Bharathidasan University

Tiruchirappalli – 620 023, Tamil Nadu

M.Tech. Remote Sensing and GIS

Course : 24MTRS-05

GEOGRAPHIC INFORMATION SYSTEMS (GIS)

Unit-2 DATA INPUT, VERIFICATION, STORAGE & OUTPUT

Dr. K. Palanivel

Professor, Department of Remote Sensing

24MTRS-05: GEOGRAPHIC INFORMATION SYSTEM **--- 4 credits**

UNIT I **Basics of GIS** - Definition - Evolution of GIS - Geospatial, spatial and non-spatial data - Components of GIS - Computer Hardware, Software Modules and Organisational Context of GIS - Data Structure in GIS - Types of Data (Points, Lines and Polygons) - Data sources - Ground and remote sensing survey - Data Structures (Raster data structures and Vector data Structures) – Database Structures.. 12 Hrs.

UNIT II **GIS Data Input, Verification, Storage and Output** - Spatial Data Input Processes and Devices (Sources of data, - Different Types of Data Entry methods, viz., Manual input, Run length code, Digitization, Automated Scanning, etc. – Vector to Raster conversion - Raster to Vector conversion - Input devices) - Entry of non-spatial data – Linking of Spatial & Non-spatial data – Element generation - Geodatabase creation - Data Verification (Errors of different types) - Correction (Rubber Sheet Transformation, Bilinear interpolation, Cubic Convolution, etc.) - GIS capabilities for Data correction – Data output (Types of Output, GIS Capabilities for output, Output devices) - File formats for raster and vector. 14 Hrs.

UNIT III **Raster and vector data Interpolation and Analyses** - Raster data analysis: Local, neighborhood and regional operations - Map algebra - Vector data analysis: Topological analysis, point-in-polygon, line-in-polygon, polygon-in-polygon - Proximity analysis: Buffering, Thiessen polygon - Non topological analysis: Attribute data retrieval and analysis – Concepts of SQL – ODBC - Basic Principles of Interpolation – Methods of Interpolation - Global Methods of Interpolation, Local Interpolation (Trend Surface Analysis) – Local Interpolation (Splines) - Optimal Interpolation (Kriging). 12 Hrs.

UNIT IV **Surface Analysis, 3D Visualization and Network Modelling** - Need for Three Dimensional Models - Methods of DEM & TIN - Products of DTM (Contour Maps, Shaded Relief Map, Maps Related to Slopes, Line Sight Maps, Drainage Analysis, Volume Estimation etc.) Usefulness of DEM/DTM. Overlay analysis, Capabilities (Point Operations, Regional Operations, Neighbourhood Operations) - Networking and Dynamic Segmentation – Applications, Minimum Distance Model, Maximum Covering Model (P-median model), Urban Transportation Planning Model. 14 Hrs.

UNIT V **Data Classification & Advanced GIS** - Principles – Types of Classification (Exogenous, Arbitrary, Idiographic & Serial) – Multivariate Analysis. Artificial Intelligence - Expert Systems - Object Oriented GIS - Web based GIS: Definition, merits - Architecture - Map server - Spatial data infrastructure - Spatial data standards - Free and open source - Proprietary GIS software. 12 Hrs.

UNIT VI **Current Contours – GIS - Case studies (Not for Final Exam only for Discussion)** - Recent scientific and technological development, advancement, Industrial application and Job opportunities.

REFERENCES

1. Burrough, P.A 1986: Principles of Geographical information Systems for Land Resources Assessment, Clarandone Press, Oxford.
2. Avery, T.V,Interpretation of Aerial Photography Burgass, Publishing Company.
3. Gautham, N.C 1970: Urban Landuse Study Through Aerial Photo binterpretations Techniques, Pink Publishing House, Mathura.
4. American Society of Photogrammetry, 1983: Manual of Remote Sensing (2nd Edition), ASP Falls Church, Virginia.
5. Campbell, J 1984: introductory Cartography, Printers Hall Englewood Cliffs, N.J
6. Dent B.D 1985: Principles of Thematic Map Design, Addition - Wesley, Reading, Mass.
7. Freeman, H and GG.Pieroni 1980: Map Data Processing, Academic Press, New York.
8. Monmonier, M.A 1982: Computer Assisted Cartography - Principles and Prospects, Prentice Hall, Englewood Cliffs, NJ
9. Tomlinson, RF Calkins, HS and D.F.Marble 1976: Computer Handling of Geographic Data, UNESCO, Geneva.
10. Graeme F. & Bonham – Carter; Geographic information Systems for Geoscientists; Modelling with GIS, Pergamon.
11. Lo, C.P. and Yeung, Albert K.W., “Concepts and Techniques of Geographic Information Systems”, Pearson, 2016.

OBJECTIVE

To understand the fundamentals, data handling, analysis techniques, and advanced applications of Geographic Information Systems (GIS).

COURSE OUTCOMES

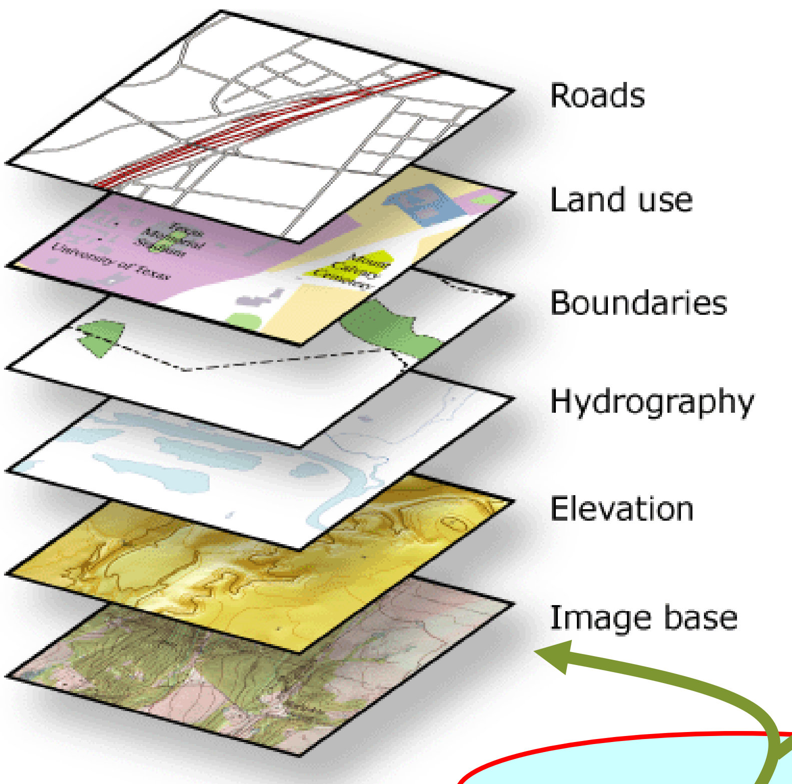
- The concepts of GIS, including data types, components, and data structures.
- Develop proficiency in GIS data input, verification, storage, and output processes.
- Gain knowledge in raster and vector data analysis, including interpolation methods and proximity analysis.
- Understand three-dimensional modeling, surface analysis, and network modeling techniques.
- Explore classification methods, AI integration, web-based GIS, and the use of open-source and proprietary GIS software.

Unit - 2

UNIT II GIS Data Input, Verification, Storage and Output - Spatial Data Input Processes and Devices (Sources of data, - Different Types of Data Entry methods, viz., Manual input, Run length code, Digitization, Automated Scanning, etc. – Vector to Raster conversion - Raster to Vector conversion - Input devices) - Entry of non-spatial data – Linking of Spatial & Non-spatial data – Element generation - Geodatabase creation - Data Verification (Errors of different types) - Correction (Rubber Sheet Transformation, Bilinear interpolation, Cubic Convolution, etc.) - GIS capabilities for Data correction – Data output (Types of Output, GIS Capabilities for output, Output devices) - File formats for raster and vector. 14 Hrs.

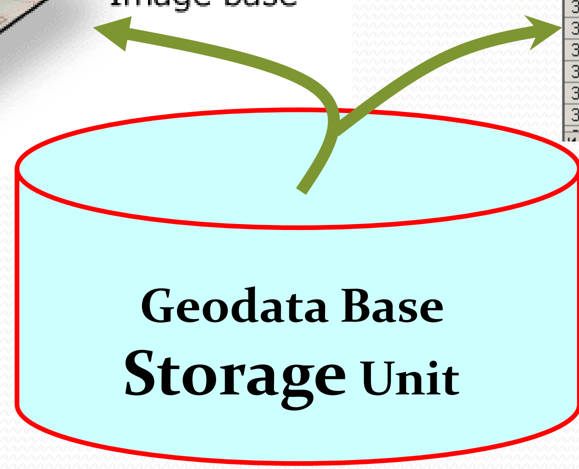
GIS Can hold large amount of geospatial data / maps

Geospatial / Spatial data / maps



Aspatial / Non spatial / Attribute data

	BLOCK_NAME	BK_AREA	SALI_AREA	PERCENTAGE	SALINITY_TYPE
2	AGASTISWARAM	97755036.16	47651257.35	48.75	COASTAL SALINE SOIL
3	ALWARTHIRUNAGARI	314587683.28	13483201.16	4.29	COASTAL SALINE SOIL
4	ARANTANGI	546979186.79	19699964.93	3.60	COASTAL SALINE SOIL
5	ARIMALAM	382442584.63	38056.28	0.01	COASTAL SALINE SOIL
6	AVUDAIYARKOIL	317311598.56	124505284.05	39.24	COASTAL SALINE SOIL
7	BHUVANAGIRI	198728518.35	26522056.91	13.35	COASTAL SALINE SOIL
8	CHENNAI	173276620.57	116210285.58	67.07	COASTAL SALINE SOIL
9	CHITHAMUR	266707327.11	82036026.70	30.76	COASTAL SALINE SOIL
10	CUDDALORE	301090086.77	234349321.02	77.83	COASTAL SALINE SOIL
11	GUMMDIPOONDI	418232625.80	198485820.68	47.46	COASTAL SALINE SOIL
12	KADALADI	801377568.81	518714059.26	64.73	COASTAL SALINE SOIL
13	KANDAMANGALAM	233537210.04	3561928.61	1.53	COASTAL SALINE SOIL
14	KEELAIYUR	173072850.20	9083648.32	5.25	COASTAL SALINE SOIL
15	KEERAPALAYAM	123066985.35	50184462.65	40.78	COASTAL SALINE SOIL
16	KILLIYOOR	27797205.53	975230.88	3.51	COASTAL SALINE SOIL
17	KOLLIDAM	272680537.73	465285.90	0.17	COASTAL SALINE SOIL
18	KOTTUR	321190878.64	437653.63	0.14	COASTAL SALINE SOIL
19	KURINJIPADI	403874698.25	102104013.42	25.28	COASTAL SALINE SOIL
20	KURUNTHENCODE	150643684.38	76575441.17	50.83	COASTAL SALINE SOIL
21	LATHUR	378322678.78	227214144.85	60.06	COASTAL SALINE SOIL
22	MANAMELKUDI	187969286.34	90731336.29	48.27	COASTAL SALINE SOIL
23	MANDAPAM	221958482.90	221958448.74	100.00	COASTAL SALINE SOIL
24	MARAKKANAM	423770925.99	169722836.98	40.05	COASTAL SALINE SOIL
25	MINJUR	459683083.78	452608481.54	98.46	COASTAL SALINE SOIL
26	MUNCHIRAI	187408797.71	123207679.80	65.74	COASTAL SALINE SOIL
27	MUTHUPETTAI	372762749.08	275672726.32	73.95	COASTAL SALINE SOIL
28	NAINARKOIL	265298425.88	5869174.18	2.21	COASTAL SALINE SOIL
29	OTTAPIDARAM	789985062.30	58580178.42	7.42	COASTAL SALINE SOIL
30	PARANGIPETTAI	232530511.68	202813776.86	87.22	COASTAL SALINE SOIL
31	PATTUKKOTTAI	414210092.49	142415280.27	34.38	COASTAL SALINE SOIL
32	PONDI	304809120.44	168067150.78	55.14	COASTAL SALINE SOIL
33	PUZHAL	134550930.49	77517267.23	57.61	COASTAL SALINE SOIL
34	RADHAPURAM	309678174.59	151774863.02	49.01	COASTAL SALINE SOIL
35	RAJAKKAMANGALAM	147554170.04	86895022.01	58.89	COASTAL SALINE SOIL



DATA INPUT

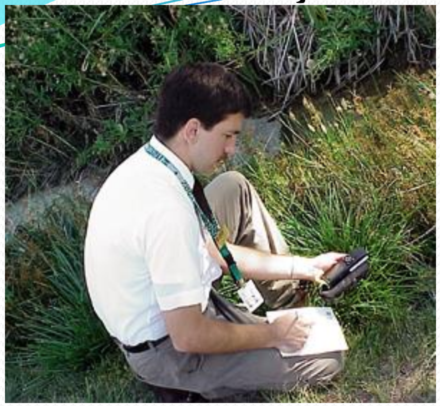
2.1 ENTERING SPATIAL DATA

2.2 ENTERING NON SPATIAL DATA

2.3 LINKING SPATIAL DATA TO NON SPATIAL DATA

Data Sources for GIS

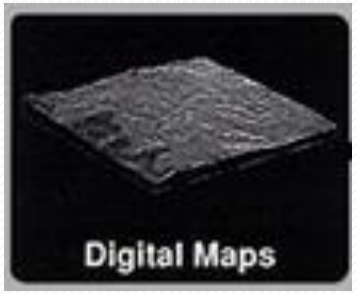
Field surveys



Collecting latitude and longitude coordinates with a Global Positioning System (GPS) receiver.

BOTH SPATIAL & NON-SPATIAL DATA

Remote sensing data

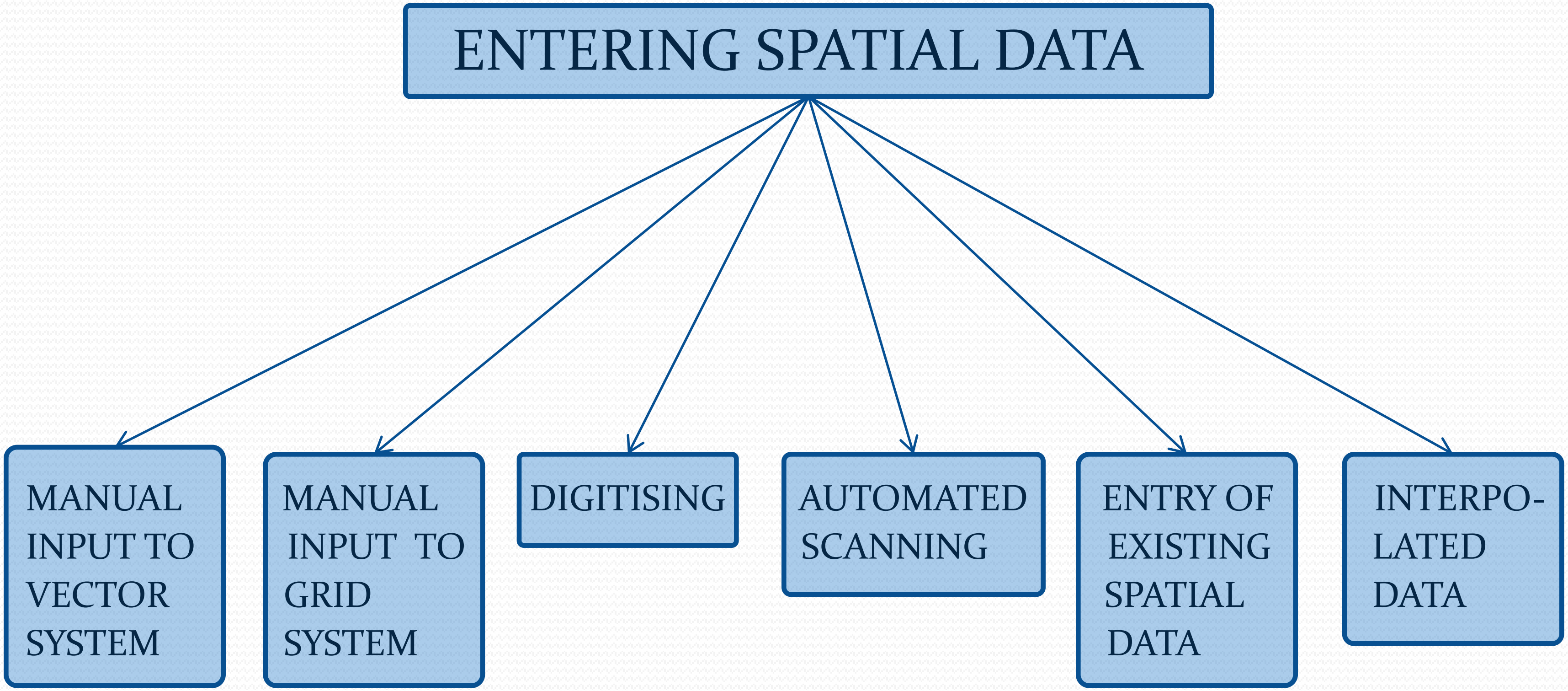


Digital data files

Collateral or Secondary data collection

Literatures & References

ENTERING SPATIAL DATA

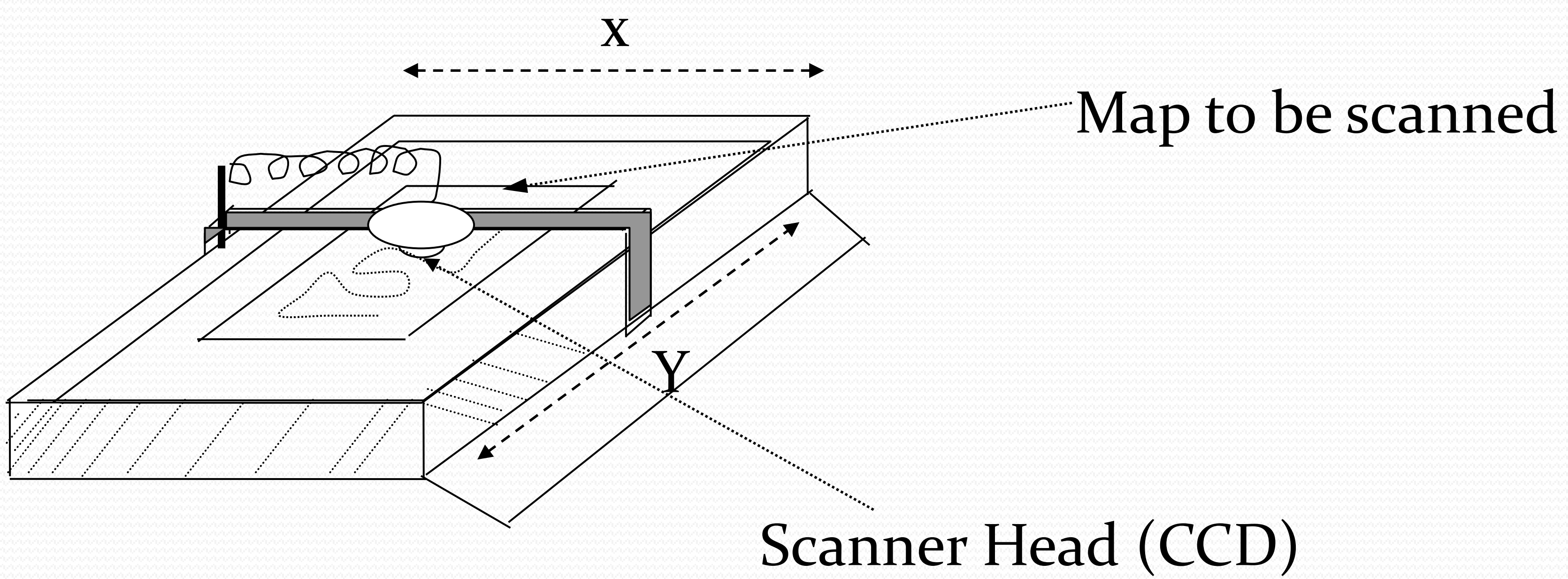


Data Entry in GIS

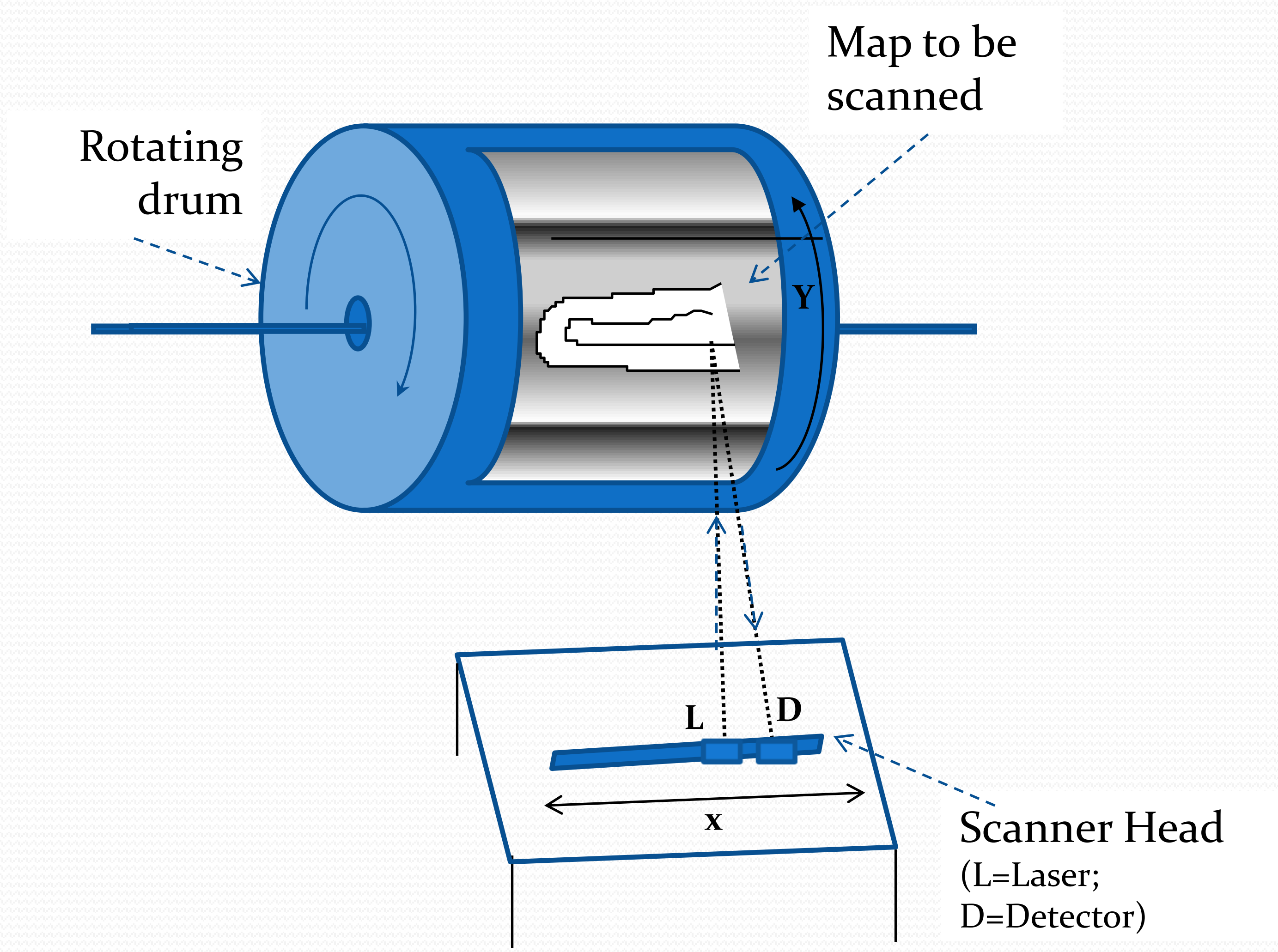
- Digitization using digitizer board
- Onscreen digitization
  - Scanning – Automatic / Semi-Auto.
  - Geo-referencing
  - Digitization &
  - Projection

- A straight line can be digitized by inserting two nodes only, i.e., with a starting/from node, and finish with an end/to node. Otherwise, the 3rd and the other extra nodes will **deform the shape** of the straight line feature.
- An acute curvature has to be digitized with many no. of nodes.
- Manual entry of series of X,Y data
- Entry of existing spatial data using .txt, .dbf, .xls files.

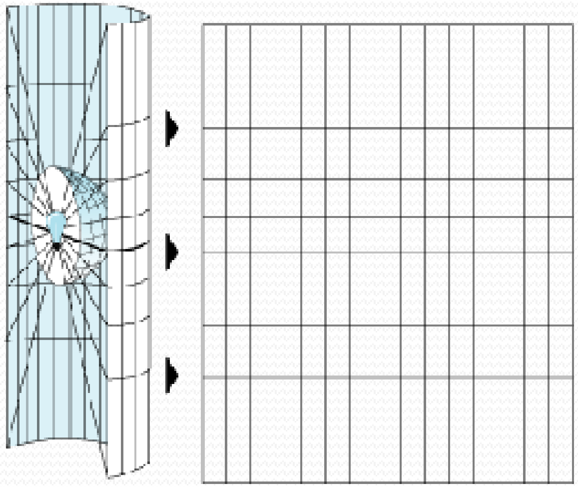
AUTOMATED SCANNING
Flat bed Scanner

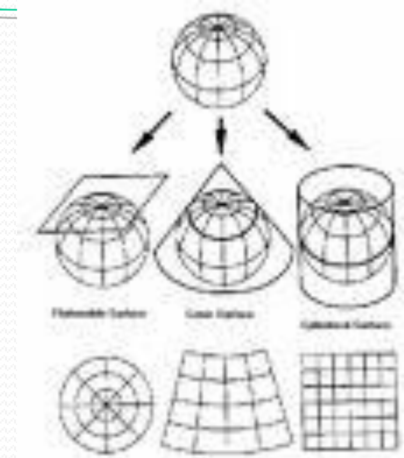


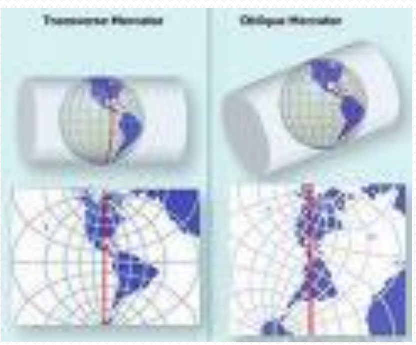
Drum Scanner

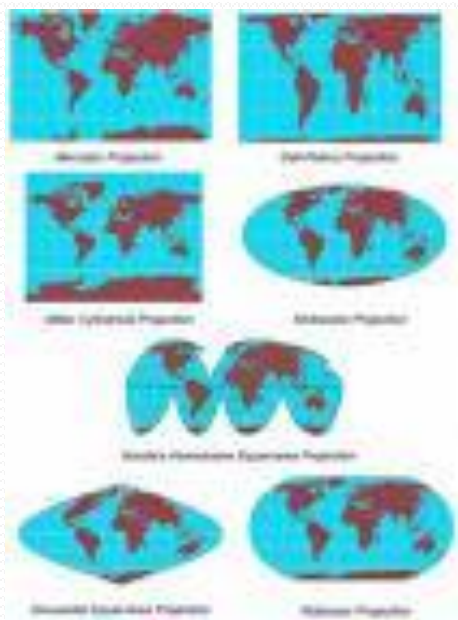


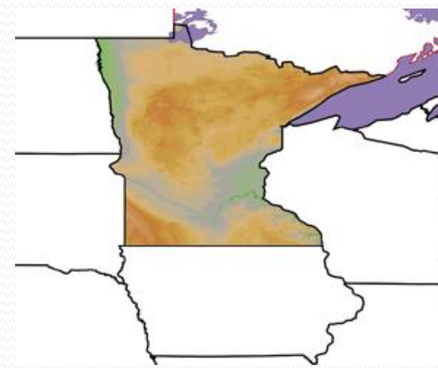
Map Projection

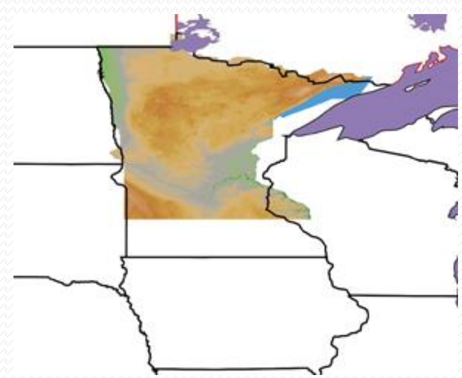


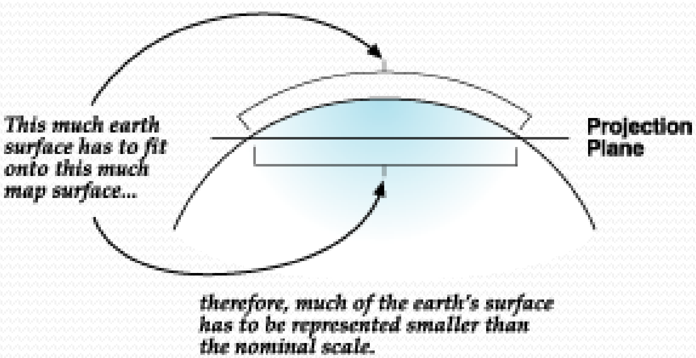












Map Projection...contd...

A. MAP RECTIFICATION USING GROUND CONTROL POINTS (GCP's)

- RAW DIGITAL DATA ARE EITHER IN DIGITIZER BOARD UNIT OR DISPLAY SCREEN UNIT
- UPDATE THEIR CO-ORDINATE VALUES WITH DECIMAL DEGREES

DD = (DEGREE + (MINUTE / 60) + (SECONDS / 3600))

B. PROJECT THEM TO THE REQUIRED PROJECTION SYSTEM

DETAILS REQUIRED:

1. **INPUT DETAILS**

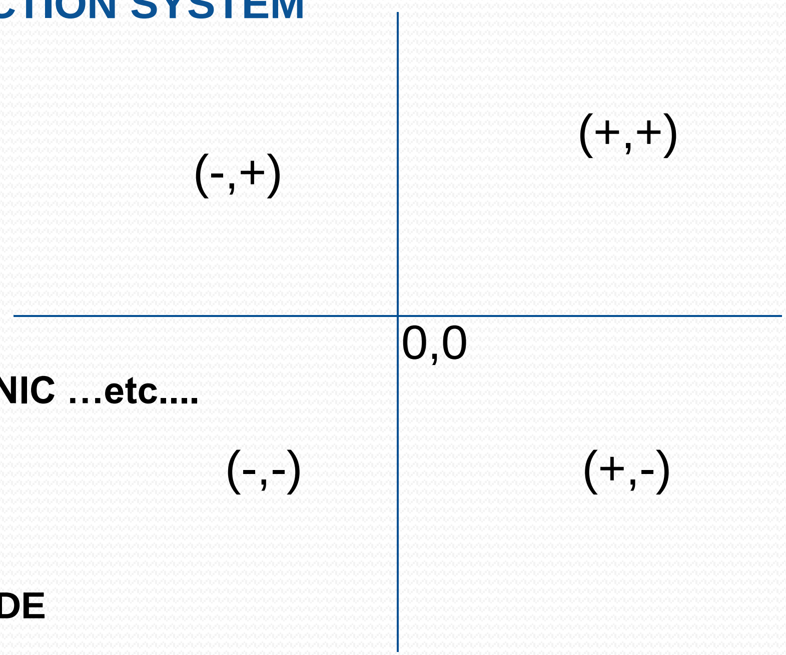
   PROJECTION TYPE – GEOGRAPHIC

   UNITS – DD

2. **OUTPUT DETAILS**

   PROJECTION TYPE (EXPECTED) – POLYCONIC …etc....

   UNITS – METERS



3. **CENTRAL MERIDIAN IN DD**

   (MAX – MIN LONGITUDE/2) + MIN. LONGITUDE

4. **LATTITUDE OF PROJECTIONS ORIGIN IN DD**

   LAT. @ BOTTOM LEFT CORNER OF MAP

5. **DATUM PLANE**

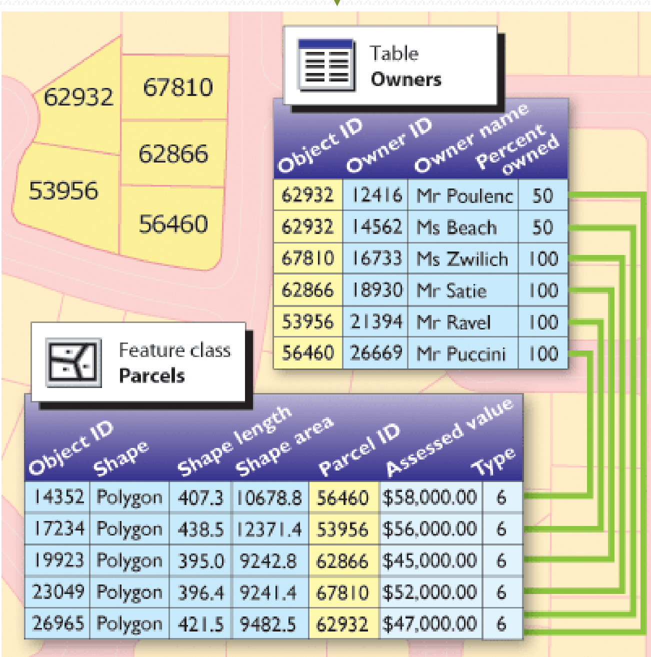
6. **FALSE EASTING & FALSE NORTHING**

GIS Database Management

Spatial Data ↔ Non Spatial Data

Unique Identifier (U_ID) /
Feature Identifier (F_ID) /
Label-ID / Object-ID / Parcel-ID...

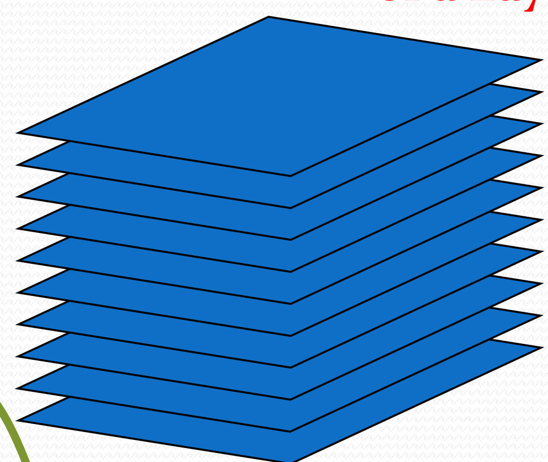
Provide Link using 'Join / Relate' methods



Object ID	Owner ID	Owner name	Percent owned
62932	12416	Mr Poulenc	50
62932	14562	Ms Beach	50
67810	16733	Ms Zwilich	100
62866	18930	Mr Satie	100
53956	21394	Mr Ravel	100
56460	26669	Mr Puccini	100

Object ID	Shape	Shape length	Shape area	Parcel ID	Assessed value	Type
14352	Polygon	407.3	10678.8	56460	$58,000.00	6
17234	Polygon	438.5	12371.4	53956	$56,000.00	6
19923	Polygon	395.0	9242.8	62866	$45,000.00	6
23049	Polygon	396.4	9241.4	67810	$52,000.00	6
26965	Polygon	421.5	9482.5	62932	$47,000.00	6

Preferential display / retrieval of a Layer

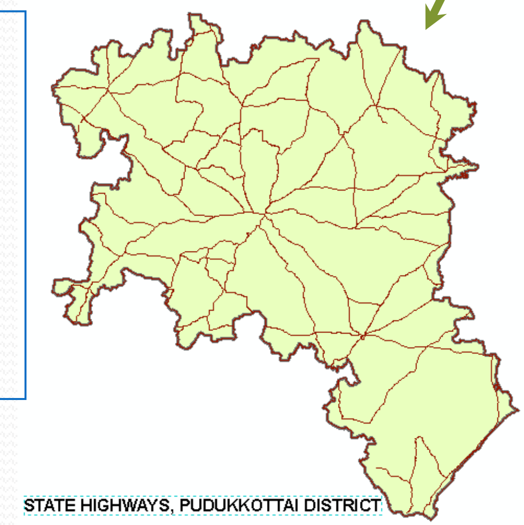


What are the data linking methods?

One to One = "Join"

One to Many
Many to One
& Many to Many } = "Relate"

State Highways of Pudukkottai District
Tamil Nadu, India



DATA VERIFICATION, DATA QUALITY ANALYSIS & SOURCES OF ERRORS

Decisions… to identify and acquire QUALITY products…

What to discuss…

- **Factors affecting data quality**
- **Sources of errors**
- **Types of GIS errors**
- **Methods to deal with errors**

TERMINLOGY – Used in assessing data quality

- **Data Quality** – Refers to how good the data are. Degree of excellence.
  Overall fitness or suitability of data for a specific purpose
  or is used to indicate data free from errors and other problems.
- **Error** – is a departure/deviation from the correct data value.
- **Data Accuracy** – The extent to which a measured data value approaches
  its true value. Data Accuracy Standard by ASPRS (American
  Society for Photogrammetry and Remote Sensing, in terms of
  RMS error – 16.7' for 1:20,000, 2' for 1:2400 scale maps.
- **Data precision** – The recorded level of detail.
- **Bias** – Refers a consistent / regular / constant error. A systematic variation of
  data from reality
- **Resolution** – The size of the smallest features captured in the data.
- **Generalization** – The degree of simplification when drawing a map.
- **Completeness** – The degree to which data are missing.
- **Compatibility** – It indicates the reasonable usage of two data sets together.
- **Data Consistency** – The commonality of same methods of data capture,
  storage, manipulation and editing, when adopted to
  generate database to ensure compatibility.
- **Applicability** – The suitability of a particular data set for a particular purpose.

Development of computer methods for handling spatial data

- **Computer cartography**
  - Computer cartography (digital mapping) is the generation, storage and editing of maps using a computer.
- **Spatial statistics**
  - Initially, developments were in areas such as measures of spatial distribution, three-dimensional analysis, network analysis and modeling techniques.
- **CAD**
  - Computer-aided design (CAD) is used to enter and manipulate graphics data. Traditional users of CAD used for the production, maintenance and analysis of design graphics.
- **GIS**
  - Geospatial information system on natural, physical and human resources and hazards having all data handling facilities with automation and customization.
- **SDSS**
  - Spatial Decision Support System – Automated GIS functionality loaded with raw data, cooked data, information and maps which are ready to directly use by the users. Moreover, it provides options to build new methodology to analyze data with update, edit and other functions of GIS.

What type of error?

Causes of errors in spatial data

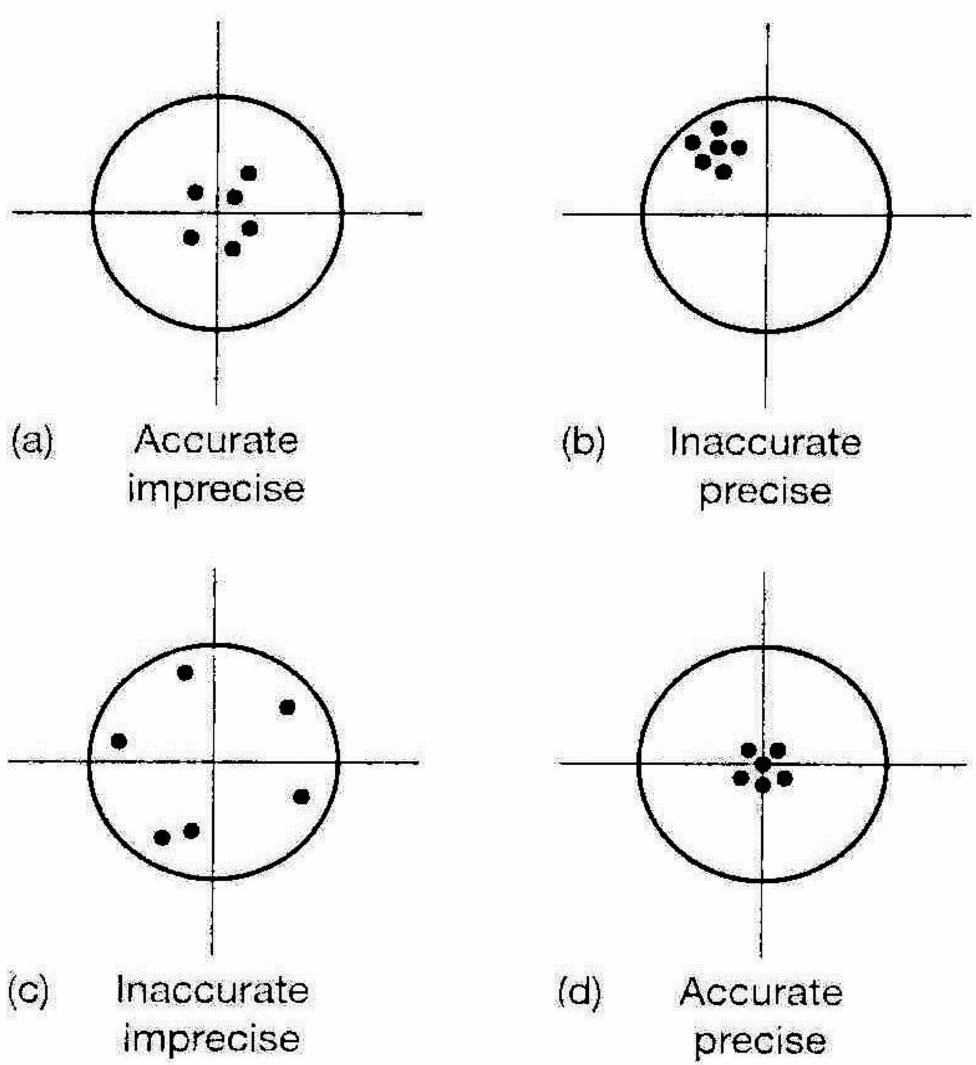
i. **Accuracy of content**
ii. **Instrument / measurement errors**: accuracy (ex. During altitude measurement or soil samples, usually related to instruments)
iii. **Computational errors**: precision (ex. To what decimal point the data is represented?)
iv. **Human error**: error in using instruments, selecting scale, location of samples
v. **Data model representation errors**
vi. **Errors in derived data**

1. **Obvious sources of error**
   1. Age of the data
   2. Areal coverage-partial or complete
   3. Map scale
   4. Density of observations
   5. Relevance
   6. Format
   7. Accessibility
   8. Cost
2. **Errors resulting from natural variations or from original measurements**
   1. Positional accuracy
   2. Accuracy of content-qualitative and quantitative
   3. Sources of variation in data
      1. Data entry faults
      2. Data output faults
      3. Observer bias
      4. Natural variation

Factors affecting the quality of Geospatial data

- **Currency / Age of data** – Time series-different times and up to date
- **Completeness** - Areal coverage
- **Consistency** - Map scale and resolution, relevance, standard descriptions
- **Accuracy and Precision** - Density of observations, positional accuracy, attribute accuracy-qualitative and quantitative, topological accuracy, lineage-when, by whom, how?
- **Data Accessibility** - Data formats, data exchange and Interoperability, Cost and copyright
- **Sources of errors in data** – Data entry and output faults, Choice of original data model, Natural variation and uncertainty in boundary location, topology, observer bias, processing-Numerical errors in the computer, computer limitation in number precision
- **Sources of errors in derived data and in the results of modelling and analysis** – Problems associated with map overlay, classification and generalization problems, choice of analysis model, misuse of logic, error propagation, method used for interpolation.

Errors during collection of data



DATA VERIFICATION IN GIS

Sources of possible errors

1. ERRORS ARISES DURING ENCODING AND INPUT OF SPATIAL / NON-SPATIAL DATA - Errors in source data for GIS

- Survey data can contain errors due to mistakes made by people operating equipment, or due to technical problems with equipment.
- Remotely sensed, and aerial photography data could have spatial errors if they were referenced wrongly, projected wrongly, and mistakes in classification and interpretation would create attribute errors.

a) SPATIAL DATA IN WRONG PLACE
b) SPATIAL DATA ARE DISTORTED
c) SPATIAL DATA ARE IN WRONG SCALE
d) SPATIAL DATA ARE INCOMPLETE OR DOUBLE
e) SPATIAL DATA LINKED TO A WRONG NON SPATIAL DATA
f) SIMILAR ERRORS IN NON SPATIAL DATA

Sources of possible errors ...contd...

a) SPATIAL DATA IN WRONG PLACE

Mislocation of spatial data – minor error to gross spatial location errors
Minor - due to careless digitizing
- wrong data entry in field or in lab
- due to GPS errors
-
Gross - due to data origin

b) SPATIAL DATA ARE DISTORTED

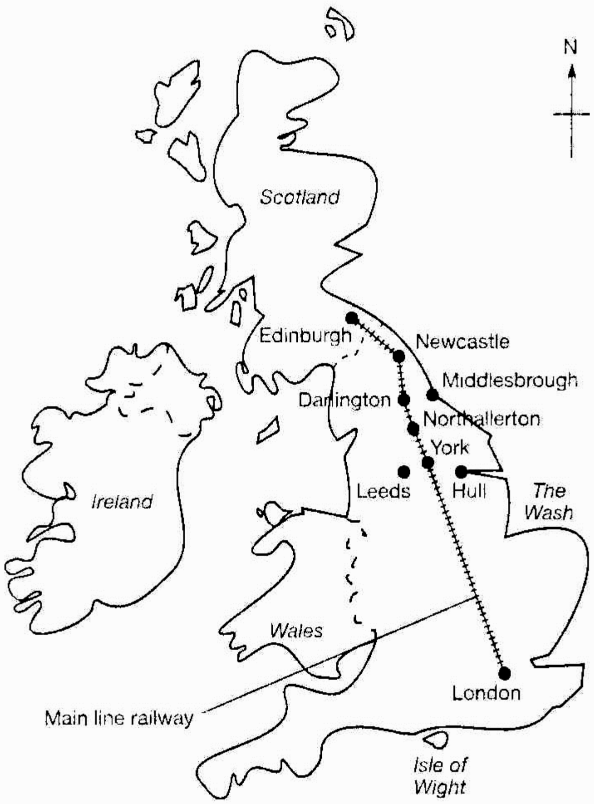
Due to shrinkage, improper rectification, projection

2. Errors arising from our understanding and modeling of reality

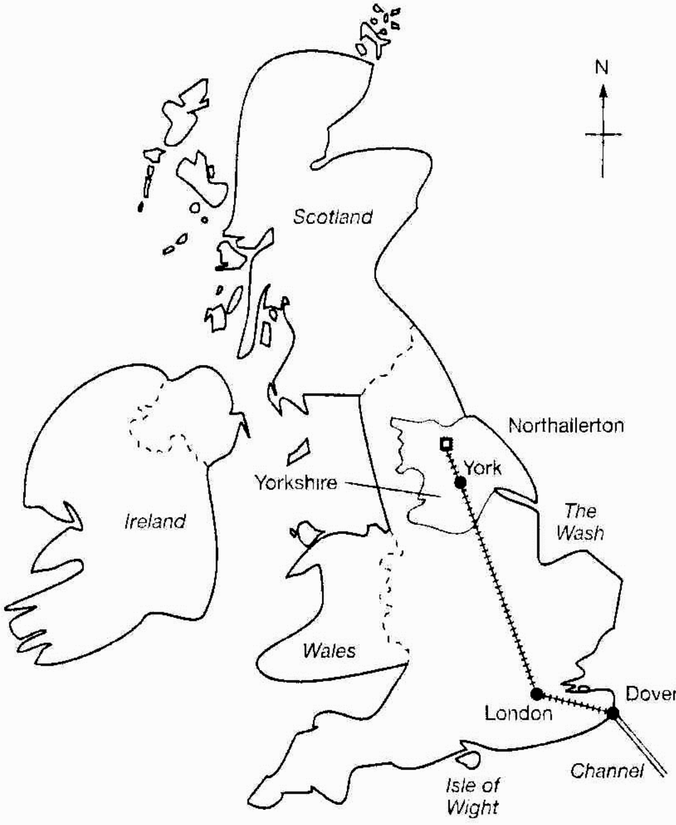
- The different ways in which people perceive reality can have effects on how they model the world using GIS.
- Mentally prepared maps to be personal, fragmentary, incomplete and frequently erroneous.
- In all cases, distance and shape would be distorted in inconsistent ways and the final product would be influenced by the personality and experience of the 'cartographer'.

Errors through Perceptions or reality – mental mapping ...contd...

Map prepared by person 1

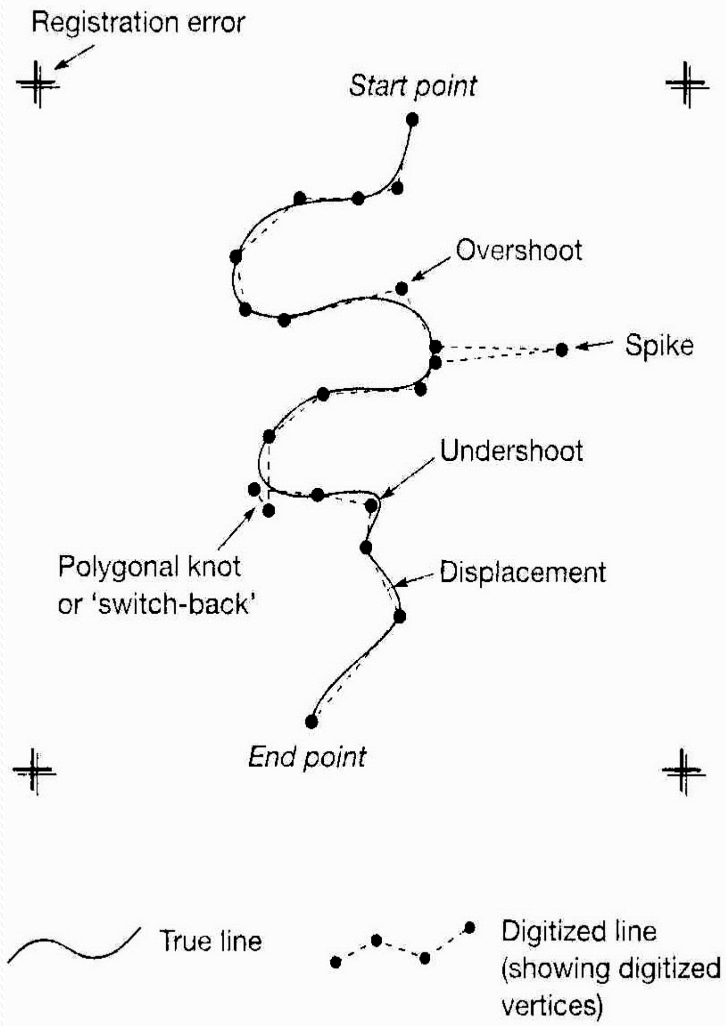


Person 2



3. Operational errors introduced during manual digitizing – data encoding

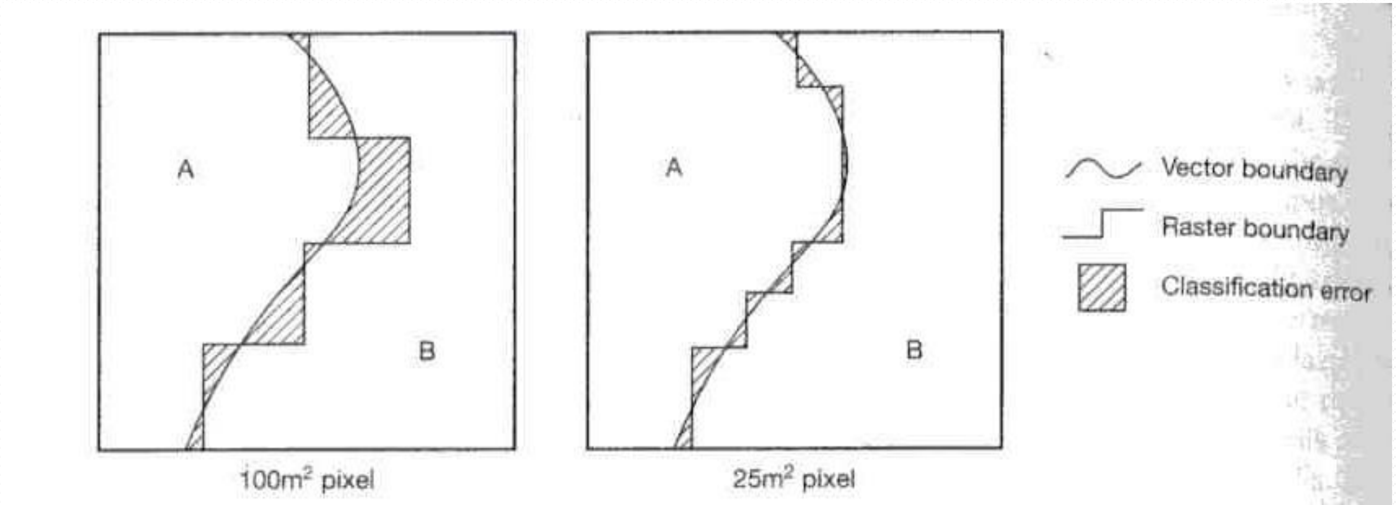
- **Psychological errors**: Difficulties in perceiving the true center of the line being digitized and inability to move the cursor cross-hairs accurately along it;
- **Due to Mental / Physical Tiredness**: Double digitization / incomplete / missing / wrong entry of spatial and nonspatial / linking of feature.
- **Physiological errors**: It results from involuntary muscle spasms that give rise to random displacement.
- **Line thickness**: The thickness of lines on a map is determined by the cartographic generation employed.
- **Method of digitizing**: Point mode and stream mode.



4. Errors during data editing and data conversion

- -Non-Topological errors in vector GIS
  - Double / wrong digitization of point, line, polygon, etc.

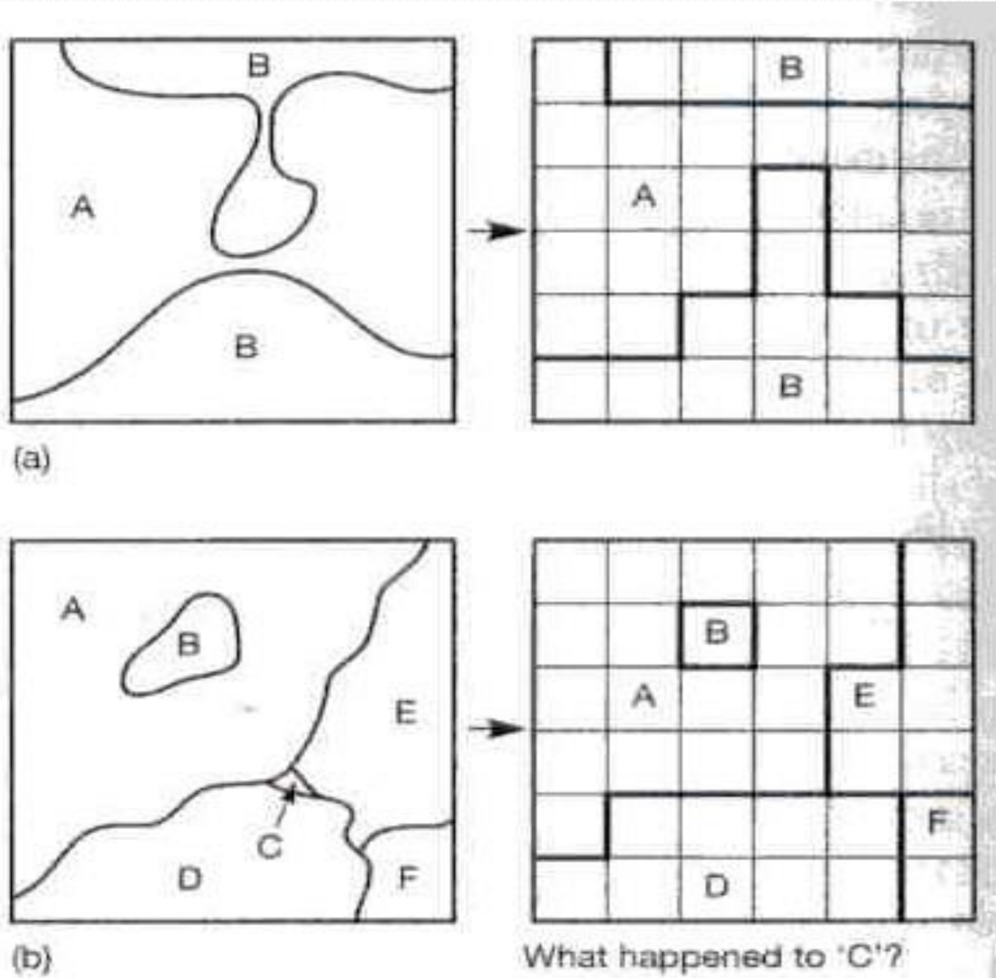
- - Errors During Data conversion



…Contd … Rasterization errors

Vector to raster conversion can cause an interesting assortment of errors in the resulting data. For example

- Topological errors
- Loss of small polygons
- Effects of grid orientation
- Variations in grid origin and datum



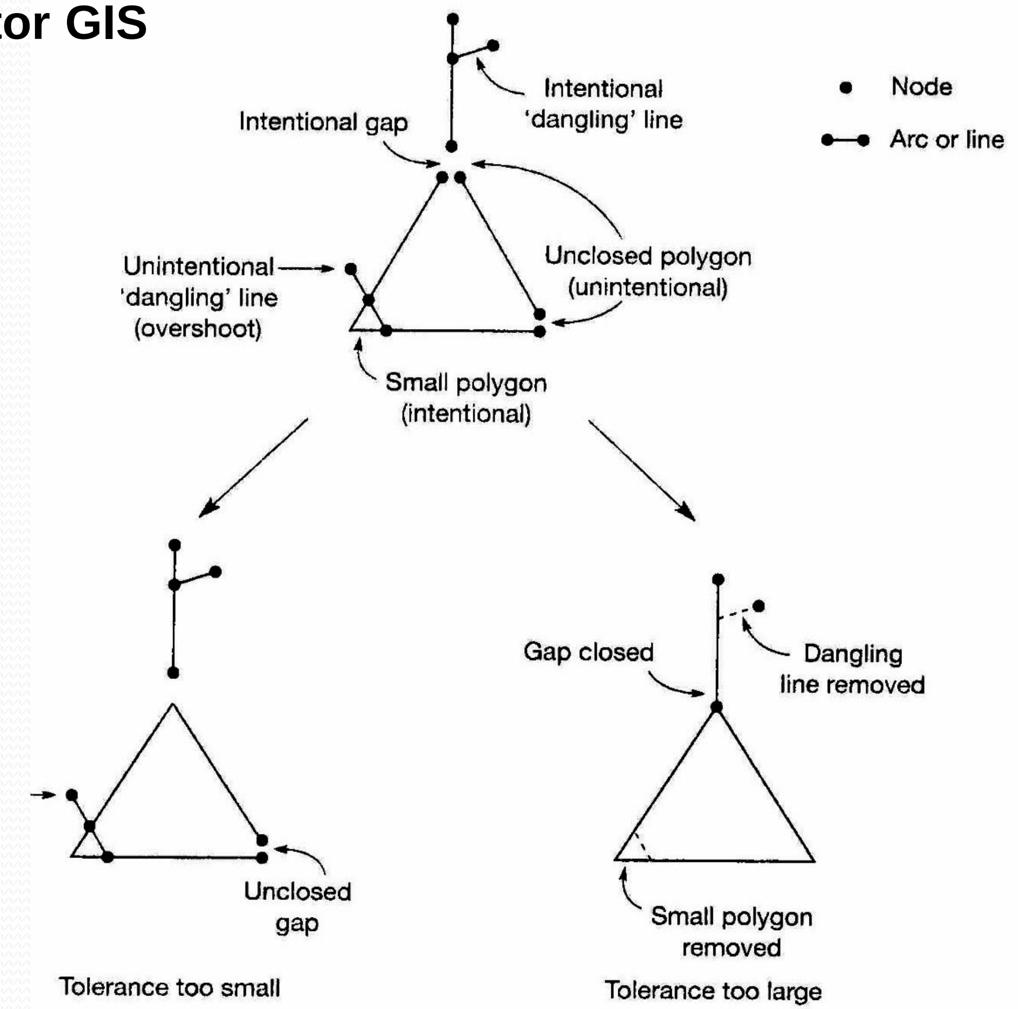
Topological error in vector GIS: (a) loss of connectivity and creation of false connectivity (b) loss of information

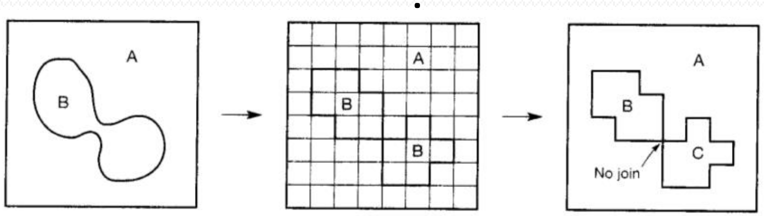
5. Topological Errors in data

-Topological errors in vector GIS

(a) Effects of tolerance on topological cleaning

(b) Topological ambiguities in raster to vector





6. Errors arising through processing / analysis

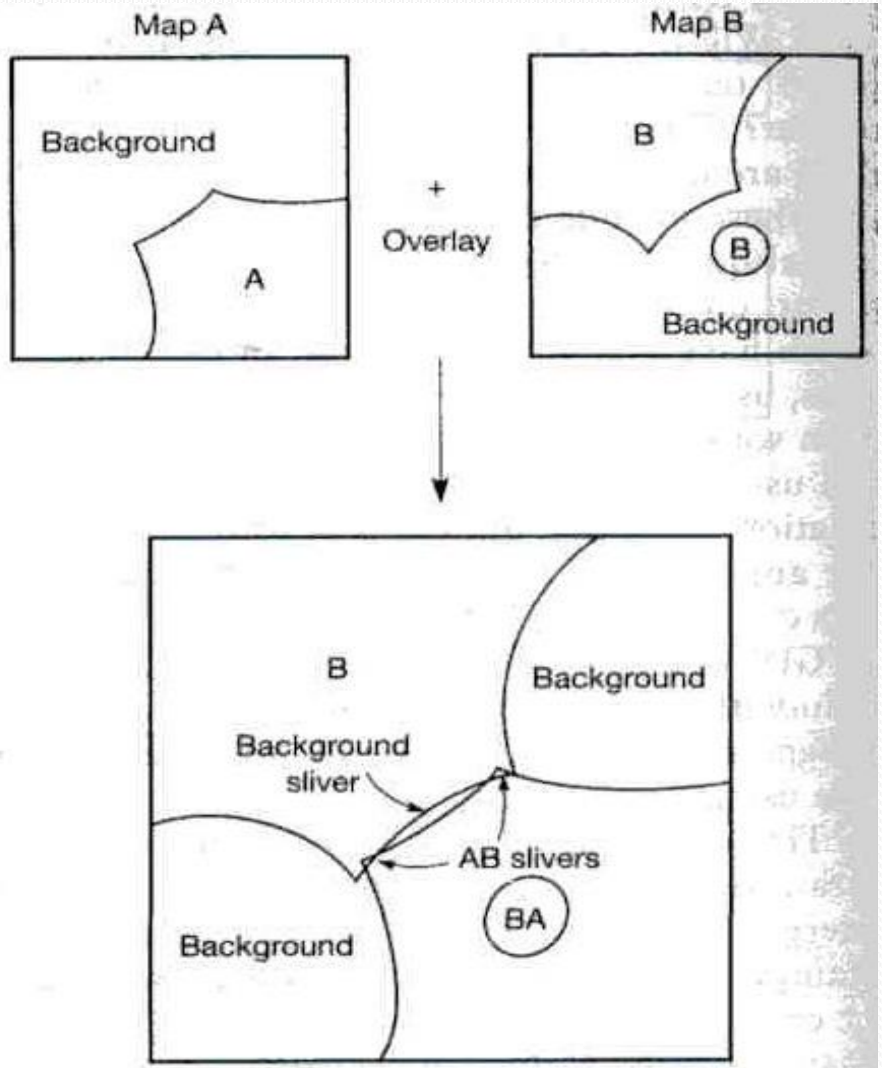
1. Numerical errors in the computer
2. Limitations of computer representations of numbers
3. Faults arising through topological analyses
4. Misuse of logic
5. Problems associated with map overlay
6. Classification and generalization problems
7. Methodology
8. Class interval definition
9. Interpolation

Errors during data processing...contd...

- GIS operations that can introduce errors include the classification of data, aggregation or disaggregation of area data and the integration of data using overlay technique.
- Where a certain level of spatial resolution or a certain set of polygon boundaries are required,
- Data sets that are not mapped with these considerations may need to be aggregated or disaggregated to the required level.

Error due to Analysis...contd...

- Attribute error result from positional error (such as the missing ‘hole’ feature in map A that is present as an island in map B). If one of the two maps that overlaid contains an error, then a classification error will result in the composite map (polygon BA).



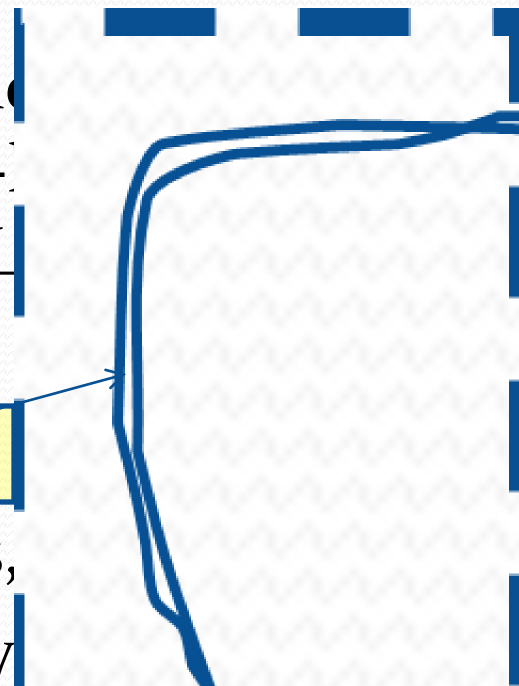
Composite (A + B) with sliver polygons

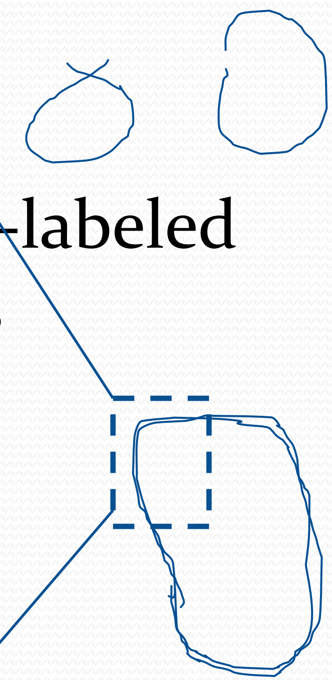
Error types in Vector Data

Points - Un-labeled Points, Multi-labeled Points
Missing Points, Multiple Points

Lines - Overshoots, Und… …g
Lines/Arcs, Un-… …lti-labeled
Lines, Missing L… …hes

Polygons - Sliver polygons, …
Weird Polygons, … …s,
Un-labeled Poly… …Polys
Missing Polys, Multiple Polygons





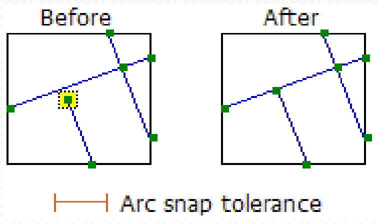
Methods to deal with errors

- Initial data: Control quality of measurement, develop standards, prevent human error.
- Data models: select correct data models based on experience or model appropriateness, reduce errors during conversion from one to another.
- Build Topology properly – Geometrical properties of spatial features such as Containment, Adjacency, and Connectivity.

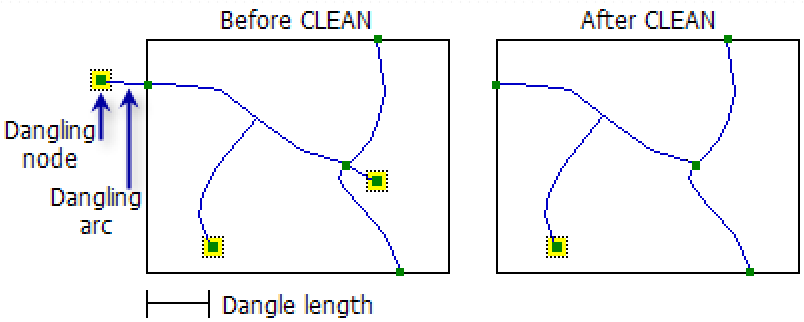
Finding and managing errors in GIS

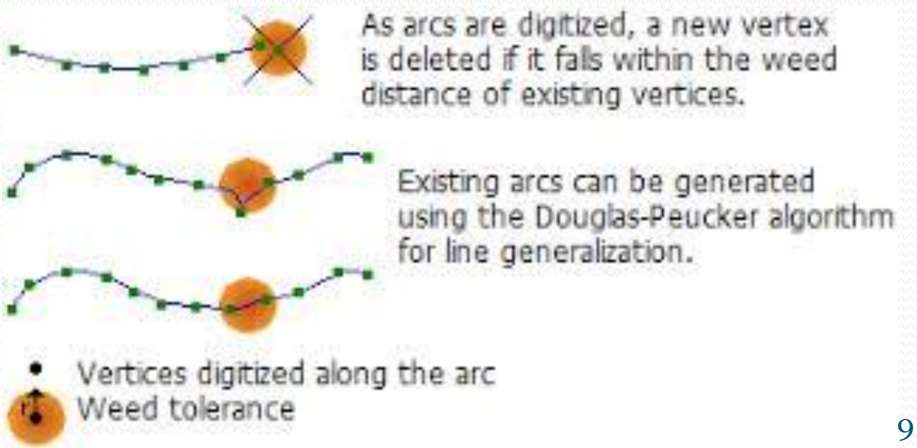
- Checking for errors
  - Probably the simplest means of checking for data errors is by visual inspection.
  - Various statistical methods can be employed to help pinpoint potential errors.
  - Estimating degree of an error helps in controlling and correcting errors
  - Use topological relations to find and locate errors
  - Maintain the ASPRS standard of data quality : RMS error should be less than 5%.

Editing topological errors



- Properly define Dangle length, Fuzzy tolerance, Snap tolerance – to remove dangles,
- Use Flip, Select to remove wrong arc directions and duplicate lines.
- Editing using Topology Rules -25 rules to remove the topological errors easily for the entire data sets at a single stretch.





Editing of Non-topological errors

- Extend/Trim lines
- Delete / Move features
- Reshaping features
- Split lines and polygons
- Merge features
- Buffer, union, intersect features
- Copy, put, get features in other maps – to avoid slivers due to integration
- Edge matching
- Line simplification and
- Line smoothing.

GIS CAPABILITIES FOR DATA VERIFICATION

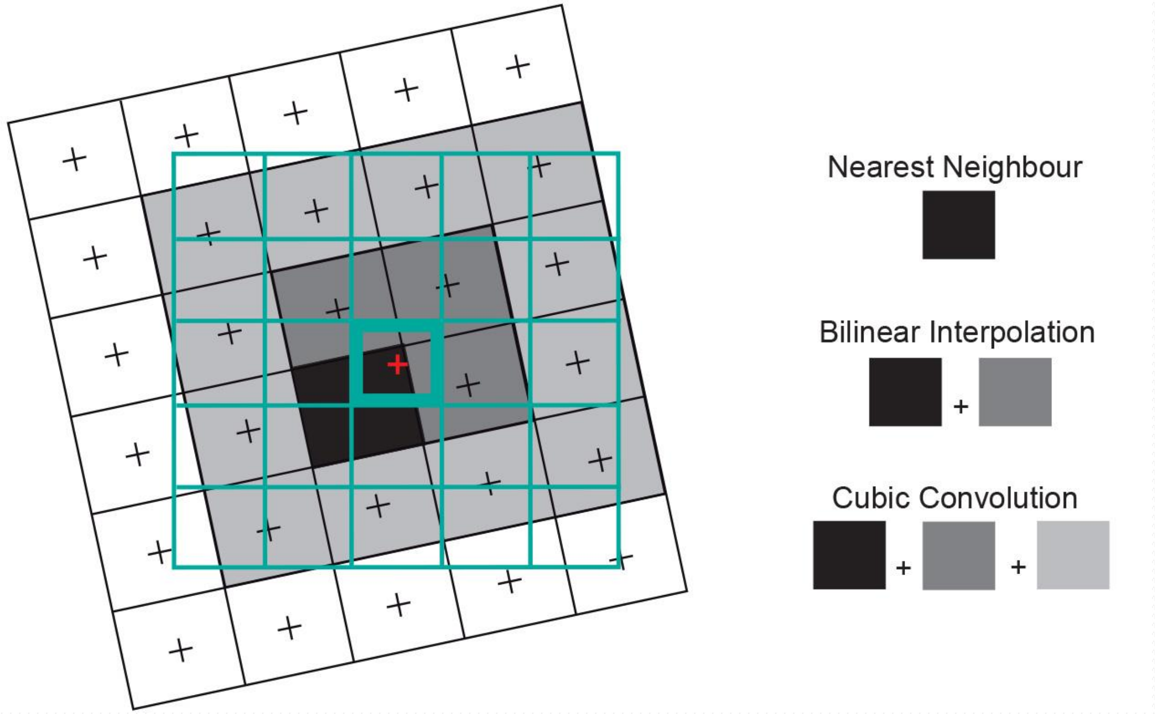
Rubber sheet transformation and warping

- Keeping the faulty digitized map as an elastic sheet that can be stretched in all directions so as to correct point positions by linking vectors of accurate base map.
- A number of points on the faulty map are linked by vectors to the correct positions on the base map
- The rubber sheeting algorithms stretch and compress the faulty map until the linking vectors have shrunk to zero length and the tie points are registered with each other.
- Now, values are calculated for all the other points on the faulty map and relocated correctly.

Bilinear interpolation & Cubic Convolution

- Both are simple interpolation methods by resampling techniques for continuous data sets with no discernible boundaries used to calculate new pixel values.
- **Bilinear interpolation** - Uses a weighted average of the attributes of four surrounding pixels to calculate the output value.
- Two-dimensional interpolation along horizontally and vertically and produces a smoother surface than cubic convolution.
- **Cubic convolution** - Uses a weighted average of the 16 nearest input cell centers to calculate the output value.
- It fits a smooth curve through the points to find the value, which can change the values of the input and cause the output value to be outside of the range of input values.

- Cubic convolution tends to sharpen the edges of the data more than bilinear interpolation and does an excellent job of smoothing continuous data.



Ref.: https://ltb.itc.utwente.nl/498/concept/81586

Data verification

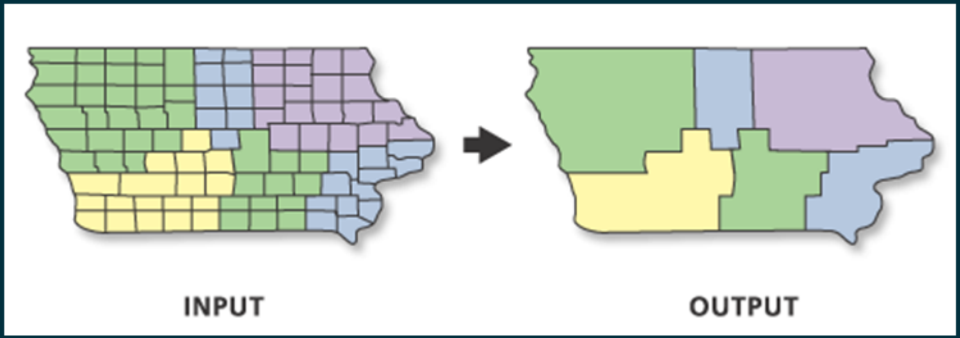
- Comparative checking physically over light table with transparent/transluscent/thin paper hardcopy of the digitized map in the same scale as that of the original map and mark the
  - Missing data
  - Locational errors
  - Multiple entry
- Generate topology – Build Topology options
  - Utilizing topology rules
  - Locate and Display errors like, Node errors, Dangle errors-(overshoots), Pseudo-nodes, open polygons(undershoots), Sliver polygons, Loops/Weird polygons, Spike polygons, …

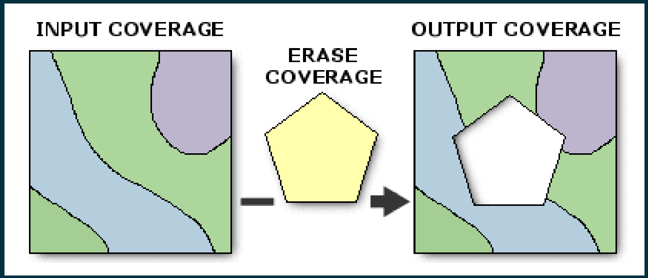
GIS CAPABILITIES FOR DATA VERIFICATION ...contd...

- ADD / DELETE / CHANGE – interactive editing of the alignment, length, text, text font and attributes of graphic entities
- MOVE / ROTATE – To a new position
- STRETCH / RECTIFY – adjust co-ordinates to fit a true base
- TRANSFORM SCALE, PROJECTION
- ZOOM / WINDOW
- CLIP, UPDATE
- JOIN / EDGE MATCH – map continuity
- POLYGON OVERLAY & MERGE
- 3D PROJECTION – Block diagram
- 3D DEM / DTM to TIN Conversion
- VECTORIZATION - Raster to Vector Conversion (Line Thinning algorithm, Patch to Polygon conversion)
- RASTERIZATION - Vector to Raster Conversion (Gridding)
- GENERALIZATION & SMOOTHING
- DATA RETRIEVAL & REPORTING

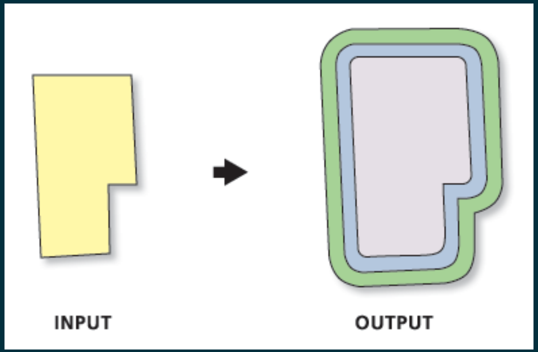
Data Preprocessing and Postprocessing capabilities

Classification/Grouping , Regrouping,/Reclassification

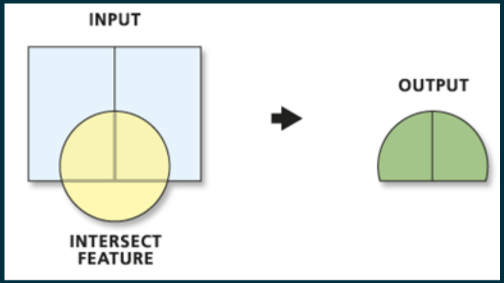




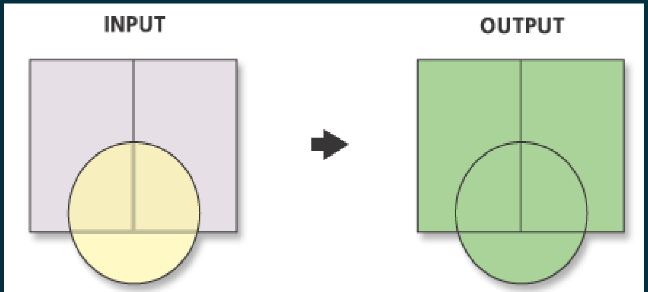
ERASE



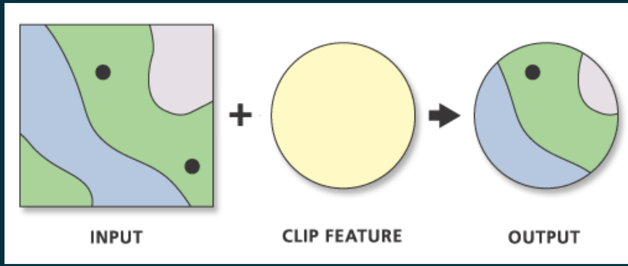
BUFFER



CLIP



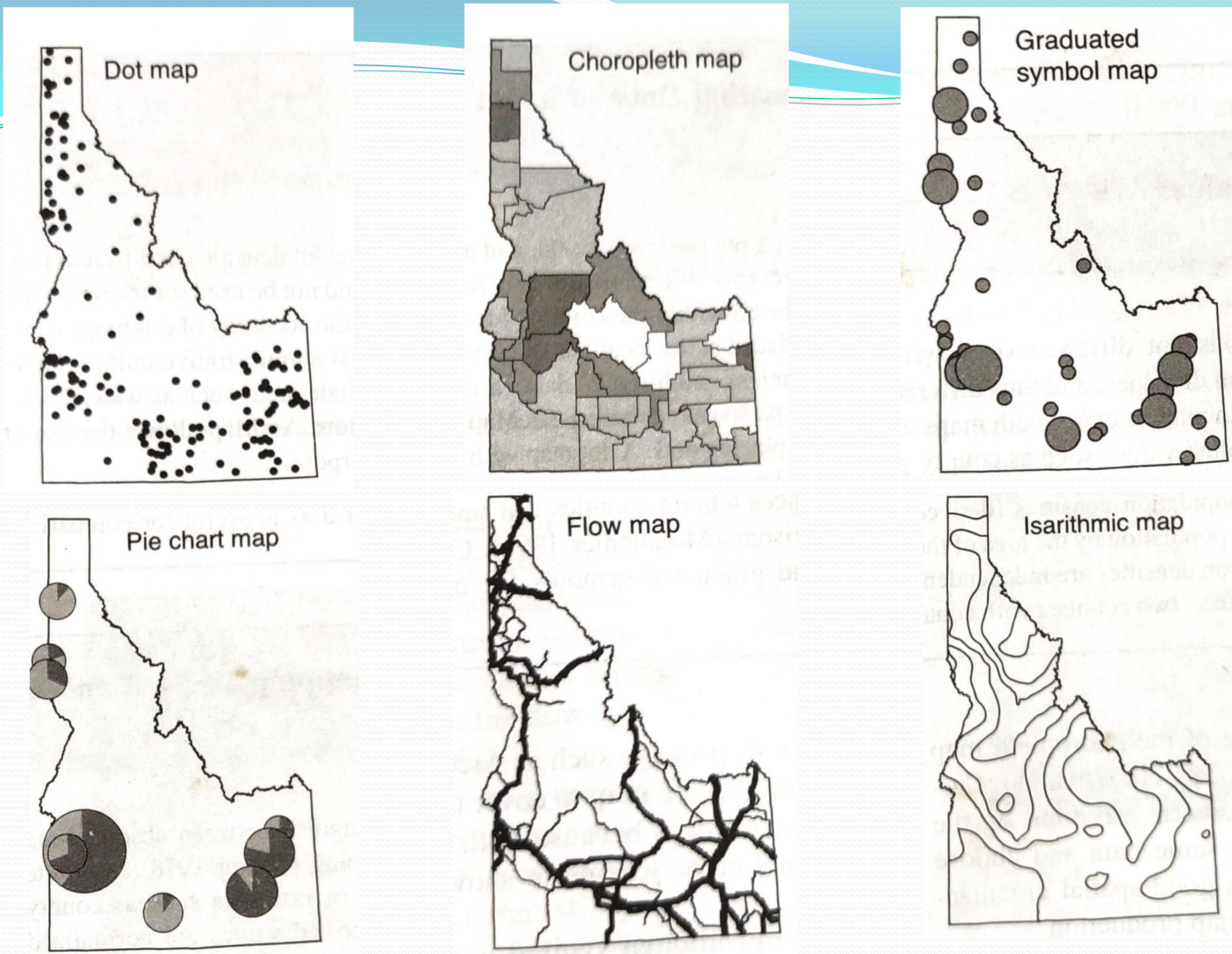
UNION



INTERSECT

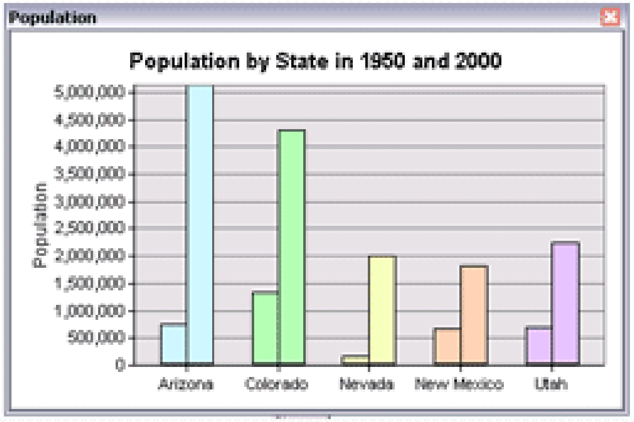
GIS OUTPUT CAPABILITIES

- SIMPLE DISPLAY - CARTOGRAPHIC LAYOUT OPTIONS
- CARTOGRAPHIC ELEMENTS - SCALE, LEGEND, TITLE, SUBTITLE, NORTH ARROW…
- STYLE & COLOUR CHANGE (COLOUR RAMP – MONO COLOUR RAMP-CHROMA, DOUBLE COLOUR RAMP, ,MULTI COLOUR RAMP, TEXTURE, COLOUR SYMBOL, SHAPE, VALUE, PATTERN, HUE…)
- INCLUDE LOCATION MAP – KEY MAP, MAP INSET, GRAPHS, PHOTOS, ETC.
- DOT MAP, CHOROPLETH MAP, DASYMETRIC MAP, GRADUATED COLOUR MAP, GRADUATED SYMBOL MAP, PROPORTIONAL SYMBOL MAP, CHART MAP, FLOW MAP, ISARITHMIC MAP
- CLASSIFIED DISPLAY OF DATA – EQUAL INTERVAL, EQUAL FREQUENCY, MEAN AND STANDARD DEVIATION, NATURAL BREAKS, USER DEFINED
- 3D DISPLAY – FLY-THRU MODEL, FENCE DIAGRAM, STACKED LAYERS …
- OVERLAY OF MANY THEMES
- LIVE MAPS & INTERACTIVE MAPS
- PLOTTER / PRINTER O/P, WEB DISPLAY
- QUBIS – QUERY BASED INFORMATION (MAP) RETREIVAL SYSTEM
- SDSS – SPATIAL DECISION SUPPORT (MAP) SYSTEM - ON-TIME / STRATEGIC MAPS

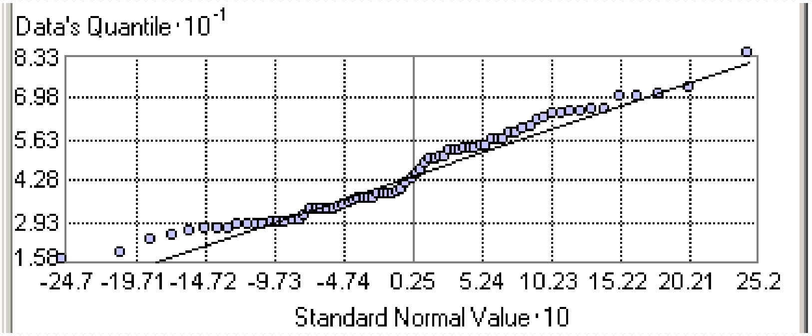


Ref.: *Kang-tsung Chang 2007, Intro. to GIS, TATA Mc Graw-Hill, P.185.*

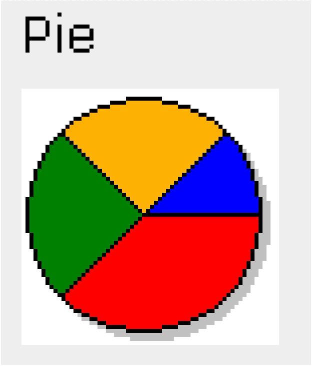
GIS can display in the form of Charts, Histograms, 3D visualized output, DEM, etc,.

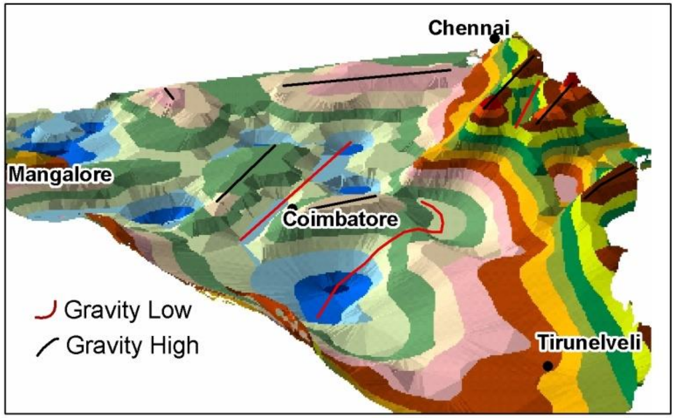


Charts

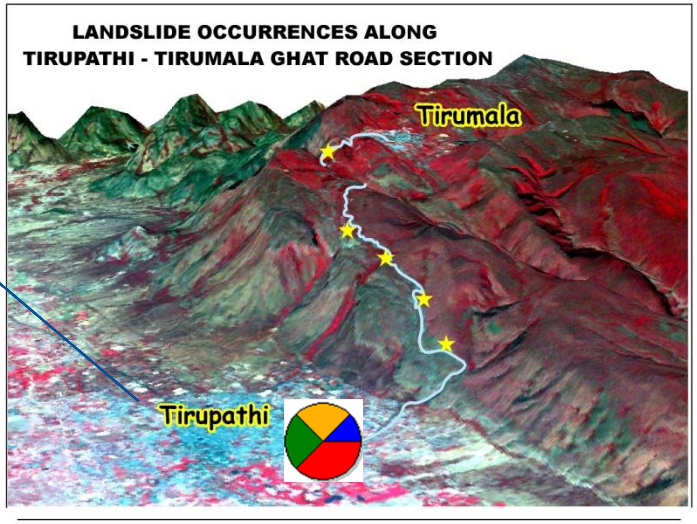


Histograms

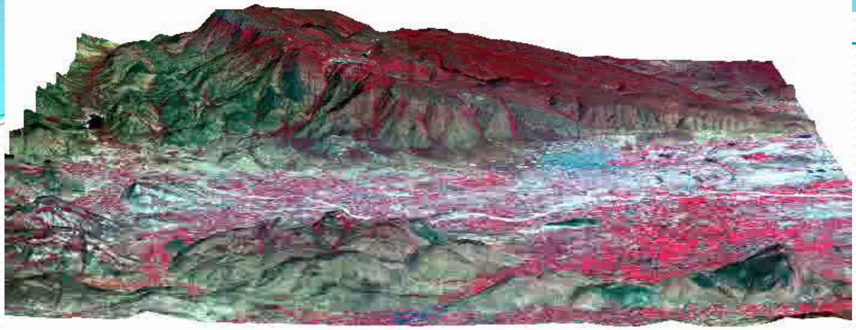


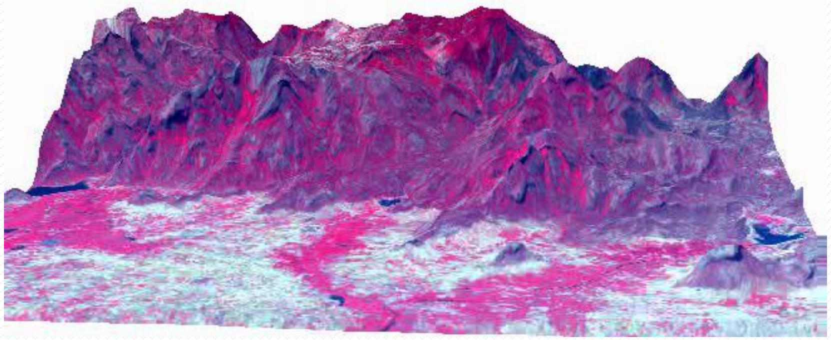


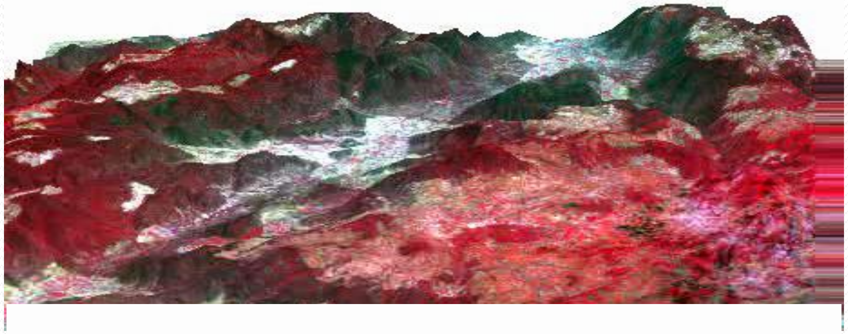
3D IMAGE

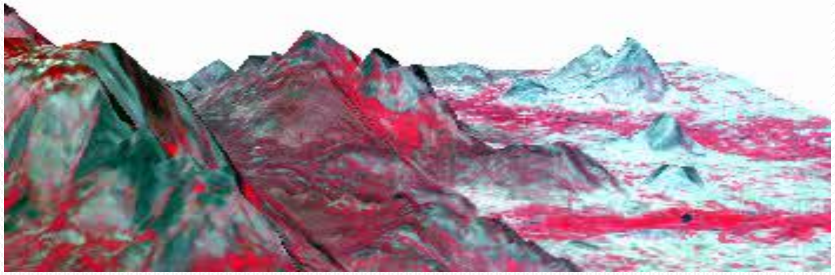


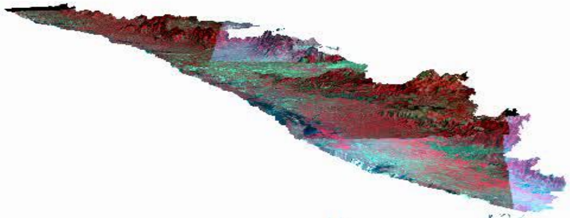
DIGITAL ELEVATION MODEL(DEM)

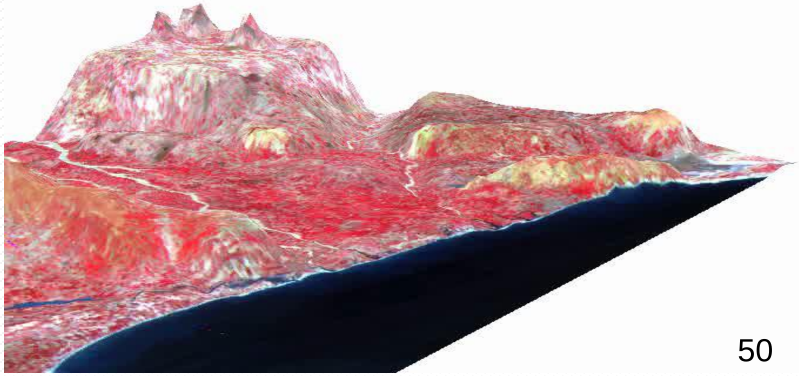


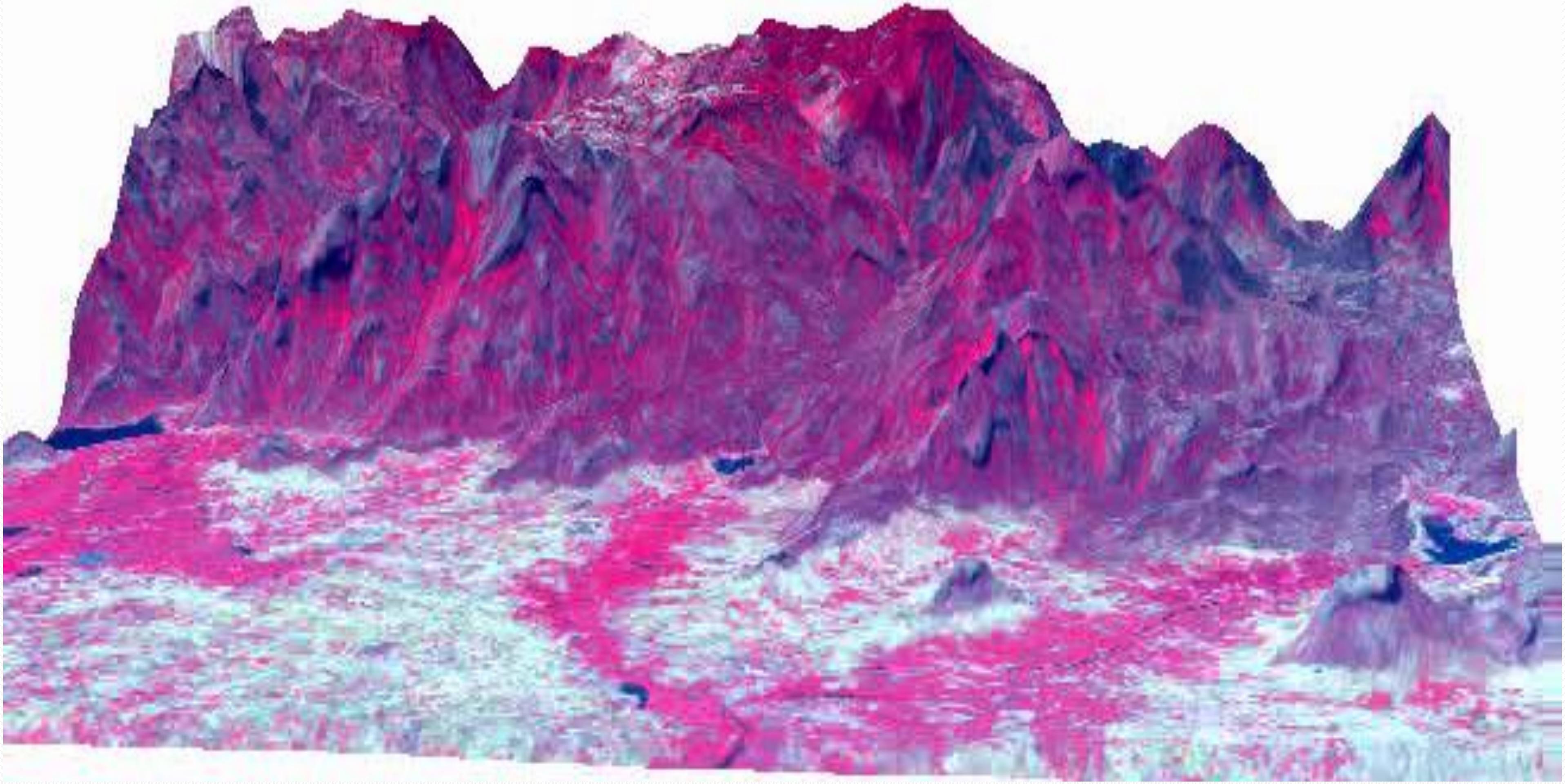


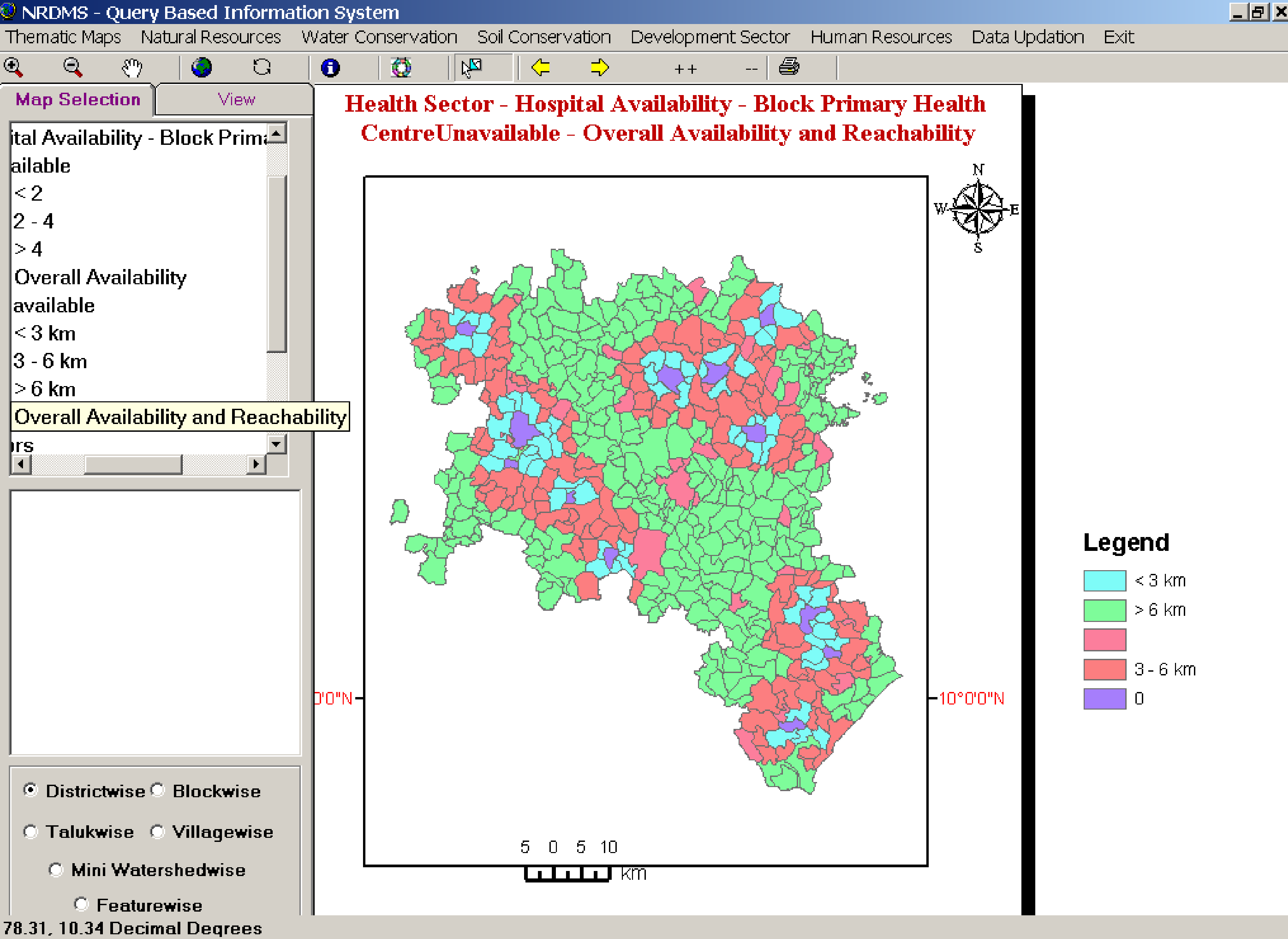











NRDMS - Query Based Information System
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Soil Conservation
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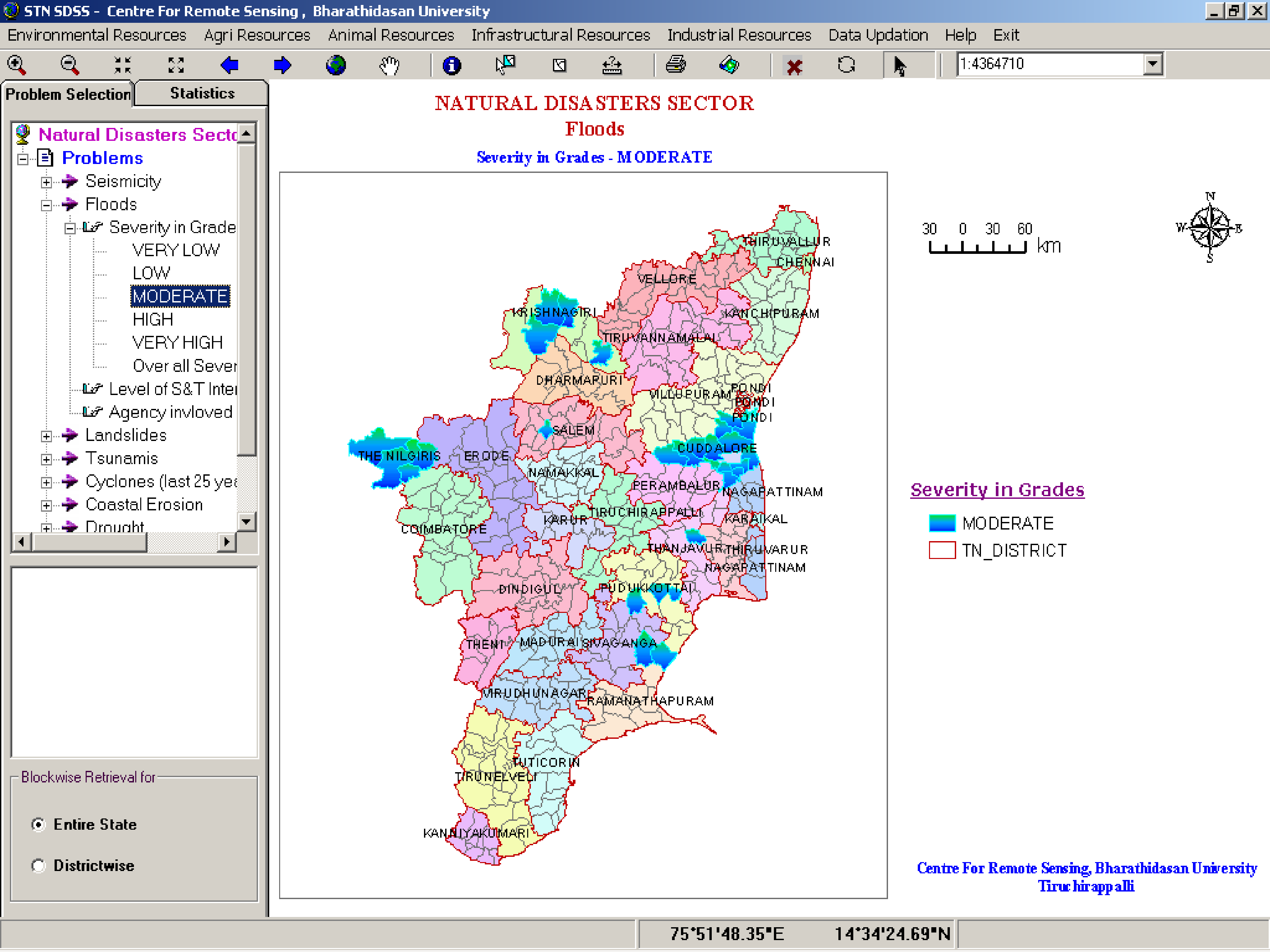
STN SDSS - Centre For Remote Sensing , Bharathidasan University
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Tsunamis
Cyclones (last 25 yea
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Drought
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Severity in Grades - MODERATE
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TIRUVANNAMALAI
DHARMAPURI
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SALEM
CUDDALORE
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PERAMBALUR
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Centre For Remote Sensing, Bharathidasan University
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14°34'24.69"N