

5.0 VECTOR BASED SPATIAL DATA ANALYSIS

The technology of GIS has developed so fast over the past one decade that it is now accepted as an essential tool for the effective use of geographic information. There are many problems such as soil erosion, deterioration of environment, deforestation, population growth, drought conditions, shortage of drinking water etc. These are complex issues and require integrated responses. One difficulty in organizing such integration e.g. among soil, water, vegetation has been the lack of means to link the data in comparable and manageable sets. In order to overcome these difficulties GIS offers entry of many types of data in a single spatial framework and has capability of collection, compilation, storage, retrieval, analysis, manipulation, display and integration of environmental, economic and social data in a single system.

It facilitates the following:

- Overlay of data for the purpose of comparison.
- Updating of information to illustrate changes over time.
- Changes of scale for micro-analysis.
- Derivation of non-available data through manipulation of known factors.
- Integration of physical and social science data sets.
- Incorporation of remotely sensed data such as satellite imagery for continuous environmental monitoring.
- Modeling of physical, economic and social processes for the process of simulation & prediction.

Both remote sensing and GIS are involved in the analysis of phenomenon, which has geographic or spatial significance because GIS technology is ideally suited for analysis of spatial phenomena, and Remote Sensing is the most common source of spatially continuous data.

The information in a map database is normally geographically referenced using a map projection. The map database or (Graphic database) in the GIS contains all the descriptive information related to map feature. The attribute database contains all the descriptive information related to map features. GIS links these two data bases and permits a wide range of integrated, queries, searches and manipulations.

5.1 **Introduction to Spatial Data Analysis:**

- ❑ Geographic analysis allows us to study and understand the real world processes by developing and applying manipulation / analysis criteria and models and to carryout integrated modeling.
- ❑ These criteria illuminate (highlights) underlying trends in geographic data, making new information available.
- ❑ A GIS enhances this process by providing tools which can be combined in meaningful sequence to reveal new or previously unidentified relationships within or between data sets, thus increasing the better understanding of real world phenomena.
- ❑ Spatial analysis is the vital part of GIS and can be done in two ways:
 - a) Vector based analysis**
 - b) Raster based analysis**
- ❑ In addition to the basic functions related to automated cartography and database management system, the most important uses of GIS are spatial analysis capabilities.
- ❑ Making maps alone does not justify the high cost of building GIS. The same maps may be produced using a simpler cartographic package. Like wise, if the purpose is to generate tabular output, then simpler database management software or a statistical package may be a more efficient system.
- ❑ It is a spatial analysis that requires the logical connection between attribute data and map features.

- ❑ This capability makes GIS a much more powerful and cost-effective tool than other automated cartographic packages or database management system.
- ❑ Indeed, functions required for performing spatial analysis that are not available in either cartographic package or database management systems are commonly implemented in GIS.

5.2 GIS usage in Spatial Analysis:

- i) Query (Spatial and Aspatial) and generation of new items from the original set.
- ii) Single layer operation
- iii) Multi layer operation
- iv) Geometric modelling Network analysis
- v) Raster/Grid analysis

1. **Query:** Spatial analysis in GIS involves three types of operations

- a) Attribute query: also known as Aspatial query.
- b) Spatial query
- c) Generation of new data sets from the original database.

a) Attribute Query: It retrieves a data subset from a map by working with its attribute data. Here the selection is done by asking logical questions
e.g. Arc view -> Query builder -> Region name – Bale.

b) Spatial Query: refers to the process of retrieving data from a map by working with map features. Here selection of features is on location or spatial relationship which requires processing of spatial information

e.g. select district through which NH-5 is passing.

- Villages falling within five Km along the canal.
- Villages where there is no sampling points.

c) Generation of new datasets from original database: The results of attribute data query and spatial data query can be visually inspected or can be saved as new maps for further processing.

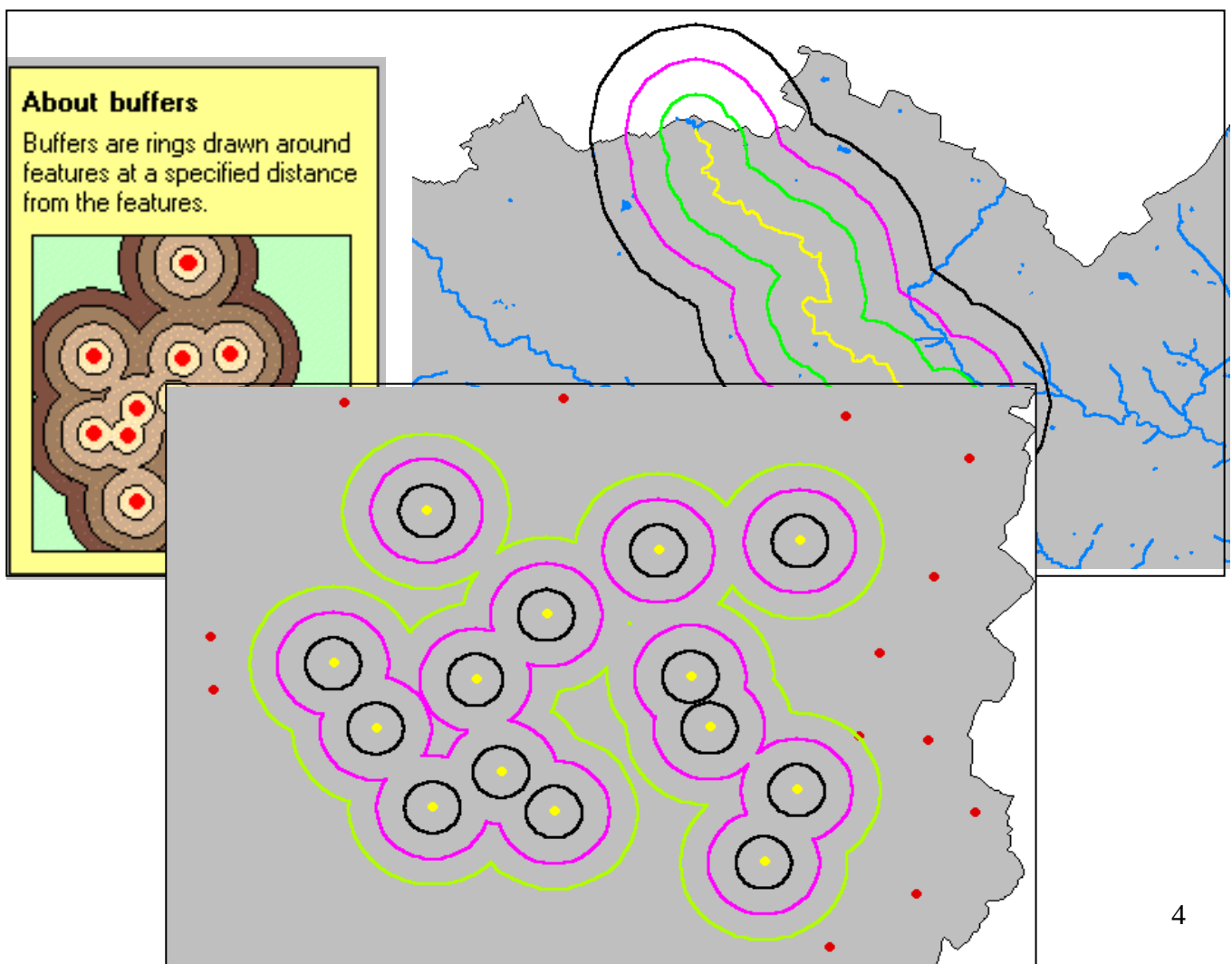
E.g. select region = Bale

Convert to shape file -> Bale

2. Single Layer Operation:

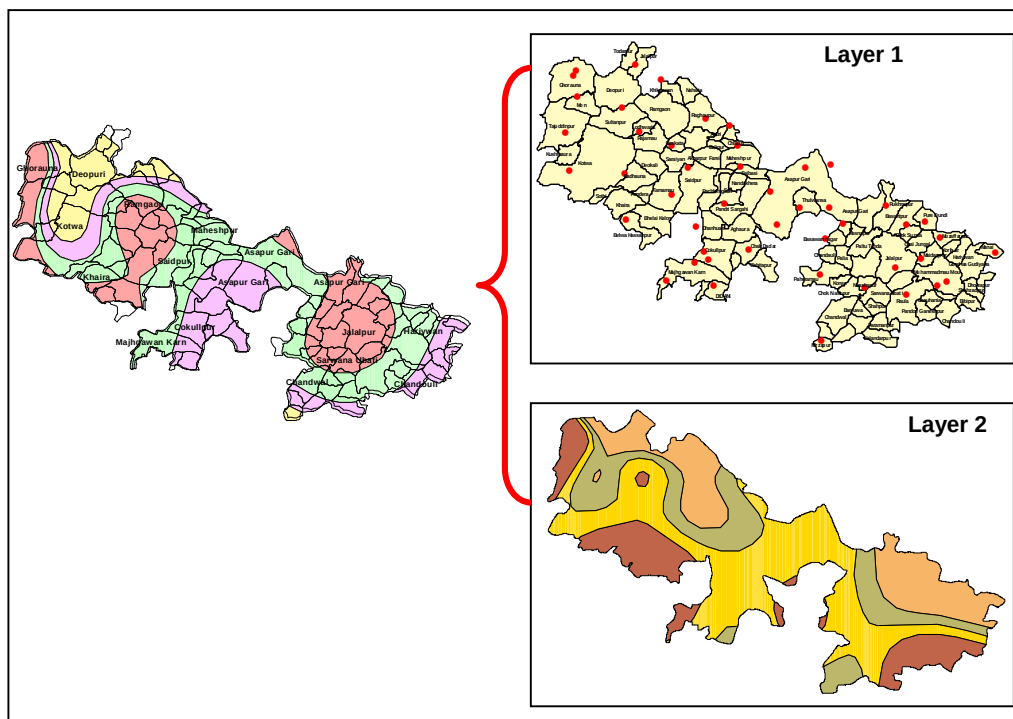
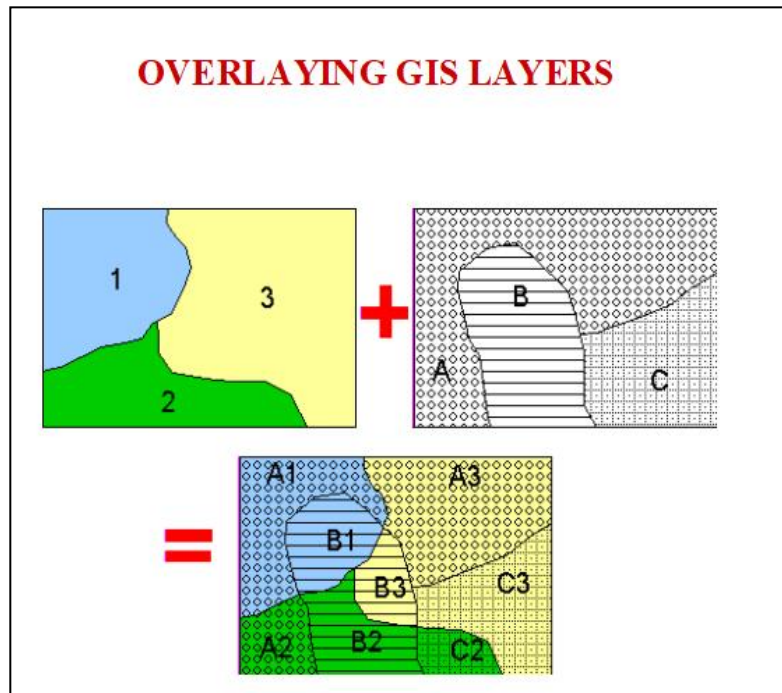
This includes the following analysis

- Creation of buffer zone around selected features
- Selected map features may be points, lines or polygons.
- A buffer zone is often treated as a protection zone and is used for planning and regulation.
- This analysis becomes important when calculating the impact area around well location or area along road for any construction activities.



3. Multi Layer Operation:

- Here two or more themes are combined to generate a new theme
- The newly generated theme has characteristics of both parent layers.



4. Geometric modelling:

- a) Distance measurement : refers to measuring straight line distance between geographic features
- b) Calculating area, length and perimeter
- c) Geometric buffer (find the feature present at a specified distance of other feature.

5. Network analysis:

- a. Designed specifically for line features having corrected topology. Used to solve transportation problem and locational analysis like-

GIS Can Help in

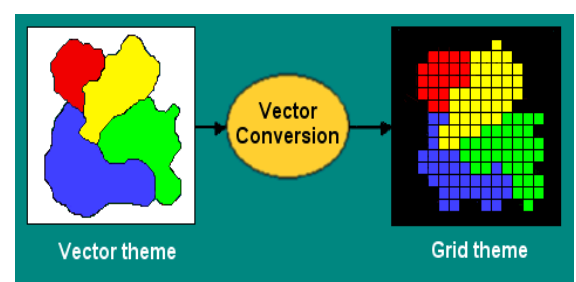
- **FIND BEST ROUTE**
Shortest Route, Traffic Free, Less Time and Fuel etc.
- **FIND CLOSEST FACILITY**
School, College, Hospital, Market Place, etc.
- **FIND SERVICE AREA**
Petrol Pump, Telephone / Gas service station etc.

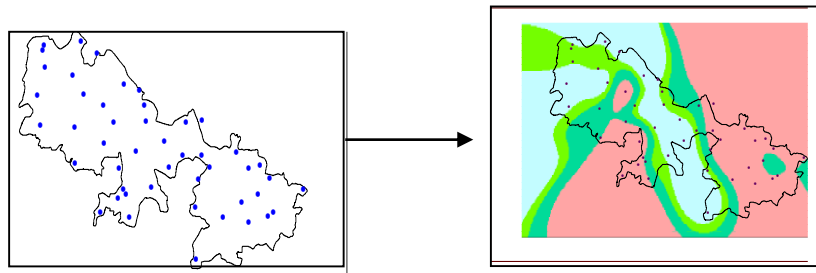
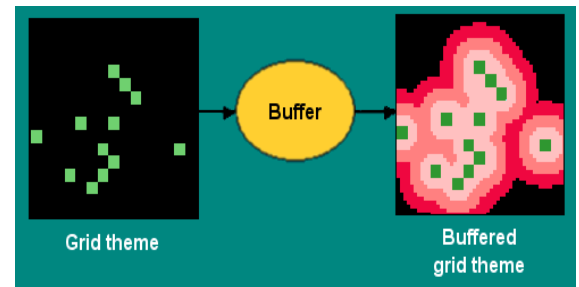
6. Raster grid analysis:

- Used for surface generation and analysis
- Many theme overlay can be carried out using arithmetic or weighted overlay technique
- Modelling is easy

Some analysis are:

- **Polygon to Grid**
- **Point to Grid Surface**
- **Point Grid to Buffer**





5.3 Vector Based Spatial Data Analysis:

Vector overlay is based on Topological Overlay. Map overlay combines the geometry and attribute of two feature maps to create the output. One of the two maps is called Input must and other the overlay map. The first consideration of map overlay is feature type. The input map may be point, line or polygon. The output has the same feature type as input.

Polygon in polygon overlay:

- Output in polygon coverage
- Two coverage can be overlaid at a time
- Each polygon contains attributes of both maps.
- There is no limit of no. of layer to be combined
- New FAT is created having information about each newly created features.

Line in polygon overlay

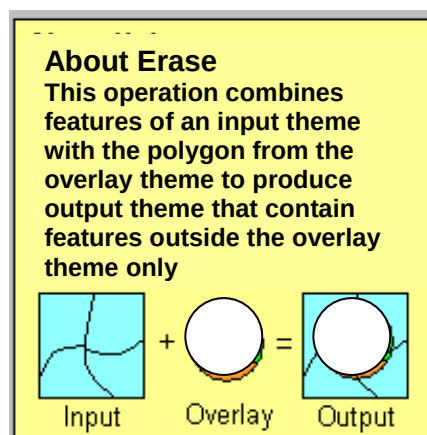
- Output is a line coverage with additional attributes.
- No polygon boundaries are copied.
- New arc-node topology is created.

Point in polygon overlay

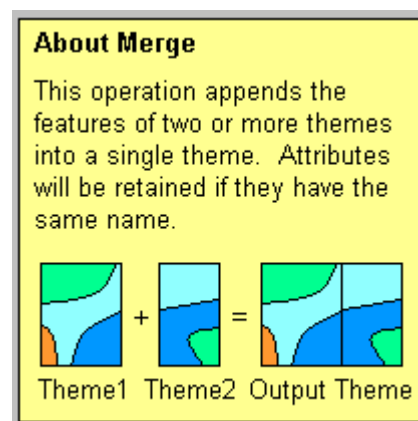
- Output is a point with additional attribute
- No new point features are created
- No polygon boundaries are copied

Few examples of vector based spatial analysis are described below:

Erase coverage – erase features from a coverage that overlaps another coverage.



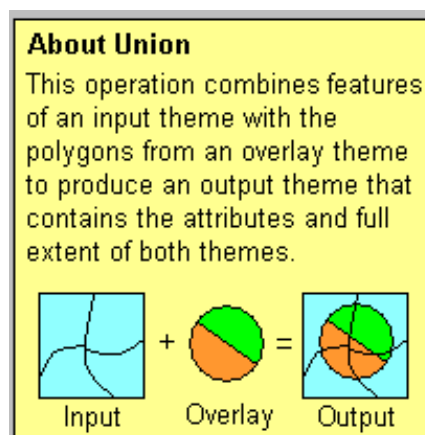
Merge features – Used to join two adjacent map features



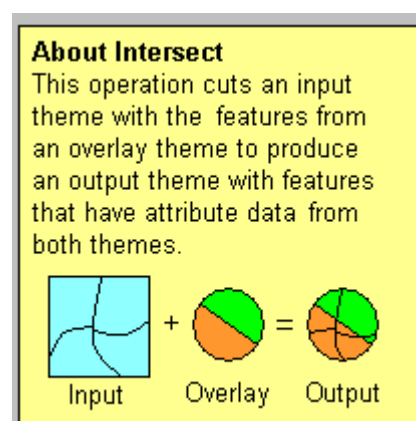
Dissolve – Dissolve polygons having same attribute value



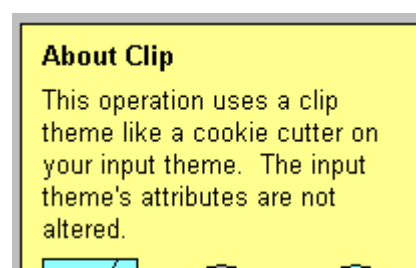
Union – Computes the geometric intersection of two features. All features and attributes of both coverages are preserved.



Intersection: Computes the geometric intersection of two coverages. Only features common in both are preserved.



Clip: Extract feature from a coverage that overlaps another coverage
CLIP [in cover] [clip cover] [out cover]



Logical Operators:

Normally vector overlay operations are carried out through logical operators e.g.

AND : common area/Intersection/Clipping operation

OR : Union or Addition

NOT : Reverse

XOR : Minus

Conditional features are also used for editing feature attribute table

EQ : Equal to

NE#, <> Not equal to

GE >= Greater than or Equal to

LE <= Less than or equal to

GT > Greater than

LT < Less than

CN Containing

NC Not containing

Steps for performing geographic analysis:

- 1) Establish the objectives and criteria for analysis
- 2) Prepare data for spatial operations.
- 3) Perform spatial operations
- 4) Prepare data for tabular analysis
- 5) Perform tabular operations.
- 6) Evaluate and interpret the results
- 7) Refine the analysis as necessary