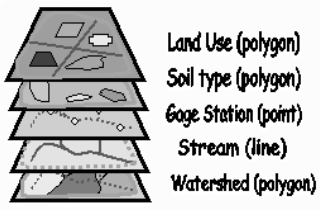
Introduction to GIS - 2

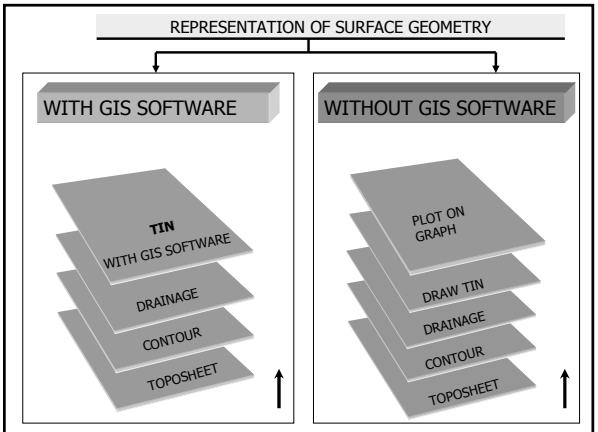
Prof. D. Nagesh Kumar
Department of Civil Engineering
Indian Institute of Science
Bangalore – 560 012, India
http://www.civil.iisc.ernet.in/~nagesh

Outline

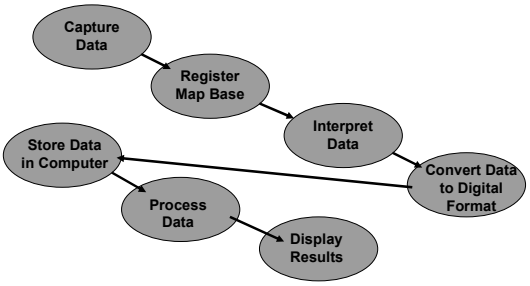
- Using GIS
- Representation of spatial objects in GIS
- Comparison of Raster and Vector formats
- TIN Mode

Geospatial Database: a set of compatible data layers or themes

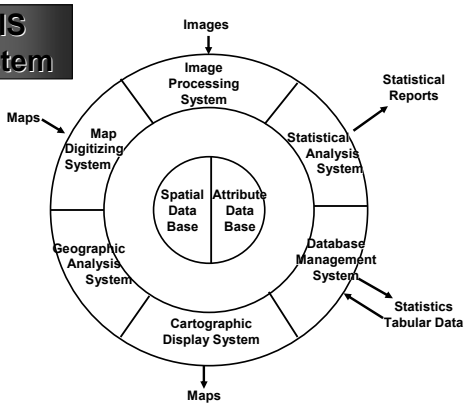




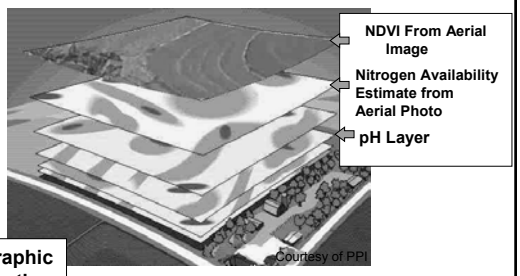
GIS Process



GIS System

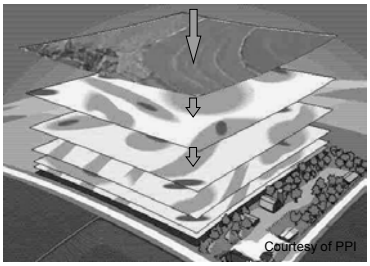


GIS - Map Stacking



Geographic Information System

"Drilling Down" Through The Data Layers



GIS Data Formats

- There are two formats used by GIS systems to store and retrieve geographical data:
  - *Raster*
  - *Vector*

Raster Format

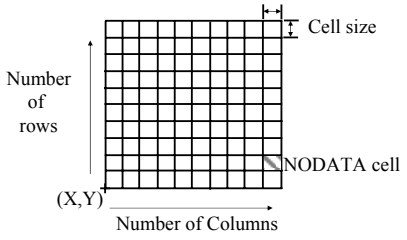
- Data are divided into cell, pixels, or elements
- Cells are organized in arrays
- Each cell has a single value
- Row and Column Numbers are used to identify the location of the cell within the array
- Perhaps the most common example of raster data is a digital image

Discrete and Continuous Space

Discrete Space: Vector GIS

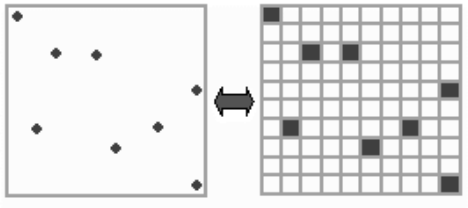
Continuous Space: Raster GIS

Spatial Data: Raster format

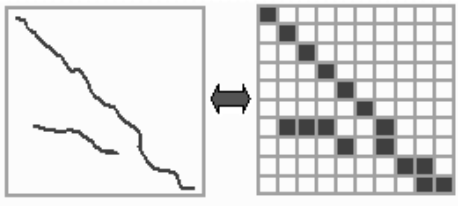


Definition of a Grid in GIS

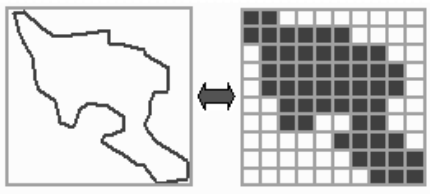
Points as Cells



Line as a Sequence of Cells



Polygon as a Zone of Cells



Vector Format

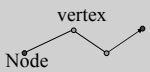
- Data are associated with points, lines, or boundaries enclosing areas
- Points are located by coordinates
- Lines are described by a series of connecting vectors (line segments described by the coordinates of the start of the vector, its direction, and magnitude or length)
- Areas or polygons are described by a series of vectors enclosing the area

Spatial Data: Vector format

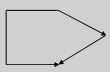
Vector data are defined spatially:

Point - a pair of x and y coordinates

Line - a sequence of points



Polygon - a closed set of lines



Vector Format

- Any number of factors or attributes can be associated with a point line or polygon
- Data are stored in two files
  - a file containing location information
  - a file containing information on the attributes
- A third file contains information needed to link positional data with their attributes

Feature Attribute Table

Fields →

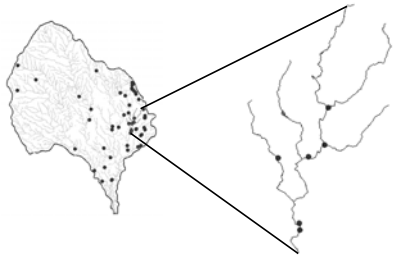
Records ↓

Attributes of World94.shp

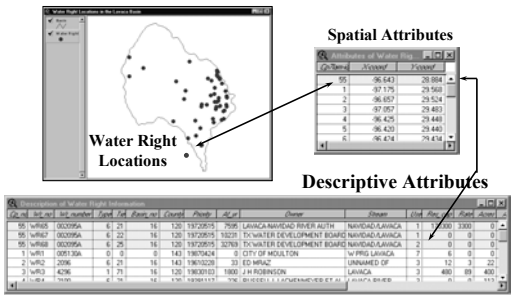
Area	Perimeter	Yi94_	Yi94_id	Abbrevname	Fips_code
0.338	2.587	1	2	Luxembourg	LU
4.901	14.010	2	3	Switzerland	SZ
64.797	56.870	3	4	France	FR
9.182	14.281	4	5	Korea Rep	KS
0.907	6.132	5	6	Cyprus	CY
36.691	79.545	6	7	Japan	JA
3.490	8.074	7	8	Bhutan	BT
23.654	26.242	8	9	W Sahara	WI
0.903	4.086	9	10	Qatar	QA
9.050	17.116	10	11	Untd Arab Em	TC
2.907	7.737	11	12	Taiwan	TW

Locations on the Stream Network

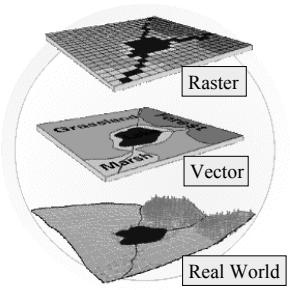
Digital Stream Network
Connects Control Point Locations



Relational Linkages



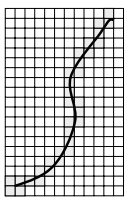
Raster-Vector Data Model



Vector and Raster Representation of *Point* Map Features

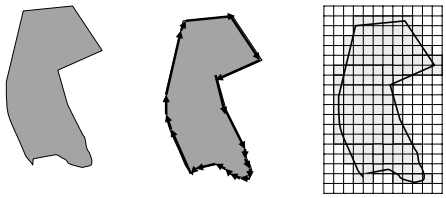
Map Feature	GIS Vector Format	GIS Raster Format
○	○	□
	(X,Y) Coordinate in space	Cell Located in an Array

Vector and Raster Representation of *Line* Map Features

Map Feature	GIS Vector Format	GIS Raster Format
		

Vector and Raster Representation of *Area* Map Features

Map Feature | GIS Vector Format | GIS Raster Format



Vector and Raster Formats

- Most GIS software can display both vector and raster data
- Raster formats are efficient when comparing information among arrays with the same cell size
- Raster files are generally very large because each cell occupies a separate line of data
- Vector formats are efficient when comparing information whose geographical dimensions are different

Comparison of Raster and Vector Formats

Raster

- **Raster formats are efficient when comparing information among arrays with the same cell size.**
- **Raster files are generally very large because each cell occupies a separate line of data, only one attribute can be assigned to each cell, and cell sizes are relatively small.**

Vector

- **Vector formats are efficient when comparing information whose geographical shapes and sizes are different.**
- **Vector files are much smaller because a relatively small number of vectors can precisely describe large areas and a many attributes can be ascribed to these areas.**

Comparison of Raster and Vector Formats

Raster

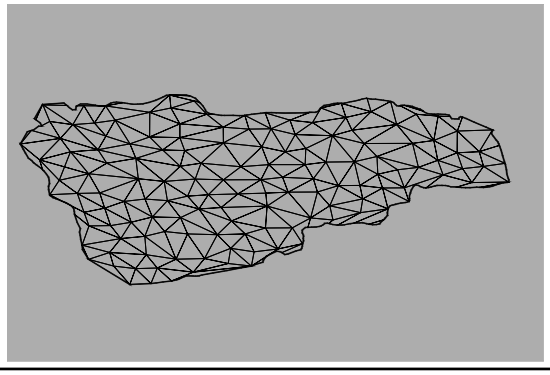
- **Raster representations are relatively coarse and imprecise**

Vector

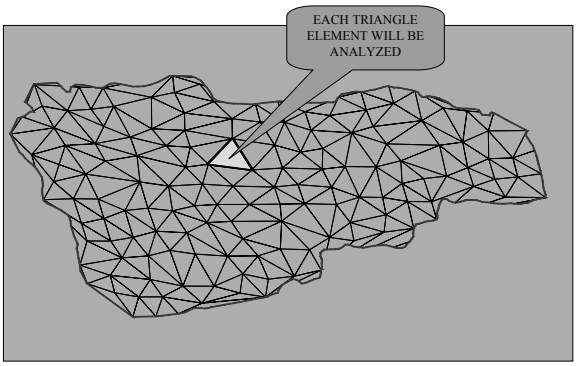
- **Vector representations of shapes can be very precise.**

Most GIS software can display both raster and vector data. Only a limited number of programs can analyze both types of data or make raster type analyses in vector formats.

TRIANGULATED IRREGULAR NETWORK (TIN)



TRIANGULATED IRREGULAR NETWORK (TIN)



Coordinate Systems

- Spatial data are generally recorded as latitude and longitude, frequently as decimal degrees
- Other systems commonly used are the Universal Transverse Mercatur - UTM and State Plane Coordinates. These systems are projections of the curved surface of the globe on to a plane surface

Coordinate Systems

- **UTM, the preferred system, distance unit is the meter.**
- **The unit of the state plane system is the foot.**
- **There is generally a different coordinate system for each state in the state plane system.**
- **In the UTM system projections are made in zones of approximately 6 degrees of longitude.**

Coordinate Systems

- **There are two datums (reference planes) commonly used to make projections: North American Datum of 1927 (NAD27) and the World Geographic Reference System of 1984 (WGS84). The WGS84 datum can be used world wide. The default datum of many GPS receivers is the WGS84 datum.**

UTM Specifications

- **UTM position is specified by:**
  - **Number of the Zone**
  - **North (or South) of the equator**
  - **East of the western boundary of the zone**
  - **Distances are in meters**
- **Coordinates are referred to as "Northings" and "Eastings"**
  - **N xxxxxx, E yyyyyy**

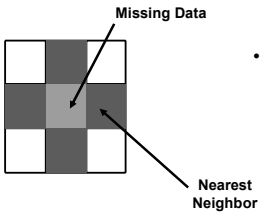
Interpolation to Predict Missing Data

- **Frequently, data are collected at discrete points located at significant distance apart or some of the data are missing.**
- **Interpolation is used to predict the values of the missing data.**
- **There a number of interpolation algorithms available in SST *Toolbox* and other software.**

Interpolation Algorithms

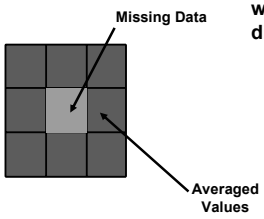
- **Nearest neighbor**
- **Local Averaging**
- **Inverse distance to a power**
- **Radial bias functions**
- **Shepard's Method**
- **Kriging**
  AND
- **Simple Contouring**

Nearest Neighbor



- Value of the nearest measurement to the missing data.
- In the case of values at the same distance, the average of those values

Local Average



- Average of all values within a predetermined distance.