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# M.A. GEOGRAPHY

## SEMESTER - II

### REVISED SYLLABUS AS PER NEP 2020

# TOOLS AND TECHNIQUES OF GEOGRAPHICAL ANALYSIS-I

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**M.A. GEOGRAPHY**

**SEMESTER - II**

**REVISED SYLLABUS AS PER NEP 2020**

# TOOLS AND TECHNIQUES OF GEOGRAPHICAL ANALYSIS-I

## SYLLABUS

| Title of the Course – Tools and Techniques of Geographical Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year – 1 | | | | Semester - II | | | | |
| Course Type | Course code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC - 2 | GEOG 509 | 00 | 04 | 04 | 120 | 00 | 100 | 100 |

**Course Objectives:**

Main objective is to get acquainted with various geographical tools useful for analysis of various geographical and human landscapes and development

**Course Outcomes:**

At the end of the practical course students must be able to practically:

CO 1. The students are expected to learn how various geographical tools can be used for geographical analysis.

CO 2. Student will get acquainted with various types of geographical resources like maps, aerial photographs, satellite imageries and so on. The same will offer them to develop the skills that are required in spatial planning and development.

**Unit 1 : S.O.I. Topographical Maps: (30 Hours)**

1.1 Introduction Index to sheet- Scales- Conventional signs and symbols

1.2 Study and interpretation of topographical maps with reference to:

i. Glacial; Fluvial, Aeolian and Coastal landforms

ii. Drainage pattern

iii. Land-use

iv. Settlement

v. Transport and Communication

1.3 Study and interpretation of O.S sheets and USGS maps and Land-use.

**Unit 2 : Aerial photography and geomorphic setup: (30 Hours)**

1.1 Aerial Photography: Construction of stereo vision, Photo Interpretation and preparation of photo map, Determination and application of scale for distance, area and Determination height. Image Interpretation, Conjunctive use of Map, Aerial Photographs and Satellite Imagery

1.2 Interpreting the geomorphic setups in the field, on maps and satellite images

**Unit 3 : Techniques of Soil and Sediment Analysis: (30 Hours)**

1.1 Soil profile, Weathering profile and Sedimentary Facies.

1.2 Textural analysis: Sieve analysis laboratory procedure; PHI, Millimeter and Microns Scale- Grade; Methods of graphic representation of data-Histogram, Frequency curve, cumulative arithmetic and probability curve; Measures; Formulae for statistical parameters of grain size and interpretation.

1.3 The soil textural triangle: Drawing sand, silt and clay on triangular graph paper, identification of soil type and interpretation.

1.4 Chemical Analysis –pH, EC, Organic carbon, Colour and percentage of soil moisture determination.

**Unit 4 : Techniques in Human Geography (30 Hours)**

1.1 Network Analysis:

**a)** Topological graphs -Connectivity- Calculations of Alpha, Beta and Gamma Indices.

**b)** Mapping of relative accessibility and connectivity – Matrices- point of minimum Aggregate travel distance

1.2 Measuring development: Choice and relevance of indicators - Calibration of ratios and indices; Construction of diagrams and maps - Mapping and interpretation of Levels of development, Regional imbalance, Gender gap

**Suggested Reading Materials:**


1. Robinson, A. H. and Others (1995): Elements of Cartography, VI Edition, John Wiley & Sons, New York.
2. Anson, R. W. and Ormeling, F. J., (Ed.) (1993): Basic Cartography for Students and Technicians, Vol.I, International Cartographic Association and Elseiver Applied Science Publishers, London.
3. Dickinson, G. C. (1977) Statistical Mapping and the Presentation of Statistics, Edward Arnold Ltd., London.
4. Monkhouse, F. J. and H. R. Wilkinson, (1971): Maps and Diagrams, Methuen & Co. Ltd., London.
5. Hodgkiss, A. G. (1970): Maps for Books and Theses, David and Charles Publishers Ltd., London.
6. Misra R. P. and A. Ramesh, (1969): Fundamentals of Cartography, Prasaranga, University of Mysore
7. Young, P. V. and Schmid, C. F. (1979) : Scientific Social Surveys and Research, ntice Hall, New Delhi.
8. Mahmood Aslam (1977), Statistical Methods in Geographical Studies, Rajesh Publication, New Delhi.
9. Hammond,R. and McCullagh,P.S. (1974), Quantitative Techniques in Geography: An Introduction, Oxford University Press, London.
10. Yeates, M (1974), An Introduction to Quantitative Analysis in Human Geography, McGraw Hill Book Co., New York.
11. Cole, J. P. and King, C. A. M., (1968), Quantitative Geography, John Wiley and Sons, London.
12. Fotheringham,A.S., Brunsdon, C., Charlton,M ,(2000) Quantitative Geography: Perspectives on Spatial Data Analysis, Sage Publication Ltd, London,

13 . Baily,T.C., and Gatrell, A. C, (1995), Interactive Spatial Data Analysis, Prentice Hall, London

14. Griffith ,D. A. , Layne, L.J.,(2002) A Casebook for Spatial Statistical Data Analysis: A Compilation of Analyses of Different Thematic Data Sets , Amazon.com
15. Wicox, P.R. (2003), Applying Contemporary Statistical Techniques, Academic Press, Amsterdam
16. Crang M. and Cook, I. 2007, Doing Ethnographies, Sage.

# 1

# S.O.I. TOPOGRAPHICAL MAPS

**Unit Structure**



## 1.1 OBJECTIVES

The main objective is to get familiar with various geographical tools used for analysis of various geographical and human landscape developments.

## 1.2 INTRODUCTION

Map is a tool of analysis. It is possible to study spatio-temporal aspect with the help of maps. Basically there are two types of maps which are used by geographer i.e. topographical maps and thematic maps. Topographical map refers to study of physical aspects such as landforms, settlements, sources of water, alignment of roads and railways and land use etc. On the other hand a thematic map focuses on depiction of only one theme using different cartographic techniques.

## 1.3 SUBJECT DISCUSSION

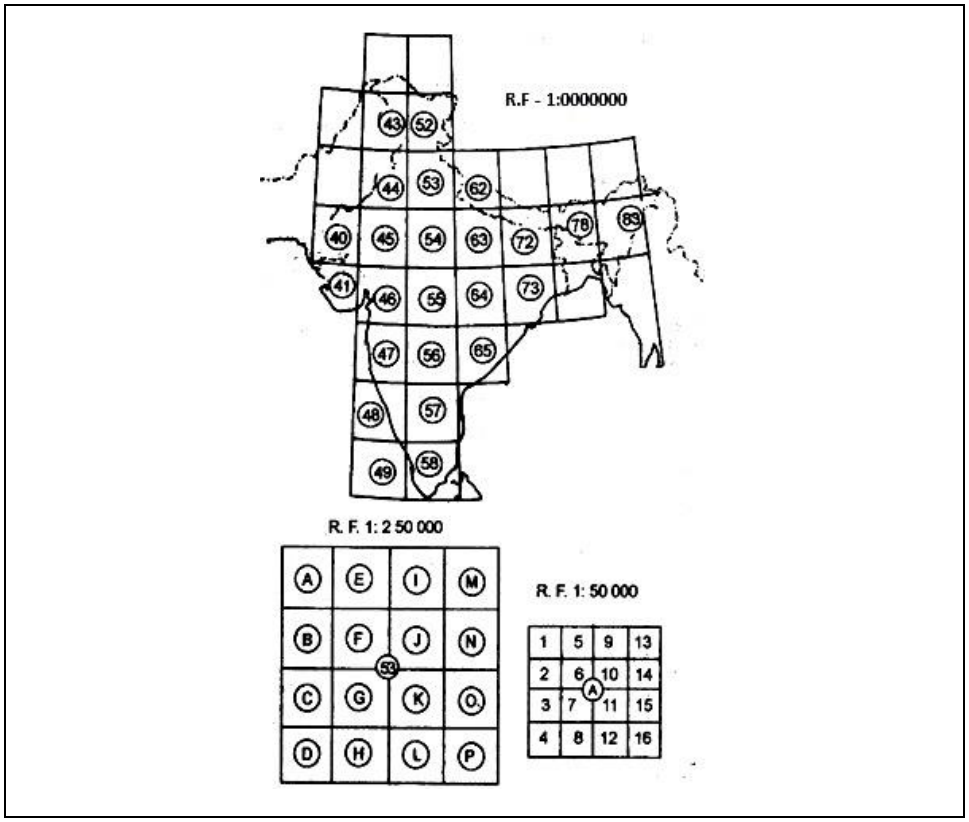
Trigonometric surveys were carried out by the British surveyors for Indian subcontinent which were very accurate. Accordingly topographical maps were prepared on various scales. Unique index number was allotted to each of the map and a common conventional signs and symbols were derived. In the following discussion we will take a review of indexing of the maps, scale and depiction of different landscape.

## 1.4 INTRODUCTION INDEX TO SHEET- SCALES – CONVENTIONAL SIGNS AND SYMBOLS

### Topographical Maps – Index to Sheet

Topographical map has specific sheet number. British surveyors had developed very accurate and useful system to map every inch of land under British Empire – which extended from Afghanistan in the west to Burma in the east. The numbers are given from North to South, West to East excluding water bodies. Topographical maps are maps of small area drawn on a very large scale depicting detailed physical and cultural features of the area or it is systematic miniature representation of earth surface which involves the transformation of three dimensional features on the two dimensional surface. Survey of India is the national mapping agency responsible for production of Survey of India topographical maps on various scales.

**Indexing of Survey of India Top sheets**



This entire area is covered by the grid of Latitudes and longitudes. This area covered in one Top sheet at the scale of 1: 1000,000 and is termed as million sheet map e.g. **44**. Area coverage 4 degree x 4 degree.

These million sheets is subdivided into 16 parts (each) and they are termed as Quarter inch map which is represented by alphabets from A to P. e.g. **45/J.** The scale of this map is 1"= 4 Miles (British system) and 1:250000 (Metric system). Area coverage 1 degree x 1 degree

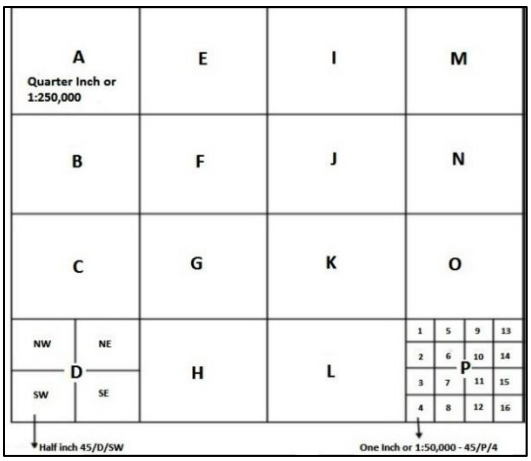
Each of the quarter inch maps is further subdivided into four parts as NE, NW, SW and SE which are known as half inch maps. The scale of this map is 1:100,000. However it is available only in British system. e.g. **45/J/NE.**

On the other hand Quarter inch sheet is also subdivided into 16 parts and are numbered from 1 to 16. The scale of this map is 1"=1 Mile (British system) and scale 1:50,000 (Metric system). e,g, **45/J/11**. Area coverage 15' x 15'

Each of the 1:50,000 sheets are further subdivided into two categories i.e. 4 divisions and 6 divisions. Thus the number for 1:25,000 will be **47/J/11/NW** or **47/J/11/6.** The area coverage is 7.5"x7.5" (4 divisions) and 7.5" x 5"(6 divisions)

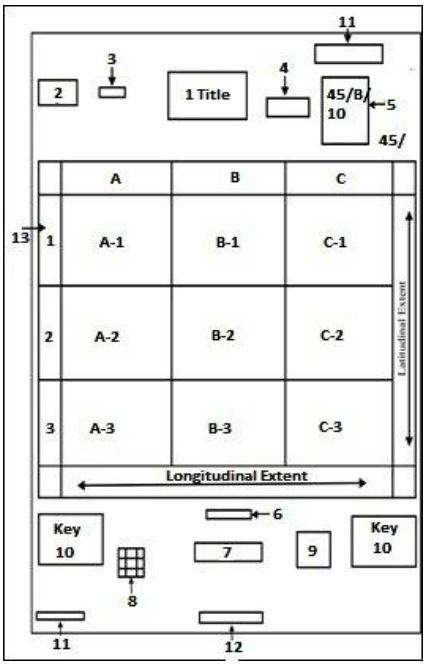
The following figure and the table will give you better idea about the numbering system and its area coverage and corresponding scale. In this table the maps which are common both in British and metric scale have been included.

**Million Sheets 45**



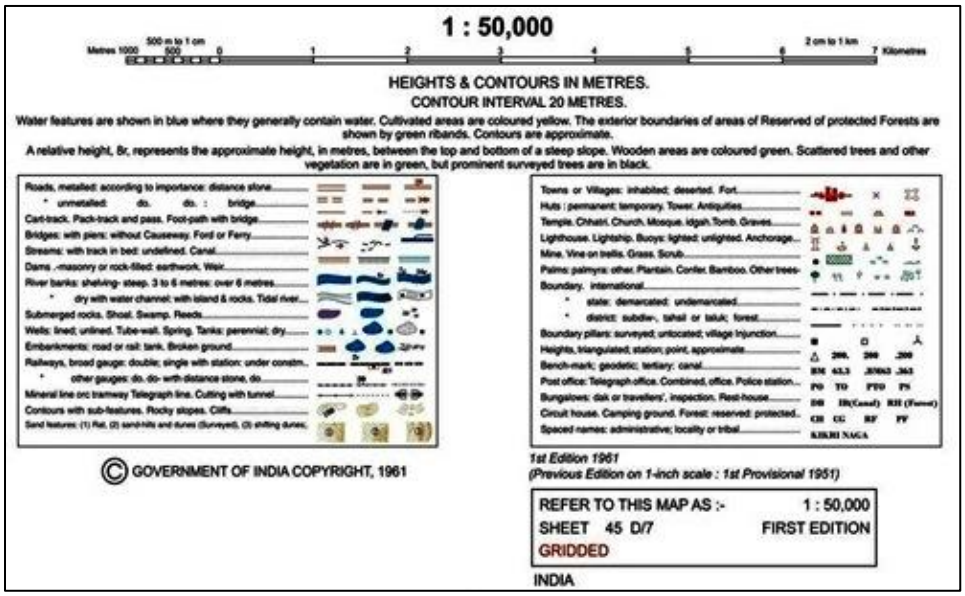

| Name of Topomap | Extent | British Scale | Metric Scale | Reference |
|---|---|---|---|---|
| Million Sheet | 4 X 4 | 1 inch to 16 miles | 1 cm to 10 km. | 47 |
| Quarter inch Sheet | 1 X1 | 1 inch to 4 miles | 1 cm to 2.5 km. | 47 D |
| Half – inch Sheet | $30^1$ X $30^1$ | 1 inch to 2 miles | 1 cm to 1 km. | 47/D/SW |
| One inch Sheet | $15^1$ X$15^1$ | 1 inch to 1 miles | 2 cm to 1 km | 47/D/10 |

## Basic elements of the topographical map




1. Title – Name of the region or state.
2. Sub – title Name of the district
3. Year of survey.
4. Magnetic declination
5. Index No. or sheet No.
6. Year of publication
7. Map scale and contour interval.
8. Index to sheets.
9. Administrative index.
10. Key
11. Reference to map
12. Special Note if any
13. Main Map- Map square

## Example of SOI Toposheet Index

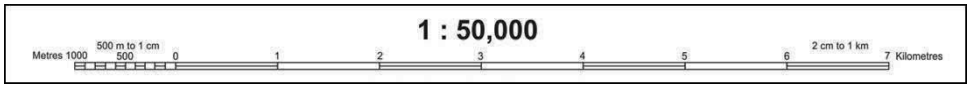



### Scale of the map

Three types of scales

1. Verbal – 2cm = 1 Km
2. RF – it is the ratio of unit of measurement on the map and its corresponding units on the ground. In this exercises it is 1:50,000. It means 1 cm on the map is equal to 50,000 cm /500 meters or 0.5 km on the ground

3. Graphical scale – the most suitable one. This is because verbal and RF will get enlarged in terms of alphabets and number in reproduction. However the graphical scale will get proportionately enlarged or reduced in the process of reproduction. This scale is also useful to calculate straight line distance (road, railway), curve distance (river) and area calculation.




These maps are used for various purposes from national level - village level planning as well as regional planning viz. Hence Survey of India prepares topographical maps as per the needs of experts in various fields; e.g. A million inch map at a scale of 1:100000 are useful for regional planning over very large areas while a map at a scale of 1:50,000 are useful for village level planning.

**Topographical Maps- Signs and Symbols.**

Map is considered as generalized picture of the area, which it represents. India has diversity in its physical features ranging from mighty Himalayas in the north, deserts in the North West, dense forest in the east and plateau and Ghats in the west. Survey of India has made the chart of conventional signs and symbols in such a way that each of the physical and cultural features is represented. New symbols have also been added in the recent open source maps; e.g. trees have different shapes and sizes. It is impossible to represent each and every tree as per its original shape / size. (and it is not necessary.) All types of trees are represented by one sign or symbol. E.g. vegetation is represented by green colour. Reserved forest is represented by alphabets – R.F. and protected forest by – P.F. simple drawing of tree is also used to represent trees / forest in pictogram. These symbols can be categorized into point, linear and aerial location, Point – settlement, temple, well, Linear – river, road, cart track, railway, pipeline and Aerial – vegetation, plantation, agriculture and stony waste. These features are shown in different conventional colour as:

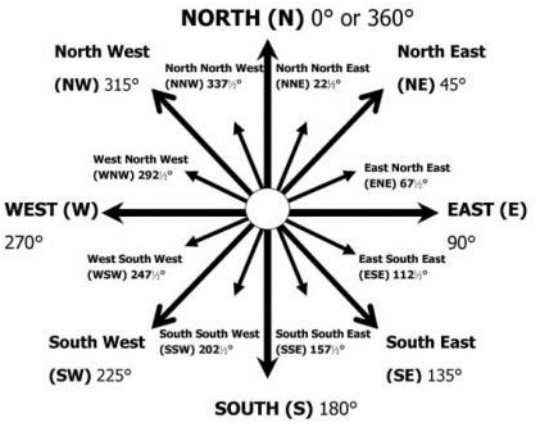
- Blue (perennial water features),
- Green (natural vegetation),
- Brown (landforms –contours and shading),
- Red (settlement and roads as well as cultural features),
- Yellow (cultivated area), and
- Black (railway, power line, non-perennial water bodies, embankment etc.).

## Grid reference

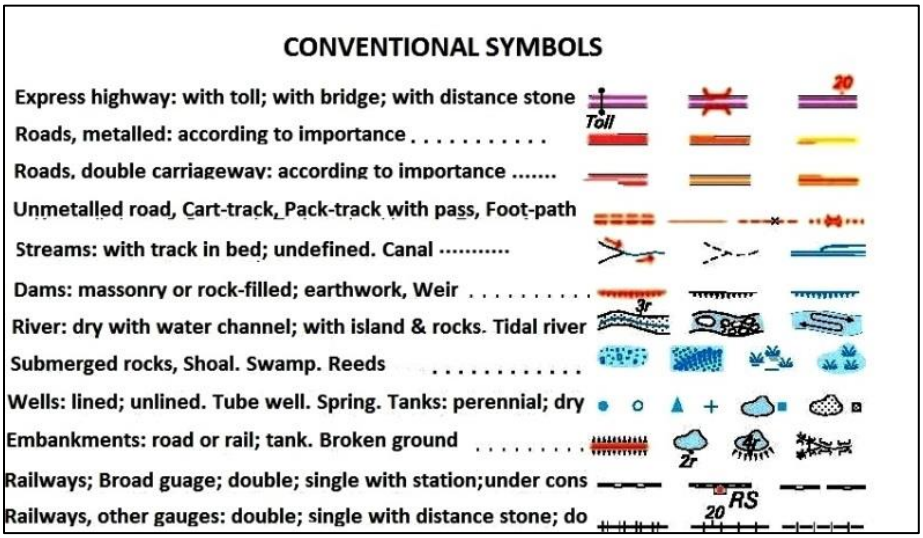
**An artificial grid reference is given on the topomap which helps researcher to locate the feature accurately. There are two methods of grid reference.**

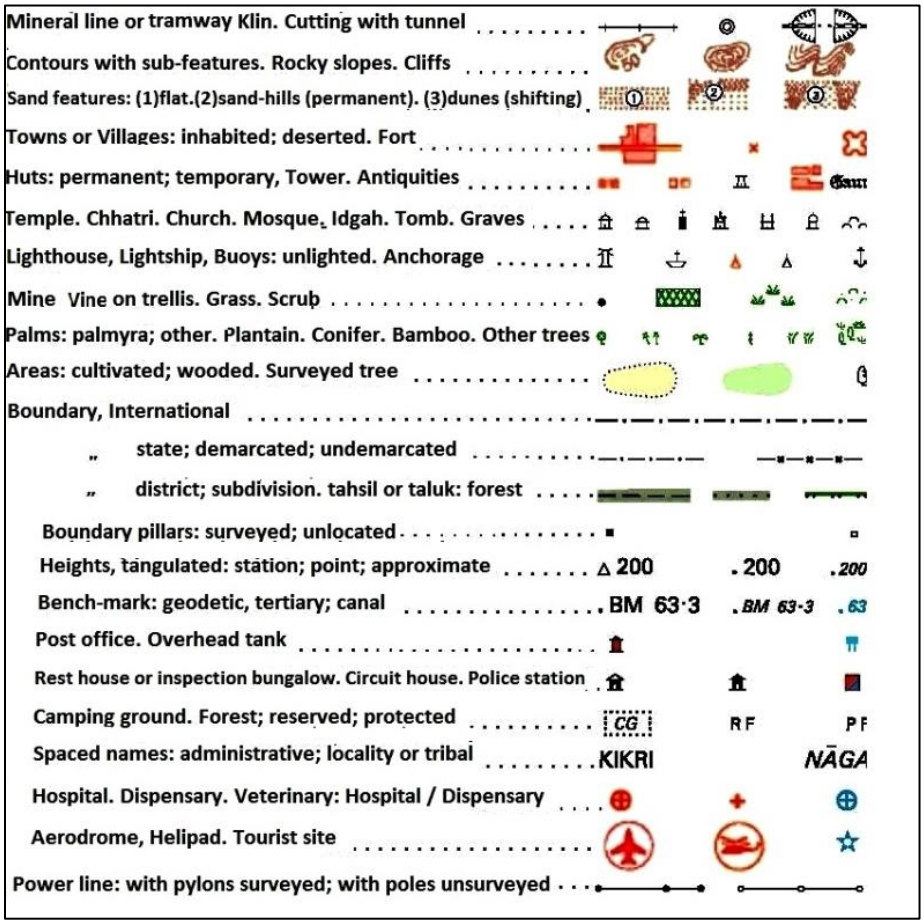
- In 4 figure grid reference Easting grid reference is given first then the Northings reference - 0720
- In 6 figure grid reference the desired square (selected for 4 figure coordinates) is further subdivided into 10 equal parts and one more digit is added after original Easting and Northings - 07**4**20**2**

## Calculation of bearing

| | |
|---|---|
| While doing these exercises for topomap one has to place the compass oriented north at the point of origin and then calculate the bearing of the selected object in a clockwise direction. The bearing from place A to B in clockwise direction will be forward bearing and the bearing from place B to A will be the backward bearing. Cardinal direction chart<br><br>Is very useful for calculation of bearing as well as direction of river |  |

**Signs and symbols used in the Topographical map are given below.**






**Methods of Relief Representation on Topo map**

Spot height gives the actual height of a place which is shown on the map by dot followed by the number giving the height above sea level in meters

Bench mark is the exact height above sea level of some permanent objects and is represented on the map by B.M. followed by the number giving the actual height of the reference point

Fine broken lines drawn on the map for representing the degree and direction of the slope are called hachures

Hill shading is a method of representing relief on a map by shading only those slopes that face south and east presuming that the source of light is in the North West

The method of showing various relief features with the help of certain standard colour on a relief map is called layer colouring

Sometimes ‘r’ value mentioned on the map is the relative height or depth with reference to the feature for example a) near river if the figure is ‘4 r’ then the depth is 4 meters, b) near dune if the figure is ‘5r’ the height of dune is 5 meters

The imaginary line joining the places of equal height above mean sea level is called contours. Contours are drawn in brown colour are very important

in identifying different relief features. However the peaks with permanent ice caps are shown in blue colour. The index contour is always in dark colour and is in multiple of hundred. The contour interval changes as per the scale of the map. For general interpretation we use 1:50,000 scale maps where the contour interval is 20 meters. The spacing of contours determines the gradient of the landforms. One can also identify concave, convex or stepped surfaces from the contours

The contour provides the following information

A. the height of the ground above mean sea level,

B. the shape of the ground,

C. the slope of the ground.

**Concept of Vertical exaggeration**

It is important for drawing profiles from the contours. The VE is nothing but the ratio of unit of measurement on x axis and its corresponding value on y axis. Unless and until a proper VE is selected you will not get the desired profile. In this exercises the RF of the map is 1:50,000 where the x axis scale will be 2 cm = 1 km or 1 cm = 500 meters. To represent the topography one has to enhance / enlarge the scale on y axis.

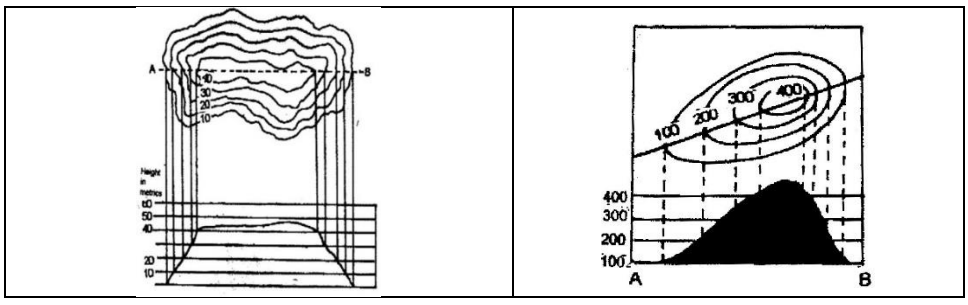
For example: VE 5 times then 500 / 5 = 100

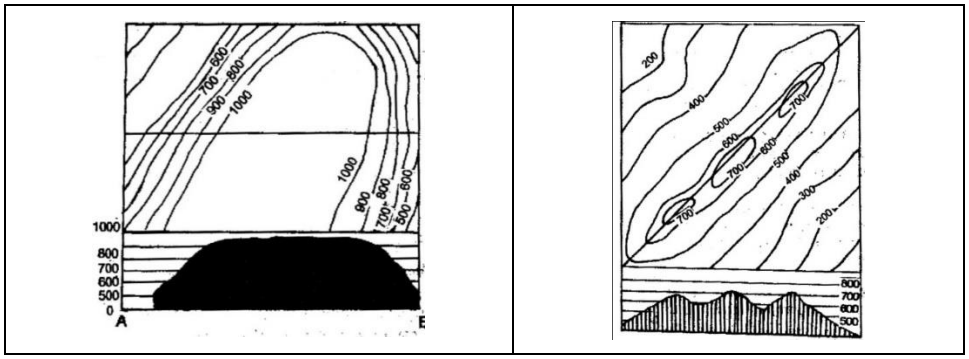
Or VE 10 times then 500/ 10 = 50

**Identification of landforms using contours**

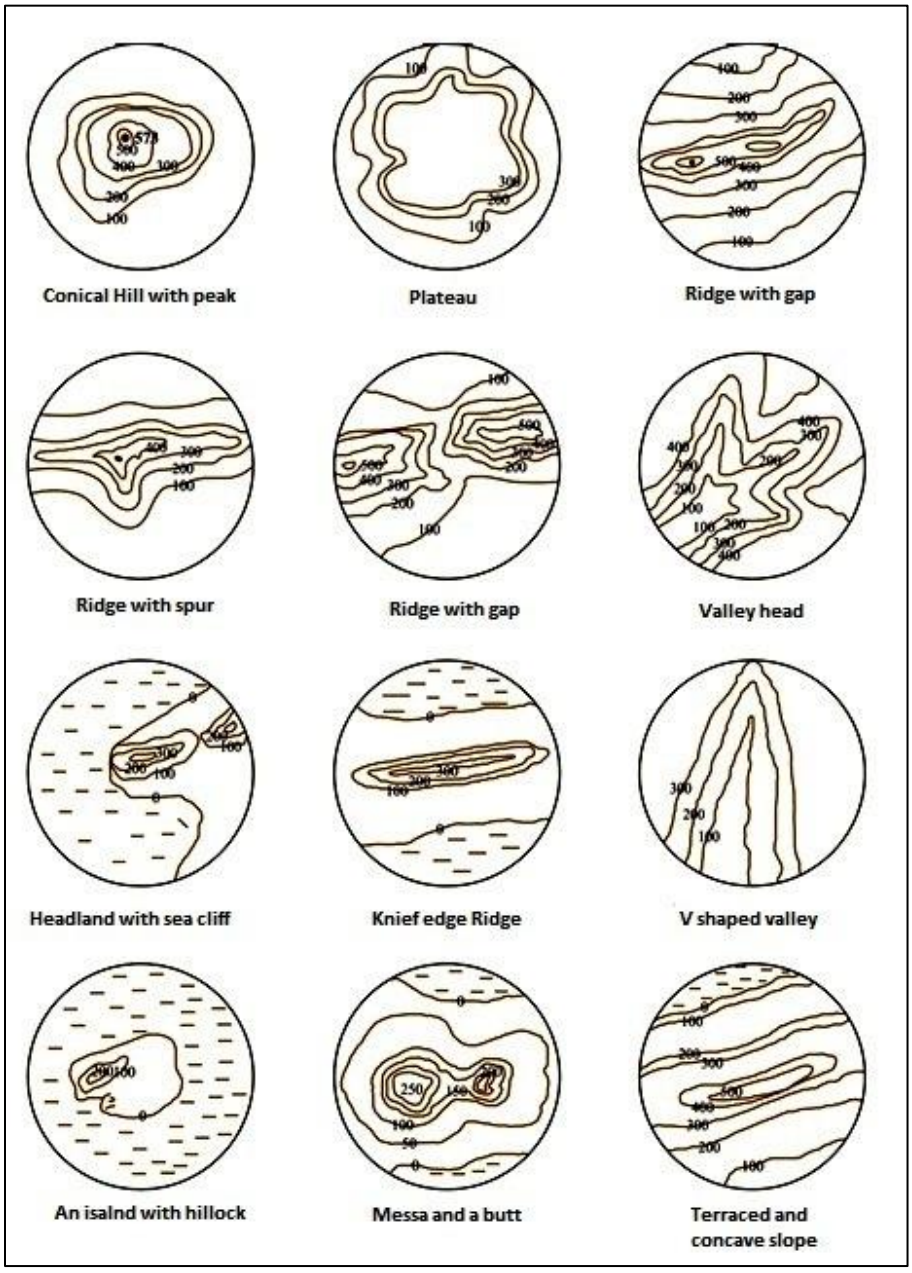
To identify the features associated with different agents of erosion such as glacial, river (fluvial), wind (Aeolian) and sea waves (coastal) on the topographic maps, an in-depth knowledge of contour reading is necessary. The contour interval will vary as per the scale of the map. The distance between the contours will determine the slope of the landform. If the contours are sparse then the slope is gentile and if they are closed to each other the slope is steep. The following are the few examples of some of the relief features.

However, it is also important to note that the contours of terrain depend largely on the line of intersection and its shape is directly related to the line. Therefore, studying landforms requires a thorough knowledge of contours and their alignment.

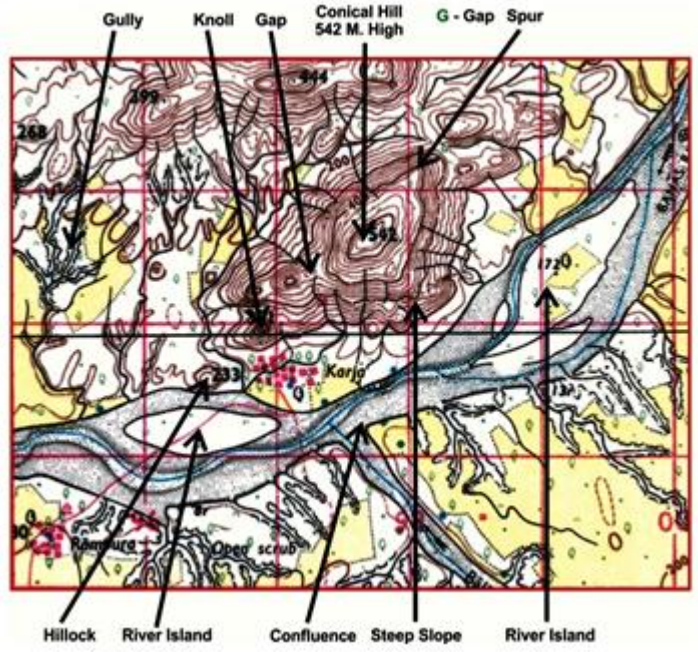





Source: www.ncert.nic.in




**Source:** Amrite, V.G., New Topomap Book, Akshar Prakashan, ISBN 9789383075799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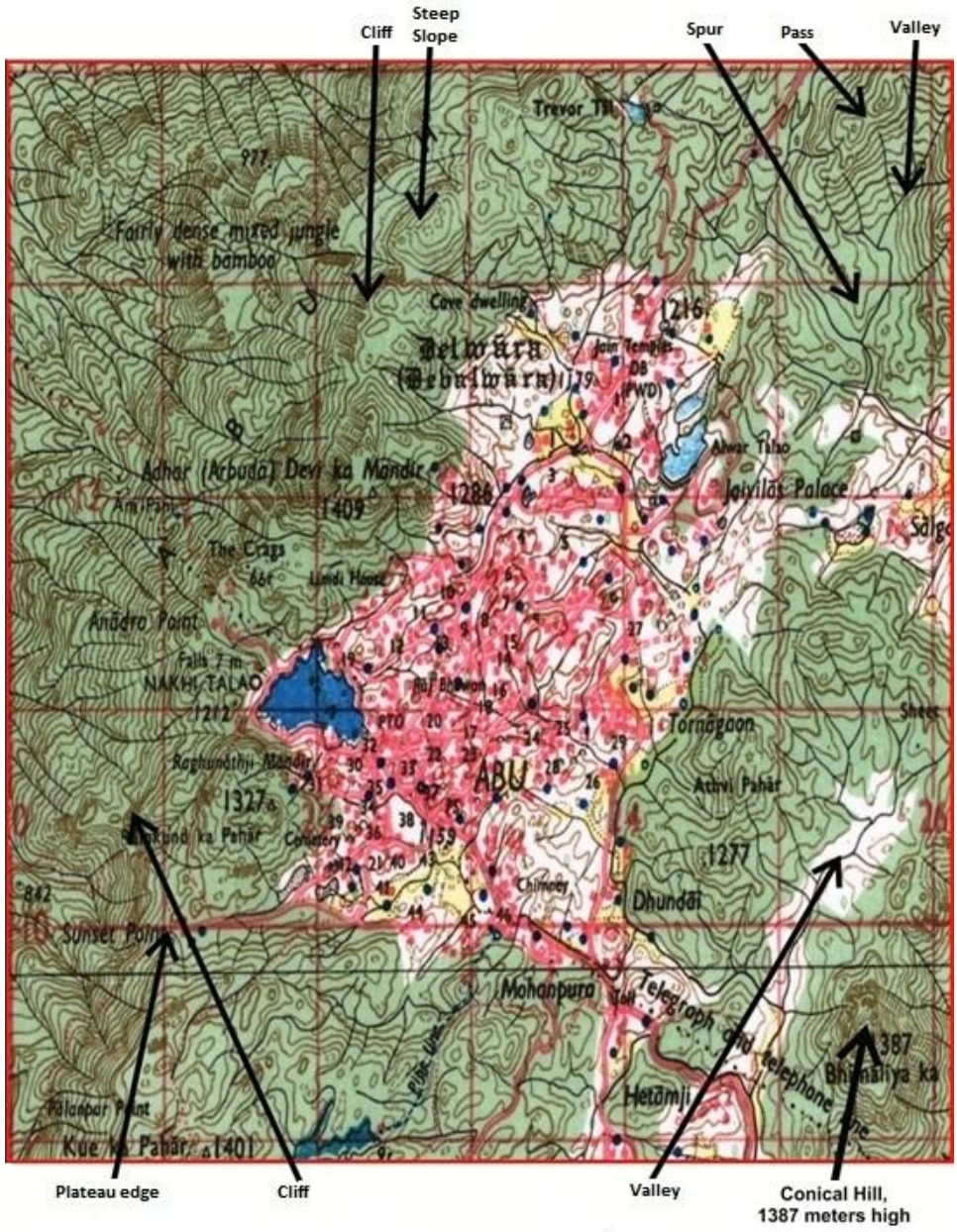
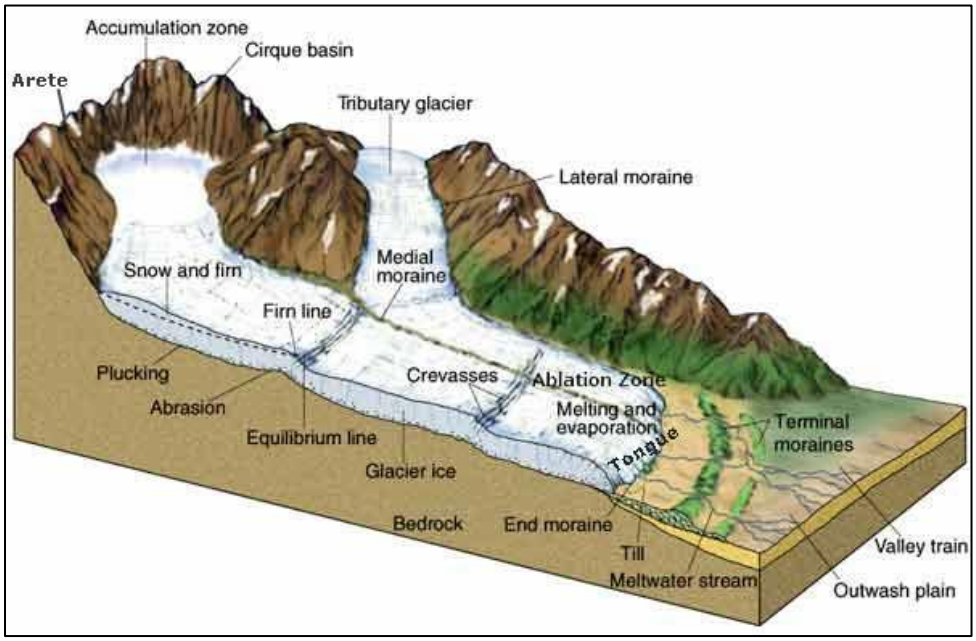



**Source:** Amrite, V.G., New Topomap Book, Akshar Prakashan, ISBN 9789383075799

## 1.5. STUDY AND INTERPRETATION OF TOPOGRAPHICAL MAPS WITH REFERENCE TO

### 1.5.1a Glacial landforms

Glaciers erode and transport a lot of material from the highlands to the lowlands. Erosional work by glacier is carried through **abrasion** (friction) and **plucking** (wearing and tearing of frozen blocks of rocks at the base and of the path of glacier).




**Source:** www.lotusarise.com

**Erosional landforms**

**(1) U Shaped valley :** 'U' Shaped valley is developed because of simultaneous plucking and abrasion of solid glacier flows. Glacial valley is steep with wide base as top giving the shape of 'U'. In U-shaped valley, sometimes waterfalls from hanging valley build up alluvial fans of coarse material.

**(2) Hanging valley :** Hanging valley develops when vertical erosion of the main valley is much faster and greater than that of tributary valley, which contain many small or no glaciers. After glaciers has retreated the floor of the main valley lies far below the floor of the tributary valley appearing as hanging valleys. The streams of hanging valleys join the main glacier via waterfalls, which may be several hundred meters high.

**(3) Cirque :** A cirque is a semi-circular steep sided depression formed through glacial erosion. A cirque is formed at the head of a valley glacier where snow accumulates and gets compacted in the depressions to form a cirque glacier that flows down the slope to feed the valley glacier

**(4) Horn peak :** When many glaciers develop cirques on the opposite slope of a ridge, they cut across parts of the ridge top forming wide gaps. The consecutive gaps are separated by tall remnants of ridge. These higher remnants of the ridge are called horns.

**(5) Roche Moutounee :** Roches moutonnees are streamlined asymmetric hillocks, mounds or hills having one side smoothly molded wit gentle slope and the other side with craggy steep slope. They are found in the glacier valleys of Kashmir Himalaya.

**(6) Crag and Tail :** Differential erosion rate of hard and soft rock in glacial region creates crag and trail topography by glaciers. The area which experiences glacier flow causes erosion to from a steep slope forming Crag. Whereas the other sides are protected from erosion and forms a long gentle tail**.**

**(7) Fiord :** Glacial troughs occupied by the sea are called as **'Fiords'.** Fiords are deep near the coastal area and become shallow at a distance towards the sea. For example they are found in Norway, Finland, Sweden, Labrador, Alaska, and British Columbia.

**(8) Col, pass, and saddle:** When two glaciers develops cirques on the opposite sides or slopes of a ridge, and they meet by cutting across the ridge, a passage of sag is formed, leaving two horns

on the two sides or leaving arêtes on their sides. Such a sag or gap in the ridge is called a '**Col**'. When 'Col' is lowered sufficiently through erosion so that they are used regular crossing across the ridge, they are called as 'passes'. A very wide pass is known as a 'saddle'.

**Depositional –**

They are developed due to settling of glacier sediments of varying size. They include moraines or morainic ridges and drumlins.

A **moraine** is any glacially formed accumulation of unconsolidated glacial debris (soil and rock) that occurs in glaciated regions. There are four types of moraines classified on the basis of their formation and location in the glacier region

a) **Terminal moraines:** They are also known as end moraines formed due to deposition of glacial till across the moving ice sheets at the snouts of glaciers after ablation of ice.

b) **Lateral moraines:** These are parallel high ridges of debris that are deposited along the sides on the top of the glacier that get preserved**.**

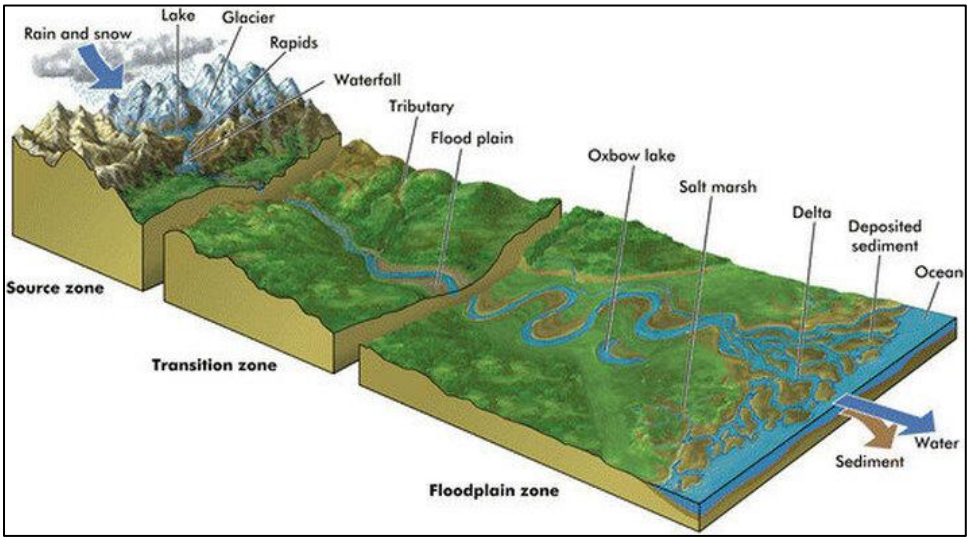
c) **Medial moraines**: is a ridge of moraine running down the center of a valley floor. Medial moraines are formed at the confluence of two glaciers where the debris on the edges of the adjacent valleys sides join and are carried on top of the enlarged glacier. After the melting of the glacier or its retreat the debris is deposited and a ridge down the middle of the valley floor is created. These are medial moraines. The Kaskawulsh glacier in the Kluane National Park, Yukon Canada.

d) **Ground moraines**: Ground moraines are till-covered areas with irregular topography often forming gently rolling hills or plains **.** Ground moraines are formed when the till melts out of the glacier in irregular heaps, forming rolling hills. They are accumulated at the base of the ice as lodgment till, but may also be deposited as the glacier retreats. In alpine glaciers, ground moraines are often found between the two lateral moraines. Ground moraines may be modified into drumlins by the overriding ice.

## 1.5.1b Fluvial Landforms.

Different types of landforms features can be identified produced because of erosion carried by the running water of a river during its different stages from its source to its mouth. These

features are developed in the upper course (1st stage) of a river.




**Source:** www.geographypod.com

**Erosional –**

**(1)** **V Shaped valley :** Rivers flowing with strong water force in the regions of heavy rainfall often leads to mass wasting that erodes its bank and bed rapidly forming steeper slopes on its sides to develop 'V' shaped valley

**(2)** **Gorge and Canyon :** It often forms when a waterfall retreats up stream. Gorge is formed in the mountains where vertical cutting is more rapid and strong than lateral cutting to develop very steep and deep valley, for example Ganga, Brahmaputra, Narmada. When they are large in size they are called as Canyons for example Colorado of U.S.A.,

**(3)** **Interlocking spurs:** When the river is in its youthful stage vertical erosion rapidly deepens the river channel. The river twists and turns around obstacles of hard rocks. There will be move erosion on the concave banks of bends of the river and this ultimately results into the formation of spurs, which are alternate on each side of the river to interlock. On the other hand, to the opposite convex bank there is very little erosion. Thus, interlocking spurs are one of a series of tapering ridges which alternately project into a river valley and around which the river winds its course

**(4) Rapids:** These features are found in the mountain areas where the underlying rock structure is composed of alternately hard and soft composition. Thus the soft rock is eroded easily while the hard resistant rock remains at its place to develop rapids that appear as step like structure

**(5) Water fall :** When a layer of hard and soft rock lies across a bed of a river, the soft rocks on the down-stream side are more quickly eroded than soft rocks. The river bed thus steepened where it crosses and thus waterfall is developed. A waterfall develops when the hard rock layer is horizontal, dips gently upstream or is vertical. Continuous erosion causes waterfall to retreat upstream forming a deep valley

**(6) Pot holes :** Pot Holes are commonly found along the upper course of the river, where flows directly over solid bed rocks. Here, the water of a fast flowing river swirls if the bed of the river is uneven. The large and small pebbles carried by a swirling river cut circular depression on the bed of the river. These depressions gradually deepen the bed and are called pot holes,

**Depositional –**

**(1) Alluvial fan :** The force of the river slightly reduces due to decrease in slope that causes deposition of large materials in the bed of a river. As a result its flow further slows down due to obstruction causing more deposition. The river tries to find its way by developing channels in its bed to flow downward. The shape thus created appears like a fan and since the deposited is fine soil it is termed as alluvial fan

**(2) Meanders :** A sweeping course of a river is known as meander or the curves formed in the course of a river are known as meanders. A meander usually has a steep slope on its outer curve, where the velocity of the river is high and therefore, erosion is greatest and a gentle on the inner curve, where the velocity is slowest. Generally, meanders the gradient is gentle, discharge is fairly high steady and material carried is fine.

**(3) Ox – bow lake :** Ox-bow lakes are curved lakes found on the flood plain of a river. Oxbow lakes are caused by the loops of meanders being cut off at times of flood and a river subsequently adopting a shorter Course

**(4) Flood plain and Natural levees :** Flood plain area of periodic flooding that occurs inland along the course of river valleys. When the river discharge exceeds the capacity of channel, water rises over the channel banks and floods the adjacent low-lying area. As water spills out of the channel some alluvium will be deposited on the banks to form levees This water will slowly seep into flood plain, depositing a new layer of rich fertile alluvium. Many important flood plains such as Ganga, Brahamaputra, Nile, Mississippi are found in different parts of the world.

Levee is a naturally formed raised bank along the side of a river channel. When river overflows its banks, the rate of in the flood area is less than that in the channel and silt is deposited. After water have withdrawn the silt is left on the bank of the river, which grows during successive floods. Slowly the height of levee increases above the surrounding flood plain. Notable levees are found on the lower reaches of the Mississippi river in U.S.A and Po river in Italy. In times of severe flood , sometime, levees burst, through which water spreads out over surrounding flood plains; and produce disastrous floods.

As flow of water becomes relatively slow and wide due to the gently sloping land or lowland the large amount of material carried and transported by a river from the uplands is thus deposited in its different parts. This obstructs the flow of water and over the time this continuous process gives rise to the formation of different types of depositional landforms. These are

**(5) Delta : Deltas:** A large, roughly triangular shape body of sediments deposited at the mouth of a river is known as Delta. Most of the eroded material is carried by a river is ultimately deposited into the sea or a lake into which it flows. Such eroded material sometimes is collected in the mouth of a river. This material builds up into low lying swampy or marshy plain. Such plain is called delta. As deposition of the material brought by the river goes on increasing in the mouth of the river, the river is forced to divide into number of channels. Each channel is further divided into more and more channels. All these channels are called **distributaries.**

**Types of Deltas : There are three types of deltas :**

**a) Arcute Delta:** This is very common type of delta. This type of delta is composed by course sediments, such as sand and gravels. eg. Nile Delta. Such delta has a number of distributaries other examples of this type of delta are Ganga, Indus, Irrawddy, Mekong etc.

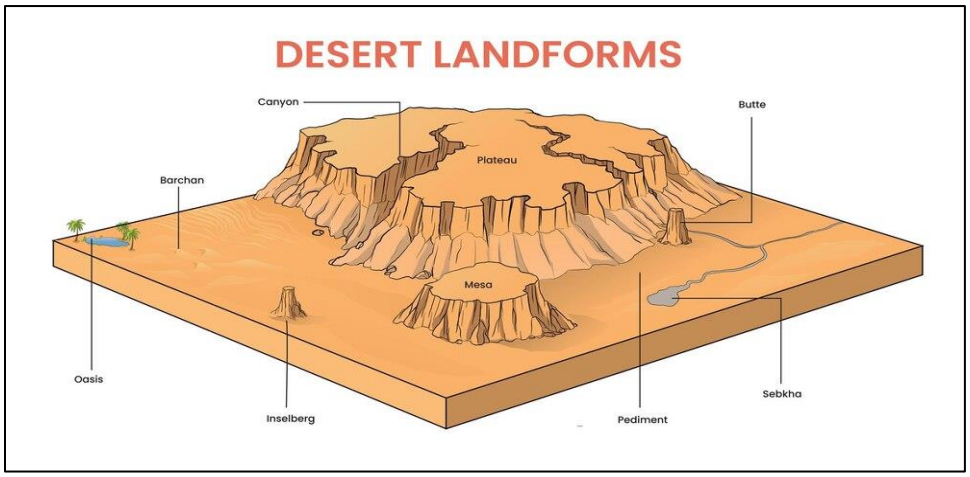
**b) Bird's Foot Delta:** This type of delta is made up of very fine sediments called silt. The river channels are divided into few distributaries, clearly defined channels across the delta. The best example of this type of delta is the delta of Mississippi river in U.S.A. This type of delta develops in seas which have few ocean currents and tides to disturb the deposited sediments.

**c) Estuarine Delta :** This type of delta develops in the mouth of a submerged river such delta takes the shape of estuary. The best examples of this type of delta are Elbe river in Germany, ob in Russia and Vistula river in Poland.

**Necessary conditions for the formation of Delta:** For the formation of delta the river must have large quantities of eroded material. In order to have large quantities of eroded material, the river must have active erosion in its

upper course of its valley. The material brought by river must be deposited at the faster rate than it can be removed by the action of ocean currents and tides.

### 1.5.1c Aeolian Landforms




www.freepik.com

**(1) Deflation hollows (Blow out) :** removal of sand particles in large amount by strong winds blowing in a particular region gives rise to the formation of a basin. This feature produced by wind erosion is termed as deflation basin

**(2) Mushroom Rock :** It is also known as mushroom rocks in Death Valley California. This is an upstanding rock in desert, caped with a harder stratum and undercut by wind at base. It is indicative of differential erosion. The base is being softer, more easily eroded rock. They are more common in arid area such as eastern province of Saudi Arabia.

**(3) Yardang :** Yardangs are formed by wind erosion when bands of hard and soft rocks lie parallel to the prevailing winds in a desert region. Such rocks are turned into ridge and furrow landscape by wind and abrasion. The belt of hard rock standup as rocky ribs up to 15 meters in height yardangs are very in the central Asian deserts and in the Atacama desert.

**(4) Inselberg :** In some desert areas erosion by wind has removed all the original surface except for isolated pieces which stand up as round topped masses of rocks called Inselbergs. Inselbergs are common in Australian Desert, Kalahari Desert in Africa, Northwest Nigeria and parts of Algeria.

**(5) Mesa and Butte :** This landform feature is developed in semi or semiarid region where the erosion of upland is uniform on the top giving rise to flat topped are called as Mesa.

**(6) Rock window :** they are formed by erosive action of a wind that are more prominent in a particular direction and area/point

**(7) Vemtifact:** Angular fragments of the rocks developed by wind erosion in the stony desert area is termed as Ventifact or Dreikanters

**Depositional –**

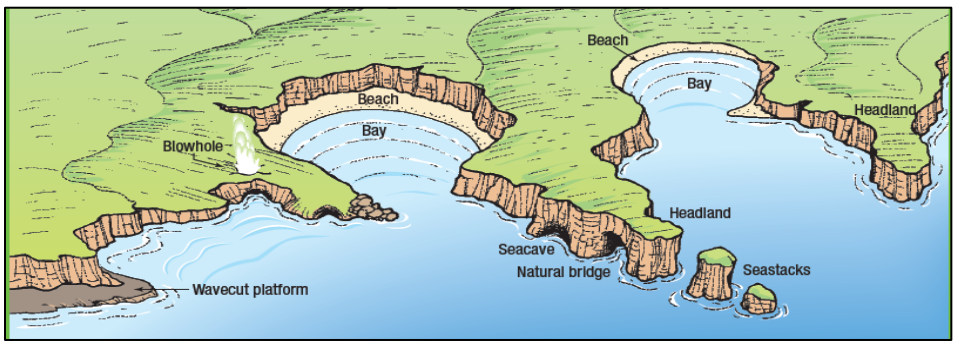
**Sand dunes :** When very powerful wind blows across the desert, carry large amounts of desert dust and sand particles from one desert to another desert or in surrounding areas. When wind velocity decrease such material is immediately deposited, resulting in formation of some depositional features by wind called as sand dunes

**(a) Longitudinal or seif dunes :** Seif dune is generally long and straight dune, which is parallel to the prevailing wind. The corridors between the dunes are swept clear of sand by this wind. The dunes are lengthened by the prevailing wind. Seif dunes are generally several hundred meters high and many kilometers long. Many seif dunes occur in that desert of Rajasthan and desert in Western Australia.

**(b) Barkhan :** It is a crescent shaped dune, lies at right angles to the prevailing wind. A barkhan usually develops from the accumulation of sand caused by a small obstruction like a rock or some vegetation. As the mound of sand grows bigger and bigger its two edges are slowly carried forward down-wind and a typical crescent shape slowly develops. The windward face of barkhan is gently sloping but the lee-ward is steep and slightly concave. A barkhan moves slowly forward as sand particles are carried up the windward face and slip down the lee-ward side. The height of barkhan ranges from a few meters to 30 meters.

**(c) Loess :** Every year wind blows fine particles out of the deserts. Some particles are blown into sea and some are deposited on land. Fine particles deposited on the land outside desert are called Loess. There are extensive deposits of loess in North China. Loess in China are formed by dust blown out by wind from Gobi Desert Loess deposits in China has been intensively eroded by rivers and produced 'badland' landscape.

**1.5.1d Coastal Landforms.**




**Source:** www.creatwebquest.com

**Erosional –**

**(1) Bay and Headland :** On exposed coasts, the continued action of waves on rocks of various resistance causes the coast lines to be eroded irregularly . This is particularly pronounced where hard rocks e.g. granite basalt occurs in alternative bands with softer rocks e.g. sand and clay. The soft rocks are worn back into inlets, bays and harder rocks persists headlands capes etc.

**(2) Sea Cliff :** A steep rocky coast rising almost vertically above sea-level is called as sea-cliff.

**(3) Caves, Sea Arches and Sea Stacks and Sea Stump:** These minor erosional features are produced by wave action during the process of cliff formation. Prolonged wave attack on the base of the cliff excavates holes. When two caves approach one another from either side of the headland and unite, until, they form an arch. Further erosion by waves will ultimately lead to the total collapse of the arch. The seaward portion of the headland will remain as a pillar of rock known as a **stack.** In course of time these stubborn stack will gradually be removed. The vertical rock pillars are eroded leaving behind only the stump, which are only just visible above the sea level, particularly at low tides

**(4) Wave cut platform:** Generally any very steep rock facing adjoining the coast forms cliff. The rate of recession however, will depend on its geological structure, i.e. the stratification and jointing of the rocks and their resistance to wave attack. If the bed deep seaward, large block of rock will be dislodged and fall into sea. The cliff will rise in series of stapes. On the other hand, if the beds dip landwards, the cliff will be more resistant to wave erosion. At the base of the cliff the sea cuts a notch which gradually undermines the cliff as the cliff recedes landwards and eroded base is left behind called wave-cut platform

**Depositional –**

**(1) Beach :** The most important depositional feature of the work of deposition by sea waves is beach. The main action of constructive waves is to deposit mud, sand and pebbles. When these materials deposited along a coast, form a gently sloping platform called a beach. Beaches usually lie between high and low water levels, but storm waves along some coast throw pebbles and stones well beyond the normal level reached by waves at high tide. The material deposited in this way produces a ridge called a storm beach.

**(2) Spit :** Spit is a narrow, low ridge of sand or pebbles joined to the land at one end and its other end is terminating in the sea. Sometimes, a spit develops at a headland and projects across a bay. Its waves swing into the bay obliquely, the end of the spit becomes curved or like a hook.

**(3) Bar :** It is very similar to spit. The bar which extends right across is a very common type of bar. It starts as a spit growing out from a headland, stretches across the bay to next headland. Such bar is called a bay-bar

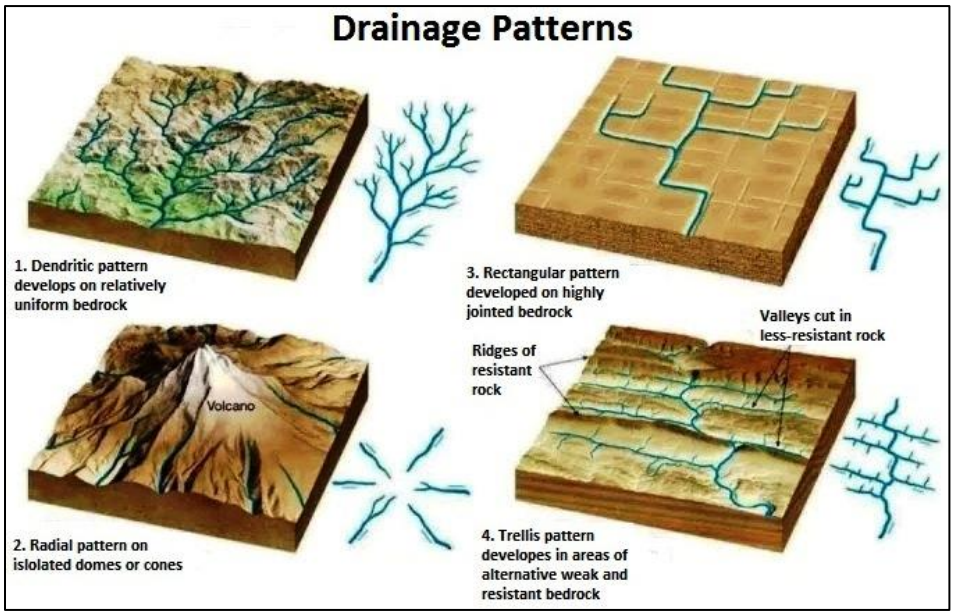
**(4) Lagoon:** A shallow body of seawater separated from Open Ocean by a spit or by Barrier Island or reef.

**(5) Tombolo:** This feature is developed close to the coast where the deposition of sand takes place connecting the mainland with the coastal island is Tombolo.

### 1.5.2 Drainage pattern

Flow of water through channels is called as drainage and the network of such channels is a drainage system. This system is affected by factors like climate (amount and period of rainfall for feeding of rivers at their source.), topography (slope of the land surface), geology (underlying rock structure).

Broadly there are four major types of drainage i.e. dendritic, radial rectangular and trellis. These types can be observed on the topographical maps. Besides in some cases one can find parallel and contorted patterns.




**Source:** geologyin.com

1. **Dendritic Drainage Patterns :** The Greek word Dendron means tree and this drainage Pattern resembles tree and its branches and so it is known as dendritic drainage pattern. This type of drainage pattern develops on the almost plain horizontal area having slight slope. Hence it is easy to identify on the topographical maps; especially maps of the plain regions.

2. **Radial Drainage Pattern :** Rain water flows in all directions from hill or mountain and so Radial drainage pattern is formed. In this case

all streams flow in different directions from the central elevated portion.

3. **Rectangular drainage pattern:** This type is found in a region which has undergone faulting. As a result there are alternate resistant ridges and low resistant valleys. In this type the streams almost run in straight lines with right-angle bends for the main stream as well as for tributaries.

4. **Trellis Drainage Pattern :** This drainage pattern is controlled by the hard and soft rock structures or folded strata

### 1.5.3 Land-use

Survey of India in their report on topographical map section 1- General – Introductory remarks have given a detailed explanation about use of conventional colours for 1:50,000 topographical maps. These colours are not only restricted for aerial features but also to linear and point features. These colours convey a lot of information in a compact and easy-to understand format. The following is an extract of the original document (source: https://surveyofindia.gov.in) 7. Colours for 1:50,000 Sheets : The 1:50,000 sheets will be published in colours as follows:-

**(a)** **Black :**All outline, lettering, prominent surveyed trees, live or barren dead moraines (lateral medial or terminal), scree, rock-falls and symbols not mentioned below

**(b)** **Red:** Roads, tracks and paths; road bridges, masonry dams; road tunnels, fords and ferries (symbols only); towns, beacons, steamer signals, navigation marks, etc. Metalled roads, towns, and villages (except huts and ruined villages) will have a red tint.

**(c)** **(i)** **Blue :** Lines of high and low water, fathom lines and their lettering, mud on foreshore, submerged sand, rocks, etc; limits of double-line rivers and of the perennial water in them from the sea as far as the tides reach; singe-line streams which generally contain water; perennial canals; steamer services; falls and rapids; licks, weirs, siphons; canal bench-marks and their heights; sluices along perennial canals; aqueducts; pipe lines; marshes; reed symbol in perennial waters; springs; wells; limits of all areas of permanent snow or glaciation; recognized routes over glaciers contours above permanent snow line; contour values of blue contours.

**(ii)** **Blue Tine:** Will be used over sea areas (except foreshore), and over the water areas of rivers and canals which are too wide to be shown by a single-line, and of lakes and tanks;

**(d)** **Green:** Scattered trees except prominent surveyed trees; scattered scrub and bushes including trees and bushes; external boundary of reserved and protected forests. Green tint will to indicate all wooded areas, dense or open.

**(e)** **Yellow:** Cultivated areas

**(f)** **Brown:** Mounds; rock cliffs whether above or below the snow line; broken ground; rocks and sand except in the beds of rivers, lakes or tanks, or on the foreshore; stony waste; dead moraines if under vegetation (grass, scrub or trees).

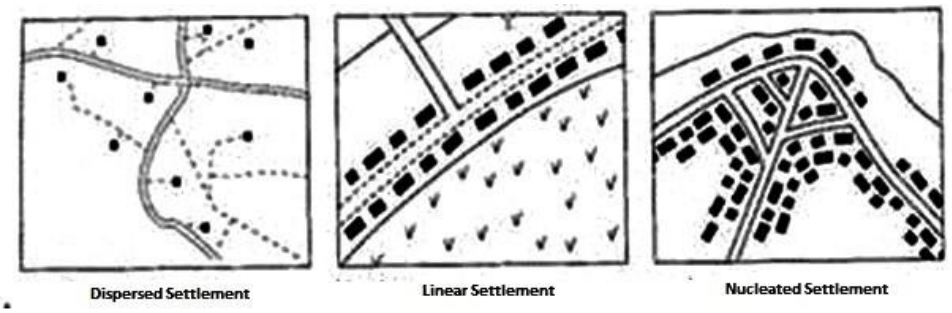
### 1.5.4 Settlements

Rural settlements can be classified on the basis of location as i) wet point settlements which are close to the source of water and ii) dry point settlements which are away from the risk of flooding.

On the basis of functions the rural settlements can be classified as agriculture, lumbering, fishing, and mining villages.

On the basis of spacing these settlements can be broadly classified as dispersed, linear and nucleated settlements which are found in the topographical maps. However there are many more patterns like circular, fan shape, star shape, arrow shape, terrace pattern etc.

Different site and situations are associated with local topography or relief of the regions. Rural and urban settlements are different in their characteristics, shape and functions.




The definition of urban settlement varies from country to country. Generally population, occupational structure and administrative set up are considered to recognize a place as urban. On the basis of location the urban settlements are classified as coastal, nodal and continental. On the basis of pattern it is much more similar to rural settlements, as linear, circular, square, fan, star and arrow. On the basis of functions the urban settlements can be classified as industrial, educational, administrative, regional, tourism, cultural and commercial. .

### 1.5.5 Transport and communication

It is one of the important factors for establishment and growth of either rural or urban settlement. Various types of transport lines can be identified on the toposheet in a hierarchical order from local level to higher level. They act as a means of transport.

Dense network of transport and communication is found in the more developed plain region e.g. Indo Gangetic plain. On the other hand it is almost absent in the in accessible hilly regions like Himalayan mountain ranges of high attitude. Transport lines are straight in the plain regions and curved shape in hilly regions. There is a variation in different types of mode e.g. Road – foot path, Kutchcha road, village road, district road, state highway, national highway; Railway – Meter gauge, broad gauge. Embankments or cuttings are found along the railway tracks or roads.

Ford and Ferry points are found at the river courses. Ferry boats are used where water is deeper. It is easy to cross river at Ford point.

Power lines are also indicated in the toposheets.

The level of different functions varies from rural to urban settlements. A village may have temple, post office, school, primary health centre and bus stop while urban settlement will have temple, post office, school, college, dispensary, hospital, weekly market, tehsil office, bus depot, railway station, airport etc.

**Map Analysis and Interpretation**

Map analysis is the process of analysing each and every fact and factor identified in the process of map reading. The questions like 'where' and 'how' are the features related to each other. Thus the plain relief becomes the cause (factor) for straight road (fact), while the flat land is responsible for farming and cultivation. On the other hand steep slopes will alter the transport alignment.

The topographical map gives a general idea of the region including physical and natural as well as manmade features. However the information depicted is selective in nature.

The map analysis includes the identification of facts and factors thus it establishes the relationship between the two variables 'where & how'. The toposheets also help in change detection of any area. It can be expansion of settlement, change in the road condition, deforestation, erosion, massive mining etc. Thus the interpretation starts with recapitulation of geography of India as a backdrop for further investigation.

One important point to be considered while interpreting the topographical maps is the information depicted in the toposheet pertaining to the particular area at the time of printing of the sheet.

Topographical maps are used for various purposes i.e. from national level – regional planning of the grass root level planning of village. Hence Survey of India prepares topographical maps to later needs of the experts from different fields e.g. Million inch sheet or topographical map sheet on the scale of 1:100000 is useful for regional planning at very large area while topographical maps at the scale 1:50,000 or 1:25,000 are useful for grass root level planning of villages

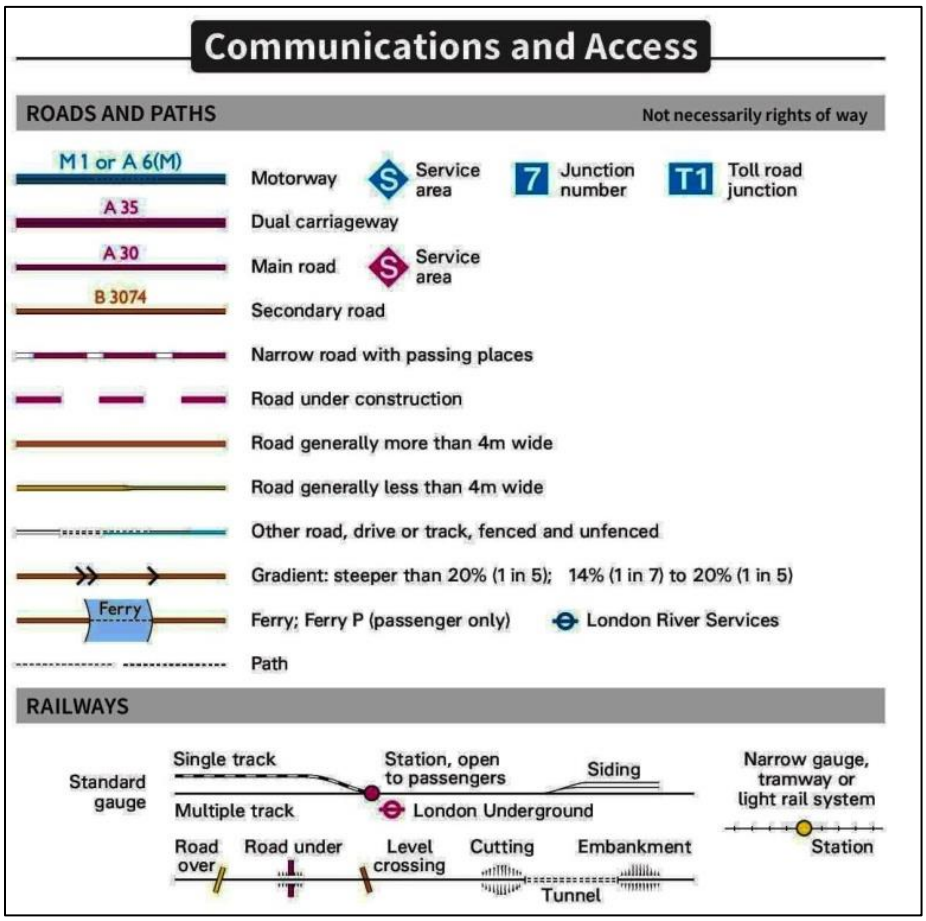
## 1.6. STUDY AND INTERPRETATION OF O.S. SHEETS AND USGS MAPS AND LAND-USE

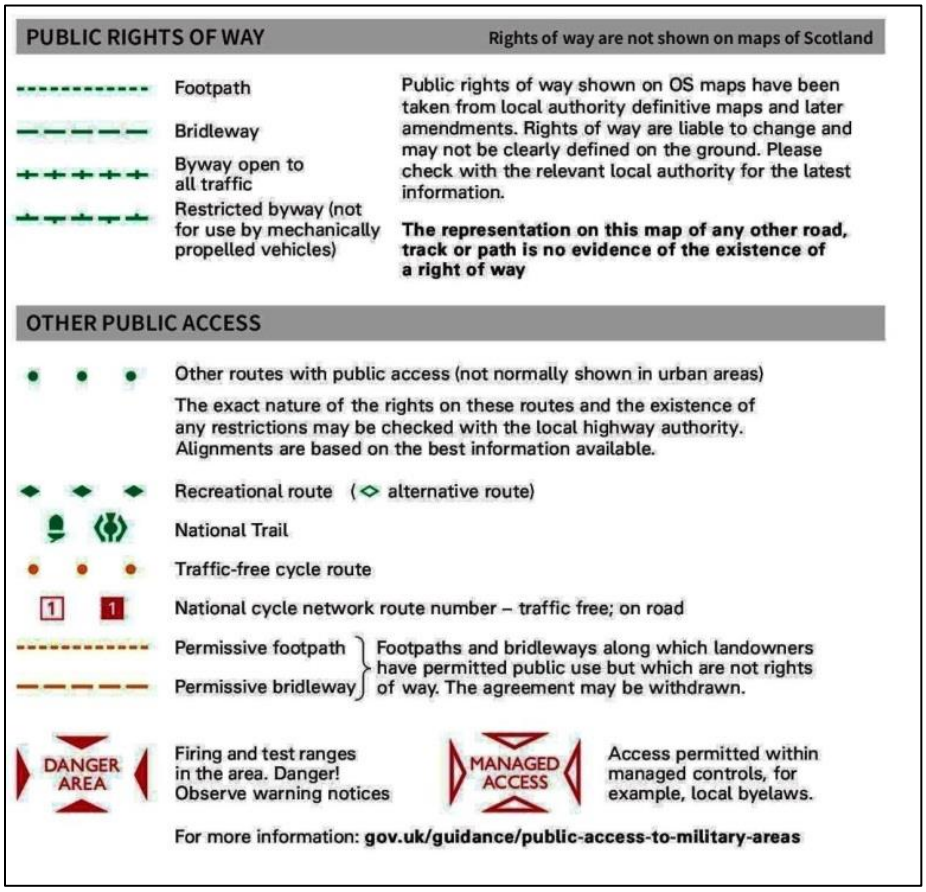
Similar to Survey of India topographical maps, these maps are on various scales. However the depiction, contour interval, conventional signs and symbols, use of colour are different than SOI sheets. These maps help the researcher to identify the physical features easily. These maps are available easily and there is no restriction policy. In India the topomaps along the coast and border of our country are classified as restricted maps. Hence the O.S and U.S maps facilitate researcher to study coastal, aeoline, fluvial and glacial landforms.

The physical set up, pattern of settlements, type of transport, cultural features of these sheets is different from SOI sheets. As a result there is a striking difference between the signs and symbols used in Indian, O,S and U.S toposheets. The symbology and colour scheme is also distinct from each other.

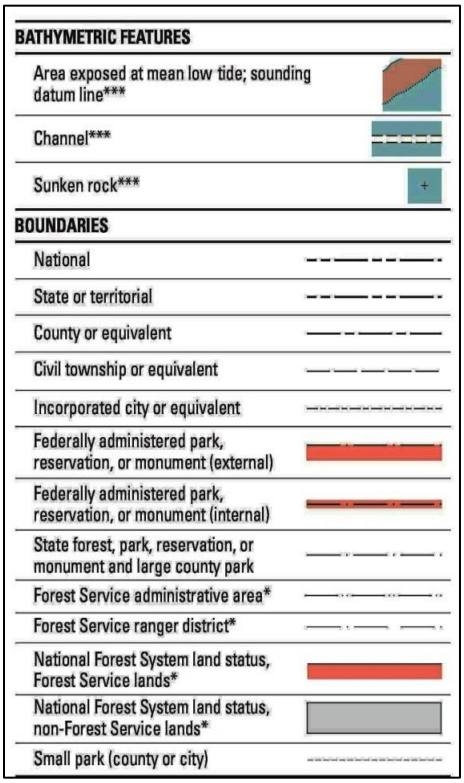
A detailed chart of signs and symbols used in both these sheets are available on the internet (https://getoutside.ordinancesurvey.co.uk for O.S sheets and https://pubs.usgs.gov for U.S sheets). The following page will give you general idea about these symbols.

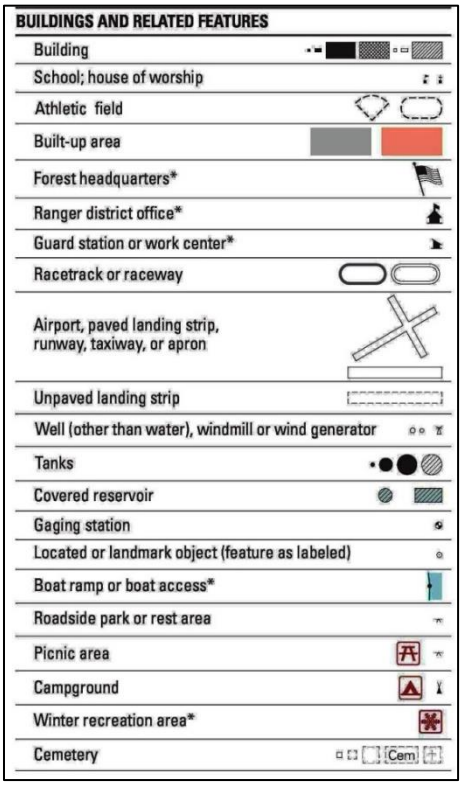
**Ordinance Survey Sheets (UK)**

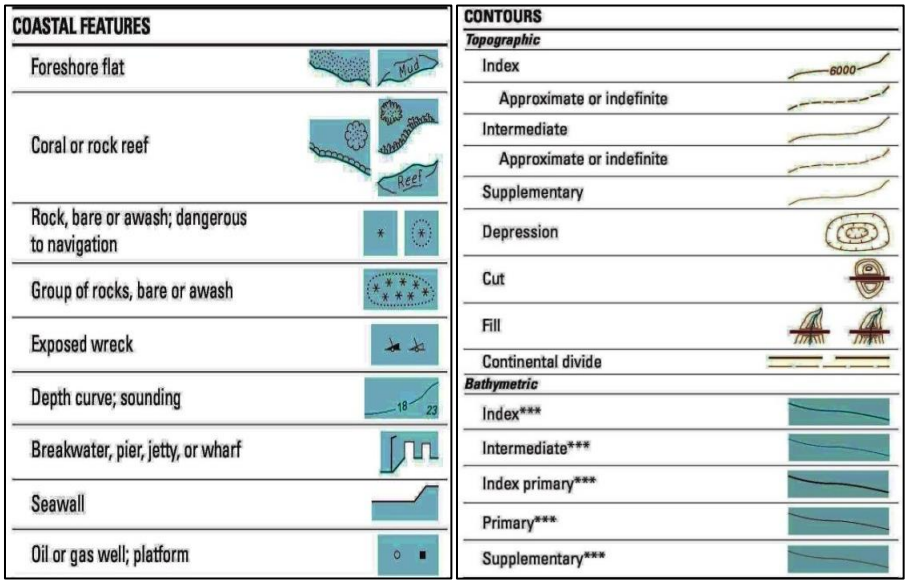


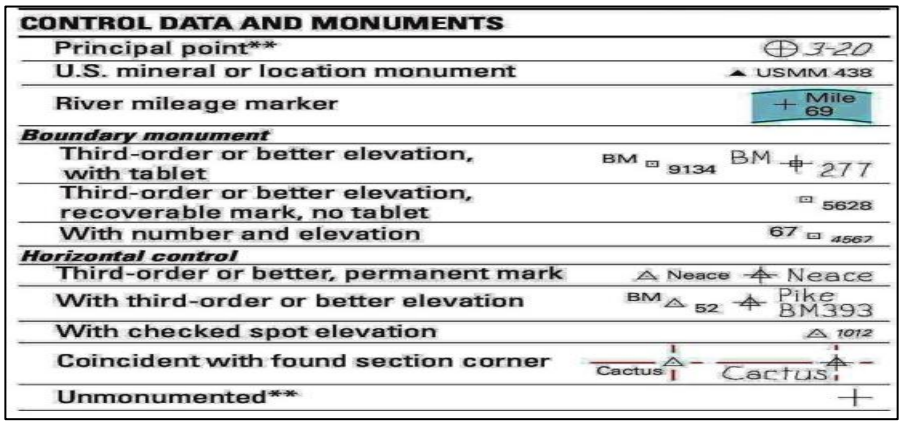



## USGS sheets (USA)



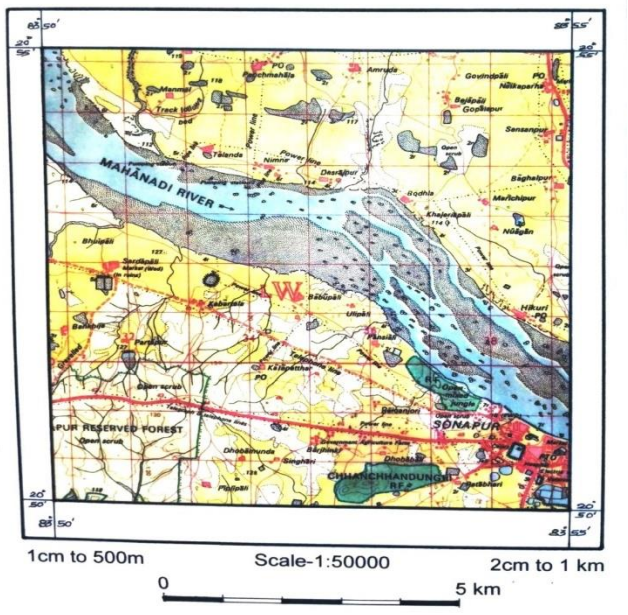


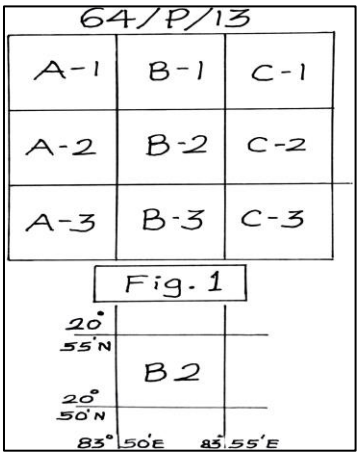

Let us take few examples of the topographical maps and interpret them.

## Interpretation of the Topographical Maps

Map No.64/P/13- B2 (Orissa)



**1) General Information:** This Topographical Map belongs to the state of Orissa or Odisha, which is situated along the East coast of India. This map is prepared by the Survey of India (SOI) and we are interpreting the B 2 quadrant of this map.




The longitudinal extent of this map is 88 degrees 50 minutes East to 83 degrees 55 minutes East and the latitudinal extent of this map is 20 degrees 50 minutes North to 20 degrees 55 minutes North. The scale of this map is 1:50000 or Two cm to 1km.

This part of the Topographical Map is grided by red squares. Each square is of 2cm × 2cm, which means as per the scale of this map (2cm to 1km) it represents an area of 1 square km.

These grid lines are very useful in finding out the exact location of any place using 4 or 6 figure co-ordinates.

The latitudinal extent of this map is 20 degrees 50 minutes North to 20 degrees 55 minutes North. Which means it's less than 23 degrees 30 minutes North (Below the Tropic of Cancer.) Hence this map area of Orissa is in the Tropical Belt.

**2) Relief**

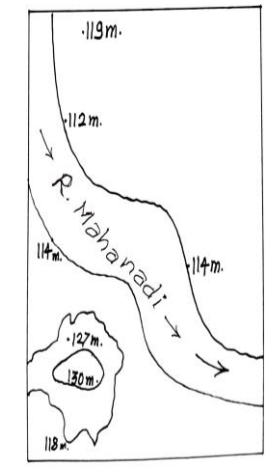


Fig. 2 Relief

There are very few contours in the northern part of the map, which indicates that the area is flat or has a gentle slope. The broad stream of the river and deposition of sand in the river represents the lower course of the river; hence the adjoining area can be the part of the flood plain

The river represents the area of lowest elevation in any region, as water always flows in the direction of the slope and hence the height of the land is lowest along the river, which is about 112 m.

There is a small hill in the South Western corner of the map, whose height is about 130 m.- indicated by the contours. Spot heights are marked

at different places. in the North the spot heights are 119,118 m. and in the south it is 118,128 m.etc.,which indicates that except for a few elevated areas, the overall slope of the land is very gentle

Small patches of badlands are found along the river and its tributaries at a few places, especially in the northern part. These bad lands must have formed due to stream erosion

### 3) Drainage

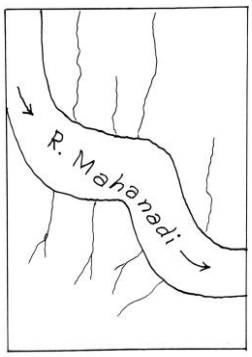


Fig. 3 Drainage

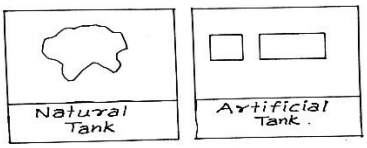


Fig 4

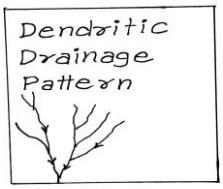


Fig.5

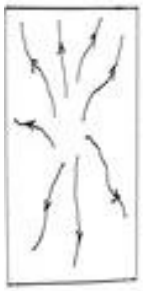


Fig.6 Radial Drainage Pattern

River Mahanadi flows from the N.W. corner of the map to the S.E. corner of the map.(Fig.3)

Mahanadi,as the name indicates Maha (means big) it is a major river in the Orissa. The width of this river is about 2 km.at some places. There are wide stretches of sand in the river, which indicates that during the Monsoon season these are covered by the overflowing water and in the post monsoon season, when the amount of water in the river decreases, these sand deposition stretches are exposed. The wide river bed, deposition of sand and almost flat or gently slopping surrounding areas/region give us a clue that this river is in the third or last stage and the surrounding areas, especially the northern portion is the flood plain area of this river.

There are many natural and artificial tanks in this region. Natural tanks have the irregular shape, but the artificial tanks have geometric shapes like square or rectangular (Fig.4)

Many small streams join Mahanadi, but all of them are non-perennial da or seasonal, as all these streams are black in colour.

Dendritic drainage pattern is found at the S.W. corner of the map(Fig.5)

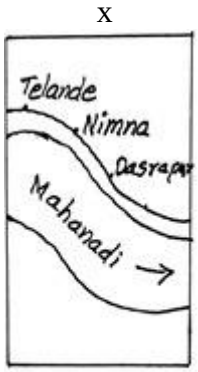
Similarly Radial drainage pattern is found in the S.W. part of the map. There is a small elevation/hill whose height is about 130 m. Hence rain water which falls on this hill flows in all directions and so the radial drainage pattern develops. (Fig 6)

**4) Vegetation**: Vegetation in this map is limited to two areas to the north and south of the Sonapur city in the form of Reserved Forest (R.F.) CHHANCHHANDUNGRI Reserved Forest and other reserved forest.

This region being fertile plane area adjoining the perennial Mahanadi river. It is used extensively for the purpose of agriculture, which is represented by the yellow colour.

Open scrubs are found at many places in the southern part of the map, to the south of Mahanadi.

**5) Settlements:-**

| | | |
|---|---|---|
|  Fig. 7 |  Fig. 8 | These are represented by red colour. Sonapur is the major city in this area, ,located at the south east corner of the map area.All roads converge at Sonapur and hence it can be the example of nucleated settlement.(Fig.7)<br><br>Few settlements like Telande, Nimna, Dasrapur and Badhia are found in the form of linear pattern of settlements,developed along the road, which is parallel to the northern bank of river Mahanadi (Fig.8)<br><br>Few scattered /dispersed settlements are found in the north and south part of the map. Considering vast areas of yellow colour (Agriculture) these can be the agricultural villages. |

**6) Infrastructure/ Roads**: There are two major roads connected to Sonapur. Small roads are parallel to the river to the north and south of Mahanadi.Few roads are found in the region connecting major roads.

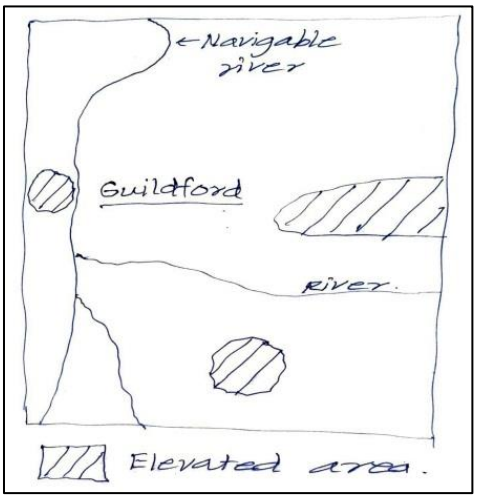
**7) Service/ Land use**: There are power lines; telephone lines in this region. Most of the area is utilised for cultivation. Roads are almost straight due to the gently slopping area. Post and Telegraph office, Hospital, Court, Jail, Inspection Bungalow of PWD and market area are at Sonapur. Govt. Agriculture farm is near Sonapur. Hence agriculture is the predominant land use in this region.

## O.S. Sheet Guildford


1) **General Information**: O.S. means Ordinance Survey. These topographical maps are prepared by British cartographers for military purpose. Initially it was in the British system of measurement (1 inch = 1 Mile). But now it is converted into metric system (2 cm =1 km). The given O.S. Sheet is grided by black lines. Each square of the grid is 2 cm x 2 cm. and the scale of the map is 2 cm to 1 km and hence one square of the grid represents one square kilometer. It is possible to get rough estimate of this region about its area. In the grid there are 8 squares in the row and 10 squares in the column which means total area of the map is 8 x 10 = 80 sq. km. This system is useful to find out exact location of any place on the map using four or six figure coordinates

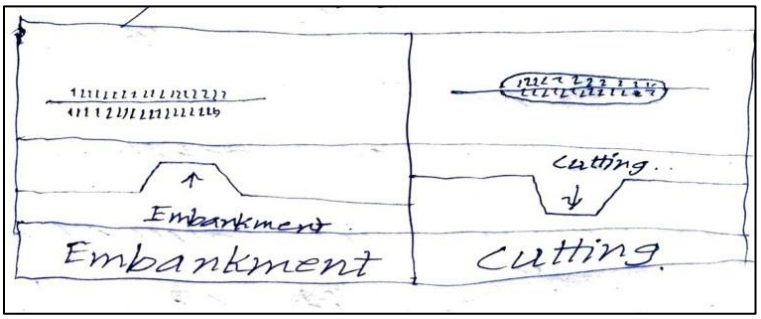
**2)** **Relief:** The region is almost flat having small elevated areas (upto 100 m) in the central and southern part of the map area.

**3)** **Drainage:** There are two major rivers. One passes through the township of Guildford in North – South direction. The northern part of this river is navigable (as this word is written along the course of the river). Other river, which flows in the East-West direction joins main river to the south of Guildford.




**4)** **Vegetation:** Small patches of vegetation are scattered all over the map region. Vegetation patches are extensive in S.E and N.E. part of the map area; e.g. Catt's wood, Derry's wood.

**5)** **Settlement and Transport:** Guildford is the major town in this region. All roads and railway lines converge at Guildford and hence it can be called as nodal point settlement. The development and expansion of Guildford has taken place in West, North and East along the transport lines. Roads are marked by red lines and railways by the black lines. There are embankments and cuttings along the railway tracks.




Embankments are found in the lower areas or at the depressions (to keep the railway track in the level condition). Cuttings are found in the hilly regions, where the portion of the hill is cut for railway track or road.

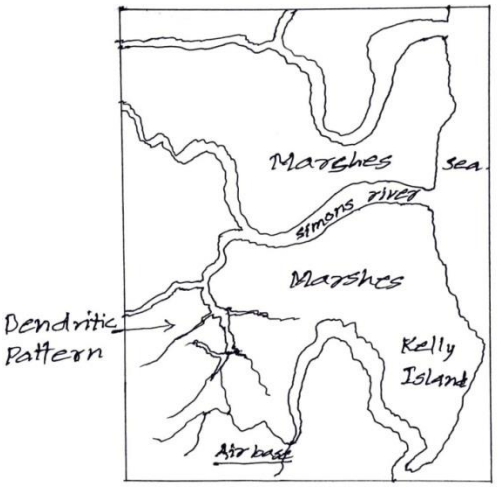
Ferry is operated to cross the river, to the south of Guildford. The tunnel is found at Guildford town along the railway track.

Guildford is an ancient town as there is a castle at the core of Guildford. The name castle is written in Old English text, which means it is a historic monument. Similarly there is Roman temple in the South East corner of the map area. There is a old manor to the west of Guildford.

**U. S. Sheet**


1) **General Information:** This U.S. sheet represents coastal marshy area. Sea is on the East. As the region is not suitable for human habitation and hene normal settlemtns are roads are not found in this region. This region is used for military purpose as indicted by the "Dover Air Force Base' and rifle range found in the southern part of this region.

**2) Relief:** There is only one contour line of 10 m. in the south-western part of the map area; hence the entire region ha height less than 10 meters. Marshes are spread all over the region. Three major meandering rivers in this region are Leipzig river, Simons River and Mahon river. Bombay Hook island, Kent island, Kelly island are between these rivers. The depth of water is about 2 to 7 meters in the sea to the east part of the map as indicated by the bathymetric contours. Dendritic pattern of drainage has developed in this region due to gentle slope or almost flat land.




**U. S. Sheet**

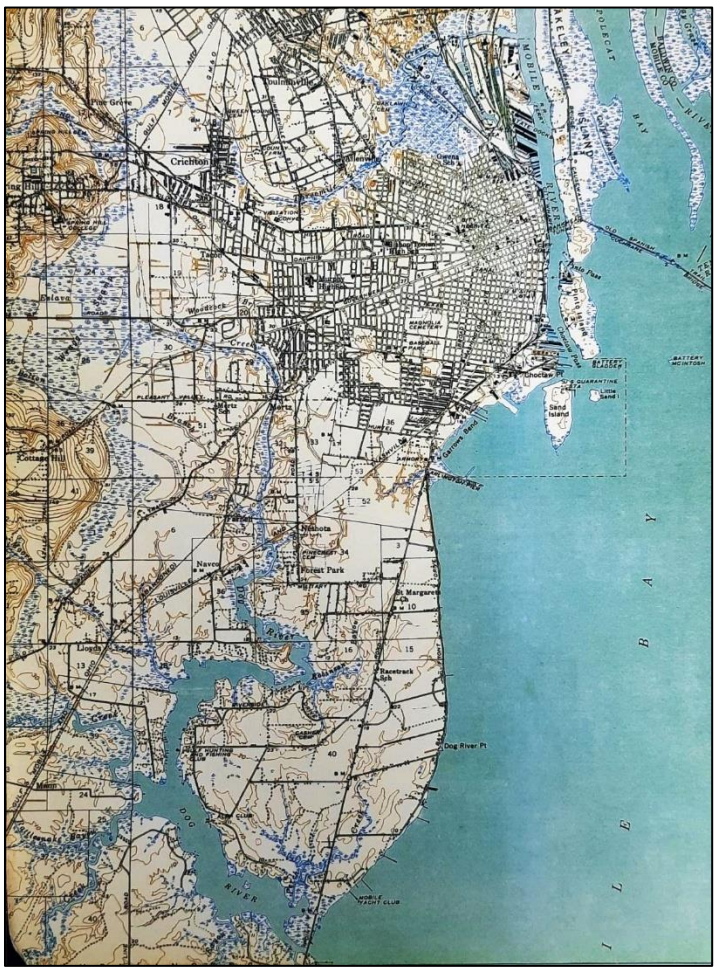
1) **General Information:** This U. S. Sheet belongs to arid or desert region as there is an absence of vegetation.

2) **Relief and physical features:** The entire arid region is covered by mountain ranges, hills and valleys. Sonoma Mountain is in the north-south direction in the western part of the area. It has peaks at the height of 8070 m, 9779 m. Contour lines are very very close together, which represents very steep slopes. The height of Battle Mountain is 8265 m. This is situated at the eastern part of the region. Buffalo valley is between Battle mountain and Sonama range. Similarly Pumpernickel valley is to the north of Battle mountain.

'Bajada' is the depositional plain at the base of rock pediments. There are scattered all over the region. Hot springs are in the Pumpernickel valley. Playa lake is in the southern part of the map region. Many canyons having steep slopes are found along the hill slopes.

3) **Settlements and Roads:** Settlements are scattered as the region is arid, part of the desert area. Roads are found along the gentle slopes of the river valley between the steep mountain ranges.

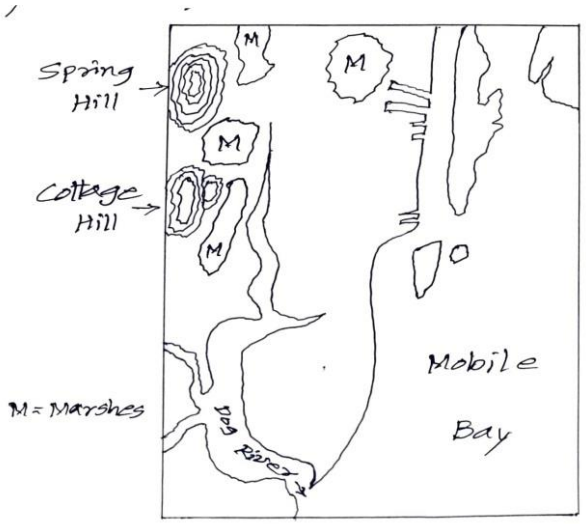
**U. S. Sheet**



**1) General Information:** This U. S. Sheet represents coastal areas with bay, rivers, marshes and hilly regions along with the major township of "Mobile".

**2) Relief:** The western part of the map has scattered hills e.g. Cottage hills (183 m), Spring hill (217 m). The contour lines of these two hills are very close, which indicates that the slopes are very steep.

Wolf River is situated at the N.W corner of the map. Dog River flows in the north-south direction in the western part of the map. Extensive patches of swamp or marshy areas are located between the Dog river and hills. Marshes are also found in the northern part of the map. Few islands are found in the N.E part of the map area. Blakeley Island is the major island which has spread in the north-south direction. Major part of the island is covered with marshes. Pinto Island and Sand Island are to the south of Blakeley Island. Little Sand island is to the east of Sand Island.




**3) Settlements:** Settlements are mainly found in the northern part of the map. 'Mobile' is the major township developed along the Mobile River. It I well planned township as there is a rectangular pattern of rods in the Mobile town. There are few other settlements scattered near Mobile town. Disperse pattern of settlement is found in the southern part of the map area. Isolated settlements are scattered in this region.

**4) Transport Lines:** Most of the roads and railway lines are almost straight because this region is the coastal region which is almost flat or has gentle slope. Railway line is of meter gauge. It connects port area near Mobile town with other parts of the region. The density of roads is more in the northern part of the region near Mobile town.

**5) Land use:** The entire region is developed urban area with modern facilities. Port activities paly an important role. There are state docks, Arlington Pier etc. There is Mobile yatch club, Baseball park, City hospital, Murphy high school, Forest park etc.

## 1.7 SUMMARY

In this unit we have studied the numbering system of Survey of India topographical maps along with scale, conventional signs and symbols. Features associated with glacial, wind, fluvial and coastal landforms have been studied. However it is important to note that scale of the map plays an important role in identification of such features. It may not be possible all the time to identify such features easily on the top map. Air photos, satellite images and actual photographs taken by different researchers will be very helpful in understanding such features. As discussed earlier the physical set up, surrounding of Indian settlements is different than that of United Kingdom and United States of America. While studying O.S or U.S.G.S topomaps researcher will have to visualize these features in proper perspective.

## 1.8 CHECK YOUR PROGRESS OR EXERCISE

**A. True or False**

**1.** Point, line and aerial symbols are used in topographical maps.

**2.** Survey of India is the national agency who produces topographical maps.

**3.** Map scales do not change in topographical maps.

**4.** Contour lines never merge with each other.

**5.** Topographical maps are always oriented north on top. .

**B. Fill in the Blanks**

**1.** _____ colour is used for depiction of embankment.

**2.** Perennial well is the _____type of symbol.

**3.** Contour depicts _____ above MSL.

**4.** The angle in prismatic compass from place A to place B in clockwise direction is called _____

**5.** The R.F. scale of the topographical map 47 /J/11 would be _____

**C. Multiple Choice Questions**

**1.** Ox bow lake is the feature of _____ landscape

a. Fluvial **b.** Glacial **c.** Aeolian **d.** Coastal

**2.** Hanging valley is the feature of _____ landscape

a. Fluvial b. Glacial c. Aeolian d. Coastal

3. Mushroom rock is the feature of _____ landscape

a. Fluvial **b.** Glacial **c.** Aeolian **d.** Coastal

4. Beach is the feature of _____landscape

   a. Fluvial **b.** Glacial **c.** Aeolian **d.** Coastal

5. Alluvial fan is the feature of _____ landscape

   a. Fluvial **b.** Glacial **c.** Aeolian **d.** Coastal

**D. Answer the following Questions**

1. Explain the importance of conventional signs and symbols in topographical map.
2. Explain the use of conventional colours in topographical maps.
3. How the slopes are identified in the topographical map?
4. Explain the stages of river and the features associated with each stage.
5. Discuss significance of scale of the topographical map with reference to depiction of information.

## 1.9 ANSWERS TO THE SELF-LEARNING QUESTIONS

A.1. True

A 2. True

A 3. False

A 4. False

A. 5. True

B. 1. Black

B. 2 Point

B. 3 Height

B. 4 Forward bearing

B. 5 1:50000

C.1. a

C.2. b

C.3. c

C.4. d

C.5. a

**Answers to the Self-learning questions**

1. Write about the design of sings and symbols, their characteristics and importance in depicting the information.

2. The true form of existing features is into consideration while using the conventional colours (e.g. perennial water body –blue). But in some cases modification is done to bring out the hierarchy of the feature.(e.g. road marked in red colour)

3. Contour which joins the places of equal height. The spacing of the contour determines the slope. Closer the contours steeper the slope and farther the contour gentle the slope. A good diagram will be necessary to bring out the slope types clearly.

4. Upper, middle and lower course are the three broad categories of the river. In upper course erosional features can be observed. In middle and lower course depositional features can be observed. .

5. The scale determines the area coverage thereby affect the type of information to be depicted. A large scale map of 1:25,000 will have more detail information than that of the map on 1:50,000 scale.

## 1.10 TECHNICAL WORDS AND THEIR MEANING

**Bearing –** it is an angle measured in prismatic compass from place A to B. It is measured in degree and range is between 1 degree to 360 degree.

**Magnetic declination** – it is an angle between magnetic north and true north. On the topographical map it is shown as angle between magnetic north and grid north (this is with reference to the grid of the topographical map).

## 1.11 TASK

Refer to Survey of India site and down load educational map series at the scale of 1:50000. Study various features of topographical maps and make notes accordingly.

## 1.12 REFERENCES FOR FURTHER STUDY

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# 2

# AERIAL PHOTOGRAPHY AND GEOMORPHIC SET UP

**Unit Structure**



## 2.1 OBJECTIVES

The main objective of this unit to understand concept of remote sensing and the process involved in capturing the image. We will also study the factors responsible for visual image interpretation along with the satellite images.

## 2.2 INTRODUCTION

Remote sensing can be considered as revolution in acquiring, capturing and disseminating the information without touching the object. The era of remote sensing started with launching of Sputnik satellite by then Russia in 1957 followed by USA in 1958. India launched its first satellite Aryabhatt in 1975. Over a period of nearly 27 years new innovations were made and research was carried out in this field. Now satellite with specific programmes like Cartosat, Oceansat is being launched by many countries. ISRO (Indian Space Research Organisation) is responsible for these activities.

## 2.3 SUBJECT DISCUSSION

Remote sensing is process of collecting information about object or area scientifically from a distance without any physical contact with them. Various satellites are launched by different countries for acquiring the data.

Variety of satellite images with different bands is now available for different use. Low flying aircrafts are also used to capture air photographs. These can be single (high oblique or low oblique) and in pair. These images and photographs are used in different fields like geography, geophysics, land surveying, earth sciences, defense etc. In India National Remote Sensing Centre is responsible for generating satellite images.

## 2.4 AERIAL PHOTOGRAPHY

Construction of stereo vision, Photo interpretation and preparation of photo map, Determination and application of scale for distance, area and Determination of height. Image interpretation, Conjunctive use of Map, Aerial Photograph and Satellite Imagery

## 2.5 INTERPRETING THE GEOMORPHIC SETUPS IN THE FIELD, ON THE MAPS AND SATELLITE IMAGES

Remote Sensing is the collection of information relating to objects without being in physical contact with them. To acquire the data electromagnetic radiation is used. It is also possible to collect the data from inaccessible areas such as Amazone basin, Arctic and Antarctic regions, Oceans etc.

The term "remote sensing" generally refers to the use of satellite- or aircraft-based sensor technologies to detect and classify objects on Earth, including on the surface and in the atmosphere and oceans,

Electro-magnetic radiation which is **reflected** or **emitted** from an object is the usual source of remote sensing data. A device to detect the electro-magnetic radiation reflected or emitted from an object is called a "remote sensor" or "**sensor**". Cameras or scanners are examples of remote sensors. A vehicle to carry the sensor is called a "**platform**". Aircraft or satellites are used as platforms.

Landsat I was the first satellite which was launched by USA in 1972. Tremendous progress was also made by India. Aryabhatta was launched in 1975 followed by Bhaskar, Rohini, INSAT series, IRS series, GSAT, EDUSAT, Oceansat and Cartosat.

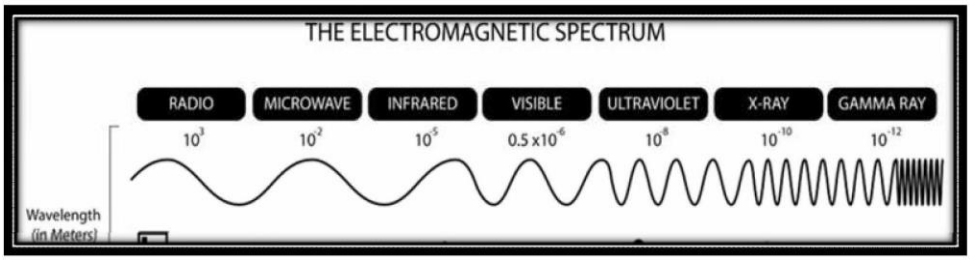
Remote sensing is used in number of fields including Geography, land surveying, and most earth science disciplines, it also has military, intelligence, commercial, economic planning and humanitarian applications.

**Concept of EMR:**

It refers to the waves of the electromagnetic field, propagating (radiating) through space carrying electromagnetic radiant energy. It includes radio waves, microwaves, infrared, (visible) light, ultraviolet, X-,and gamma radiation.

Wavelength is a measure of the distance between repetitions of a shape feature such as peaks, valleys. Wavelength is commonly designated by the Greek letter *lambda* (λ). The heat produced by the sun travels from the sun to the earth via waves known as electromagnetic waves. These waves can vary greatly in their wavelength. The electromagnetic waves coming to earth from sun come in variety of lengths so scientists consider it as spectrum. Thus, the waves all together are called as electromagnetic spectrum.

"The EMS is the continuum of all EM waves arranged according to frequency and wavelength". At one end of spectrum are the waves with lowest frequencies. At the other end are highest frequency waves. The spectrum is broken into regions that define each of the different wave types.




Radio waves are the type of electromagnetic radiation with wavelength in the electromagnetic spectrum longer than infrared light. Naturally occurring radio waves are generated by radio transmitters and received by radio receivers. These waves used for fixed and mobile radio communication, broadcasting radar and other navigation systems, communication satellites, computer network.

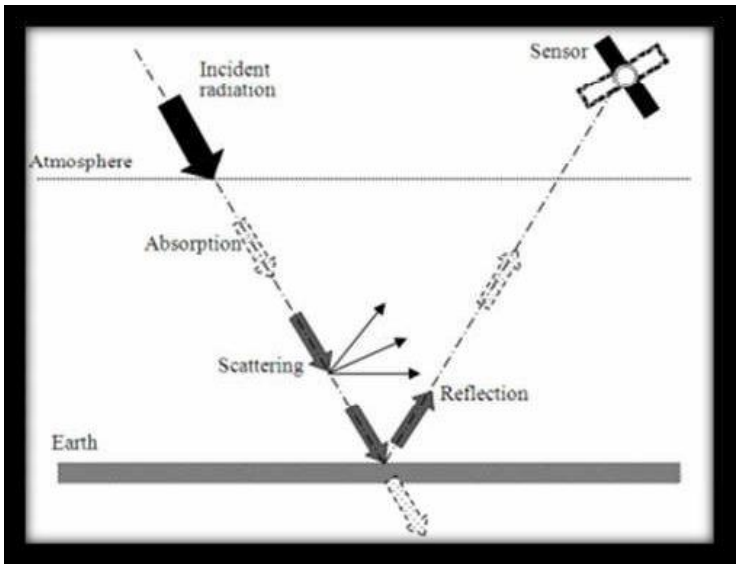
An electromagnetic wave with wavelength in the range 0.00- 0.3m, shorter than that of a normal radio wave but longer than those of infrared radiation. Microwaves are used in radar, in communication and for cooking in microwave ovens and in various industrial processes.

Visible light is defined as the wavelengths that are visible to most human eyes these waves are seen as the colour of rainbow. Each colour has different wavelength. Red has longest while violet has the shortest wavelength .is the natural source for the visible light waves and our eyes see the reflection of this sunlight of the objects around us.

Ultra violet radiations shorter than that of visible light but longer than x rays. X-rays wavelengths are shorter than those of gamma rays. The gamma rays have the high frequency high energy and are shorter wavelengths rays.

The radiation from the energy source passes through some distance before being detected by the remote sensors. The interaction of EMR with atmospheric particles may be a surface phenomenon (scattering) or volume phenomenon. (absorption)Scattering and absorption are main process that alters the properties of the EMR in atmosphere.

**EMR Interaction with Atmosphere and Earth Surface**




**Atmospheric scattering** is the process by which small particles in the atmosphere diffuse a portion of the incident radiation in all direction. There is no transformation while scattering. But the spatial distribution of the energy is altered during scattering. There are three different types of scattering as follows:

**Absorption** is the process in which incident energy is retained by particles in the atmosphere at a given wavelength. Unlike scattering, atmospheric absorption causes an effective loss of energy to atmospheric constituents. The absorbing medium will not only absorb a portion of the total energy, but will also reflect, refract or scatter the energy. The absorbed energy may also be transmitted back to the atmosphere. The most efficient absorbers of solar radiation are water vapour, carbon dioxide, and  zone. Gaseous components of the atmosphere are selective absorbers of the electromagnetic radiation, i.e., these gases absorb electromagnetic energy in specific wavelength bands.

**Resolution: spatial, temporal, spectral and radiometric**

Resolution refers to the capability of distinguishing between two separate but adjacent objects or sources of light or between two nearly equal wavelengths. Resolution is a measure used to describe the sharpness and clarity of an image or picture.

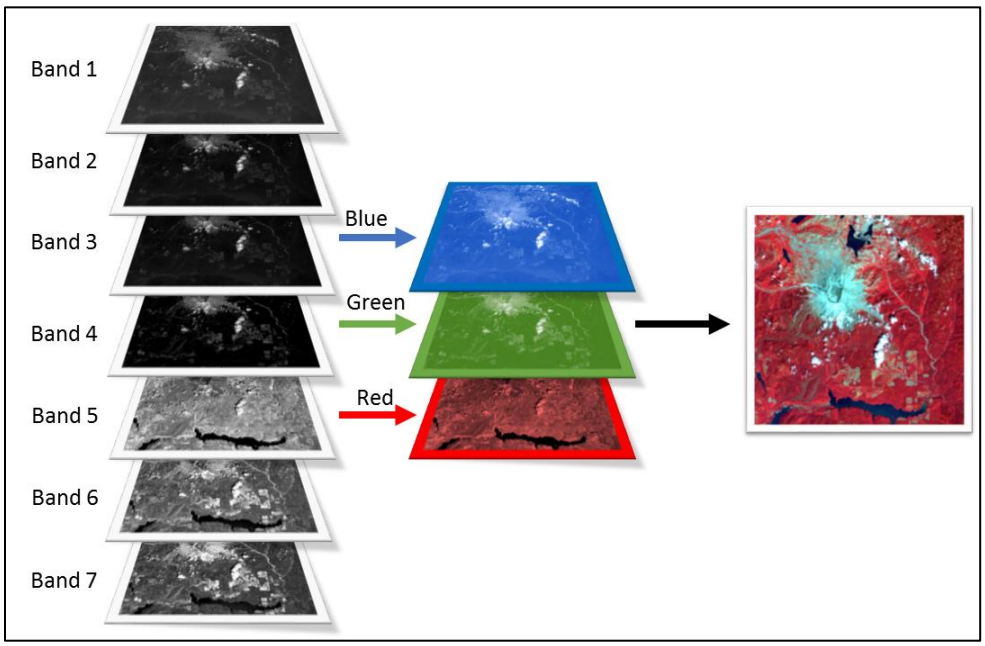
**There are 4 types of resolution as follows:**

**Spatial Resolution :** A digital image consists of an array/ display of pixels. Each pixel contains information about a small area on the land surface, which is considered as a single object. Spatial resolution is a measure of the area or size of the smallest dimension on the Earth's surface over which an independent measurement can be made by the sensor. It is expressed by the size of the pixel on the ground in meters. Based on the spatial resolution, satellite systems can be classified as low-resolution systems, medium

resolution systems, high resolution systems and very high-resolution systems.


**Temporal Resolution:** Temporal resolution is defined as the amount of time needed to revisit and acquire data for the exact same location. When applied to remote sensing, this amount of time depends on the orbital characteristics of the sensor platform as well as sensor characteristics. The temporal resolution is high when the revisiting delay is low and vice-versa. Temporal resolution is usually expressed in days.

**Spectral Resolution:** Spectral resolution represents the spectral band width of the filter and the sensitiveness of the detector. The spectral resolution may be defined as the ability of a sensor to define fine wavelength intervals or the ability of a sensor to resolve the energy received in a spectral bandwidth to characterize different constituents of earth surface. The finer the spectral resolution, the narrower the wavelengths range for a particular channel or band. Many remote sensing systems are multi-spectral, that record energy over separate wavelength ranges at various spectral resolutions. In remote sensing, different features are identified from the image by comparing their responses over different distinct spectral bands. Broad classes, such as water and vegetation, can be easily separated using very broad wavelength ranges like visible and near-infrared. However, for more specific classes' viz., vegetation type, rock classification etc., much finer wavelength ranges and hence finer spectral resolution are required.

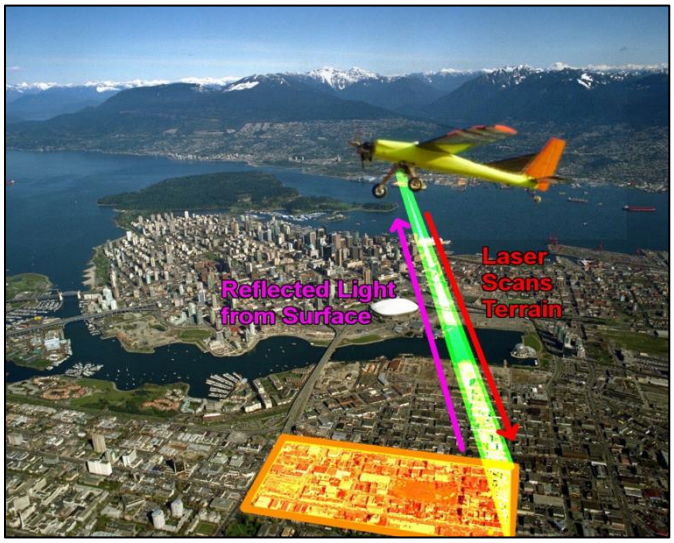



**Radiometric Resolution:** While the arrangement of pixels describes the spatial structure of an image, the radiometric characteristics describe the actual information content in an image. Every time an image is acquired on film or by a sensor, its sensitivity to the magnitude of the electromagnetic energy determines the radiometric resolution**.** The radiometric resolution of an imaging system describes its ability to discriminate very slight differences in energy. The finer the radiometric resolution of a sensor the more sensitive it is to detecting small differences in reflected or emitted energy.

### Types of Aerial Photographs and Satellite Images

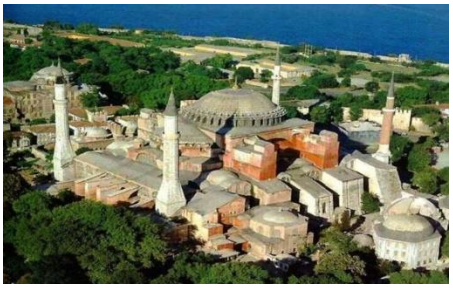
As far as aerial photographs are concerned there are three types of photos i.e. High oblique, low oblique and vertical. High and low oblique photographs depend on the angle at which the photograph is taken. In high oblique photograph more area is covered while in low oblique photograph less area is covered with more details.

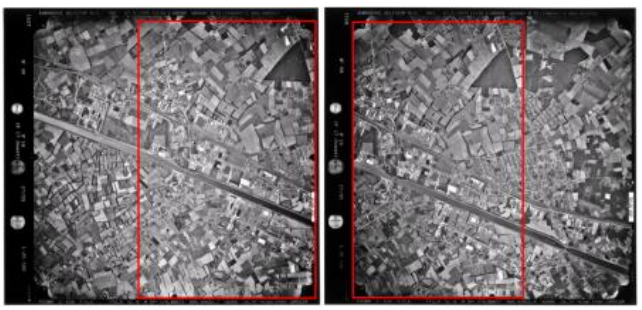
In case of vertical photographs (which we called as stereo pairs) the path and row is important. The aircraft take pictures in succession on specific path. In stereo pairs at least 50% of overlap is necessary to get stereo effect.




Similarly there are different types of satellite images which are used for different purposes. Just like the topographical maps which are at different scales i.e. 1:250,000, 1:50,000 or 1:25,000, the scale of the satellite imagery is determined by the camera used in the satellite and its resolution

**Few examples of aerial photographs**

| **Low oblique** | **High oblique** |
|---|---|
|  |  |

| **Vertical** | **Stereo pair** |
|---|---|
|  |  |

**Calculation of scale of the aerial photograph:**

Formula to calculate the scale of aerial photographs

1. $S_p = f / (H-h)$

Where f = focal length, H = Flying height, h – height of the object

In this example f = 152 mm, H = 2780 m, h = 500 m

(first convert f into meters = 0.152 m)

= 0.152m /2780 – 500 m

Therefore 1 / X = 0.152 m / 2280 m

X = 2280 / 0.152

X = 15,000

Scale 1:15,000

**Calculation of distance aerial photograph:** Once we calculate the scale, it would be easy to calculate distance and area of the object on the photograph. Measure the distance between the two objects and multiply by the scale factor.

e.g. The scale of the photograph is 1:20,000

length of the bridge = .635 mm or .25 inches

= 1 / 15,000 = 0..25 / X

X = 0.25 x 15,000 = 3750 inch

Length of the bridge - 3750 / 12 = 312.5 feet

**Calculation of area of the aerial photograph:** For area calculation it is measured in square units where length and width is taken into consideration. For example if an area is 100 x 500 meters then the area would be 50,000 meters. Suppose you would like to convert these numbers to square feet then you must multiply them by 10.76 (i.e. 3.28 x 3.28) and not just by 3.28 (ratio of feet per meter. In majority of the cases this is a very common mistake.

Example – Scale of the air photo – 1:15,000

Length of a field – 10 mm

Width of the field – 7 mm

Calculate the area in hectares
(10000 square meters = 1 Hectare)

Length = 10 mm x 15,000 = 1,50,000 mm

Convert them into meter: 1,50,000 / 100 = 1,500 m

Width = 7 mm x 15,000 = 1,05,000 mm

Convert them into meter: 1,05,000 / 100 = 1,050 m

Area = 1,500 m x 1,050 m = 15,75,000 sq. m

15,75,000 / 10,000 = 157.5 hectares

**Determination of height of the object:** There are different methods to calculate the height of the object such as church method, shadow method, radial displacement method, parallax measurement and stereo plotters. Shadow method and radial displacement method are commonly used.

**Radial displacement**

The magnitude of the displacement in the image between the top and the bottom of an object is known as its relief displacement and is related to the height of the object and the distance of the object from the principal point. This method can only be used if the object that is being measured is be far enough from the principal point to measure the displacement and the top and bottom of the object are visible in the photo.

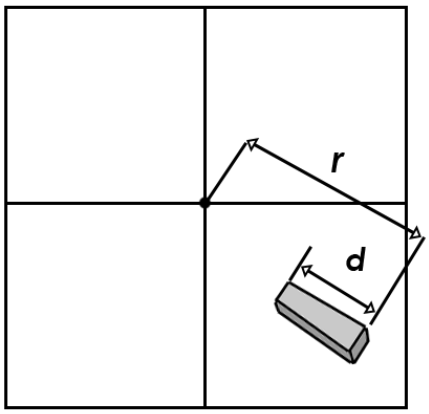
$$h^o = \frac{dH'}{r}$$

$h^o$ = height of the object

d = length of displaced object on the photo

r = radial distance from principal point to displaced image point

H' = flying height above the surface (flying height above sea level – average elevation)




**Source:** https://www.nrsc.gov.in

Example: Length of the displaced building = 2.0 mm,

The radial distance to the principal point = 56 mm.

Flying height above the surface = 1200 m

Height of the building – $h^0$ = dH' / r

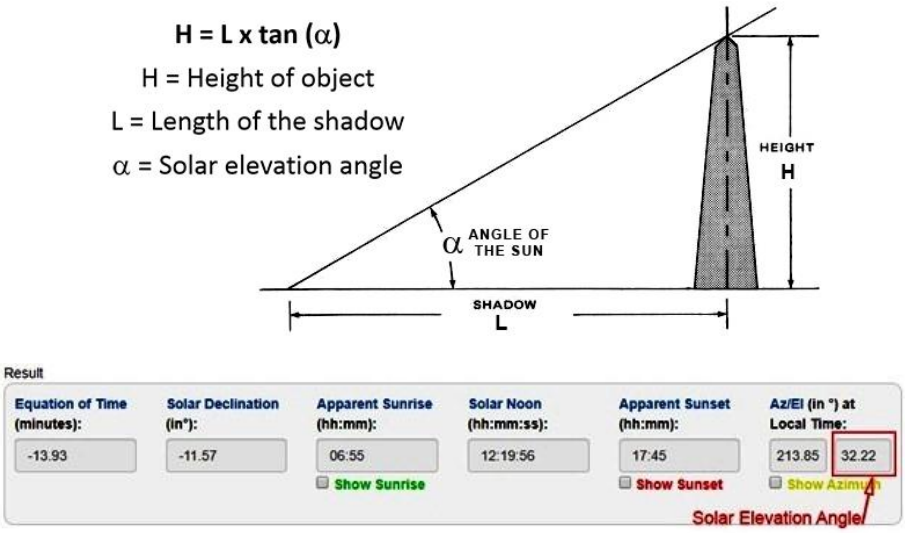
= 2.0 mm x 1200 m / 56 mm

= 2400 / 56

= 42.857 or 42.86 m

**Shadow method:** If one can measure the length of the shadow and if the angle of the sun is known then a simple trigonometry calculation will give you height of the object.

If you can measure the length of a shadow and know the angle of the sun, the height of the object can be calculated using simple trigonometry. However information about where and when the air photograph is taken is necessary to know the solar elevation angle. Once you know the location then the angle can be obtain by using NOAA solar calculator.



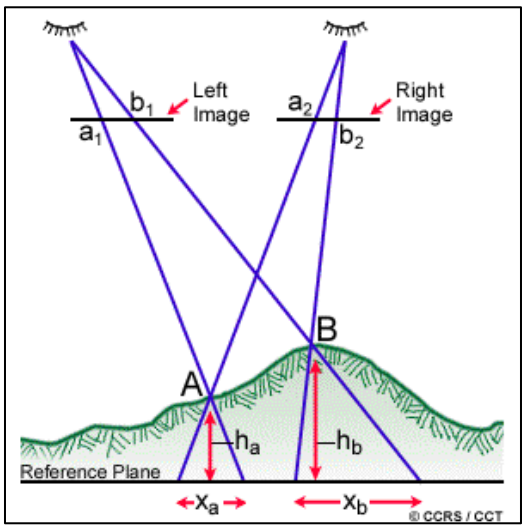

**Source:** https://www.nrsc.gov.in

The two methods which we discussed, it is possible to calculate the height of the object on a single air photograph. In many cases the base of the object is may not be visible or the displacement is too small to measure, then use of stereo pair of photograph becomes inevitable.

## Parallax Measurement

In stereo pairs principle point (PP) (centre of the first photograph) also can be identified in the next adjacent photograph which is called as conjugate principle point (CPP). Similarly an object can be identified in both the photographs. However there will be apparent displacement in the position of an object due to change in the camera position. The parallax is the straight line distance that can be measured on a stereo pair which is parallel to the line of flight. Stereoscope (with parallax bar) is the instrument which is used for this calculation.

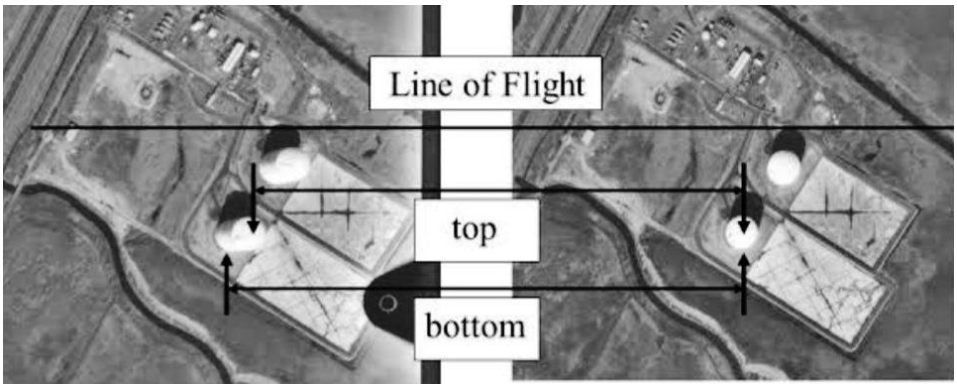
### Stereoscopic parallax




**Graphic from http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/stereosc/chap4/**

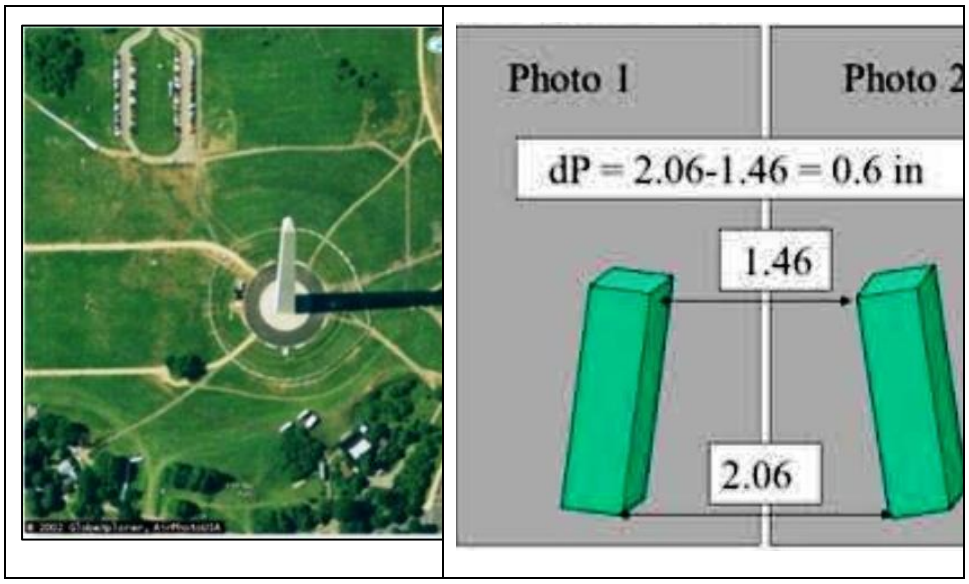
The displacement of an object caused by a change in the point of observation is called parallax.

Stereoscopic parallax is caused by taking photographs of the same object but from different points of observation. There is a displacement between the top and the base of the object in stereo pairs.




**Calculating Object Heights using Stereoscopic parallax**

Height calculation of Washington Monument via stereo parallax




**Computing height using stereoscopic parallax**

•h = (H') * dP / (P + dP)

where h = object height

H' = flying height

dP = differential parallax

P = average photo base length

**Solved example:**

h = (H') * dP / (P + dP)

where h = object height

H' = flying height = 4,600ft

dP = differential parallax = 0.6in

P = average photo base length = 4.4in

•h = (4,600ft * 0.6in) / (4.4in + 0.6in) = 2760 ft in / 5 in = 552 ft

•True height = 555.5 ft

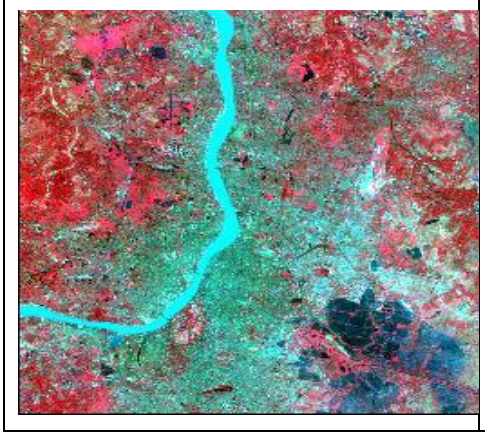
Ref: T.E. Avery & G.L. Berlin.(1992), Fundamentals of Remote Sensing and Air Photo Interpretation, MacMillan

**Stereo plotters:** With the introduction of new technology and massive up gradation in the computer systems analogical plotters are being replaced by analytical plotters. These are very costly and cannot be afford by an individual. Now more sophisticated photogrammetry instruments are also available. These instruments will replace the stereo plotters.

**Few examples of Satellite Images**

**Landsat**

**LISS III**



**Panchromatic**

Similar to topomaps and air photos the satellite images are captured using different cameras. The coverage and details will depend on the camera. Resolution is the deciding factor. It is the pixel value which determines the type of information. Depending upon the type of image, the details of the landscape vary from one image to other. There are two types of images, TCC (True colour composite) and FCC (False colour composite). In FCC red colour is used for vegetation, blue to blackish blue for water bodies, grey for settlements and transport network. The following are the few examples of satellite images and their respective resolution.

Landsat – 30 meters (1 pixel unit covers 30 x 30 meters area)

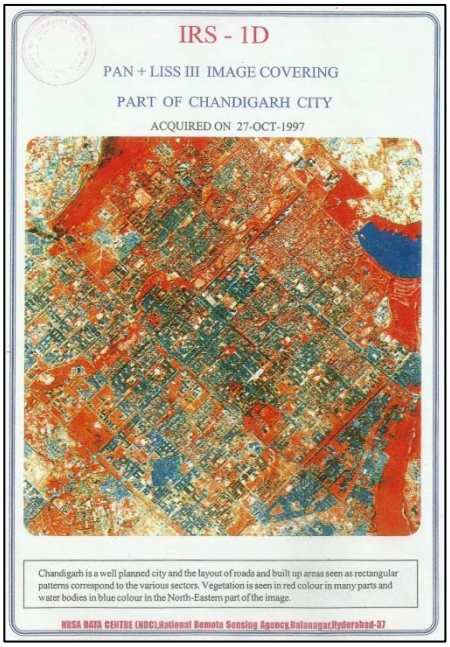
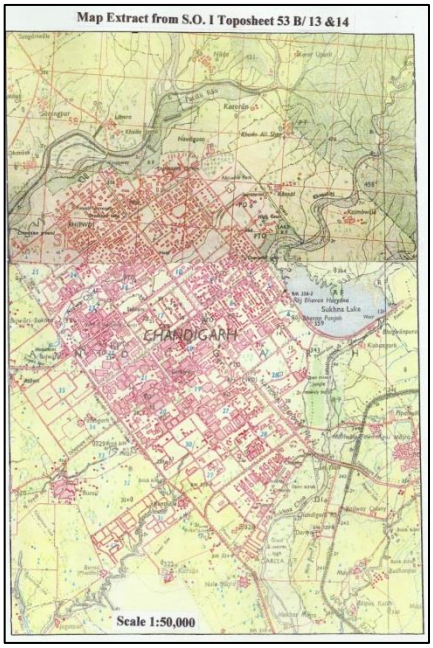
LISS – 24 meters (1 pixel unit covers 24 x 24 meters area)

Panchromatic – 1 meter (1 pixel unit covers 1 meter area)

It is interesting to know that the area which is covered by 1 pixel of Landsat will be covered by 30 pixel of panchromatic image.

Change detection – as discussed earlier topographical map provides data base for carrying out change detection studies. Air photos or satellite image is superimposed digitally on the topographical area and with the help of relevant software.

**Calculation of the scale of the satellite imagery with reference to toposheet**

| IRS Image of Chandigarh | Top sheet of Chandigarh |
|---|---|
|  |  |





Locate 2 identical points on the map and measure their distance

Similarly locate same points on the photo / image and measure their distance

Note down the map scale

Using the formula calculate photo / imagery scale

Map Scale x Map Distance = Photo Scale x Photo Distance

Map Scale 1:50,000, Map Distance = 2 cm, Photo Distance = 4 cm

Photo Scale = Photo distance / Map scale x Map Distance

= 4 / 1/50,000 x 2

= 4 / 1,00,000

= 1/ 25,000

= 1:25,000

**Application of remote sensing in geography**

**Forest cover mapping:** Based on the sensing data forest cover mapping to monitor forest cover changes is been carried on. In India, this is done by forest survey of India.

**Crop Average and Production Examination:** Satellite Remote sensing based, estimation of Crop Average and Production forecast for major crop is carried on. This is very important for department of agriculture.

**Flood mapping:** It is used in satellite data; mapping of the flooded areas and estimation of damage is being carried out.

**Mineral Exploration:** Remote sensing is widely used to explore the area of minerals.

**Hazard assessment:** For identifying different types of hazards and hazard zones, Remote sensing is greatly used.

**Ocean Resources:** Coastal zones maps are prepared with the help of Remote sensing.

**Marine Resources:** Fishery potential charts are being generated using satellite data.

**Water Quality Monitoring:** Water pollution has become a very serious problem in the industrial zones. Water Quality monitoring is one of the typical application of remote sensing.

**Measurement of sea surface temperature:** Satellite Remote sensing can provide thermal information as well.

**Snow Survey:** Aerial distribution of snow can be identified very easily from satellite remote sensing data.

**Soil mapping:** Mapping of Saline and Alkaline soils is very easily carried out using remote sensing.

**Environnemental Impact Assessment (EIA):** Satellite Remote sensing data has been used to access the impact of different activities like Mining, Agriculture, and Industries on the environment.

**Urban Studies:** Many new applications in urban studies have been carried out with the help of available satellite data.

**Monitoring oil spills:** The location of political spills events can be identified and monitored by remote sensing.

**Bathymetric Surveying:** At present remote sensing is also used for depth measurements and also to make bottom depth chart.

**Land cover and land use map:** Satellite data long with field survey data can be combined to create land cover and land use map in detail.

**Monitoring Atmospheric Emissions:** Software has been developed so that satellite dates can be used to estimate natural and polluting emissions.

## 2.5 INTERPRETATION THE GEOMORPHIC SETUPS IN THE FIELD ON MAPS AND SATELLITE IMAGES

### Characteristics of Air Photos

1. It gives bird's eye view of a larger area
2. It is a permanent record at the time when the photograph is taken, historical backup
3. It gives three dimensional perspective
4. As they are sensitive to radiation in wavelength, they can capture images which cannot be observed by human eye.
5. They are readily available at different scales such as low oblique, high oblique or stereo pairs
6. More economical than that of field survey

### Characteristics of satellite images

1. It has spatial, spectral, temporal and radiometric resolution
2. Different bands can be combined depending on the query
3. Less possibility of distortion
4. Different types such as panchromatic, LISS III, Landsat, infrared images are available
5. The process is continuous and hence repetitive images can be acquire for particular place over a period of time.
6. Very useful for temporal analysis
7. Just like toposheet marginal information gives details of date, time, satellite and azimuth etc

**Characteristics of the topographical map**

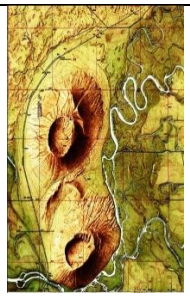
1. Accurate surveying by sophisticated means
2. Represents relief (contours, bench marks, datus), water bodies, transport and landuse
3. Available with different scales
4. Use of conventional signs and symbols
5. Use of coordinate system
6. Act as a very authentic and important base for spatio-temporal analysis

In view of the different characteristics of photos, images and toposheets, spatio-temporal studies (change detection) are carried out by researcher to identify the changes in the landscapes over a period of time. Photogrammetry techniques are used in such processes. Some of the examples of such studies are

1. Expansion of urban areas
2. Depletion of forest cover
3. Changes in the landuse-landcover characteristics
4. Impact of natural calamities on the surroundings such as volcanoes, floods
5. Changes in the high altitude glaciers due to global warming
6. Geomorphological changes e.g changes in course of river

Topographical maps, air photos and satellite images are important sources of geographical information. Sometimes it becomes necessary to use any two of these resources in combination to understand the morphology of the landscape.

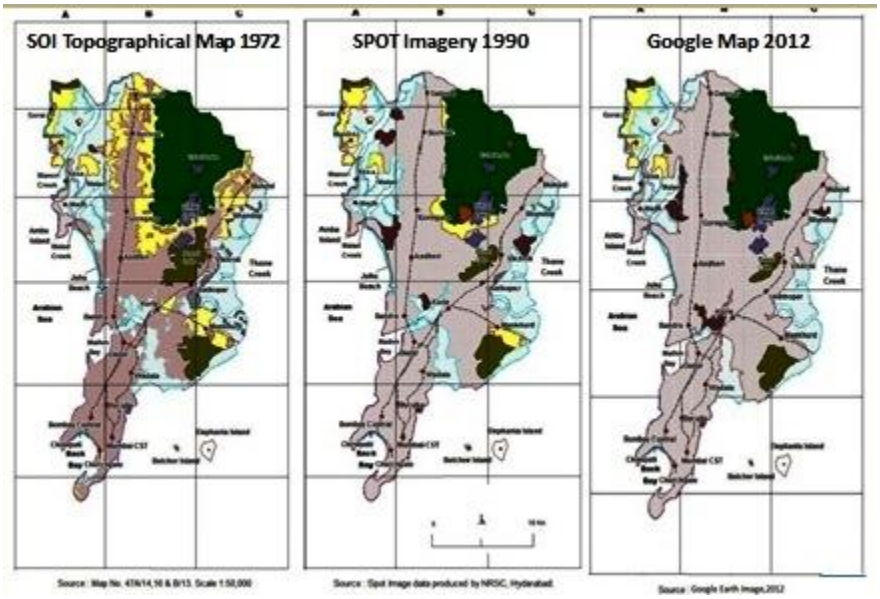
Menan Butts are the two volcanic hills in U.S.A with huge craters. To understand the salient characteristics of this geomorphic feature it would be appropriate to study the topographical map, satellite image and the actual photograph taken by researcher.

| Topographical map | Satellite image | Actual photograph |
|---|---|---|
|  |  |  |

Similarly it would be very much difficult to identify the mushroom rock on the topographical map,(Mushroom Rock Sate Park, Smoky Hills, Kansas, USA) but a digital photograph of the same will give the exact idea about the erosional work of wind. (Source: Kansas Tourism)

A study of Mumbai city was carried out to access the change in the land use / land cover from 1972 to 2012 using topographical map, Google map and Spot image.

Spatiality of Landuse Ladcover Transition- A Case study of Mumbai




**Dynamic Ecology**

| Sr. No. | Land Use | Top sheet to Spot* | Spot to Google* | Top sheet to Google* |
|---|---|---|---|---|
| 1 | Built up | 105.69 | 68.66 | 174.35 |
| 2 | Cultivation | -23.4 | -47.6 | -71.00 |
| 3 | Forest | -38.63 | -23 | -61.63 |
| 4 | Open jungle | -20.69 | -9.52 | -30.21 |
| 5 | Lake | 0 | 0 | 0 |

| Sr. No. | Land Use | Top sheet to Spot* | Spot to Google* | Top sheet to Google* |
|---|---|---|---|---|
| 6 | Mud flat | -20.01 | -47.1 | -67.11 |
| 7 | Beach | -0.63 | 0 | -0.63 |
| 8 | Salt pan | -10.29 | -5.21 | -15.5 |
| 9 | Reclamation | 10.1 | 20 | 30.1 |
| 10 | Human Encroachment | 6.7 | 12.2 | 18.9 |

- Area in square kilometers

## 2.6. SUMMARY

In short remote sensing is a technique available to mankind for variety of purposes. This technology is very useful in change detection and especially monitoring natural or manmade calamities. It is also useful in minimizing the impacts of cyclones, floods etc. it also helps in pinpointing significant changes in landuse such as deforestation. This technique is also useful in planning purpose.

## 2.7 CHECK YOUR PROGRESS OR EXERCISE

**A. True or False**

1. Satellite data can be acquired for 24 hours.
2. Size of the pixel determines quality of the image. .
3. Temporal comparison is not possible in case of satellite image.
4. Air photographs are produced only in pairs.
5. Topographical maps provides data base for change detection.

**B. Fill in the Blanks**

1. _____was the first satellite launched by India.
2. The surrounding which we see with our eyes is _____part of EMR.
3. _____ determines the stereo vision of air photograph.
4. FCC is called as _____
5. RGB in image production stands for _____

**C. Multiple Choice Questions**

1 Resolution of panchromatic image is _____ meter

a) 15 x 15 b) 8 x 8 c) 1 x 1

2 Shades of _____colour represents vegetation in FCC

a. Green b. Red c. Grey

3. Very clear and defined foreground is the characteristics of _____ photograph.

a. High oblique b. Stereo c. Low oblique

4. Clear background with large area coverage is the characteristics of _____ photograph

a. High oblique b. Stereo c. Low oblique

5. 3 D visualization is possible only in _____ landscape

a. High oblique b. Stereo c. Low oblique

**D. Answer the following Questions**

1. Discuss the concept of EMR and its role in remote sensing. .
2. Explain the various types of satellite images.
3. Explain various types of air photographs.
4. Which are the different fields in which remote sensing techniques are used?

## 2.8 ANSWERS TO THE SELF-LEARNING QUESTIONS

A.1. True

A 2. True

A 3. False

A 4. False

A. 5. True

B. 1. Aryabhatt

B. 2 Visible

B. 3 Overlap

B. 4 False colour composite

B. 5 Red, Green, Blue

C.1. c

C.2. b

C.3. c

C.4. a

C.5. b

**D: Answers to the Self-learning questions**

1. Electro-magnetic radiation which is **reflected** or **emitted** from an object is the usual source of remote sensing data. A device to detect the electro-magnetic radiation reflected or emitted from an object is called a "**sensor**". Cameras are examples of remote sensors. A vehicle to carry the sensor is called a "**platform**". Aircraft or satellites are used as platforms. It is very significant in remote sensing as it provides base of generation of various type of data.

2. Different satellites are launched by different countries for variety of purposes. A variety of satellite images are available for scrutiny. The camera fixed on the satellite determines these types. Landsat, LISS III, Pancromatic are the few examples. The resolution, area coverage differs from one another. The pixel unit determines the quality of the satellite images.

3. There are three major types of air photos. Compared to the satellite image these photos are taken at a lower elevation. High oblique (with a clear foreground with less area coverage), Low oblique (with visible background with more area coverage) and stereo pair (small area with 3 D effect are used for various purposes.

4. Forest cover mapping, Flood mapping, Snow survey, Urban studies, land cover and land use mapping, Environmental impact assessment, Hazard assessment, Mineral explorations are some of the fields where remote sensing is used.

## 2.9. TECHNICAL WORDS AND THEIR MEANING

**EMR-** Electro Magnetic spectrum is the spectrum where electromagnetic radiation reflected by the object is captured. It ranges from radio waves to Gamma rays. Visible spectrum is a very narrow window which allows us to see the surrounding with your eyes.

**Resolution -** Resolution refers to the capability of distinguishing between two separate but adjacent objects or sources of light

## 2.10. TASK

Refer to various sites such as digital globe, quick bird, airbus, geospatial world, EOS and observe the satellite images and see how resolution changes. You can also write a short note on each of the type of images. .

## 2.11. REFERENCES FOR FURTHER STUDY

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# 3

# TECHNIQUES OF SOIL AND SEDIMENT ANALYSIS

**Unit Structure**



## 3.1 OBJECTIVES

In this unit we will study the characteristics of the different layers of soil profile. We will also know the various methods to assess different properties of the soil such as texture, pH, EC etc. We will also study the significance of each of these tests.

## 3.2 INTRODUCTION

Soil is considered as a natural material which covers the earth's surface. This is made up of solids, liquids and gases. You must have studied the rock cycle in earlier classes. It is the subdivision and fragmentation of the rocks in to particles of different size. Though the soil type is determined by many factors, parent rock is the most deciding factor for soil formation.

## 3.3 SUBJECT DISCUSSION

Hunting and food gathering were the main activities of human in the pre Neanderthal era followed by Homo sapiens. All early civilizations have settled near the source of water i.e. river. In due course of time they also learned to produce the crops in the areas of fertile soil. Soil plays a very

important role in everybody's life. Soil science is the study of soil as a natural resource, its characteristics and management

## 3.4 SOIL PROFILE, WEATHERING PROFILE AND SEDIMENTARY FANCIES

### Soil Profile

It is a process of determining the composition and properties of soil. It is very important process in understanding the condition of soil such as its health, fertility and suitability for various purposes. There are three ways by which soil analysis can be carried out

a. Physical analysis: it involves texture, structure, density and moisture content

b. Chemical analysis: it involves pH, nutrient levels, contaminants and organic matter.

c. Biological analysis: it involves microbial activity, soil biota and enzymatic activity

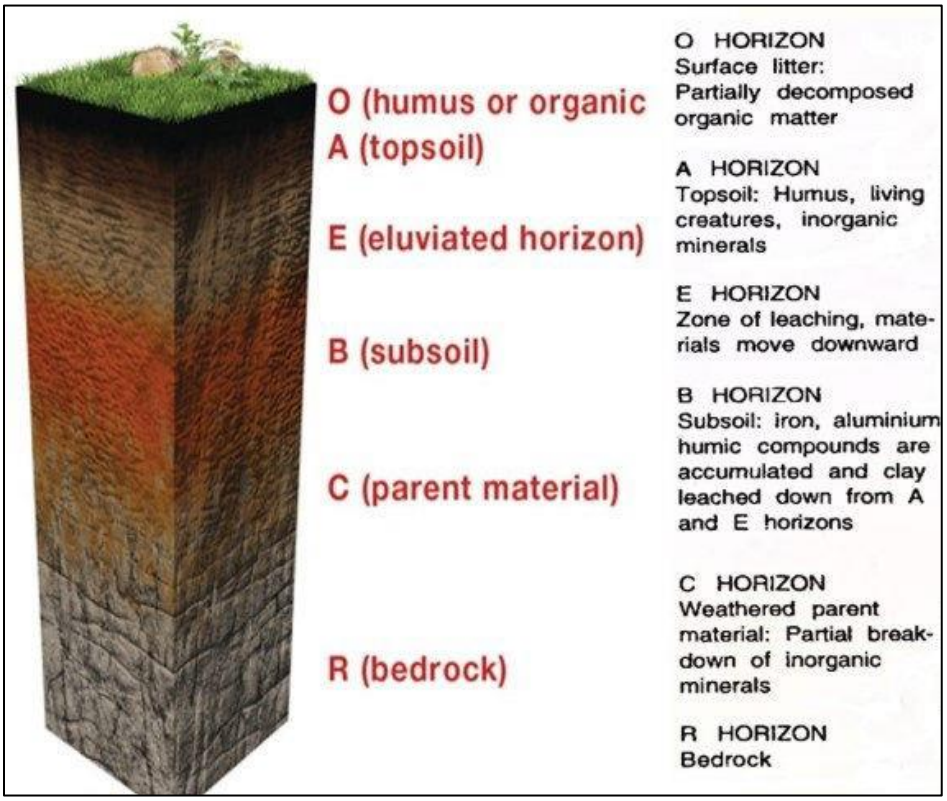
While constructing a house, well or tank we find a vertical cross section of soil. Various layers of soil are clearly visible. These layers may physically and chemically be different than other layers (such as texture, colour, depth and chemical composition). These differences are due to interaction of soil-farming factors as parent material, slope, native vegetation, weathering and climate. Generally a soil profile is studied to a depth of 3 to 5 feet. A soil horizon is a layer generally parallel to the soil surface, whose physical characteristics differ from the layers above and beneath. Horizons are defined in most cases by obvious physical features, chiefly colour and texture.

There are three primary soil horizons, called master horizons. They are A, B, and C. These are part of a system for naming soil horizons in which each layer is identified by a code: O, A, E, B, C, and R.

This layer is generally soft, porous and can retain more water. It is called the topsoil or the A-horizon.

The next layer has a lesser amount of humus but more of minerals. This layer is generally harder and more compact and is called the B-horizon or the middle layer.

The third layer is the C-horizon, which is made up of small lumps of rocks with cracks.




**O Horizon**

Layers dominated by organic material. Some O layers consist of un-decomposed or partially decomposed litter (such as leaves, needles, twigs, moss, and lichens).

They may be on top of either mineral or organic soils.

**A Horizon or Surface soil**

It is the part of top soil.

In this layer, organic matter is mixed with mineral matter.

It is the layer of mineral soil with the most organic matter accumulation and soil life.

This layer is depleted of (eluviated of) iron, clay, aluminum, organic compounds, and other soluble constituents.

When depletion is pronounced, a lighter colored “E” subsurface soil horizon is apparent at the base of the “A” horizon.

**E Horizon**

“E” stands for eluviated layer.

It is the horizon that has been significantly leached of clay, iron, and aluminum oxides, which leaves a concentration of resistant minerals, such as quartz, in the sand and silt sizes.

These are present only in older, well-developed soils, and generally occur between the A and B horizons.

**B Horizon or Subsoil**

It is subsurface layer reflecting chemical or physical alteration of parent material.

This layer accumulates all the leached minerals from A and E horizon.

Thus iron, clay, aluminum and organic compounds accumulate in this horizon [illuviation (opposite of eluviation)].

**C Horizon or Parent rock**

Weathered parent material accumulates in this layer, i.e. the parent material in sedimentary deposits.

It is a layer of large unbroken rocks.

This layer may accumulate the more soluble compounds (inorganic material).

**R Horizon or Bedrock**

This layer denotes the layer of partially weathered bedrock at the base of the soil profile.

Unlike the above layers, R horizons largely comprise continuous masses of hard rock.

Soils formed in situ will exhibit strong similarities to this bedrock layer.

These areas of bedrock are under 50 feet of the other profiles.

**Changes to the soil profile**

As a soil ages, horizontal layers develop and changes result. The causes of these changes are classified as four processes. Each process occurs differently at various depths in the soil.

Addition—this process occurs as materials such as fallen leaves, windblown dust, or chemicals from air pollution are added to the soil.

Loss—this process occurs when materials are lost from the soil because of deep leaching or erosion from the surface.

Translocation—this process involves the movement of materials within the soil. It can occur with deeper leaching into the soil or with upward movement caused by evaporating water.

Transformation— in this process, materials is altered in the soil. Examples are organic-matter decay, weathering of minerals to smaller particles, and chemical reactions.

## 3.5 TEXTURAL ANALYSIS

Sieve analysis laboratory procedure; PHI, Millimeter and Microns Scale – Grade; Methods of graphic representation of data – Histogram, Frequency curve, cumulative arithmetic and probability curve; Measures; formulae for statistical parameters of grain size and interpretation.

**Definition of soil texture:**

It indicates relative content of particles of various sizes, such as sand, silt and clay in the soil. The texture of the soil influences the amount of water and air it can hold and the rate at which water can enter and move in the soil.

Sand, silt and clay are the three major components of the soil. Depending on the varying percentage of these components, type of soil can be determined. If a researcher would like to determine soil texture more accurately, it is advisable to collect distributed soil samples from the study area. This method is also called as mechanical soil analysis. The following table gives particulars of the grain size.

| **Type** | **Diameter in mm** |
|---|---|
| Clay | Less than 0.002 mm |
| Silt | 0.002 – 0.05 mm |
| Sand | 0.05 – 2 mm |

Interestingly FAO (United Nation's Food and Agricultural Organization) has derived quick tests which are simple and can be directly carried out in the field such as i) throw ball test, ii) squeeze ball test, iii) bottle test, iv) mud ball test, v) ball shaking test, vi) dry crushing test, vii) manipulative test, viii) shaking test etc. However these tests will give general idea about the dominant component of the soil (sand, silt or clay). If you would like to define the textural class of the soil more accurately qualitative determination of particular size should be carried out in the laboratory. This procedure is also called as mechanical soil analysis.

**Procedure**

1. Your soil sample should be dried
2. Particles which are more than 2 mm size such as gravels and stones should be removed
3. The weight of the remaining sample (also called as 'fine earth') should be accurately measured.
4. This sample will pass through series of sieves with mesh of different sizes (down to about 0.1 mm)
5. Weight of the content of the each sieve will be accurately measured

6. Determine the percentage of each of them (soil sample of each sieve / total soil sample x 100

7. Plot them on the triangular graph and interpret the results

E.g. 1) Weight of sieved soil sample = 20 grams

2) Weight of total soil sample = 80 grams

= 20 / 80 x 100

= 25%

The percentage of soil sample is 25%.

As mentioned earlier that the soil type is classified into three major categories depending on percentage of sand, silt and clay. United Nation's Food and Agricultural organization has derived a detailed classification of soil depending on varying percentage of these three components.

| **Common names of soils (General texture)** | **Sand** | **Silt** | **Clay** | **Textural class** |
|---|---|---|---|---|
| Sandy soils (Coarse texture) | 86-100 | 0-14 | 0-10 | Sand |
| | 70-86 | 0-30 | 0-15 | Loamy sand |
| Loamy soils (Moderately coarse texture) | 50-70 | 0-50 | 0-20 | Sandy loam |
| Loamy soils (Medium texture) | 23-52 | 28-50 | 7-27 | Loam |
| | 20-50 | 74-88 | 0-27 | Silty loam |
| | 0-20 | 88-100 | 0-12 | Silt |
| Loamy soils (Moderately fine texture) | 20-45 | 15-52 | 27-40 | Clay loam |
| | 45-80 | 0-28 | 20-35 | Sandy clay loam |
| | 0-20 | 40-73 | 27-40 | Silty clay loam |
| Clayey soils (Fine texture) | 45-65 | 0-20 | 35-55 | Sandy clay |
| | 0-20 | 40-60 | 40-60 | Silty clay |
| | 0-45 | 0-40 | 40-100 | Clay |

**Source:** https://fao.org

The best topsoil for growing plants is Loamy soil is a mixture of sand, clay and another type of soil particle known as silt. Silt occurs as a deposit in river beds. The size of the silt particles is between those of sand and clay. The loamy soil also has humus in it. It has the right water holding capacity for the growth of plants.

Clayey and loamy soils are both suitable for growing cereals like wheat, and gram. Such soils are good at retaining water.

For paddy, soils rich in clay and organic matter and having a good capacity to retain water are ideal.

For lentils (masoor) and other pulses, loamy soils, which drain water easily, are required.

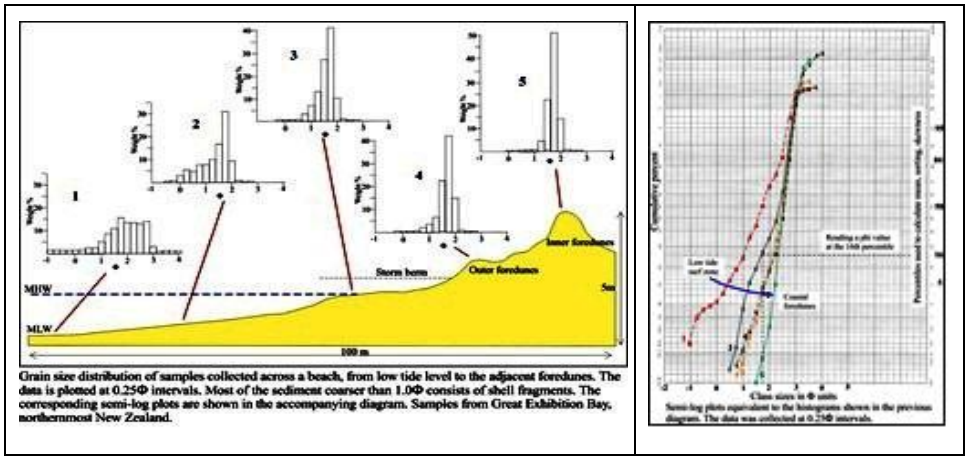
For cotton, sandy loam or loam, which drain water easily and can hold plenty of air, are more suitable.

**Representation of soil grains:**

Graphical representation of these results can be done with the help of simple statistical techniques such as histogram, frequency curve, cumulative and arithmetic as well as probability curves. Changes in the size of grains in high tide and low tide, amount of deposition of coarse sand in surf zone.

Cumulative weight percentage (on log scale) against phi value of individual sieve (on leniar scale) can also be plotted.

Median and mode are useful descriptors of sediments. Mean values represent the most common sizes classes in a sample and may give an indication of the prevalent current strength. On the other hand Skewness describes the symmetry of grain size distributions, or more commonly the departure from symmetry.




Grain size distribution of samples collected across a beach, from low tide level to the adjacent foredunes. The data is plotted at 0.25Φ intervals. Most of the sediment coarser than 1.0Φ consists of shell fragments. The corresponding semi-log plots are shown in the accompanying diagram. Samples from Great Exhibition Bay, northernmost New Zealand.

**Source:** https://www.geological-digressions.com/

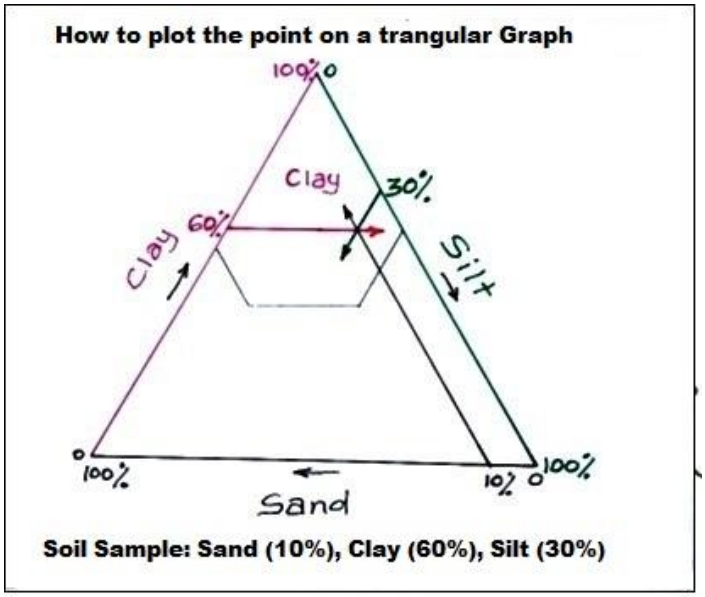
## 3.6 THE SOIL TEXTURE TRIANGLE

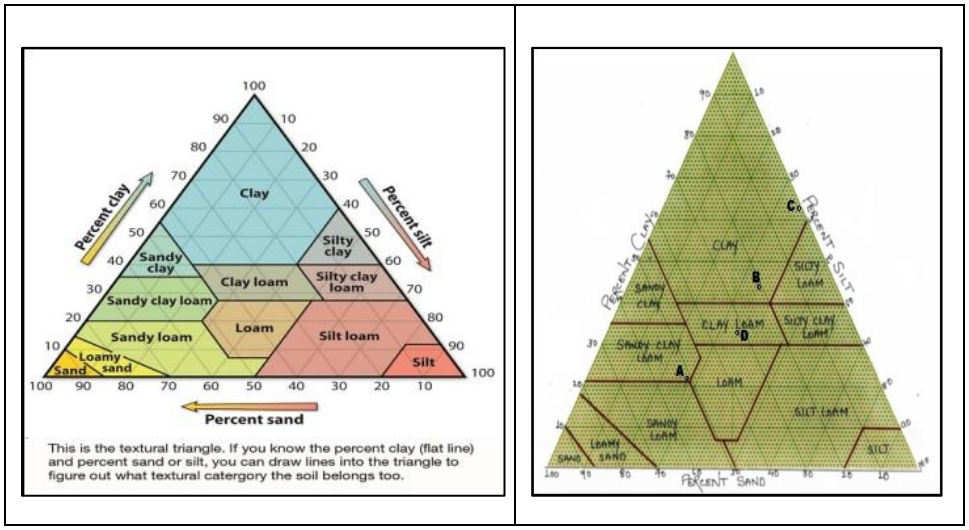
**Drawing sand, silt and clay on triangular graph, identification of soil type and interpretation.**

Plotting of soil sample on Triangular Graph Paper

Determine the soil texture of the following samples

| Sample | Sand | Silt | Clay | Texture class (after plotting on triangular graph) |
|---|---|---|---|---|
| A | 53.5 | 24.7 | 21.8 | Sandy Clay Loam |
| B | 21.8 | 33.4 | 44.8 | Clay |
| C | 0.12 | 27.28 | 62.6 | Silty Clay |
| D | 33.3 | 33.3 | 33.4 | Clay Loam |




## 3.7 CHEMICAL ANALYSIS – PH, EC, ORGANIC CARBON, COLOUR AND PERCENTAGE OF SOIL MOISTURE DETERMINATION

### i) Determination of pH

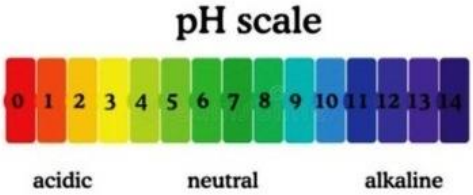
pH is the potential of hydrogen in the soil. The number describes the existence of acidity or alkalinity present in the soil. Plants/ crops have different types of requirements with respect to acidity or alkalinity of the soil. Some type of plants prefer alkaline types of soil, some plants like their soil neutral, others prefer acid soil.

There are different methods of determining pH; i) strip method, ii) colorimetric method, iii) Laboratory pH meter method and iv) pocket pH meter The reading of the pH will determine the nature of soil. The range varies from 1 to 14. The following table will give pH number and type of solution.

| pH Number | Type of solution |
|---|---|
| 1 to 6 | Acids |
| 7 | Neutral |
| 8 to 14 | Alkali |

**i) Strip Method**

1. Take a soil sample in 50 mL bicker and using distilled water make a soil solution (1:2, 10 gram soil sample + 20 mL distilled water)
2. Steir it well and keep it for some time
3. Dip the pH testing paper in the solution and wait for few minutes. See the colour on the strip and identify the pH value by comparing it with pH scale.



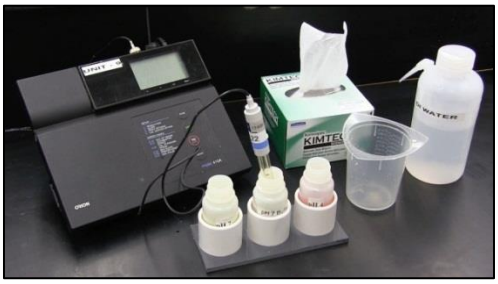

Though this method is very quick but it has its own limitations.

1. There is a chance of marginal error upto 0.5 to 1 pH
2. The strip is single use
3. The strip can be affected by the surrounding light
4. There can be a difference of opinion about the colour of the strip from person to person (in case of a very narrow margin of difference)

**ii) Colorimetric method**

Similar to the strip method, in colorimetric method we take soil sample in a test tube and add drops of CPR solution. By gently swirling the test tube for some few minutes, allow the sample to mix with the solution. Keep the test tube on standby mode for 5 minutes. Readymade colour charts are available, compare the colour with the readymade chart and note the pH value.

**iii) Laboratory pH meter** (calibration of the machine with standard tablets of pH is necessary before the actual procedure).



**Procedure:**

1. Put on the pH meter
2. Take a soil sample in 50 mL beaker and using distilled water make a soil solution (1:2, 10 gram soil sample + 20 mL distilled water)
3. Stir it well with the glass rod and keep it for some time
4. Wash the electrodes of pH meter with distilled water and clean with tissue paper
5. Calibrate the pH meter- there are readymade solutions or tablets available of different pH values such as 4, 7 or 9.2. Turn the meter on pH mode from standby mode. Dip the electrode in to 4 pH solution. With calibration button adjust the reading to 4.00. Take out the electrode and wash with distilled water and gently clean with tissue paper. Follow the same procedure for 9.2 pH solution and again wash the electrodes. Calibration of pH machine is very important for determination of pH.
6. Now take soil solution and dip the electrodes into it. The meter will display the reading which you can note it down. The advantage of pH meter is you can carry out this exercise for number of soil solutions.

In this process it is necessary to wash the electrodes with distilled water before we take the reading of new sample in the field.

Now readymade tool kit bags are also available which can be carried out in the field.

**iv) Pocket pH meter**

The pocket pH instrument is very handy and can be taken in the field. The procedure for pocket pH meter is more or less same like laboratory pH meter.


1. Open the cap of pH meter and rinse the bottom part of the pH meter with distilled water, wipe the same with tissue paper. Never wipe the glass electrodes with the tissue. Similarly rinse and wipe the black cap also

2, Take a solution of 4.01 in the cap and dip the bottom part of the pH meter. There will be some reading on the display. Screw driver is provided with the meter. Adjust the reading by turning the screw driver in the knobs on the right side of the instrument. Turn the screw driver clockwise for increasing reading and anticlockwise or decreasing reading.

3. Carry out similar exercise for 7.01 solutions and rinse the instrument with distilled water.

4. For every calibration do not forget to clean the black cap also. Now your pocket pH meter is calibrated.

5. Pour soil solution into black cap and insert the pocket pH meter. Take the reading (at least for two / three times) and complete the procedure.

pH values are significant in various fields such as food and beverage, pharmaceutical, oil & gas, agriculture and water treatment plant.

**ii) Determination of EC**

Soil electrical conductivity (EC) is a measurement of how well soil conducts electricity, and is an important parameter in soil science and agriculture. It's used to determine the amount of soluble salts in soil, and can also be used to estimate other soil properties like texture and moisture.

The electrical conductivity indicates the amount of soluble (salt) ions in soil. The determination of electrical conductivity (EC) is made with a conductivity cell by measuring the electrical resistance of a 1:5 soil: water suspension.

Different plants have different suitable soil EC values according to the characteristics of fertilizer requirements and different growth stages. The optimal EC value for plant growth is usually between 0.8 – 1.8 and should not exceed 2.5

Soil EC is affected by planting, irrigation, land use, fertilizer, manure, and compound fertilizer application. Intrinsic factors that affect EC include unalterable soil minerals, climate, and soil texture.

In current agricultural production, excessive fertilization is a common concern. Soil salinity seriously affects the normal growth of crops, so we must pay attention to the index of soil EC value. Measuring the EC value can facilitate the farmers to carry out scientific and reasonable regulation of water and fertilizer, which is conducive to the healthy growth of crops and achieves increased production and income.

**How to measure EC in soil**

There are several common methods for testing soil EC value:

**Handheld EC meter**: A handheld EC meter is a simple and easy-to-use tool that measures the EC value of soil extract. The meter is equipped with a probe that is inserted into the soil extract, and the reading is displayed on a digital screen.

**Laboratory analysis**: Soil samples can be sent to a laboratory for analysis, where the EC value is measured using conductivity meter. This method provides accurate results, but it can be time-consuming and expensive.

**Soluble salt test strips**: Soluble salt test strips are paper strips that are dipped into a soil extract. The color of the strip changes based on the EC value of the soil extract, and the result can be compared to a color chart to determine the EC value.

**Electrical resistivity imaging (ERI)**: ERI is a geophysical method that uses electrodes to measure the electrical resistivity of soil. By measuring the resistivity, the EC value of the soil can be estimated.

Temperature affects the electrical conductivity of the soil hence in laboratory we carry out the exercise in the laboratory at room temperature.

The EC is expressed in deciSiemens per meter (dS/m)

**Instrument**

EC meter

Pocket EC meter

Reagent 0.01 N Potassium Chloride solutions (KCl) – 1.41 dS $m^{-1}$ is the cell constant value of the solution

**Procedure**

1. Put on the EC meter at least 20 minutes before the actual process
2. The reading on the EC meter should be 1.41
3. Preparation of soil sample – take 50 mL beaker, add 10 grams soil + 20 mL distilled water (ratio 1:2)
4. Stir or shake the sample (1 hr)
5. Allow standing for half an hour - we will get clear supernatant liquid
6. Dip the electrodes only in clear supernatant liquid
7. Take the EC reading – it will determine the salinity of the soil

Classes of salinity and EC (1dS/m = 1mmhos / cm (NRCS soil survey handbook)

| EC (dS/m) | Salinity Class |
|---|---|
| 0 – 2 | Non – saline |
| 2 – 4 | Very slightly saline |
| 4 – 8 | Slightly saline |
| 8 – 16 | Moderately saline |
| ≥ 16 | Strongly saline |

### iii) Determination of Organic carbon

Estimates of total organic carbon (TOC expressed as C) are used to assess the amount of organic matter in soils. Soil organic matter is a seat of nitrogen. It can predict set of nitrogen in the soil. Titration method developed by Walkley and Black 1934 is commonly used for the purpose. In this method organic matter is oxidized and digested in potassium dichromate and sulphuric acid. Unconsumed potassium dichromate is back titrated with ferrous ammonium sulphate. It is a redox titration method.

In a soil sample if we add potassium dichromate and sulphuric acid then it is digested leading to chromium sulphate and $CO_2$. Two molecules of potassium dichromate can digest three carbons. The reaction is as follows:

$2K_2Cr_2O_7 \equiv 3\ C$

In other words 2 liters of 1 normal potassium dichromate can digest 36 grams of carbon

(2 liter 1N $K_2Cr_2O_7 \equiv 36$ g of C) or

1 mL of 1 normality potassium dichromate can digest 0.0018 grams of carbon (1mL 1N $K_2Cr_2O_7 \equiv 0.0018$ g of C).

**Reagents required for the experiment:**

1. 1.0 N Potassium dichromate ($K_2Cr_2O_7$)
2. 0.5 N ferrous ammonium sulphate (FAS)
3. Biphenyl amine indicator
4. Concentrated Sulphuric Acid ($H_2SO_4$)
5. Sodium Fluoride

**Apparatus required for the experiment:**

1. 250 mL conical flask
2. 20 mL Measuring cylinder
3. 10 mL automatic zero Pipettes
4. 50 mL burette
5. 1000 mL volumetric flask.
6. 100 mL volumetric flask.

**Soil Sample:**

1. Air dried soil which has been ground to pass a 0.42 mm sieve. Weight accurately about 1 gram.

**Procedure:**

1. Take 1 gm soil sample in 500 mL conical flask
2. Add 10 mL 1 N Potassium dichromate ($K_2Cr_2O_7$)
3. Add slowly and carefully 20 mL concentrated $H_2SO_4$ with constant stirring
4. Shake it gently for 5 minutes and keep it aside for 30 minutes for digestion at room temperature in dark place.
5. After ½ an hour add 200 mL distilled water + 3 mL ortho-phosphoric acid or a pinch of sodium fluoride (NaF) + 1mL (DPA) diphenyl amine indicator
6. The solution will turn into violet blue to violet colour
7. In 50 mL burette take 0.5 N ferrous ammonium sulphate solutions
8. Titrate the content until the solution turns into green colour
9. Close the burette and take the reading.

We have done the above procedure for 1 gram of soil sample. Similarly follow the entire process for incubated or blank sample (i.e. without soil sample) and note down the reading.

Now with the formula calculate organic carbon percentage

Organic Carbon (%) = 10 (B-S)/ B x 0.0018 x 100 / Weight of sample (grams) where

B = Titre value (mL) of blank

S = Titre value (mL) of sample

10 is the value of Potassium Dichromate used in mL

% oxidizable organic matter (OOM) in soil = % Organic Carbon x 1.724

Total organic matter (TOC) = % OOM x 1.30

Let us take one example where value of B (blank) = 22 and value of S (sample) = 20

OC (%) = 10(22-20)/22*0.003*100 / 1

= 0.27%

OOM (%) = 0.27*1.724 = 0.465%

TOC = 0.465*1.30

= 0.60

Rating of % Organic carbon

| % Organic Carbon | Description |
|---|---|
| < 0.30 | Very Low |
| 0.30 – 0.50 | Low |
| 0.50 – 0.75 | Medium |
| 0.75 – 1.0 | High |
| > 1.0 | Very High |

If the % OC is low then we have to carry out soil management where it is necessary to add organic matter which can be in form of farm yard manure, vermicomposting or green manures

**iv) Determination of colour**

Munsell Color chart was originally prepared by Albert H. Munsell who was an an artist, nearly a century ago. Number of modifications and additions were made with the passage of time. It is a very handy booklet where each page is detachable. A transparent film is provided before each colour chart to prevent it from any damage. Holes are provided along with two filters i.e. white and black. These filters help in exact identification of the colour of the soil and also avoid distraction of the researcher. The white filter is used for darker soil while black filter is used for lighter soils. It is advisable to carry out exercise of identification of colour in a day light. A wide variety of industries and disciplines use Munsell Soil Color Books including academia, forestry, forensics, environmental and soil science, building and contracting, landscaping, real estate, health departments, geology and archaeology. The chart uses three notations to indicate a soil's color:

**Value**

The lightness or darkness of the soil, indicated by a number on a scale of 0 to 10. The value scale runs vertically from lightest at the top to darkest at the bottom.

**Chroma**

The strength or intensity of the soil's color, indicated by a number on a scale of 0 to 8. The chroma scale runs horizontally from weakest on the left to strongest on the right.

**Hue**

The color's dominant hue, which is divided into five categories: red, yellow, blue, green, and purple.

Here's some more information about how to interpret the Munsell Soil Color Chart:

A low chroma (2 or less) indicates a gray soil that may be wet or waterlogged. A higher chroma indicates a better drained, more oxidized soil.

A soil's value can indicate its horizon. For example, A horizons are often darker with a lower value (2 or 3) due to humus, while E horizons are often light colored (5 or 6 value).

**Munsell Soil Books Include the Following Soil Color Charts:**

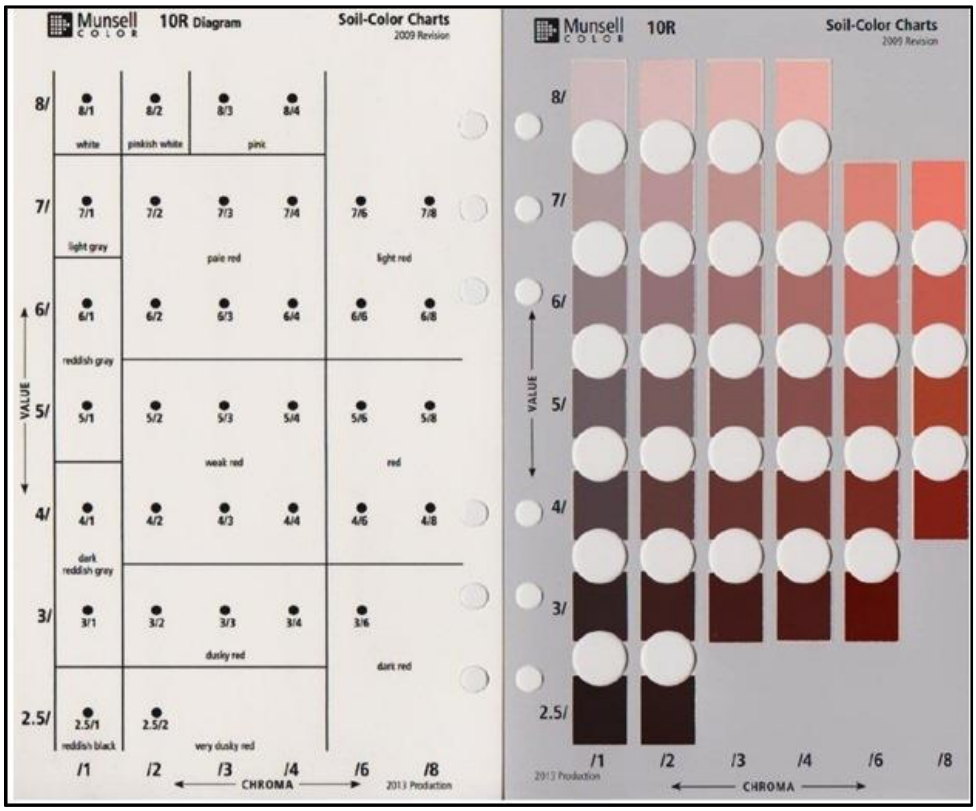
- Munsell 10R Soil Chart
- Munsell 10YR Soil Chart
- Munsell 2.5Y Soil Chart
- Munsell 2.5YR Soil Chart
- Munsell 5Y Soil Chart
- Munsell 5YR Soil Chart
- Munsell 7.5YR Soil Chart
- 10Y – 5GY Colors – Olive greens Soil Chart
- Gley 1 & 2 Soil Charts (2 – Separate Soil Charts)
- Munsell 5R Individual Soil Chart
- Munsell 7.5R Individual Soil Chart
- "New" White Page, 7.5R, 10YR, & 2.5Y

The book is organized to make it faster and easier for you to identify and communicate the color of soil in the field. Soil color indicates the makeup of the soil within a given geographic area, which can influence the land's fitness for use, such as wetlands, optimum crops to plant, viability for waste water systems and other uses.

Reference: https://www.munsell.com

**Procedure**

1. Take the soil sample on the paper
2. Tentatively identify the general colour of the soil and then select the proper chart page
3. Take out the page from detachable book of Munsell Colour Chart
4. Slowly move the sample from one hole (provided in the chart) to other from top to bottom
5. Once the nearest colour is identified, use filters for final selection of the colour
6. Refer to the explanation given on the left side of the chart and identify the characteristics of the collected sample




**v) Chemical Analysis - Determination of Soil Moisture:**

Procedure:

1. Weight of empty crucible
2. Add soil to the crucible and weigh again
3. Put the crucible in the oven
4. Heat it for one hour at $110^{o}$ C
5. Cool it and weigh it again

Example: The weight of an empty crucible is 22 grams. With the soil the crucible weight is 45 grams before heating and 38 grams after heating. Determine the soil moisture percentage

Weight of the empty crucible = 22 grams

Weight of the crucible with soil sample before heating = 42 grams

Weight of the soil sample = 20 grams

Weight of the crucible with soil sample after heating = 36 grams

Weight of the moisture in the soil = 6 grams

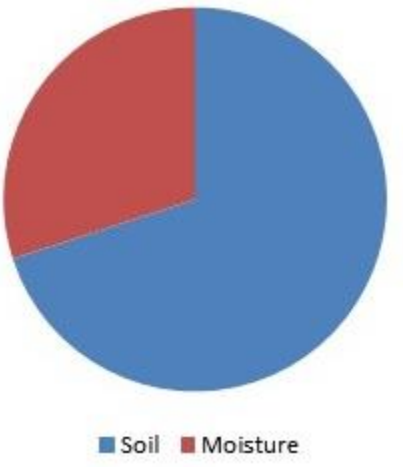
Soil moisture (in %) = 6 x 100 / 20

= 30. %

Therefore, soil sample contains 30.4 % of moisture

(To enhance the accuracy, weights should be recorded accurately to at least 3rd or 4th decimal)

**Result of Moisture Analysis**




## 3.8 SUMMARY

Soil is an important component of biosphere. There are different layers of soil which we called as soil profile. Different parameters are used to assess the quality of the soil. Physical and chemical analysis helps us to determine the utility of the soil for different crops.

## 3.9 CHECK YOUR PROGRESS OR EXERCISE

**A. True or False**

1. Any type of soil will have organic matter.
2. Sand, silt and clay are the three major component of the soil.

3. Soil requirement for crop production changes from crop to crop.
4. pH test is used in the fields other than biogeography.
5. Type of soil not determined by parent rock.

**B. Fill in the Blanks**

1. Moisture of the soil is calculated in _____
2. _____ paper is used for pH test of the soil.
3. Titration process is involved in calculation of soil's _____
4. Electrical conductivity is expressed in terms of soil's _____
5. _____, _____ and _____ are used to determine colour of the soil in Munsell method.

**C. Multiple Choice Questions**

1. Plotting of the soil texture is done on _____ graph
   a. Centimeter b. Log c. Triangular
2. Solution of _____ is used in calibration of pocket pH meter.
   a. 4 and 6 b. 4 and 7 c. 5 and 9
3. Property of any soil sample can be _____
   a. Only Alkaline b. Only Acidic c. Only Neutral
   d. Alkaline, Acidic or Neutral

**D. Answer the following Questions**

1. What are the different layers found in soil profile?
2. What are the different methods of chemical analysis of the soil?
3. Explain the significance of Munsell scale.

## 3.10 ANSWERS TO THE SELF-LEARNING QUESTIONS

A.1. True

A 2. True

A 3. True

A 4. True

A. 5. False

B. 1. Percentage

B. 2 Litmus

B. 3 Organic Carbon

B. 4 salinity

B. 5 Value, Chroma and Hue

C.1. c

C.2. b

C.3. d

**D Answers to the Self-learning questions**

1. A soil profile can be easily observed at construction site or digging of the well. The layers of the profile can be distinguish on the basis of their thickness and colour. The major layers of the profile are O (humus of organic), A (top soil), E (eluviated horizon) , B(subsoil), C (parent material, R (bedrock)

2. Chemical properties of the soil are very important as it determines characteristics of the soil. pH test indicate whether the soil is alkaline, acidic or neutral. Electrical conductivity refers to amount of soluble (salts) ions in the soil. Organic carbon is used to assess the amount of organic matter in the soil.

3. Colour of the soil is yet another important parameter. The colour of the soil reflect on bedrock or parent rock properties and different chemical reaction associated with the soil. Munsell an artist evolved a systematic method of identifying type of soil on the basis of colour. A colour code is developed by Munsell and it was updated and few more pages were added to the original chart from time to time.

## 3.11 TECHNICAL WORDS AND THEIR MEANING

**Soil Profile –** these are the various layers of the soil which are clearly visible. These layers are different from each other (such as texture, colour, depth and chemical composition). Generally soil profile is studied upto the depth of 3 to 5 feet

**Titration process –** it is to find out how much of a particular substance in a liquid by measuring how much of another substance is needed to react with it.

## 3.12 TASK

Download Munsell colour chart. Compare and try to identify the soil sample from your vicinity.

## 3.13 REFERENCES FOR FURTHER STUDY

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# 4

# TECHNIQUES IN HUMAN GEOGRAPHY

**Unit Structure**



## 4.1. OBJECTIVES

The main objective of the unit is to study the relevance of network analysis, their effectiveness and simple but effective statistical techniques to measure the regional development and to bring out regional imbalances.

## 4.2. INTRODUCTION

There are many factors such as physical, economic and socio-political factors which determine the regional development. Transport is one of the major indicators. Development of transport its accessibility and connectivity leads to economic growth of the country. According to International Money Fund, 2022 U.S.A heads the list following by Canada, Saudi Arabia and Portugal sharing the second place in transport network. This excellent network plays a crucial role in regional development.

## 4.3. SUBJECT DISCUSSION

Transportation is a backbone of national and global production systems which is constantly reshaping the world. The societies and economic organization are becoming more complex, the relevance of transport

growing day by day. Many researchers have made an attempt to assess the disparity in the development using different techniques and different indictors. However selection of these indicators is the key factor in analysis as some of the factors are positive and negative

## 4.4 NETWORK ANALYSIS:

### 4.4.1 Topological graphs – Connectivity – Calculations of Alph, Beta and Gamma Indices

**Conversion of map into topological graph**

Conversion of road network into topological graph is essential for understanding the connectivity of the network. Initially nodes are identified and given the number and then straight lines (edges) are drawn to connect these nodes. However hanging roads (i.e. which are not having any connection) are not taken into consideration. Numbers are also given to edges. Please note that the number of edges will be always more than that of nodes.

Example: A road network map of Yeotmal district of Maharashtra is selected for the exercise (Fig 4.1). A topological graph is also drawn for the same where nodes are marked in black while edges are marked in red. (Fig 4.2)

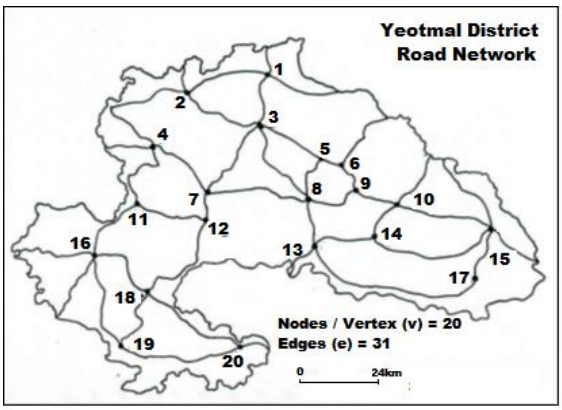



Fig 4.1

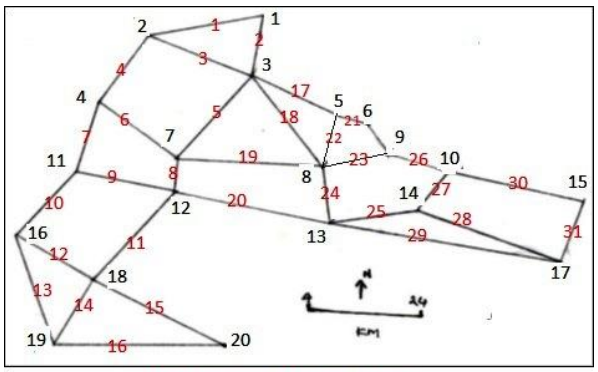



Fig 4.2

## Connectivity Indices

There are three indices which reflect the connectivity of the network.

### Connectivity indices

### Beta Index (β)

B = e / v,

Whereas

e = link / edges; v = nodes / vertex

In this example e = 31 and v = 20

β index is ratio of total number of area in the netowork to the total number of nodes, Here it is 1.55. Thus from the given β index value we can conclude that the given road network is more complex network because of the value is greater than 1.00

### Alpha Index (α)

α = e – v + 1 / 2 v – 5

Whereas:

e = link / edges; v = nodes / vertex

In this example e = 31 and v = 20

= 31 – 20 +1 / 2 x (20) – 5

= 11 + 1 / 40 – 5

= 12 / 35

**= 0.34**

It is the actual number of circuits in a network to the maximum possible number of circuits. Thus from the given α index value we can conclude that since the α index value is less than 1.00, the said road network is not well connected.

### Gamma Index (γ)

γ = e / 3(v-2)

Whereas:

e = link / edges; v = nodes / vertex

In this example e = 31 and v = 20

= 31 / 3 (20-2)

= 31 / 3 (18)

= 31 / 54

**= 0.57**

It is the relationship between the number of observed links and number of possible links. Thus from the given γ index value which is 0.57 we can conclude that since the γ index value is between 0 and 1, the said road network is not completely well connected.

### 4.4.2 Mapping of relative accessibility and connectivity –Matrices – point of minimum Aggregate travel distance

**Simple Connectivity Matrix**

A network can be represented as a connectivity matrix, which is rather simple to construct:

The size of the connectivity matrix depends on the total number of nodes in the network. In this example we have 20 nodes in the network. So a connectivity matrix of 20 x 20 will be represented.

There are two types of connections;

**Direct connection** - where whether the node is connected directly to another node is taken into consideration. In this example node no 1 is directly connected to 2 and 3. A value of 1 will be given in the table against these direct connected nodes.

**No- connection** – where nodes are not directly connected to each other are not taken into considered. In this example except node 2 and 3 none of the other nodes are connected, hence a value of 0 will be given in the table against non-connected nodes.

**Interpretation of Direct Path Matrix**

It is observed from the above table that higher the value of direct path more is the connectivity. Here 3 and 8 nodes are the most connected nodes. The direct path index is 3.1 and the table shows the hierarchical pattern of connectivity

**Direct Path Matrix**

| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **∑** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| **2** | 1 | - | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| **3** | 1 | 1 | - | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| **4** | 0 | 1 | 0 | - | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| **5** | 0 | 0 | 1 | 0 | - | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| **6** | 0 | 0 | 0 | 0 | 1 | - | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| **7** | 0 | 0 | 1 | 1 | 0 | 0 | - | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| **8** | 0 | 0 | 1 | 0 | 1 | 0 | 1 | - | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | ∑ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **9** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | - | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| **10** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | - | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 3 |
| **11** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | - | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| **12** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | - | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 |
| **13** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | - | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 3 |
| **14** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | - | 1 | 0 | 0 | 0 | 0 | 0 | 3 |
| **15** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | - | 0 | 1 | 0 | 0 | 0 | 3 |
| **16** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | - | 0 | 1 | 1 | 0 | 3 |
| **17** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | - | 0 | 0 | 0 | 2 |
| **18** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | - | 1 | 1 | 4 |
| **19** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | - | 1 | 3 |
| **20** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | - | 2 |
| | 2 | 3 | 5 | 3 | 3 | 2 | 4 | 5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 4 | 3 | 2 | 62 |

In real world situation there is a possibility of large number of indirect paths which are not considered for this exercise. So it is necessary to construct the Shortest Path Matrix which shows the accessibility of the network

**Shortest Path Matrix**

Similar to the connectivity matrix this also involves a number of rows and columns equivalents to the number of nodes in the network. An accessibility matrix is always a square matrix. In this analysis we have to find out all the possible ways to establish a connection between the two points and then select the shortest path

For example: if we consider the link between node 3 and 13 then the following possibilities can be explored

a. 3-5-6-9-10-14-13 = 6

a. 3-5-6-9-8-13 = 5

c. 3-5-8-13 = 3

d. 3-7-8-13 = 3

**e. 3-8-13 = 2**

In this case option e is to be considered as it is the shortest path between these two points. Similarly one has to find out the shortest paths for other nodes

**Shortest Path Matrix**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | ∑ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | - | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 4 | 3 | 3 | 3 | 4 | 5 | 4 | 4 | 4 | 5 | 5 | 60 |
| **2** | 1 | - | 1 | 1 | 2 | 3 | 2 | 2 | 3 | 4 | 2 | 3 | 3 | 4 | 5 | 3 | 4 | 4 | 4 | 5 | 56 |
| **3** | 1 | 1 | - | 2 | 1 | 2 | 1 | 1 | 2 | 3 | 3 | 2 | 2 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 46 |
| **4** | 2 | 1 | 2 | - | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 5 | 2 | 4 | 3 | 3 | 4 | 53 |
| **5** | 2 | 2 | 1 | 3 | - | 1 | 2 | 1 | 2 | 3 | 4 | 3 | 2 | 3 | 3 | 5 | 3 | 4 | 5 | 5 | 54 |
| **6** | 3 | 3 | 2 | 4 | 1 | - | 3 | 2 | 1 | 2 | 5 | 4 | 3 | 3 | 3 | 6 | 4 | 5 | 6 | 6 | 66 |
| **7** | 2 | 2 | 1 | 1 | 2 | 3 | - | 1 | 2 | 3 | 5 | 1 | 2 | 3 | 4 | 3 | 3 | 2 | 3 | 3 | 43 |
| **8** | 2 | 2 | 1 | 2 | 1 | 2 | 1 | - | 1 | 2 | 3 | 2 | 1 | 2 | 3 | 4 | 2 | 3 | 4 | 4 | 42 |
| **9** | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 1 | - | 1 | 4 | 3 | 2 | 2 | 2 | 5 | 3 | 4 | 5 | 5 | 53 |
| **10** | 4 | 4 | 3 | 4 | 3 | 2 | 3 | 2 | 1 | - | 5 | 4 | 2 | 1 | 1 | 6 | 2 | 5 | 6 | 6 | 64 |
| **11** | 3 | 2 | 3 | 1 | 4 | 5 | 2 | 3 | 4 | 5 | - | 1 | 4 | 4 | 6 | 1 | 5 | 2 | 2 | 3 | 61 |
| **12** | 3 | 3 | 2 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | - | 3 | 1 | 2 | 5 | 1 | 4 | 5 | 5 | 51 |
| **13** | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 2 | 4 | 3 | - | 4 | 5 | 2 | 4 | 1 | 2 | 2 | 53 |
| **14** | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 1 | 4 | 4 | 1 | - | 1 | 6 | 2 | 5 | 6 | 6 | 64 |
| **15** | 5 | 5 | 4 | 5 | 3 | 3 | 4 | 3 | 2 | 1 | 6 | 5 | 2 | 1 | - | 7 | 1 | 6 | 7 | 7 | 77 |
| **16** | 4 | 3 | 4 | 2 | 5 | 6 | 3 | 4 | 5 | 6 | 1 | 2 | 5 | 6 | 7 | - | 6 | 1 | 1 | 2 | 73 |
| **17** | 4 | 4 | 3 | 4 | 3 | 4 | 3 | 7 | 3 | 2 | 5 | 4 | 1 | 2 | 1 | 6 | - | 5 | 1 | 6 | 68 |
| **18** | 4 | 4 | 3 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 2 | 1 | 4 | 5 | 6 | 1 | 5 | - | 1 | 1 | 63 |
| **19** | 5 | 4 | 4 | 3 | 5 | 6 | 3 | 4 | 5 | 6 | 2 | 2 | 5 | 6 | 7 | 1 | 1 | 1 | - | 1 | 71 |
| **20** | 5 | 5 | 4 | 4 | 5 | 6 | 3 | 4 | 5 | 6 | 3 | 2 | 5 | 6 | 7 | 2 | 6 | 1 | 1 | - | 80 |
| | | | | | | | | | | | | | | | | | | | | | 1199 |

**Interpretation of Shortest Path Matrix**

It is observed form the table that the lesser the value to shortest path matrix more is the accessibility. In this case node no 8 is most accessible node with good network.

## 4.5 MEASURING DEVELOPMENT

Choice and relevance of indicators – calibration of ratio and indices; Construction of diagrams and Maps – Mapping and interpretation of Levels of development. Regional imbalances, Gender gap

**Measuring Development**

Regional Development can be defined as policies aimed at reducing regional disparity. Regional development of any country or region depends on many factors. Physical factors like physical setup, climate, supply of water; economic factors like natural resources, technology, infrastructure, availability of labour force, education and cultural factors race, religion play a crucial role in regional development.

There are different parameters which are used as indicators of development. These can be positive or negative indicators. Life expectancy, literacy rate, GNP per capita are the examples of positive indicators while maternal death, infant mortality rate are the examples of negative indicators.

**Techniques of spatial development:**

Various simple statistical techniques are used in assessment of regional development. In this chapter we will study range, quartile deviation, mean deviation, ranking method and Z score methods in regional assessment.

In measures of central tendency we get one representative number (Mean, Median and Mode) for the given data. Hence we can compare the two data sets easily. It is degree to which numerical data tend to spread about an average value is called the variation of dispersion of the data.

**Range**

Range is the difference between the value of the smallest item and the value of the largest item included in the distribution

Range = Max. Value — Min. Value

For ungrouped data find out the range for the following data 5,1,7,8,15,20,9,10,12,14,21,3,6,5,5,2,4,10

Maximum Value - Minimum Value = 21 – 1 = 20

Coefficient of Range = H – L / H + L

= 21 – 1 / 21 + 1

= 20 / 22

= 0.909 or = 0.91

Group Data - Discrete

| Marks | 10 | 20 | 30 | 40 | 50 | 60 | 70 |
|---|---|---|---|---|---|---|---|
| Students | 5 | 8 | 5 | 20 | 6 | 16 | 7 |

Maximum Value - Minimum Value = 70 – 10 = 60

Coefficient of Range = H – L / H + L

= 70 - 10 /70 + 10

= 60 / 80

= 0.75

**Merits of Range**

1. Simplest and easiest method of dispersion
2. It requires minimum time to calculate the range

**Limitations of Range**

1. Rang is not based on each and every item of distribution
2. Range is most unreliable measure of dispersion

**Quartile Deviation**

In quartile deviation data is divided into four parts (25%) each. First quarter is at 25%, second quarter is at 50%, third quarter is at 75% and fourth quarter is at 100%. Difference between the third (Q3) and first (Q 1) is terms as inter quartile range. Inter quartile range is reduced to the form or semi-inter quartile range or quartile

Formula Q l = n+1/4

Q3 = 3(n +1/4)

Quartile Deviation = Q3- Q1 /2

Coefficient of Quartile deviation = Q3-Q1/Q3+Q1

**Merits of Quartile Deviation**

1. It is superior to range as a measurement of dispersion
2. It can be used for open end distributions
3. Quartile deviation is not affected by the extreme values

**Limitations of Quartile Deviation**

1. Quartile deviation ignores 50% items i.e. the first and the last 25%
2. It is not much used for further statistical analysis
3. Its value is affected by sampling fluctuations

Calculate the quartile deviation and quartile co-efficient for the following data

| | **Sr. No** | **Height of place in Meters** | **No. of Locations** | **Cumulative Frequency** |
|---|---|---|---|---|
| | 1 | 58 | 2 | 2 |
| | 2 | 59 | 3 | 5 |
| | 3 | 60 | 6 | 11 |
| Q1 | 4 | 61 | **15** | 26 |
| | 5 | 62 | 10 | 36 |
| Q3 | 6 | 63 | 5 | 41 |
| | 7 | 64 | 4 | 45 |
| | 8 | 65 | 3 | 48 |
| | 9 | 66 | 1 | **49** |

Formula Q1 = n+1 / 4

= 49 + 1 / 4

= 50 / 4

= 12.5

It is in the cumulative frequency class of 26 where the value is 61 (height)

Formula Q3 = 3(n+1) / 4

= 3(49 + 1) / 4

= 3(50) / 4

= 150 / 4

= 37.5

It is in the cumulative frequency class of 41 where the value is 63 (height)

Q.D = Q 3 – Q 1 / 2

= 63 – 61 / 2

= 2/2

= 1.00

Coefficient of Range

= Q3 – Q1 / Q3 + Q1

= 63 – 61 / 63 + 61

= 2/ 124

= 0.016

**Calculate Q.D. for a frequency distribution**

Example: 2

Calculate Q.D. for the following distribution of marks scored by a class.

| **Sr. No** | **Class Interval (CI)** | **No of Students** |
|---|---|---|
| 1 | 0-10 | 5 |
| 2 | 10-20 | 8 |
| 3 | 20-40 | 16 |
| 4 | 40-60 | 7 |
| 5 | 60-90 | 4 |
| | Total | 40 |

**Table: 2 calculate the cumulative frequency**

| | Sr. No | Class Interval (CI) | No of Students (f) | Cumulative frequency (cf) |
|---|---|---|---|---|
| | 1 | 0-10 | 5 | **5** |
| Q1 | 2 | **10-20** | **8** | **13** |
| | 3 | 20-30 | 16 | 29 |
| Q3 | 4 | **30-40** | **7** | **36** |
| | 5 | 40-50 | 4 | 40 |
| | | Total | **40** | |

$$\mathbf{Q.D = \frac{Q3 - Q1}{2}}$$

**Q1= N/4**

= 40/4

**=10**

Q1 is the size of n/4the value in a continuous series.

Thus, it is the size of $10^{th}$ value.

The class containing the $10^{th}$ value is 10-20,

Hence, Q1 lies in class 10-20

Now, to calculate the extract value of Q1

The following formula is used.

$$Q1 = L + \frac{\frac{N}{4} - cf}{f} i$$

Where,

L= 10 (Lower limit of the relevant quartile)

cf =5 (value of cf for the class preceding the quartile class)

i= 10 (interval of the quartile calls) &

f= 8 (frequency of the quartile class)

$$\text{Thus, } Q1 = L + \frac{\frac{N}{4} - cf}{f} i$$

$$= 10 + \frac{10-5}{8} 10$$

$$= 10 + \frac{5}{8} 10$$

$$= 10 + 0.625 * 10$$

$$= 10 + 6.25$$

**Q1 = 16.25**

**Q 3 = 3N/4**

= 3*40/4

= 120/4

**= 30**

Thus, Q3= $L+\frac{\frac{3N}{4}-cf}{f}i$

$= 40+\frac{30-29}{7}10$

$= 40+\frac{1}{7}10$

$= 40+0.14*10$

$= 40+1.42$

**Q3 = 41.42**

**QD** $\frac{\mathbf{Q3-Q1}}{\mathbf{2}}$

QD $\frac{41.42-16.25}{2}$

QD $\frac{25.17}{2}$

**QD= 12.58**

**Coefficient of QD** $\frac{\mathbf{41.42-16.25}}{\mathbf{41.42+16.25}}$

Coefficient of QD $\frac{25.17}{57.67}$

$$\textbf{Coefficient of QD} = \mathbf{0.43}$$

**Mean Deviation**

It is also known as the average deviation. It is the average difference between the items in a distribution and the median or mean of that series. In mean deviation of each item in the series is found out from the median. All deviations are added together ignoring (+ or-signs). 'This total is divided by the number of observations

Mean deviation = ∑id/n ».d = Sum of all deviations

N = number of observations / items

| Sr. No | Weight in kg (X) | Deviation $(X - X^{-})$ |
|---|---|---|
| 1 | 44 | -6 |
| 2 | 42 | -8 |
| 3 | 45 | -5 |
| 4 | 48 | -2 |
| 5 | 50 | 0 |
| 6 | 52 | +2 |
| 7 | 54 | +4 |
| 8 | 56 | +6 |
| 9 | 59 | +9 |
| | $\sum$ 450 | 42* |

- Ignore – or + signs

Mean = $\sum X / n$

= 450 / 9

= 50

Mean Deviation (MD)

= $\sum X - X^{-} / n$

= 42 / 9

= 4.67

Coefficient of Mean Deviation

= M D / X

= 4.67 / 450

= 0.0103

**Merits of Mean Deviation**

1. It is relatively simple to understand and compute
2. It is based on each and every item of the data
3. Its less affected by the extreme items of the data

**Limitations of Mean Deviation**

1. Algebraic sighs (+,-) are ignored in M.D.
2. It may not give us accurate results 3. It is not capable of further statistical analysis

**Standard Deviation**

Standard deviation is the square root of the arithmetic average of the squares of the deviations measured from the mean. To find the standard deviation (SD) the following steps are taken

1. Find the deviation from the mean.
2. Square those deviations.
3. Find the mean of the sum of these deviations square.
4. Find the square root of the mean

Merits of Standard Deviation

1. It is the best method of deviation
2. It is based on every item of the distribution
3. It is used in further statistical analysis

Limitations of Standard Deviation

1. It is difficult and time consuming to calculate than other methods
2. It gives more weight to extreme items and less to those which are near the mean

**Standard Deviation:**

Grouped data - discrete

| **X** | **d = (x – $x^-$)** | **$D^2$** |
|---|---|---|
| 2 | - 10.42 | 108.67 |
| 3 | - 9.42 | 88.78 |
| 5 | - 7.42 | 55.05 |
| 9 | - 3.42 | 11.69 |
| 13 | + .58 | 0.33 |
| 22 | + 9.58 | 91.77 |
| 33 | + 20.58 | 423.53 |
| € x = 87 | | 779.82 |

$X^- = €x / n = 87 / 7 = 12.42$

$S.D = √€ d^2 / n$

$= √779.82 / 87$

$= √8.96$

$= 2.99$

**Continuous Series**

| **Rainfall in cm** | **No of days (f)** | **Mid-Point (x) (S I)** | **Product (fx) (S II )** | **d (x – $x^-$) (S III)** | **fd (S IV)** | **$d^2$ (S V)*** |
|---|---|---|---|---|---|---|
| 30 - 35 | 5 | 32.5 | 162.5 | -19.44 | - 97.2 | 9447.84 |
| 35 - 40 | 6 | 37.5 | 225 | -14.44 | - 86.64 | 7506.48 |
| 40 - 45 | 10 | 42.5 | 425 | -9.44 | - 94.4 | 8911.36 |
| 45 - 50 | 15 | 47.5 | 712.5 | - 4.44 | - 66.6 | 4435.56 |

| Rainfall in cm | No of days (f) | Mid-Point (x) (S I) | Product (fx) (S II ) | d ($x - \bar{x}$) (S III) | fd (S IV) | $d^2$ (S V)* |
|---|---|---|---|---|---|---|
| 50 - 55 | 20 | 52.5 | 1050 | 0.56 | 11.2 | 125.44 |
| 55 - 60 | 16 | 57.5 | 920 | 5.56 | 88.96 | 7913.88 |
| 60 - 65 | 7 | 62.5 | 437.5 | 10.56 | 73.92 | 5464.90 |
| 65 - 70 | 11 | 67.5 | 742.5 | 15.56 | 171.16 | 29295.74 |
| | $\sum f = 90$ | | €fx = 4675 | | | 73102.2 |

*Steps to calculate SD

S I Calculate the midpoint of the range: 30 – 35 = 32.5

S II Multiply mid-point and frequency (take total and apply formula $\sum fx / n$)

S III Calculate the $x - \bar{x}$ value for each

S IV Multiply f and d to get the value of fd

S V Calculate the square of fd and take the total which is $\sum d^2$

Apply the formula of $\sqrt{\sum d^2 / n}$

$\bar{X} = \sum x / n = 4675 / 90 = 51.94$

$S.D = \sqrt{\sum d^2 / n}$

$\sqrt{73102.2/90}$

$= \sqrt{812.24}$

= 28.49

**Ranking Method**

It is one of the simplest methods for regionalization.

Steps:

A. Calculate the rank for individual variable (rank to be given from highest to lowest)

B. Calculate cumulative rank and using quartile method group the data into 4 categories

C. Arrange the data into four groups and interpret the results

D. In some cases you may be asked to draw a neat map of levels regionalization using choropleth technique

Konkan, Western Maharashtra, Vidarbha and Marathwada are the broad physical subdivisions of Maharashtra whereas Amravati, Aurangabad, Konkan, Nagpur, Nashik and Pune are the administrative divisions.

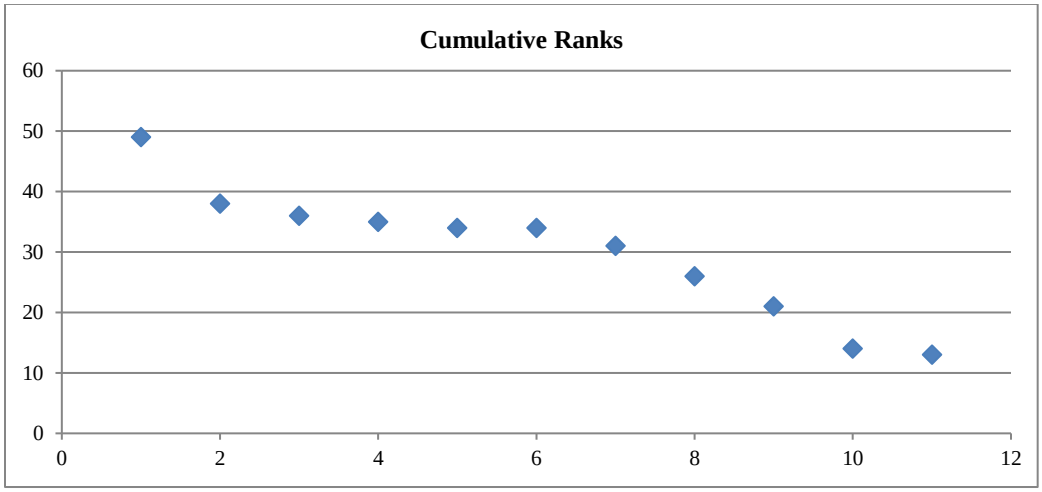
Aurangabad, Jalna, Parbhani, Hingoli, Nanded, Bid, Latur and Osmanabad are the districts of Aurangabad division. An attempt has been made to assess the status of various talukas of Bid district of Maharashtra.

Selected Indicators

1. Female literacy (%)
2. Households having permanent houses (%)
3. % of main workers to Total Workers
4. Households with electricity
5. Households with banking facility

| Sr. No | Name of the Taluka | Ind 1 | Rank | Ind 2 | Rank | Ind 3 | Rank | Ind 4 | Rank | Ind 5 | Rank | Cumulative Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Ashti | 42.32 | 2 | 65.89 | 5 | 94.24 | 2 | 72.8 | 5 | 58.33 | 11 | 26 |
| 2 | Patoda | 40.51 | 11 | 69.08 | 4 | 95.09 | 1 | 70.1 | 7 | 63.66 | 8 | 31 |
| 3 | Shirur | 40.72 | 10 | 62.22 | 6 | 91.73 | 8 | 70.64 | 6 | 67.44 | 5 | 35 |
| 4 | Georai | 41.59 | 7 | 55.39 | 11 | 90.29 | 10 | 78.84 | 4 | 68.56 | 2 | 34 |
| 5 | Manjlegaon | 41.87 | 5 | 58.34 | 9 | 91.92 | 7 | 68.59 | 8 | 65.36 | 7 | 36 |
| 6 | Wadwani | 41.19 | 9 | 58.18 | 10 | 89.45 | 11 | 62.43 | 9 | 59.73 | 10 | 49 |
| 7 | Bid | 41.89 | 4 | 70.44 | 2 | 93.28 | 4 | 79.22 | 2 | 60.13 | 9 | 21 |
| 8 | Kej | 41.71 | 6 | 60.33 | 8 | 92.52 | 6 | 59.26 | 11 | 68.28 | 3 | 34 |
| 9 | Dhanur | 41.07 | 8 | 61.38 | 7 | 90.75 | 9 | 62.35 | 10 | 67.86 | 4 | 38 |
| 10 | Parli | 42.29 | 3 | 70.90 | 1 | 93.79 | 3 | 83.9 | 1 | 67.17 | 6 | 14 |
| 11 | Ambejogai | 43.38 | 1 | 69.88 | 3 | 92.75 | 5 | 79.12 | 3 | 75.20 | 1 | 13 |

**Arrangement of cumulative rank in descending order**

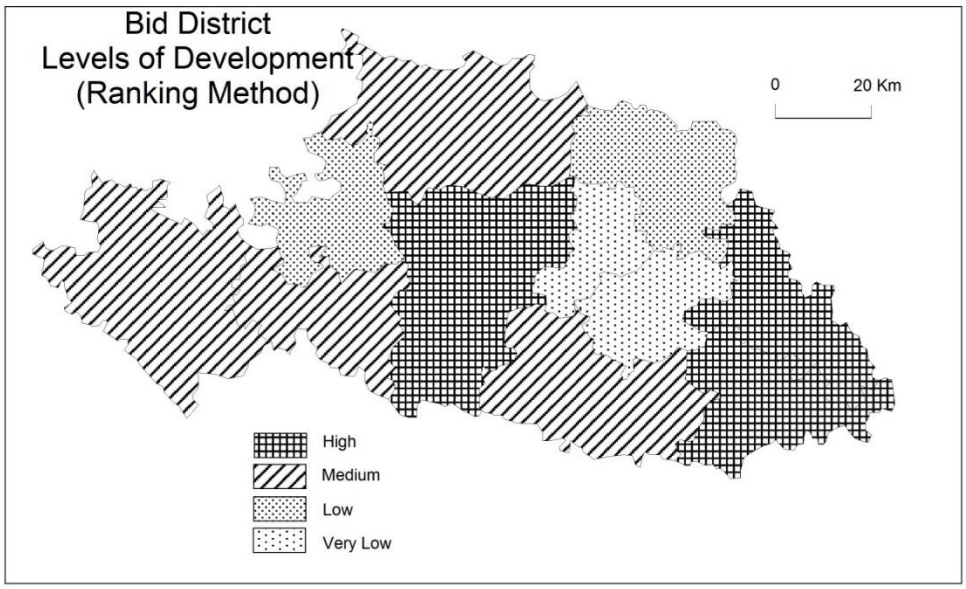



After using quartile method following classes can be obtained

1. High development – less than 21 ( Ambejogai, Parli, Bid)
2. Moderate development- 22- 34 (Ashti, Patoda, Georai, Kej)

3. Low development – 35 – 36 (Shirur, Majlegaon)

4. Very low development – above 36 ( Dhanur, Wadwani)




Z Score is also known as standard score gives us an idea of how far from the mean a data point In Statistics, the standard score is the number of standard deviations by which the value of a data is either below or above the mean value of what is being observed or measured. This deviation can be positive or negative.

**Formula –**

$Z = x - \tilde{x} / s.d.$

Z = Standard score

x = Observed value

$\tilde{x}$ = Mean of the sample

s.d. = Standard deviation of the sample.

Steps:

1. Take a total of the variable (X) (column 3) and divide it by the number (N) to calculate mean ($\sum X / N$)

2. Calculate mean deviation using the formula ($X - X^-$) (Column 4)

3. Calculate the square of ($X - X^-$) (Column 5)

4. Calculate SD value using formula $\sigma = \sqrt{(X - X^-)^2 / N}$

5. Calculate Z score using the formula ($X - X^- / SD$) (Column 6). This procedure is for one variable. Similarly you can calculate z score values for the other available variables

6. Make a table of total z score values and then take an average z score value

7. Classify these values into 4 /5 different categories

8. Using choropleth technique draw a neat map of levels regionalization

With the help of given data for selected indicators using z-score method. Identify the levels of development in the region using appropriate cartographic technique and interpret the results (In this case decimal points are rounded off)

**Selected Indicators**

1. Female literacy (%), 2. Households having permanent houses (%), 3. % of main workers to Total Workers, 4. Households with electricity, 5. Households with banking facility

**Table 1:**

| Sr. No | Name of the Taluka | Indicators ⟶ | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | Ashti | 42.32 | 65.89 | 94.24 | 72.8 | 58.33 |
| 2 | Patoda | 40.51 | 69.08 | 95.09 | 70.1 | 63.66 |
| 3 | Shirur | 40.72 | 62.22 | 91.73 | 70.64 | 67.44 |
| 4 | Georai | 41.59 | 55.39 | 90.29 | 78.84 | 68.56 |
| 5 | Manjlegaon | 41.87 | 58.34 | 91.92 | 68.59 | 65.36 |
| 6 | Wadwani | 41.19 | 58.18 | 89.45 | 62.43 | 59.73 |
| 7 | Bid | 41.89 | 70.44 | 93.28 | 79.22 | 60.13 |
| 8 | Kej | 41.71 | 60.33 | 92.52 | 59.26 | 68.28 |
| 9 | Dhanur | 41.07 | 61.38 | 90.75 | 62.35 | 67.86 |
| 10 | Parli | 42.29 | 70.90 | 93.79 | 83.9 | 67.17 |
| 11 | Ambejogai | 43.38 | 69.88 | 92.75 | 79.12 | 75.20 |

**Table 2: Calculation of 'Z' score for female literacy rate**

| Sr. No | Name of the Taluka | X | $X - X^-$ | $(X - X^-)^2$ | $Z = x - x^- / SD$ |
|---|---|---|---|---|---|
| 1 | Ashti | 42 | 0.28 | 0.08 | 0.46 |
| 2 | Patoda | 41 | -0.72 | 0.52 | -1.18 |
| 3 | Shirur | 41 | -0.72 | 0.52 | -1.18 |
| 4 | Georai | 42 | 0.28 | 0.08 | 0.46 |
| 5 | Manjlegaon | 42 | 0.28 | 0.08 | 0.46 |
| 6 | Wadwani | 41 | -0.72 | 0.52 | -1.18 |
| 7 | Bid | 42 | 0.28 | 0.08 | 0.46 |
| 8 | Kej | 42 | 0.28 | 0.08 | 0.46 |
| 9 | Dhanur | 41 | -0.72 | 0.52 | -1.18 |
| 10 | Parli | 42 | 0.28 | 0.08 | 0.46 |
| 11 | Ambejogai | 43 | 1.28 | 1.64 | 2.10 |
| | | $\sum = 459$ | | $\sum = 4.18$ | |

| | |
|---|---|
| Here Mean = $\sum X / N$<br>= 459 / 11<br>= 41.72<br>$X^{-}$ = 41.72 | Standard deviation:<br>$\sigma = \sqrt{\frac{\sum(x-\bar{x})}{N}}$<br>$\sigma = \sqrt{4.18/11}$<br>$= \sqrt{0.38}$<br>= 0.61<br>SD= σ = 0.61 |

**Table 3: Calculation of 'Z' score for % of households having permanent houses**

| Sr. No | Name of the Taluka | X | $X - X^{-}$ | $(X - X^{-})^2$ | $Z = x - x^{-} / SD$ |
|---|---|---|---|---|---|
| 1 | Ashti | 66 | 2.28 | 5.20 | 0.42 |
| 2 | Patoda | 69 | 5.28 | 27.88 | 0.98 |
| 3 | Shirur | 62 | -1.72 | 2.96 | -0.32 |
| 4 | Georai | 55 | -8.72 | 76.04 | -1.62 |
| 5 | Manjlegaon | 59 | -4.72 | 22.28 | -0.88 |
| 6 | Wadwani | 58 | -5.72 | 32.72 | -1.06 |
| 7 | Bid | 70 | 6.28 | 39.44 | 1.17 |
| 8 | Kej | 60 | -3.72 | 13.84 | -0.69 |
| 9 | Dhanur | 61 | -2.72 | 7.40 | -0.50 |
| 10 | Parli | 71 | 7.28 | 53.00 | 1.35 |
| 11 | Ambejogai | 70 | 6.28 | 39.44 | 1.17 |
| | | $\sum$ = 701 | | $\sum$ = 320.18 | |
| Here Mean = $\sum X / N$<br>= 701 / 11<br>= 63.72<br>$X^{-}$ = 63.72 | | | | Standard deviation:<br>$\sigma = \sqrt{\frac{\sum(x-\bar{x})}{N}}$<br>$\sigma = \sqrt{320.18 / 11}$<br>$= \sqrt{29.10}$<br>= 5.39<br>SD= σ = 5.39 | |

**Table 4: Calculation of 'Z' score for % of main workers to total workers**

| Sr. No | Name of the Taluka | X | $X - X^{-}$ | $(X - X^{-})^2$ | $Z = x - x^{-} / SD$ |
|---|---|---|---|---|---|
| 1 | Ashti | 94 | 1.64 | 2.69 | 0.96 |
| 2 | Patoda | 95 | 2.64 | 6.97 | 1.54 |
| 3 | Shirur | 92 | -0.36 | 0.13 | -0.21 |
| 4 | Georai | 90 | -2.36 | 5.57 | -1.38 |
| 5 | Manjlegaon | 92 | -0.36 | 0.13 | -0.21 |
| 6 | Wadwani | 89 | -3.36 | 11.29 | -1.96 |
| 7 | Bid | 93 | 0.64 | 0.41 | 0.37 |
| 8 | Kej | 93 | 0.64 | 0.41 | 0.37 |

| Sr. No | Name of the Taluka | X | $X - X^-$ | $(X - X^-)^2$ | $Z = x - x^- / SD$ |
|---|---|---|---|---|---|
| 9 | Dhanur | 91 | -1.36 | 1.85 | -0.80 |
| 10 | Parli | 94 | 1.64 | 2.69 | 0.96 |
| 11 | Ambejogai | 93 | 0.64 | 0.41 | 0.37 |
| | | $\sum = 1016$ | | $\sum =$ | |

Here Mean = $\sum X / N$

= 1016 / 11

= 92.36

$X^- = 92.36$

Standard deviation:

$$\sigma = \sqrt{\frac{\sum(x-\bar{x})}{N}}$$

$\sigma = \sqrt{32.55}/11$

$= \sqrt{2.95}$

= 1.71

SD= σ = 1.71

**Table 5: Calculation of 'Z' score for % of households with electricity**

| Sr. No | Name of the Taluka | X | $X - X^-$ | $(X - X^-)^2$ | $Z = x - x^- / SD$ |
|---|---|---|---|---|---|
| 1 | Ashti | 73 | 0.46 | 0.21 | 0.06 |
| 2 | Patoda | 70 | -1.54 | 2.37 | -0.20 |
| 3 | Shirur | 71 | -0.54 | 0.29 | -0.07 |
| 4 | Georai | 79 | 7.46 | 55.65 | 0.96 |
| 5 | Manjlegaon | 69 | -2.54 | 6.45 | -0.33 |
| 6 | Wadwani | 62 | -9.54 | 91.01 | -1.22 |
| 7 | Bid | 79 | 7.46 | 55.65 | 0.96 |
| 8 | Kej | 59 | -12.54 | 157.25 | -1.61 |
| 9 | Dhanur | 62 | -9.54 | 91.01 | -1.22 |
| 10 | Parli | 84 | 12.46 | 155.25 | 1.60 |
| 11 | Ambejogai | 79 | 7.46 | 55.65 | 0.96 |
| | | $\sum = 787$ | | $\sum = 670.81$ | |

Here Mean = $\sum X / N$

= 787 / 11

= 71.54

$X^- = 71.54$

Standard deviation:

$$\sigma = \sqrt{\frac{\sum(x-\bar{x})}{N}}$$

σ √670.81/11

$= \sqrt{60.98}$

= 7.80

SD= σ = 7.80

**Table 6: Calculation of 'Z' score for Percentage of households with banking facility**

| Sr. No | Name of the Taluka | X | $X - X^-$ | $(X - X^-)^2$ | $Z = x - x^- / SD$ |
|---|---|---|---|---|---|
| 1 | Ashti | 58 | -17.64 | 311.17 | -2.46 |
| 2 | Patoda | 64 | -8.64 | 74.65 | -1.21 |
| 3 | Shirur | 67 | 1.46 | 2.13 | 0.20 |
| 4 | Georai | 69 | 3.36 | 11.29 | 0.47 |
| 5 | Manjlegaon | 65 | -0.54 | 0.29 | -0.08 |
| 6 | Wadwani | 60 | -5.54 | 30.69 | -0.77 |
| 7 | Bid | 60 | -5.54 | 30.69 | -0.77 |
| 8 | Kej | 68 | 2.46 | 6.05 | 0.34 |
| 9 | Dhanur | 68 | 2.46 | 6.05 | 0.34 |
| 10 | Parli | 67 | 1.46 | 2.13 | 0.20 |
| 11 | Ambejogai | 75 | 9.46 | 89.49 | 1.32 |
| | | $\sum = 721$ | | $\sum = 7.16$ | |

Here Mean = $\sum X / N$

= 721 / 11

= 65.54

$X^- = 65.54$

Standard deviation:

$$\sigma = \sqrt{\frac{\sum(x-\bar{x})}{N}}$$

$\sigma = \sqrt{564.64 / 11}$

$= \sqrt{51.33}$

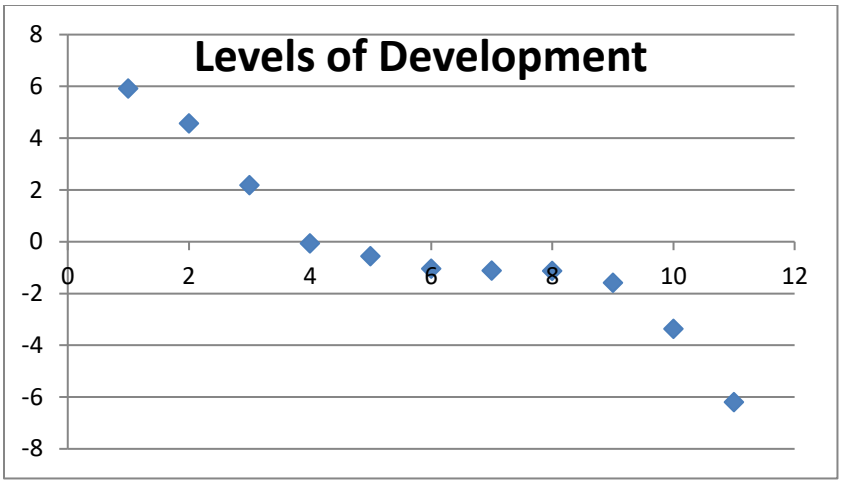
= 7.16

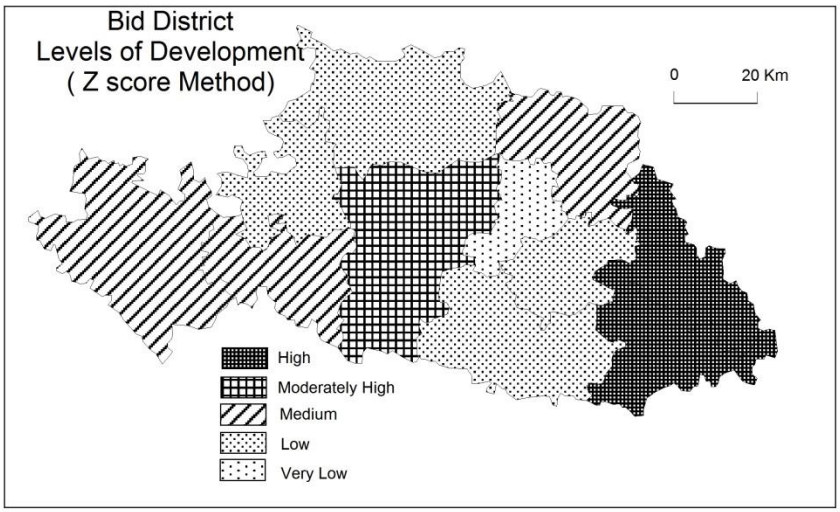
SD= $\sigma$ = 7.16

**Final Z score table**

| Sr. No. | Name of the Taluka | Indicators ⟶ | | | | | Cumulative Z score | Average Z score |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| 1 | Ashti | 0.42 | 0.46 | 0.96 | 0.06 | -2.46 | -0.56 | -0.112 |
| 2 | Patoda | 0.98 | -1.18 | 1.54 | -0.20 | -1.21 | -0.07 | -0.014 |
| 3 | Shirur | -0.32 | -1.18 | -0.21 | -0.07 | 0.20 | -1.58 | -0.316 |
| 4 | Georai | -1.62 | 0.46 | -1.38 | 0.96 | 0.47 | -1.11 | -0.222 |
| 5 | Manjlegaon | -0.88 | 0.46 | -0.21 | -0.33 | -0.08 | -1.04 | -0.208 |
| 6 | Wadwani | -1.06 | -1.18 | -1.96 | -1.22 | -0.77 | -6.19 | -1.238 |
| 7 | Bid | 1.17 | 0.46 | 0.37 | 0.96 | -0.77 | 2.19 | 0.438 |
| 8 | Kej | -0.69 | 0.46 | 0.37 | -1.61 | 0.34 | -1.13 | -0.226 |
| 9 | Dhanur | -0.50 | -1.18 | -0.80 | -1.22 | 0.34 | -3.36 | -0.672 |
| 10 | Parli | 1.35 | 0.46 | 0.96 | 1.60 | 0.20 | 4.57 | 0.914 |
| 11 | Ambejogai | 1.17 | 2.10 | 0.37 | 0.96 | 1.32 | 5.92 | 1.184 |

**Classification of cumulative values**




## 4.6 SUMMARY

In this unit we have access the significance of transport, it accessibility and connectivity. However the development of transport essentially based on the physical set up of the region and healthy economic status always boost the development of transport network. Similarly regional development is affected by various physical, economic, social and political factors. Simple statistical but effective techniques are available for assessment of regional development. The selection of these techniques largely depends on the selection of indicators, range and variation in the data and the choice of mapping technique.

## 4.7 CHECK YOUR PROGRESS OR EXERCISE

### A. True or False

1. Number of edges are always more than nodes

2. Ranks can be arranged in ascending or descending orders

3. Formula for quartile deviation for discrete and continuous data is different.

4. Regionalization is carried out on the basis of cumulative Z score

5. Isopleth is the most suitable technique for regionalization

**B. Fill in the Blanks**

**1.** _____ and _____ are one of the easiest methods of central tendency.

2. The process of conversion of transport network in connectivity diagram is called _____

3. Shortest path matrix refers to _____ of the matrix.

4. Direct path matrix refers to _____ of the matrix.

5. Topological graph shows the relation between _____and , _____

**C. Multiple Choice Questions**

1. Mean deviation _____ plus and minus signs

   a) Adds **b)** Subtracts **c)** Ignore

2. Quartile deviation divides the data into ____ equal parts

   a. 2 b. 4 c. 3

3. It is desirable to select minimum _____ and maximum _____ classes for choropleth technique.

   a. 3,5 **b.** 3,6 **c.** 2,6

4. Selection of the specific criteria for study of regional development depends upon

   a. Researcher b. Subject matter

   c. Researcher as well as subject matter

**D. Answer the following Questions**

1. Comment on ranking method of regionalization.

2. Explain the Z score method of regionlisation

3. Discuss various indices used for accessing connectivity of network.

4. Comment on direct and shortest path matrix

## 4.8 ANSWERS TO THE SELF-LEARNING QUESTIONS

A.1. True

A 2. True

A 3. True

A 4. False

A. 5. False

B. 1. Range and mean

B. 2 Topological diagram

B. 3 Accessibility

B. 4 Connectivity

B. 5 edges and nodes

C.1. c

C.2. b

C.3. a

C 4. c

**D. Answers to the Self-learning questions**

1. Ranking method is one of the simple but effective methods of regionalization. In this process ranks are given to the individual variables either in ascending or descending order. In case if there are negative indicators then the ranks are reassigned. Cumulative ranks are categories either with natural break or quartile method and choropleth technique is used to show spatial variation

2. Similar to the ranking method Z score is more effective method of regionalization. It is the deviation from mean which is taken into consideration for individual variable. After calculating cumulative Z score , it is advisable to have average Z score for further mapping. This technique brings out regional disparity in a effective way.

3. Alfa, Beta and Gama indices are used to examine effectiveness of the network. Alpha index refers to actual number of circuits to the maximum possible circuits. Beta index refers to area and total nodes while Gamma index take into consideration observed and possible links of the network.

4. Shortest path and direct path matrix is the two matrix which we use in network analysis.

In the shortest path matrix number of possibilities to connect point A to B are examined and then selection of the shortest path is made. This matrix refers to the accessibility of the network. In direct path only the direction connection between A and B is taken into consideration. This matrix refers to connectivity of the network.

## 4.9 TECHNICAL WORDS AND THEIR MEANING

**Variable** – the criteria which is selected for assessment of regional development. The selection of the criteria is very important.

**Choropleth** – It is a simple technique of mapping. Administrative divisons are taken into consideration and available data for such units are marked. This technique is suitable for regionalization exercise.

## 4.10 TASK

Take a transport map of either taluka or district (refer to Census of India site) of your state and calculate connectivity indices along with shortest path and direct path matrix. Interpret the results.

## 4.11 REFERENCES FOR FURTHER STUDY

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