8 Remote Sensing and GIS

Introduction :

The term Remote Sensing envisages : "The process of measurement or acquisition of information of some property of some object or phenomenon by a recording device that is not in physical or intimate contact with the object under study"

So, as per this definition, processes like medical imaging (CT Scan, MRI, Sonography), seismic imaging etc would also be included under the ambit of remote sensing. But, for the sake of brevity, the term Remote Sensing is almost restrictively used for the process of image (data) acquisition by orbiting satellites and photography of the Earth by cameras on aircraft and drones.

Historical account of remote sensing :

As a spin-off from the surveillance technology effectively used by defense establishments around the world since man hoisted a camera on a hot-air balloon in year 1858 for photographing terra firma, remote sensing has come a long way. Among the very first 'civilian' efforts mandated exclusively for 'Earth Observation' (EO) is the LandSat 1, formerly the 'Earth Resources Technology Satellite 1' (ERTS 1) which proudly takes its place in any museum of technology. The data from this satellite and its younger and better siblings, is since the early 1970' regarded as the longest span of consistently acquired visual record of our planetary surface. Efforts of a similar kind are also being successfully carried out by the IRS (Indian Remote Sensing Satellites) series, albeit since the early 1988. Till today, the ISRO has launched a host of remote sensing satellites and we have 13 fully functional remote sensing satellites in orbit as of date. This also includes the RISAT- 1 a radar satellite.

Do you know?

- Who coined the term remote sensing?

The term 'remote sensing', first used in the United States in the 1950s by Ms. Evelyn Pruitt of the U.S. Office of Naval Research, is now commonly used to describe the science—and art—of identifying, observing, and measuring an object without coming into direct contact with it.

Ms. Evelyn Pruitt (1908 – 1969)

Do you know?

Indian Remote Sensing Satellites launched by ISRO and their status. Source: NRSC/ISRO

Sr. No.	Satellite	Date of Launch	Launch Vehicle	Status
1	IRS-1A	17 March 1988	Vostok, USSR	Mission Completed
2	IRS-1B	29 August 1991	Vostok, USSR	Mission Completed
3	IRS-P1 (also IE)	20 September 1993	PSLV-D1	Crashed, due to launch failure of PSLV
4	IRS-P2	15 October 1994	PSLV-D2	Mission Completed
5	IRS-1C	28 December 1995	Molniya, Russia	Mission Completed
6	IRS-P3	21 March 1996	PSLV-D3	Mission Completed
7	IRS 1D	29 September 1997	PSLV-C1	Mission Completed

Sr. No.	Satellite	Date of Launch	Launch Vehicle	Status
8	IRS-P4 (Oceansat-1)	27 May 1999	PSLV-C2	Mission Completed
9	Technology Experiment Satellite (TES)	22 October 2001	PSLV-C3	Mission Completed
10	IRS P6 (Resourcesat-1)	17 October 2003	PSLV-C5	In Service
11	IRS P5 (Cartosat 1)	5 May 2005	PSLV-C6	In Service
12	IRS P7 (Cartosat 2)	10 January 2007	PSLV-C7	In Service
13	Cartosat 2A	28 April 2008	PSLV-C9	In Service
14	IMS 1	28 April 2008	PSLV-C9	In Service
15	Oceansat-2	23 September 2009	PSLV-C14	In Service
16	Cartosat-2B	12 July 2010	PSLV-C15	In Service
17	Resourcesat-2	20 April 2011	PSLV-C16	In Service
18	Megha-Tropiques	12 October 2011	PSLV-C18	In Service
19	RISAT-1	26 April 2012	PSLV-C19	In Service
20	SARAL	25 Feb 2013	PSLV-C20	In Service
21	RESOURCESAT-2A	07 Dec 2016	PSLV-C36	In Service
22	Cartosat-2D	15 Feb 2017	PSLV-C37	In Service
23	Cartosat-2E	23 June 2017	PSLV-C38	In Service
24	Cartosat-2F	12 Jan 2018	PSLV-C40	In Service

- **RESOURCESAT-3 is a planned** Satellite to carry Atmospheric Correction Sensor (ACS) and is stated to be launched in 2021. This satellite is also important from the point of mineral exploration.

Process of remote sensing :

Fig. 8.1 illustrates the generalized processes and elements involved in Earth observation through remote sensing satellites or platforms like aircraft with digital imaging systems. Two basic processes involved are data acquisition and data analysis.

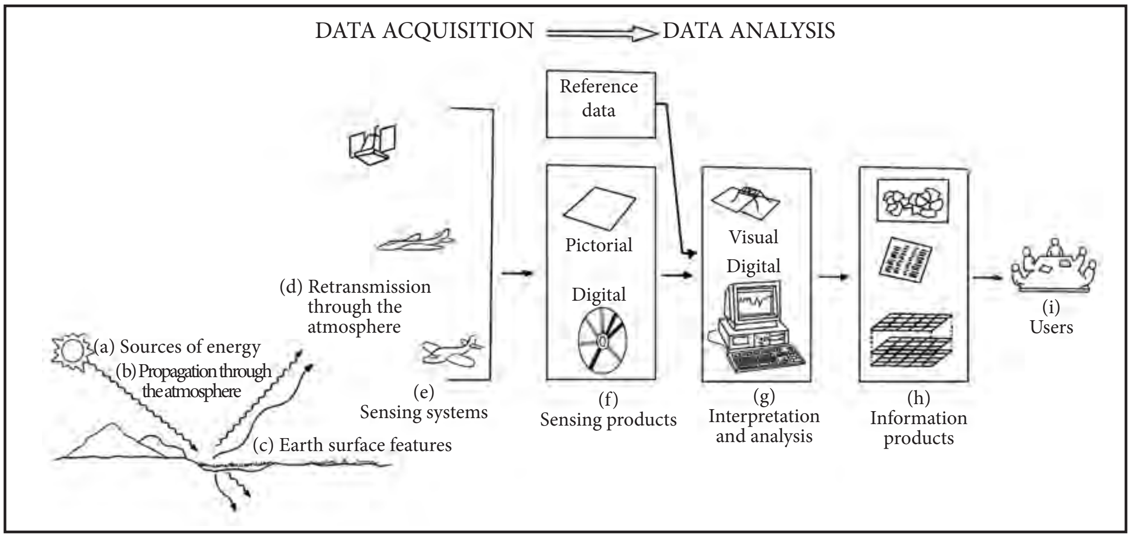


Fig. 8.1 : The process of remote sensing

i) The elements of the data acquisition process are :

a) Energy sources :

b) Propogation or transmission of energy (sunlight) through the atmosphere

c) Energy interactions with Earth's surface

d) Retransmission of the reflected energy through the atmosphere

e) Spaceborne (satellites) or airborne (drones, aircraft) sensors

f) Generation of sensor data in digital or picture form

ii) The data analysis process includes

a) Studying the pictorial data, visually or digital data using computers. Reference data in the form of ground truth or 'spectral signature files' is used to create output images/information which is thematic eg. geology, landuse, vegetation cover etc.

b) This information is then compiled, generally in the form of maps or datatables, which can also be used as an input in GIS.

Classification and Types of remote sensing :

The most common source of illumination of the Earth's surface is sunlight. Most of our remote sensing satellites that orbit around the Earth, have sensors that are designed to record the reflected sunlight from the Earth's surface, and hence cannot collect image data during night. Such a mode of remote sensing is called – 'passive' remote sensing (fig. 8.2). The example is, a simple camera without a flash.

Satellites like India's RISAT are different, and they carry a source of electro – magnetic energy in form of RADAR. Such satellites are also capable of imaging during night, though the images so obtained do not contain information about the sunlight being reflected from the Earth's surface, and are used primarily for preparing contour maps. This mode of remote sensing is known as 'active' remote sensing (fig. 8.3). Here a simple example is the same camera as stated above, but now equipped with a flash for illumination.

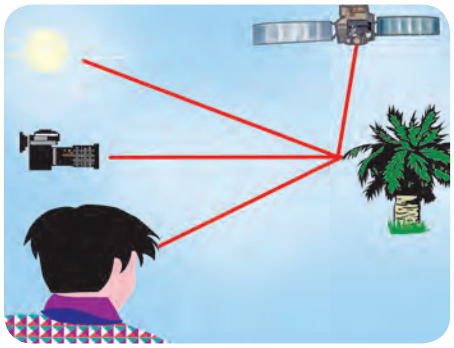


Fig. 8.2 : Passive Remote sensing – Sun is the primary source of illumination. Carried out by remote sensing satellites which record data in the visible and near infra-red wavelengths. e.g. IRS and Cartosat series of satellites launched by ISRO.

Do you know?

Dr. Pisharoth Rama Pisharoty (10 February 1909 – 24 September 2002) was an Indian physicist and meteorologist, and is considered to be the father of remote sensing in India. Dr. Pisharoty became the Director of Colaba and Alibag Magnetic Observatories in 1959 and Founder Director of the Indian Institute of Tropical Meteorology, Pune in 1962. In 1967 he retired as Director of the Institute of Tropical Meteorology and joined the Physical Research Laboratory, Ahmedabad as a senior professor at the invitation of Vikram Sarabhai. He was entrusted with the job of introducing remote sensing technology to India. His pioneering experiment of detection of coconut wilt-root disease using Soviet aircraft and US equipment was considered to be the first success in remote sensing in India.

Dr. Pisharoty served as the Director, Remote Sensing and Satellite Meteorology, at ISRO Space Applications Centre, Ahmedabad during 1972-75. He also served as the Vice-President of the International Association of Meteorology and Atmospheric Sciences, and as a member of Joint Organising Committee for Global Atmospheric Research Programme from 1969 to 1977.

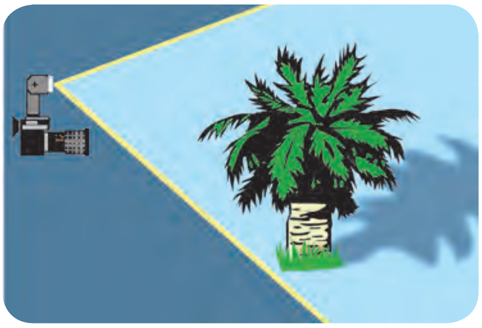


Fig. 8.3 : Active Remote Sensing – External source of Electro Magnetic Energy (EME). Carried out by remote sensing satellites which carry a RADAR. e.g. RISAT I launched by ISRO.

The most popular and commonly used data from remote sensing satellites is usually the one collected in the visible wavelength of light (detected by human eye) and in the near infra-red as well as thermal infra-red wavelengths as depicted (fig. 8.4). The visible and thermal range data is recorded by sensors called multi spectral scanners. The multispectral scanner (MSS) onboard our IRS series of satellites is called LISS (Linear Imaging Self Scanning).

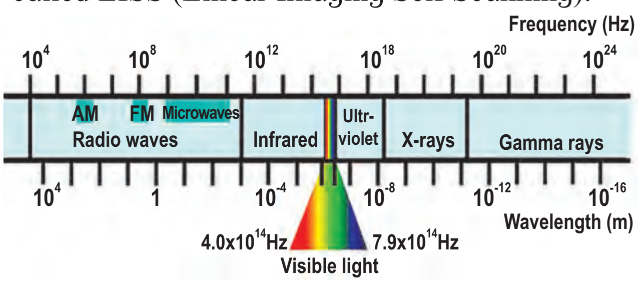


Fig. 8.4 : Wavelengths of Electromagnetic Spectrum (EMS) used in remote sensing

Sources of remote sensing data :

Data from our remote sensing satellites is available from the National Remote Sensing Centre in Hyderabad. Data is made available as printed imageries and also in digital format. Most of the data collected by our satellites in the past decade has been made available by ISRO for free. We can download digital data from the BHUVAN portal.
(https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php)

Orbit of remote sensing satellites :

Almost all remote sensing satellites are placed in a Low Earth Orbit (LEO) which range from 300 kms to 700 kms above the Earths surface. The need for repetitive coverage necesseciates that these satellites be secured in a 'sun synchronous polar orbit' (fig. 8.5). This orbit allows for repetitive coverage of the Earth's surface, where the local equatorial crossing time of the polar orbit is adjusted to be between 10:30 and 11:00 hrs. This aids in obtaining imagery with the optimum illumination from the sun and also the slight shadow from topographic features, which aids in visual interpretation.

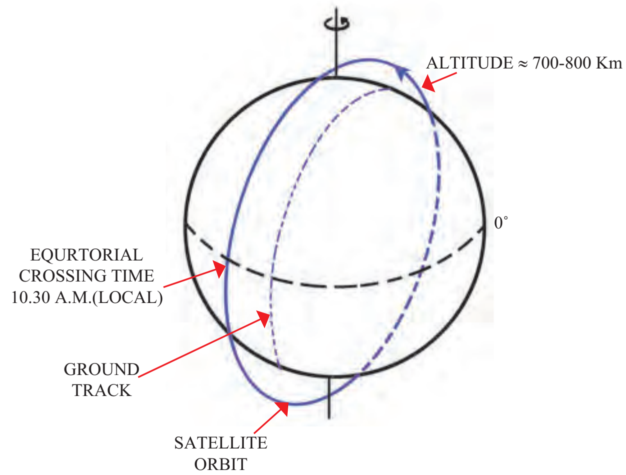


Fig. 8.5 : Orbit of a remote sensing satellite

Sometimes, for special missions, remote sensing satellites are also launched in a LEO which is oblique equatorial orbit. e.g. Razaksat - the Malaysian remote sensing satellite, which exclusively scans a narrow region on either side of the equator, allowing quick repetitive coverage of Malaysia.

Do you know?

Communication satellites are placed in Geo Stationary Orbit (GEO) which is about 36000 to 41000 km above Earth's Surface. India`s INSAT series of satellites are communication satellite which also transmit television signals.

Resolution of satellite data:

The term 'resolution' of a satellite imagery, generally refers to – spatial resolution – or what is very simply understood as the size of the smallest object on the Earth's surface that can be distinctly identified. Our early satellites like the IRS 1A had sensors (digital cameras) which scanned the Earth at a ground resolution of 72.5 m and today we have our Cartosat 2F which has sensors that can scan the Earth at a resolution of less than 1m. The (fig. 8.6) depicts sample imagery taken from our IRS satellites, demonstrating the impact of higher resolution on the interpretability of the features seen in the images.

Satellite Imagery :

Remote sensing satellites record data in digital form and the data is collected in discrete wavelengths. The distinct range of wavelengths are called 'bands'. The IRS satellites collect data in multiple bands depending on the mission requirements. e.g. the IRS P6 LISS 3 sensor collects data in four bands –

Band 2: 0.52-0.59 µm, (green)

Band 3: 0.62-0.68 µm, (red)

Band 4: 0.77-0.86 µm, (NIR)

Band 5: 1.55-1.70 µm, (SWIR)

Band 1 (blue) has been discontinued in many of the IRS satellites because of its limited use and the lack of clarity due to its sensitivity to water vapour in the atmosphere.

Types of Satellite imagery data :

Pan Chromatic : This is an imagery with a single band image, but the data usually has a very high ground resolution. e.g. PAN sensor of Cartosat 2E - is capable of taking panchromatic (black and white) images in a selected portion of the visible and near-infrared spectrum (0.50–0.85 µm) at a resolution of 65 cm.

Colour Composites : A colour imagery requires data in multiple bands, so that one primary colour can be assigned to each of the bands. As we have three primary colours (blue, green and red), at any one instance, we use just three bands to create colour composites. There are two types of colour composites – true colour composite (TCC) and false colour composite (FCC)

True Colour Composite (TCC) : A true colour composite is created by assigning the same colour to a band as the colour of the wavelength range of that band. This creates an image which appears identical to the colours of the Earth`s surface that we can see when viewed from an aircraft. The images we see in Google Earth or Google Maps are examples of TCC. (fig. 8.7)

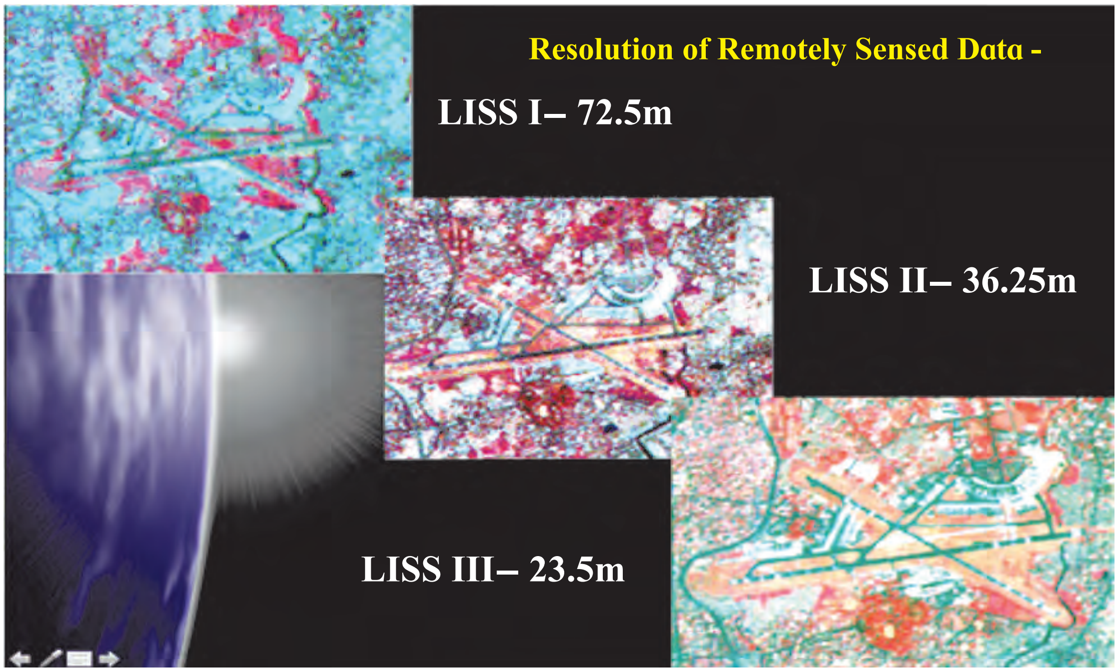


Fig. 8.6 : Sample imagery taken from our IRS satellites

Fig. 8.7 : A True Colour Composite (TCC)

False Colour Composite (FCC) : A false colour composite is created by assigning any of the three primary colours to any of the selected bands in a way where the assigned colour does not match the colour of the wavelength range of that band.

A special type of FCC is a Standard FCC where the green band, red band and near Infra-red bands are assigned blue, green and red colours respectively. This results in all the areas with green vegetation is present, to appear in shades of red. (fig. 8.8) Standard FCC is very useful in demarcating forested areas, crop land, grass land or high bio-mass cover areas on the Earth's surface.

Elements of Image Interpretation :

Visual Interpretation of Satellite Imagery is accomplished using the following criteria (aided by shadow and texture)

- **Shape :** It refers to the general form, configuration or outline of individual objects e.g. roads, airports etc. the shadow cast by tall objects or Earth`s relief (hills, valleys etc) also aids in understanding the shape, thereby helping in interpretation (fig. 8.9.)

Fig. 8.9 : Image interpretation - Shape

- **Size :** The size of an object is one of the most useful clue to its identity, e.g. settlements, reservoirs. It is scale dependent. Fig 8.10 is a FCC depicting a stream network with vegetation (red). If the scale is unknown,

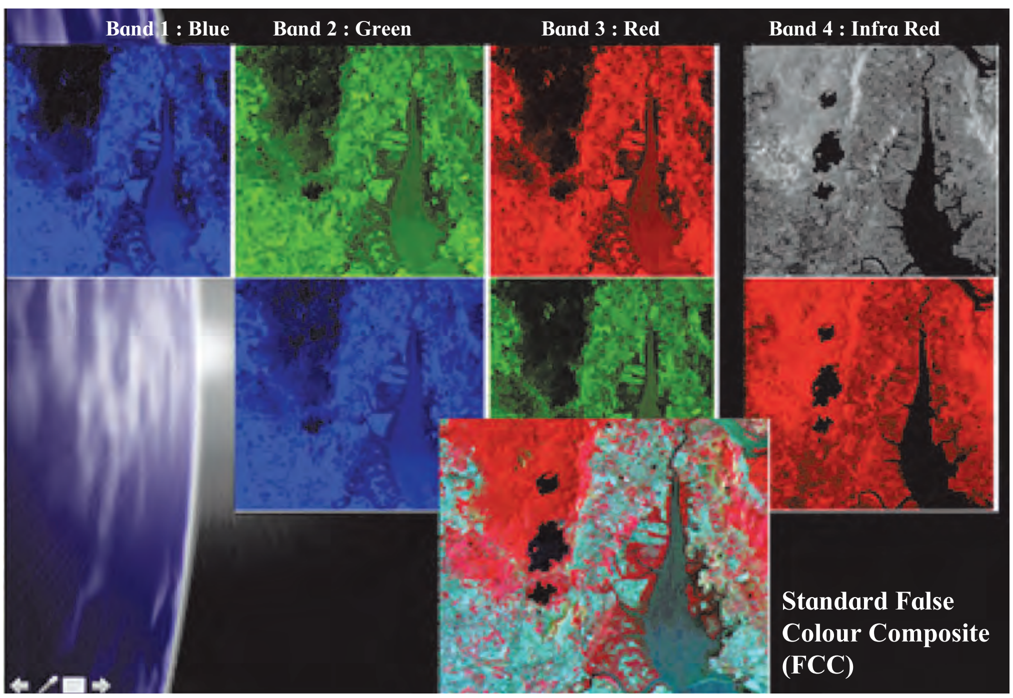


Fig. 8.8 : Resolution of remotely sensed satellite data- sample images from our IRS

the size of the objects in the image cannot be judged and could be misinterpreted as a photo taken under the microscope depicting blood vessels in the human body.

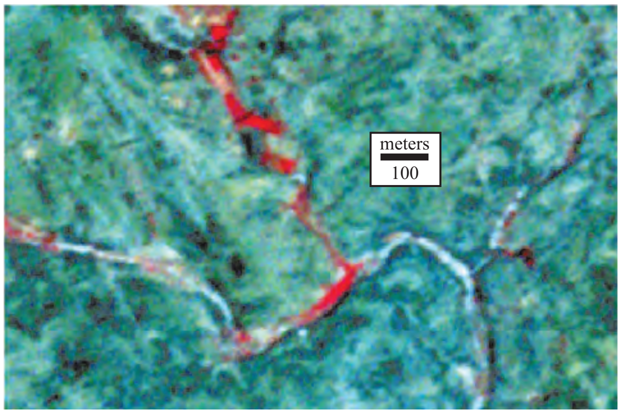


Fig. 8.10 : Image interpretation - Size

- **Pattern :** It relates to spatial arrangement of objects, e.g., uplands, lowlands, deltas, drainage pattern etc (fig. 8.11).

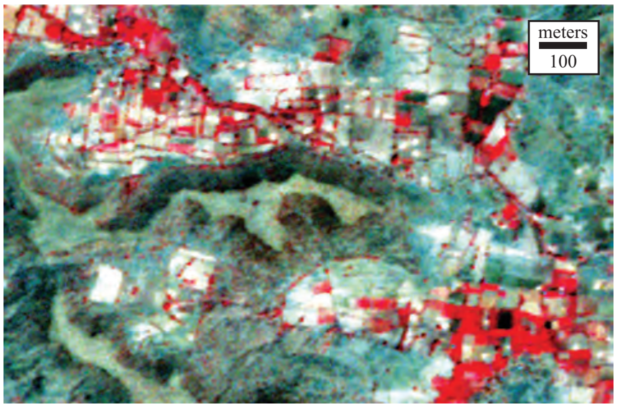


Fig. 8.11 : Image interpretation -

- **Tone :** It is the relative lightness of colour of objects in imageries, e.g., various shades of red for different types of vegetation in FCC (fig. 8.12).

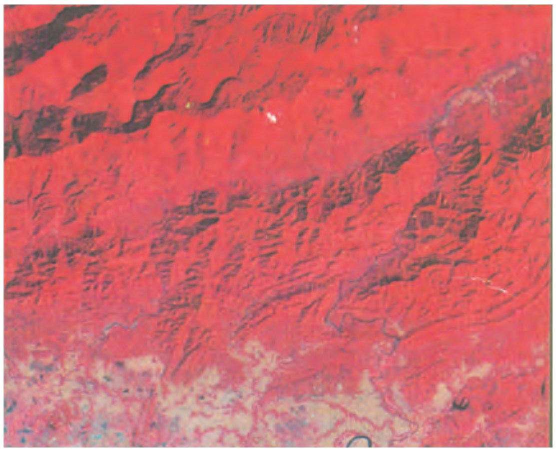


Fig. 8.12 : Image interpretation - Tone

- **Association :** Refers to the occurrence of certain features in relation to others. eg., Sand dunes are associated with deserts, mangroves with coastal regions and buildings associated with urban areas etc (fig. 8.13).

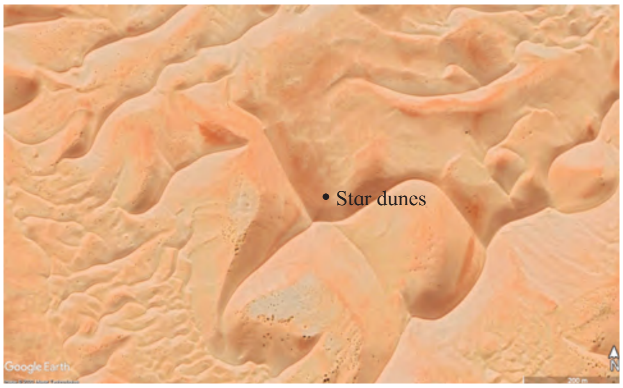


Fig. 8.13 : Image interpretation - Association

Aerial Photographs :

Photographs of the Earth`s surface using cameras (film or digital) are called as aerial photographs. Today such photographs can be obtained by drones (UAV: Unmanned Aerial Vehicles) equipped with digital cameras. Such photographs are generally acquired with low flying drones and hence bring out details of the Earth’s surface features in very high resolution e.g. (fig. 8.14).

Fig. 8.14 : Aerial photo captured by drone

GIS – an Introduction :

A Geographic Information System (GIS) is today, necessarily a computer based system or environment, that can manage, analyse, and display geographic data or spatial data.

Geographic or Geo-spatial data is represented by a series of geographic datasets that contain information of spatial objects with respect to their location and all other descriptive attributes. The GIS has to necessarily be able to create and link such datasets with visual interfaces in form of maps or various thematic layers.

So a GIS has to be able to allow us to:

- View
- Query
- Interpret
- Visualize
- Understand and
- Geographic/ geo-spatial data on a computer.

A GIS combines a set of intelligent maps and other views that show features and feature relationships on the Earth's surface data and apply analytic rules to create a model that helps to answer questions.

The satellite imageries obtained from remote sensing satellites are very effectively used for creation and updating of the various thematic layers that are used in any GIS.

Do you know?

Dr Roger F. Tomlinson, (17 November 1933 – 7 February 2014) was an English geographer and the primary originator of modern computerised GIS, and has been acknowledged as the 'Father of GIS'.

It was during his tenure in the 1960s with Ottawa-based aerial survey company Spartan Air Services that Dr. Tomlinson conceptualized combining land use mapping with emerging computer technology. This pioneering work led him to initiate, plan and direct the development of the Canada Geographic Information System, the first computerised GIS in the world.

From the 1970s until his death, Dr. Tomlinson worked in geographic consulting and research for a variety of private sector, government, and non-profit organisations, largely through his Ottawa-based company, Tomlinson Associates Ltd., which has branches of consulting geographers in Canada, the United States, and Australia.

He was Chairman of the International Geographical Union GIS Commission for 12 years. He pioneered the concepts of worldwide geographical data availability as Chairman of the IGU Global Database Planning Project in 1988. He was also a president of the Canadian Association of Geographers.

What can a GIS do?

Today, a GIS has to be able to answer six wise questions – Where, When, Who, What, Why and How, and hence finds applications in all domains. It does so based on the ability of any GIS to organize geographic / geo-spatial data into a series of thematic layers with linked tables. Since geographic datasets in a GIS are georeferenced (have Latitude and Longitude or some grid reference), they have real world locations and overlay one another (fig. 8.15).

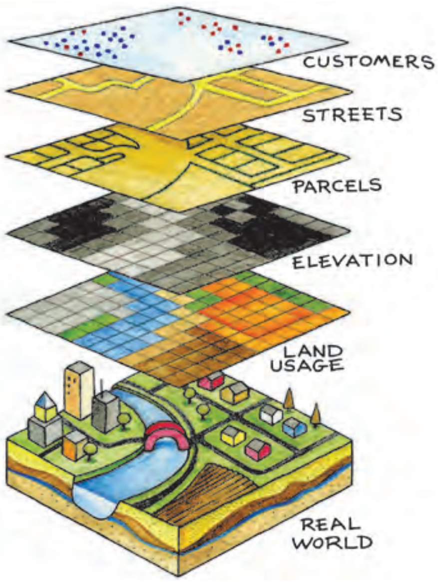
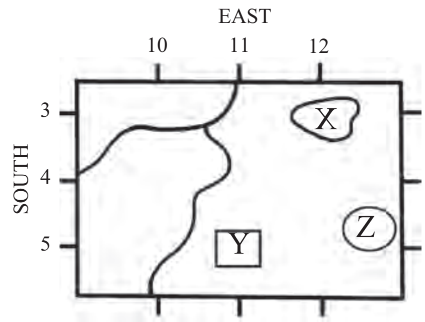


Fig. 8.15 : The concept of thematic georeferenced thematic layers in a GIS. (credit – Saylor Academy)

GIS generic question – Location :

GIS GENERIC QUESTION : LOCATION



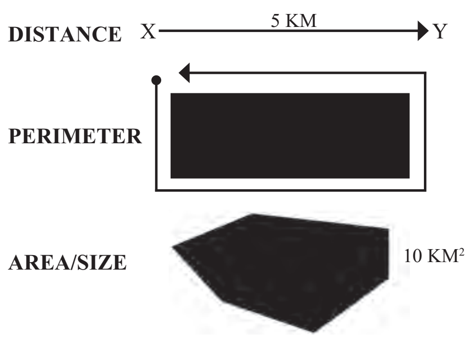
Where is Feature X?
ANSWER : X = 3˚ SOUTH, 12˚ EAST

What exist at a specific location?
Ex : What is at 5˚ South, 11˚ East?
ANSWER : Y

GIS generic question – Measurement :

A GIS has to be able to answer queries related to distance between features, length of perimeter, area of a feature etc.

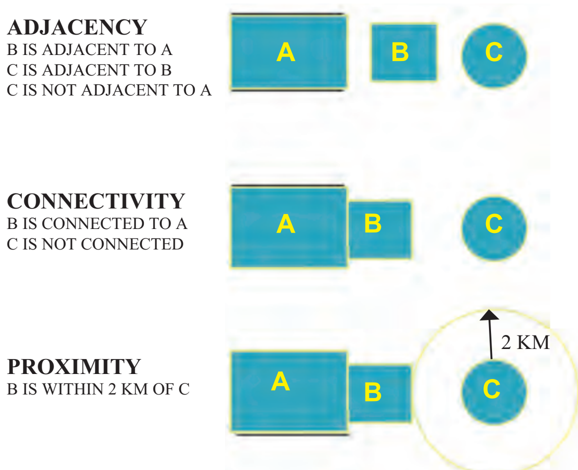
GIS GENERIC QUESTION : AERIAL RELATIONSHIP MEASUREMENT



GIS generic question – Neighbourhood analysis :

Queries based on the adjacency, connectivity and proximity should necessarily be answered.

NEIGHBOURHOOD ANALYSIS



Activity 1 :

Assume that your school/college is the polling centre for elections. Using a printout of the satellite imagery of your school and its surroundings, on a transparency sheet –

1) Mark the 100m buffer distance from the various gates of your school, on every road that leads to your school.
2) Prepare an overlay map that will show all the houses that will get effected due to this 100m rule, where no cars / vehicles would be allowed during the day of elections.

GIS generic query from Attributes database :

In a GIS, every feature in a map is necessarily tagged or linked along with its location to an attributes table or database. We can query the details of specific properties of the features seen in the map. e.g. for a specific geological formation depicted with a specific colour on a GIS enabled geological map, we should be able to query from the database – the rock type, its age, its engineering properties, its mineralogy etc.

GIS GENERIC QUESTION: ATTRIBUTES

PROPERTY NUMBER	AREA (Ma)	OWNER	TAX CODE	SOIL QUALITY
1	1000,000	THOMAS	B	HIGH
2	50,100	BHARATI	A	MEDIUM
3	90,900	BHARATI	B	MEDIUM
4	40,800	ABHIJIT	A	LOW
5	30,200	ABHIJIT	A	LOW
6	120,200	SALMA	B	HIGH

WHO?

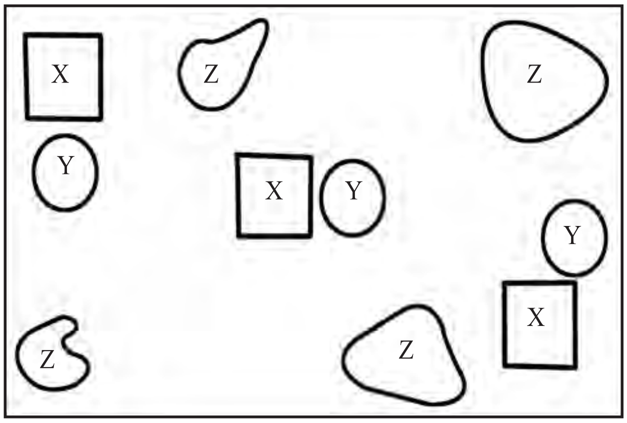
A) Attribute description
E.g. What are the attributes of property 2 ? (Record)

B) Where do certain conditions exist? (Field)
E.g. Who owns High Soil Quality properties?
Answer : Thomas and Salma

GIS generic questions - Patterns and Relationships :

As all features on a GIS enabled map would have linked attribites that would quantify the shape, location, areas etc of various features, it is necessary that a GIS be able to answer queries related to spatial correlation. Such queries are of immense use when geologists are working on mineral exploration. As specific minerals occur in certain geological structures or at specific locations in geological structures, queries related to patterns and mutual relationships help a geologist in mineral occurrence targeting.

GIS GENERIC QUESTION: PATTERNS and RELATIONSHIPS

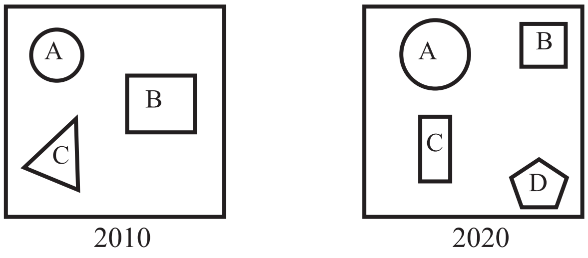


1) Does feature X occur in a pattern?
   Yes. in a line from NW to SE.
2) Is there a relationship between X and Y?
   Yes. Y is always close to X.
3) What other spatial or functional patterns exist?
   Feature Z is always near a border and increases size from West to East.

GIS generic query – Trend analysis :

Apart from geological investigations, GIS is very effectively used for a wide range of analysis. Studying and predicting the growth or change in development of towns and cities is one such area. A GIS can effectively answer queries related to changes in shape, size and locations of features that have been assigned attributes in the linked database.

GIS GENERIC QUESTION : TRENDS



1) How did items A,B,C change from 2010 to 2020?
   A : Increased size
   B : Decreased size, moved
   C : Changed shape
2) What has changed since 2010?
   Change in size of A and B
   Change in location of B
   Change in shape of C
   Addition of D

Activity 2 :

Frame a query or question using – 'where, when, who, what, why, will, which, can and how' as one or more of the words, and list out the various data sets and maps you would need to answer your query. Prepare a brief note on how you will attempt to solve your query using a GIS.

e.g. of a query: 'Will our storm evacuation plan be successful?'

Applications of remote sensing and GIS :

1) Disaster Management and Mitigation (DMM) :

As 'natural disasters' know no bounds - more so the manmade boundaries, the need for global coordination of observing and geographic information systems to address the entire cycle of DMM is necessary. Remote sensing conventionally supplied the post disaster visuals, used very effectively for pre and post assessment. Every state has a State Disaster Management Authority, and at regional level there is a very good understanding of Earth observation technology and a good policy framework. As natural disasters do not confirm to manmade boundaries, all the states and also global nations are committed and cooperate by providing the information and analysis derived from the analysis of various Earth Observation Systems. Such real time data from the sky and space is supplemented by direct linkages with live data from global earthquake monitoring, ocean wave height monitoring, volcanic eruption event prediction, precipitation, snow, and wind speed monitoring - leading to effective early warning system. When appended with geospatial databases which contain census and other social parameters, the rescue and mitigation workers on the ground take effective decisions and appropriate rescue infrastructure is optimally utilized.

2) Natural resources exploration :

The exploration of Oil and Gas, their extraction and production, electricity generation, transport and distribution, form merely a part of the activities of the energy sector. It encompasses not only non-renewable resources, but also renewable resources such as solar, wind, biomass, and hydropower. The energy industry is heavily dependent on EO data. e.g., weather data can form useful estimates for electricity supply and demand. Satellites are important in the exploration, extraction, and transport the world's oil and gas reserves, several of which are located in remote and hostile territory. EOS data can be used to build global resource maps for planning renewable energy projects.

More recently, renewable energy systems have benefitted from the contribution of EO data in not only their optimization, but also in their integration with traditional energy supply systems. While renewable energy sources such as solar, wind, or wave power are environmentally a safer option than fossil fuels, they are highly susceptible to environmental changes. Their availability depends largely on the prevailing weather conditions at their localities. Data on cloud cover and solar irradiance, along with wind speeds and directions, combined with environmental parameters such as land elevation and land cover models are vital elements in planning for the location and operation of renewable energy installations. An example of EOS data in this field is the Surface Meteorology and Solar Energy (SSE) dataset, funded by NASA, a compilation of temperature, wind, and solar radiation data derived from satellite observations and model analysis. Such datasets estimate variability on timescales ranging from seasonal, to several years.

3) Water :

The slowly but sure depleting reserve of the worlds fresh water reserves has been proved by ground observations as well as EO satellite data for gravity measurements. The fact that the Amazon river basin also contains the world's largest single groundwater repository was also confirmed by such observations. On a regional and local scale, watershed and rainwater conservation practices have been drawing heavily on observations from EO satellites for fine tuning the water conservation practices which depend on terrain conditions apart from the climatic zones.

The Asian Water Cycle Initiative (AWCI) utilises apart from meteorological datasets, EO data also for watershed characterisation and prioritisation. At a micro-watershed level, EO data is being effectively used for monitoring and documenting change in groundwater conditions which manifest as a change in vegetation and soil moisture. In Maharashtra, organisations like AQUADAM and Watershed Organisation Trust (WOTR), have incorporated remote sensing data in a GIS This is so because, water resources management is a people and community centric activity where remote sensing data becomes just one data input. It is an excellent tool for benchmarking. But it needs effective integration with GPS along with inputs from local community. Any application developed for 'water' management also needs to have a 'peoples component'. So apart from mapping and change detection, remote sensing data, especially the visualisations generated from such data are today being very effectively used to bring about an awareness among the participants about their prevalent environment. The modeling done for forecasting water demands and resources depletion, is similarly communicated through the rich visualisation modules available in GIS. Such visual medium for educating and opinion building among the impacted communities around the world, plays an important role in water conservation, and convincing impacted communities about the importance of appropriate exploration and sustainable exploitation strategies.

Activity 3 :

Using a printout of the satellite imagery from Google Earth (at known scale) depicting your school/college, prepare individual maps on a transparency sheet as listed below.

a) The school campus.

b) All roads leading to your school/college from the neighborhood.

c) Location of the houses of all your classmates in the school/college vicinity.

Using these three layers, and the measured distances along the roads, arrive at the best location for meeting your friends after school/college such that – all your friends can reach their home from this spot in the same amount of time. Discuss the method followed by you with your classmates.

Activity 4 :

Discuss and Debate :

Is Google Maps a GIS? List your reasons.

Is Google Earth a GIS? List your reasons.

Summary :

Remote sensing has evolved into a fine tuned data collection method over the last century – since the advent of the camera and the aircraft. Satellite remote sensing has effectively added the advantage of repetitive coverage which comes in handy when collecting data on dynamic and temporally varying themes such as water, agricultural fields, and infrastructure development and so on. Multi layered remote sensing carried through drones, aircraft and satellites allows for easy collection of data over a variety of scales and resolutions. Today, data collected through these Earth observation systems, is being effectively used for near real time update to spatial data within GIS.

The power of spatial analysis along with excellent visual creations done through GIS has become ubiquitous and is accepted if not expected in all walks and processes of day to day human functioning. The excellent monitoring of the global pandemic caused due to the Covid – 19, its fallout, spread, containment and control have been made possible through the perfect dovetailing of data from multiple - agencies, countries, formats and scales made available on global data platforms. The study and understanding of how GIS systems work and their capabilities is today an essential part of every Earth-science student's curriculum.

Plate 1 : Satellite imagery - geologically faulted area. (source - Google Earth)

Plate 2 : Satellite imagery - geologically folded area. (source - Google Earth)

Plate 3 : Satellite imagery - rock outcrops showing joints. (source - Google Earth)

Plate 4 : Satellite imagery - Intrusive rocks - dykes. (source - Google Earth)

EXERCISE

Q. 1. Fill in the blanks with correct choice from the list :

1) The term remote sensing was first used in …………… year.
   a) 1949 b) 1959 c) 1988 d) 1996

2) The term remote sensing was coined by ………… Of the U.S. office of Naval Research
   a) Kalpana Chawla b)Valentina Tereshkova
   c) Evelyn Pruitt d) Edelyn Bishop

3) The first civilian Remote sensing satellite launched by the U.S.A was ……………
   a) IRS-1A b) SPOT
   c) RAZAKSAT d) ERTS1

4) The U.S. remote sensing satellite ERTS 1 was later renamed ……………
   a) USRS-1 b) USA SAT-1
   c) LANDSAT-1 d) LSAT-1

5) The first Indian Remote sensing satellite was called ……………….
   a) Rohini-1 b) PSLV-1
   c) Bhaskara d) IRS-1A

6) The IRS 1A was launched in the year ………………
   a) 1950 b) 1978 c) 1988 d) 1998

7) The RISAT-1 is India's first ……………. Satellite.
   a) Remote Sensing b) Risk assessment
   c) Radar d)Resource mapping

8) Most remote sensing satellites cannot collect image data during ………………
   a) an earthquake b) a tsunami
   c) night d) winter

9) The abbreviation GIS stands for ……………
   a) Geological Information System
   b) Geographical Information System
   c) Geomorphological Information System
   d) Geophysical Information System

10) A GIS has the ability to organise geographic data into a series of …………… layers.
   a) coloured b) imagery
   c) thematic d) GPS

11) ……………….. is not an example of Remote sensing.
   a) Drone flying b) CT scan
   c) Sonography d) Satellite imaging

12) Vegetation in a standard FCC appears
   a) Green b) Blue
   c) Infra-red d) red

13) …………..... is not an example of active remote sensing
   a) MRI b) Seismic imaging
   c) RADAR d) Drone photography

14) ………….. is not an example of passive remote sensing
   a) LIDAR b) Drone photography
   c) Satellite imaging
   d) Digital camera without a flash

15) ………….. is not a Indian remote sensing satellite
   a) In SAT-1A b) Resource Sat-2
   c) Carto Sat-2F d) IRS-1C

16) Today a remote sensing satellite cannot detect
   a) Oil spills on ocean surface
   b) Open cast coal mines
   c) Underground oil reserves
   d) People sitting on a sandy beach

17) A remote sensing satellite is never in
   a) Sun synchronous equatorial orbit
   b) Geo stationary HEO
   c) Sun synchronous polar orbit
   d) LEO obliged equatorial orbit

Q. 2. Choose the correct sequence :

1) i) Sensing system – Interpretation and Analysis – Users information products – Sensing products.
   ii) Users – Sensing products – Information products – Interpretation and analysis – Sensing systems
   iii) Sensing systems –Sensing products – Interpretation and Analysis – Information products – User

iv) Sensing systems – Information products – Sensing products – Interpretation and Analysis – Users

2) i) Sources of energy – Sensing systems – Propagation through the atmosphere – Retransmission through the atmosphere – Earth surface features.

ii) Earth surface features – Sources of energy – Sensing systems – Propagation through the atmosphere –Retransmission through the atmosphere.

iii) Sources of energy – Propagation through the atmosphere – Earth surface features – Retransmission through the atmosphere – Sensing systems.

iv) Sources of energy – Earth surface features propagation through the atmosphere – Retransmission through the atmosphere – Sensing systems.

Q. 3. Very short answer :

1) List the two types of Remote sensing.
2) The most commonly used data from Remote sensing satellites is?
3) Remote sensing satellites are usually placed in what kind of orbit?
4) In which form do remote sensing satellites record data?
5) What are 'bands in remote sensing satellite data?
6) What is Pan chromatic imagery?
7) List the types of colour composites available as satellite imagery.

Q. 4. Short answer :

1) What kind of questions should a GIS be able to answer?
2) What does a GIS allow us to do?
3) List the five dements by which interpretation of satellite imagery is accomplished.
4) Explain the term 'resolution' of a satellite imagery.
5) What is the official source of remote sensing satellite data in India?
6) What is the special type of orbit that remote sensing satellites are placed in? Why?
7) Explain with an example how a GIS can query from attributes database.
8) Explain the various elements of image interpretation.
9) Explain how colour composite satellite imageries are prepared.

Q. 6. Long answer :

1) Explain with an example how a GIS can query and answer questions about 'Patterns and relationships'.
2) Explain with an example how a GIS can answer questions an 'trends'
3) With a neat diagram explain the entire sequence in the 'process of remote sensing'.
4) Explain with a diagram the logic behind the creation of a 'False colour composite' satellite image. Why is vegetation depicted in 'red' tone on a standard FCC ?
5) Can Google Earth be considered a GIS? Explain your reasons.
6) Explain how remote sensing and GIS can be effectively used in any one of the listed applications.
   a) Disaster management and mitigation
   b) Natural resources exploration
   c) Water