DATA MODEL IN GIS

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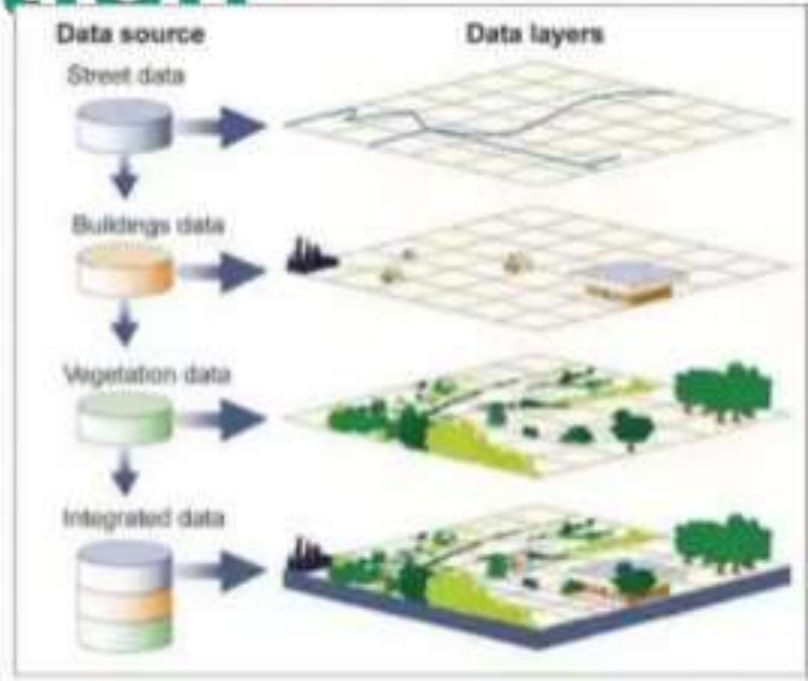
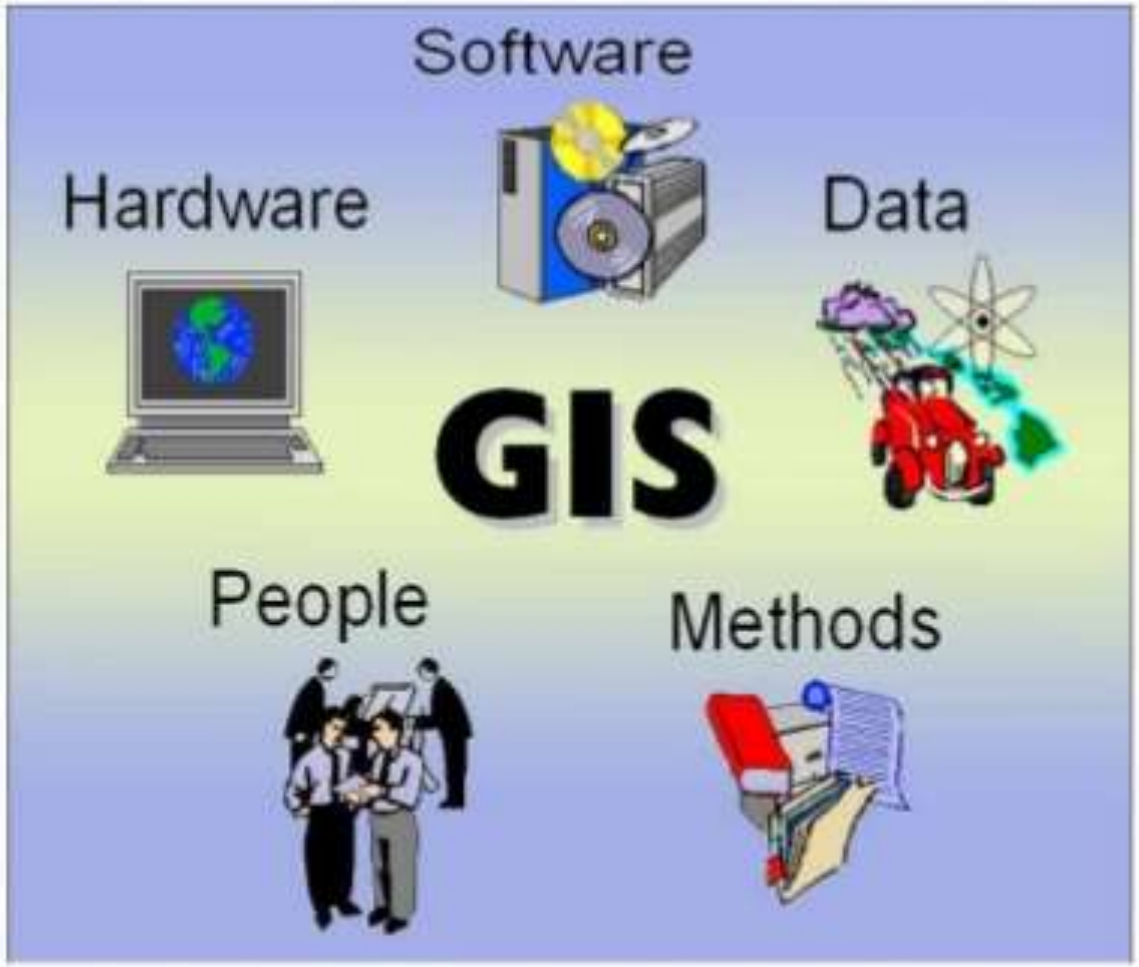
Introduction



- Geographic Information System is an integrated system of computer Hardware and Software, coupled with procédures and human analyst which together support the capture, management, manipulation, analysis, modelling and display of spatially referenced data.
- GIS can store many different types of data on one map.
- This enables people to more easily see, analyze and understand patterns and relationships.

Components of GIS

GIS consists of 5 key components:



- **Hardware:** it consists of a computer system on which the GIS software will run.
- **Software:** GIS software provides the functions and tools needed to store, analyze, and display geographic information.
- **People:** GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work.
- **Method:** a successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organizations.
- **Data:** Geographic data and related tabular data that can be collected in-house. Digital map forms the basic data input for GIS.

Data Types in GIS

The data in a GIS can be classified into two main categories:

1. **Spatial data**

   Describes the absolute and relative location of geographic features.

2. **Attribute data or Non-spatial data**

   Describes characteristics of the spatial features. These characteristics can be quantitative and/or qualitative in nature.

The Data Model

- Data model is a conceptual description (mental model) of how spatial data are organized for use by the GIS.
- The data model represents a set of guidelines to convert the real world (called entity) to the digitally and logically represented spatial objects consisting of the attributes and geometry.
- The attributes are managed by thematic or semantic structure while the geometry is represented by geometric-topological structure.

There are two major types of geometric data model ; vector and raster model.

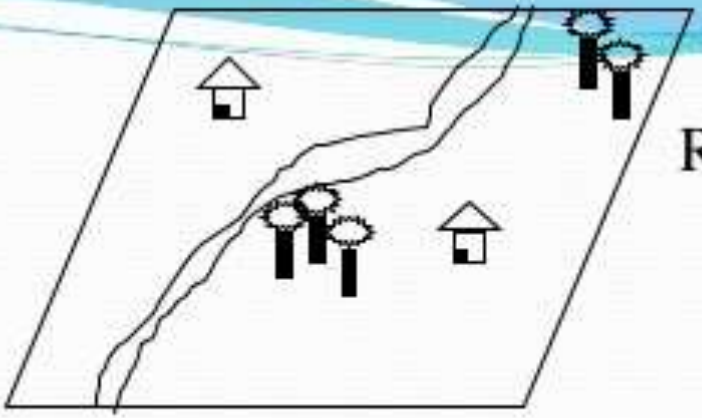
a. Vector Model

Vector model uses discrete points, lines and/or areas corresponding to discrete objects with name or code number of attributes.

b. Raster Model

Raster model uses regularly spaced grid cells in specfic sequence. An element of the grid cell is called a pixel (picture cell). The conventional sequence is row by row from the left to the right and then line by line from the top to bottom. Every location is given in two dimensional image coordinates ; pixel number and line number, which contains a single value of attributes.

Concept of Vector and Raster

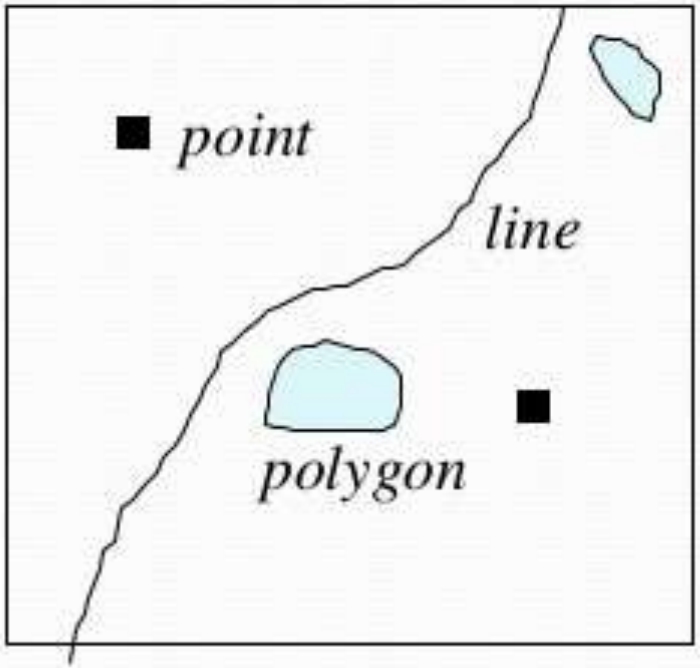


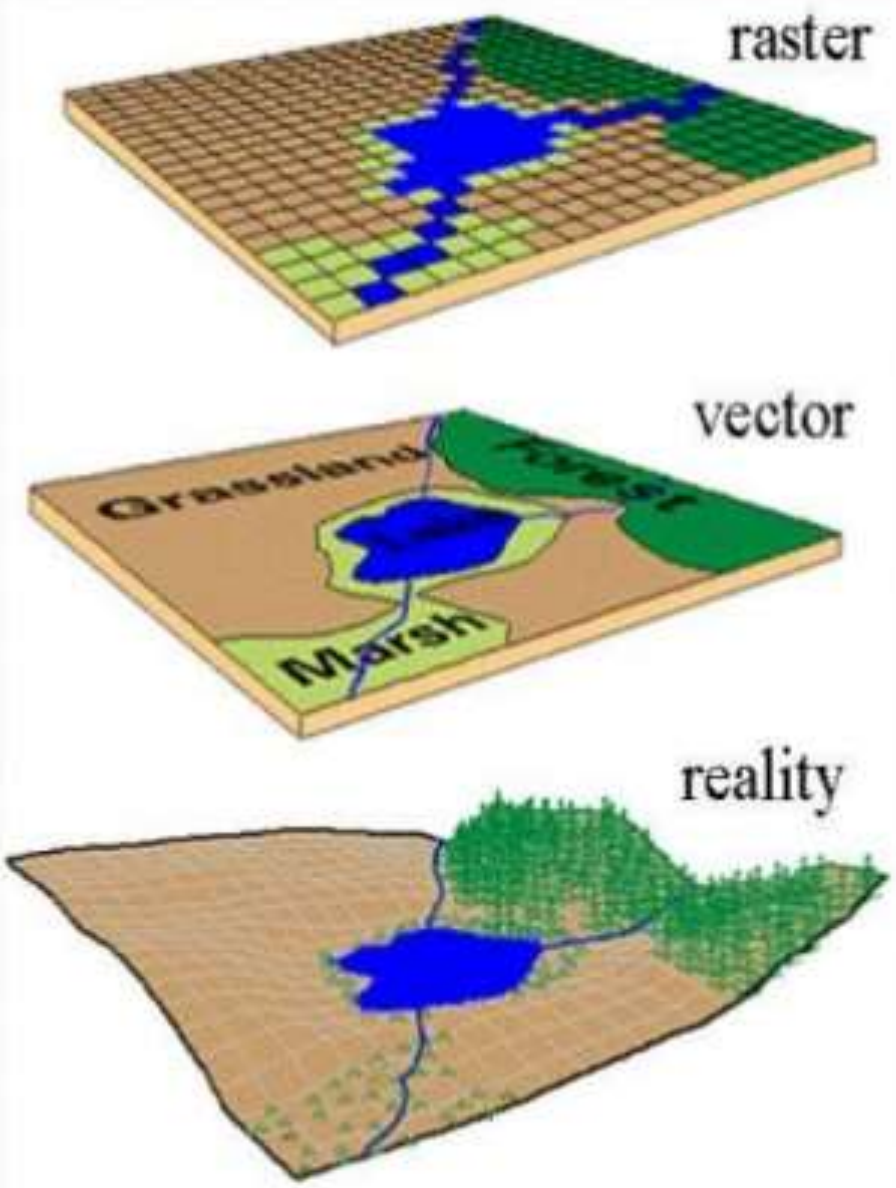
Real World

Raster Representation

	0	1	2	3	4	5	6	7	8	9
0								R	T	
1							R			T
2		H					R			
3							R			
4					R	R				
5				R						
6			R		T	T		H		
7			R		T	T				
8		R								
9		R								

Vector Representation




raster
vector
Grassland
Forest
Marsh
reality

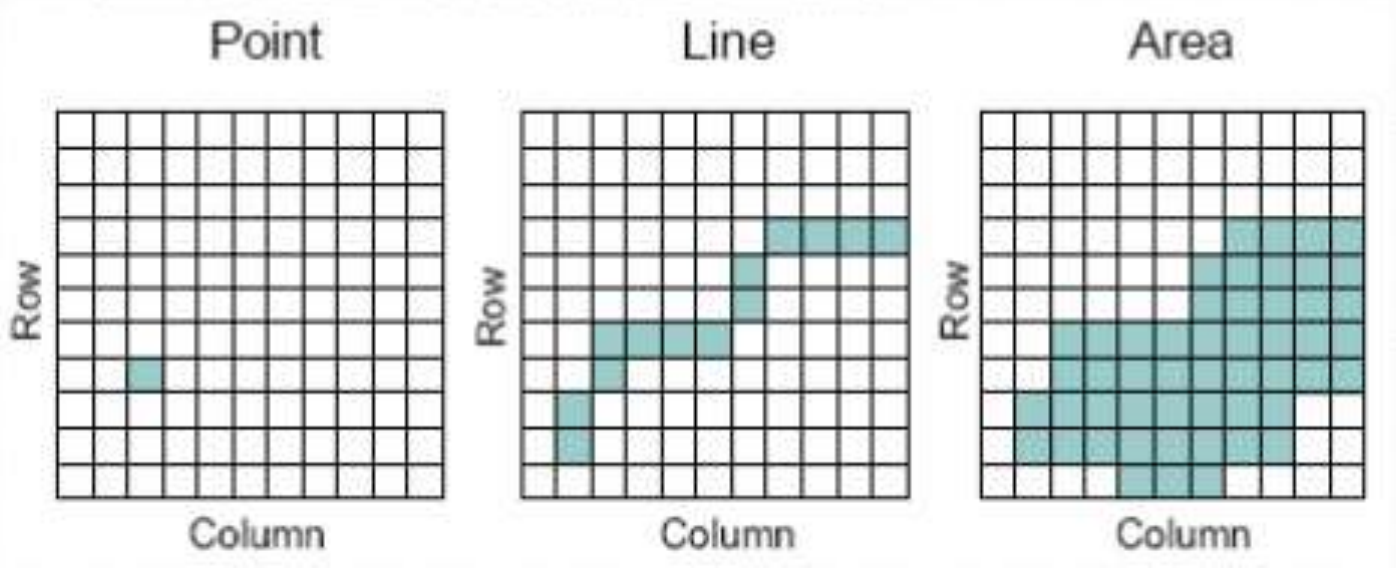
Data models in GIS

- RASTER DATA MODEL
- VECTOR DATA MODEL
- TRIANGULATED IRREGULAR NETWORK MODEL(TIN)
- DIGITAL ELEVATION MODEL (DEM)
- NETWORK MODELS

Raster Data Model

The term raster implies a regularly spaced grid . Raster data consists of rows and columns of cells (or pixels). In this format a single value is stored against each cell. Raster data can represent a multiplicity of things including:

- Visual images (that is colour and/or hue)
- Discrete value, such as land use
- Continuous value, such as rainfall
- Null values if no data is available.



Cell Size of Raster Data

- The level of detail represented by a raster is often dependent on the cell (pixel) size or spatial resolution of the raster. The cell must be small enough to capture the required detail but large enough so computer storage and analysis can be performed efficiently.

Smaller cell size

- Higher resolution
- Higher feature spatial accuracy.
- Slower display
- Slower processing
- Large file size

Larger cell size

- Lower resolution
- Lower feature spatial accuracy
- Faster display
- Faster processing
- Smaller file size

Advantages of Raster

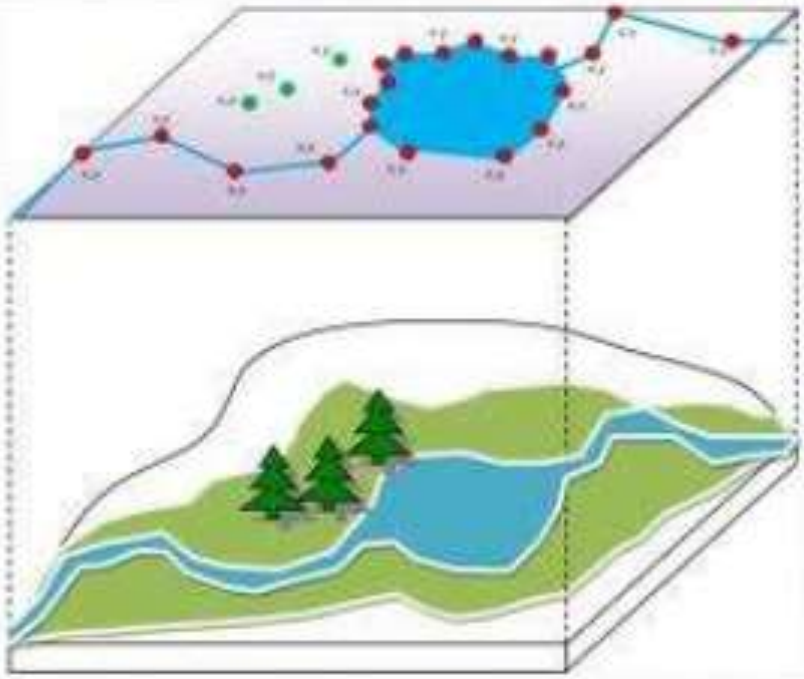
- It is a simple data structure.
- It has the ability to represent continuous surfaces and perform surface analysis.
- The ability to uniformly store points, lines, polygons and surfaces.
- The ability to perform fast overlays with complex datasets.

Disadvantages of Raster

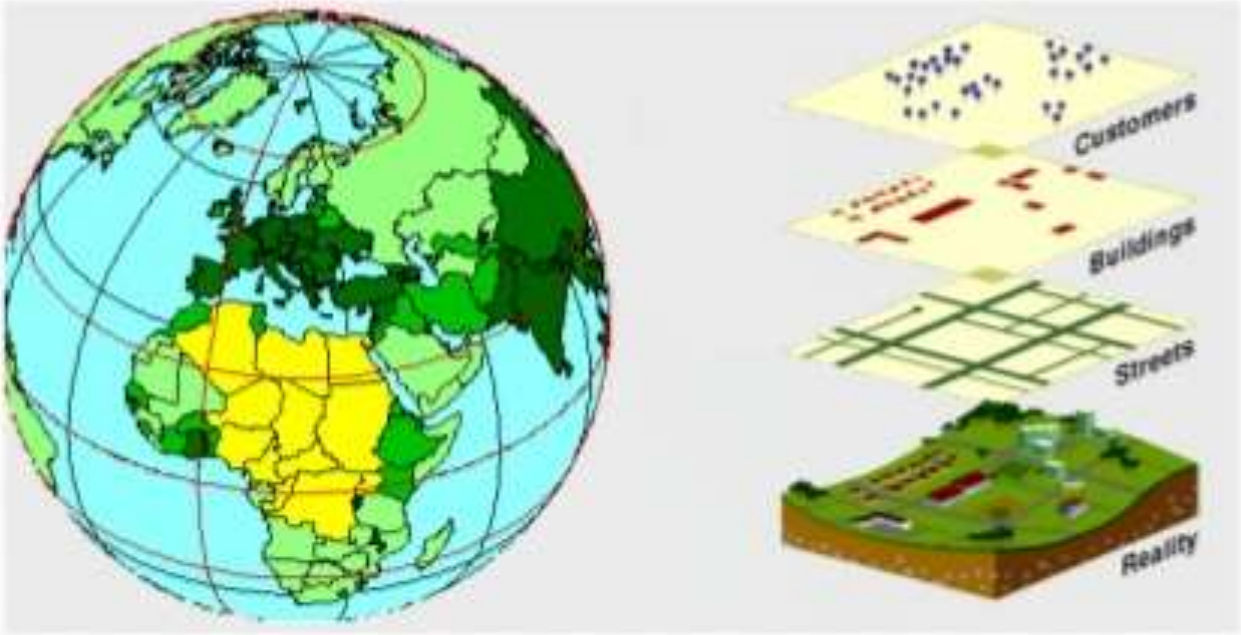
- There can be spatial inaccuracies due to limits imposed by raster dataset cell dimension.
- Raster datasets are potentially very large. Resolution increases as the size of cells decreases. Accordingly cost and disk space used also increases.
- There is also a loss of precision that accompanies restructuring data to a regularly spaced raster cell boundary.

Vector Data Model

- Vectors are graphical objects that have geometrical primitives such as points, lines and polygons to represent geographical entities in the computer graphics.
- A vector refers to a geometrical space which has a precise direction, length and shape
- Points, Lines and Polygons can be defined by the coordinate geometry.



- A vector spatial data model uses two-dimensional Cartesian (x, y) coordinate system to store the shape of a spatial entity.

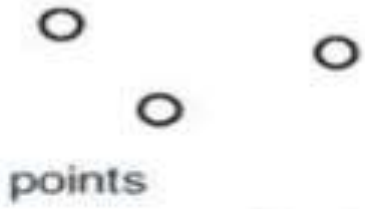


- In vector world the point is the basic building block from which all spatial entities are constructed.
- The simplest spatial entity, the point, is represented by a single (x, y) coordinate pair.
- Line and area entities are constructed by connecting a series of points into chains and polygons.

	Qualitative Distinction	
POINT		Town
		Church
		Triangulation pillar
		Wind pump
LINE		River
		Road
		Railway
		Boundary
AREA		Marsh
		Desert
		Forest
		Political units

Point

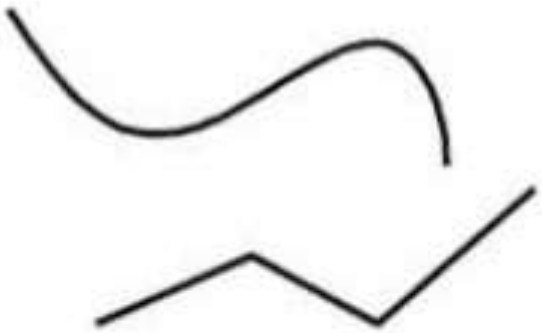
- A point is a 0 dimensional object and has only the property of location (x,y)



- Points can be used to Model features such as a well, building, power pole, sample location etc.
- Other names for a point are vertex, node, 0-cell.

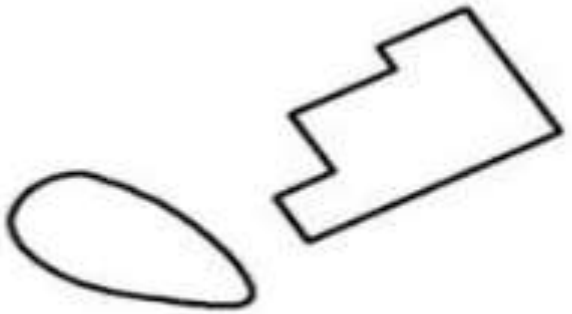
Line

- A line is a one-dimensional object that has the property of length
- Lines can be used to represent road, streams, faults, dikes, marker beds, boundary, contacts etc.
- Lines are also called an edge, link, chain, arc, 1-cell
- Connected multiple lines are called **polylines.**



Polygon

- Polygon features are made of one or more lines that encloses an area.
- A polygon is a two-dimensional object with properties of area and perimeter represented by a closed sequence of lines.
- A polygon can represent a city, geologic formation, dike, lake, river, etc.



Advantages of Vector

- Requires less disk storage space.
- Efficient for topological relationship
- Graphical output more closely resembles hand-drawn maps.
- Easy to edit
- Accurate map output
- Efficient projection transformation

Disadvantages of Vector

- Complex data structure.
- Less compatibility with remotely sensed data.
- Expensive software and hardware.
- Not appropriate to represent continuous data
- Overlaying multiple vector are often time consuming.

Difference between Raster and Vector

Raster

- It is a simple data structure.
- Overlay operations are easily and efficiently implemented.
- High spatial variability is efficiently represented in a raster format.
- The raster format is more or less required for efficient manipulation and enhancement of digital images.

Vector

- More complex data structure.
- Overlay operations are more difficult to implement.
- The representation of high spatial variability is inefficient.
- Manipulation and enhancement of digital images cannot be effectively done in the vector domain.

- The raster data structure is less compact.
- Topological relationships are more difficult to represent.
- The output of graphics is less aesthetically pleasing because boundaries tend to have a blocky appearance rather than the smooth lines of hand drawn maps. This can be overcome by using very large number of cells, but it may result in unacceptably large files.

- Vector provides a more compact data structure.
- Provides efficient encoding of topology.
- The vector data model is better suited to supporting graphics that closely approximate hand-drawn maps.

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