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REMOTE SENSING- I

1.0. After going through this chapter, you will be able to understand the following:

Unit Structure :

1.1 OBJECTIVES

- To understand the new Geospatial technology: concept, components and importance.
- To understand the concept and history of remote sensing
- To understand the concept of EMR
- To learn concepts like resolution and applications of remote sensing

1.2 INTRODUCTION

Geospatial Technology is the new era of technology it can be very used full in geography, especially for geographic mapping purposes. Remote Sensing is the collection of information relating to objects without being in physical contact with them. Thus, our eyes and ears are remote sensors, and the same is true for cameras and

microphones and for many instruments used for all kinds of applications. Remote sensing is the process of acquiring data/information about objects/substances not in direct contact with the sensor, by gathering its inputs using electromagnetic radiation or acoustical waves that emanate from the targets of interest. An aerial photograph is a common example of a remotely sensed (by camera and film, or now digital) product.

1.3 SUBJECT DISCUSSION

Remote sensing makes it possible to collect data on dangerous or inaccessible areas. Remote sensing applications include monitoring deforestation in areas such as the Amazon Basin, the effects of climate change on glaciers and Arctic and Antarctic regions, along with depth sounding of coastal and ocean depths. Remote sensing also replaces costly and slow data collection on the ground, ensuring in the process that areas or objects are not disturbed.

1.4 GEOSPATIAL TECHNOLOGY : CONCEPT, COMPONENTS AND IMPORTANCE

Geospatial technology is a term that describes the range of modern tools contributing to the geographic mapping and analysis of the Earth and human societies. These technologies have been evolving in some form since the first maps were drawn in prehistoric times. In the 19th century, the long important schools of cartography and mapmaking were joined by aerial photography as early cameras were sent aloft on balloons and pigeons, and then on aeroplanes during the 20th century. The science and art of photographic interpretation and map-making was accelerated during the Second World War and during the Cold War it took on new dimensions with the advent of satellites and computers. Satellites allowed images of the Earth's surface and human activities therein with certain limitations. Computers allowed storage and transfer of imagery together with the development of associated digital software, maps, and data sets on socioeconomic and environmental phenomena, collectively called geographic information systems (GIS). An important aspect of a GIS is its ability to assemble the range of geospatial data into a layered set of maps which allow complex themes to be analyzed and then communicated to wider audiences. This 'layering' is enabled by the fact that all such data includes information on its precise location on the surface of the Earth, hence the term 'geospatial'.

Especially in the last decade, these technologies have evolved into a network of national security, scientific, and commercially operated satellites complemented by powerful desktop GIS. In addition, aerial remote sensing platforms, including unmanned aerial vehicles (e.g. the Global Hawk reconnaissance drone), are seeing increased non-military use as well. High quality hardware and data is now available to new audiences such as universities, corporations, and non-governmental organizations. The fields and sectors deploying these technologies are currently growing at a rapid pace, informing decision makers on topics such as industrial engineering, biodiversity conservation, forest fire suppression, agricultural monitoring, humanitarian relief, and much more.

There are now a variety of types of geospatial technologies potentially applicable to human rights, including the following:

- Remote Sensing: imagery and data collected from space- or airborne camera and sensor platforms. Some commercial satellite image providers now offer images showing details of one meter or smaller, making these images appropriate for monitoring humanitarian needs and human rights abuses.
- Geographic Information Systems (GIS): a suite of software tools for mapping and analyzing data which is georeferenced (assigned a specific location on the surface of the Earth, otherwise known as geospatial data). GIS can be used to detect geographic patterns in other data, such as disease clusters resulting from toxins, sub-optimal water access, etc.
- Global Positioning System (GPS): a network of U.S. Department of Defense satellites which can give precise coordinate locations to civilian and military users with proper receiving equipment (note: a similar European system called Galileo will be operational within the next several years while a Russian system is functioning but restricted).
- Internet Mapping Technologies: software programs like Google Earth and web features like Microsoft Virtual Earth are changing the way geospatial data is viewed and shared. The developments in user interface are also making such technologies available to a wider audience whereas traditional GIS has been reserved for specialists and those who invest time in learning complex software programs.

1.5. DEFINITION AND CONCEPT OF REMOTE SENSING

Definition: Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object.

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, based on propagated signals (e.g. electromagnetic radiation). It may be split into "active" remote sensing (i.e., when a signal is emitted by a satellite or aircraft and its reflection by the object is detected by the sensor) and "passive" remote sensing (i.e., when the reflection of sunlight is detected by the sensor).

Electro-magnetic radiation which is **reflected** or **emitted** from an object is the usual source of remote sensing data. However, any media such as gravity or magnetic fields can be utilized in remote sensing. 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. The technical term "remote sensing" was first used in the United States in the 1960's, and encompassed photogrammetry, photo-interpretation, photo-geology etc. Since Landsat-1, the First earth observation satellite was launched in 1972; remote sensing has become widely used. The characteristics of an object can be determined; using reflected or emitted electro-magnetic radiation, from the object. That is, "each object has a unique and different characteristic of reflection or emission if the type of deject or the environmental condition is different.” Remote sensing is a technology to identify and understand the object or the environmental condition through the uniqueness of the reflection or emission.

- **History of Indian Remote Sensing**

Remote sensing has been with us for longer than you may think. In the 1600 Galileo used optical enhancement to survey celestial bodies. Photographer Gaspard Felix Tournachon attempted to perform land surveys in 1859 using photos taken from balloons.

- **Development of Remote Sensing in India from Years 1975 – 2017**

1) Aryabhatta satellite was launched in the year 19 April 1975
2) Bhaskar Segal satellite was launched in the year 7 June 1979
3) Rohini RS – 1 satellite was launched in the year 18 July 1980
4) Bhaskar – II satellite was launch in the year 20 November
5) INSAT - 1B Satellite was launched in the year 30 August 1983
6) Stretched Rohini Satellite Services (SROSS - 1) satellite was launched in the year 24 March 1987
7) IRS – IA Satellite was launch in the year 17 March 1988
8) INSAT – IC satellite was launch in the year 12 June 1990
9) 1RS – 1 N satellite was launch in the year 29 August 1991

10) Stretched Rohini Satellite Series (SROSS C) was launched in the year 20 May 1992

11) INSAT - 2B Satellite was launched in the year 23 July 1993

12) Stretched Rohini Satellite Series (SROSS – C2) was launched in the year 4 May 1994

13) INSAT - 2D Satellite was launched in the year 4 June 1997

14) INSAT - 2E Satellite was launched in the year 3 April 1999

15) INSAT - 3B Satellite was launched in the year 22 March 2000

16) GSAT – 1 satellite was launched in the year 18 April 2001

17) EDUSAT Satellite was launched in the year 20 October 2004

18) Oceansat – 2 (IRS - P4) satellite was launched in the year 23

19) GSAT – 4 Satellite was launched in the year 15 April 2010

20) YouthSat satellite was launched in the year 20 April 2011

21) IRNSS – 1F Satellite was launched in the year 10 March 2016

22) Cartosat – 2D satellite was launched in the year 15 February 2017

23) Remote sensing is the process of acquisition of information about objects or phenomenon without making physical contact with the object and thus in contrast to on site observations. 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. the process involved in remote sensing is collection of data about an object from distance. Remote means far away and sensing means getting information. Here sensors are used to sense objects. The sensor records information about an object by measuring the "ELECTROMAGNETIC ENERGY" reflected back to the earth surface September 200

1.6. CONCEPT OF ELECTROMAGNETIC RADIATION (EMR)

Electromagnetic radiation (EM radiation or EMR) 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.

Electromagnetic waves are produced whenever charged particles are faster, and these waves can subsequently interact with other charged particles. Electromagnetic radiation is associated with those EM waves that are free to propagate themselves ("radiate") without the continuing influence of the moving charges that produced them, because they have achieved sufficient distance from those charges.

➢ **Wave Length & Wave Frequency**

Wavelength is a measure of the distance between repetitions of a shape feature such as peaks, valleys, or zero- crossings, not a measure of how far any given particle moves. The range of wavelengths or frequencies for wave phenomena is called a spectrum. The name originated with the visible light spectrum but now can be applied to the entire electromagnetic spectrum as well as to a sound spectrum or vibration spectrum. Wavelength is commonly designated by the Greek letter *lambda* (λ).

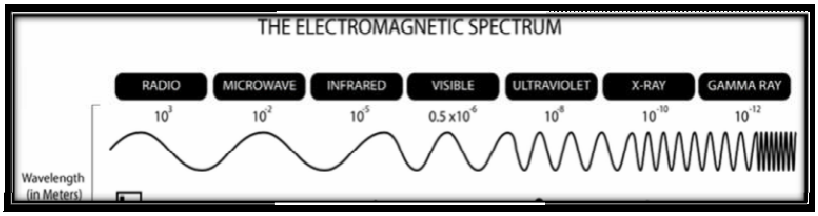
Assuming that waves move at a fixed wave speed, wavelength is inversely proportional to frequency of the wave: waves with higher frequencies have shorter wavelengths, and lower frequencies have longer wavelengths.

Examples of wave-like phenomena are sound waves, light, water waves and periodic electrical signals in a conductor.

➢ **Electromagnetic Spectrum**

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.

- Infrared radiation has longer wavelengths than those of visible light. Infrared was discovered in 1800 by astronomer SIR W.HERSCHEL. These radiations are just beyond what our eyes can detect on the red site of the rainbow. We are surrounded by infrared every moment.

- 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.

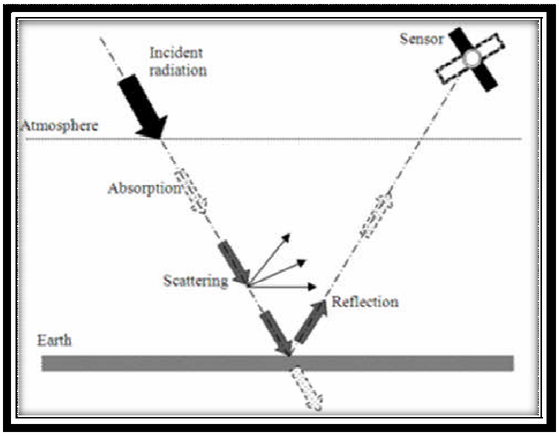
- Ultra violet radiations shorter than that of visible light but longer than x rays. It constitutes of 10% of the total light output of the sun and it is present in the sunlight. These waves just beyond what our eye can see beyond violet side of rainbow. Ultraviolet are absorbed by the atmosphere particularly ozone layer UV rays can be used in hospitals, UV lamps, to sterilize surgical equipment etc.

- X-rays wavelengths are shorter than those of gamma rays. X-rays are high in frequency and carries lots of energy. They pass through most of the substances and are majorly used in medical industry.

- The gamma rays have the high frequency high energy and are shorter wavelengths rays. These rays are the product of radioactive element.

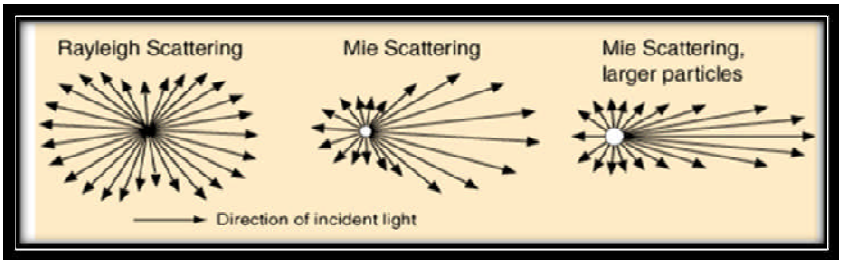
➢ EMR Interaction with Atmosphere and Earth Surface

The radiation from the energy source passes through some distance before being detected by the remote sensors. The interaction of MR 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.



- **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:

1. **Rayleigh scattering** occurs when particles are very small compared to the wavelength of the radiation. These could be particles such as small specks of dust or nitrogen and



oxygen molecules. Rayleigh scattering causes shorter wavelengths of energy to be scattered much more than longer wavelengths.

2. **Mie scattering** occurs when the particles are just about the same size as the wavelength of the radiation. Dust, pollen, smoke and water vapour are common causes of Mie scattering which tends to affect longer wavelengths than those affected by Rayleigh scattering.

3. **Non-Selective Scattering** occurs when the particles are much larger than the wavelength of the radiation.

- **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 ozone. Gaseous components of the atmosphere are selective absorbers of the electromagnetic radiation, i.e., these gases absorb electromagnetic energy in specific wavelength bands.

1.7. 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.

1.8 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.
- **Environmental 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 along 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.

1.9 OPEN DATA SITES OF REMOTE SENSING: EXPLORE/ ACCESS/ OPEN BHUVAN WEBSITE

Visit the websites that provide free remotely sensed data.

1.10 CHECK YOUR PROGRESS

1. Fill in the Blanks:

a) The technical term "remote sensing" was first used in the in the ___________1960's.

b) __________is the process in which oncident energy retained by particles in the atsmophere at a given wavelength.

c) ____________are the type of electromagnetic radiation with wavelength in the electromagnetic spectrum longer than infrared light.

d) Infrared was discovered in 1800 by astronomer ___________.

e) Wavelength is inversely proportional to_________of the wave.

2. Name the Following:

a. A device to detect the electro-magnetic radiation reflected or emitted from an object

b. A measure used to describe the sharpness and clarity of an image or picture

c. The first earth observation satellite that was launched in 1972

d. The resolution which is usually expressed in days.

e. A common example of a remotely sensed product.

3. Match the Column:

A	B
a. Rayleigh scattering	i. Medical industry
b. X rays	ii. Aircraft
c. Aryabhatta	iii. Sensor
d. Platform	iv. Very small particles
e. Camera	v. First Indian satellite

1.11 ANSWERS TO THE QUESTIONS

1. Fill in the Blanks:

a. United States

b. Absorption

c. Radio waves

d. Sir W. Herschel e. Frequency

2. Name the Following:

a. Remote Sensor/ Sensor

b. Resolution

c. Since Landsat-1

d. Temporal

e. An aerial photograph

3. Match the Column:

a. Very small particles

b. Medical industry

c. First Indian satellite

d. Aircraft e. Sensor

1.12 TECHNICAL WORDS AND THEIR MEANINGS

- **Wavelength**: the distance between successive crests of a wave, especially points in a sound wave or electromagnetic wave.
- **Spectrum**: a band of colours, as seen in a rainbow, produced by separation of the components of light by their different degrees of refraction according to wavelength.
- **Radiation**: the emission of energy as electromagnetic waves, especially high-energy particles which cause ionization.

1.13 TASK

Visit Google Earth and observe the globe carefully. Try downloading historical images for an area of your choice using the relevant tool. Discuss the changes that have taken place and possible reasons for the same.

6.13. REFERENCES FOR FURTHER STUDY

- Joseph, George (2005): 'Fundamentals of Remote Sensing', Universities Press, Hyderabad
- Campbell, James (2011): 'Introduction to Remote Sensing, Guildford Press, New York
- Kumar, S (2005): 'Basics of Remote Sensing and GIS', Laxm Publications, New Delhi

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2

REMOTE SENSING – II

2.0. After going through this chapter you will be able to understand the following:

Unit Structure :

2.1 OBJECTIVES

- To learn different tasks of image interpretation
- To learn the elements of image interpretation
- To understand the process of visual image interpretation
- To learn the process of thematic mapping

2.2 INTRODUCTION

Image interpretation is a powerful technique that helps us to identify and distinguish various features in satellite imageries and aerial photographs. Image interpretation involves identification of various features such as forest cover, water bodies, urban settlement, agriculture, barren land, etc. Identifying individual features from images and photographs is a key to interpretation and information extraction.

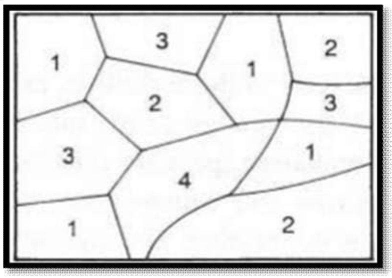
2.3. SUBJECT DISCUSSION

Remote sensing is the art of extraction of information about an object or phenomena without coming into physical contact with it. It is done through satellites and air mounted cameras. Therefore, there are two types of remotely sensed data- satellite imageries and aerial photographs respectively. Capturing images and photographs is the first step for interpretation and extracting information about the area under study. This chapter shall help us understand the keys of visual interpretation and preparation of thematic maps from base maps.

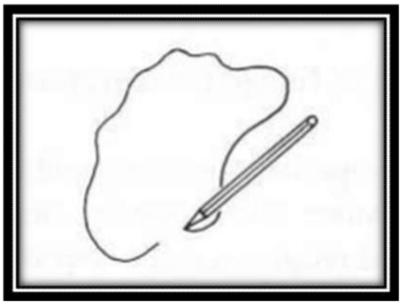
2.4 TASKS OF IMAGE INTERPRETATION: CLASSIFICATION, DELINEATION, MEASUREMENT

Image interpretation is not an art, but, a technique. If it is followed systematically, the accuracy of image interpretation will improve. The task of image interpretation can be classified into the following:

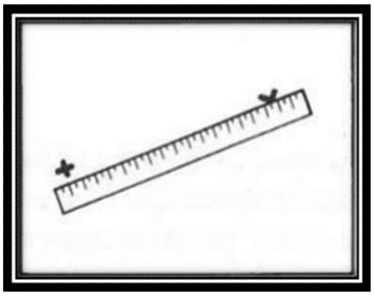
a. **Classification**: This task includes identification of elements on the images and classifying them into various features with the help of a table. It also includes enumeration of features to keep a count of the same. Same number or symbols may be used to depict same features. For example in the figure, numbers are used to indicate the same features. No. 1 represents fields, no. 2 represents water body, no. 3 represents settlements and no. 4 represents government land.



b. **Delineation**: This task includes delineation of features that are identified using similar numbers or symbols. This is done using a marker or colour so that different boundaries can be identified. It helps in creating a new map showing clearly delineated features and land uses. The figure depicts how features can be delineated using a pencil or a pen.

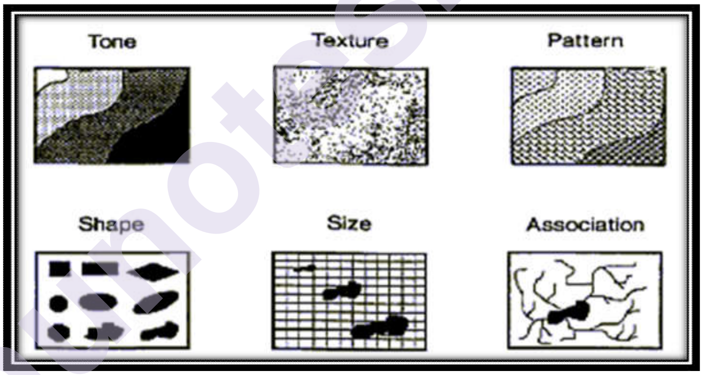


c. **Measurement**: This task helps us to measure the distance between features and area, perimeter, etc. of the features. The scale of the image helps to convert the distance measured using a geometric scale (in cms., mm., etc.) into distance on the ground (in Kms., miles etc.). The figure besides represents how the distance between features can be measured on scale.



2.5 ELEMENTS OF IMAGE INTERPRETATION: TONE, TEXTURE, PATTERN, SIZE, SHAPE, SHADOW AND ASSOCIATION

a. **Tone**: Tone refers to the particular quality of brightness, deepness, or hue of a shade of a colour. Therefore tone refers to relative brightness or colour of a feature on an image. The tonal variation makes it easier to differentiate between various features on an image. Shapes, patterns and textures on an image are identifiable mainly due tonal variation.



b. **Shape**: Shape refers to the outline or structure of a particular feature. The man made features are generally regular, symmetric or sharp in shape while all natural features are irregular in shape. Most of the features can solely be identified using the shape element of visual interpretation.

c. **Size**: Comparing size of a feature in context with others in an image helps in better understanding and interpretation of an image. A quick estimate of size of a feature makes image interpretation process faster and convenient.

d. **Pattern**: Pattern refers to spatial arrangement of features. A repeated sequence of certain form or relationships is characteristic of many natural and constructed features which give an added advantage for interpretation.

e. **Texture**: Texture refers to frequency of tonal changes in a certain area of an image. It is product of shape, size, tone, shadow and pattern of a particular feature. It decides upon the visual roughness or smoothness of an image. Abrupt changes in grey scale results in Rough texture while very minor tonal variations are seen in smooth textures.

f. **Shadow**: Shadow refers to a dark area produced by the features coming between light rays and surface. Shadows provide certain relative height information of the feature and also an idea of the terrain profile.

g. **Association**: Association is occurrence of certain feature in relation with other. Certain features are not directly identifiable by its appearance in an image but could be interpreted easily according to its relationship with the surroundings. For example association of boats with water, aircraft with runway, playground with school etc.

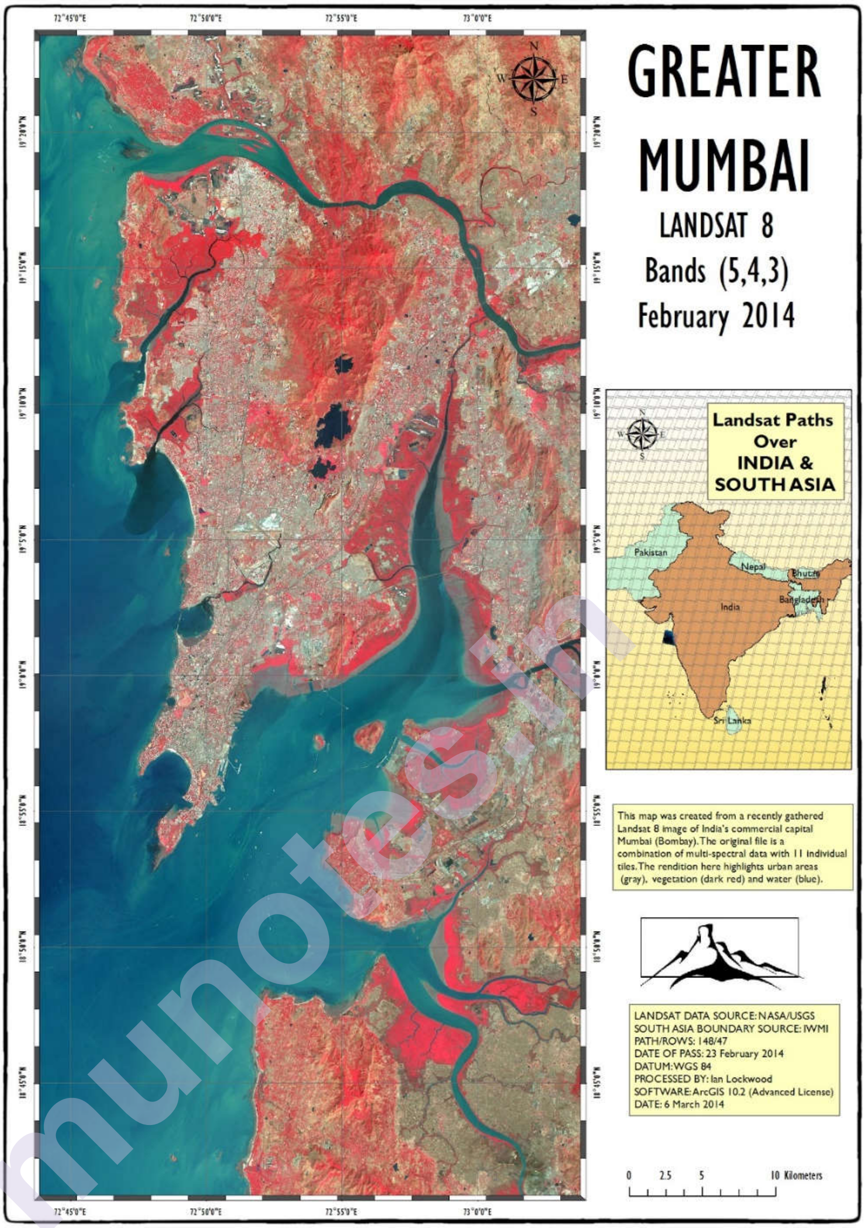
h. **Colour key**: The satellite imageries are of two types- False Colour Composite (FCC) and True Colour Composite (TCC). The FCC represents the features in different colours from its actual colours which make it to be called as false colours. The TCC represents all features in the same colour as on the ground. However, FCC is more reliable. The following table shows the common features' colours which may help you in interpreting the images:

Feature	Colour in FCC	Colour in TCC
Vegetation/Agriculture	Red	Green
Water bodies	Black to Dark Blue	Blue
Settlements	Grey	Varies depending upon the area
Transport lines	Black	Red/Grey

2.6 VISUAL IMAGE INTERPRETATION

Just like how we visualize and try to understand our environment, visual interpretation involves visualizing and understanding features in an image or a photograph. It includes the meaning of the image content but also goes beyond what can be seen on the image in order to recognize spatial patterns. This process can be roughly divided into 2 levels:

- The **recognition of objects** such as streets, fields, rivers, etc. The quality of recognition depends on the expertise in image interpretation and visual perception.



- A **true interpretation** can be ascertained through conclusions (from previously recognized objects) of situations, recovery, etc. Subject specific knowledge and expertise are crucial.

Here is an example of visual image interpretation to help you understand the process:

Interpretation: The above satellite imagery is of Greater Mumbai. It has been captured from Landsat 8 in February 2014. The bands used represent the image are 5, 4 and 3.

In the image, it can be observed that, there exists a lot of vegetation which is represented in red colour. The red colour on the coasts represents mangrove vegetation and the red patch in the eastern part represents natural vegetation which is a part of Sanjay Gandhi National Park. An airport can also be observed in the central part. Three lakes can be observed in the southern parts of Sanjay Gandhi National Park viz. Powai lake, Tulsi lake and Vihar lake. There exists a huge water body around the city which is Arabian Sea in the west and south and Thane creek in the east. In the north of the island exists Ulhas river. The city is highly urban in nature, the settlements are therefore dense in nature. It is thus a clustered pattern of settlement.

2.7 THEMATIC MAPPING: GENERATION OF HEMATIC MAPS USING TRACE PAPER

To prepare a thematic map by tracing, a proper base map is essential first. The following are the requirements in a base map:

- Proper map scale to enable appropriate presentation of interpreted information

- Geographic coordinate system to establish the geographic reference

- Basic map information to be printed in light tones as background which results in enhancement of interpreted information.

Following are the types of base maps which can be used to create a thematic map:

- A **topographic map** with a scale of 1:50,000, 1:100,000 or 1:250,000 is usually the preferable base map for higher resolution satellite image interpretation.

- **Orthophoto maps** are more easily used by cartographers for the transfer of interpreted information, particularly in the case of forest classification.

- **NATMO maps** are best source of thematic information. They are ready to use thematic maps with all the essential elements.

The procedure for tracing the thematic map is as follows:

Place a tracing paper on the base map. Mark the corners and fix them using a paper clip or a nail so that the paper doesn't move while tracing. Now start tracing the borders along with the information as per requirement. Now transfer the traced information onto a paper where the map will be finalized using a tracing table. With the light in the tracing table, it will be easier to see through the paper and error minimization. Represent information with the help of different colours and symbols.

2.8 SUMMARY

Remote sensing is the art of extraction of information about an object or phenomena without coming into physical contact with it. Image interpretation involves identification of various features such as forest cover, water bodies, urban settlement, agriculture, barren land, etc. Identifying individual features from images and photographs is a key to interpretation and information extraction. The elements of image interpretation include shape, size, tone, texture, pattern, association and shadow.

2.9 CHECK YOUR PROGRESS

1. Fill in the Blanks

a. _________is a powerful technique that helps us to identify and distinguish various features

b. ________ refers to spatial arrangement of features

c. Geographic coordinate system is used to establish the ________

d. __________ helps in creating a new map showing clearly delineated features and land uses

e. A quick estimate of _________ of a feature makes imageinterpretation process faster and convenient.

2. Match the Columns

A	B
a. Classification	i. Distance between two features
b. Measurement	ii. Location of features
c. Association	iii. Identification of features
d. FCC	iv. Demarcating features
e. Delineation	v. Vegetation in Red colour

3. True of False

a. Tracing table helps to see through the paper for proper creation of thematic maps

b. Transport lines are represented in red colour in FCC images

c. The man made features are generally regular, symmetric or sharp in shape

d. NATMO maps are best source of thematic information

e. The TCC represents all features in the different colour.

2.10 ANSWERS TO THE QUESTIONS

1. Fill in the blanks:

a. Image interpretation

b. Pattern

c. Geographic reference

d. Delineation

e. Size

2. Match the Columns:

a. iii

b. i

c. ii

d. v

e. iv

3. True or False:

a. True

b. False

c. True

d. True

e. False

2.11 TECHNICAL WORDS AND THEIR MEANINGS

- **Remote sensing:** The scanning of the earth by satellite or high-flying aircraft in order to obtain information about it.
- **Aerial photography:** Aerial photography is the taking of photographs of the ground from an elevated/direct-down position. Usually the camera is not supported by a ground-based structure.
- **Satellite imagery:** Satellite imagery is images of Earth or other planets collected by imaging satellites operated by governments and businesses around the world.
- **Thematic map:** A thematic map is a map that emphasizes a particular theme or special topic such as the average distribution of rainfall in an area. They are different from general reference maps because they do not just show natural features like rivers, cities, political subdivisions and highways.

2.12 TASK

- Interpret two satellite imageries- cultural and physical
- Interpret any two aerial photographs

2.13 REFERENCES FOR FURTHER STUDY

- Lille sand, Thomas; Kiefer Ralph and Chipman, Jonathan (2015): 'Remote Sensing and Image Interpretation', Wiley Publications, USA.
- Bryson, Norman; Holly Michael and Moxey, Keith eds. (1994): 'Visual Culture: Images and Interpretations', Wesleyan University Press, USA.
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3

GLOBAL POSITIONING SYSTEM (GPS)

3.0. After going through this chapter, you will be able to understand the following:

Unit Structure :

3.1 OBJECTIVES

- To understand the definition and concept of GPS
- To understand the components and types of GPS
- To learn the applications of GPS and undertake hands-on practical with GPS

3.2 INTRODUCTION

The Global Positioning System was conceived in 1960 under the sponsorship of the U.S. Air Force, but in 1974 the other branches of the U.S. military joined the effort. The first satellites were launched into space in 1978. The System was declared fully operational in April 1995. The

Global Positioning System consists of 24 satellites, that circle the globe once every 12 hours, to provide worldwide position, time and velocity information. GPS makes it possible to precisely identify locations on the earth by measuring distance from the satellites. GPS allows you to record or create locations from places on the earth and help you navigate to and from those places. Originally the System was designed only for military applications and it wasn't until the 1980's that it was made available for civilian use also.

3.3 SUBJECT DISCUSSION

The Global Positioning System (GPS), originally Navstar GPS, is a space-based radio navigation system owned by the United States government and operated by the United States Air Force. It is a global navigation satellite system that provides geolocation and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The GPS system provides critical positioning capabilities to military, civil, and commercial users around the world. The United States government created the system, maintains it, and makes it freely accessible to anyone with a GPS receiver. Advances in technology and new demands on the existing system have now led to efforts to modernize the GPS.

The Russian Global Navigation Satellite System (GLONASS) was developed contemporaneously with GPS, but suffered from incomplete coverage of the globe until the mid-2000s. GLONASS can be added to GPS devices, making more satellites available and enabling positions to be fixed more quickly and accurately, to within two meters. There are also the European Union Galileo positioning system, China's BeiDou Navigation Satellite System, India's NAVIC and Japan's Quasi-Zenith Satellite System.

3.4 DEFINITION AND CONCEPT

- **Definition**: GPS stands for "Global Positioning System." It may be defined as 'a satellite navigation system used to determine the ground position of an object.'

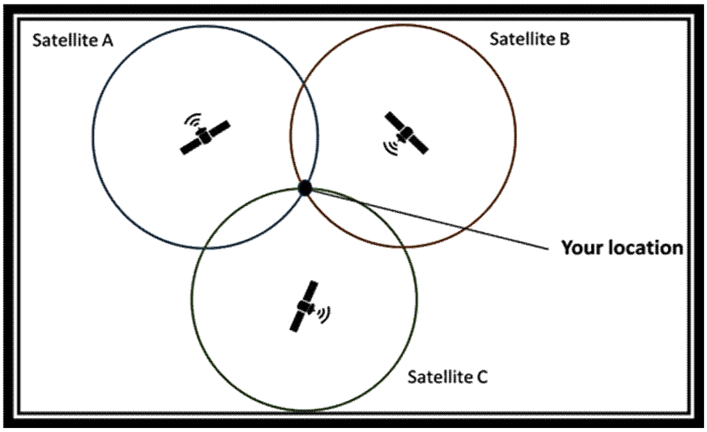

Fig: 01: Trialteration of GPS

➢ **Concept**: GPS receivers take information transmitted from the satellites and uses triangulation to calculate a user's exact location. The GPS constellation consists of two dozen GPS satellites in medium Earth orbit. A GPS receiver can tell its own position by using the position data of it, and compares that data with 3 or more GPS satellites. To get the distance to each satellite, the GPS transmits a signal to each satellite. The signal travels at a known speed. The system measures the time delay between the signal transmission and signal reception of the GPS signal. The signals carry information about the satellite's location. Determines the position of, and distance to, at least three satellites, to reduce error. The receiver computes position using trilateration.

➢ **Functioning of GPS**: The basis of the GPS is a constellation of satellites that are continuously orbiting the earth. These satellites, which are equipped with atomic clocks, transmit radio signals that contain their exact location, time, and other information. The radio signals from the satellites, which are monitored and corrected by control stations, are picked up by the GPS receiver. A GPS receiver needs only three satellites to plot a rough, 2D position, which will not be very accurate. Ideally, four or more satellites are needed to plot a 3D position, which is much more accurate.

3.5 COMPONENTS OF GP

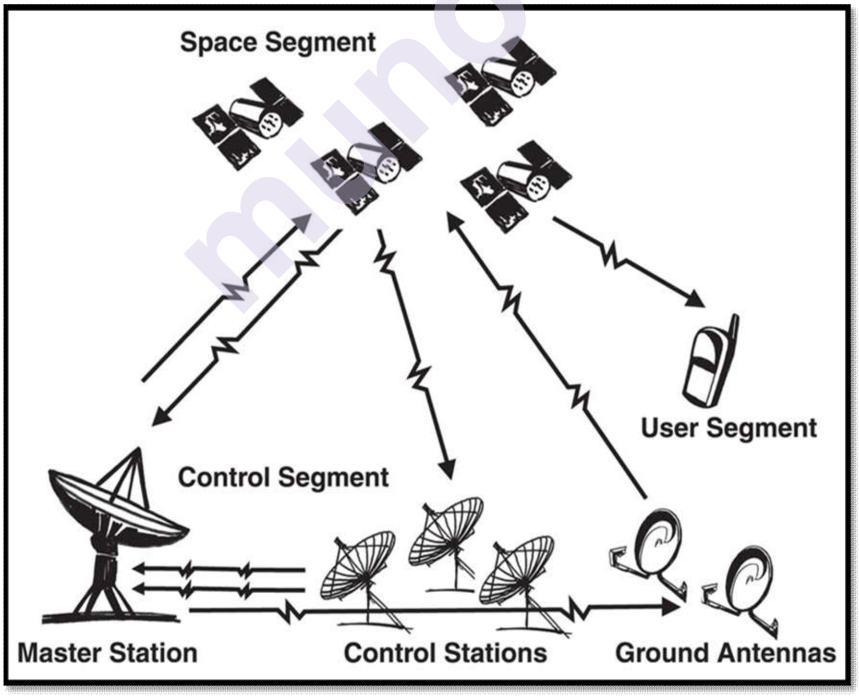

Fig: 02: Components/ Segments of GPS

➢ **Space Segment:** The space segment consists of 29 satellites circling the earth every 12 hours at 12,000 miles in altitude. This high altitude allows the signals to cover a greater area. The satellites are arranged in their orbits so a GPS receiver on earth can receive a signal from at least four satellites at any given time. Each satellite contains several atomic clocks. The satellites transmit low radio signals with a unique code on different frequencies, allowing the GPS receiver to identify the signals. The main purpose of these coded signals is to allow the GPS receiver to calculate travel time of the radio signal from the satellite to the receiver. The travel time multiplied by the speed of light equals the distance from the satellite to the GPS receiver.

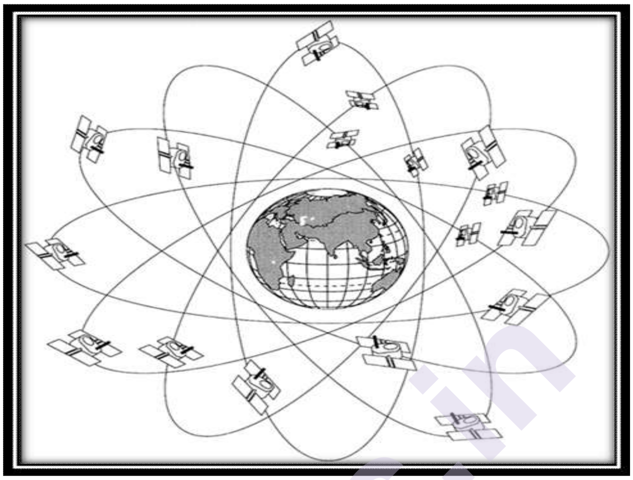

Fig: 03: Satellite Constellation of GPS

- **Control Segment:** The control segment tracks the satellites and then provides them with corrected orbital and time information. The control segment consists of five unmanned monitor stations and one Master Control Station. The five unmanned stations monitor GPS satellite signals and then send that information to the Master Control Station where anomalies are corrected and sent back to the GPS satellites through ground antennas.

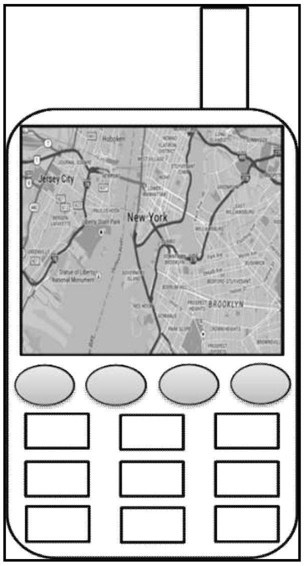

Fig: 04: GPS Receiver

- **User Segment:** The user segment consists of the users and their GPS receivers. The number of simultaneous users is limitless. The user receivers can be hand-held or, can be placed in a vehicle. All GPS receivers have a calendar programmed into their computer, which tells them where each satellite is at any given moment.

3.6 TYPES OF GPS: MAN HELD GPS AND DGPS

- **GPS:** A global positioning system (GPS) is a navigation system that consists of one or more earth-based receivers that accept and analyze signals sent by satellites in order to determine the receiver's geographic location. A GPS receiver is a handheld, mountable, or embedded device that contains an antenna, a radio receiver, and a processor. Many include a screen display that shows an individual's location on a map. Some also function as a portable media player. Many mobile devices such as smart phones have GPS capability built into the device or as an add-on feature. Some users carry a handheld GPS receiver; others mount a receiver to an object such as an automobile, boat, airplane, farm and construction equipment, or computer.

- **DGPS:** DGPS stands for Differential Global Positioning System, is an enhancement in GPS that is created to provide more location accuracy. Satellites in the space provide signals to the earth's surface at the speed of light, but through any atmospheric change there can be an error. And due to this error, a delay can be caused, and for all these errors, DGPS is created and it adjusts these errors to provide accurate location. Fixed, ground based reference stations are used in the DGPS systems, that broadcasts the difference between positions GPS satellite systems and known fixed positions. DGPS refers to a general technique of Augmentation.

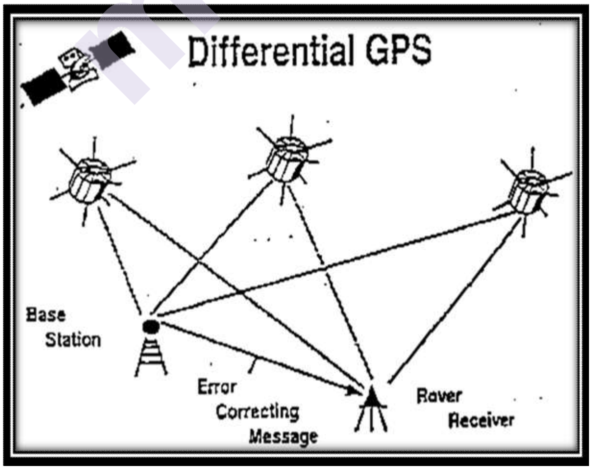

Fig: 05: Functioning of DGPS

3.7 APPLICATIONS: GPS APPLICATIONS IN GEOGRAPHY AND GENERAL USE

GPS isn't just used by civilians; it's also used by pilots, boat captains, farmers, surveyors, scientists and the military too. Following are some of the applications of GPS:

- **Aviation**: Almost all modern aircraft are fitted with multiple GPS receivers. This provides pilots (and sometimes passengers) with a real-time aircraft position and map of each flight's progress. GPS also allows airline operators to pre-select the safest, fastest and most fuel-efficient routes to each destination, and ensure that each route is followed as closely as possible when the flight is underway.

- **Marine**: When high accuracy GPS is fitted to boats and ships, it allows captains to navigate through unfamiliar harbours, shipping channels and waterways without running aground or hitting known obstacles. GPS is also used to position and map dredging operations in rivers, wharfs and sandbars, so other boats know precisely where it is deep enough for them to operate.

- **Farming**: Farmers rely on repeat planting season after season to maximize their crop productions. By putting GPS receivers on tractors and other agricultural equipment, farmers can map their plantations and ensure that they return to exactly the same areas when sewing their seeds in future. This strategy also allows farmers to continue working in low visibility conditions such as fog and darkness, as each piece of machinery is guided by its GPS position instead of visual references. High accuracy GPS is also used to map soil sample locations, allowing farmers to see where the soil is most fertile across individual fields or even entire farms.

- **Science:** Scientists use GPS technology to conduct a wide range of experiments and research, ranging from biology to physics to earth sciences. Traditionally, when scientists wanted to understand where and how far animals roam, they had to tag animals with metal or plastic bands and then follow them to various locations to monitor their movement. Today, scientists can fit animals with GPS collars or tags that automatically log the animal's movement and transmit the information via satellite back to the researchers. This provides them with more detailed information about the animal's movements without having to relocate specific animals. Earth scientists also use GPS technology to conduct a wide range of research. By installing high accuracy GPS receivers on physical features such as glaciers or landslips, scientists can observe and study both the speed and direction of movement, helping them to understand how landscapes change over time. Similarly, GPS receivers can be installed on solid bedrock to help understand very small and very slow changes in tectonic plate motion across the world.

- **Surveying:** Surveyors are responsible for mapping and measuring features on the earth's surface and under water with high accuracy. This includes things like determining land boundaries, monitoring changes in the shape of structures or mapping the sea floor. Surveyors have historically required line-of-sight between their instruments in order to undertake such work, but the availability of high accuracy GPS receivers has reduced the need for this. GPS can either be setup over a single point to establish a reference marker, or it can be used in a moving configuration to map out the boundaries of various features. This data can then be transferred into mapping software to create very quick and detailed maps for customers.

- **Military:** The GPS system was originally developed by the United States Department of Defence for use by the US military, but was later made available for public use. Since then, GPS navigation has been adopted by many different military forces around the world, including the Australian Defence Force. Some countries have even decided to develop their own satellite navigation networks for use during wartimes. Today, GPS is used to map the location of vehicles and other assets on various battlefields in real time, which helps to manage resources and protect soldiers on the ground. GPS technology is also fitted to military vehicles and other hardware such as missiles, providing them with tracking and guidance to various targets at all times of the day and in all weather conditions

3.8 HANDS-ON/ PRACTICAL: DEMARCATION OF POINT, LINE AND POLYGON FEATURES USING GPS

Using a GPS, a survey can be conducted. Location of point features like trees, wells, street lights, etc. can be recorded. Similarly, a linear feature like a pathway, road, a route, railway line, river etc. can be selected. The locations of starting point and ending point can be recorded. Also, several locations on the circumference of an aerial feature like a garden, a playground, parking area of a mall, etc. can be recorded. After the survey is over, we can connect the GPS to a computer having the required software and transfer the locational information to demarcate the point, line and polygon features or a mental map can be drawn to plot the locational information at the points surveyed. Use of appropriate cartographic symbols is highly essential.

3.9 SUMMARY

The Global Positioning System (GPS), originally Navstar GPS, is a space-based radio navigation system owned by the United States government and operated by the United States Air Force. GPS stands for "Global Positioning System." It may be defined as 'a satellite navigation system used to determine the ground position of an object.' GPS receivers take information transmitted from the satellites and uses triangulation to calculate a user's exact location. It consists of three components viz. space segment, control segment and user segment. DGPS stands for Differential

Global Positioning System, is an enhancement in GPS that is created to provide more location accuracy

GPS isn't just used by civilians; it's also used by pilots, boat captains, farmers, surveyors, scientists and the military too. Using a GPS, a survey can be conducted. Location of point features like trees, wells, street lights, etc. can be recorded.

3.10 CHECK YOUR PROGRESS

1. Fill in the Blanks:

a. The Global Positioning System (GPS) is originally ________ GPS.

b. The basis of the GPS is a ___________that are continuously orbiting the earth.

c. Use of appropriate ____________symbols is highly essential in map making.

d. DGPS refers to a general technique of _________________.

e. The GPS constellation consists of two dozen GPS satellites in _________Earth orbit.

2. Name the Following:

a. The segment controlling the satellite constellation.

b. GPS used to calculate difference in the location value

c. Method of calculating location used by GPS

3. Match the Column:

A	B
a. Trees	i. Polygon feature
b. Mobile GPS	ii. Line feature
c. Food Court in a mall	iii. Error correction
d. DGPS	iv. Point feature
e. 100 mts. race track	v. User Segment

3.11 ANSWERS TO THE QUESTIONS

1. **Fill in the Blanks:**

   a. Navstar

   b. Constellation of satellites

   c. Cartographic

   d. Augmentation

   e. Medium

2. **Name the Following:**

   a. Control segment

   b. DGPS

   c. Trialteration method

3. **Match the Column:**

   a. Point feature

   b. User Segment

   c. Polygon feature

   d. Error correction

   e. Line feature

3.12 TECHNICAL WORDS AND THEIR MEANINGS

- **Satellite**: An artificial body placed in orbit round the earth or another planet in order to collect information or for communication.

- **Navigation**: The process or activity of accurately ascertaining one's position and planning and following a route.

- **Constellation**: A satellite constellation is a group of artificial satellites working in concert.

- **Point, line and polygon features**: Features used to represent real elements on computer in the form of vector data.

3.13 TASK

Using GPS in your smart phone or in car try to record locational information for different areas and plot them on a mental map.

3.14 REFERENCES FOR FURTHER STUDY

- El-Rabbany, Ahmed (2002): 'Introduction to GPS: The Global Positioning System', Artech House, London.
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- Brawn, David (2003): 'GPS: The Easy Way', Discovery Walking Guides Limited, England.

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4

GEOGRAPHICAL INFORMATION SYSTEM- I

4.0. After going through this chapter you will be able to understand the following:

Unit Structure :

4.1 OBJECTIVES

- To understand the concept and components of GIS
- To understand the applications of GIS
- To undertake hands-on/ practical using available or free software- Q GIS

4.2 INTRODUCTION

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. GIS can help individuals and organizations better understand spatial patterns and relationships. It is a crucial part of spatial data infrastructure. GIS can use any information that includes location. Many different types of information can be compared and contrasted using GIS. With GIS technology, people can compare the locations of different things in order to discover how they relate to each other. For example, using GIS, a single map could include sites that produce pollution, such as factories, and sites that are sensitive to pollution, such as wetlands and rivers. Such a map would help people determine where water supplies are most at risk.

4.3 SUBJECT DISCUSSION

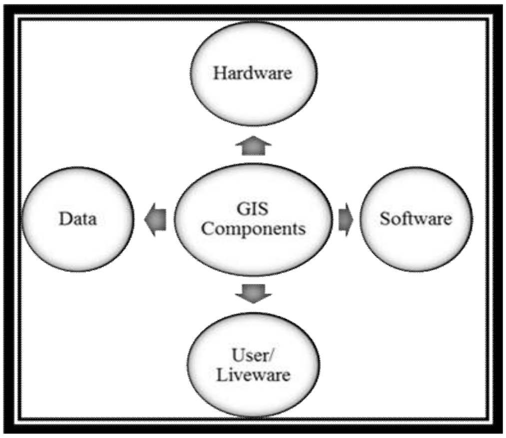
Technology has always been a companion to man and has helped in his development. GIS is one of the advanced technologies that has enabled man to understand changes that have taken place in the past, analyse space at one place and predict future of the same. The technology is computer based and is easy to grasp, but, requires expertise so that predictions and outcomes can be accurate. The technology has a geographical base, but, relates to every possible field and is still progressive.

3.4 DEFINITION, CONCEPT AND COMPONENTS

- **Definition**: A geographic information system (GIS) is a system designed to capture, store, manipulate, analyse, manage, and present spatial or geographic data.

- **Concept:** GIS is majorly a mapping technology. It may be carried out manually and digitally. It is heavily dependent on spatial and attribute data. It allows the data to be created and stored in the form of geometrical features in different layers. Each layer has its own identity and ability to be edited. All layers together make the entire map or the dataset. It enables various spatial, query and geometrical analysis. There are several commercial and open source softwares like ArcGIS and QGIS respectively. GIS basically helps in analysing land without visiting it much.

- **Components:** The components of GIS are as follows:



1. Software: GIS software provides the functions and tools needed to store, analyse, and display geographic information. Key software components are (a) a database management system (DBMS) (b) tools for the input and manipulation of geographic information (c) tools that support geographic query, analysis, and visualization (d) a graphical user interface (GUI) for easy access to tools. GIS softwares are either commercial software or software developed on Open Source domain, which are available for free.

2. **Hardware**: Hardware is the computer on which a GIS operates. Today, GIS runs on a wide range of hardware types, from centralized computer servers to desktop computers used in stand-alone or networked configurations.

3. **Data**: The most important component of a GIS is the data. Geographic data or spatial data and related tabular data can be collected in-house or bought from a commercial data provider. Spatial data can be in the form of a map/remotely-sensed data such as satellite imagery and aerial photography. These data forms must be properly georeferenced (latitude/longitude). Tabular data can be in the form attribute data that is in some way related to spatial data.

4. **Users:** GIS technology is of limited value without the users who manage the system and to develop plans for applying it. GIS users range from technical specialists who design and maintain the system to those who use it to help them do their everyday work. The user-friendly interface of the GIS software allows the nontechnical users to have easy access to GIS analytical capabilities without needing to know detailed software commands.

4.5 APPLICATIONS OF GIS IN GEOGRAPHY AND RELATED FIELDS

1. **GIS in Mapping**: Mapping is a central function of Geographic Information System, which provides a visual interpretation of data. People from different professions use map to communicate. It is not necessary to be a skilled cartographer to create maps.

2. **Telecom and Network services**: GIS can be a great planning and decision making tool for telecom industries. This technology allows telecom to enhance a variety of application like engineering application, customer relationship management and location based services.

3. **Accident Analysis and Hot Spot Analysis**: GIS can be used as a key tool to minimize accident hazard on roads, the existing road network has to be optimized and also the road safety measures have to be improved. This can be achieved by proper traffic management. By identifying the accident locations, remedial measures can be planned by the district administrations to minimize the accidents in different parts of the world.

4. **Urban Planning**: GIS technology is used to analyse the urban growth and its direction of expansion, and to find suitable sites for further urban development.

5. **Transportation Planning**: GIS can be used in managing transportation and logistical problems. GIS can also help in monitoring rail systems and road conditions.

6. **Environmental Impact Analysis**: EIA is an important policy initiative to conserve natural resources and environment. The EIA can be carried out efficiently by the help of GIS. By integrating various GIS layers, assessment of natural features can be performed.

7. **Agricultural Applications**: GIS can be used to create more effective and efficient farming techniques. It is fully integrated and widely accepted for helping government agencies to manage programs that support farmers and protect the environment. This could increase food production in different parts of the world so the world food crisis could be avoided.

8. **Disaster Management and Mitigation**: Today well-developed GIS systems are used to protect the environment. It has become an integrated, well developed and successful tool in disaster management and mitigation. GIS can help with risk management and analysis by displaying which areas are likely to be prone to natural or man-made disasters. When such disasters are identified, preventive measures can be developed.

9. **Determine land use/land cover changes**: Land cover means the feature that is covering the barren surface .Land use means the area in the surface utilized for particular use. The role of GIS technology in land use and land cover applications is that we can determine land use/land cover changes in the different areas. Also it can detect and estimate the changes in the land use/ land cover pattern within time. It enables to find out sudden changes in land use and land cover either by natural forces or by other activities like deforestation.

10. **Navigation (routing and scheduling)**: Web-based navigation maps encourage safe navigation in waterway. This division is providing public information that makes citizens awareness of these vessel locations through web map. The web map will be regularly updated to keep the boating public informed of these coastal hazards to minimize risk of collision and injury.

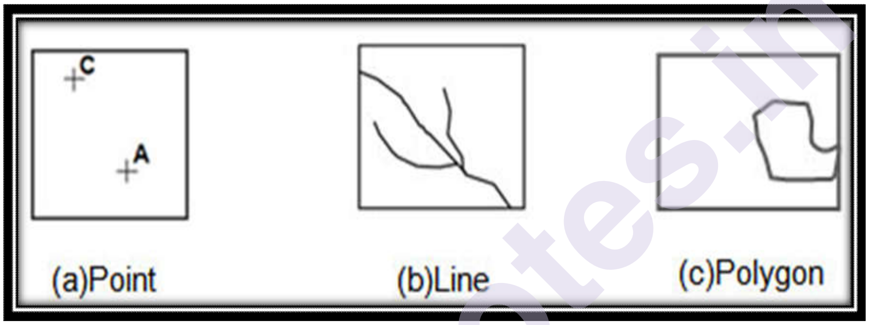
4.6 HANDS-ON/ PRACTICAL USING AVAILABLE OR FREES SOFTWARE- Q GIS QUANTUM GEOGRAPHICAL INFORMATION SYSTEM (QGIS):

QGIS stands for Quantum GIS. It is a cross-platform free and open-source desktop geographic information system (GIS) application that supports viewing, editing, and analysis of geospatial data. QGIS functions as geographic information system (GIS) software, allowing users to analyse and edit spatial information, in addition to composing and exporting graphical maps. QGIS supports both raster and vector layers; vector data is stored as either point, line, or polygon features. Multiple formats of raster images are supported and the software can geo-reference images.

- **Geo-referencing:** Geo-referencing means to associate something with locations in physical space. The term is commonly used in the geographic information systems field to describe the process of associating a physical map or raster image of a map with spatial locations.

Georeferencing may be applied to any kind of object or structure that can be related to a geographical location, such as points of interest, roads, places, bridges, or buildings Geographic locations are most commonly represented using a coordinate reference system, which in turn can be related to a geodetic reference system such as WGS-84.

- **Digitization:** Digitizing in GIS is the process of converting geographic data either from a hardcopy or a scanned image into vector data by tracing the features. During the digitizing process, features from the traced map or image are captured as coordinates in either point, line, or polygon format.



1. Point layer: Points are the zero-dimensional objects that contain only a single coordinate pair. Points are typically used to model singular, discrete features such as buildings, wells, power poles, sample locations, and so forth. Points have only property of locations. Other types of point feature include the node and the vertex. Points can be spatially linked to form more complex features.

2. Line layer: Lines are one dimensional features composed of multiple, explicitly connected points. Lines are used to represent linear features such as roads, streams, faults, boundaries, and so forth. Lines have a property of length. Lines that directly connect nodes are sometimes referred to as chains, edges, segments or arcs.

3. Polygon layer: Polygons are two-dimensional features created by multiple lines that loop back to create a "closed" feature. In the case of polygons, the first coordinate pair on the first line segment is the same as the last coordinate pair on the last line segment. Polygons are used to represent features such as city boundaries, geologic formations, lakes, soil associations, vegetation communities and so forth. Polygons have the properties of area and perimeter. Polygons are also called areas.

4.7 SUMMARY

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. The components of GIS are hardware, software, user and data. Applications of GIS include mapping, disaster management and mitigation, hazard reduction, soil analysis, agricultural analysis, transportation analysis and a lot more. QGIS is one of the free and open source softwares of GIS. It helps in performing a lot of spatial and aspatial analysis. The three main features of GIS are point, line and polygon.

4.8 CHECK YOUR PROGRESS

1. Fill in the Blanks:

a. GIS is majorly a ________technology.

b. GIS can help with risk management and analysis by displaying which areas are likely to be prone to ___________.

c. ________ can be spatially linked to form more complex features.

d. ____ is an important policy initiative to conserve natural resources and environment

e. GIS technology is of limited value without the ________ who manage the system

2. Name the Following:

a. Set of information

b. Open source (free) GIS software

c. Human component of GIS

d. Zero dimensional features

e. Multi-dimensional features

3. Match the Column:

A	B
a. Point	Imagery
b. Line	Aerial photograph
c. Polygon	Tube wells
d. Satellite	Pond
e. Air mounted Camera	River

4.9 ANSWERS TO THE QUESTIONS

1. Fill in the Blanks:

a. Mapping

b. Natural or man-made disasters

c. Points

d. EIA

e. Users

2. Name the Following:

a. Data

b. QGIS

c. User/ Liveware

d. Point

e. Polygon

3. Match the Column:

a. Tube wells

b. River

c. Pond

d. Imagery

e. Aerial photograph

4.10 TECHNICAL WORDS AND THEIR MEANINGS

- **Data**: Set of information is called data. Here, it can be of two types viz. spatial data (related to space) and attribute or apsatial data (related non-spatial information).

- **Remote Sensing**: The art of capturing information about an object or phenomena without coming into physical contact with it. It can be captured either through satellites or air mounted cameras.

- **Geo-referencing:** The procedure of assigning coordinates to spatial data.

- **Digitization**: It is the process of digitally tracing spatial data to create maps.

4.11 TASK

Visit the GIS department of MCGM and study their mapping procedure to understand the concept better. Try to enlist the problems faced by the experts and solutions they apply to overcome them.

4.12 REFERENCES FOR FURTHER STUDY

- Bernhardsen, Tor (2002): 'Geographic Information Systems: An Introduction', John Wiley and Sons, New York
- Longley, Paul et. al. (2011): Geographic Information Systems and Science, John Wiley and Sons, New York
- www.mapsofindia.com

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5

GEOGRAPHICAL INFORMATION SYSTEM- II

4.0. After going through this chapter you will be able to understand the following:

Unit Structure :

4.1 OBJECTIVES

- To understand the applications of GIS
- To undertake hands-on/ practical using aan vailable or free software- Q GIS

4.2 INTRODUCTION

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. GIS can help individuals and organizations better understand spatial patterns and relationships. It is a crucial part of spatial data infrastructure. GIS can use any information that includes location. Many different types of information can be compared and contrasted using GIS. With GIS technology, people can compare the locations of different things in order to discover how they relate to each other. For example, using GIS, a single map could include sites that produce pollution, such as factories, and sites that are sensitive to pollution, such as wetlands and rivers. Such a map would help people determine where water supplies are most at risk.

4.3 SUBJECT DISCUSSION

Technology has always been a companion to man and has helped in his development. GIS is one of the advanced technologies that has enabled man to understand changes that have taken place in the past, analyse space at one place and predict future of the same. The technology is computer based and is easy to grasp, but, requires expertise so that predictions and outcomes can be accurate. The technology has a geographical base, but, relates to every possible field and is still progressive.

4.4 APPLICATIONS OF GIS IN GEOGRAPHY AND RELATED FIELDS

1. **GIS in Mapping**: Mapping is a central function of Geographic Information System, which provides a visual interpretation of data. People from different professions use map to communicate. It is not necessary to be a skilled cartographer to create maps.

2. **Telecom and Network services**: GIS can be a great planning and decision making tool for telecom industries. This technology allows telecom to enhance a variety of application like engineering application, customer relationship management and location based services.

3. **Accident Analysis and Hot Spot Analysis**: GIS can be used as a key tool to minimize accident hazard on roads, the existing road network has to be optimized and also the road safety measures have to be improved. This can be achieved by proper traffic management. By identifying the accident locations, remedial measures can be planned by the district administrations to minimize the accidents in different parts of the world.

4. **Urban Planning**: GIS technology is used to analyse the urban growth and its direction of expansion, and to find suitable sites for further urban development.

5. **Transportation Planning**: GIS can be used in managing transportation and logistical problems. GIS can also help in monitoring rail systems and road conditions.

6. **Environmental Impact Analysis**: EIA is an important policy initiative to conserve natural resources and environment. The EIA can be carried out efficiently by the help of GIS. By integrating various GIS layers, assessment of natural features can be performed.

7. **Agricultural Applications**: GIS can be used to create more effective and efficient farming techniques. It is fully integrated and widely accepted for helping government agencies to manage programs that support farmers and protect the environment. This could increase food

production in different parts of the world so the world food crisis could be avoided.

8. **Disaster Management and Mitigation**: Today well-developed GIS systems are used to protect the environment. It has become an integrated, well developed and successful tool in disaster management and mitigation. GIS can help with risk management and analysis by displaying which areas are likely to be prone to natural or man-made disasters. When such disasters are identified, preventive measures can be developed.

9. **Determine land use/land cover changes**: Land cover means the feature that is covering the barren surface .Land use means the area in the surface utilized for particular use. The role of GIS technology in land use and land cover applications is that we can determine land use/land cover changes in the different areas. Also it can detect and estimate the changes in the land use/ land cover pattern within time. It enables to find out sudden changes in land use and land cover either by natural forces or by other activities like deforestation.

10. **Navigation (routing and scheduling)**: Web-based navigation maps encourage safe navigation in waterway. This division is providing public information that makes citizens awareness of these vessel locations through web map. The web map will be regularly updated to keep the boating public informed of these coastal hazards to minimize risk of collision and injury.

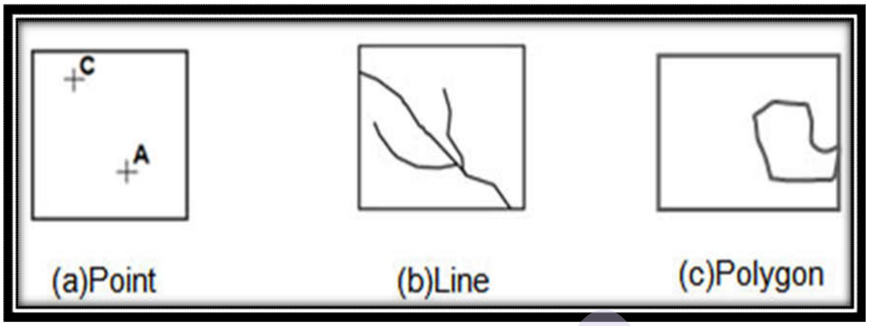
4.6 HANDS-ON/ PRACTICAL USING AVAILABLE OR FREES SOFTWARE- Q GIS QUANTUM GEOGRAPHICAL INFORMATION SYSTEM (QGIS):

QGIS stands for Quantum GIS. It is a cross-platform free and open-source desktop geographic information system (GIS) application that supports viewing, editing, and analysis of geospatial data. QGIS functions as geographic information system (GIS) software, allowing users to analyse and edit spatial information, in addition to composing and exporting graphical maps. QGIS supports both raster and vector layers; vector data is stored as either point, line, or polygon features. Multiple formats of raster images are supported and the software can geo-reference images.

- **Geo-referencing:** Geo-referencing means to associate something with locations in physical space. The term is commonly used in the geographic information systems field to describe the process of associating a physical map or raster image of a map with spatial locations.

Georeferencing may be applied to any kind of object or structure that can be related to a geographical location, such as points of interest, roads, places, bridges, or buildings Geographic locations are most commonly represented using a coordinate reference system, which in turn can be related to a geodetic reference system such as WGS-84.

- **Digitization:** Digitizing in GIS is the process of converting geographic data either from a hardcopy or a scanned image into vector data by tracing the features. During the digitizing process, features from the traced map or image are captured as coordinates in either point, line, or polygon format.



1. **Point layer:** Points are the zero-dimensional objects that contain only a single coordinate pair. Points are typically used to model singular, discrete features such as buildings, wells, power poles, sample locations, and so forth. Points have only property of locations. Other types of point feature include the node and the vertex. Points can be spatially linked to form more complex features.

2. **Line layer:** Lines are one dimensional features composed of multiple, explicitly connected points. Lines are used to represent linear features such as roads, streams, faults, boundaries, and so forth. Lines have a property of length. Lines that directly connect nodes are sometimes referred to as chains, edges, segments or arcs.

3. **Polygon layer:** Polygons are two-dimensional features created by multiple lines that loop back to create a "closed" feature. In the case of polygons, the first coordinate pair on the first line segment is the same as the last coordinate pair on the last line segment. Polygons are used to represent features such as city boundaries, geologic formations, lakes, soil associations, vegetation communities and so forth. Polygons have the properties of area and perimeter. Polygons are also called areas.

4.7 SUMMARY

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. The components of GIS are hardware, software, user and data. Applications of GIS include mapping, disaster management and mitigation, hazard reduction, soil analysis, agricultural analysis, transportation analysis and a lot more. QGIS is one of the free and open source softwares of GIS. It helps in performing a lot of spatial and aspatial analysis. The three main features of GIS are point, line and polygon.

4.8 CHECK YOUR PROGRESS

1. Fill in the Blanks:

a) GIS is majorly a __________ technology.

b) GIS can help with risk management and analysis by displaying which areas are likely to be prone to ___________.

c) ____________ can be spatially linked to form more complex features

d) ____ is an important policy initiative to conserve natural resources and environment

e) GIS technology is of limited value without the ________ who manage the system

2. Name the Following:

a. Set of information

b. Open source (free) GIS software

c. Human component of GIS

d. Zero dimensional features

e. Multi-dimensional features

3. Match the Column:

A	B
a. Point	Imagery
b. Line	Aerial photograph
c. Polygon	Tube wells
d. Satellite	Pond
e. Air mounted Camera	River

4.9 ANSWERS TO THE QUESTIONS

1. Fill in the Blanks:

a. Mapping

b. Natural or man-made disasters

c. Points

d. EIA

e. Users

2. Name the Following:

a. Data

b. QGIS

c. User/ Liveware

d. Point

e. Polygon

3. Match the Column:

a. Tube wells

b. River

c. Pond

d. Imagery

e. Aerial photograph

4.10 TECHNICAL WORDS AND THEIR MEANINGS

- **Data**: Set of information is called data. Here, it can be of two types viz. spatial data (related to space) and attribute or apsatial data (related non-spatial information).
- **Remote Sensing**: The art of capturing information about an object or phenomena without coming into physical contact with it. It can be captured either through satellites or air mounted cameras.
- **Geo-referencing:** The procedure of assigning coordinates to spatial data.
- **Digitization**: It is the process of digitally tracing spatial data to create maps.

4.11 TASK

Visit the GIS department of MCGM and study their mapping procedure to understand the concept better. Try to enlist the problems faced by the experts and solutions they apply to overcome them.

4.12 REFERENCES FOR FURTHER STUDY

- Bernhardsen, Tor (2002): 'Geographic Information Systems: An Introduction', John Wiley and Sons, New York
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