem balance. Considering this fact numerous conservation efforts were made to protect and restoring the loss biodiversity. These efforts at global level are: (i) on-site protection management system (in-situ), and (ii) off-site protection management system (off-situ). In-situ conservation, the conservation of species in their natural habitats, includes biosphere reserves, national parks, wildlife sanctuaries, biodiversity hotspots, etc. Ex-situ conservation is the preservation of components of biodiversity outside their natural habitats (e.g. gene bank, microbial culture collection, collection of living organisms in zoo, botanical garden, etc.). There are also biodiversity conservation programme at country level based on national priority task.

### **3.6.6. International Biological Programme:**

Human has immense impact upon nature. Human exploited natural resources unlimitedly. The International Biological Programme or IBP, an international level study on ecological and environmental issues, happened during 1964 to 1974. It was an attempt to promote and apply the methods of science to ecosystem and urgent environmental issues. It is a worldwide plan of research concerned with the biological basis of productivity and human welfare. Though, there was a continuous process of starting of this type of study from 1959 but finally it has been started in 1964. This idea was stimulated by the success of International Geophysical Year (IGY), 1957-1958. This programme was concluded in 1974. The main effort of IBP was to coordinate large scale ecosystem ecological and environmental studies. This study aimed to observe the impact of natural environmental changes on biological communities. The activities of man are bringing undesirable degradation of the environment. Its aim is to study the human impact and to fill the gaps in knowledge by means of sufficient research. The successful main result of this programme was studies of five biomes involving grassland biome, deciduous forest biome, etc. This programme enriched as well as intensified the study of ecosystem ecology. The IBP's research structure contained seven programme areas. These are as follow (<http://www.nasonline.org>):

1. Productivity of terrestrial communities.
2. Production processes.
3. Conservation of terrestrial communities.
4. Productivity of freshwater communities.
5. Productivity of marine communities.
6. Human adaptability.
7. Use and management of biological resources.

In criticism, many biologists, particularly molecular biologists and evolutionary ecologists, remarked that this programme was dramatic concerning its scale of funding than academic achievements. This programme also has no clear socially and scientifically pressing goal.

### **3.6.7. Man and Biosphere Programme:**

Man and the Biosphere Programme (MAB) is an Intergovernmental Scientific Programme of UNESCO. It has been introduced in the year of 1971. This programme is to promote interdisciplinary approaches to research and education as well as management in ecosystem conservation and sustainable use of natural resources. MAB programme combines science and arts to improve human livelihood and to safe natural ecosystems. The fundamental aim of this type of scientific agenda is to improve human and environment relationship at global scale. The MAB programme also aimed to ecosystem specific networking development at regional, national and global level. In 1977, the World Network of Biosphere Reserves was introduced by the MAB. Towards implementation of the research outcomes and decisions taken by MAB on ground, MAB in maximum relies on this World Network of Biosphere Reserves. This World Network shared knowledge, experiences, innovations, etc. for sustainable development regional to global scale. The MAB programme addresses several challenging environmental problems in different sectors. It is aimed to improve quality life, equal sharing of resources and to manage ecosystem. This programme promotes the scientific approaches for economic development of a region and society without hampering environmental sustainability. It presents innovative approaches to economic development which is socially and culturally appropriate and environmentally sustainable. The MAB programme is a unique platform to share

knowledge and research from different disciplines on human interference, sustainable development, environmental degradation, biodiversity loss, climate change, etc. There are several regional and sub-regional networks of MAB like AfriMAB in Africa, Southeast Asian Biosphere reserve Network, etc.

Framework of MAB programme within the World Network of Biosphere Reserves strives to ([www.unesco.org](http://www.unesco.org)):

- i) Identification and assessment of the environmental changes due to human and natural activities and inverse impacts of these changes.
- ii) Study and interpretation of dynamic interrelationship between ecosystem and socio-economic processes.
- iii) To ensure the basic human welfare with a habitable environment.
- iv) To promote the transfer of knowledge on environmental problems for sustainable development.

The main governing body of MAB programme is the International Coordinating Council of the Man and the Biosphere Programme, known as MAB Council or ICC. Role of MAB Council is:

- i) To guide and supervise the MAB Programme.
- ii) To review the progress of the MAB Programme.
- iii) To recommend research projects to countries.
- iv) To make proposals on regional or international cooperation.
- v) To assess priorities among projects and MAB activities in general.
- vi) To coordinate the Member States participating in the MAB Programme.
- vii) To coordinate activities with other international scientific programmes.
- viii) To consult with international nongovernmental organisations.

### **3.7 Self-Assessment Tests**

- i. What is biogeography?
- ii. What is the scope of biogeography as an interdisciplinary subject?
- iii. Briefly discuss about the significance of biogeography.
- iv. What is plant ecology?

- v. Write a short note on physiological adaptation of plants.
- vi. Explain the concept of climax with suitable example.
- vii. What is plant succession?
- viii. Describe the role of climate and soil on plant distribution.
- ix. Briefly discuss about means and barriers of dispersal of animals.
- x. What is dispersal of animals?
- xi. What is biodiversity?
- xii. Elucidate the controlling factors of biodiversity.
- xiii. What are the present issues of biodiversity?
- xiv. What initiatives have been taken for biodiversity conservation?
- xv. What is IBP?
- xvi. Write a short note on Man and Biosphere Programme.

### **3.8 Summaries and Key points**

Biogeography is a sub-discipline of geography. It is the study of spatial patterns and temporal distributions and variations of all plants, animals and microorganisms. Plant ecology is the study of plant species in their natural environment. In biogeography, plant ecology studies the distribution and abundance of plants over the surface of the earth, the effects of environmental factors upon the abundance of plants, and the interactions among and between plants and other organisms. A plant species must either have evolved in an area or dispersed through natural processes or through human agency. Physiological adaptation is very much significant for survival of a plant species. Plant communities are broadly distributed into biomes based on the present dominant plant species. Adaptation is defined as the process by which an organism enables to exist under existing conditions of a habitat as well as environment. Environment always changes over a period of time and that influences on existing community, which is the cause of modification of existing community or replaced by another community. This relative occurrence of species over a specific area is known as succession or ecological succession. The end point or final stage of succession is referred to as stabilisation. In this stage, final community becomes less or more stabilised for a longer period of time by process of equilibrium with the environment. This ultimate community is known as climax community and

the stage defined as climax stage. Environmental factors control plants growth and development, distribution and variation, etc. Climatic factors, among all the environmental conditions, dominantly control the life and development, distribution and variation of plants. Soil is another most dominating ecological factor called edaphic factor for plants growth and distribution. Impact of climate and soil on the distribution of plants is very much understood with changing biomes over the earth surface. The distribution of animals over the earth surface is the result of migration of animals over time into ecologically suitable region. Dispersal is the movement of organisms away from their birthplace. The spreading of animals from the place of their origin to other areas is called animal dispersal. Dispersal is an ecological process that plays an adaptive role in the life history of the organisms which are involved. In biogeography, there are several dispersal routes. Barriers are that type of environment or features in nature which are hostile to the organisms those are under long distance dispersal. Biodiversity denotes the variety of all life forms on earth and the essential interdependence of all living things. Biodiversity has wider significance and value in all level to support the life on earth. The International Biological Programme or IBP is an international level study on ecological and environmental issues during 1964 to 1974. It was an attempt to promote and apply the methods of science to ecosystem and urgent environmental issues. The fundamental aim of MAB programme is to improve human and environment relationship at global scale. The MAB programme also aimed to ecosystem specific networking development at regional, national and global level.

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**Website Resources:**

[shodhganga.inflibnet.ac.in](http://shodhganga.inflibnet.ac.in)

[www.wikipedia.org](http://www.wikipedia.org)

[www.unesco.org](http://www.unesco.org)

[www.nasonline.org](http://www.nasonline.org)

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**Post-Graduate Degree Programme (CBCS)**  
**in**  
**GEOGRAPHY**

**Semester-I**

**Paper: GEO103T**

**Self-Learning Material**



**DIRECTORATE OF OPEN AND DISTANCE LEARNING**  
**UNIVERSITY OF KALYANI**

**Kalyani, Nadia**  
**West Bengal, India**

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Utmost care has been taken to develop the SLMs useful to the learners and to avoid errors as far as possible. Further suggestions from the learners' end would be gracefully admitted and to be appreciated.

During the academic productions of the SLMs, the team continuously received positive stimulations and feedback from Professor (Dr.) Sankar Kumar Ghosh, Hon'ble Vice- Chancellor, University of Kalyani, who kindly accorded directions, encouragements and suggestions, offered constructive criticism to develop it within proper requirements. We gracefully, acknowledge his inspiration and guidance.

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Their concerted efforts have culminated in the compilation of comprehensive, learner-friendly, flexible texts that meet the curriculum requirements of the Post Graduate Programme through Distance Mode.

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Director  
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University of Kalyani



# **SYLLABUS**

## **Paper–GEO103T**

**(Credit – 4; Marks – 100; Internal Evaluation – 20 + Semester-end Examination – 80)**

### **GROUP – GEO103T.1: SOCIAL GEOGRAPHY**

**(Credit – 2; Marks - 50: Internal Evaluation – 10, Semester-end Examination – 40)**

- Unit-1: Concept of space: geographical, material and social
- Unit-2: Geography and social life; Social structure and Social processes
- Unit-3: Social class and caste; Social distance
- Unit-4: Geography of inequality: race, ethnicity and gender
- Unit-5: Human ecology of disease and emergence of Medical Geography; Health and social well-being
- Unit-6: Social Geography and Millennium Development Goals
- Unit-7: Human Development Index and Gender Empowerment Measures
- Unit-8: Subaltern studies in Geography

### **GROUP – GEO103T.2: CULTURAL GEOGRAPHY**

**(Credit – 1; Marks - 25: Internal Evaluation – 5, Semester-end Examination - 20)**

- Unit-9: Culture as a geographical process; Mosaic of culture, language, religion and customs
- Unit-10: Emergence of ethnic geography: ethnic neighbourhood and ghetto; Ethno-ecology of PTGs in India
- Unit-11: Partition of Indian and Diaspora; Globalization
- Unit-12: Cultural ecology and folk geography: study on folk architecture, folk music and dance, folk fairs and festivals; Emergence of Tourism Geography from Cultural Geography

### **GROUP – G103CT.3: POLITICAL AND HISTORICAL GEOGRAPHY**

**(Credit – 1; Marks - 25: Internal Evaluation – 5, Semester-end Examination - 20)**

- Unit-13: Geographical perspectives on formation of State; Concept of State after Ratzel and Marx; Colonialism, Imperialism and Federalism for understanding core-periphery relationship;

Unit-14: Concept of Geopolitics; Geopolitical significance of international water disputes with India and its neighbouring countries;

Unit-15: Concept of Electoral Geography; Approaches to the study of geography of elections: Areal and Spatial Behavioural approaches; Spatial organization of electoral areas and the geography of representation

Unit-16: Scope and content of Historical Geography; Ancient period: Territorial organization of JANAPADAS in India; Agriculture, industry, trade and urbanization under the Mughal Empire; Plantation farming and textile industry during Colonial India

# Content

	<b>Page No.</b>
1.1 Introduction	10
1.2 Learning Objectives	10
1.3 Assessment of Prior Knowledge	10
1.4 Learning Activities	11
1.5 Feedback of Learning Activities	11
<b>Unit-1</b>	
1.6.1 Concept of space	11
1.6.1.1 Geographical space	13
1.6.1.2 Material space	13
1.6.1.3 Social space	14
<b>Unit-2</b>	
1.6.2 Geography and social life	15
1.6.3 Social Structure	15
1.6.4 Social Processes	16
<b>Unit-3</b>	
1.6.5 Social Class and Caste	16
1.6.6 Social Distance	18
<b>Unit-4</b>	
1.6.7 Geography of Inequality	18
1.6.8 Race	18
1.6.9 Ethnicity	19
1.6.10 Gender	19
<b>Unit-5</b>	
1.6.11 Health	20
1.6.12 Social well-being	21
1.6.13 Human Ecology of Disease and Emergence of Medical Geography	23
<b>Unit-6</b>	
1.6.14 Social Geography and Millennium Development Goals	24
<b>Unit-7</b>	
1.6.15 Human Development Index	25
1.6.16 Gender Empowerment Measures	26
<b>Unit-8</b>	
1.6.17 Subaltern studies in Geography	27
1.7 Self-assessment Test	28
1.8 Summaries and Key Points	28
1.9 References	29
2.1 Introduction	30
2.2 Learning objectives	33
2.3 Assessment of prior knowledge	33
2.4 Learning activities	34
2.5 Feedback of learning activities	34
2.6 Examples and illustrations	35
<b>Unit-9</b>	
2.6.1 Culture as a geographical process	35
2.6.2 Cultural Landscape	40
2.6.3 Linguistic Regions in India	42

<b>Unit-10</b>		
2.6.4	Emergence of Ethnic geography: Ethnic Neighbourhood and Ghetto	47
2.6.5	Ethno-ecology of PTGs in India	49
<b>Unit-11</b>		
2.6.5	Partition of India and Diaspora	50
<b>Unit-12</b>		
2.6.6	Globalization, Cultural ecology and Folk geography	52
2.6.7	Folk Festivals	52
2.6.8	Folk Literatures	53
2.6.9	Folk Architecture	53
2.6.10	Folk Dance	53
2.6.11	Folk Music	54
2.6.12	Emergence of Tourism Geography from Cultural Geography	55
2.7	Self-assessment Tests	56
2.8	Summaries and key points	56
2.9	Study tips	57
3.1	Introduction	60
3.2	Learning Objectives	61
3.3	Assessment of Prior Knowledge	62
3.4	Learning activities	62
3.5	Feedback of Learning Activities	62
3.6	Examples and illustrations	62
<b>Unit-13</b>		
3.6.1	Geographical perspectives on formation of State	62
3.6.2	The basic concepts of a state according to Ratzel and Marx	63
3.6.3	Colonialism, Imperialism and Federalism for understanding core-periphery relationship:	66
<b>Unit-14</b>		
3.6.4	Concept of Geopolitics	69
3.6.5	Geopolitical significance of international water disputes with India and its neighboring countries:	71
<b>Unit-15</b>		
3.6.6	Concept of Electoral Geography	71
3.6.7	Geography of elections and Areal approach and Behavioural model of electoral geography	73
3.6.8	Spatial organization of electoral areas and Geography of representations	74
<b>Unit-16</b>		
3.6.9	The Scope and content of Historical Geography:	74
3.6.10	The Ancient period: Territorial organization of JANAPADAS in India	75
3.6.11	The Agriculture, industry, trade and urbanization under the Mughal Empire:	76
3.6.12	Impact of Plantation farming and textile industry during Colonial in India	78
3.7	Self-assessment test	79
3.8	Key Terms	80
3.9	Study tips	80

## **Group – GEO103T.1: Social Geography**

**(Credit – 2; Marks – 50; Internal Evaluation – 10 + Semester-end Examination - 40)**

### **1.1 Introduction**

Social geography is that part of human geography which studies different social issues and their spatial relations. It studies human groups in respect to their social behavior, their social outlook. To explain the social theories, it borrows ideas from sociology, anthropology, economics etc. Class, caste, race, religion, language, tribes etc. are the principal focus of this discipline. It also studies social space which is quite distinguished from physical space. This module will enable you to understand different social components and social processes, medical geography, human development index etc.

### **1.2 Learning Objectives**

The discussions in this self-learning material in the field of social geography have attempted several following objectives that together serve as the basis of the above chapter.

1. First, from geographic perspectives, there is a need to learn about the concept of space, its type and how they are related to social phenomena of the earth surface.
2. Second, to examine the structure, form, process, and interaction among or within societal groups in a systematic and orderly manner and their resultant outcome in society (like caste, class, racial and ethnic groups etc.).
3. Societal development does not occur in a balanced way over horizontal and temporal dimensions. Broadly speaking there is imbalance at the levels of living of various social groups. Therefore the third objective is to learn about the social well-being, its causes and indicators, social distance, inequality and the measures of key dimensions of human development etc.
4. Fourth, to study the effect of location on human health and spatial distribution of disease, its alleviation measures through various international organizations to achieve development of society
5. Lastly, subaltern studies whose goals are to refocus history on the unique role of marginalized people in bringing about large-scale transformations in society.

### **1.3 Assessment of Prior Knowledge**

It is better if the learners carry basic knowledge about

- The scope and content of social geography,
- The difference between sociology and social geography,
- The Indian society

### **1.4 Learning Activities**

- A well-equipped class room with black-board, over-head projector, and loudspeaker is needed to explain these concepts.
- A series of thematic maps related to social inequality, development indices, concentration of different races both at global and national level is of much necessary to explain the current contents of social geography.

### **1.5 Feedback of Learning Activities**

- Preparation of Gender Development Index map at state levels in India,
- Identification of different racial groups of the world and their spatial concentration,
- Differentiation between race and caste

#### **1.6.1 Concept of Space**

Space is one of the most significant aspects of the disciplines of social science as it is fundamental to our understanding of geography. Space is the endless three-dimensional extent in which objects and events have relative position and direction. Physical space is often conceived in three linear dimensions, although modern physicists usually consider it, with time, to be part of a boundless four-dimensional continuum known as space-time. The concept of space is considered to be of fundamental importance to an understanding of the physical universe. However, disagreement continues between philosophers over whether it is itself an entity, a relationship between entities, or part of a conceptual framework.

The term "space" has been defined variously by scholars:

According to Harvey space is “a thing in itself”.

In general terms, the Oxford English Dictionary defines space in two ways;

1. A continuous extension viewed with or without reference to the existence of objects within it.
2. The interval between points or objects viewed as having one, two or three dimensions.

However, the human geographers' interest is in the objects within the space and their relative position, which involves the description, explanation, and prediction of the distribution of phenomena. Thus, the relationship between objects in space is the center of the study.

**Michel Foucault** defines space as; "The space in which we live, which draws us out of ourselves, in which the erosion of our lives, our time and our history occurs, the space that claws and gnaws at us, is also, in itself, a heterogeneous space.....we live inside a set of relations.

### **Characteristics of space**

1. Name
2. Site
3. Situation
4. Mathematical location: It can be represented by a point, line or polygon geometry on a map.
5. Centrality
6. Similarity
7. Connection

### **Absolute Space**

It is a container which holds all the earthly matters, e.g., village, city, factory, forest, roads, and railways etc. Absolute conceptions of space in which space is a distinct, physical and elementary real or empirical entity in itself.

### **Characteristics**

1. It is physical, real which can be perceived through experience.
2. The concept of absolute space associated with German Philosopher Immanuel Kant.
3. Geographer divided the absolute space into small fragments and when these fragments are divided unevenly then it is called an area, but when these fragments are divided on a fixed parameter then it is called as a region.

## **Relative Space**

Relative concept of space in which space is merely a relation between events, or aspects of events and thus bound to time and process.

### **Characteristics:**

1. It discusses the relationship between different events.
2. Space cannot be judged only through absolute viewpoint. Space is depended on what people see, what he thinks and in which way it can be used. It means relative space is social space.
3. It is of various types, like, social space, economic space, and relational space.

### **1.6.1.1 Geographical space**

Geographical space is often considered as land that has a relation to ownership in which space is considered as property or territory. Space has also impact on human behavior because it is considered as an important factor in architecture and farming system. Therefore, the impact of space found on the design and structure of buildings and agricultural system.

Ownership of space is not restricted to land; it is also related to air-space and water space.

There are three types of geographical space. These three types of space are independent of one another.

1. **Real Space:** This is the common geographical space which can be reflected by maps or remote sensing images and so forth.
2. **Phase Space:** It can be described by time series of the geographical system. The concept of phase space taken from physics, but it is very helpful in reflecting the regularity in the temporal series of geographical evolution.
3. **Order Space:** It is defined by referring to the definition of phase space. It is characterized by hierarchical data including the geographical data based on rank order.

### **1.6.1.2 Material space**

The concept of material space can be extended to other kinds of problems not explicitly concerned with economic factor but also focus on the relative location of human material culture. In such cases, geographers speak more generally of material space.

The material culture generally focused on land utilization for any kind of production or manufacture, residential purpose etc. and consequential land use imprints on geographical

space. By developing analytical models of material space it is possible to figure out not only the general thrust of these intuitively obvious relationships but also their relative importance in quantitative terms. Land use model is the general approach that used mathematics and geometry to derive the quantitative and qualitative properties of space of interest to geographers and material space in particular.

Within this subject matter, Von Thunen's agricultural land use model looks at material space from the special perspective of trying to determine the best location for agricultural crops. On the other hand, the urban morphology of cities and towns also emphasizes at material space from the particular viewpoint of land value that a place has in material culture. From these perspectives, space is interesting only when viewed as material production: something agricultural production, manufacturing, urban land use etc.

### **1.6.1.3 Social space**

The geographical space which is perceived or used by an individual or a social group may be treated as a social space through the space of an individual is connoted as personal space.

A social space is a physical or virtual space such as a social center, online social media, or another gathering place where people gather and interact. Some social spaces such as town squares or parks are public places; others such as pubs, websites or shopping malls are privately owned and regulated.

**Henri Lefebvre** emphasized that in human society all 'space is social: it involves assigning more or less appropriated places to social relations, social space has thus always been a social product. Social space becomes thereby a metaphor for the very experience of social life - 'society experienced alternatively as a deterministic environment or force (*milieu*) and as our very element or beneficent shell (*ambiance*)'. In this sense 'social space spans the dichotomy between "public" and "private" space is also linked to subjective and phenomenological space'.

There is no single social space exist, but rather that multiple social spaces can exist and overlay within a specific geographical area.

Indiscipline of humanistic geography "social space", not physical or objective space, was made the object of inquiry' (Smith 1990). Radical approaches, most notably those inspired by Marxism, sought to understand space as the product of social forces, observing that different

societies use and organize space in different ways; and to explain the processes through which social differences become spatial patterns of inequalities (Smith 1990).

From the philosophical point of view, the understanding of space and society termed as the 'socio-spatial' process which discriminates geographer thinking from a sociologist. In this sense assessed the various social categories (such as class, gender, sexuality, and race)

## **1.6.2 Geography and Social Life**

The way we are adapted to our society is called social life. At the most basic, social life is the combination of various components: activities, people, and places. While all of those components are required to done a social life, the nature of each component is deferent for every person, and can change for each person, as affected by a variety of external influence ethnography is a big factor in determining our social life prevalent social life is greatly affected by geographic conditions, or the natural physical environment geographic conditions, or the natural physical environment presented by the country inhabited, must be recognized as including aspect, soil, water supply, other mineral resources, flora, fauna, and topography.

## **1.6.3 Social Structure**

**Social structure**, in sociology, the distinctive, stable arrangement of institutions whereby human beings in a society interacts and lives together. Social structure is often treated together with the concept of social change, which deals with the forces that change the social structure and the organization of society.

In another word, social structure is the patterned social arrangements in society that are both emergent from and determinant of the actions of the individuals. On the macro scale, social structure is the system of socioeconomic stratification (e.g., the class structure), social institutions, or, other patterned relations between large social groups. On the mesoscale, it is the structure of social network ties between individuals or organizations. On the micro scale, it can be the way norms shape the behavior of individuals within the social system.

Studies of social structure attempt to explain such matters as integration and trends in inequality. In the study of these phenomena, sociologists analyze organizations, social categories (such as age groups), or rates (such as of crime or birth). This approach, sometimes

called formal sociology, does not refer directly to individual behavior or interpersonal interaction. Therefore, the study of social structure is not considered a behavioral science; at this level, the analysis is too abstract. It is a step removed from the consideration of concrete human behavior, even though the phenomena studied in social structure result from humans responding to each other and to their environments. Those who study social structure do, however, follow an empirical (observational) approach to research, methodology, and epistemology.

Social structure is sometimes defined simply as patterned social relations—those regular and repetitive aspects of the interactions between the members of a given social entity. Even on this descriptive level, the concept is highly abstract: it selects only certain elements from ongoing social activities. The larger the social entity considered, the more abstract the concept tends to be. For this reason, the social structure of a small group is generally more closely related to the daily activities of its individual members than is the social structure of a larger society. In the study of larger social groups, the problem of selection is acute: much depends on what is included as components of the social structure. Various theories offer different solutions to this problem of determining the primary characteristics of a social group.

#### **1.6.4 Social Processes**

Social processes are the ways in which individuals and groups interact, adjust and readjust and establish relationships and pattern of behavior which are again modified through social interactions. Those activities, actions, and operations that involve the interaction between people. This framework element serves as a broad placeholder for all social processes. All subcategories currently emphasize the driving forces that directly act upon an endowment. The SDI Group will eventually expand the definition to include all underlying social processes that control the driving forces.

The elemental processes are (1) Cognitive mapping and validation, (2) Tension management and communication of sentiment, (3) Goal attaining and concomitant ‘latent’ activity, (4) Evaluation, (5) Status-role performance, (6) evaluation of actors and Allocation of status-roles, (7) Decision-making and initiation of action (8) Application of sanctions, (9) Utilization of facilities. The comprehensive or master processes are (1) Communication, (2) Boundary maintenance, (3) System linkage, (4) Social control, (5) Socialization, and (6) Institutionalization.

### **1.6.5 Social Class and Caste**

Sociologists and anthropologists have defined caste as a major form of stratification. Though this form of inequality is found all over the country, there are a few misconceptions about it. There is a general understanding that caste and class are polar opposites. It is also understood that caste is essentially a rural phenomenon while class is found in urban communities.

**Professor M.N. Srinivas** in his *Caste in Modern India* says that “A sociologist would define caste as heredity, endogamous, usually group, having a traditional association with an occupation, and a particular position in the local hierarchy of castes. Relations between caste are governed among other things, by the concept of population and purity, and generally, maximum commonality within the case”

**According to Yogendra Singh**, caste is a cultural phenomenon. Further elaborating the concept of caste he says that besides being a cultural phenomenon, caste is also a structural phenomenon. The structural aspect of caste is stressed by functionalists who very much dwell on structural-functional analysis.

On the other hand, caste as a structural phenomenon consider it as a system of social organization, an institutionalized system of interaction among hierarchically-ranked hereditary groups for marriage, occupation, economic division of labour, enforcement of cultural norms and values by caste bodies and performance of rituals based on principles of purity and pollution.

#### **Basic Characteristics of Caste System**

##### ***Group Hierarchy***

Based on ritual status, purity-impurity, each caste system may be divided into some hierarchical groups. Each individual in every group hierarchy plays the certain standard of living and some fixed norms.

##### ***Segmental Division of Society***

Society is divided into some segment or groups, in other words, it is believed that a person belonging to a higher caste gets polluted even by the shadow of a person of low caste, or by accepting food or drinks from him.

### ***Restriction on Mixing***

In a caste-ridden society, there are certain unwritten laws in which mixing with other castes is forbidden. The people belonging to a higher position in the caste hierarchy do not mix with the so-called low caste people.

### **1.6.6 Social Distance**

The separation of two or more social groups, either by mutual desire or by discrimination involving one or more against the others. Social distance is usually identified through the amount of interaction between the groups - as in rates of intermarriage: it is rarely complete but is represented by a range of distance from totally integrated at one extreme to those which live almost entirely separate life at the other.

By contrast, *segregation* describes a situation in which members of different racial groups rarely come into contact with one another or interact as social equals. Under segregation, separation along racial lines applies to nearly all aspects of life and those contacts between racial groups that do occur are socially controlled. Social distance is reflected in a “color line” that clearly demarcates dominant and subordinate groups.

### **1.6.7 Geography of Inequality**

**The study of social inequality** has occupied geographers for decades; however, in the last few decades, as globalization has taken greater influence on the global economy, the focus has increased. Simple examples of geographic social inequality are evident in major cities, where housing, food stores, basic services, healthcare, and other infrastructure are generally more available to wealthy urban dwellers than the urban poor.

#### **Spatial Inequality**

The evidence of spatial factors affecting social inequality, particularly in regards to access to resources and infrastructure, have been called “spatial inequality,” where individual access is not equal. Often urban geographers see that neighborhoods themselves can promote social inequality, as high crime and unemployment create perceptions of negativity and make it more difficult for individuals to aspire to improve their condition. This has the long-term, adverse effect in creating poverty traps, where breaking out of a cycle of poverty becomes increasingly harder the more individuals are surrounded by others in a similar situation.

### 1.6.8 Race

A **race** is a grouping of humans based on shared physical or social qualities into categories generally viewed as inherently distinct by society. First used to refer to speakers of a common language and then to denote national affiliations, by the 17<sup>th</sup> century the term *race* began to refer to physical (phenotypical) traits. Modern scholarship regards race as a social construct, that is, a symbolic identity created to establish some cultural meaning. While partially based on physical similarities within groups, the race is not an inherent physical or biological quality.

Social conceptions and groupings of races vary over time, involving folk taxonomies that define essential types of individuals based on perceived traits. Scientists consider biological essentialism obsolete and generally discourage racial explanations for collective differentiation in both physical and behavioral traits

#### **Race as a Social Category**

Humans vary remarkably in wealth, exposure to environmental toxins, and access to medicine. These factors can create health disparities. Krieger (2000) describes disparities that result from racial discrimination as “biological expressions of race relations.” African Americans, for example, have higher rates of mortality than other racial groups for 8 of the top 10 causes of death in the U.S. (Race, Ethnicity, and Genetics Working Group, 2005). Although these disparities can be explained in part by social class, they are not reducible to class distinctions.

### 1.6.9 Ethnicity

**Ethnicity** means a definite state of belonging to a particular social group that has a common national or cultural tradition. As per the Sociologists, it corroborates a large group of people who have the same racial origins or the similar state of belonging to such a group. On the other side, an ethnic group refers to that community social person who shares common and distinctive cultural traits, background, association, allegiance, religion, language etc.

### 1.6.10 Gender

**Gender** refers to the socially constructed characteristics of women and men – such as norms, roles, and relationships of and between groups of women and men. It varies from society to society and can be changed. While most people are born either male or female, they are taught appropriate norms and behaviors – including how they should interact with others of the same or opposite sex within households, communities, and workplaces. When individuals or groups do not “fit” established gender norms they often face stigma, discriminatory practices or social exclusion – all of which adversely affect health. It is important to be sensitive to different identities that do not necessarily fit into binary male or female sex categories. Gender norms, roles, and relations influence people’s susceptibility to different health conditions and diseases and affect their enjoyment of good mental, physical health, and wellbeing. They also have a bearing on people’s access to and uptake of health services and on the health outcomes they experience throughout the life-course. There are often misconceptions about terms related to gender. Learn more by reading the glossary of terms related to gender, equity, and human rights

### 1.6.11 Health

**Health** is the ability of a biological system to acquire, convert, allocate, distribute, and utilize the energy with maximum efficiency. The World Health Organization (WHO) defined human health in a broader sense in its 1948 constitution as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." This definition has been subject to controversy, in particular as lacking operational value, the ambiguity in developing cohesive health strategies, and because of the problem created by use of the word "complete", which makes it practically impossible to achieve. Other definitions have been proposed, among which a recent definition that correlates health and personal satisfaction.

The relationship between space and health dates back to Hippocrates, who stated that "airs, waters, places" all played significant roles impacting human health and history. A classic piece of research in health geography was done in 1854 as a cholera outbreak gripped a neighborhood in London. Death tolls rang around the clock and the people feared that they were being infected by vapors coming from the ground. John Snow predicted that if he could locate the source of the disease, it could be contained. He drew maps demonstrating the

homes of people who had died of cholera and the locations of water pumps. He found that one pump, the public pump on Broad Street, was central to most of the victims. He concluded that infected water from the pump was the culprit. He instructed the authorities to remove the handle to the pump, making it unusable. As a result, the number of new cholera cases decreased.

**Health geography** is the application of geographical information, perspectives, and methods to the study of health, disease, and healthcare.

### 1.6.12 Social Well-being

According to the Dictionary of Human Geography (Johnston et al. 1981), the social well-being may be defined as: "The degree to which a population's needs and wants being met."

According to P.L Knox (1974) "well-being is... the satisfaction of the needs and wants of the population".

A good society based on Market Exchange, for example, is one which all people have sufficient income to meet their basic needs, where all are treated with equal dignity and have an equal right, where they have reasonable access to their opinions are heard and respected.

In another word, social well-being is the integration of the overall welfare of an individual's levels of livings which incorporates the following subject matters:

1. **Physical well-being:** Environmental conditions like climate, pollutions of various kinds etc.
2. **Material well-being:** Well-being in terms of all the material needs.
3. **Social well-being:** Social safety, kinship etc.
4. **Economic well-being:** Per capita income, savings, expenditures etc.
5. **Spiritual well-being:** Religious faith, customs

It is used as a common term for a family of overlapping concepts including the level of living, the quality of life, social satisfaction, social welfare and standard of living. But there always remained a problem to define these terms precisely. Standard of living is concerned with the circumstances aspired by a group. There is a distinction between economic welfare and social welfare. Economic welfare refers to the satisfaction which people get from the consumption of goods and services procured by money or available as public provision. While social welfare includes things, which contribute towards the quality of human existence. Knox considers the 'level of living' as the best concept to develop social indicators.

Smith says the human well-being, whatever it connotes to, is not capable of being measured at present or in the future in a generally accepted way.

During the 1970s, the first attempt to map the social well-being was taken up, as a part of a common acceptance of the need for territorial social indicator with which to chart and understand spatial variable in the quality of life. Social data were collected and used to describe the state of the nation and to help formulate government policy since the 17<sup>th</sup> century.

The Organization for Economic Cooperation and Development (OECD) was launched in 1970, oriented toward identifying the social demands goal and problem which are likely a major concern of socio-economic planning process, measuring and reporting change relative to this concern and finally social decision making.

The OECD program has defined the concern and the indicators of social well-being in detail and gives more emphasis on individual well-being.

**Table 1: List of Social Concern and Indicators**

Sl. No.	Concern and Sub concerns	Indicators
1	Goal Area: Health	<ul style="list-style-type: none"> <li>I. Life expectancy at age (20, 40, 60)</li> <li>II. Prenatal mortality</li> <li>III. Maternal mortality</li> <li>IV. Physical accessibility</li> </ul>
2	Goal Area: Individual Development through Learning	<ul style="list-style-type: none"> <li>I. The proportion of individuals (in specific age cohorts) who have obtained specified results on specific measures related to basic and further knowledge, skills, and values</li> <li>II. Regular education</li> </ul>
3	Goal Area: Employment and Quality of Working Life	Average number unemployed/average number employed + average number unemployed Industrial fatal accident rate; Industrial permanent impairment rate; Industrial short-term disabilities rate Dispersion of weekly earnings of employees;
4	Goal Area: Time <b>and</b> Leisure	-
5	Goal Area: Personal Economic Situation	<ul style="list-style-type: none"> <li>I. Level of income aspect</li> <li>II. Gini-coefficient of individual disposable Wealth Compensation received/gross loss</li> </ul>

6	Goal Area: Physical Environment	I. Percentage of individuals living in poor dwellings indoor space II. Air pollution aspect
7	Goal Area: The Social Environment	-
8	Goal Area: Personal Safety and the Administration of Justice	Deaths from unexpected events
9	Goal Area: Social Opportunity and Participation	-

Source: Yost, 1997

### 1.6.13 Human Ecology of Disease and Emergence of Medical Geography

**The study of Human Ecology of disease** is an important one. It is precisely the interplay between humans and their environment which leads either the production of or prevention of, a disease. More specifically, it is cultural and socioeconomic which we look for. Factors which we look for when we are dealing with etiology can include population genetics, general physiology, immunological and nutritional status. These factors must be understood by geographers if they intend to soundly research any medical geography. The biggest factor in all of what a geographer must look for is Geography. Classical geography is important in all aspects of medical geography.

**Medical geography** has a long history. Since the time of the Greek doctor, Hippocrates (5th-4th centuries BCE), people have studied the effect of location on one's health. For example, early medicine studied the differences in diseases experienced by people living at high versus low elevation. It was easily understood that those at living low elevations near waterways would be more prone to malaria than those at higher elevations or in drier, less humid areas. Though the reasons for these variations were not fully understood at the time, the study of this spatial distribution of disease is the beginnings of medical geography.

This field of geography did not gain prominence until the mid-1800s though when cholera gripped London. As more and more people became ill, they believed they were becoming infected by vapors escaping the ground. John Snow, a doctor in London, believed that if he

could isolate the source of the toxins infecting the population they and cholera could be contained.

As part of his study, Snow plotted the distribution of deaths throughout London on a map. After examining these locations, he found a cluster of unusually high deaths near a water pump on Broad Street. He then concluded that the water coming from this pump was the reason people were becoming sick and he had authorities remove the handle to the pump.

Once people then stopped drinking the water, the number of cholera deaths dramatically decreased.

Snow's use of mapping to find the source of disease is the earliest and most famous example of medical geography. Since he conducted his research, however, geographic techniques have found their place in a number of other medical applications.

Another example of geography aiding medicine occurred in the early 20th Century in Colorado. There, dentists noticed that children living in certain areas had fewer cavities. After plotting these locations on a map and comparing them with chemicals found in the groundwater, they concluded that the children with fewer cavities were clustered around areas that had high levels of fluoride. From there, the use of fluoride gained prominence in dentistry.

#### **1.6.14 Social Geography and Millennium Development Goals**

The **Millennium Development Goals (MDGs)** were the eight international development goals for the year 2015 that had been established following the Millennium Summit of the United Nations in 2000, following the adoption of the United Nations Millennium Declaration. All 191 United Nations member states at that time, and at least 22 international organizations, committed to helping achieve the following Millennium Development Goals by 2015:

1. To eradicate extreme poverty and hunger
2. To achieve universal primary education
3. To promote gender equality and empower women
4. To reduce child mortality

5. To improve maternal health
6. To combat HIV/AIDS, malaria, and other diseases
7. To ensure environmental sustainability
8. To develop a global partnership for development

Each goal had specific targets, and dates for achieving those targets. To accelerate progress, the G8 finance ministers agreed in June 2005 to provide enough funds to the World Bank, the International Monetary Fund (IMF) and the African Development Bank (AfDB) to cancel \$40 to \$55 billion in debt owed by members of the heavily indebted poor countries (HIPC) to allow them to redirect resources to programs for improving health and education and for alleviating poverty.

Critics of the MDGs complained of a lack of analysis and justification behind the chosen objectives, and the difficulty or lack of measurements for some goals and uneven progress, among others. Although developed countries' aid for achieving the MDGs rose during the challenge period, more than half went for debt relief and much of the remainder going towards natural disaster relief and military aid, rather than further development.

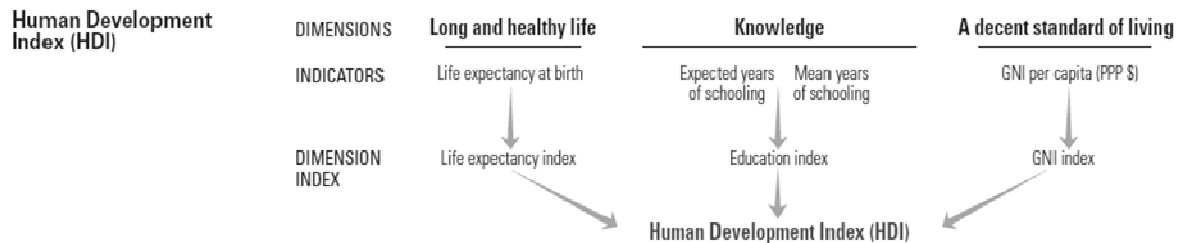
As of 2013, progress towards the goals was uneven. Some countries achieved many goals, while others were not on track to realize any. A UN conference in September 2010 reviewed progress to date and adopted a global plan to achieve the eight goals by their target date. New commitments targeted women's and children's health, and new initiatives in the worldwide battle against poverty, hunger, and disease.

Among the non-governmental organizations assisting were the United Nations Millennium Campaign, the Millennium Promise Alliance, Inc., the Global Poverty Project, the Micah Challenge, The Youth in Action EU Programme, "Cartoons in Action" video project and the 8 Visions of Hope global art project.

### **1.6.15 Human Development Index**

The HDI was created to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone. The HDI can also be used to question national policy choices, asking how two countries with the same level of GNI per capita can end up with different human development outcomes. These contrasts can stimulate debate about government policy priorities.

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



The HDI simplifies and captures only part of what human development entails. It does not reflect on inequalities, poverty, human security, empowerment, etc. The HDRO offers the other composite indices as a broader proxy on some of the key issues of human development, inequality, gender disparity, and poverty.

### 1.6.16 Gender Empowerment Measures

The GEM was designed to measure "whether women and men are able to actively participate in economic and political life and take part in decision-making"

In other words, empowerment of women is linked to the 'agency of women'. Amartya Sen, while emphasizing the importance of women's agencies for securing gender justice and hence social progress, argues that gender inequality does not decline automatically with the process of economic growth.

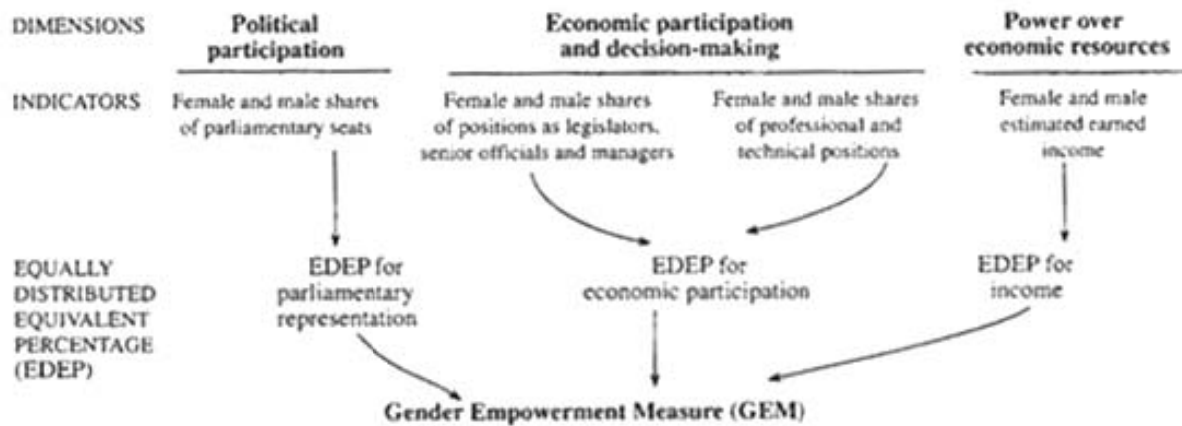
GEM is the United Nations Development Programme's attempt to measure the extent of gender inequality across the globe's countries, based on estimates of women's relative economic income, participation in high-paying positions with economic power, and access to professional and parliamentary positions. It was introduced at the same time as the Gender-related Development Index (GDI) but measures topics like empowerment that are not covered by that index.

**Five elements of women's empowerment are:**

- (i) Education,
- (ii) Ownership rights over property and assets,
- (iii) Position and status of women in the labor market,

- (iv) Opportunities to work, and
- (v) Familiar and societal attitude regarding women's employment. For overall development of a society, empowerment of women is prerequisite.

The Human Development Report, 1995 focusing on women's opportunities rather than their capabilities introduced 'Gender Empowerment Measure' or GEM.



### 1.6.17 Subaltern Studies in Geography

Subaltern studies are a broadly influential academic movement whose goal is to refocus history on the unique role of subaltern or marginalized people in bringing about large-scale transformations in society. The implications of subaltern studies for geography are especially apparent in the group's exploration of specialized categories of class, ancestry, and religion. Subaltern studies began in 1982, when a collective of South Asian scholars in Britain, including Dipesh Chakrabarty and Partha Chatterjee, began publication of a book-length journal titled *Subaltern Studies*, edited by Ranajit Guha. Much of the collective's early work dealt with the politics of peasants who had been involved in the mass movements that ultimately led to India's independence. The journal's inauguration stemmed from a critique both of nationalist historians of India, who tended to focus on the local elites, and of orthodox Marxists, whose restriction of the concept of the working classes to industrial workers alone was, as the members of the subaltern studies collective argued, Eurocentric and badly suited to the varied economy of the Indian subcontinent. Subaltern studies' turn away from traditional methods of historical research was signaled by ongoing debates over the definition of the term *subaltern*. Although influenced by the Marxist philosopher Antonio Gramsci, who used it to refer primarily to industrial laborers, in the work of the collective the word

*subaltern* came to describe any group that is wholly left out of the elite. In this light, the collective's focus also developed in relation to long-standing populist debates in South Asia, from the nationalist writings of N. G. Ranga and L. Natarajan to the variegated Marxism of scholars like A. R. Desai.

## **1.7 Self-assessment Test**

*2 Marks for each question*

1. Define geographical space.
2. What do you mean by social segregation?
3. Define race?
4. What is the meaning of ethnicity?
5. What do you mean by social well-being?
6. What are basic objectives of health geography?
- 7.

*6 marks for each question*

1. Differentiate social space from material space and how they are related to each other.
2. What is human development index and how it is measured?
3. How caste and class are related to each other?
4. Discuss the historical evolution of medical geography as sub-discipline of social geography.

## **1.8 Summaries and Key Points**

This self-earning material explains the key concept of different kinds of space starting from geographical space to social space. It has analysed the ideas of social structure and social processes. It involves discussions on a number of social elements, such as race, caste, class etc. It shows the objectives and methods of determination of human development index, gender development index and gender empowerment strategies. This material has also focused on the emergence of medical geography and a number of subaltern studies in the broader domain of social geography.

## 1.9References

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## **Group – GEO103T.2: Cultural Geography**

**(Credit – 1; Marks – 25; Internal Evaluation – 5 + Semester-end Examination - 20)**

### **2.1 Introduction**

Culture (Williams, 2008) in its etymological sense has many dimensions, and it impinges on the whole lot, that people generally carry out with their social structure including their ideas, attitudes, behaviour and values. Culture is not hereditarily and its existence often depends upon community sharing. According to Hofstede (1980) culture is ‘the collective programming of the mind which distinguishes the members of one group from another’. Culture is a multifaceted notion, and no single explanation of it is sufficient to properly define all the associated corners. Culture as a geographical process shapes both the ethnicity and livelihood with structured behaviour. Culture generally conceptualized as a resilient outline of thoughts and metaphors which may alter human cohort.

Apart from physical geography, Cultural geography is one of the main and influential branches of Human geography. Cultural geography mainly analysed the cultural issues found across the globe and how they associated with location specific group of people. Cultural geography mainly flourished from the University of California, Berkeley and enriched by the pioneering works of Carl Sauer. He defined landscapes as the source point of culture and also specification of geographical studies. In recent times cultural geography deals with the distinctiveness of cultural processes in some more focused fields like Regional planning, Feminist geography, Geography of Gender and Political geography.

#### **Need for the Study of Cultural Geography:**

- ❖ To provide an analytical overview on Humanistic quest.
- ❖ To identify the foundation and circumstances accountable for the development of a particular cultural complex, its change over time and landscape especially on micro level spatial structure.
- ❖ To conserve the pale and distinctive cultural qualities and cultural composites.
- ❖ To detect the typical examples as well as causes responsible for the cultural dispersion and spatial association of a particular culture.
- ❖ To know the process of commoditization (Photograph No.1) of a typical culture as an intricate whole, manifestly undergo with non-human culture.



Photograph No.1: Process of Commoditization in Brijnath Temple, Uttarakhand  
Source: Taken by the author, September, 2018

Flow of a particular culture depends on four basic **factors**:

- ❖ **Cultural Trait:** Essential entity of culture.
- ❖ **Cultural Complex:** Consistent clusters of Cultural Traits.
- ❖ **Acculturation Process:** By the vocalizations and activity indentation of settler groups (Sweeney, 2007).
- ❖ **Geographical Imaginations:** According to Daniels (2011), 'Geographical Imagination' is also an indispensable part of culture as well as Cultural Geography.

**Types of Culture:**

- ❖ **Material Culture:** The earthly, non-abstract erection of a particular cultural group like – food, clothing, shelter, music, dance, literature, art objects etc.

**Example:** Areflection of the women issues in Taliban detained Kabul in 'A Thousand Splendid Suns', written by Khaled Hosseini (2007) as a specification of landscape literature.

- ❖ **Non-Material Culture:** The abstract formations of a particular cultural group with a continuous lineage like- values, beliefs, cultural practices etc.

**Example:** Celebration of '*Nainastami*' in Nainital Hill Station as a traditional cultural practice (Photograph No.2).

- ❖ **Local Culture:** A group of homogeneous people who portray themselves as combined cluster regarding occurrence, traditions and behavior from other cultural group of people.

**Example:** Traditional rituals performed by Bengali Hindus during the occasion of ‘*Durga Puja*’ (Photograph No.3).

- ❖ **Popular Culture:** An extensive group of heterogeneous people ever-present in terms of World landscape frequently changing their taste in terms of music, dance, food and clothing etc.

**Example:** Celebration of all seasonal festivals by cosmopolitan Kolkata like Durga Puja, Eid, Christmas Day etc. and accordant changes in customs.

### **Constituents of Culture:**

The vital constituents of culture, according to Huxley model (Sweeney, 2007) reveal three aspects-

- ❖ **Mentafacts:** The nucleus of culture associated with thoughts, principles and values.

**Example:** Collection of Bengali folklores like ‘*Thakurmar Jhuli*’ (Photograph No.4).

- ❖ **Sociofacts:** Cultural facet linked with individual and community behaviour, consistency and power.

**Example:** Caste wise marriage norms and family behaviour, Political systems etc.

- ❖ **Artifacts:** The acquisitive demonstration of culture, like clothing, tools, technologies and equipments etc.

**Example:** The art crafts of ‘Terracotta’ (Photograph No.5).made in Bishnupur, West Bengal.



Photograph No.2: ‘*Nainastami*’ at Nainadevi Temple,  
Source: Taken by the Author, September 2018



Photograph No. 3: ‘*Durga Puja*’ at West Bengal  
Source: Taken by the Author, October, 2018



Photograph No.4: 'Thakurmar Jhuli'  
Source: Taken by the Author, November, 2018



Photograph No. 5: 'Terracotta' at Bishnupur  
Source: Taken by the Author, September, 2016

## 2.2 Learning Objectives

After studying this unit you should be able to:

- Describe the relationship between geography and culture
- Discuss the different types and components of culture as a geographical process
- Explain the basis of concepts illustrating the mosaic of culture, language, religion and customs
- Know the emergence of ethnic geography through the ideas of Ethnic Neighbour hood and Ghetto
- Find out the actual root of Ethno-ecology of PTGs in India
- Understand the ideology related to Partition of India and Diaspora
- Observe the inherent mutual relationship between Globalization, Cultural ecology and folk geography ( with a special emphasis on the study on folk architecture, Folk music and dance, Folk fairs and festivals)
- Analyze the trend of development of Tourism Geography from Cultural Geography

## 2.3 Assessment of Prior Knowledge

Culture, as an explanation of the totality of life of a group of people, is one of the most significant parts that geographers studied. The global cultural difference depends on cultural diversification of different cultural groups in a particular context of space and time. 'According to UNESCO, culture is usually "Interpreted as art, we speak of culture in

connection with behaviour of people in the moral values and human relations. We denote it by action, behaviour and attitudes considered useful for the interests of society or of a certain social group. We mean standard of living, of habitation and clothing, of physical culture. We appraise by it the culture of language, of thought, of work...” (Arun, 2011). In the discussion of culture as a location specific geographical process the different components of culture like language, religion, neighbourhood pattern, ecological aspects of livelihood, influence of domain specific folk culture is a very significant need of the present hour. In connection with the above discussion you may assess your prior knowledge through the following questions:

- What is the dominant Religion in India?
- What is the main festival of West Bengal?
- Which place of West Bengal is well known for ‘*Terracotta*’ art and crafts?
- In which language ‘*Santhal*’ people generally communicate with each other?
- Which District of West Bengal is famous for ‘*Tusu*’ dance?

## **2.4 Learning Activities**

From the above discussion you have learnt about the different dimensions of cultural geography. You have also studied about the diversified elements of culture, its continuity as a process as well as the interrelationship between the components. After going through the discussion you may have interested about the cultural composition of your own area as a micro culture and a keen interest may also generate in you to know the magnitude of different cultural components in the area where you live. You may undertake any one of the following activities regarding cultural geography and establish your findings.

## **2.5 Feedback of Learning Activities**

- Documentation of the cultural activities in the local area
- Gathering of data related to ethnic neighbourhood
- Preparation of a chart showing the origin and performing rituals of the local customs
- Collection of models related to local folk art
- Identification of the influence of partition on present day Diaspora

## 2.6 Examples and Illustrations

### 2.6.1 Culture as a geographical process

Specifically, cultural components have three main dimensions- Normative, expressive and idea related dimensions. As dynamic one, cultural process are both learned and shared. The common cultural components include Religion, Language, Architecture, Music, Dance, Sports, Values, Belief, Recreation, Ethics, and Customs and so on. Cultural processes gradually but vigorously shape the inner formation of culture and recognized themselves as collective premeditated processes. A cultural process includes every sort of aspects, expands the thoughts and influences the structure of power and micro area specification.

According to Mitchell (1995), 'In all cases 'culture' is symbolic, active, constantly subject to change and riven through with relations of power. And in all cases culture is, perhaps, not a thing but rather an identifiable process, an analytic category, a mappable level or sphere'. He also observed that, 'It is an important ontological category which must be theorized and understood if we hope to understand human differentiation, behaviour, experience and contest'.

**Table No. 1: Shifting of Ideology related Explanation of Culture as a Process:**

Discussed by	Ideology
Gramsci (1971)	Considered Culture as a depiction of 'social integration'.
Williams (1983)	Recognized Culture as a 'tending of natural growth'.
Sayer (1984)	Culture is a 'classic' 'chaotic concept'.
Cosgrove and Jackson (1987, 1999)	Considered Culture as a means of alteration from everyday occurrence to signify implications and ethics.
Jackson (1989)	Stressed on 'theorization of culture as level, domain, idiom or medium'.
Jackson (1989)	Again considered culture as a medium of development of 'distinct patterns of life'.
Duncan (1990)	Documented Culture as a 'signifying system'.
Ley and Duncan (1993), Gregory (1993)	Marked the 'reconceptualization of culture' as 'cultural turn'.
Olwig (1993)	Suggested that, Culture is 'an ongoing hidden discourse'.
Nineteenth Century European traditions	Identified five types of aspects related to cultural process: <ul style="list-style-type: none"> <li>• 'unexamined' 'patterns' and 'differentiations'</li> <li>• 'processes' of 'patterns' development</li> <li>• Markers of 'differentiation'</li> <li>• 'cultural activity'</li> <li>• 'hierarchical ordering'</li> </ul>

Source: Computed by the author on the basis of information collected from Mitchell, 1995

Culture as a geographical process includes the concepts of cultural region, cultural diffusion, cultural ecology, cultural hearth and cultural realm. A **cultural region** is a part of the surface of the Earth which shares regular cultural elements. Delineation and mapping culture regions are very important in terms of the location of specific cultural traits.

- ❖ The concept of culture region is associated with both space and time.
- ❖ Cultural regions, shows multifaceted variety.
- ❖ Cultural regions diverge to a great extent in terms of size.
- ❖ Cultural regions can be observed in different regional settings.
- ❖ Cultural regions tend to materialize and spread out over point in time.

**Cultural Diffusion** includes the movement of culture around the territorial space across its boundary limits through migration, trade and transport, socio-economic communications and exchange of ideas between groups of people. Cultural diffusion is imitation specific and way specific. Cultural diffusion usually occurred along the regions which get in touch with each other. It may affect both the convergence ('The Columbian Exchange) and divergence (Culture of India after the spread of Islam) of culture. Generally, Cultural diffusion acts as a catalyst regarding the formation of common or similar universal culture, i.e. Globalization. Cultural diffusion may evident through a number of incidents: (Information collected from:<https://www.cvisd.org/site/handlers/filedownload.ashx?moduleinstanceid=11814&dataid=15877&FileName=Cultural%20Diffusion.pdf>)

- ❖ The extension of new goods.

**Example:** Trade of Chinese Silk along the 'Silk Route' to Europe.

- ❖ The transmission of new technologies.

**Example:** Spread of Satellite Technologies.

- ❖ The exchange of new ideas.

**Example:** The spread of Buddhist culture in Sri Lanka.

- ❖ The spread of different diseases.

**Example:** Outbreak of Bubonic Plague from China and Central Asia to Europe.

- ❖ Dispersal of Political ideas.

**Example:** Extension of 'Democracy' in the countries like Chile, Argentina etc.

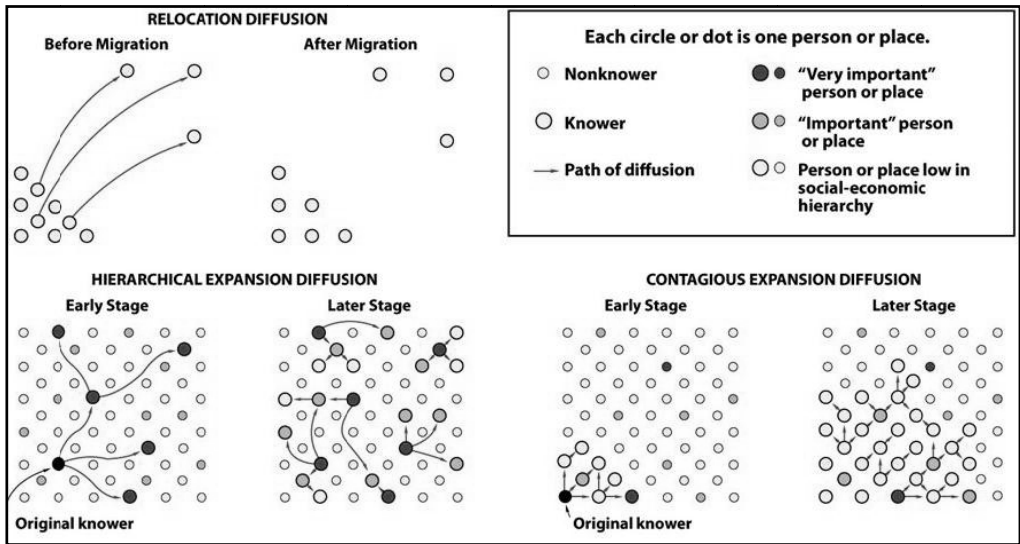


Figure No.1: Types of Cultural Diffusion

Source: <http://shodhganga.inflibnet.ac.in/bitstream/10603/186329/1/chapter-1.pdf>

On the other hand, **cultural ecology** denotes both physical environment and culture. Different components of physical environment, like relief, climate, natural vegetation, soils fabricate diversified forms of culture. Ecology has a coherent attachment with both the physical and human world and consequently with culture. Ecology creates an intermingled structure of environment and human culture. Cultural ecology gets popularized through the pioneering works of Karl Butzer and David Stoddart. In this context, Bustos (2009), stressed on 'Geattari's concept of 'Ecosophia' which includes, 'the environment, social relationships and human subjectivity'.

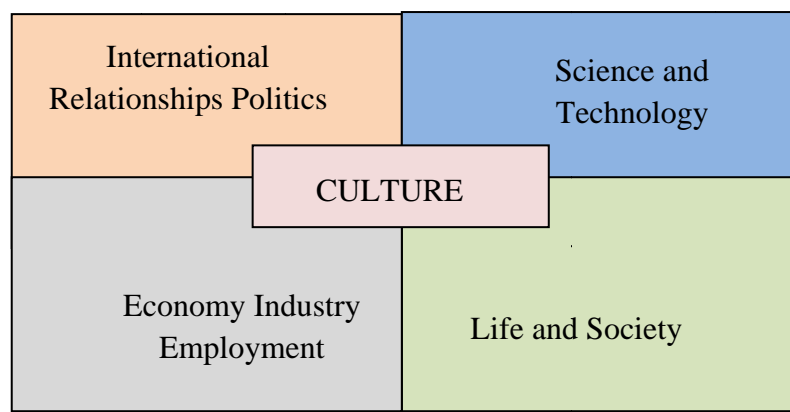


Figure No.2: Extension of culture

Source: Information taken from [https://www.infoamerica.org/icr/n01/infoamerica01\\_bustos.pdf](https://www.infoamerica.org/icr/n01/infoamerica01_bustos.pdf)

**Cultural realm** specifies the intact expanse throughout which a culture exists. It generally includes all the allied components of culture. The resemblance between cultural complexes generally develops cultural realms. Brock Webb categorizes four major and two minor cultural realms throughout the World. On the basis of that the major cultural realms are:

- ❖ **Occidental Realm:** It is a Christianity influenced, urbanized and commercialized realm which includes:
  - West European
  - Continental European
  - Mediterranean
  - Anglo-American
  - Australian and
  - Latin American Realm.
- ❖ **Islamic Realm:** It is well expanded by the flux of Islamic beliefs. This ‘Oriental’ culture is very much customary and conventional.
- ❖ **Indic Realm:** This ‘sub-continental’ culture is ‘paddy dominant’ and is very much influenced by caste system and family values.
- ❖ **South-East Asian Realm:** This is a relatively recent and Buddhism dominant cultural realm.

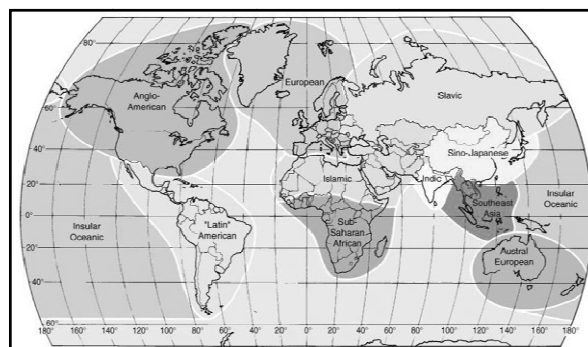


Figure No.3: Major Cultural Realms of the modern world

Source: <http://shodhganga.inflibnet.ac.in/bitstream/10603/186329/1/chapter-1.pdf>

When land use includes cultural alteration due to domestication of individual identity it is termed as **cultural hearth**. The main cultural hearths of the ancient world were:

- The Nile River Valley
- The Indus River Valley
- The Wei-Huang Valley
- The Ganges River Valley
- Mesopotamia
- Mesoamerica
- West Africa

The main characteristics of the ancient cultural hearths are:

- ❖ Specification of labour
- ❖ Urbanized culture
- ❖ Existence of proper administration
- ❖ Expanded trade acquaintances
- ❖ Spread of elaborative knowledge, especially in the field of science, mathematics, astronomy and
- ❖ Expansion of technical knowhow.

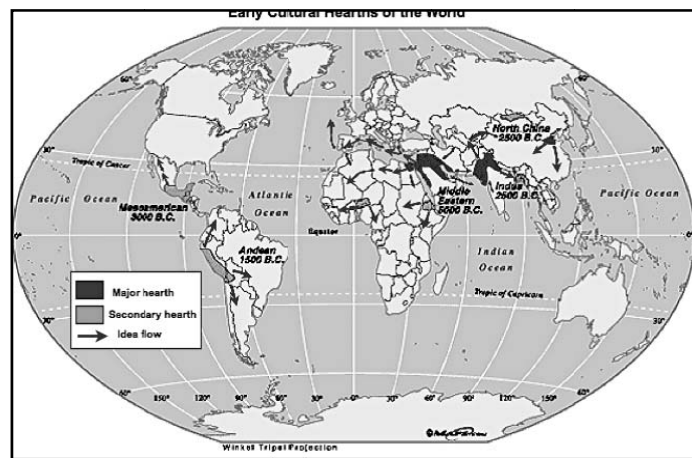


Figure No.4: Ancient Cultural Hearths of the World  
 Source: <http://www.geog.ucsb.edu/~sweeney/g5/culture.pdf>

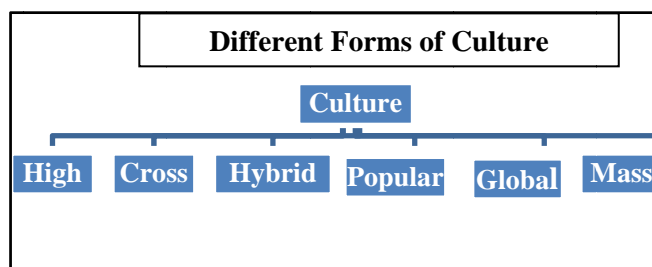


Figure No. 5: Different forms of culture  
 Source: Computed by the author on the basis of information collected from [www.ocr.org.uk](http://www.ocr.org.uk)

## 2.6.2 Cultural Landscape

The physical surface of the Earth shaped and transformed through unique and localized human activities is known as Cultural landscape. The ideology gets popularized by the works of eminent Geographer Carl O. Sauer in 1925. According to him, the essential features of Cultural landscape are: ‘Individuality’, Anthropocentricity, ‘Manifold Change’, Aesthetic Qualities’, Interruption and ‘Way of Living’. Usually, a cultural landscape holds the evidences of multiple human progressions.

- **Mosaic of culture, Language, Religion and customs**

**Cultural mosaic** is a specified form of ‘Multiculturalism’ (Sackmann, 1997) and is a perfect blend of language, religion and customs in the way of different cultural traits. It includes ‘cultural relativism’ and ‘sub culture’ in a true sense. According to Barkes (2010) “Multiculturalism provides a political framework for social equality and cultural differences as for substantial elements of social order”.

According to Chao and Moon (2005), ‘Viewing an individual’s culture as a *cultural mosaic* allows for simultaneous observation of global individual culture and localized cultural influences’.

**Table No. 2: Taxonomy of a Cultural Mosaic (After Chao and Moon, 2005):**

Primary category	Definition	Sample tiles
Demographic	Physical characteristics and social identities inherited from parents and ancestors	Age Ethnicity Gender Race
Geographic	Natural or man-made physical features of a region that can shape group identities	Climate Temperature Coastal/inland Urban/rural Regional/country
Associative	Formal and informal groups that an individual chooses to associate and identify with	Family Religion Employer Profession Politics Avocations

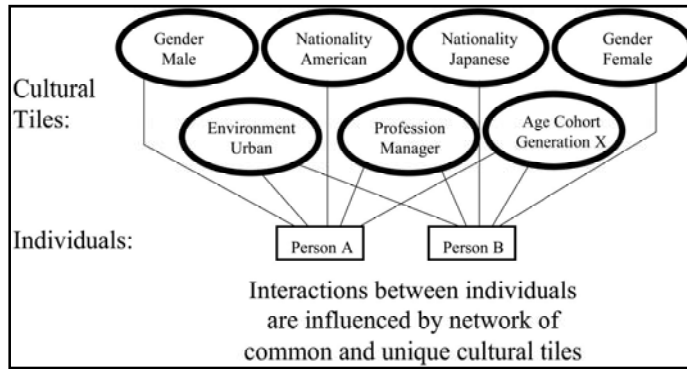


Figure No.6: Bipartite representation of a cultural mosaic (After Chao and Moon, 2005)

In the discussion of **Language** both the accent and dialect of a particular community acts as a part of their culture. Language is a very significant tool for socio-cultural interaction as well as social clustering. Language helps in effectual community participation and expression of individual and community preference. By tradition, as India is a ‘Multilingual’ one, the recognition of functional Literacy here, also depends on more than one language (Sridhar and Kachru, 2000). According to, Sridhar and Kachru (2000), ‘It is being recognized that at the macro level, just as different varieties of one language are identified with high and low functions in monolingual societies, so, too, in bilingual societies, different languages undergo specialization of function. The important distinction is less the difference in languages than the differences in contexts, functions, and use’.

According to the Census of India, 1961, 187 languages have been found as spoken ones where only 23 among them were dominated in terms of population (Bhasin *et.al*, 1994). A brief account on the major languages has given below:

**Table No. 3: Major language groups and their areas of concentration**

Family	Nick name	Sub Groups	Areas of concentration
Austro-Asiatic Language	Nishada	Mon-Khmer Group Munda Group	Assam Central and Eastern regions of India
Tibeto-Chinese Language	Kirata	Siamese-Chinese Tibeto-Burman	North –Eastern parts of Himalayas
Dravidian Language	Dravida	South Central North	Central and Southern part of India
Indo-European Language	Aryan	Iranian Dardic Indo-Aryan	Northern, Western part of India and parts of Pakistan

Source: Computed by the author on the basis of information collected from Bhasin *et.al*, 1994.

### 2.6.3 Linguistic Regions in India

Bhasin *et.al* (1994), mentioned that, ‘According to Grierson (1903-1928), India has 179 languages and 544 dialects’. On the basis of ‘numerical strength’ the major linguistic regions of India are:

Kashmiri	Gujarati
Punjabi	Marathi
Hindi/Urdu	Kannada
Bengali	Telugu
Assamese	Tamil
Oriya	Malayalam

As the local clustering of Tribal languages is very vast and multifarious they are not included in the lingual regionalization (Bhasin *et.al*, 1994). ‘Hindi’ has been recognized the official language of India. The 8th schedule of the Indian constitution (Art. 344(1) and Art.351) takes into account a scheduled 22 languages.

#### Major Script Systems Used in India:

The major script systems used in India are:

Bengali-Assamese-Manipuri*	Malayalam*
Devnagari*	Oriya*
Gujarati*	Tamil*
Gurumukhi Telugu*	Perso-Arabic
Kannada-Telugu*	Roman

\*derived from ‘Brahmi Script’.

Source: Bhasin *et.al* (1994)

**Table No. 4: Major language sub-groups and their areas of concentration:**

Sub-Groups	Languages
Mon-Khmer Branch	Khasi, Nicobarese etc.
Munda Branch	Santali, Mundari etc.
Siamese-Chinese Branch	Khamti
Tibeto-Burman Branch	a. Tibeto-Himalayan Branch <ul style="list-style-type: none"> <li>• Bhutia Group (Ladakhi, Lahuli etc.)</li> <li>• Himalayan Group (Chamba, Kanauri etc.)</li> </ul> b. North-Assam Branch (Aka, Dafla etc.) <ul style="list-style-type: none"> <li>c. Assam-Burmese Branch</li> </ul>

	<ul style="list-style-type: none"> <li>• Bodo Group (Boro, Garo etc.)</li> <li>• Naga Group (Sema, Lotha etc.)</li> <li>• Kachin Group (Kawri, Singpho etc.)</li> <li>• Kuki-Chin Group (Pawi, Chiru etc.) <ul style="list-style-type: none"> <li>• Burma Group (Mru etc.)</li> </ul> </li> </ul>
South Dravidian Branch	Tamil, Malayalam, Kannada, Telugu, Toda etc.
Central Dravidian Branch	Gondi, Konda etc.
North Dravidian Branch	Oraon , Malto etc.
Iranian Branch	Persian etc.
Dardic Branch	a. Kafir Group (Wai Ala), b. Khowar Group (Khowar) and c. Dard Group (Dardi etc.)
Indo-Aryan Branch	<p>a. Outer Sub-Branch</p> <ul style="list-style-type: none"> <li>• North-Western Group (Lahnda, Western Punjabi, Sindhi) <ul style="list-style-type: none"> <li>• Southern Group (Marathi-Konkani)</li> </ul> </li> <li>• Eastern Group (Oriya, Bihari [Bhojpuri, Magadhi, Maithili], Bengali etc.)</li> </ul> <p>b. Mediate Sub-Branch</p> <ul style="list-style-type: none"> <li>• Central Group (Hindi, Urdu, Gujarati, Rajasthani etc.) <ul style="list-style-type: none"> <li>• Pahari Group <ul style="list-style-type: none"> <li>i. Eastern Pahari (Nepali)</li> <li>ii. Central Pahari (Kumauni and Garhwali)</li> <li>iii. Western Pahari (Kului, Mandi etc.)</li> </ul> </li> </ul> </li> </ul>

Source: On the basis of information taken from Bhasin *et.al* (1994)

**Religion** depicts group identity as a part of culture. Religious beliefs and associated rituals and **Customs** have a very traditional origin and it shapes the way of life of different cultural groups as a part of their distinguished culture. Religion is a sensation of unconditional reliance. According to Bloomfield's (1908) meaningful insight, 'Transmigration of souls, pessimism, and the all-absorbing desire to be released from an endless chain of existences, linked together by successive deaths, —these are the axioms of both Brahmanism and Buddhism'.

The general characteristics of Religion especially in terms of India are-

- Conventionalism
- Existence of various parables and icons
- Ideology of deliverance
- Holy spaces and substances (Photograph No. 6)
- Consecrated events
- Revered Literatures
- Holy community

- Occurrence of Blessed events
- Religion affects all the aspects of a micro culture like, food habits, shelter, clothing, music and distinguished people choice
- Spatio-temporal distribution of Religion influences the individual and community identity of a particular culture
- India has a plurality of Religion governing by a number of customs and rituals
- Indian Religious faith is very much associated by caste system directly or indirectly and hence sometimes faces a problem of communal violence.
- Traditional Religious devotion in India is very much associated with close touch with Nature and transformation of Gods.

The key issues related to religion has furnished below:



Photograph No. 6: Holy Places (Church in Nainital, ttarakhand)  
Source: Taken by the Author, September, 2018

**Table No. 5: Major religions and their areas of concentration**

Religious Categories	Religion	Sub Groups	Areas of concentration
Universalizing	Christianity Islam Buddhism	Catholic, Protestant Shiah, Sunni Hinayana, Mahayana	Asia, Europe, America and Africa, Australia
Ethnic	Hinduism Sintoism Judaism	Saiba, Vaishnabh	South and South-East Asia
Tribal	Animism	-	Scattered

Source: Computed by the author on the basis of information collected fromClothey, F.W. (2006). Religion in India: A historical introduction.

**Table No. 6: Population under different religions:**

Religious Group	Percentage of Population
Hindu	79.80
Muslim	14.23
Christian	2.30

Sikh	1.70
Buddhist	0.70
Jain	0.37
Other Religion	0.66
Not Stated	0.24

Source: Census of India (2011)

**Table No. 7: Prime Religions in India at a Glance:**

Religion	Origin	Principle	Sects	Dominating Areas
Hinduism	With the Aryan invasion in India (around 1500 B.C.)	Perpetuity of soul and its regeneration	<ul style="list-style-type: none"> <li>• Saiba</li> <li>• Vaishnabh</li> </ul>	Almost the entire country (India) excluding some few scattered pockets
Islam	In Arabia in the initiation of 7 <sup>th</sup> Century by the Prophet Muhammad	Equality and Peace	<ul style="list-style-type: none"> <li>• Major (Shia and Sunni)</li> <li>• Minor (Momin, Domon, Khoja, Bohra etc.)</li> <li>• Families (Saiyad, Saikh, Pathan and Moghul)</li> <li>• Interior Group (Sharif)</li> <li>• Exterior Group (Ajlaf Alrop)</li> </ul>	Kashmir Valley, Ganga Delta etc.
Christianity	By Jesus Christ and his disciples	Absolute devotion to the Lord	<ul style="list-style-type: none"> <li>• Catholics</li> <li>• Protestants</li> </ul>	Kerala, Tamilnadu, Andhra Pradesh, Nagaland, Meghalaya, Mizoram etc.
Sikhism	Guru Nanak Dev and Nine other Gurus	'Brotherhood'	<ul style="list-style-type: none"> <li>• Sardars</li> <li>• Majhabis</li> </ul>	Major parts of Punjab and Haryana
Buddhism	By Lord Buddha during 6 <sup>th</sup> Century B.C.	' <i>Astangik Marga</i> '	<ul style="list-style-type: none"> <li>• Hinayan</li> <li>• Mahayanas</li> </ul>	Maharashtra, Sikkim, Mizoram, Arunachal Pradesh etc.
Jainism	By Vardhaman Mahavir	'right actions and good deeds'	<ul style="list-style-type: none"> <li>• Svetambara</li> <li>• Digambara</li> </ul>	Rajasthan, Maharashtra, Gujarat etc.

Source: On the basis of information taken from Bhasin *et.al* (1994), Excluding Parsis and Jews

**Custom** is a repetitive act regarding the necessities (victuals, protection and attire) as well as overlapping social characteristics on physical environment. The spatial distribution of custom often becomes characteristic of different cultural group of people. Popular customs has a wider extent than the locally confined folk customs. Customs are basically a set of traditional activities performed temporally by different cultural groups with the inclusion of all facets of cultural identities like, Religion, Language, Clothing, Food habits, Literature, Music, and Dance etc. The portrayal of different customs in everyday livelihood, in every instance helps to recognize the socio-cultural pulsate of a community in general. The rigidity and liberal execution of Customs largely depends upon the performing community and the sect of culture over which these are implemented. Generally Customs are more rigid in the cases of Religion, Marriage, differential social networking and Gender issues. In a multicultural sect like India, Customs vary widely according to different cultural groups, but sometimes the mixing of contiguous culture develops convoluted Customs with in a single community. In India, apart from cultural vividness, sect wise general customs are as follow:

<b>Custom Criteria</b>	<b>General Customs</b>
Religion	<ul style="list-style-type: none"> <li>• Removal of shoes during taking an entry in religious place.*</li> <li>• Believe in ‘Mythology’ and ‘sacred texts’.*</li> <li>• Performing ‘Yoga’ for body and ‘Pranayam’ for peaceful mind.</li> <li>• Performing variety of rituals in naming ceremony of a child and ‘funeral’** of a person.</li> </ul>
Language	<ul style="list-style-type: none"> <li>• In domestic and locality conversation mother tongue shows dominancy.</li> <li>• Promotion of regional language is mostly preferred.</li> </ul>
Marriage	<ul style="list-style-type: none"> <li>• Largely ritual based.</li> <li>• Very much festive with music, dance and food</li> <li>• Huge get-together of extended family</li> </ul>
Social	<ul style="list-style-type: none"> <li>• Social structure is generally ‘Patrilineal’.</li> <li>• Family values and Social values always prioritized.</li> <li>• Joint family system is always preferable.</li> </ul>
General greeting	<ul style="list-style-type: none"> <li>• ‘Indian nod’ and ‘<i>Namaste</i>’ *</li> <li>• All activities must be preferably done by right hand.*</li> <li>• ‘Adjustment’ in every sect of life.</li> </ul>
Food habit	<ul style="list-style-type: none"> <li>• Both Vegetarian and Non-Vegetarian but well cooked food with the application of different types of local spices.</li> <li>• Well use of Deserts and sweets with regional varieties.</li> </ul>
Dressing pattern	<ul style="list-style-type: none"> <li>• Modest dressing (especially for women)*</li> <li>• Light colored cotton made dress is preferable during summer months.</li> <li>• Women prefer colorful dresses and different ornaments during festivals.</li> </ul>
Immigration effect	<ul style="list-style-type: none"> <li>• Generally observed in terms of local community marriage,</li> </ul>

	rituals and food habits (especially in border districts).
Gender effect	Greeting by handshake with a woman depends on the approval of the woman herself.*
Literature	<ul style="list-style-type: none"> <li>• Reflects the livelihood of local people in different forms.</li> <li>• A wide variety exists in different languages.</li> <li>• Preserves the regional cultural identity. ***</li> </ul>
Movie	<ul style="list-style-type: none"> <li>• Dominance of ‘Melodrama and romance’.*</li> <li>• Promote local literature and religion based story line.</li> </ul>
Music	<ul style="list-style-type: none"> <li>• Indian classical music follows separate ‘<i>Gharanas</i>’/Schools (‘<i>Carnatic</i>’ and ‘<i>Hindustani</i>’*) and ‘<i>Guru</i>’/Guide culture.</li> <li>• Local folk music reflects local needs with a close contact with the Nature or local environment.</li> <li>• A wide variety of musical instruments.</li> </ul>
Dance	<ul style="list-style-type: none"> <li>• Generally based on ‘popular motifs in Hindu mythology’*</li> <li>• Every sect has its own dressing apparel.</li> </ul>

Source: \*On the basis of information collected from Indian-society-culture.pdf, \*\*Gatrad (1994), \*\*\*Inman, A. et.al (2007)

#### 2.6.4 Emergence of Ethnic geography: Ethnic Neighbourhood and Ghetto

Ethnic geography, as an inseparable whole of cultural as well as human geography mainly focused on the way of peopling of different ethnic groups. According to Eijk (2010), ‘neighbourhood is a multifaceted concept’. He also pointed out that, ‘the neighbourhood is a geographical space that people share to live’.

Neighbourhood impinges its micro space for diverse categories of people but always in different ways. Ethnic-neighbourhood again shares itself into some common settings like educational institutions, community gatherings etc. In ethnic neighbourhood (Aytar and Rath, 2012), spatial extension largely depends upon the day to day interaction within the immediate neighbourhood with the ‘local ties’ and ‘local network’ in association with ‘repeated encounters’ (Eijk, 2010). Variant involvement affects the neighbourhood ties differently and creates social segregation. For this, ethnic –neighbourhood especially requires mixed association of people with a well-built social inclusion policy framework.

The spreading of ethnic groups across their immediate neighbour hoods i.e. **ethnic neighbourhood** often determined by some factors like physical barriers, perception of local government and administration, allocation of primary needs like food, clothing and shelter, variety in economic activities as well as socio-cultural cohesion. Now a day’s ethnic neighbourhood suffers from the problem of segregation across the globe especially in the

case of ethnic minority groups. According to Vaughan, Arbaci and Mateos (2011), ‘Underlying the pre occupation with the geographic concentration of minority groups is a deeply rooted assumption that sees spatial separation as a clear symptom of a lack of social integration’.

Etymologically, ‘**Ghetto**’ (Duneier, 2016) refers to the part of the city proper which are generally occupied by Jews. This is a closed, rigid and knit section with a greater cultural importance. The word ‘Ghetto’ comes from the phrase “Geto Nuovo” means new establishments. In terms of establishment and development of ‘Ghetto’ Eastern European countries shows dominancy.

### **General Characteristics of Ghetto:**

- Ghetto is a specialized multicultural and subordinate urban feature.
- Ghetto deals with conciliation of community in an unrestricted space.
- It is associated with the ‘streetscape’ (Vaughan, Arbaci and Mateos, 2011) and morphology of the built up area.
- It is very much connected with ‘space syntax’ with ‘historical analysis of residential settlement patterns’ (Vaughan, Arbaci and Mateos, 2011).
- It is very much linked with hefty transformations in population size, urban configuration and community guiding principles.
- Ghetto reflects the relationship between ‘minority integration’ and existence of specified landscape.
- It deals with explicit forms of ethnic- neighbourhood.
- Socio-economic upshots of the main urban structure generally alter the mode of micro spatial distribution of space within the Ghetto.

**Example:** The Venetian Ghetto.



Photograph No.7: Part of Ethnic neighbourhood near Aizawl City, Mizoram  
Source: Taken by the author, October, 2017

## **2.6.5 Ethno-ecology of PTGs in India**

The Scheduled Tribe population shows the real essence of ethno-ecology in terms of their convoluted relationship with physical environment. Singh (1978) raised the question regarding the actual definition criteria between 'Tribes' and 'Scheduled Tribes' in India. Tribal society also faces a huge alteration in terms of their socio-political structure and alteration in an agrarian economy. Singh (1978) also pointed out that, 'The transition from the tribal to the peasant system was however neither uniform nor complete. Dependence on forest as a source of food, shelter and occupation was still crucial in many ways'. The impact of Christianity also transforms the Tribal culture in many ways. They face a regular 'struggle for control of resources' (Singh, 1997). Both the Drafts of National Tribal Policy 2004 and 2006 stressed on the 'approach of assimilation' (Srivastava, 2008) instead of maintaining their own unique livelihood. Even, there is no clear differences have been shown to demarcate 'Caste' and 'Tribe' separately. Srivastava (2008) also noticed that 'tribal migrants are permanent' which largely affects their 'collective personality'. PTGs or Primitive Tribal Groups are basically an enlisted 75 Scheduled Tribe Groups (Draft 1973, Section 12) identified as 'more backward' (Srivastava, 2008) than other similar groups in terms of low level of agricultural development, remoteness and scattering of habitats, small numerical strength, waning population, low literacy and poor socio economic conditions. They are basically the 'vulnerable tribes' (Srivastava, 2008) and the 'poorest of poor amongst the STS' (Radhakrishna, 2009). Primitive Tribal Groups again subdivided into two categories among which the 'primary tribes' or 'heritage group' (Srivastava, 2008) needs more care and attention as they are more isolated in terms of civilized world. The ethno-ecological characteristics of PTGs in India includes, primitive agricultural practices, dependency on gathering economy, mass illiteracy, malnutrition, immense poverty, lack of basic minimum needs, social isolation etc. The present trend of urbanization and industrialization make them marginalized and displaced from their actual ethno-ecological root. They need both a locality development as well as community development approach together to sustain their actual identity. Moreover, effective policy formation, adequate data collection, generation of activities closely linked with forest, health and literacy development programmes and formation of land ownership laws will be more effective (Vidyarthi, 1972).

The distribution of major PTGs in India is given below:

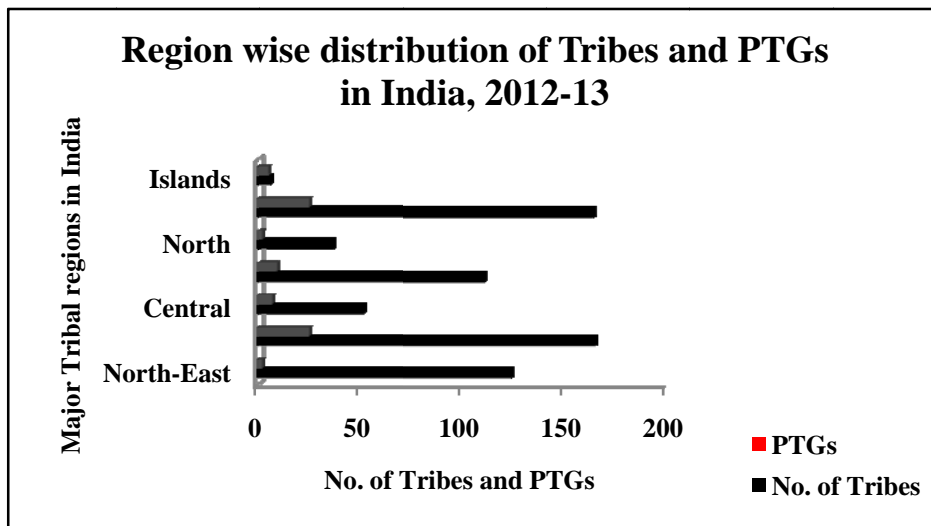


Figure No.7

Source: Based on the Annual Report of Ministry of Tribal affairs, 2012-13 (<https://tribal.nic.in>)

### 2.6.5 Partition of India and Diaspora

‘Diaspora’ may be analysed as a process of establishment of displaced population in a greater sense exterior to the margins of their original homeland. As a postmodern perception it may also visualized as a process of conscious self identification. According to Hickman (2005), Diaspora has six basic characteristics:

- Diffusion
- Shared memory
- Isolation
- Admiration and lust for the homeland
- A belief in its refurbishment
- A self-explanation in terms of this homeland

Partition (Ghosh, 2007) of India results a ‘Diaspora’ (especially from Pakistan and Bangladesh) not only in its boundary states but also in the interior corners which includes a long way of peopling with their respective cultural traits. The behavioural aspect of this long term ‘Diaspora’ exerts a greater influence in the internal communal harmony of the country also. Time relevant Literature is a great expression of Indian partition and Diaspora as it reflects the individual common memory related to resettlement. According to Karmakar (2015), ‘The *Indian Diaspora* as a subject of study has wide appeal across various disciplines, namely, anthropology, history, literature and cultural studies, and sociology, etc’. Diaspora is not coupled with mere immigration, because the purpose of immigration may

vary for individuals. Karmakar (2015) also observed that, 'The problem of 'home' is present not just in the literal sense, but also in the metaphoric sense'. She also identified a number of characteristics regarding the Indian Diaspora:

- Indian Diaspora is a diversified one which is associated with subsistence and lineage identity regarding ones belonging.
- It carries the 'interstitial space' (Karmakar, 2015)
- The kind of 'commitment' in the Diaspora varies in terms of 'generation' (Karmakar, 2015)
- The Diaspora always include the 'nation left behind and the nation where they reside' (Karmakar, 2015)
- They have specific kind of longing regarding marriage, food habits, food items and different traditions
- There is a difference between elderly and young Indian Diaspora. The old ones generally referred the state of affairs regarding 'pre-partitioned' (Karmakar, 2015) India, expectations from 'Independence', soreness of disarticulation and contact with freedom fighting. The new ones generally continue the unfolding of the elders' experiences.



and Diaspora

Photograph No. 8 (a) and (b): Indian partition

Source: [pinterest.co.uk](http://pinterest.co.uk) and [hindustantimes.com](http://hindustantimes.com)

### **2.6.6 Globalization, Cultural ecology and Folk geography**

Cultural ecology in its factual sense enriched all the forms of folk culture and its distribution over space and time, even the essential influence of globalization also not able to impede the

corroboration of this creative radiance. Folk geography reflects in many forms like folk architecture, folk music and dance, folk fairs and festivals. All of these forms act as catalysts to promote individual micro culture within the extensive arena of macro cultures. The synthesis of this diversified relationship between culture and ecology intensify the value coordination of a particular locale also. It helps to reveal an individual community culture based on specific environmental and ecological conditions.

‘Folk’ reflects the differentials of anything related to micro-culture which is aboriginal in nature. Folk Geography considers a number of aspects among which, Folk festivals, Folk literatures, Folk architecture, Folk dances and Folk music are the key concerns. These constituents shape the local cultural landscapes in a number of ways as these carries a long sequential tradition with a well-built local values and belief systems. Globalization, with the free movement of cultural ideologies generally greatly influences the components of Folk cultures. Sometimes these Folk cultures become able to sustain it self through minor alterations but sometimes they develop a totally customized new local culture with the effect of globalization.

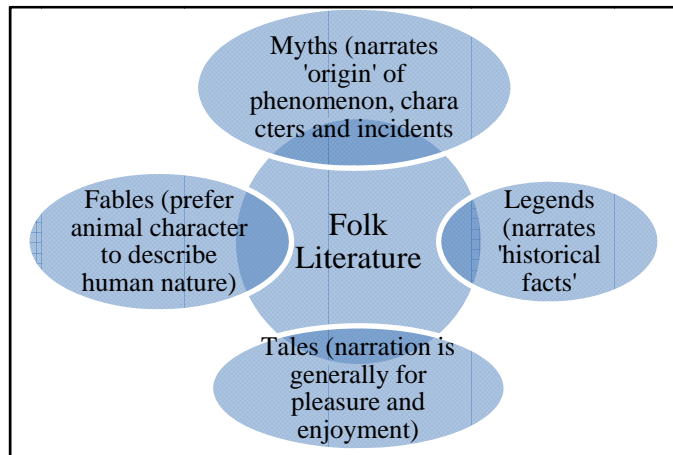
### **2.6.7 Folk Festivals**

According to Satprakashananda (1956), ‘Those festivities in which the common folk take the initiative and give expression to their natural tendencies and capacities, their ideas and sentiments, can be counted as folk festival’. The main characteristics of Folk festivals are:

- Well established differences in ‘forms and features’ (Satprakashananda, 1956) according to spatial distributions.
- Usually associated with local Religion, worshipping of local God and local economic activities.
- Normally follows a certain day and seasonality.
- Creates a ‘bond of union’ (Satprakashananda, 1956) among local people.
- Generally differ in place of occurrences (Satprakashananda, 1956).
- By and large follows different rituals with fasting and dancing with musical instruments.
- Commonly associated with ‘street procession’, ‘illumination’, ‘beautification’ (like ‘*Rangoli*’) and ‘occurrences of fairs’ (Satprakashananda, 1956).

### 2.6.8 Folk Literatures

According to Hodgson (1940), in Folk literatures, 'native people of every continent come to life'. He divided the Folk literature into following four categories:



### 2.6.9 Folk Architecture

Folk architecture and construction is very much associated with local climate, local structure of natural environments and its constituents also largely depends upon locally available materials. Its shape, arrangement of rooms, doors and windows also depends upon local environment. Folk architecture often carries the aesthetic and beautifying sense of local Folk.

### 2.6.10 Folk Dance

Buckland (1983) describes Folk dance as 'an indigenous form'. She distinguished the term 'primitive' dance from 'folk' dance as a modification of the former in the context of culture in a more complex one. She describes the following characteristics of Folk dances:

- Folk dance is a fundamental part of a particular community.
- It is generally associated with local 'religious belief'.
- It is generally unfettered in composition
- It is generally conveyed by the entire cultural neighborhood.
- Generally devoid of critical analysis and usually not institutionalized.

### 2.6.11 Folk Music

Smith (1994) described Music as a clout to sense a particular landscape differently. He pointed out that, ‘local music scenes can be interrogated to draw out the links between music practice, the construction of identity, and the empowerment of people and communities’. Folk music especially though neglected but often reflects as a symbol of the resistance for liberty. Buckland (1983) describes the following characteristics of Folk music:

- Folk music is devoid of ‘written criteria’.
- Folk music is generally not institutionalized.
- Folk music invites free audience response.

In a culturally diversified country like India, folk culture itself forms various perceptions regarding globalization. For example, the ‘*Tusu*’ and ‘*Bhadu*’ Songs of Purulia District of West Bengal, ‘*Chhau*’ dance (with the preparation of masks) from Purulia District of West Bengal, ‘*Sikar Utsav*’ ‘by Santhal people is very significant.



Photograph No. 9: Folk musical instruments, domestic tools and folk architecture

Source: taken by the author from Tribal Museum, Mizoram, October, 2017

## 2.6.12 Emergence of Tourism Geography from Cultural Geography

‘Tourism geography’ (Williams, 1998) is the branch of cultural geography that seeks to analyse the aspect of travel and tourism as an industrial unit as well as edifying social activity. Both the geography of tourism and the geography of culture stressed upon the movement of ‘people, goods and services’ in a spatio-temporal context. The geography of tourism as a part of cultural geography concerned about the scale of movement, the range of diffusion of people as well as the socio-cultural impacts of tourist movement on environment. Often a very small segment of local culture as folk culture attracts peoples from places which on the other hand, influence the cultural pattern and livelihood of the local people. The tourism infrastructure of a particular place depends upon the local culture especially local food and local customs. Different layers of tourist infrastructure largely depend upon the local hierarchy of culture. ‘Mass forms of tourism’ largely depends upon the popular culture.

### Characteristics of Tourism Geography:

- Geography of Tourism is closely associated with cultural land use and Locational Theories.
- It is linked with the cultural convenience and spatial relationships of economic doings of a particular locality.
- It is very much connected with the overall variety of the tourist resource stand and ‘touristic utility’ (Lundgren, 1984) of land (Photograph No.10).
- It deals with the study of cultural priority and tourist behaviour.
- It stressed on tourism related ‘impact’ (Lundgren, 1984) process especially the ‘ecological’ (Lundgren, 1984) facets of ‘impact’ studies.
- Geography of Tourism includes ‘transport function’ (Lundgren, 1984) to study the ‘metropolitan dynamics’ as apart of landscape culture.
- Geography of Tourism also takes account of the locality improvement factor connected with local micro culture generally affects the visitors’ activities.
- It deals with culture controlled various historical appearances of tourism.



Photograph No.10: ‘Naini Lake’ increases the ‘touristic utility’ of Nainital, Uttarakhand  
Source: Taken by the Author, September, 2018

## **2.7 Self-assessment Tests**

1. Define culture.
2. What are the different types of culture?
3. Give examples of cultural components.
4. What is cultural mosaic?
5. Give a brief account on spatial distribution of different language groups.
6. Write a short note on Religion.
7. What is Ghetto?
8. Define primitive tribal groups in India.
9. What is Diaspora?
10. What is cultural ecology?
11. How globalization affects folk culture?
12. What is Geography of Tourism?

## **2.8 Summaries and Key Points**

Now, let's sum up with the main key points you have learnt. Now you have able to define culture including its components like language, religion, customs, beliefs and values as a system as well as a continuous, dynamic geographical process. All these components added values to the repetitive acts or customs and characterize the individuality of different cultural groups. The perception regarding Multiculturalism also signifies the mosaic of culture across the globe. Both the language and religion acts as influential tool for cultural expression of a specific community. The concepts regarding ethnic neighbourhood and 'Ghetto' provide a meaningful insight regarding the cultural influence on social isolation and resultant settlement pattern. Another specification of displaced and marginalized culture may study with the cultural livelihood of primitive tribal groups (PTGs). Indian partition and resultant Diaspora shows a process of socio-cultural continuum which itself exerts a greater influence on the basic cultural fabric of the country. Globalization as a macro cultural element affects the ethno-ecology and distinctive local folk culture and creates a massive alteration in the cultural composition. Lastly, Tourism geography as an emerging branch of cultural geography measures the magnitude of movement of culture in the form of peoples, goods and services.

## 2.9 Study tips

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**Web Contents:**

- <http://shodhganga.inflibnet.ac.in/bitstream/10603/186329/1/chapter-1.pdf>
- <http://www.geog.ucsb.edu/~sweeney/g5/culture.pdf>
- <https://tribal.nic.in>
- <https://www.census2011.co.in>
- <https://www.cvisd.org/site/handlers/filedownload.ashx?moduleinstanceid=11814&dataid=15877&FileName=Cultural%20Diffusion.pdf>
- [https://www.infoamerica.org/icr/n01/infoamerica01\\_bustos.pdf](https://www.infoamerica.org/icr/n01/infoamerica01_bustos.pdf)
- [Indian-society-culture.pdf](#)
- [printerest.co.uk](#) and [hindustantimes.com](#)
- [www.ocr.org.uk](http://www.ocr.org.uk)

## **Group – GEO103T.3: Political and Historical Geography**

**(Credit – 1; Marks – 25; Internal Evaluation – 5 + Semester-end Examination - 20)**

### **3.1 Introduction**

Human geography began to emerge, through the process of determining the human position in nature. One important branch of human geography is political geography. Human and state are the focal actors in political geography. We have to know and interpret the formation of state, boundary, frontiers, geopolitics, federalism, imperialism and how they relate to space. Political geography differentiates integral geographical space, creates natural and socio-economic conditions for all forms of human activity, and geographical places with their unique history, structure of economy and settlements, composition of population, its identity, culture, way of life, etc. Basically political geography discusses about the relationship between political activity and geographical conditions. Political geography, which was in the pre-paradigm phase in the 1950s and the 1960s, has moved on the professionalism phase in the 1970s when it attained some kind of professional maturity (Jones, 2004). Concerns of this sub-discipline can be summarized as the inter-relationships between people, state, and territory. The range of political geography is widespread.

In the work of Sir William Petty's essays in *Political Arithmetick*, basis of political geography can be traced back to the seventeenth century. "Political geography is that part of human geography which deals with those political complexes which have a territorial component" (Goblet, 1955). Publication year of the Friedrich Ratzel's *Politische Geographie* (1897) can be considered as the birth of contemporary political geography. In particular there was a close association with regional geography, with its focus on the unique characteristics of regions, and environmental determinism, with its emphasis on the influence of the physical environment on human activities.

History and historical geography are two ways of viewing the world but they are much intricate together that's why neither one can afford to ignore or even neglect the other in order to gain comprehensive understandings of human civilization. How geographic phenomenon (physical, social, political, cultural) changed and influenced human history over

time is the focal theme of this branch of geography. 'As long as geographers are concerned with the study of places and what they are like, how they differ from each other and how their parts are interrelated, they will want to know how these places came to be what they are, and what they were like in the past' (Smith 1965, pp.- 118-121). Many geographical features need historical analysis for a satisfactory explanation of how they come to be where they are now. The historical geography is a term which has been used as a synonym for the history of geography as a discipline and although Sauer seems to have included it within the boundaries of historical geography in 1941(Sauer 1941). Keith Johnston's study of the development of knowledge about the surface of the earth was called *Asketch* of Historical Geography in 1872. Modern concept of historical geography deals with the reconstruction of past human and regional geographies. In other words, Historical Geography is the study of the people, fictional, theoretical, physical and real geographies of the past time. Historical geography deals with the geography of an area, region, or world as it had been in the past.

### 3.2 Learning Objectives

We can learn from this unit----

- i. To find out the geographical perspectives on the formation of State;
- ii. To understand basic differences in between boundaries and frontiers.
- iii. The basic concepts of a state according to Ratzel and Marx;
- iv. To analyze the Colonialism, Imperialism and Federalism for understanding core-periphery relationship.
- v. To understand the Concept of Geopolitics.
- vi. To study Geopolitical significance of international water disputes with India and its neighbouring countries.
- vii. To understand the Concept of Electoral Geography.
- viii. To study the geography of elections.
- ix. How geography of elections influence Areal and Spatial Behavioural approaches.
- x. To find out the spatial organization of electoral areas and the geography of representation.
- xi. To study the Scope and content of Historical Geography;
- xii. To know the Ancient period: Territorial organization of *JANAPADAS* in India;
- xiii. To study the Agriculture, industry, trade and urbanization in the *Mughal* Empire.
- xiv. What are the impacts of Plantation farming and textile industry during Colonial India?

### **3.3 Assessment of Prior Knowledge**

- The learners should have basic understanding of the differences between political geography and political science.
- They should also know the differences between political geography and geopolitics.
- It is easier to teach the learners if they have basic understanding of the differences of terminologies among nation, state and country.

### **3.4 Learning Activities**

- To study the geographical formation of state we can use physical and social world and India. Charts and models can be used for the study of federalism, colonialism.
- Map of Ancient India and Mughal Empire Map of India, chart model.

### **3.5 Feedback of Learning Activities**

- Differentiation of the concept of space after Ratzel and Marx,
- Preparation of a project on the international water dispute of the River Teesta,
- Preparation of a thematic map on the spatial distribution of electoral areas in India

### **3.6 Examples and Illustrations**

#### **3.6.1 Geographical perspectives on formation of State**

‘The state is a geographic feature which we visualize on the political map’, (Hartshorne, 1939). A state is traditionally defined as an area of land (or land and water) with relatively well-defined, internationally recognized boundaries. Within this territory resides a person with an independent political identity and loyalty which is usually referred to as nationalism and territoriality. No state can exist without territory and no territory can be formed into a state without people. The basic essential components of state are- permanent population, defined territory, a well-organized government in the beginning of the functional, human and territorial units must have clan and clan territory. Seven thousand years ago along the bank of Tigris-Euphrates, Nile and Ganges civilization organized state. Ratzel developed the organic state concept, after many geographers developed the concept of state. Location, size and

shape are the primary factors of evolution of any state. There are various types of perception to formation of state i.e.

- Physical elements like mountain range (examples: Nepal, Switzerland), river valley (examples: Mesopotamia, India, Babylon), oceans (Shrilanka, Australia).
- Economic elements like food, power, mineral, industry, trade,
- Human elements like govt., people, and territory.

### **Frontiers and Boundaries:**

In the political geography Frontiers and boundaries are the spatial expressions of main social and political organizations and territorial partitioning have always been recognized and identified to be of prime importance as structural elements political geography of the state. There are various types of frontiers, natural or physical frontier, ethnic, geometrical, and political.

#### **➤ Frontiers:**

‘The frontier can thus be describe as a zonal politico-geographical area that lies at the margin of the settled territory of a political unit and into which expansion can take place (k. Siddhartha). It is outer-oriented, it has no specific line. Frontiers divided into two categories-

- a) In relation to the sovereign territory of the state, like political frontiers, settlement frontiers.
- b) In relation to the indigenous population of the frontier zone, like inclusive frontiers, exclusive frontiers.
- c) In relation to the degree of frontier advancement, like dynamic frontiers, static frontiers.
- d) In relation to the degree of trans-frontiers contact, like contact frontiers, separation frontiers.

#### **➤ Boundaries:**

Boundary is an essential component of sovereignty. They mark the limits of a state. There are various types of boundaries like Physical (Riograndi divided North America and Mexico), Political, Cultural, Socio-economic.

### 3.6.2 The basic concepts of a state according to Ratzel and Marx

➤ **Concept of state after Ratzel:**

Friedrich Ratzel was a German Geographer. He has made a very important contribution to the political geography. He talked about the effect of the environment on the power of the state. He was the founder of the modern political geography. He gave a systematic treatment on the subject in his book 'Politische Geographic' in 1897. He made political geography a part of human geography. He tried to determine the significance of physical factors in relation to the state and ultimately admitted the geographical determinism.

a) **Theory of organic state:**

Ratzel developed the organic state theory with regard to the discussion of the state's evolution. He said the state was made up of two components. One is human society and the other is earth surface. He compared the state to special organism. He was deeply influenced by Darwin's natural selection and survival of the fittest. He has compared the state to living things. The state has a biological demand for the growth as for its expansion. Thus according to Ratzel, the state is involved in an endless struggle for living space or 'lebensraum'. He said the boundaries of the state are never stagnant and along with the improvement of culture, the geographical area of the state increases.

Based on the concepts of organic state, Ratzel developed seven laws of the expansion of states -

- I. The size of the state always grows with its culture.
- II. Other manifestations follow the growth of state of the growth of peoples, which must necessarily precede the growth of states.
- III. The growth of the state proceeds by the annexation of smaller members into the aggregate. At the same time, the relationship of the population to the land becomes continuously closer.
- IV. The boundary is the peripheral organ of the state, the bearer of its growth as well as its fortification, and takes part in all of the transformations of the organism of the state.
- V. The growth of the state strives toward the envelopment of politically viable positions.
- VI. The first stimuli to the spatial growth of states come to them from the outside.
- VII. The general tendency toward territorial annexation and amalgamation is transmitted from state to state and continually increases in intensity.

He was criticized for the lack of objectivity, and the living organism concept is not significant.

➤ **Concept of state after Marx:**

The theory of state was never developed by the Marx and Engels themselves. Hence Marxist theories of the state are products of his many followers. Their conception of the state is a fundamental aspect of their outlook. Two ideas have dominated Marxist political thinking first one is communist manifesto of 1848, dismissed the state is nothing more than 'a committee for organizing the affairs of the bourgeoisie.' The second one is manifestations of the state as consisting of a 'base-super-structure model' of society where this engineering analogy is used to depict a foundation of economic relations upon which the ideological and political superstructure is constructed. According to the Marxist views the state is not the result of social evolution, because it is not the representative of all classes of the society. Society is a natural organization but state is not like that. Modern state is a result of class struggle. And so it is the true representative of the ruling class of the society.

In this theory there are two main subject areas-

- Class struggle
- Dialectical materialism.

The bourgeoisie control the economy, therefore they control the state. Today bourgeoisie use state as an instrument of class rule to exploit proletariats. But according to Marxism state power is changeable and with the help of revolution this state power goes from one class to another.

In Marxist view of the human civilization on society are divided into following categories-

- The primitive society
- The slave society
- Democratic republic
- Socialism
- Communalism

As per Marxist theory state is not an eternal body, it is a result of class struggle, and instrument of class rule which representative of powerful class of the society. The dominant class of the society applies their power to the dominated class. The state is a super structure of the society.

### 3.6.3 Colonialism, Imperialism and Federalism for Understanding Core-Periphery Relationship:

#### ➤ Colonialism:

Colonialism is the principle or custom of achieving full or partial political control over other countries, it occupies with settlers and uses it economically. Colonialism is understood as the establishment of a colony in one region and subsequent maintenance, expansion and exploitation of that colony by the political power of another region. 16th century to the mid-20th century was the era of the *European colonial period*, when European powers spared and established colonies in Asia, Africa, and the Americas.

Collins English Dictionary defines colonialism as "the policy and practice of a power in extending control over weaker peoples or areas." The *Merriam-Webster Dictionary* offers four definitions, including "something characteristic of a colony" and "control by one power over a dependent area or people."

- It included political and legal domination over an alien society
  - Relations of economic, political dependence and exploration between imperial power and colony and racial and cultural inequality.
  - It is a unique territorial relationship among state based on subordination and domination.
  - It represents capitalism and uneven development within a developing globe capitalistic system.
  - It bring new configuration of the international division of labour.

The first stage of colonialism is usually reflecting the search for wealth in the form of gold, ivory and slaves. Colonialism basically in two types-

- ❖ Settler colonialism involves large-scale immigration, often motivated by religious, political, economic reasons. The Mughals come from outside of India and they

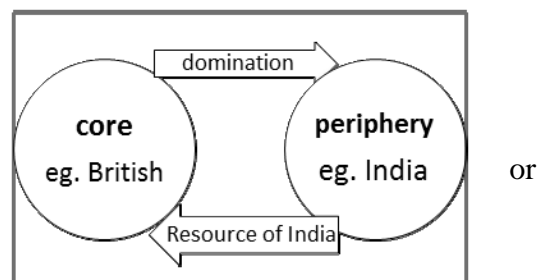


Figure: Core Periphery relationship of colonialism

described as Indians rules of foreign region, since they had made India as their home.

- ❖ Exploitation colonialism involves fewer colonists and focuses on access to resources for export. The Portuguese Empire, and later by the Spanish, Dutch, French and British belong to such groups.

The British come from the outside and ruled like an alien remaining outsider. During a core power's rise to hegemony, core-periphery relations become more informally structured. Economic linkages between center and periphery increasingly focus on the hegemonic power. The hegemonic power relies on economic mechanisms to extract the surplus value of the periphery. During a power's fall from hegemony, rival core states, which can focus on capital accumulation without the burden of maintaining the political and military apparatus of the supremacy catch up and challenge the country that dominates the world system..

➤ **Federalism:**

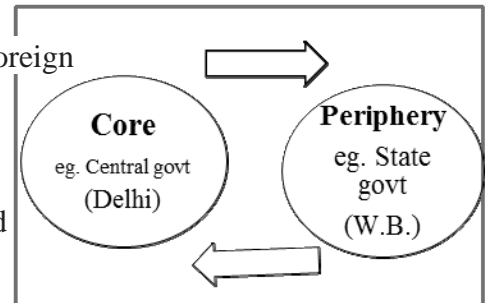
Federalism is a combination of a central government (central or 'federal' government) with regional governments (provincial, state, cantonal, regional or other sub-unit government) in a single political system. A typical example of federal government is under the constitution of the United States under the Constitution of 1787.

The term federalism is derived from the Latin word 'foedus' or 'federal' that means 'of a state in which several state forms unity but remain independent and internal affairs'. According to the definition of N.J.G. Pounds (1963) 'Federalism is a govt. device whereby outward unity maintained which allowing a degree of autonomy in some fields of government to the constituent regions of the state'.

- A division of powers between the federal govt. and the govt. of the component state.
- The central govt. can legislate on the subjects mentioned in the united list.
- The state govt. can empowered to legislate on subjects on the state list.
- Another list called concurrent list which can be made by both the central and state government.

- For an ideal federal system some favorable situation may be important, like vast area, spatially grouped diverse population, odd shape, presence of several core areas, accommodating expanding territory etc. Nature of Indian federalism are- a division of power between central and state govt. following the legislation system

- ❖ Union list: includes subjects of national importance such as defense of the country, foreign affairs, banking, communications and currency. The Union Government alone can make laws relating to the subjects mentioned in the Union List.



- ❖ State list: contains subjects of State and local importance such as police, trade, commerce, agriculture and irrigation. The State Governments alone can make laws relating to the subjects mentioned in the State List.
- ❖ Concurrent list: includes subjects of common interest to both the Union Government as well as the State Governments, such as education, forest, trade unions, marriage, adoption and succession.

The center-periphery relations of interdependence are of the utmost importance for the understanding of politics. This relationship not only refers to local and national contexts but extends to the international level as well.

### ➤ **Imperialism:**

Imperialism is an act by which a nation acquires hegemonic power to control another inhabited nation. The exploitation of this region may include, an action related to colonialism. The word imperialism derives from the Latin word imperium, which means the highest power.

According to Collins English dictionary Imperialism defined as "A system in which a rich and powerful country controls other countries, or a desire for control over other countries". Imperialism is particularly focused on the control that one group, often a state power, has on another group of people. That means all kinds of domination or control by a group of people. To eliminate this confusion about the definition of imperialism, a "formal" and "informal" imperialism may be the first meaningful physical control or "full-colonial rule", while the second is undoubtedly less direct governance, although there are still

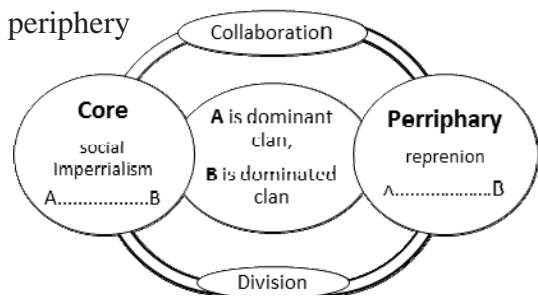
unfounded types of domination. After the first world war, these theories of imperialism were debated as the prime cause of the First World War and growth of European empires.

- These are the ‘balance of power theories’ which view imperialism as a vehicle of European diplomacy in the last 19<sup>th</sup> century between Germany, France and Britain.
- In a similar manner the world systems approach can incorporate both set of arguments in the core- periphery debate on cause of imperialism.

Johan Galtanh’s (1971) “Structural theory of Imperialism’ we used to show the core-periphery relationship in imperialism.

This produces four groups in the world economy, core/dominant clan (CA), periphery dominant clan (PA), core dominated clan (CB) and periphery dominated clan (PB).

From this we can derive four important collaborations, CA-PA whereby the dominated clans of both zones combine to organize their joint domination of the periphery,



**Figure: Core Periphery relationship of Imperialism**

social imperialism, CA-CB in which the dominated clans in the core is bought off by welfare policy as the price for social peace at home, repression PA-PB to maintain exploitation of the periphery by core as necessary and division, CA-PB. So that there is a separate of interest between dominated clans, that is a separate of interest between dominated clans that is the colonic strategy of divide and rule.

### 3.6.4 Concept of Geopolitics

Originally the term 'geopolitics' being coined by Kjellen in 1899, this branch of Geography tries to unravel international relations through the schema of geographical variables. Geopolitics in simpler word is the study of how power relations that works in space and determine global trajectory of international relations. According to a contemporary conception of geopolitics by Cohen (2003) “Geopolitics is the analysis of the interaction between, on the one hand, geographical settings and perspectives and, on the other hand, political processes. (...) Both geographical settings and political processes are dynamic, and each influences and is influenced by the other. Geopolitics addresses the consequences of this interaction.” Hence, the conversion of power in space is the focal theme of this subject that determines international relations. On the other hand "critical geopolitics" has evolved under

the broader aspect of geopolitics that tries to critically re-evaluate existing theories and how they have changed over time with special reference to the influence of the Great powers. In present post globalised world, the popularity and applicability of geopolitics is on high as this subject holds the capacity to explain international relations using space concepts and historiographical methods (Solan 2008). From the last few decades of the last century, geopolitics regained its importance to understand the shifting of global powers, rise of the developing countries, capitalistic process, globalization, and more importantly control over resources. So, this part of Geography enables us to understand greater understandings of global political-economy through geographical lenses.

### **Objectives:**

- To gain ideas on the role of geopolitics in maintaining international relations and how power is exercised in space; role of geographical variables in international politics.
- Classical geopolitical theories (Mackinder, Spykman, Mahan, Haushofer) and the emergence of the 'critical geopolitics' help to understand how dominant geopolitical doctrines have been altered for great world powers during and after colonialism.
- Neo-colonialism and geopolitics try to understand sustained uneven development in the developing countries and developed countries.
- To understand the process of control over natural and human resources using geopolitical tools across the globe.
- Technological advancements, adaptation capacity and the issue of copyright problems across countries (The case of China on FDI and technological agreements).
- Contemporary world-wide evidences:
  - a) The Brexit and the EU.
  - b) Sustained problems in the middle-east countries due to the control over fossil fuel.
  - c) East Pacific oil fields and role of different countries.
  - d) Imposition of international trade tariffs in post globalised era and the role of the State.
  - e) Interest on African countries as reservoir of both human and natural resources.
  - f) India's Look east and Act East policy and deterioration of relationship between Nepal and India.

### **3.6.5 Geopolitical significance of international water disputes with India and its neighboring countries:**

Water being a scarce resource is now one of the greatest concerns of humankind in the neoliberal era and it is to be said that if III World War happens it will happen due to the conflicts over water resources. Though international water disputes have been a major concern across countries, in recent past it has regained momentums in the form of geopolitical tool that can shape international relationships too. Particularly, in the context of South Asian developing countries where total number of population is rapidly expanding coupled with urbanization and industrialization, the demand for water is also increasing. Trans-boundary rivers, mainly the perennial ones, are now the issues of conflicts regarding water shares. India, in particular, has also been experiencing water disputes problems with its neighbouring countries and various treaties and agreements have been signed to gain proper claims over this resource. This part will allow us to understand in the neoliberal era how water can be used as a political as well as strategic tool to maintain its power over neighboring countries.

#### **Objectives:**

- Trans-border Rivers in South Asia and their importance.
- India's relationships with its neighbouring countries regarding water sharing and disputes (especially Indo-China disputes regarding The Bramhaputra River, Indo-Bangladesh disputes on Teesta conflicts, Indo-Pakistan conflict).
- Usage of water disputes as a geopolitical tool in greater sense.
- How does Capitalistic system influence state to maintain or change existing treaties and agreements and hydro diplomacy as a new avenue of state practice.
- Hydro power as an alternative option and its relationship with international water disputes in India and her neighbouring countries.

### **3.6.6 Concept of Electoral Geography**

#### **➤ Electoral Geography:**

Being a constituent member of political geography, the root electoral geography might be traced back to Andre Sieggried in the early twentieth century. According to Pattie and Johnston (2015) electoral geography is “the analysis of the interaction of space, place and electoral process”. Electoral geography is an integrated science that focally tries to analyse

the methods, voting behaviour of populace, spatial pattern of voting using geographical methods. Electoral geography has stronger links with political sciences, economics, sociology, anthropology and with other allied subjects that deals with behavioural sciences. The history of human settlement is also complex that gives birth to the multi-layered socio-economic and political fabrics that intern affect voting pattern. Electoral geography regains its importance in the late 1970's when western scholars revisit the existing contents of this subject and put forward the ideas of gerrymandering, malapportionment, electoral mapping and cartography mainly in the context of the USA and European countries. In our country, electoral geography gained importance from last one or two decades and it is still waiting to be a university subject. Electoral geographers primarily rely on Areal analysis, statistical analysis, electoral cartography and redrawing of maps, spatial behavioural approach to study the interaction between voting pattern and space.

➤ **Objectives:**

- Electoral geography tries to understand voting pattern of people and their underlying motivations with special emphasis on geographical variables;
- To analyse how 'space' can be a crucial factor of election and manipulation of space via recreation of election maps (gerrymandering) and malapportionment as social engineering;
- Electoral geography tries to map changing human behaviour with special reference to the socio-economic, political and cultural traits of voting populace.
- How different political parties response to varied space/area related factors and how do they fix up their strategy;

➤ **Contemporary examples from India:**

- The debate on the NRC issue in Assam 2018 Legislative Assembly Election;
- Rise of regional political parties in India after independence beside mainstream national political parties.

### **3.6.7 Geography of Elections and Areal Approach and Behavioural Model of Electoral Geography**

Areal approach of electoral geography deals with the mapping of voting pattern *per se* how does space affect the voting populace. Siegfried (1949) in France firstly adopted this model to understand the effects of an area or space on voting behavior (often called as areal association model). Using different statistical methods like correlation regression, factor and principal component analysis, factorial ecology, and cartographic techniques this approach aims to unearth the effects of different socio-economic variables on spatial patterns of voting given the 'area/location' of the voting populace as prime explanatory variable with sensible explanations.

As human behavior tended to be more complex with time and even more complex when they are acting as electors, areal approach no longer could systematically analyze the spatial pattern of voting. As an alternative pattern of areal approach of electoral geography, Behavioural models come up to explain complex nature of voting populace mainly by the work of Cox (1969). This approach transforms electoral geography from a 'descriptive geography of voting' to 'geographical influence of voting'. In this approach each elector is considered as 'node' and their 'nodal locations' and 'nodal links' are important to analyse as information circulates through this links. In other words this approach broadly deals with the spatial diffusion of information via human behavior particularly in the context of voting. Neighbourhood effect, the friends and neighbours effect are the popular methods of this approach along with the concept of isovote.

#### **Objectives:**

- To understand and interpret voting pattern spatially;
- These approaches will help us to understand voting pattern of a constituency using different spatio-statistical methods;
- Usage of GIS interpreting electoral outcomes in India;
- Indian election process (election process in West Bengal especially) as case study.

### **3.6.8 Spatial Organization of Electoral Areas and Geography of Representations**

This part of electoral geography is the most natal one and not only looks into the matters of spatial pattern of voting rather stresses on “the importance of three geographies as key influences on how votes are translated into seats: the geography of partisan support (where people with different political persuasions cluster); the homogeneity of those clusters; and their relative size” (Taylor &Gudgin 2012). Not only that spatial organization of electoral areas and geography of representations also deals with the jurisdiction systems (acts and laws) of different countries or differences within the same country based on local level factors (spatial factors). According to (Taylor 1973) “two basic spatial aspects of election organization can be identified. First, there is the spatial distribution of the various party votes and secondly there is the pattern of constituency boundaries”. So this part will help us to understand how vote is converted into electoral seats in a multifaceted but in a coherent manner.

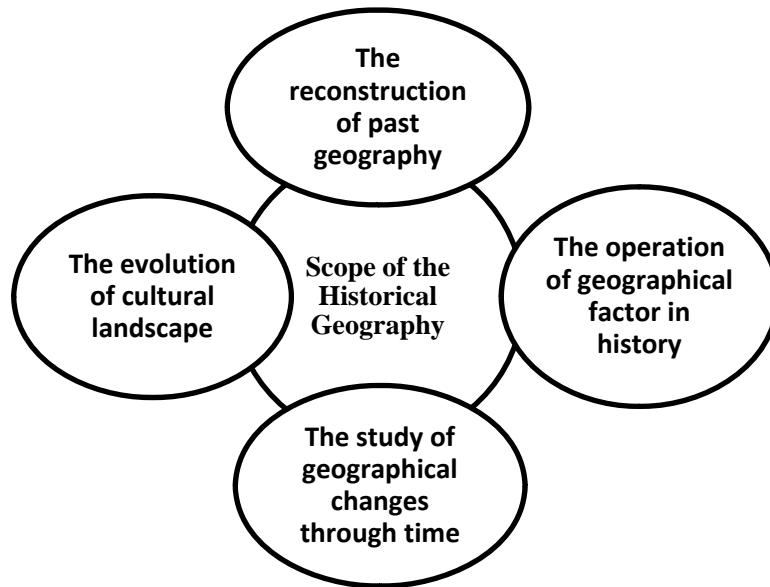
#### **Objectives:**

- How different laws and acts determine the spatial distribution of the various party votes and secondly there is the pattern of constituency boundaries;
- How different contiguous constituencies affect voting pattern;
- And lastly, but more importantly to understand how votes are transformed into seats.

### **3.6.9 The Scope and Content of Historical Geography:**

Any systematic analysis of the past through geographical lenses is historical geography, whether regional or tropical, cultural or physical. It does not therefore represent a separate subject-matter field like plant geography or economic geography. The nature of historical geography cannot be so rapidly dismissed, however. They may be listed briefly as: the cultural landscape, the reconstruction of past geographies and the study of geographical change through time. Historical geography seeks to determine how cultural features of various societies across the planet emerge and evolved by understanding their interaction with their local environment and surroundings.

Historical geographers are often concerned to project the significance of their conclusions in present time. Scopes of the Historical geography are-



Geography as the base for understanding history changed to the geographic influence upon historical events in the early 20<sup>th</sup> century. Content of historical geography are modification of space, cultural landscape, diffusion, human environment interactions, human livelihood, origin, physical system, spatial distribution, and spatial interaction.

### 3.6.10 The Ancient period: Territorial Organization of JANAPADAS in India

In the Vedic-ancient India the major powerful states were called together as *Mahajanapada* means great realm which was the amalgamation of sixteen kingdoms that existed in ancient India from sixth to fourth centuries BCE. These settlements completed its final stages prior to the times of the Buddha and Panini. *AngutraNikaya* is the first Buddhist text that mentions the following 16 *Mahajanapadas* which represented a transition from a semi-nomadic tribal society to an agrarian-based society with a vast network of state and highly- organized political structure. These states emerged as monarchies as well as republic the latter representing a model of tribal democracy. Historian Romila Thaper argued that the monarchies were a peculiarity of the fertile *Ganges* Valley. On the other hand the states that emerged on the Northern and southern periphery of the valley were mostly republic. According to *AngutraNikaya* the *Mahajanapadas* are *Gandhara*, *Kamboja*, *Asmaka*, *Vatsa*, *Avanti*, *Surasena*, *Chedi*, *Malla*, *Kuru*, *Matsya*, *Vajji*, *Anga*, *Kashi*, *Kosala*, *Magadh*, *Panchala*. The later texts such as the *DghaNikaya*, *Puranas* repeat this information and each time new *Janapadas* were added. *Gandhara* was located in the region between Kabul and

Rawalpindi, and Ujjain was the capital of Avanti. Magadh was the powerful Kingdom out of those Janapadas, it had perfect geographical positions, fertile soil, energetic rulers.

### **3.6.11 The Agriculture, Industry, Trade and Urbanization under the Mughal Empire:**

#### **➤ The Agriculture under the *Mughal* Empire:**

The most important crops in the Mughal Empire were staple crops and cash crops. The Mughals had three basic staple crops: rice, wheat, and millet. Each of the crops was grown in specific regions or zones. Rice was grown in the Eastern and South-western portions of the Empire. Wheat was grown in the northern and central regions. And for millet, it was growing dried areas of the northwest and western zones. Meanwhile, cash crops provided the empire goods to sell to foreigners in order to get silver from the westerners and also from other countries. Major cash crops included indigo, sugar, cotton, and opium. Other cash crops were soon grown as it was introduced by the westerners. When the Portuguese established trading posts in India, such as Goa, they introduced tobacco and maize cultivation to the Indians.

The agriculture of the Mughal Empire had the basic elements. There were peasants, infrastructure, tax collection, landownership, and agrarian issues. Farmers of the Mughal Empire had basic agricultural technology. They had seed drilling equipment and basic tools such as sickle and the *Kodali*, an iron blade and a wooden handle that form an angle. Tax collection was also imposed upon by the government to the peasants. The taxation imposed dates back from the time of Akbar the Great. With the help of his adviser, Todor Mai, a system was tax was based on a 10 year period average of production. 1/3 of the total production was to be paid to the government.

Agriculture of Mughal was large enough to give its peasants dissent earnings. However, its system of estates called the jagirs and zamindars allowed for the growth of mini kingdoms which eventually led to fragmentation of the Empire.

#### **➤ Industry under the Mughal Empire**

Until the 18th century, Mughal India was the most important center of production in international trade till 1750; India produced approximately 25% of the world's industrial production. The world's goods and cash crops are manufactured by the Mughalempire. Main

industries include textiles, shipbuilding and steel. Processed products include cotton clothes, yarns, threads, silk, jute goods, metal warehouses, and sugar, oil and butter. In the 17th-18th century, during the Mughal era, the growth of the manufacturing industry in the Indian subcontinent was marked as similar to the 18th century Western Europe before the reconstruction.

Mughal India had a large shipbuilding industry, which was also largely centered in the Bengal province. In the 16th-18th century, according to the shipbuilding tonnage, Bengal's annual production was 2,22,23,500 tonnes, which is larger than the combined production of the Dutch (450,000-550,000 tonnes), the British (340,000 tonnes) and the North America (23,061 tonnes).

The most important of the agrarian industry of the Mughal period was the production of various types of sugar products (molasses, sugar, etc.) from sugarcane. Mustard oil was prepared from mustard seeds and coconut oil from the coconut in the same way. In large areas agricultural products such as tobacco, coffee, blue and opiate were cultivated. Silk Boom was an important industry in Lahore, Agra and Gujarat.

#### ➤ **Trade under the Mughal Empire**

The Mughal Empire was spread over the entire east and west, as through the Bay of Bengal and through the Indian Ocean or through commercial trade through Silk Road. Rice, cloth, tobacco, and metals were the main exported goods at that time. Common imports included spices, sugar, oil, horses and textiles from other Asian countries. The maritime trade and commerce between the coastal port and north India was in the hands of Marwaris and Gujaratis, many of them were Jain by religion.

Indian trade class was well organized and extremely professional. Some ferried long distance trades, some inter-regional trade while some were specialised in local, retail trade. Previously these merchant groups were called Seth, Bohra or Modi, and later were known as Boparish/Bubani. In addition to the retail products, the merchants had their own agents, with the help of whom they bought food grains and cash crops from villages and towns. There was a special class of traders, bannazara, who carry bulk products. Bongers move towards long distances, sometimes carrying thousands of cattle, grains, pulses, ghee, salt etc. Such things as textile, silk, etc were filled with camels and mules or cartons. But it was cheap to remove bulky items in the river. Boat traffic on the waterways and coastal trade along the seashore was more developed than ever since.

### ➤ **Urbanization under the Mughal Empire**

Under the Mughal Empire, number of cities and towns was increased significantly and 15% people lived in the urban centers. Urbanisation rate was higher than the British India in the 19th century, compared to the percentage of urban population of contemporary Europe; until the 19th century, the level of urbanization in Europe did not reach 15%. During the reign of Akbar in 1600, the urban population of the Mughal empire was 17 million, which was 15% of the total population of the state. At that time, the overall urban population of Europe was larger, and even in one century after 1700, urbanisation rate of England, Scotland and Wales did not exceed 13%. When India was a British colony, share of urban population was 9.3% of its total population in 1881 and that recorded a fall of more than 3% in urbanisation rate from the previous Mughal era. In 1700, there were 23 million urban populations in comparison to 23.3 million population of British India in 1871.

Historian Nazimuddin Ahmad (1551-1621) said that during the reign of Akbar, there were 120 large cities and 3200 cityships. Lahore had near about 700,000 people, more than one million people were in Dhaka while Agra had a population size of 8,00,000 and 600,000 people were the inhabitants of Delhi. The Mughal Emperors helped to increase the industrialisation by building many factories, such as arms, court equipment, silk, carpets etc. Different precious metals, jewelery and other expensive articles were also very in the upper class. Markets like Agra, Fatehpur Sikri, Delhi, Yanpur, Ahmedabad, Burhanpur, Lahore and Murshidabad were famous then for carrying out trade activities. Trade and commercial activities were helpful for the development of urban centers. Goa, Kalkut, Kochin, Masulipatam, Pulkit, Nagapattinam, Satgaon and Sreepur were the main ports used for sea level trade. AbulFazal also noticed the silk weaving industry of Lahore, Agra and Fatehpur Sikri.

### **3.6.12 Impact of Plantation Farming and Textile Industry during Colonial in India**

Colonial India depicts significant characteristics in terms of colonial cash crop agriculture. British imperialism was more practical than that of other parallel colonial powers. Its main impulse was economic profitability, not fully devoid of financial enrichment. In terms of monopolistic trade they stressed on plantation farming and textile industry in India. Regarding spatio-temporal location, physical – environmental conditions, inbuilt infrastructure, labour-force participation, extended national and international market, soil quality and raw material quality in plantation farming and textile industry was more fruitful

than any other contemporary economic activities. The approaches related to westernization and financial support towards these specific segments of economy was more rational and time relevant in a colonial set-up. In the case of cotton textile industry there is enough exemption of duties in the export on British staples where as heavy tariff was imposed on Indian staples. The investment of foreign capital was very little in cotton textile industry and it gets larger impetus during the “*Swadeshi*” movement.

On the other hand, in the case of plantation farming, indigo, tea, coffee and rubber gained more importance. Large capital investment and endowment of land on extended lease was very common in terms of tea and coffee cultivation. Though in some cases like rubber plantation, indigenous initiatives were also taken still, the leadership was mainly under the control of colonial rulers. Moreover, in the extended part of colonial rule all of these plantation crops face a very steep competition from the other global level producers like Brazil.

### **3.7 Self-assessment test**

1. Define state.
2. Make a distinction between state and nation-state.
3. What are the difference between frontiers and boundary?
4. How mountain range and river valley play a vital role in state formation?
5. What are the economic elements of state formations?
6. Define electoral geography.
7. What is geopolitics?
8. Discuss the core periphery relationship with special reference to colonialism.
9. Give a brief outline of areal and spatial behavioral approaches for study of electoral geography.
10. What is imperialism?
11. Distinguish between history and historical geography.
12. Illustrate the scope content of historical geography.
13. Describe the agricultural and industrial scenario in Mughal period.
14. What is plantation farming?
15. Comment on the territorial organization of ancient Indian JANAPADAS.
16. Illustrate the cotton textile industry in colonial India.

### 3.8 Key Terms

State, organic state, lebensraum, boundary, class struggle, federalism, colonialism, Imperialism, core-periphery, areal approach, spatial approach, JANAPADAS, Mughal period, Colonial period, Plantation farming.

### 3.9 Study Tips

#### Web Sources

- Use atlas oxford publication (physical, political map of World and India).
- Visit these sites- <https://www.journals.elsevier.com/political-geograph>; [www.oxfordbibliographies.com](http://www.oxfordbibliographies.com)
- Visit these sites- <https://exampariksha.com/sixteen-mahajanpadas-history-study-material-notes/>; <http://www.oxfordbibliographies.com> ;

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## **Disclaimer**

This self-learning material is based on different books, journals and web-sources.

## NOTE

## NOTE