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GEOSPATIAL TECHNOLOGIES

It is the summer season in Delhi. My 10th board examination was over yesterday and today, I am very much excited at the breakfast table to know that my family is planning to visit Shimla for three days. So, my father has given me a task to check the weather conditions about Shimla from television and internet websites to wear and carry the appropriate clothes. Earlier, as usual, my mother was doing this task. I thought it surprising that 'why meaningless task is given to me, and here we are wearing proper summer clothes; and Shimla is a cool place so we can carry the same winter clothes. But I accepted silently and I said 'Yes dad'. After having breakfast I started watching television news seriously. I know at the end of all news they will provide information about the whole India. I am sitting with a pen and diary to note all the information. When I was watching television they showed a map of India with state names, major towns names as well as some clouds moving from east to west. So different places showed different information. I noted all the information but in my mind lots of questions arise from where they collect this information? How do they collect these? How do they know about the places? How they present this information. The answer is very simple: 'Geospatial Technology'. It seems simple but the task is not so easy to get this information. So here, we will understand about this technology.

Geospatial technologies are the transformative tool which is universally available to empower individuals to advocate and innovate for our common future and provide spatial information. This technology includes remote sensing, geographical information systems and global positioning systems. These technologies enhance our ability to assess and monitor complete geographical characteristics of the earth system. This technology has a huge potential to understand the complexity of our earth system phenomena and management of resources of the earth as well as modelling for the future.

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OUTCOMES

After studying this lesson, learner:

- describes geospatial technologies;
- explains concept of remote sensing, GIS and GPS technology;
- describes type of database use in geospatial technology;
- differentiates between raster and vector data structure;
- explains elements of image interpretation for information extraction;
- applications of Geospatial technologies.

2.1 GEOSPATIAL TECHNIQUES

Geospatial technology is a combination of three words: 'Geo' means Earth; 'Spatial' means space; and technology means tool instruments and methods. So, the literal meaning of geospatial technology is a collection of various technologies that provide information about the earth and provide decision-making capability towards earth's resource management and sustainable development. It is also known as the 'Science of Where'. This technology includes remote sensing, Global Positioning System (GPS) and Geographic Information System (GIS).

The aim of the remote sensing technology is to provide unbiased, near real-time remotely sensed data about the Earth's surface. This data is provided by different characteristics of satellite and sensor specifications which is very much useful to classify and assess thematic information. GPS is a tool, used for fieldwork or survey process that enables us to provide locational information of various features on the Earth's surface as well as useful to verify remotely sensed classified thematic information. GIS is a computer-based technology that provides us a platform to integrate spatial and non-spatial databases which is provided by remotely sensed data, GPS based data, primary and secondary sources of data for different kinds of spatial analyses, manipulation and modelling.   So, all these technologies, with their unique characteristics, are complementary to each other in planning and development processes of the Earth's resources. Thus, collectively, all these technologies are known as Geospatial technology. Let's discuss each technology in detail in subsequent paragraphs and learn their application collectively.

Remote sensing

The term remote sensing is a combination of two words 'remote' means a distance, it may be a centimetre or kilometres and 'sensing' means acquiring information. The simple meaning is sensing remotely or acquiring knowledge from a distance. According to Fussell (1986), "Remote sensing is the acquiring of data about an object without touching it". The acquiring of data from distance or without touching it includes complete processes of acquiring data about the earth surface which is recorded through sensors or camera, mounted on the aircraft or satellite at different platforms. This recorded data is downloaded from the satellite and processed in the laboratory to make usable for different applications for different persons. According to John. R. Jensen (2007), "Remote sensing is the process of collecting data about objects or landscape features without coming into direct physical contact with them". So, remote sensing can be defined as an art, science and technique of collecting real information, without being physical contact with an object or phenomena through the sensor or camera which is working over the wide range of electro-magnetic spectrum from the various platforms by the means of tripod, aircraft or spacecraft or satellite for multidisciplinary activity.

Process of remote sensing

Remote sensing process includes various mechanisms or activities for collecting and disseminating remotely sensed data to the user community. It includes the following processes as shown in the Fig. 2.1

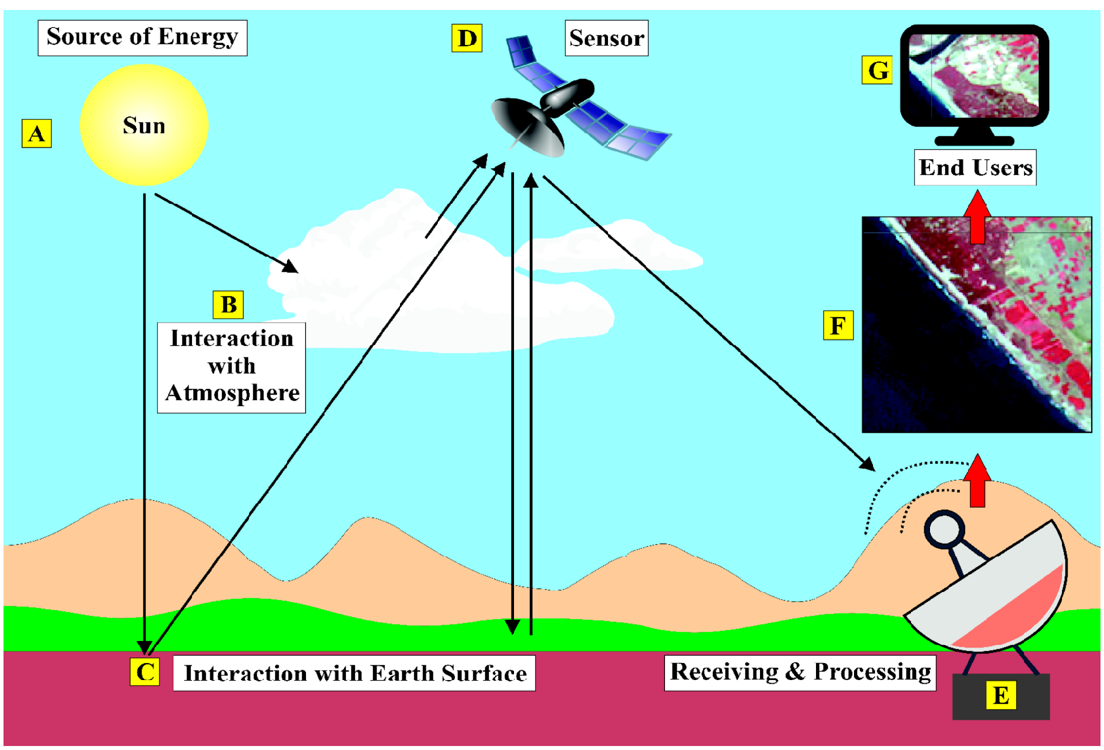

Fig. 2.1 Process of remote sensing

i. Sources of energy

ii. Interaction of electro-magnetic energy with an atmosphere

iii. Interaction of electro-magnetic energy with the earth surface.

iv. Electro-magnetic received by sensor.

v. Transmission of electro-magnetic energy from sensor to ground station.

vi. Rectification of received data

vii. Disseminate rectified data to the user community.

After discussing the processes involved in remote sensing you might be training on what are the advantages of remote sensing. You might have heard that various countries including India have been investing a huge financial resource for sending Remote Sensing satellites. Let us discuss some of the advantages of remote sensing.

Advantages of remote sensing

i. Remote sensing provides satellite imagery and aerial photographs of earth's features.

ii. It can see beyond the vision of human eye

iii. It can be focus on very specific wavelength

iv. It provides bird eye view

v. It provides repetitive looks at the same area.

vi. Remote sensors operate in all seasons

vii. It provides multi-purpose image data.

viii. It provides unbiased and near-real time data.

ix. Remote sensing data is cost-effective in comparison to traditional methods of data collection.

Principles of remote sensing : In the previous section we have discussed the processes involved in capturing remotely sensed data. Let us now discuss the processes involved in capturing such data.

Electro-magnetic energy and electromagnetic spectrum

Remote sensing depends on the energy known as electro-magnetic energy that travels with the speed of light in a wave pattern. This electro-magnetic energy is a medium of interaction between earth's feature and sensor directly and indirectly by reflection, scattering and re-radiation. There are two sources of electro-magnetic energy. One is natural, namely sun and earth; and another is artificial source, namely camera flashgun and radar. The most important source of this energy is the sun but electro-magnetic energy is also provided by geo-thermal energy emitted by the earth 's surface. The electromagnetic energy propagates through space in two fields, one is electrical and another is magnetic. Due to this reason, it is called

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electromagnetic energy. The three measurements such as wavelength, frequency and velocity are used to describe electro-magnetic energy in a wave pattern. Wavelength is a distance between successive wave crests or troughs, denoted by lamda and measured in metre (m), nanometre (nm or 10-9 m) and micrometre (µm or 10-6 m). Frequency is a number of wave cycles passing through a given fixed point. It is measured in hertz (Hz), corresponding to one cycle per second. The velocity (c) or speed of the electromagnetic energy is equal to the speed of light i.e. 3 × 108 metre/second (3,00,000 km/second or 186000 miles/second).

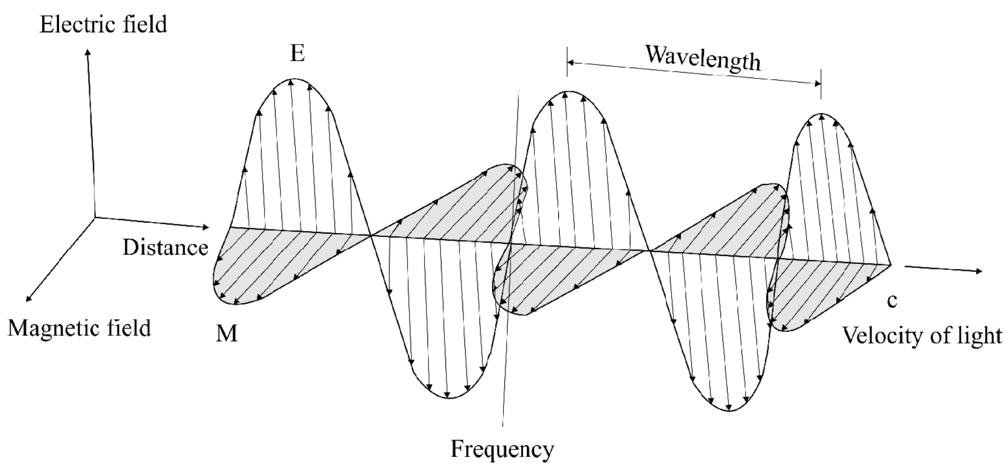

Fig. 2.2 : Electro-magnetic energy

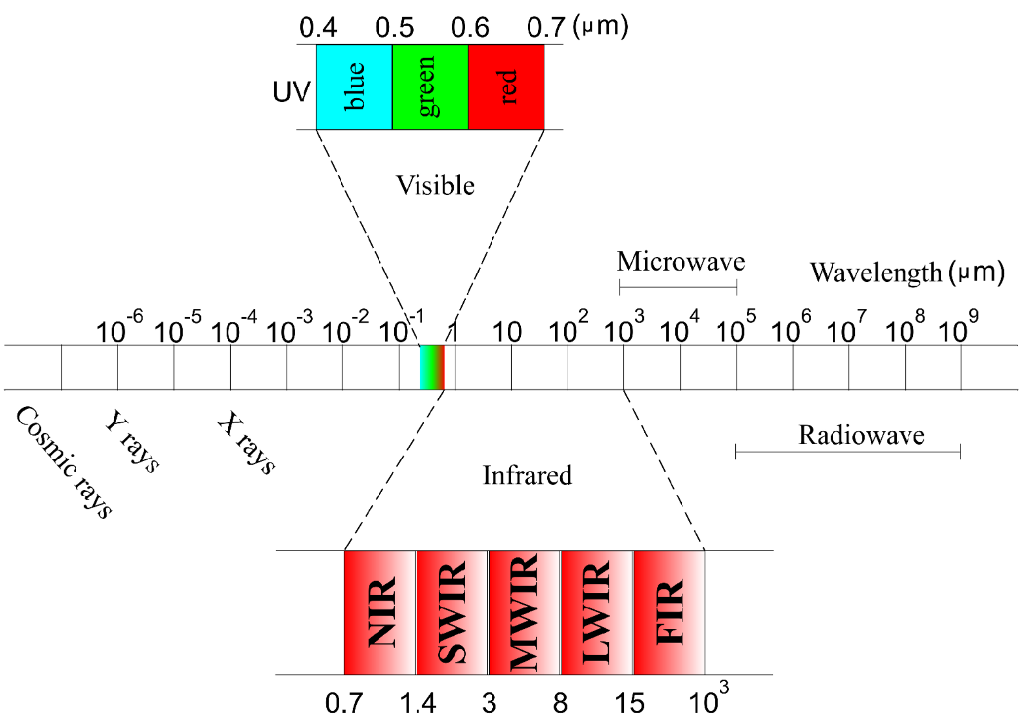

Fig. 2.3: Electro-magnetic spectrum

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The electro-magnetic energy category on the scale of wavelength is called electro-magnetic spectrum. It extends from very small wavelengths known as gamma rays to very long wavelengths known as radio waves and in between X-rays region, ultraviolet region, visible region, infrared region and microwave region are found known as spectral bands. These spectral bands that absorb electro-magnetic energy are known as absorption bands or regions and those spectral bands transparent for electro-magnetic energy are known as atmospheric windows. The atmospheric window plays an important role in remote sensing to deploy the remote sensing sensor to receive data.

Platform and sensor

Platform is a place or a stage to mount a camera or sensor aloft to acquire the data about the earth's features. On the basis of altitude above earth, the surface platform may be classified as groundborne, airborne and spaceborne. Groundborne sensors mount near to ground by means of tripod, buildings, hand-held and moving vehicle to acquire data for field work and laboratory simulation studies before mounting the sensor on an airborne or spaceborne platform. CCTV cameras installed in the school building or camera mount on moving vehicles, to monitor and acquire data are examples of groundborne platforms. A sensor mounted on aircraft to collect data from air is known as an airborne platform. Earlier balloons, pigeons and kites were used as airborne but after development of aircraft, a periodic or need based database is acquired for survey within a few hours. The aircraft is operated in our atmosphere which is dynamic in nature such as high wind speed, cyclones, clouds that distract the path of the aircraft and produce errors in the database. To remove the influence of the atmosphere , a spaceborne platform is used. When the sensor is mounted on a satellite and launched to space in a fixed orbit to acquire a database from space is a spaceborne platform. Depending upon the altitude two types of orbit are used as platform to place satellites, one is polar orbit at the height of around 800 km and another is geostationary orbit at the height of 36000 km above the earth's space. Polar orbit satellite is also known as a sun-synchronous satellite because it synchronises with the local sun-time at the same latitude or it passes over all the places on the earth having the same latitude at the same local sun-time. For example, if the satellite passes at 10:30 am on the equator, then every local time satellite passes on the equator at 10:30 am at a different longitude. So, all the remote sensing resource satellites are polar orbiting such as Indian satellite series IRS, American satellite series LandSat, European satellite series SPOT etc. a geostationary orbiting satellite is synchronised with the speed of rotation of the earth. This satellite provides a 24X7 database about the fixed area whose coverage is 70 degree north to 70 degree south latitude and it can view only one-third of the earth. All the telecommunication and meteorological satellites are geostationary orbiting like GSAT and INSAT series.

Sensor is a device that measures and records reflected, scattered or emitted electromagnetic energy into a signal in a form of either digital number or image. Our eyes also act as a sensor to see the object. Camera is one of the examples of sensor, provide photographs in digital or

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analog form. Our mobile phone is also a sensor to receive electromagnetic radio-waves and convert them into sound waves. On the basis of source of energy, sensors can be passive or active. Passive sensor receives the external source of energy, generally by the sun as reflected energy from the earth's feature as well as from the earth surface as emitted energy. Active sensors use their own source of energy, for example, RADAR is sending its own pulse as energy to illuminate earth's surface and receive the same energy from different earth's features.

The electromagnetic energy received by sensors from interacted features of earth is downloaded at ground receiving stations in the form of digital images. Digital image is a two-dimensional array of cell or picture elements known as pixels. Each pixel has a numerical value representing the energy reflected or emitted from the earth's feature known as pixel value or digital number. This data is a raw image which is not usable to the user community because of positional error and decreased visual distinction. So the raw data is corrected in terms of positional accuracy and visual enhancement technique to increase the quality of the image for image interpretation with the element available in the image.

Element of image and photo interpretation

In satellite imagery or aerial photography, we identify features on the basis of elements visibility. Sometimes a single element is sufficient and sometimes more than one element is required to identify features. For example, green colour denotes vegetation but to identify species we need other elements such as texture or location.

i. **Colour :** in the first instant colour is the most important element to identify the features or to discriminate between two features. For example, healthy vegetation appears green in true colour imagery.

ii. **Tone:** it refers to the differences in the intensity of colour from light to dark colour. In imagery or photography features appear lighter to darker shades of colour depending upon the reflectance behaviour of an object. High reflectance from feature appears lighter tone and low reflectance from feature appears dark tone. For example, laterite soil appears dark tone and salt affected soil appears light tone in satellite imagery or aerial photographs. The tonal variation is represented as a grey scale.

iii. **Size:** features on the imagery can easily identified by their size with reference to length, width, perimeter and area in the context of image or photo scale. Size is a relative term which may be small, medium and large according to the scale of imagery or photograph. For example, size variation in urban settlement which is relatively bigger than rural settlement. The width of the national highway is more than the local road.

iv **Shape:** some features are identified on the basis of the shape that appears in satellite imagery such as pyramids in Egypt or circular shape of Indian parliament or Pentagon building in the USA. Basically, shape refers to geometric shapes like linear, circular,

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square, rectangular, etc. for example, a consolidated agricultural area has a rectangular or square shape. Roads, railways, and canals have fewer curves than streams or rivers. Stadium shape may be circular or elliptical.

v. **Texture:** it refers to the roughness and smoothness of the feature in satellite imagery or aerial photograph. Texture is an arrangement of tonal variation from smoothness (uniform or homogenous or fine texture)to roughness(heterogenous or coarse texture) in imagery or photography. For example, forest and paddy agricultural field colour is green in colour but due to textural variation, forest has coarse texture and paddy field has smooth texture. Another example is water in the lake is smoother than the river or ocean.

vi. **Pattern:** Earth's surface features produce different patterns such as regular, irregular, systematic or unsystematic spatial arrangements. For example, a planned city such as Chandigarh has a checkerboard pattern which is systematic in nature but an unplanned city has a haphazard arrangement. Similarly, forest plantations or orchards have regular tree plantations but natural forests have irregular tree arrangements.

vii **Shadow:** it is a clue to identify vertical features on the earth by casting shadow such as high rise buildings or mountains can be identified in the vertical aerial photograph or imagery. For example, Qutub Minar or Eiffel tower is identified by their shadow.

viii **Site or location:** on the earth some features are site specific or geographic location specific. For example, different types of forest are found in different geographical locations such as evergreen forest found in heavy rainfall areas, coniferous forest found in cold climates. Nuclear power plant situated near a big waterbody is site specific.

ix **Association:** some features on satellite imagery or photographs are identified with the help of associated features. For example, a sugar mill is situated surrounded by a sugarcane field and molasses tank, warehouse etc. is associated with sugar mills. Vegetated area within an urban setting may be a park. Commercial centres will likely be located near major roads, railways or waterways.

x **Resolution:** Image pixel size may be capable of discriminating two closely spaced objects from each other. Resolution may be low, medium or high. Smaller features can easily be identified in the high-resolution photograph or imagery. For example, cadastral level mapping needs high resolution imagery while regional or state or above level mapping needs coarse or low-resolution imagery.

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INTEXT QUESTIONS 2.1

1. What do you mean by remote sensing?
2. Discuss the advantages of remote sensing.
3. What is the electro-magnetic spectrum?
4. How many platforms are used in remote sensing?
5. What is a sensor in remote sensing?

2.3 GLOBAL POSITIONING SYSTEM (GPS)

GPS is a network of satellites that continuous transmit signals to GPS receiver which makes it possible to know the precise location on the earth surface. So, GPS provide the positional information on the earth surface in terms of latitude and longitude. Earlier, GPS refers to a group of U.S. Department of Defense satellites known as NAVSTAR (NAVigation Satellite Timing And Ranging)The first GPS satellite was launched in February 22, 1978 by United States Air Force. Today, many countries launched their own GPS such as Russia launches GLONASS, India has launched Indian Regional Navigation Satellite System (IRNSS) known as NavIC, Chinese has BeiDou Navigation Satellite System, European union has Galileo navigation satellite system and Japan has Quasi-Zenith satellite system (QZSS). GPS signals travels in 'line of sight' means straight and it passes through clouds, glass and plastic, but not penetrate through most solid objects like building and mountains.

Fig. 2.4 : GPS

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Segment of GPS

GPS consists of three segments such as space, ground and user segment. Space segment consists of a constellation of satellites positioned at around 20,000 km above the earth which is about three times of the earth's radius. These satellites are travelling at the speed of 13000 km/hour to complete a circle of the earth every 12 hours. NAVSTAR is a constellation of 24 satellites, in which 21 satellites are operational and 3 satellites are active spares. Russian GPS satellite GLONASS has 24 satellite constellations, Indian GPS NavIChas constellation of 8 satellites, Chinese has BeiDou consist of 28 satellites, European union's Galileo consists 26 satellites, Japan's QZSS has constellations of 4 satellites in the space segment. The ground segment controls the GPS satellite and monitors their position in the outer space, clock offset and uploads navigation data to the satellite as well as ensures the proper operations. NAVSTAR, US based GPS Master control monitoring station at Colorado, USA along with 4 ground tracking stations across the world. IRNSS ground segment centre located at Byalalu near Bengaluru in Karnataka state and their ranging stations located 21 centres across India. GLONASS ground segment System Control Centre (SCC) located at Krasnoznamensk Russia along with 6 centres across the country. Beidou has a Master control Station along with 30 monitoring stations. QZSS has 2 Master Control Stations at Koba and Hitachiota along with 4 other stations to monitor the GPS satellites. The person who carries the GPS receiver is a user segment. People may be in defence, boaters, pilots, hunters and anyone who wants to know their own location in terms of latitude and longitude on earth surface as well as used for their navigation purpose. All kinds of GPS receivers are included in the user segment that may be receiver installed on your mobile phone, moving vehicles like car, bus, train, aircraft, etc. for navigation and tracking purposes.

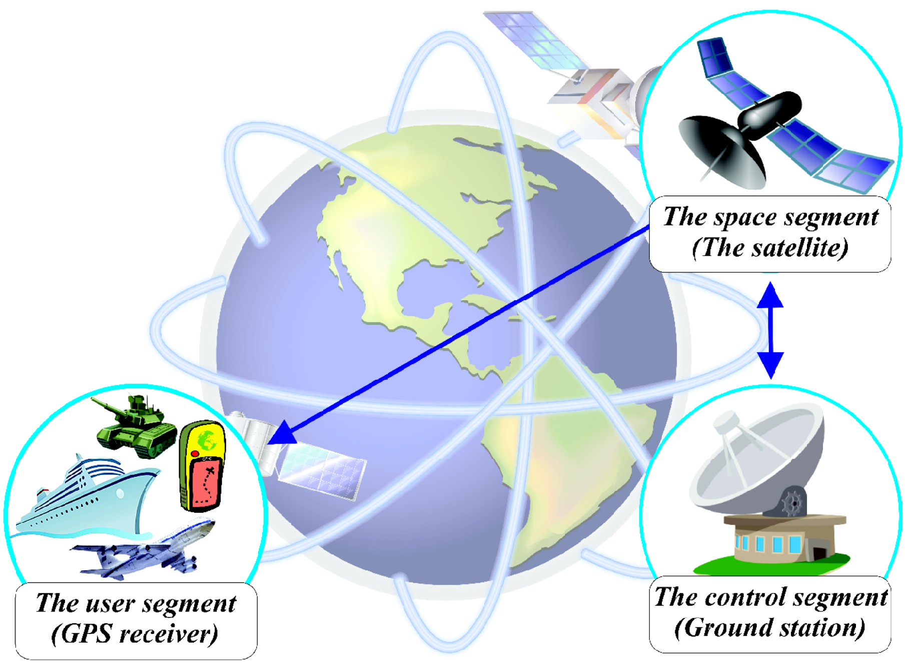

Fig. 2.5 : Segment of GPS

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How GPS receiver determine their location

Let's assume a person carries a GPS receiver on the earth surface at a distance of 18,000 km from the first satellite. Our location would be somewhere on an imaginary sphere which is in the centre with a radius of 18,000 km. The second satellite, at a distance of 19,000 km, would intersect the first sphere to create a common circle. The third satellite, at a distance of 20,000 km, then we have two common points where the third sphere intersects. So, there are two possible locations of a person, they are greatly differing in latitudinal, longitudinal position and altitude. By adding a fourth satellite, at a distance of 16,000 km, whose sphere intersecting the first three spheres at a common point is the actual location in the form of latitude, longitude and altitude of a person who carries a GPS receiver.

Uses of GPS

1. **Location:** it provides precise location who carries a GPS receiver.
2. **Navigation:** it is used in navigation of moving vehicles, ships and aircrafts.
3. **Tracking and monitoring:** it provides information about the movement of vehicles and people such as GPS-enabled police vehicles, taxis, milk vans, trains, etc.
4. **Time:** it provides precise time on a global scale.

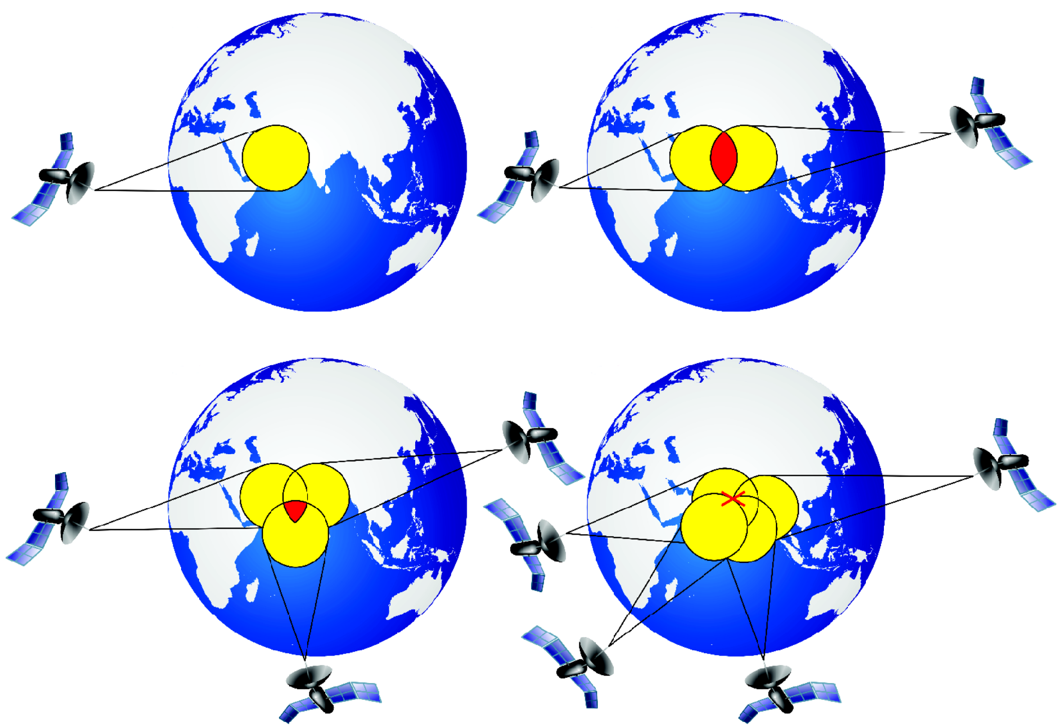

Fig. 2.6 : how to locate position

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INTEXT QUESTIONS 2.2

1. What is GPS?
2. List the segment of GPS.
3. How many GPS satellites are in the space segment of NavIC?

2.4 GEOGRAPHIC INFORMATION SYSTEM

The Geographic Information System consists of three words, geographic related to geography, that describe or study about the earth. Geography attempts to acquire knowledge of the earth where we live. The knowledge, about both facts and relationships among the various features of the earth's components like atmosphere, lithosphere and hydrosphere, which should be as accurate as possible. Information is the mean by which human perception and mental processes understand and develop their knowledge on the basis of available data. So information can be extracted by classifying or organising the data in order to convey meaning. For example, we learn English alphabet 'A,B,C,D,...S,T,U,V,...Z', which individually doesn't have any meaning, this is known as data and 'CAT' is a combination/extraction from these alphabet has a meaning a pet animal. A map consisting of geographic information carries some sort of geographical reference to help locate something in the form of symbolic references and numeric references. Systems can be defined as an ordered, interrelated set of elements or things and their attributes, linked by flows of energy and matter, which are linked with each other to fulfil their objectives. The elements within a system may be arranged in a series or interwoven with one another, e.g., a cooler system, political system, hydrological system. In cooler fan, water, electricity etc. are working together to provide cool air.In general, geographic information system is a computer-based processing system that includes computer hardware, software, database, procedure and trained person, is also known as components of GIS, has a capability of data capturing, storing, analysing and displaying geo-referenced spatial and non-spatial database.

Components of GIS

There are five components in GIS which are connected with each other to perform the geographical concept and produce in the form of maps, charts and tabular data in softcopy as well as hardcopy. Let us discuss all the components.

1. Computer hardware consists of input devices, central processing units and output devices. Input devices include keyboard, mouse and scanner. Central processing unit consists of a motherboard, processor, hard-disk, memory cards, etc. output devices include a display unit such as monitor, printer, plotter and audio system. All parts of computer hardware are connected with each other.

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2. GIS software is a set of modules for performing digitization, editing, final map preparation and analysis of databases. GIS software is commercial and open-source. ArcGIS, Erdas Imagine, MapInfo, AutoCAD Map are the commercial GIS software and QGIS, GRASS are the example of open-source GIS software which is freely available on the internet.

3. Databases are categorised into two types one is spatial database and another is non-spatial database. The accuracy of the output map depends on the authenticity and accuracy of the database. The spatial database may be any kind of map, aerial photograph, satellite imagery, sketch, etc. in hard-copy or soft-copy. The soft-copy spatial data can be in the form of raster or vector format.

4. Procedure is a well-defined method or steps to produce accurate and reproducible results. For example, depending on the objective of the map and analysis, we are collecting our database, performing all kinds of methods to prepare maps in the GIS environment, applying different kinds of analysis methods and results in the form of maps and reports are basic procedures.

5. Trained person is the key component in GIS to perform all activity to choose appropriate computer hardware, GIS software and database to apply appropriate procedure to fulfil the objective of a given task. The trained person must have knowledge of geographical concepts as well as computers and their GIS software.

Fig. 2. 7: components of GIS

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Database in GIS

GIS database is a collection of data stored in a structured manner in GIS environment which play an important role in any kind of GIS activity. All the functionalities of GIS such as data capturing, editing, analysis, querying, displaying depends on the type of database it holds in the GIS environment. In the real-world, all features are integrated to each other by cause-and-effect relationship, for example, factors affecting paddy cultivation in particular areas such as temperature, rainfall, climate, soil and water condition, etc. are looked at in an integrated manner. But, in GIS, all these factors or features of the world are stored as feature layer such as water layer, soil layer, temperature layer etc. individually (figure of GIS layer). We are using two kinds of database; one is spatial database and another is non-spatial database in GIS environment.

Spatial database is a geographical or spatial feature of the world which is represented and stored in a map form. There are many sources available such as topographical sheets, census map, aerial photograph, satellite imagery, field sketch, etc. from various organisations like Survey of India, Census of India, National Remote Sensing Centre, National Atlas and Thematic Mapping Organization, etc. These spatial databases are digitally stored in raster and vector data structures in GIS. Raster data structures represent spatial data by cells or grid format termed as pixels having two dimensions length and breadth in square shape. Each pixel is referenced by row and column. The size of the pixel is depending on the resolution of raster data. If the pixel size is very small it is known as a high-resolution image representing detailed features of the earth and vice-versa. Point feature is represented by a single pixel. Line or polyline represented by a number of neighbouring pixels connected in a given direction. Polygon is represented by a cluster or group of adjoining pixels.

Vector data structures represent spatial data in point, line and polygon or area features by locating longitude (x) and latitude (y) coordinates. Geometrically, the point feature is defined as a dimensionless single pair of x and y coordinates. Earth's features such as state capitals, electric poles, and mountain peaks are represented as point features by using unique symbology. Line feature is a one-dimension(length) connection between two or more points and stretches in one direction is also known as polyline. All kinds of linear features of the world such as road-rail network, streams, canals, water pipelines, etc. are represented by polylines. Polygon feature is a two-dimension series of lines, connected with points to form an enclosed boundary to designate area features. The starting point and end point are the same to form an enclosed boundary. All kinds of boundaries like international, national, land parcels, pond, forest, water basin, etc. are represented by polygon features. According to the scale of the map, features can be interchangeable between point and polygon; line and polygon. Suppose you are making a world map in small scale with their capital, so capital is represented by points but if you make Delhi map (capital of India) in large scale, then it would be a polygon. Similarly, the River Ganga on the world map will be represented as a polyline, but on a large scale like the Prayagraj city map would be a polygon.

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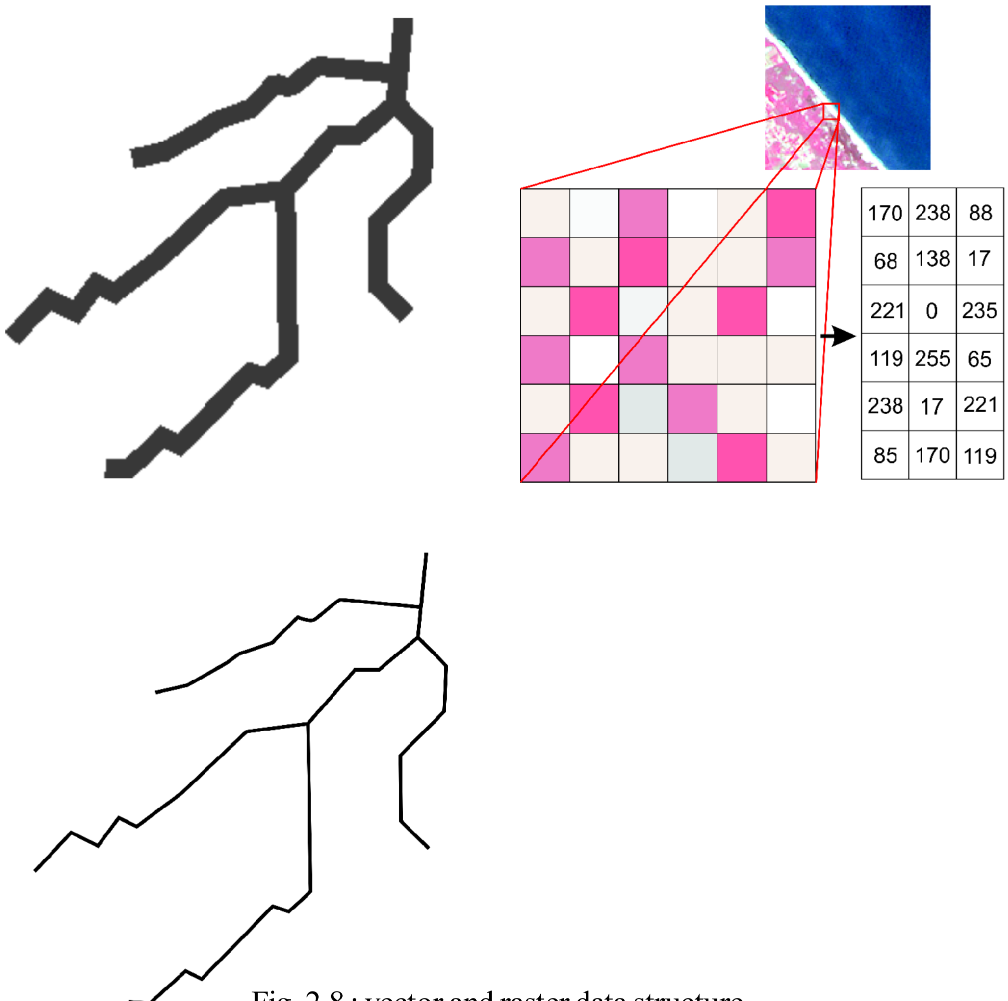

Fig. 2.8 : vector and raster data structure

Non-spatial data represents the characteristics of spatial databases known as attribute data. These data are usually alpha-numeric and provide information such as name, population characteristics, land use, etc. in tabular form consisting of rows and columns. These attribute data, join with the spatial data with relational data structure. In relational data structure, a common column available in both spatial and non-spatial data to relate each other rows which is unique in nature like common identification number (ID) is also called primary key. Each row represents a feature of a map and columns represent the desired characteristic of a particular row or feature. Changes in any feature on map can also change in attribute and vice-versa.

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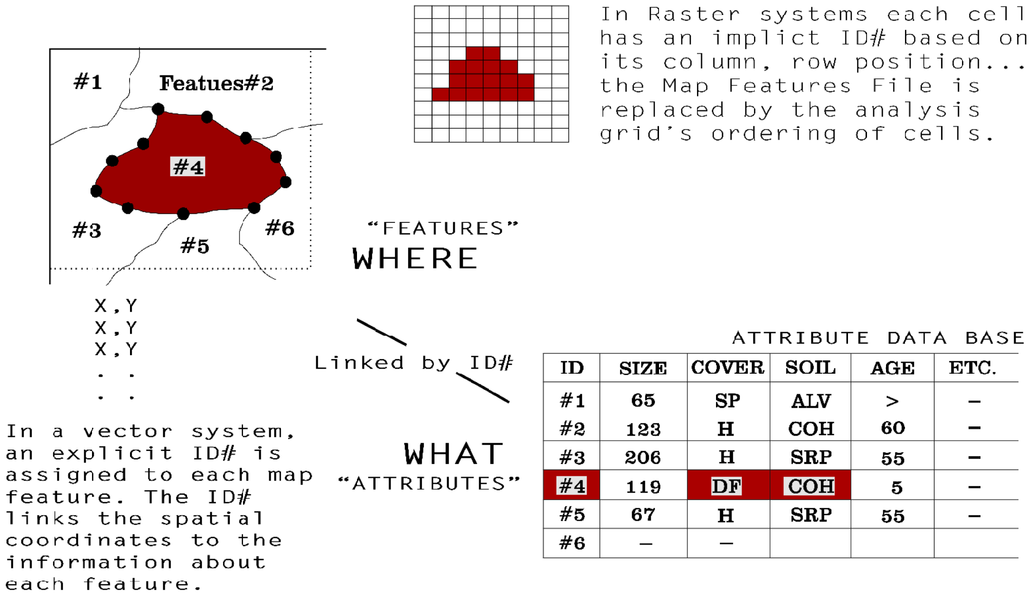

ID	SIZE	COVER	SOIL	AGE	ETC.
#1	65	SP	ALV	>	–
#2	123	H	COH	60	–
#3	206	H	SRP	55	–
#4	119	DF	COH	5	–
#5	67	H	SRP	55	–
#6	–	–			

Fig. 2.9 : relational data structure

Applications of Geospatial technologies

There are only four major applications of geospatial technologies such as mapping, monitoring, measurement and modelling. These are widely applied in various disciplines like surveying, land resource management, water resource management, forest management, agriculture application, infrastructure management, emergency management, crime management etc. Let us discuss some of these applications briefly.

i **Survey application:** Survey agencies such as Survey of India, Census of India, Forest Survey of India, Geological Survey of India and many more agencies are widely applying geospatial technology for preparing their maps. All the topographical map, administrative maps are prepared by Survey of India by using these technologies. Census of India produced census information through maps such as population distribution map, literacy rate map, etc. Geological survey of India produces geological maps of India, mineral maps by monitoring direct or indirect sources of information. The biomass studies and monitoring by Forest survey of India.

ii **Land Resource Management:** this technology is very much utilised in collecting the information about surface and subsurface. Through remote sensing we monitor and assess land use/cover and their changes. This technology provides near-real time information that can be applied to planning of land resources. The information beneath the earth is a very limited but indirect source of information and inferences made possible for assessing oil and mineral resources as well as mapping of seismic zones and volcanoes distribution map.

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iii **Agriculture:** this technology is widely applied to assess the site suitability for various crops, irrigation management, crop estimation and production monitoring as well as market information. Crop modelling can be done with the help of biophysical characteristics of the earth.

iv **Water Resource:** this technology is widely used to monitor seasonal or yearly water resources through remote sensing. It is used to assess surface as well as groundwater resources and their potential by integrating various thematic information like geomorphology, lithology, rainfall, rivers, ponds etc. This is very helpful in site suitability analysis for dams, construction of canals, water recharge structures, snow and water runoff modelling. This technology also monitors and provides the information about sediment or chemical pollutants, oil slicks in water resources.

v **Meteorology:** Daily, we are getting information about weather conditions in newspapers, radio and television. This is one example of geospatial technology applications. Rainfall and temperature data is collected from different weather stations and this data is further interpolated to understand the spatial distribution by various interpolation methods available in the GIS environment. The information about the cloud movement and cyclone monitoring is possible through remote sensing technology. So, this technology played an important role in mapping, monitoring and modelling of meteorological information.

vi **Forest Resource:** the reliable information about forest is foremost important for their management. Here, remote sensing technology provides periodic data about forest species, afforestation, deforestation, encroachment, forest fire and damage assessment in near-real time.

vii **Infrastructure Management:** Planning of road-rail network, education institutions, medical facilities, electricity development, parks, location of fire and police stations, etc, is most important in increasing the quality of life and nation building. Here, geospatial technology is very useful in the planning process for infrastructure development and their management.

viii **Emergency Management:** Remote sensing provides pre to post disaster information such as flood, landslide, avalanches, earthquake, forest fire, etc and GIS technology supporting spatial decision making during these times of extensive damage to property and life. Such kind of information and decision-making tool is foremost important to map hazard zones for planning necessary preventive measures and preparedness.

ix **Crime Management:** geospatial technology is useful in monitoring, assessing and management of crime events such as analysing historical events, identifying crime hotspots and generating future predictions. GIS based analysis is very useful for correlating crime

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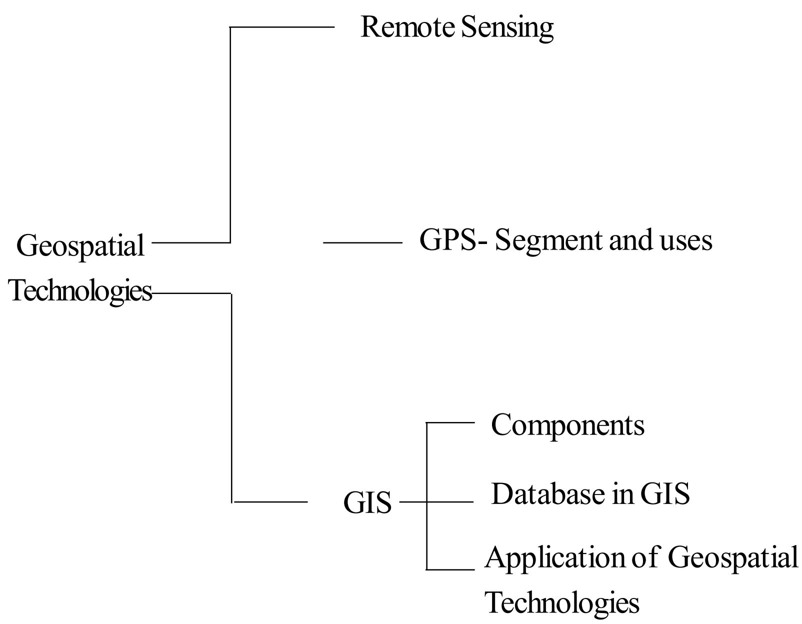
events with social conditions as well as deploying law enforcement like installation of CCTV cameras, police check-posts, day-night patrolling, etc.

INTEXT QUESTIONS 2.3

1. What are components of GIS?
2. What is a spatial database?
3. What is a non-spatial database?

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Explain the Geospatial Techniques.
2. Explain the process of remote sensing.
3. Write a short note on Element of image and photo interpretation.
4. Differentiate between spatial and non-spatial data.

5. Suggest any three areas where Geospatial technologies can be effectively utilized.

Exercise for Practical Record Book

1. Take any photograph and identify the feature on the basis of photo/image elements such as colour, size, shape, etc.
2. Draw an electromagnetic spectrum on your notebook and identify the range of visible regions.
3. Collect three types of spatial data and describe it.
4. Collect any one non-spatial data describing the rows and columns .

ANSWERS TO INTEXT QUESTIONS

2.1

1. Remote sensing is the acquiring of data about an object without touching it.
2. Remote sensing provides satellite imagery and aerial photographs of earth's features.
3. The electro-magnetic energy category on the scale of wavelength is called electro-magnetic spectrum.
4. Platforms are three types - groundborne, airborne and spaceborne.
5. Sensor is a device that measures and records reflected, scattered or emitted electromagnetic energy into a signal in a form of either digital number or image.

2.2

1. GPS is a tool, used for fieldwork or survey process that enables us to provide locational information of various features on the Earth's surface as well as useful to verify remotely sensed classified thematic information.
2. GPS consists of three segments such as space, ground and user segment.
3. 8 satellites.

2.3

4. There are five components- Computer hardware, GIS software, Databases, Procedure and trained person.
5. The spatial database may be any kind of map, aerial photograph, satellite imagery, sketch, etc. in hard-copy or soft-copy..

Notes

6. Non-spatial data represents the characteristics of spatial databases known as attribute data. These data are usually alpha-numeric and provide information such as name, population characteristics, land use, etc. in tabular form consisting of rows and columns.