Raju Shrestha
Roll No. 48

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1.) Explain the functions of a GIS. Describe the three main ways of acquiring spatial data for input into a GIS.

→ GIS are powerful tools used for capturing, storing, analyzing, managing & presenting spatial or geographical data.

The functions of GIS are:-

I.) Data capture:-

Data used in GIS often come from many sources. Data sources are mainly obtained from manual Digitization & scanning of aerial photographs, paper maps & existing digital data sets. Remote sensing, satellite imagery & GPS are promising data input sources for GIS.

II.) Data storage & management:-

- Organize & store large volume of geographic data in database.
- combines data from various sources into a unified system.

III.) Data manipulation & analysis:-

GIS allows user to manipulate & analyze geographic data to identify patterns, relationships & trends.

IV.) Data visualization:-

- creates detailed maps that visually represent geographic data.
- Develops 3D models of geographic features for better visualization & analysis.

V.) Query & reporting:-

users can perform complex queries to extract specific information from GIS database.

The three main ways of acquring spatial data for input in GIS are as follows:-

1.) Remote sensing
II.) Surveying
III.) Global positioning system (GPS)

1.) Remote sensing:-
This involves collecting data from distance typically using satellites or aircrafts. This method captures images & data about Earth surface using sensors that detect reflected or emitted radiation.

- Satellite imagery:- Satellite equipped with sensor capture images & spectral data over large areas which is useful for monitoring changes over time.

- Aerial photography:-
Aircraft equipped with cameras capture high-resolution images of specific areas. often used for detailed mapping, urban planning & environmental monitoring.

II.) Surveying:-
It is a method of collecting precise spatial data on the ground using instruments & techniques to measure distances, angles & positions like total station, theodolites & levels. It provides highly accurate & detailed spatial data essential for engineering projects, construction & cadastral mapping. Modern surveying also intigrate GPS & laser scanning (LIDAR) to enhance accuracy & efficien-cy.

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III.) Global positioning system (GPS) :-
GPS technology involves using a network of satellites that provides precise location information to GPS receivers on ground. By receiving signals from multiple satellites, GPS receiver can triangulate its exact position in terms of latitude, longitude & altitude. commonly used for field data collection such as mapping property boundaries, infrastructure, natural features & other geographic elements.

2.) Describe scale & resolution with illustrations. If the scale on a map is 1:50,000.
1.) Find the distance in meters between two places represented by a distance of 1mm on the map and,
11.) Find the distance between two places on the map that are 20 kilometers apart?

→ Scale refers to the relationship between distance on a map & the corresponding distance on the ground. It determines how much detail is represented on the map.

• Large scale :-
Represents a small area with a high level of detail. eg. 1:10,000 i.e 1 unit on map is equals to 10,000 units on the ground. This type of scale is used in the map where individu-al buildings, streets & even trees are visible.

• small scale :-
Represents a large area with small details. eg. 1:10,00,000 scale used in the map of whole country where only major cities, highways & geographic features like rivers & mountain

ranges are shown.

Resolution refers to the level of detail that can be captured in spatial data.

- High resolution:-
  Represents data with very precise coordinates, capturing a high level of detail.

- low resolution:-
  Represents data with less precise coordinates & low level of detail.

1.) Given,

Scale = 1:50,000

i.e. 1mm on map = 50,000 mm on ground

$= \frac{50,000}{1000}$ m on ground

= 50 m on ground.

∴ The distance between two places represented by 1mm in map is equal to 50m on ground.

11.) Given,

Scale = 1:50,000

Distance between places on ground = 20km

= 20,000,000 mm

Now,

Map distance $= \frac{1}{50,000} \times 20,000000$

= 400mm

∴ The distance between two places which are 20km apart is equal to 400mm on map.

3.) Describe different types of projection system used in GIS mapping. Explain the different methods of vector overlay operat-ions with illustrations.

→ A map projection is a method used to represent 3-dimensi-onal surface of earth or other round body on 2-D plane in cartography. It transform geographic coordinates (longitude & latitude) to plane coordinate (easting or northing).
The different types of projection system used in GIS mapping are:-

1.) Cylindrical projection:-
It refers to any projection in which meridians are mapped to equally spaced vertical lines & circles of latitude (parallels) are mapped to horizontal lines.
Eg. mercators, Transverse mercator, oblique mercator etc.

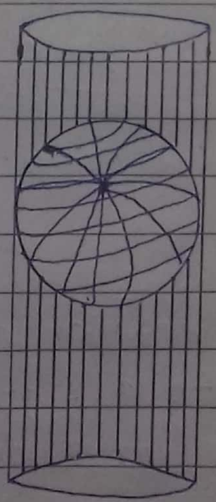


fig. cylindrical projection surface

II.) Conical projection:-

It is the type of map projection where the earth is projected onto a cone places over the globe. The cone is then unwrapped into a flat plane, resulting in a map where meridians are straight lines that converge the apex of cone whereas the arcs of circles centered on the apex are parallel. It is advantageous for regions that are wider east to west then north to south.

Eg. Equidistant conic, Albers conic & lambert conformal conic etc.

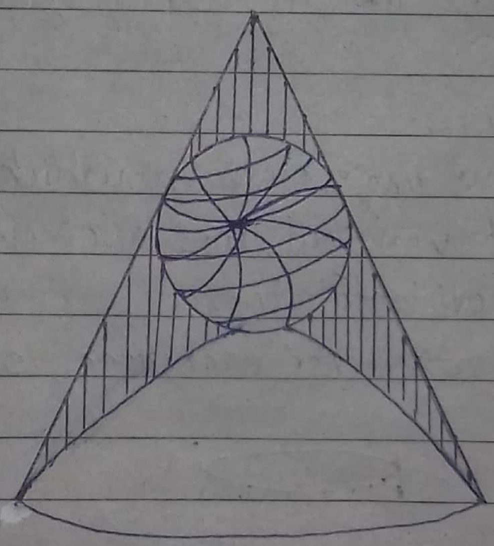


fig. Conical projection surface

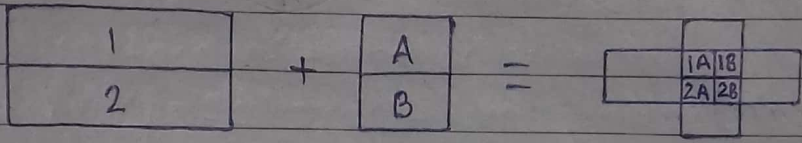
III.) Azimuthal projection:-

Azimuthal projection/plannar projections projects the earth's surface onto a flat plane typically from a single point of tangency or secancy. These projections are particularly useful for mapping polar regions, hemispheres.

Eg. orthographic, stereographic & gnomonic etc.

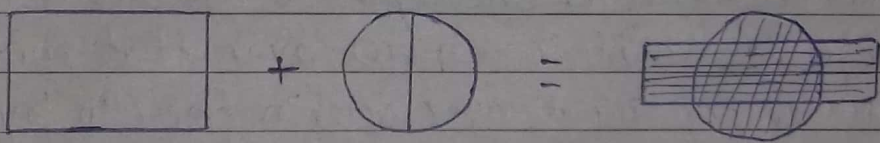
Vector overlay :-

overlay can be defined as a spatial operation, which combines different geographic layers to generate new information. Vector overlay combines the geometries & attributes of two feature-layers to create output.

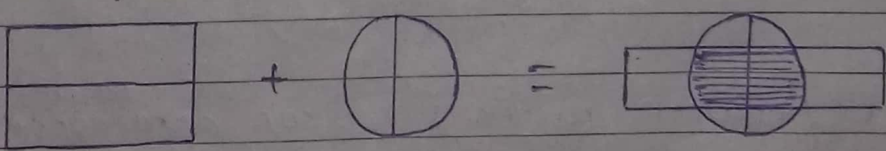


Different methods of vector overlay operation are :-

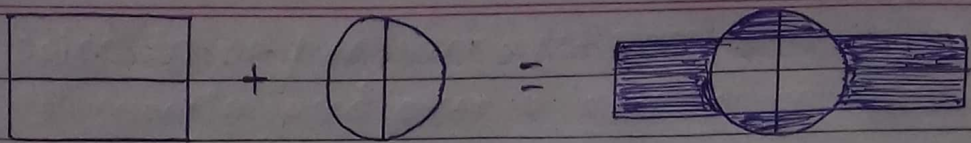
1.) Union :- It preserve all features from the inputs. The area extent of output combines area extends of both input layers.



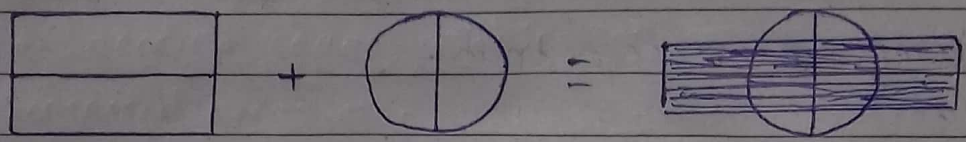
11.) Intersection :- It preserves only those features that fall within area extent common to input. Any features on its output has attribute data from both of its inputs.



111.) Symmetrical difference :- It preserve features that fall within area extent that is common to only one of the input. It is opposite to intersect interms of output area extent.



iv.) Identity :- It preserve only features that fall with the area of layer defined as input layer.



v.) Difference (Erase) :-

It results in a new layer that contains area of 1st layer minus the overlapping areas.

vi.) Clip :-

It uses the boundary of one layer to cut out a portion of another layer. It results in a new layer that contains only the features of the input layer within the clip layers boundary.

vii.) Split :-

It divides the input layer into multiple output layers based on the features of the split layer.

4.) Differentiate between raster & vector data models. Explain the different methods of image overlay operations with illustrations.

→ The difference between raster & vector data models are :-

Raster data models	vector data models
1.) Raster graphics are used to	1.) It is used to represent

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display spatial data.	features using point, line & polygon.
ii) It uses pixel where by graphics are made up of large no. of pixels.	ii.) It is rendered by mathema-tical manipulation referenced by coordinates.
iii) continuous data.	iii.) Discrete data.
iv) Raster images are more detailed within given extent.	iv.) vector image are less detailed.
v) Requires more storage space than vector.	v.) Requires less storage space.
vi.) Performance & responsiveness when manipulating raster ima-ge are slower than vector image.	vi.) They are faster.
vii) Represented data in cell or in grid matrix.	vii.) Represented data using sequential points.
viii) simple data	viii.) complex data.

The different methods for performing image overlay operations are as follows:-

1.) Vector overlay:- It combines the geometries & attribute of two feature layers to create output.

There are three types of vector overlay operations:-

a) Polygon on polygon overlay:- Here, one polygon layer is super-imposed over another polygon layer to create a new output polygon layer.

Eg: determining the percentage of a country that is zoned for residental use.

b.) point in polygon overlay:- Here, a layer of point features is superimposed over a layer a polygon features.
Eg. Identifying ATM with settlement areas.

c.) Line in polygon overlay:- It is similar to point in polygon, but lines are superimposed on polygons.
Eg. Locating roads within settlement areas, rivers with protected areas etc.

ii.) Raster overlay:- It is simpler than vector overlay & can be carried out directly on cell values. It is also more efficient than vector overlay as extent of calculation is much less. There is no need to distinguish between polygons, lines, points because all raster data comprise cells. Deviation is carried by transformation & resampling to the same cell size. There is no formation of smaller errorneous polygon.

Operators & function used in raster overlay:-

1.) Arithmetic operators:- The operators (+, -, /, *) allows for addition, subtraction, division, multiplication of two raster maps or numbers or combination of the two.

ii.) Boolean operators:- The operators (AND, NOT, OR, XOR) uses Boolean logic (TRUE or FALSE) on the input values. output values of true are written as 1 & false as 0.

iii.) Relational/comparision operators:- The operators (<, <=, <>, =, >, >=) evaluate specific relational conditions. If condition is TRUE, output is assigned 1 & if FALSE,

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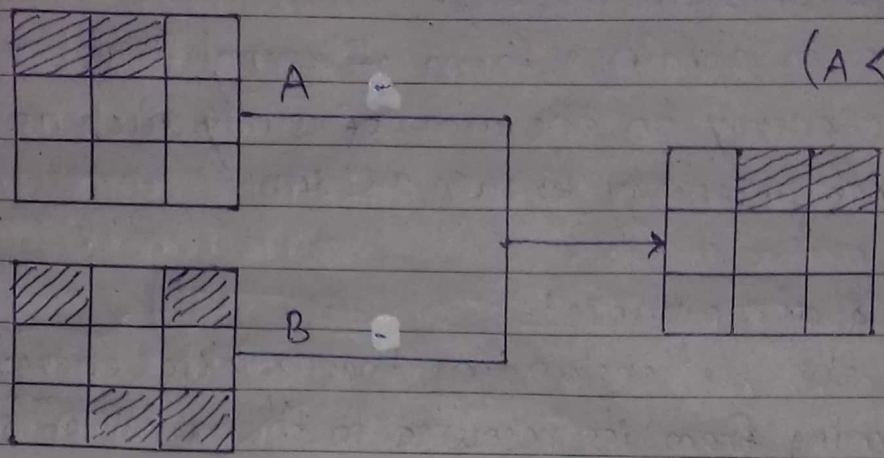
output is assigned 0.



$(A <> B \Rightarrow A \neq B)$

$C = A < B$

5.) What are the different steps in remote sensing? Describe with illustrations. Differentiate between active & passive sensor?

→ Remote sensing is the method of collecting data from distance typically using satellite or aircrafts. In remote sensing, information transfer is accomplished by use of electromagnetic radiation (EMR).

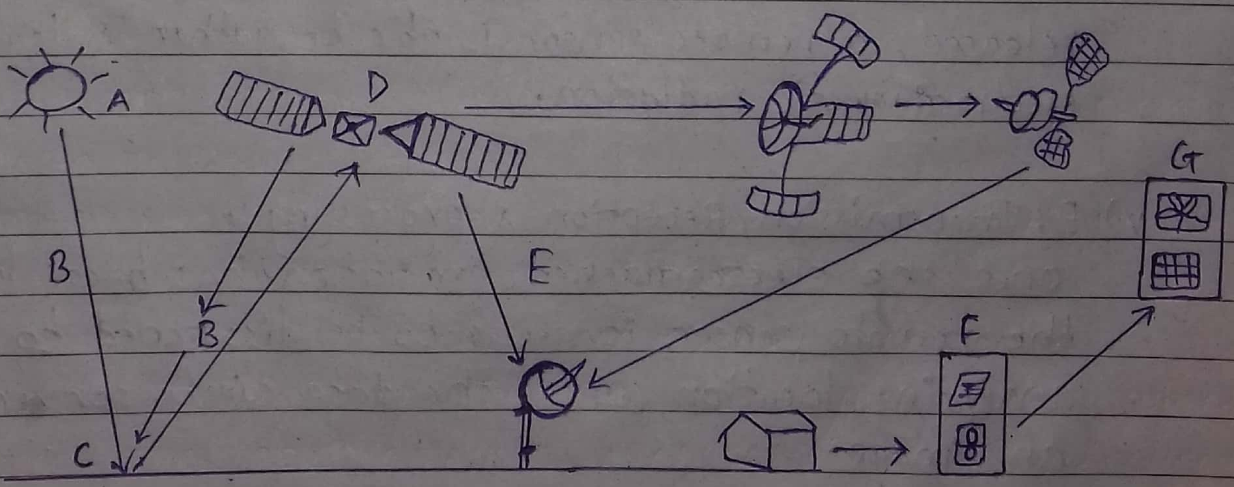


fig. steps in Remote sensing

Steps:-

I.) A: Energy source or Illumination:-
1st phase is to obtain a form of energy that enables electromagnetic energy to the area of study such as our primary source of energy known as sun.

II.) B: Radiation & atmosphere:-
2nd phase is the understanding that while energy the energy is flowing from its resource to the area of study, it will interconnect with atmospheric conditions associated.

III.) C: Interaction with the target:-
3rd phase is to recognize that the interconnection is hinged upon the features of the energy & area of study.

IV.) D: Recording of Energy by sensor:-
4th phase is that once the process of energy has been released, a remote sensor is able to gather & log the electromagnetic radiation.

V.) E: Transmission, Reception & processing:-
once the electromagnetic radiation has been logged by the remote sensor, it needs to be dispatched to an analyzing location where the data can be converted to an image.

VI.) F: Interpretation & Analysis:-
The image are then rendered into electronic format so analysis can gather intel.

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VI.) G: Application :-

The last phase is fulfilled when the analysis can make use of intel by gaining insight, discover new insight, and/or helping to resolve specific issues.

The difference between active & passive remote sensing is given below :-

	Features	Active sensor	passive sensor
1.)	source of energy	Emit the own energy for detection.	Do not emit signal, relay on external sources of energy (eg. sunlight).
II.)	Operation	can operate day & night regardless of lighting condition.	operates only when there is an external source (eg. during day time).
III.)	Range	can have longer range due to actively emitted signals.	may have limited range based on ambient signals.
IV.)	Application	used in application where control over emitted signal is necessary like terrian mapping, vegetation analysis, infrastructure monitoring.	commonly used when detecting existing signals is sufficient like - land cover mapping, temperature measurement, environmental monitoring.
V.)	Energy consumption	Generally higher due to active energy emission.	Lower as they do not emit their own energy.

vi.) Resolution	Typically higher spatial resolution.	Resolution can vary depending on sensor & external light conditions.
vii.) Example sensors	Radar system, LIDAR, active SONAR.	Infrared sensors, cameras, microphones.
viii.) Diagram