Introduction:
Eight fundamental parameters are used in the interpretation of remote sensing images: size, shape, tone, texture, site, association, shadow, and pattern. In some cases, a single such element is alone sufficient for successful identification; in others, the use of several different elements will be required.

"Size" and "shape" are pretty much self-explanatory; "tone" is the brightness of a black-and-white image or the color in a color image; "texture" is distinctive variation of tone across a single object; for some objects, their location ("site") is a valuable datum in interpretation, as might also be any "association" with nearby, readily-identifiable objects; "shadow" can at times reveal diagnostic details otherwise invisible in a vertical image; and "pattern" is a distinctive array of objects. Examples follow, using public-domain images acquired by the IKONOS satellite (with the exception of the R-G-B image, from the U. S. Geological Survey).

Aerial photo interpretation:
Aerial photo interpretation is a method of studying terrain by examining aerial photographs of it, involving detection and identification of the objects photographed, determination of their qualitative and quantitative characteristics, and recording the results graphically (using standard symbols), numerically, and textually. Aerial photo interpretation has certain features typical of terrain study in general, as well as certain differences, determined by the nature of the fields (practical and scientific) in which it is used (in combination with other methods of research).

Classification:

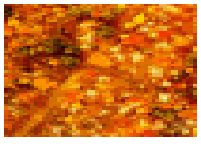
1. Tone
2. Size
3. Shape
4. Texture
5. Pattern
6. Shadow
7. Site
8. Association

First order

Tone/Color:
Tone can be defined as each distinguishable variation from white to black. Color may be defined as each distinguishable variation on an image produced by a multitude of combinations of hue, value and chroma. Many factors influence the tone or color of objects or features recorded on photographic emulsions. But, if there is not sufficient contrast between an object and its background to permit at least detection, there can be no identification. While a human interpreter may only be able to distinguish between ten and twenty shades of grey; interpreters can distinguish many more colors. Some authors state that interpreters can distinguish at least 100 times more variations of color on color photography than shades of gray on black and white photography.

Examples of tone:

Examples of color:



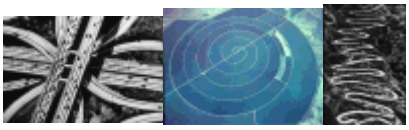
Resolution:
Resolution is defined as the ability of the entire photographic system, including lens, exposure, processing, and other factors, to render a sharply defined image. An object or feature must be resolved to be detected and/or identified. Resolution is one of the most difficult concepts to address in image analysis. Resolution can be described for systems in terms of modulation transfer (or point spread) functions; or it can be discussed for camera lenses in terms of being able to resolve so many line pairs per millimeter. There are resolution targets that help to determine this when testing camera lenses for metric quality. Photo interpreters often talk about resolution in terms of ground resolved distance, the smallest normal contrast object that can be detected and identified on a photo.

Second order -- Geometric Arrangements of Objects

Size:
The size of objects can be important in discrimination of objects and features (cars vs. trucks or buses; single family vs. multi-family residences, brush vs. trees, etc.). In the use of size as a diagnostic characteristic both the relative and absolute sizes of objects can be important. Size can also be used in judging the significance of objects and features (size of trees related to board feet which may be cut; size of agricultural fields related to water use in arid areas, or amount of fertilizers used; size of runways gives an indication of the types of aircraft that can be accommodated).

Shape:
The shape of objects/features can provide diagnostic clues that aid identification. The Pentagon building in Washington is a diagnostic shape. Man-made features have straight edges that natural features tend not to. Roads can have right angle turns, railroads do not.

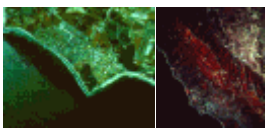
Examples of shape:



Second order -- Spatial Arrangement of

Tone/Color:
It must be noted here that pattern is scale dependent. An orchard on a low altitude aerial photo may be an area of rough texture on a high altitude air photo or an area of medium or rough texture on a satellite image. This pattern may be thought of as being scale dependent.

Examples of pattern and texture being scale dependent:



Texture:
The frequency of change and arrangement of tones. This is a micro image characteristic. The visual impression of smoothness or roughness of an area can often be a valuable clue in image interpretation. Water bodies are typically fine textured, while grass is medium, and brush is rough, although there are always exceptions.

Examples of texture:

Pattern:
Pattern is the spatial arrangement of objects. Pattern can be either man-made or natural. Pattern is a macro image characteristic. It is the regular arrangement of objects that can be diagnostic of features on the landscape. An orchard has a particular pattern. Likewise, the network or grid of streets in a subdivision or urban area can aid identification and aid in problem solving such as the growth patterns of a city. Pattern can also be very important in geologic or geomorphologic analysis. Drainage pattern can tell the trained observer a great deal about the lithology and structural patterns in an area. Dendritic drainage patterns develop on flat bedded sediments; radial on/over domes; linear or trellis in areas with faults or other structural controls.

Examples of pattern:

Third order -- Locational or Positional Elements

Site:
How objects are arranged with respect to one another; or with respect to various terrain features, can be an aid in interpretation. Aspect, topography, geology, soil, vegetation and cultural features on the landscape are distinctive factors that the interpreter should use when examining a site. The relative importance of each of these factors will vary with local conditions, but all are important. Just as some vegetation grows in swamps others grow on sandy ridges. Agricultural crops may like certain conditions. Manmade features may also be found on rivers (e.g. power plant) or on a hill top (observatory or radar facility).

Examples of site:

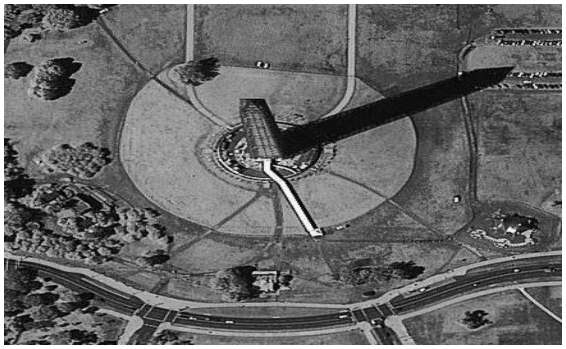
Association:
Some objects are so commonly associated with one another that identification of one tends to indicate or confirm the existence of another. Smoke stacks, step buildings, cooling ponds, transformer yards, coal piles, railroad tracks = coal fired power plant. Arid terrain, basin bottom location, highly reflective surface, sparse vegetation = playa. Association is one of the most helpful clues in identifying man made installations. Aluminum manufacture requires large amounts of electrical energy. Absence of a power supply may rule out this industry. Cement plants have rotary kilns. Schools at different levels typically have characteristic playing fields, parking lots, and clusters of buildings in urban areas. Large farm silos typically indicate the presence of livestock.

Third order -- Interpreted from lower order elements

Height:
Height can add significant information in many types of interpretation tasks; particularly those that deal with the analysis of man-made features. How tall a tree is can tell something about board feet. How deep an excavation is can tell something about the amount of material that was removed (in some mining operations excavators are paid on the basis of material removed as determined by photogrammetric analysis).

Shadow:
Geologists like low sun angle photography because shadow patterns can help identify objects. Steeples and smoke stacks can cast shadows that can facilitate interpretations. Tree identification can be aided by an examination of the shadows thrown. Shadows can also inhibit interpretation.

Examples of shadow:



Conclusion:
At the end we can easily say by the measurement of above discussion about basic elements of aerial photo interpretation are the seven circulated components.
The most basic of these principles are the elements of image interpretation. They are: location, size, shape, shadow, tone/color, texture, pattern, height/depth and site/situation/association. These are routinely used when interpreting an aerial photo or analyzing a photo-like image. A well-trained image interpreter uses many of these elements during his or her analysis without really thinking about them. However, a beginner may not only have to force him or herself to consciously evaluate an unknown object with respect to these elements, but also analyze its significance in relation to the other objects or phenomena in the photo or image.

VISUAL IMAGE INTERPRETATION

IMAGE INTERPRETATION

- **Act of examining images to identify objects and judge their significance.**
- **Information extraction process from the images.**
- **An interpreter is a specialist trained in study of photography or imagery, in addition to his own discipline.**
- **Aerial photographs and remote Sensing images employ electromagnetic energy as the mean of detecting and measuring target characteristics.**
- **Involves a considerable amount of subjective judgment**
- **Highly dependent on capability of mind to generalize**
- **Takes place at different levels of complexity**

Image is a pictorial representation of an object or a scene.

Image can be analog or digital.

Aerial photographs are generally analog, while satellite data is in digital form.

A digital image is made up of square or rectangular areas called pixels.

Each pixel has an associated pixel value which depends on the amount reflected energy from the ground.

Aerial image of South Mumbai city

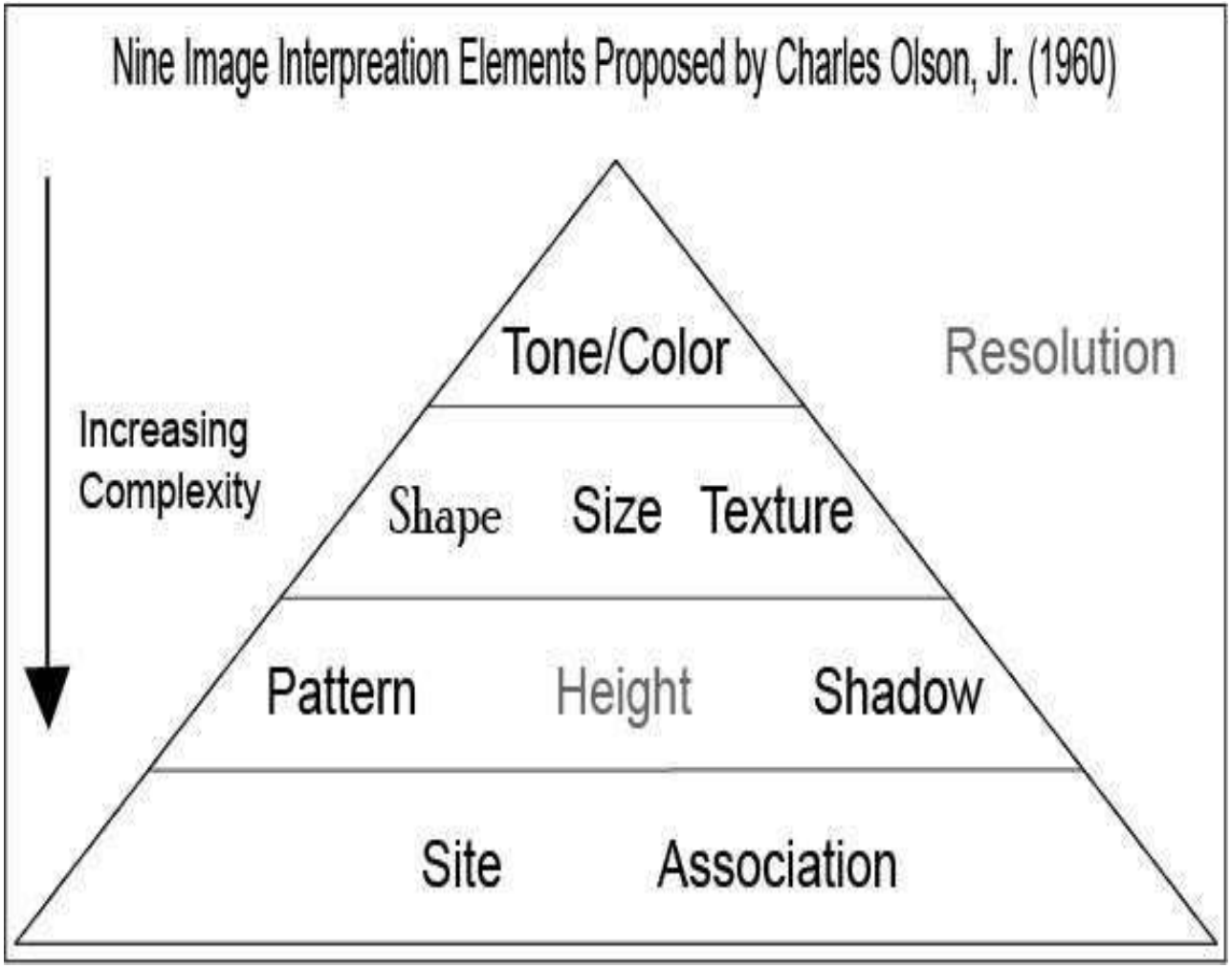
Satellite image of South Mumbai city

- **Visual image interpretation on a hardcopy image/photograph**

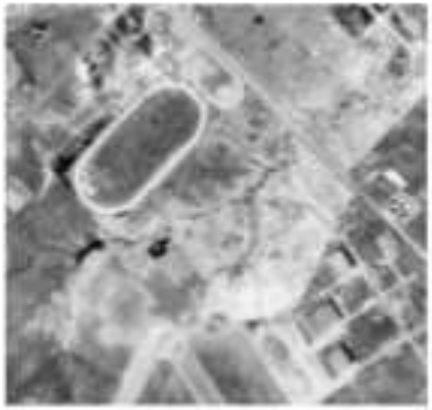
- **Visual image interpretation on a digital image**

TYPES OF INTERPRETATION

- **Qualitative**
- **Quantitative**



Elements of Image Interpretation

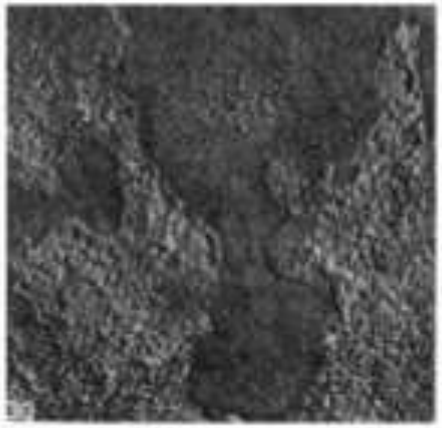


Shape
(depends on the object outline)

Size
(relative to one an other)

Tone
(brightness-hue, color)

Site
(location helps recognition)



Texture
(smooth or coarse)

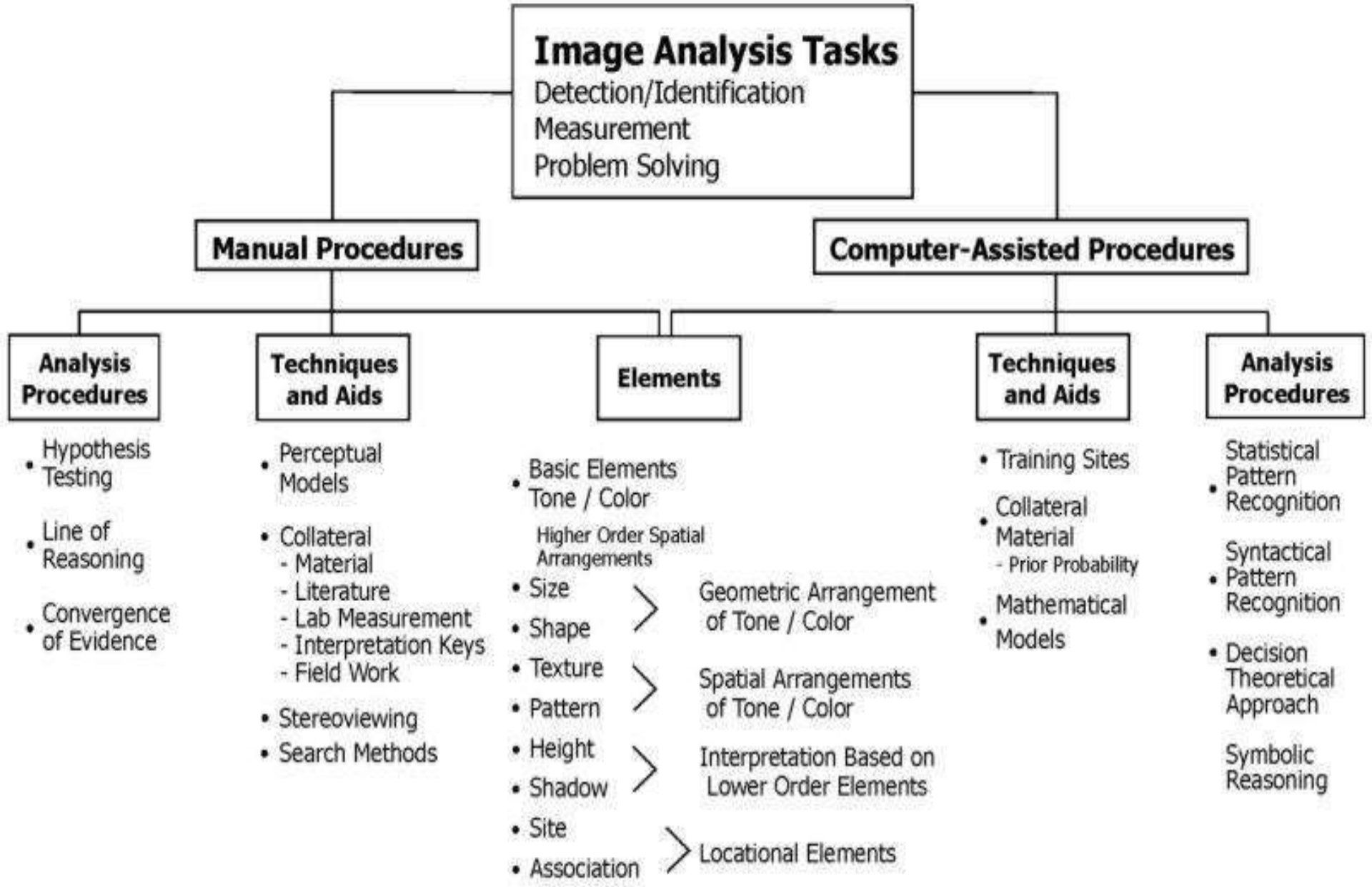
Shadow
(helps to determine height)

Association
(features that are normally found near object)

Pattern

Typical Examples of Image Interpretation

Methods of Image Interpretation



Basic Principle of Image Interpretation

- Image is a pictorial representation of pattern of landscape.
- Pattern indicates type of objects and their physical, biological, and cultural relationships
- Similar objects under similar conditions reflect similarly.
- A systematic examination of photos and supporting material.
- Interpretation is made of physical nature of the object.
- Information extracted is proportional to knowledge, skill and
- experience of analyst; the methods and equipment used.

Factors governing interpretability

- **Training & Experience**
- **Nature of object or phenomenon**
- **Quality of photographs**
- **Equipment and method of interpretation**
- **Interpretation keys, guides, manuals and other aids**
- **Prior knowledge of the area.**

Techniques of visual image interpretation

Image interpretation comprises at least three facts:

i) The measurement of images of objects

i) Identification of the objects imaged

iii) Appropriate use of this information in the solution of the problem.

Methodology depends on.....

Kind of information to be interpreted

Accuracy of the results to be obtained

The reference level of the person executing the interpretation

Kind and type of imagery or photographs available
Instruments available

Scale and other requirements of the final map

External knowledge available and any other sensory surveys that have been or will be made in the near future in the same area.

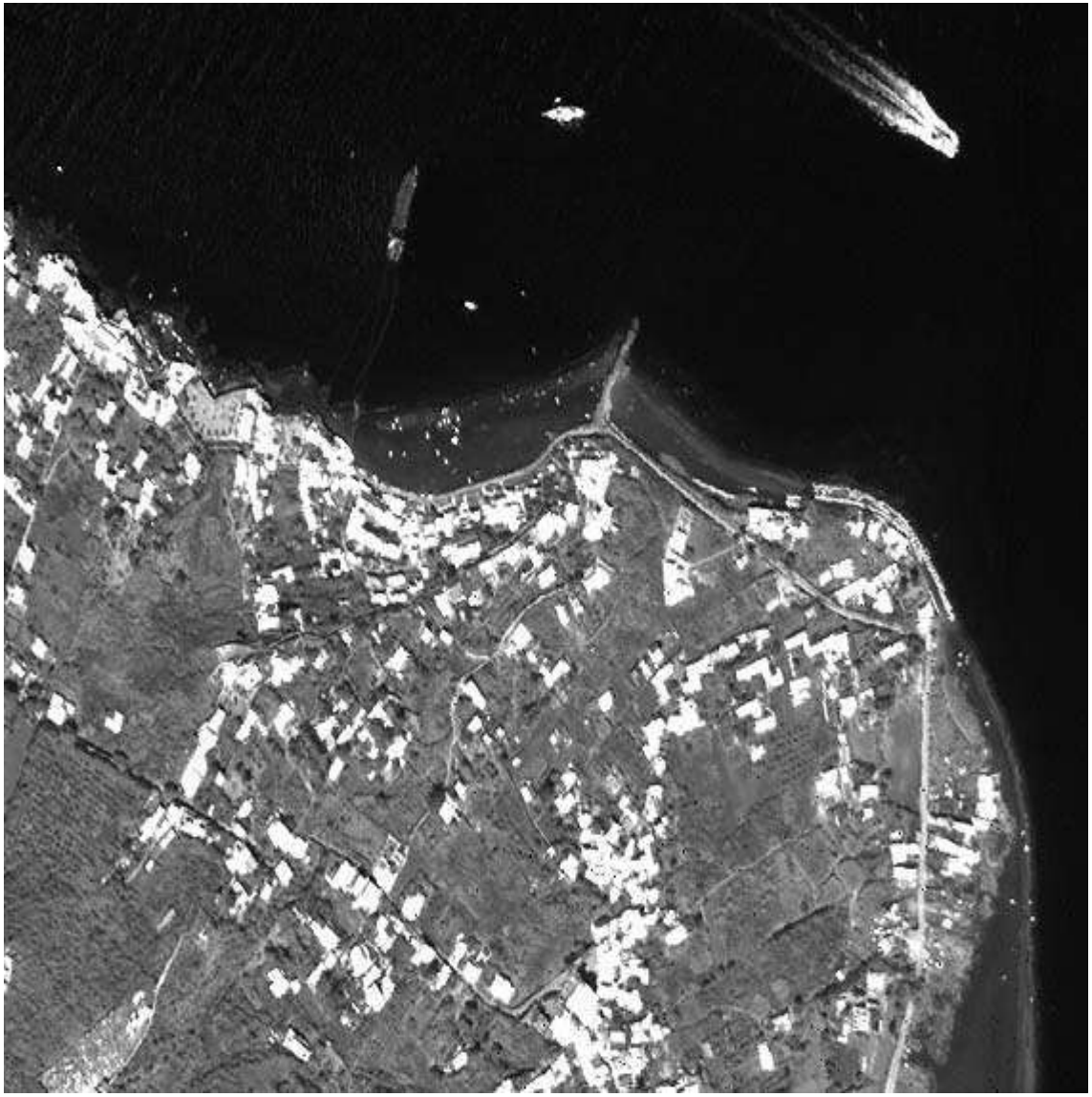
ACTIVITIES OF IMAGE INTERPRETATION

- **Detection**
- **Recognition**
- **Analysis**
- **Deduction**
- **Classification**
- **Idealization**
- **Convergence of evidence**

Sensors in photographic Image Interpretation

- Black and white panchromatic
- Black and white infrared
- Colour
- Colour infrared/ false colour

B/W Aerial Photo



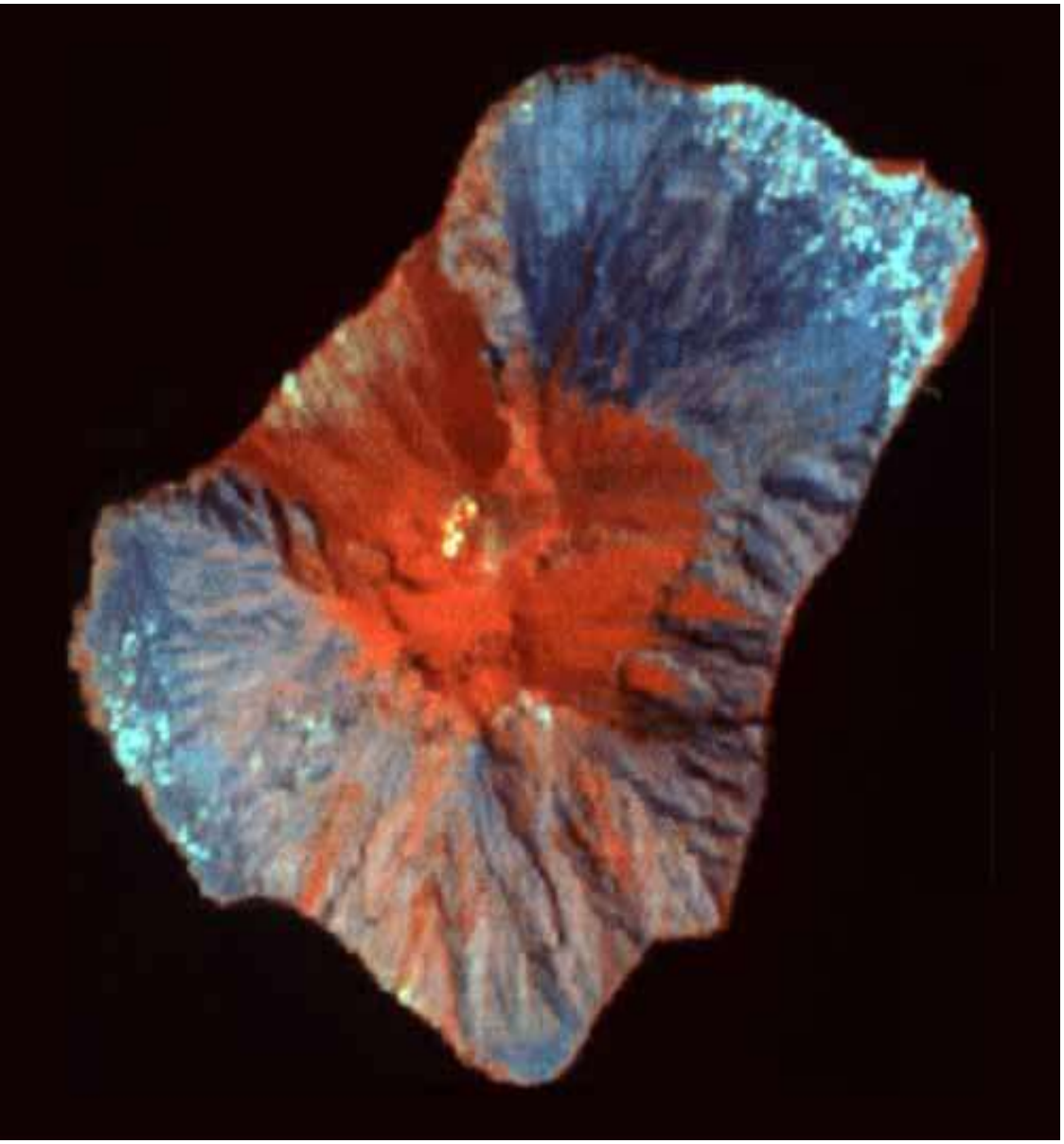
The image is stored on photographic film that is, generally speaking, sensitive to electromagnetic radiation from 0.3 µm to 0.9 µm. Panchromatic films , producing black and white images, is the most common type of film used for aerial photography.

In the upper right corner there is a hydrofoil ship. The other big ship is a tanker delivering fresh water to the island

Colour and false colour (or colour infrared) photography

Involves the use of a three layer film with each layer sensitive to different ranges of light. For a normal colour photograph, they are sensitive to blue, green, and red light - the same as our eyes. Accordingly, these photos to us the same way that our eyes see the environment. The colours resemble those which would appear to us as "normal" (i.e. trees appear green, etc.).

Mid-Infrared Image of Stromboli Island



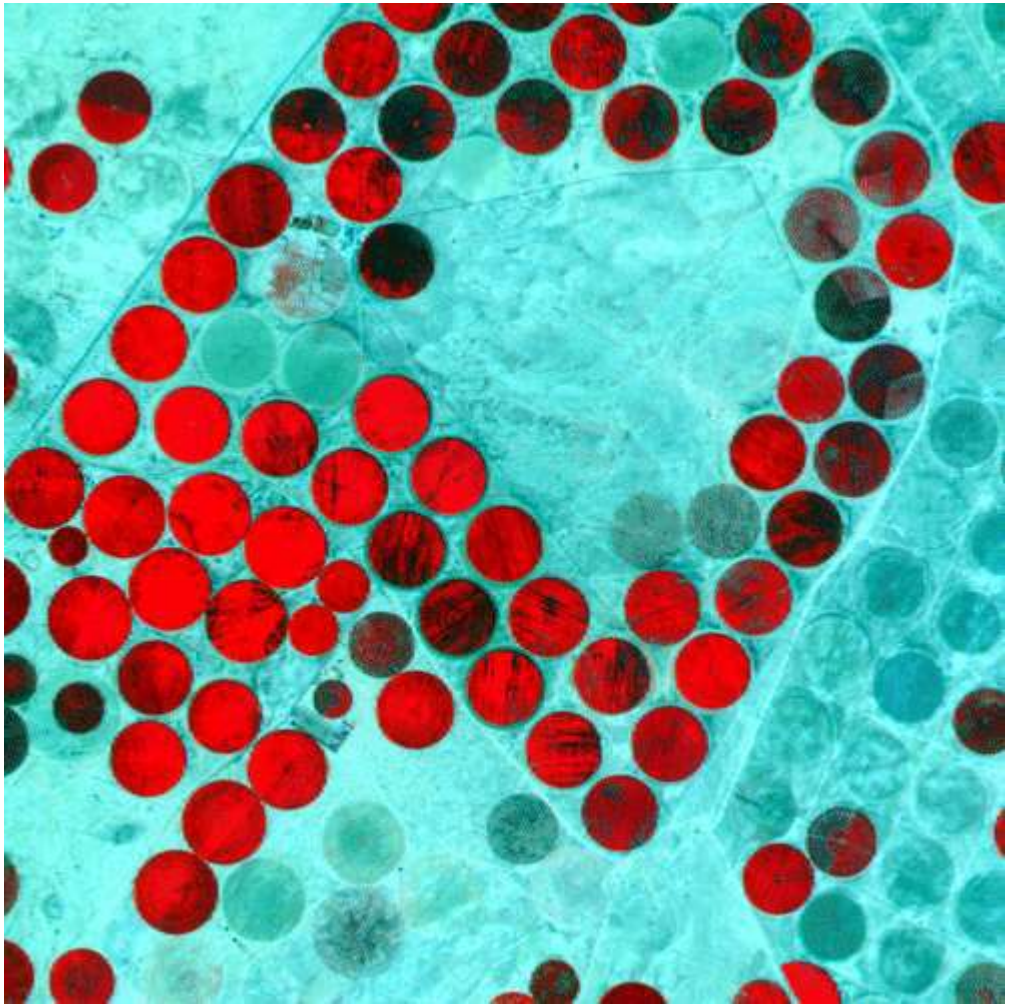
In color infrared (CIR) photography, the three emulsion layers are sensitive to green, red, and the photographic portion of near infrared radiation (up to 0.9 µm), which are processed to appear as blue, green, and red, respectively. In a false color photograph, targets with high near-infrared reflectance appear red, those with a high red reflectance appear green, and those with a high green reflectance appear blue, thus giving us a "false" presentation of the targets relative to the color we normally perceive them to be.

Image interpretation for Multispectral imagery

- Resolution
- Stereoscopic ability
- Individual Band Interpretation
- Temporal data

Landsat image Boston

Saudi Arabia Sensor : IRS1C LISS III



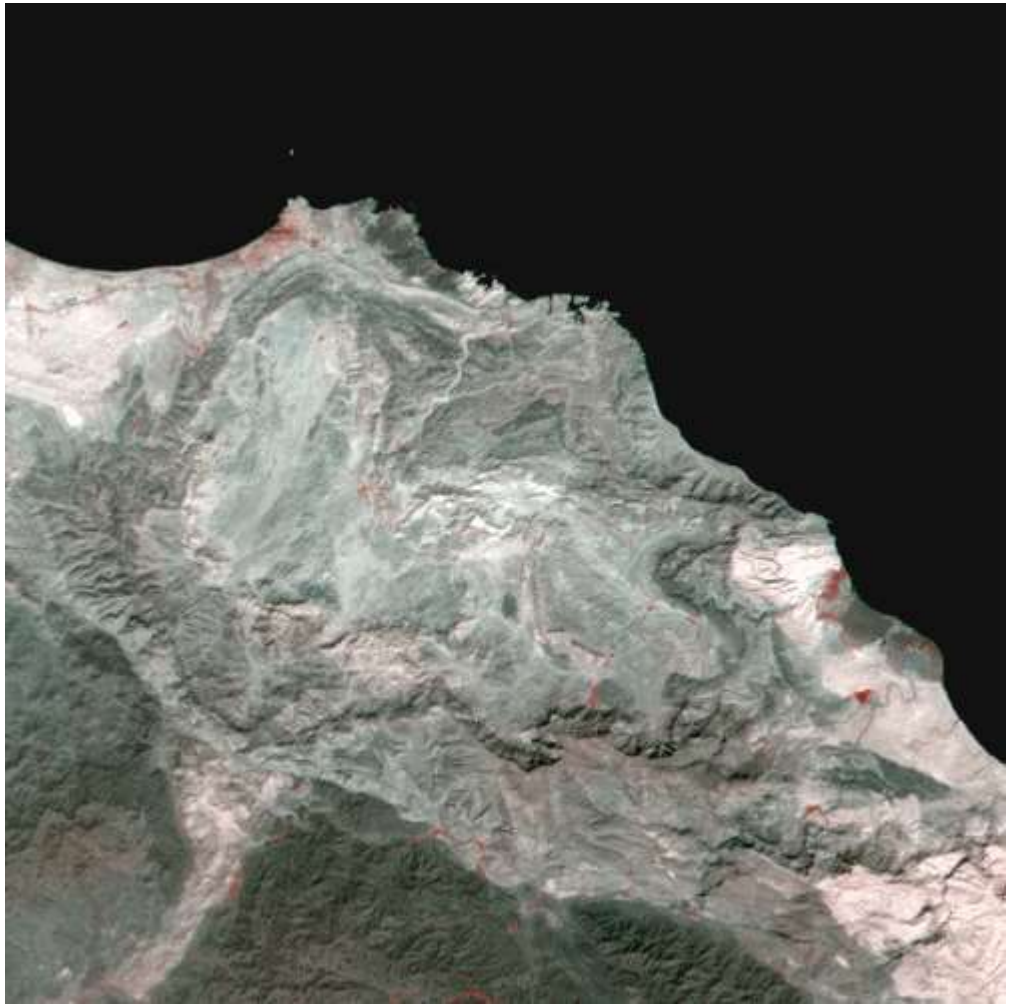
The circular features indicate sprinkler irrigation systems.

Red color indicates crop & dark color fallow land.

Goa city , India Sensor : IRS1D LISS III

This multispectral image shows Marmagoa & Tiswadi areas ofGoa state. This image also shows the sedimentation in the River Zuari & River Mandovi & the red patches represent densely vegetated areas. The Dabolim airport near the town of Vascodagama is also visible in the lower middle part of the image.

Part of Oman Sensor : IRS1D WiFS



The mountains & rocky terrain of the gulf of Oman area are seen through WiFS sensor .

In image interpretation use is made of

Image characteristics

or

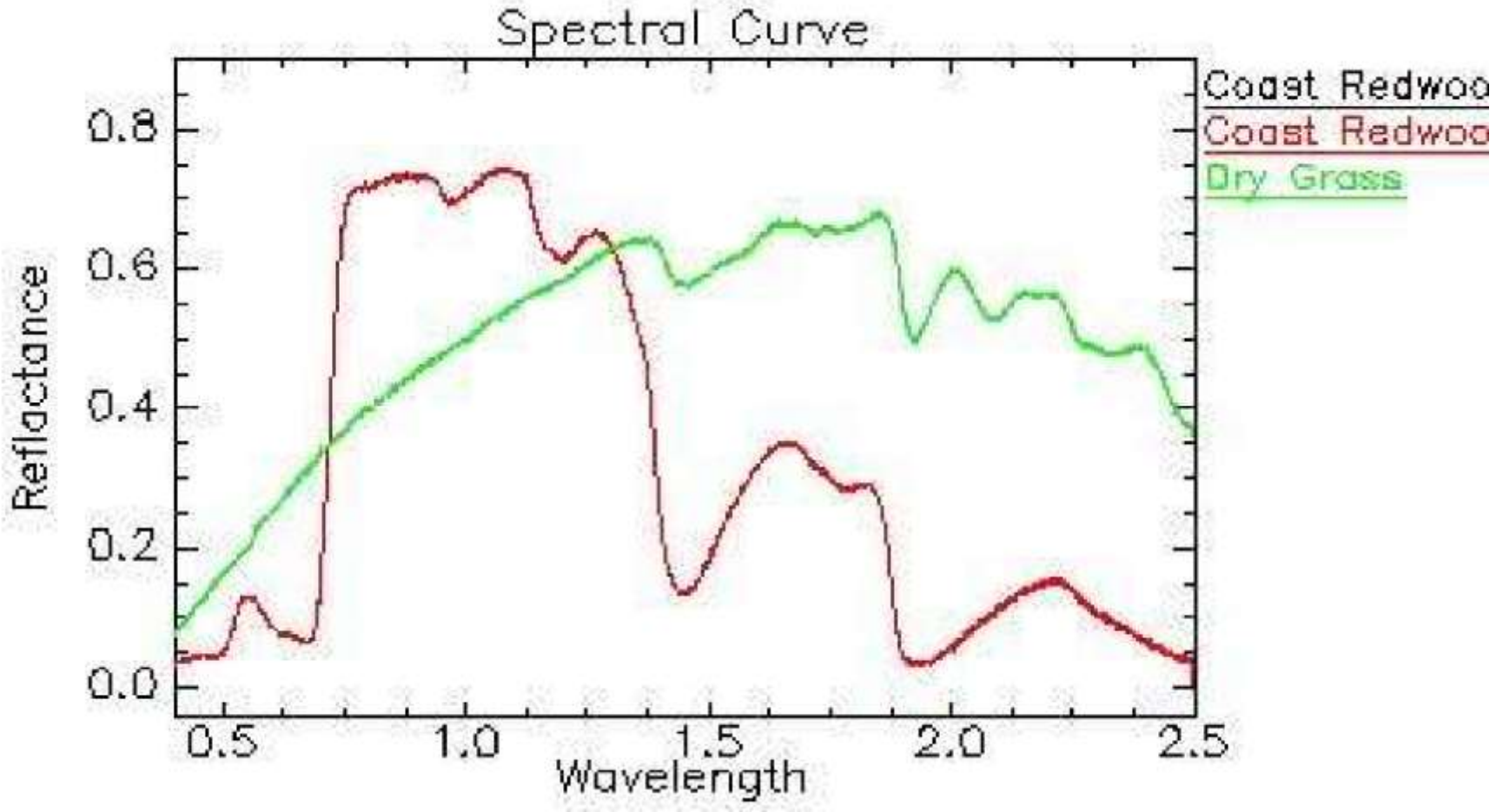
Interpretation elements

Image characteristics are distinguished in to

- Spectral characteristics
- Spatial characteristics
- Stereo characteristics
- Associated features

Spectral characteristics

- **Grey tone**
- **Colour**



Different Aspects of Grey tone

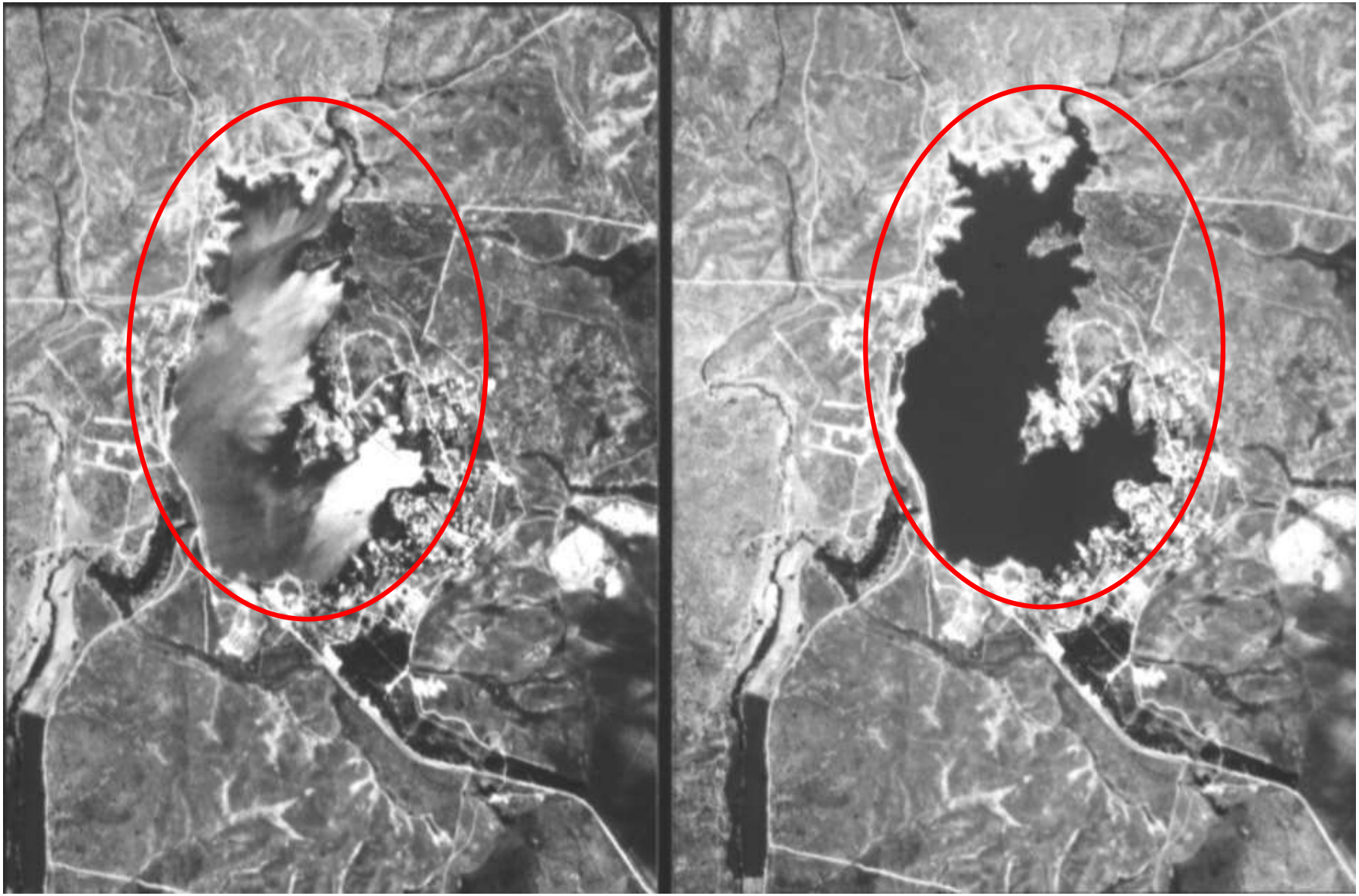
A- Farm/fields

B- River

C-Silica/sands

D- Water

A- Green/Fresh Vegetation
B- Small Plants
C- Old plants
D- Bushes/grass fields



Full colour

Panchromatic

Spatial characteristics

- shape
- size
- shadow
- pattern
- texture

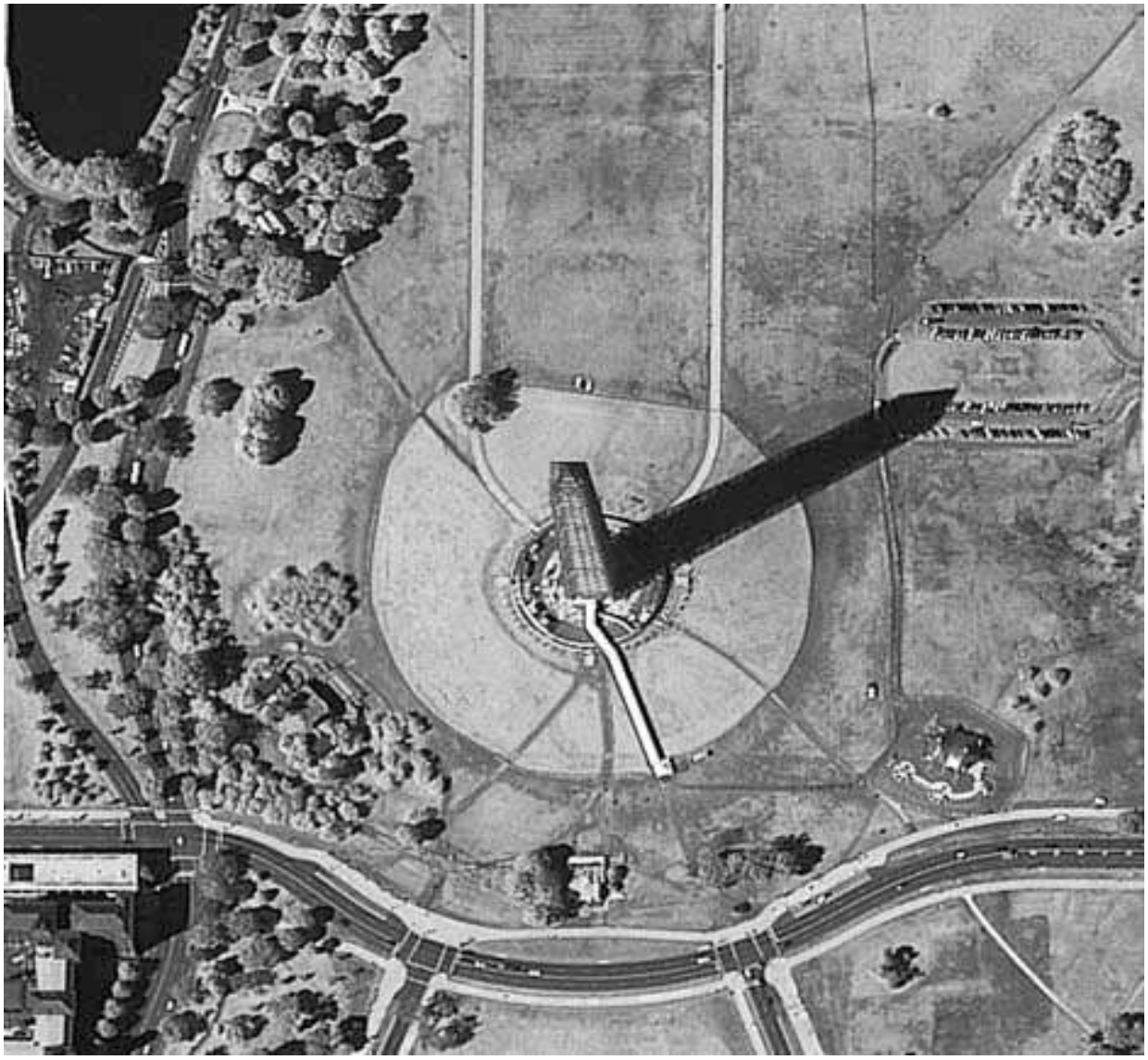
Size and Shape: The Pentagon

Size, Shape, Pattern, Shadow: The Pyramids

Pyramids near Alexandria, Egypt

Association: Hoover Dam

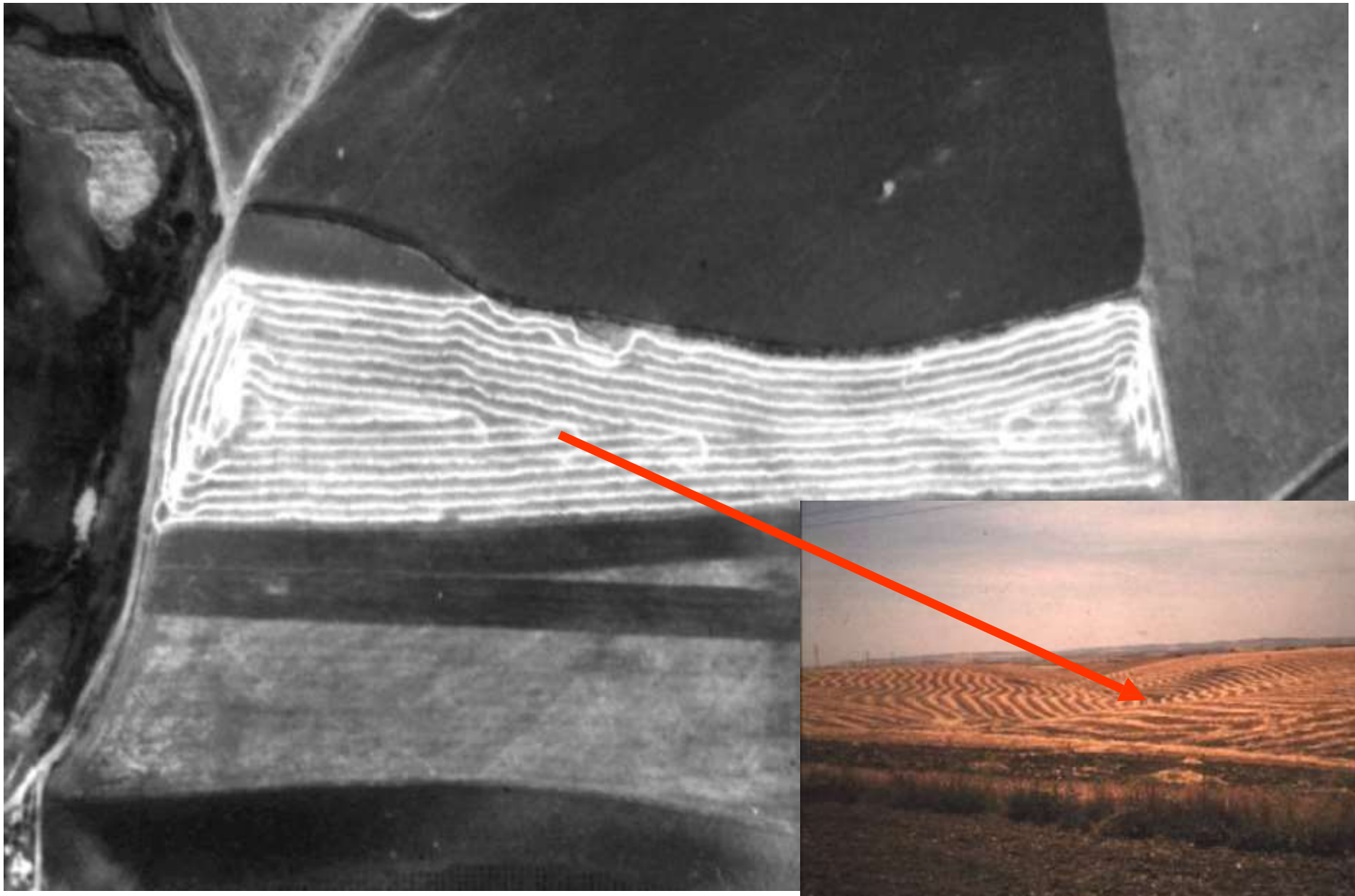
Shadow: The Washington Monument

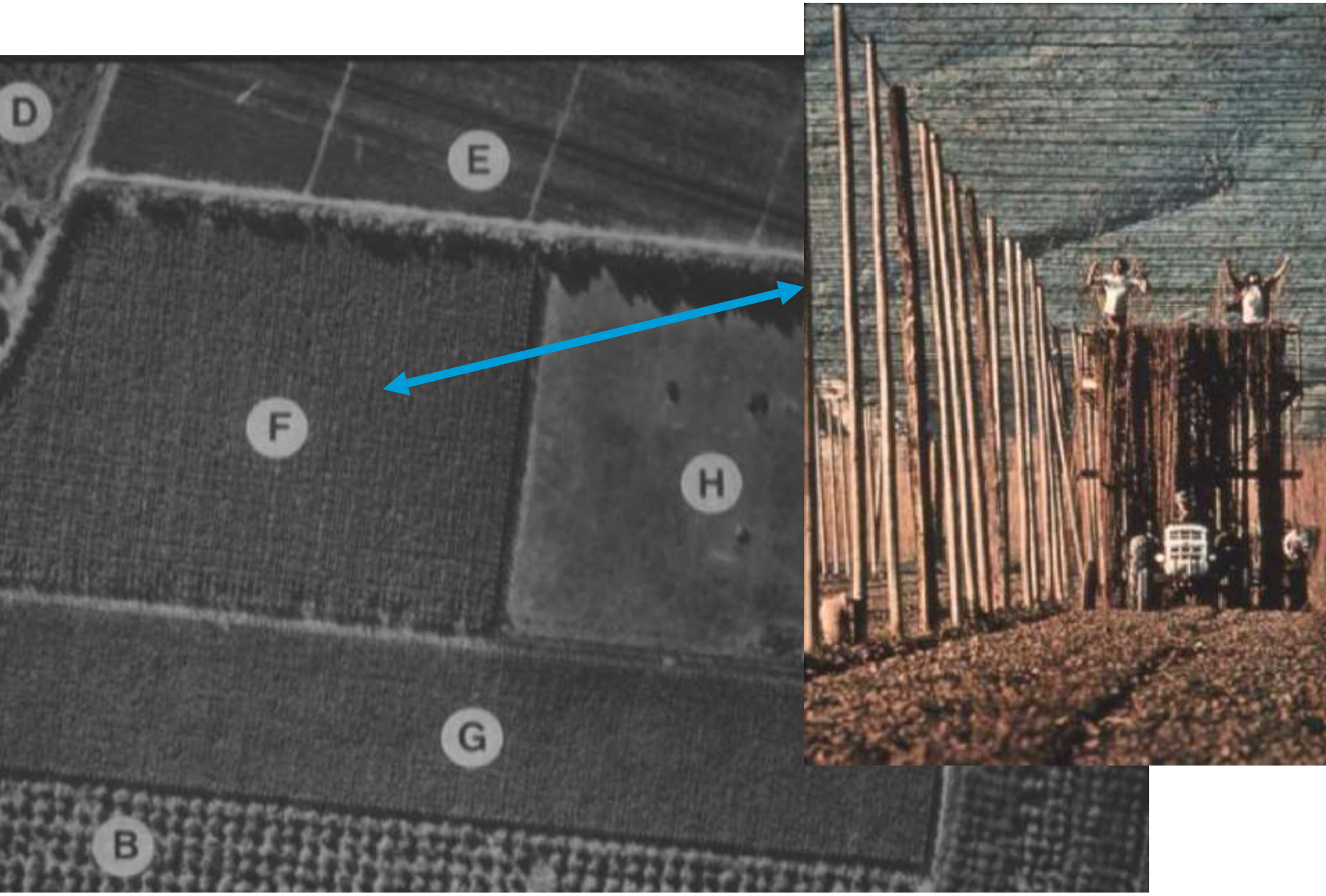


Shadow

OSBORNE
SHERRY & BRANDY

PATTERN & TEXTURE




D
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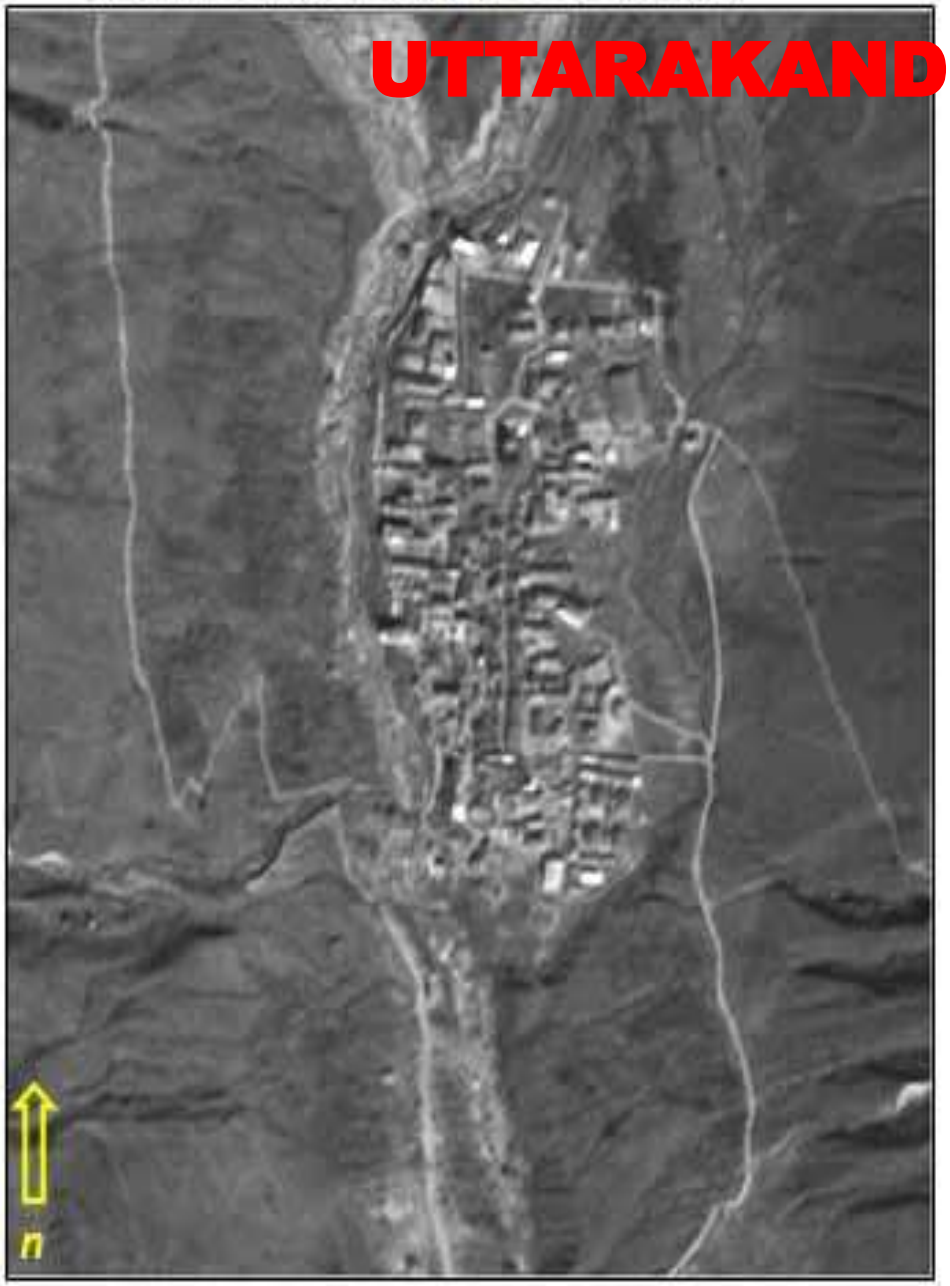
UTTARAKAND FLOODS

CARTOSAT-1 image showing pre-flood situation

CARTOSAT-2A image of 20-June-2013 showing post-flood situation



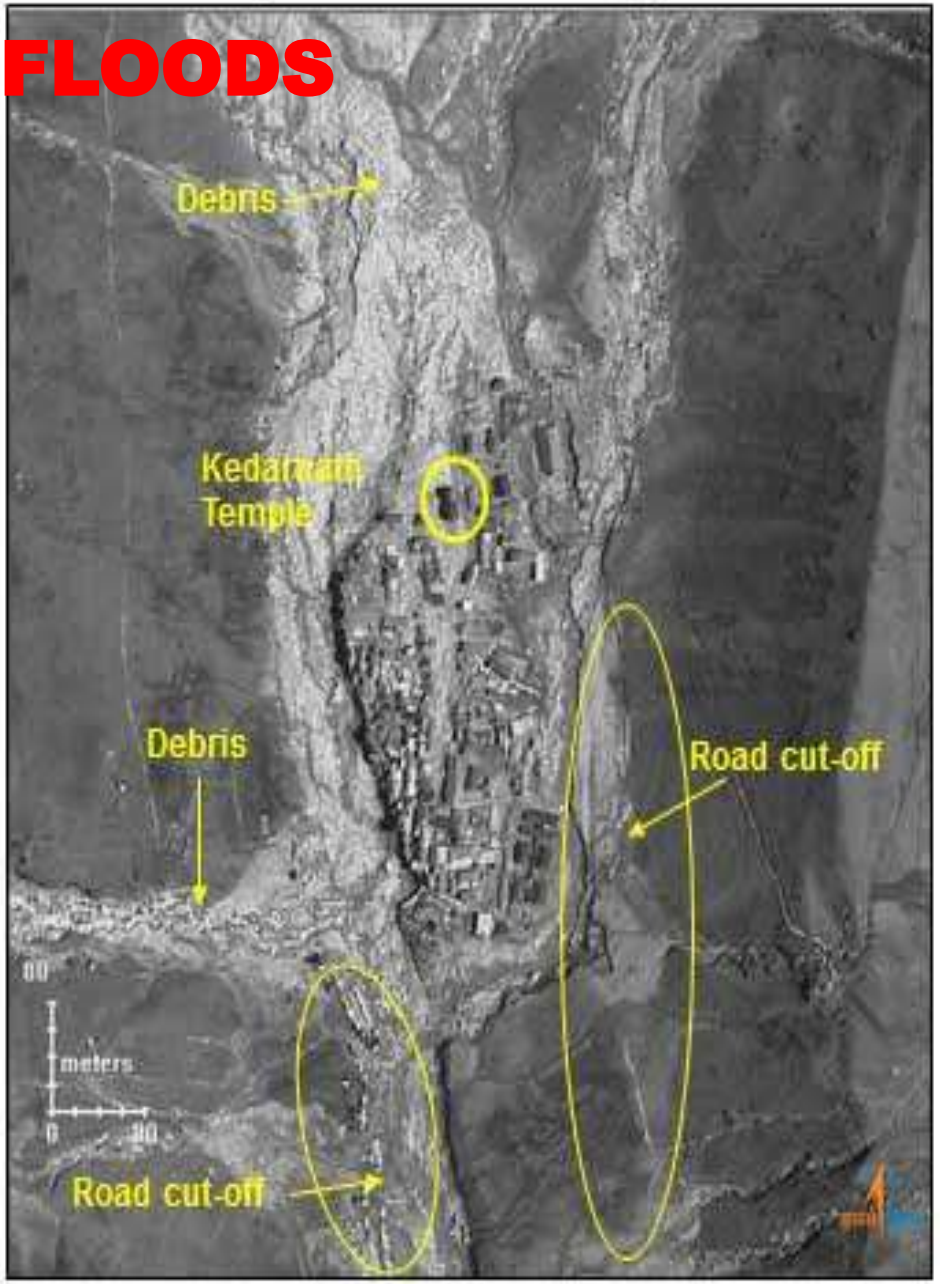
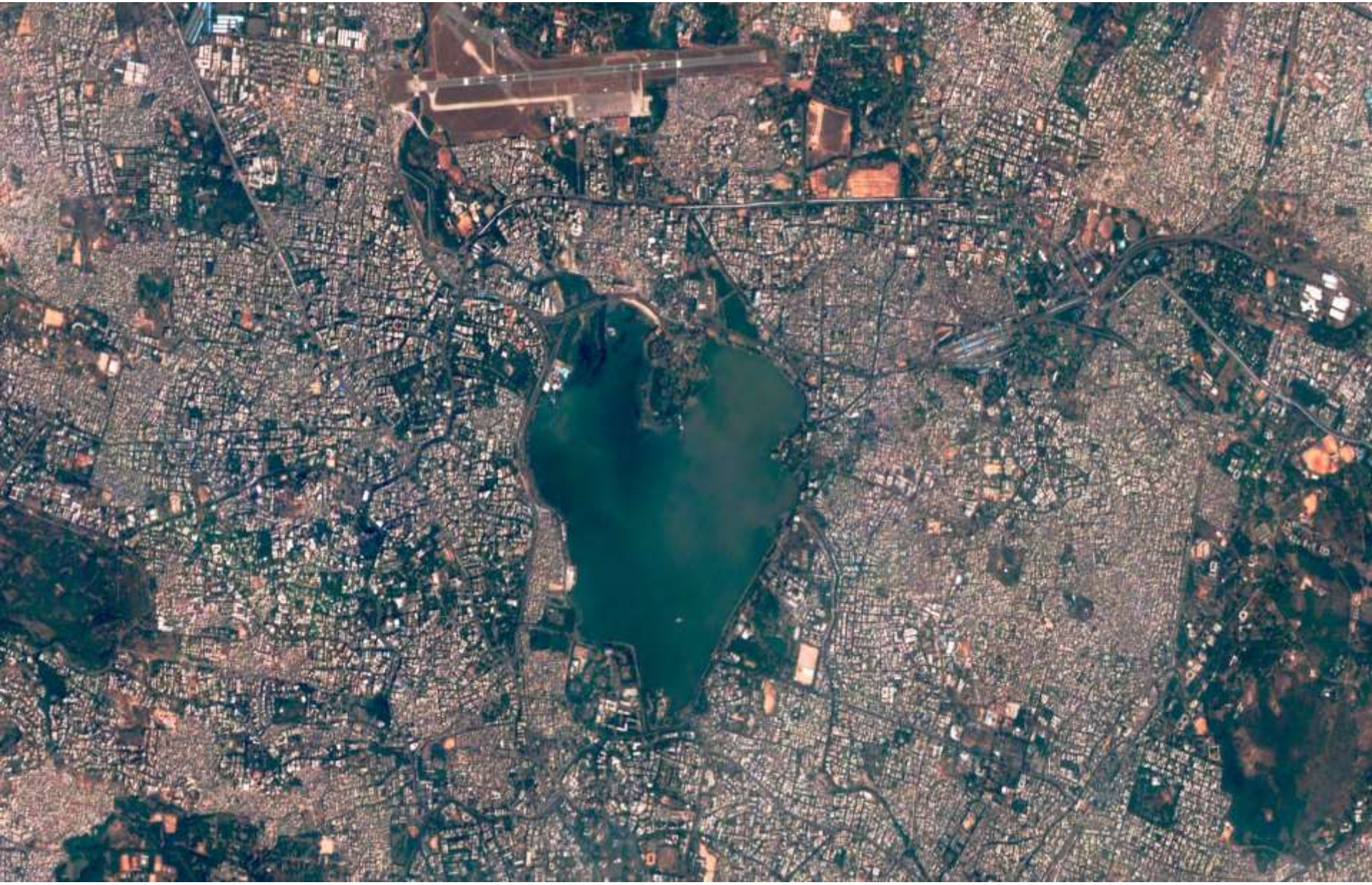
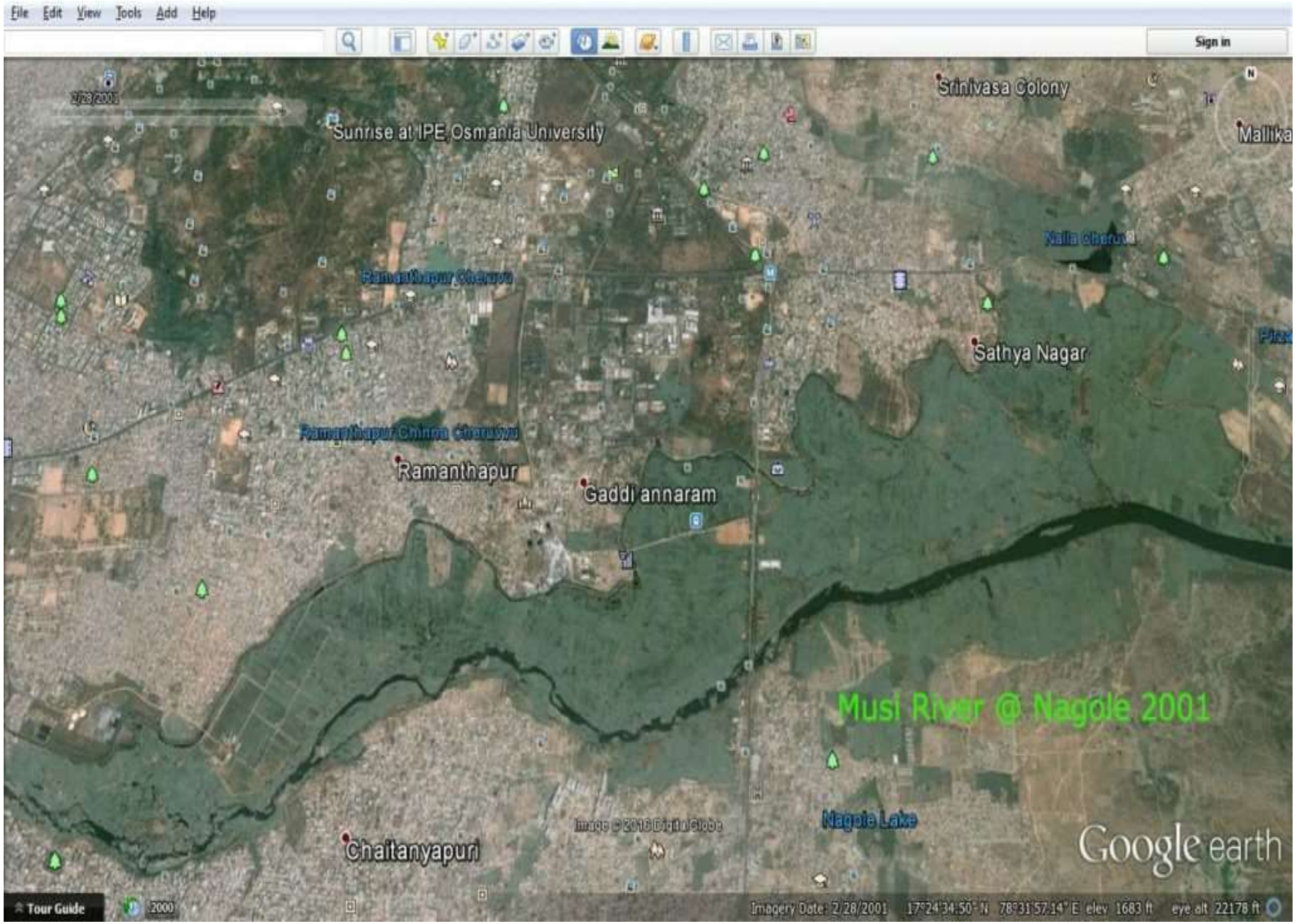


Photo courtesy: National Remote Sensing Centre, Indian Space Research Organisation

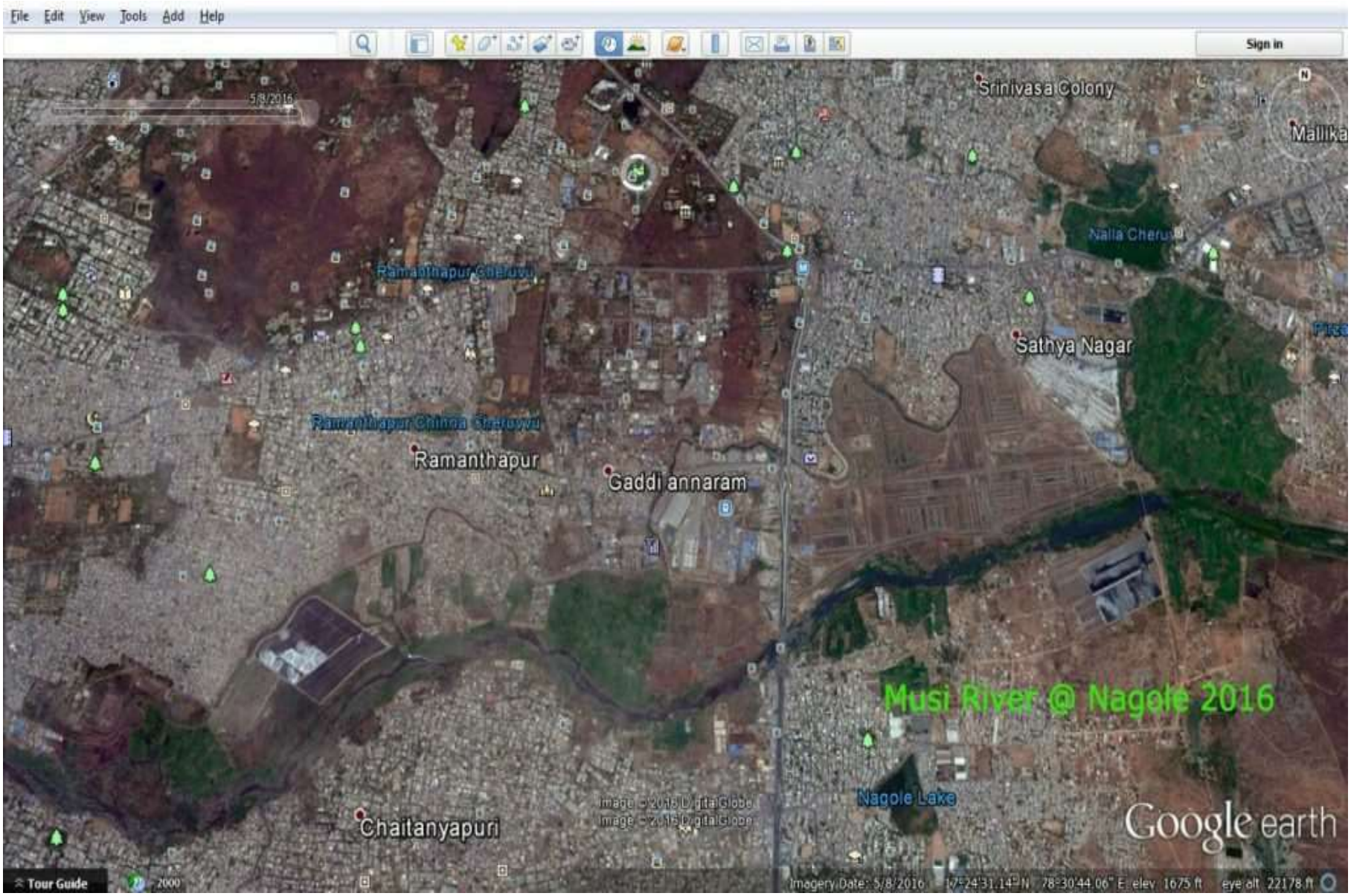
HUSSAINSAGAR LAKE

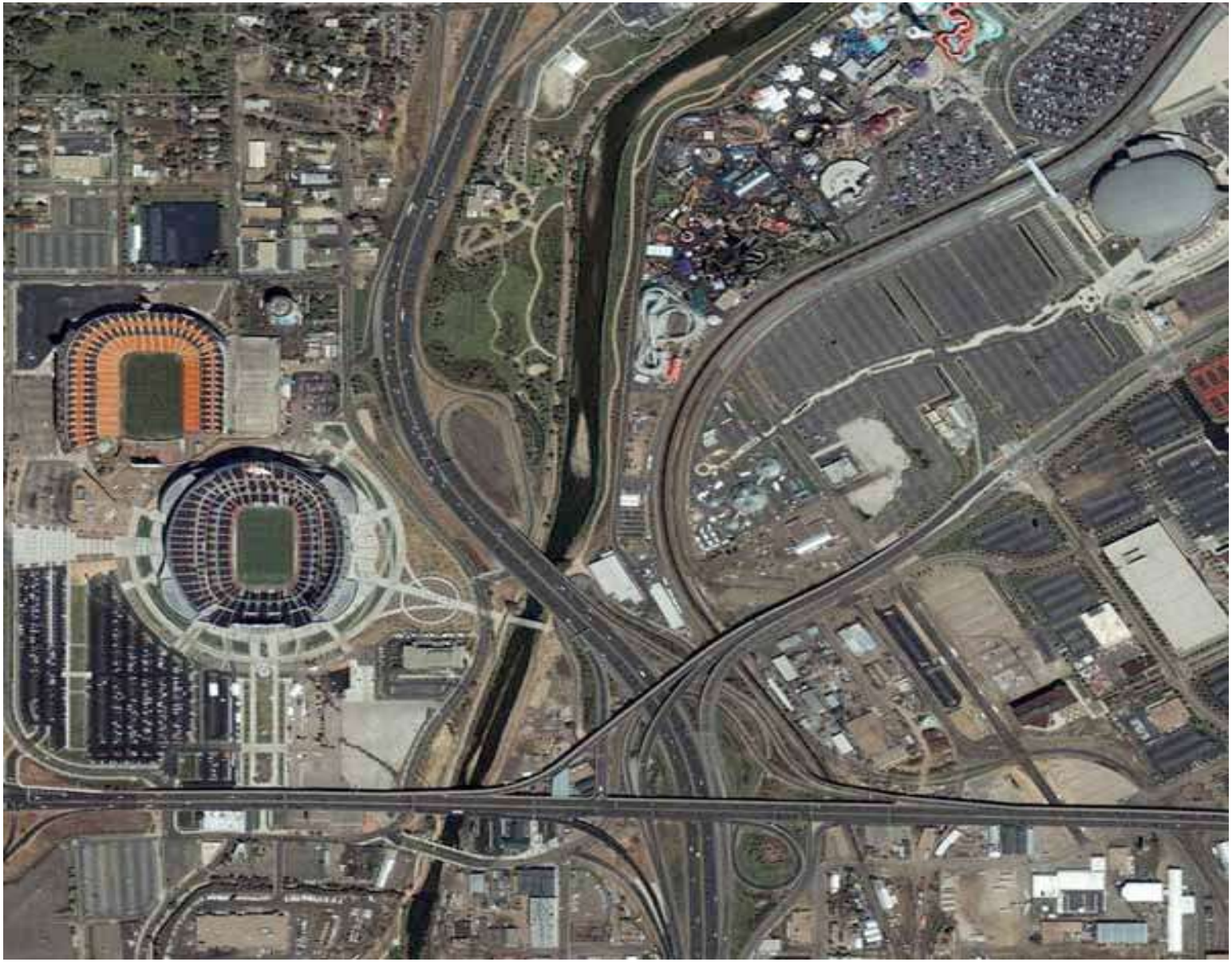


Musi River (2001)



Musi River (2016)





Davenport, Iowa

Flooded stadium

IMAGE CLASSIFICATION

Two major categories of image classification techniques include **unsupervised** (calculated by software) and **supervised** (human-guided) classification.

Unsupervised classification is where the outcomes (groupings of pixels with common characteristics) are based on the software analysis of an image without the user providing sample classes. The computer uses techniques to determine which pixels are related and groups them into classes. The user can specify which algorism the software will use and the desired number of output classes but otherwise does not aid in the classification process. However, the user must have knowledge of the area being classified when the groupings of pixels with common characteristics produced by the computer have to be related to actual features on the ground (such as wetlands, developed areas, coniferous forests, etc.).

Supervised classification is based on the idea that a user can select sample pixels in an image that are representative of specific classes and then direct the image processing software to use these training sites as references for the classification of all other pixels in the image. Training sites (also known as testing sets or input classes) are selected based on the knowledge of the user. The user also sets the bounds for how similar other pixels must be to group them together. These bounds are often set based on the spectral characteristics of the training area, plus or minus a certain increment (often based on “brightness” or strength of reflection in specific spectral bands). The user also designates the number of classes that the image is classified into. Many analysts use a combination of supervised and unsupervised classification processes to develop final output analysis and classified maps.

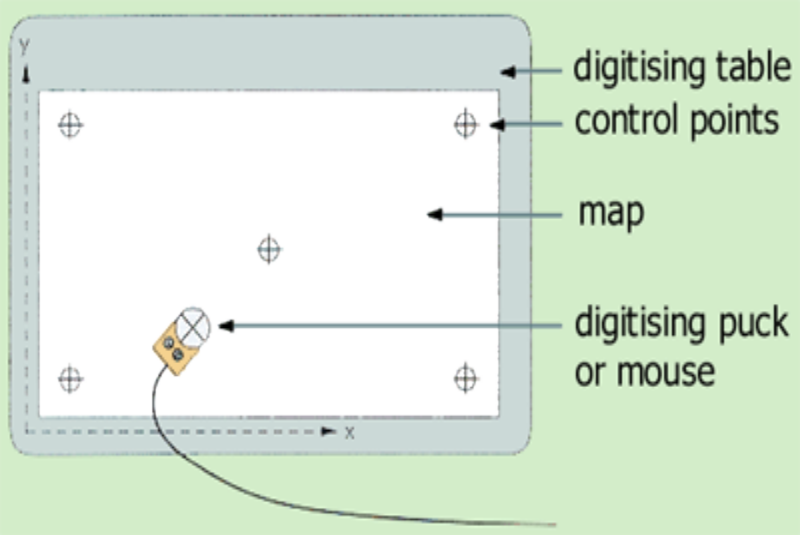
GIS

Experiment 1

ANALOG TO DIGITAL CONVERSION – SCANNING METHODS

Digitizing is the transformation of information from analog format, such as a paper map, to digital format, so that it can be stored and displayed with a computer. Digitizing can be manual, semi-automated (automatically recorded while manually following a line), or fully automated (line following).

Manual digitizing involves an operator using a digitizing table (or tablet) (known as heads-down digitizing), or with the operator using a computer screen (heads-up digitizing). The digitizing table has a fine grid of wires embedded in it that acts as a Cartesian coordinate system. The coordinate may be in plane or geographic coordinates. The procedure involves tracing map features in the form of points, lines or polygons with a mouse (puck) which relays the coordinate of each sample point to be stored in the computer. The tablet and puck acting together with the computer can locate the puck s position relative to reference information provided by the operator.



The digitizer table and puck

GIS Scanning

Another approach is to use a scanner to convert the analogue map into a computer-readable form automatically. One method of scanning is to record data in narrow strips across the data surface, resulting in a raster format. Other scanners can scan lines by following them directly.

The process of conversion of paper maps into digital format usable by computer is known as Scanning. It is used to convert an analog map into a scanned file, which is again converted to vector format through tracing. Scanning automatically captures map features, text and symbols as individual cells or pixels and produces an automated image.

The scanned file shows map features as raster lines (a series of connected pixels) and must be vectorized to complete the process of digitizing. Vectorization is converting raster lines into vector lines in a process known as tracing.

Based on the document, Scanning is mainly of two types:

Black and White Raster Scanning: It is the simplest type of scanning and can be used on line drawings, text or any one colored document. It is used in Archival Drawing Libraries, Electronic Document Distribution and Vectorization Templates.

Grey Scale and Color Raster Scanning: It is used for large size documents. Its applications include capturing images for use in desktop publishing, full color maps, aerial photography, Toposheets and cartographic base data for "high end" mapping system

Maps are often scanned in order to:

- Use digital image data as a background for other (vector) map data
- Convert scanned data to vector data for use in a vector GIS

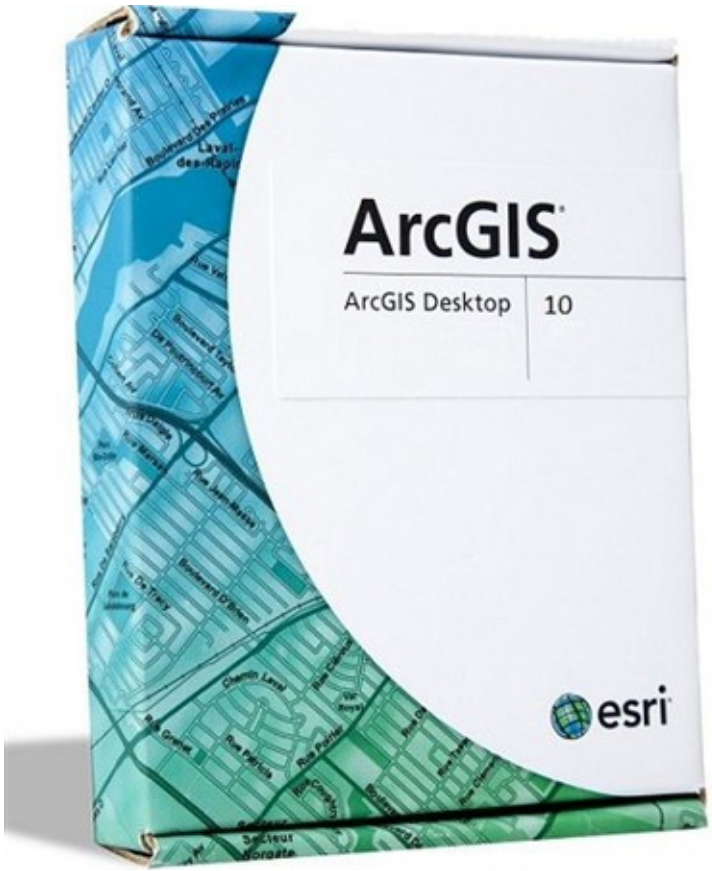
Scanning requires that the map scanned be of high cartographic quality, with clearly defined lines, text and symbols; be clean and have lines of 0.1mm width or wider.

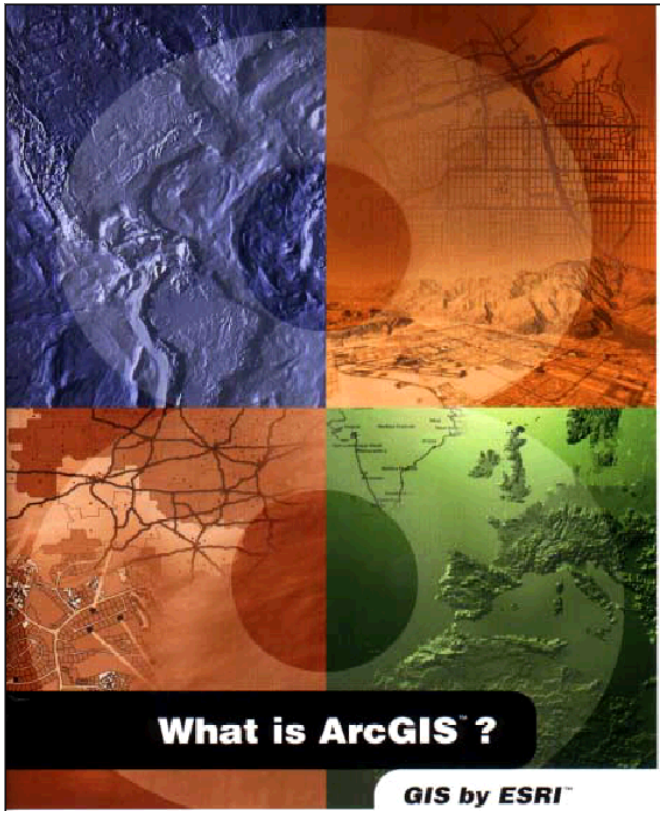
Scanning comprises two operations:

- scanning, which produces a regular grid of pixels with grey-scale levels (usually in the range 0-255)
- binary encoding - to separate the lines from the background using automated feature recognition techniques

Editing of scanned data can include: pattern recognition of shapes and symbol candidates; line thinning and vectorisation; error correction; supplementing missing data, and forming topology.

Introduction to ArcGIS





Introduction to ArcGIS

- *How data are stored in ArcGIS*
- Components of ArcGIS – ArcMap, ArcCatalog and ArcToolbox
- Extensions of ArcGIS – spatial analyst, geostatistical analyst and 3D analyst

ESRI GIS Development

Arc/Info (coverage model)

Versions 1-7 from 1980 – 1999

Arc Macro Language (AML)

100,000 licenses
1,000,000 users as of 2002

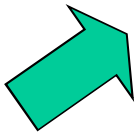
ArcGIS (geodatabase model)

Version 8.0, …, 8.3 from 2000
– Visual Basic for Applications

ArcView (shapefile model)

Versions 1-3 from 1994 – 1999

Avenue scripting language



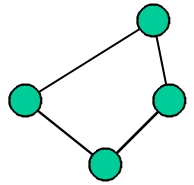
Geographic Data Models

All geographic information systems are built using formal models that describe how things are located in space. A formal model is an abstract and well-defined system of concepts. A geographic data model defines the vocabulary for describing and reasoning about the things that are located on the earth. Geographic data models serve as the foundation on which all geographic information systems are built.

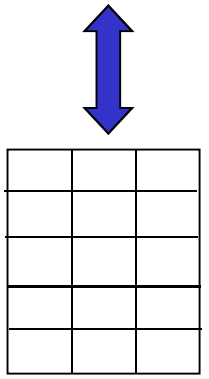
Scott Morehouse, Preface to “Modeling our World”

Data Models

- A **geographic data model** is a structure for organizing geospatial data so that it can be easily stored and retrieved.

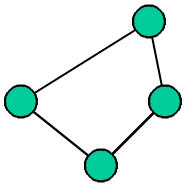


Geographic coordinates



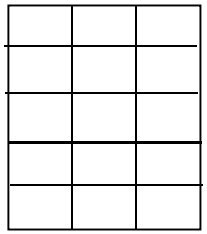
Tabular attributes

File-based Data Models



Arc

Geographic coordinates and attributes are stored in separate but linked files

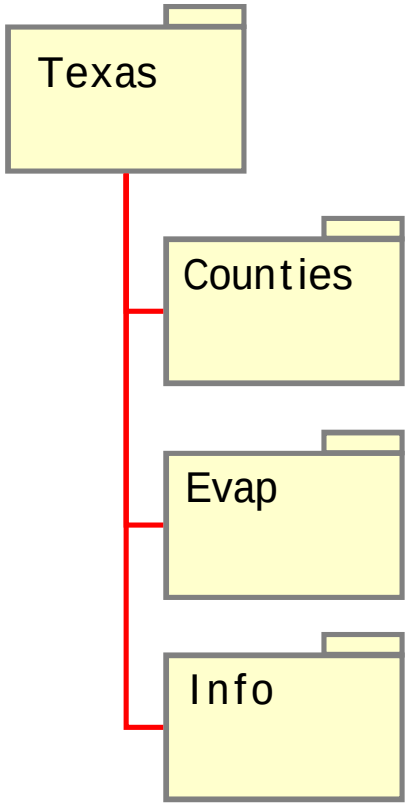


Info

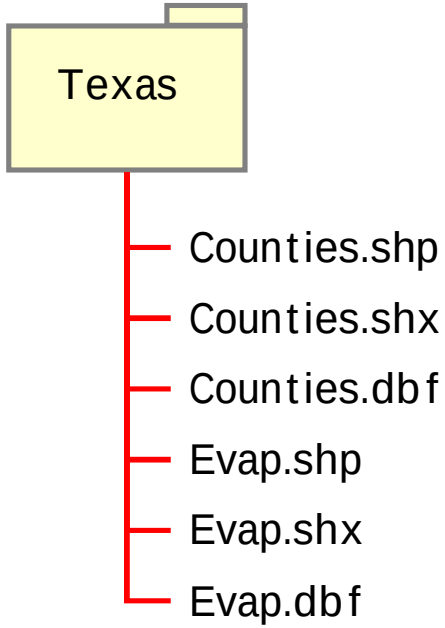
- Coverages
  - Developed for workstation Arc/Info ~ 1980
  - Complex structure, proprietary format
  - Attributes in Info tables
- Shapefiles
  - Developed for ArcView ~ 1993
  - Simpler structure in public domain
  - Attributes in dBase (.dbf) tables

Storing Data

Coverages



Shapefiles

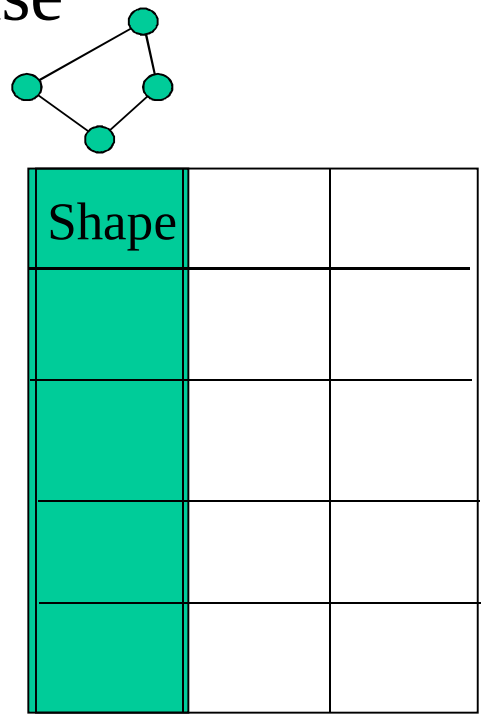


Storing Data

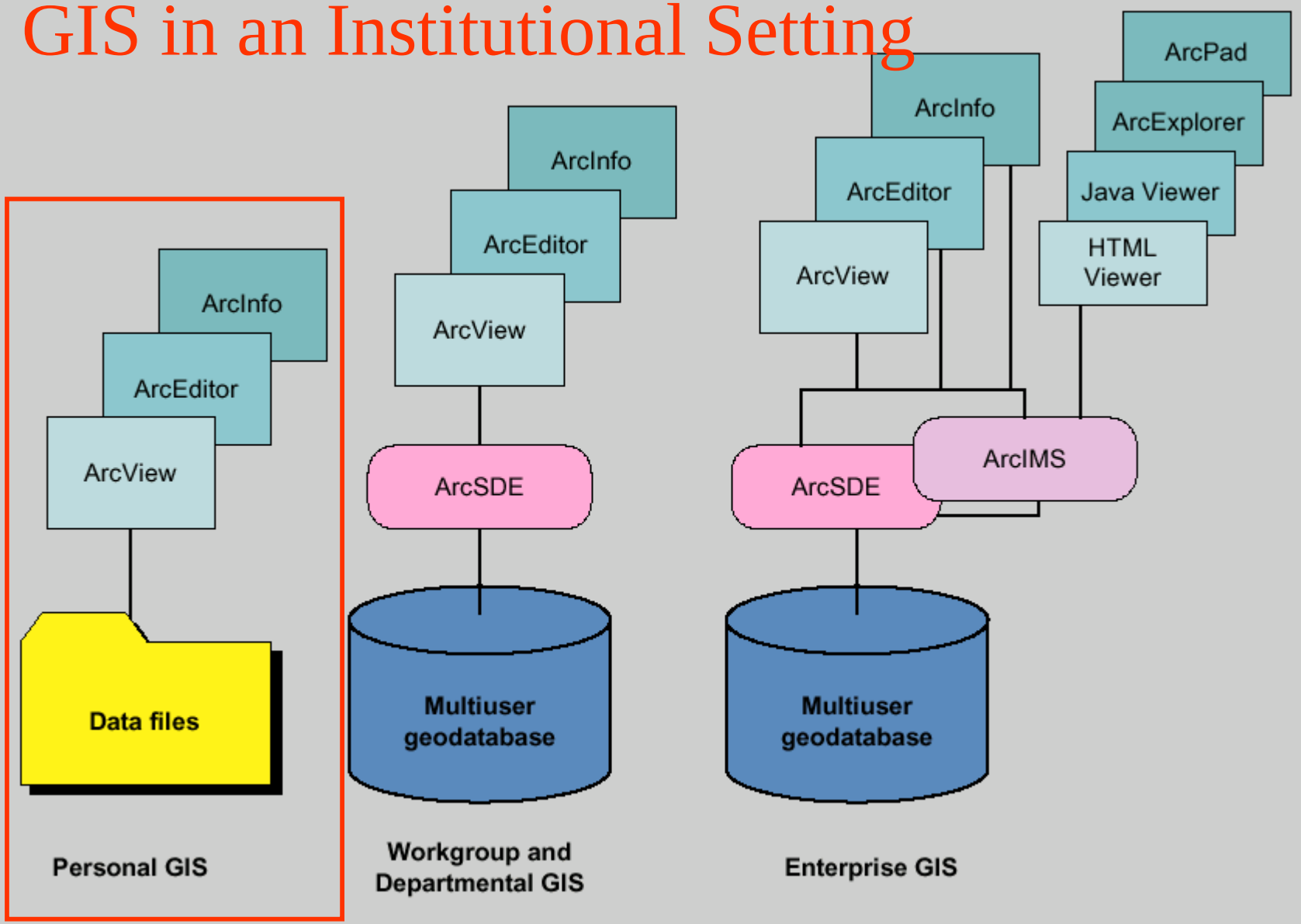
- **Coverages and Shapefiles**
  - Coverages are stored partially in their own folder and partially in the common INFO folder. Shapefiles are stored in three to five files (with extensions .shp, .shx, .dbf, .sbx and .sbn).
  - Coverages store common boundaries between polygons only once, to avoid redundancy. Shapefiles store all the geometry of each polygon regardless of redundancy.
  - Coverage features are single lines or single polygons. Shapefiles allow features to have multiple, disconnected, intersecting and overlapping components.

Geodatabase model

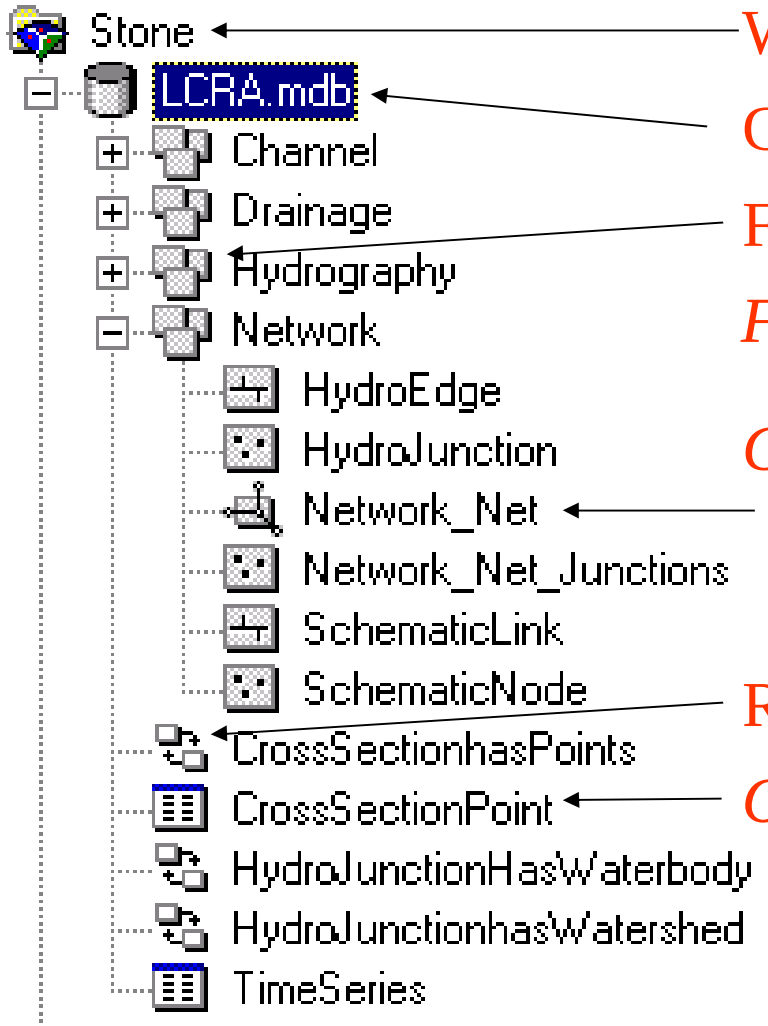
- Stores geographic coordinates as one attribute (shape) in a relational database table
- Uses MS Access for “Personal Geodatabase” (single user)
- Uses Oracle, Sybase, Ingress or other commercial relational databases for “Enterprise Geodatabases” (many simultaneous users)



GIS in an Institutional Setting



ArcGIS Geodatabase

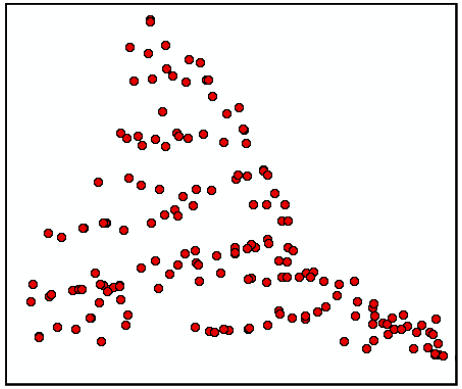


Workspace

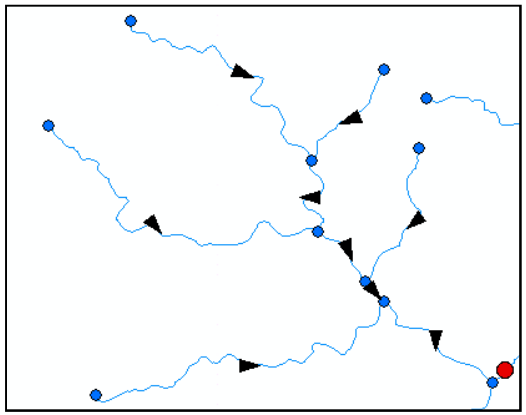
Geodatabase

Feature Dataset

Feature Class



Geometric Network



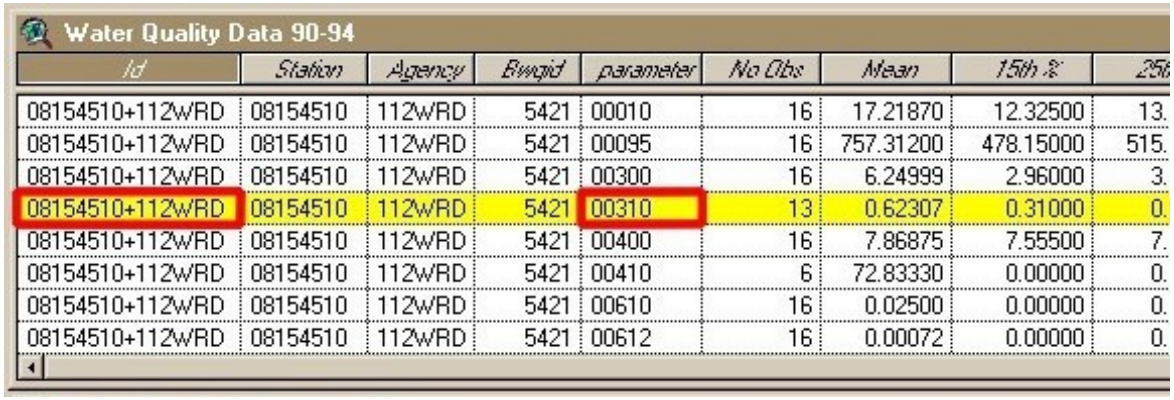
Relationship

Object Class

OBJECTID*	CrossSectionID*	CrossSectionM	Elevation
3931	Colorado/Lbj Middle 06	3464	801
3932	Colorado/Lbj Middle 06	3482	800
3933	Colorado/Lbj Middle 06	3495	800
3934	Colorado/Lbj Middle 06	3511	799
3935	Colorado/Lbj Middle 06	3527	799

Object Class

- An **object class** is a collection of *objects* in *tabular format* that have the same behavior and the same attributes.



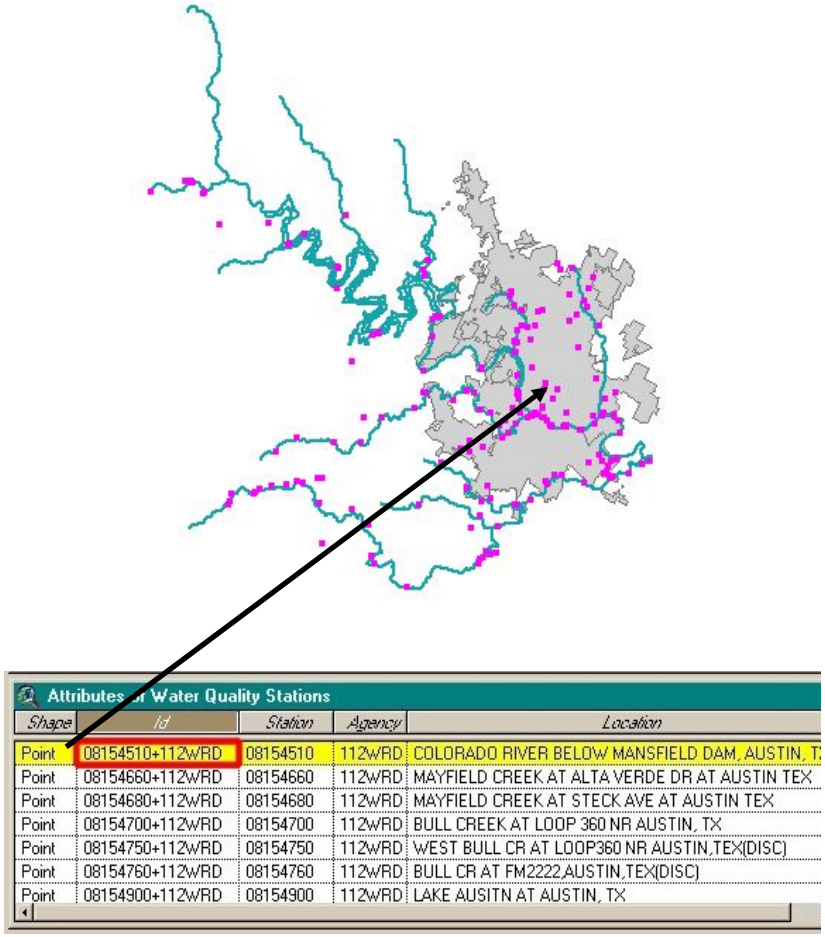
Water Quality Data 90-94

Id	Station	Agency	Bwqid	parameter	No Obs	Mean	15th %	25t
08154510+112WRD	08154510	112WRD	5421	00010	16	17.21870	12.32500	13.
08154510+112WRD	08154510	112WRD	5421	00095	16	757.31200	478.15000	515.
08154510+112WRD	08154510	112WRD	5421	00300	16	6.24999	2.96000	3.
08154510+112WRD	08154510	112WRD	5421	00310	13	0.62307	0.31000	0.
08154510+112WRD	08154510	112WRD	5421	00400	16	7.86875	7.55500	7.
08154510+112WRD	08154510	112WRD	5421	00410	6	72.83330	0.00000	0.
08154510+112WRD	08154510	112WRD	5421	00610	16	0.02500	0.00000	0.
08154510+112WRD	08154510	112WRD	5421	00612	16	0.00072	0.00000	0.

An object class is a table that has a unique identifier (ObjectID) for each record

Feature Class

- A **feature class** is a collection of *geographic objects* in *tabular format* that have the same behavior and the same attributes.



Feature Class = Object class + spatial coordinates

Relationship

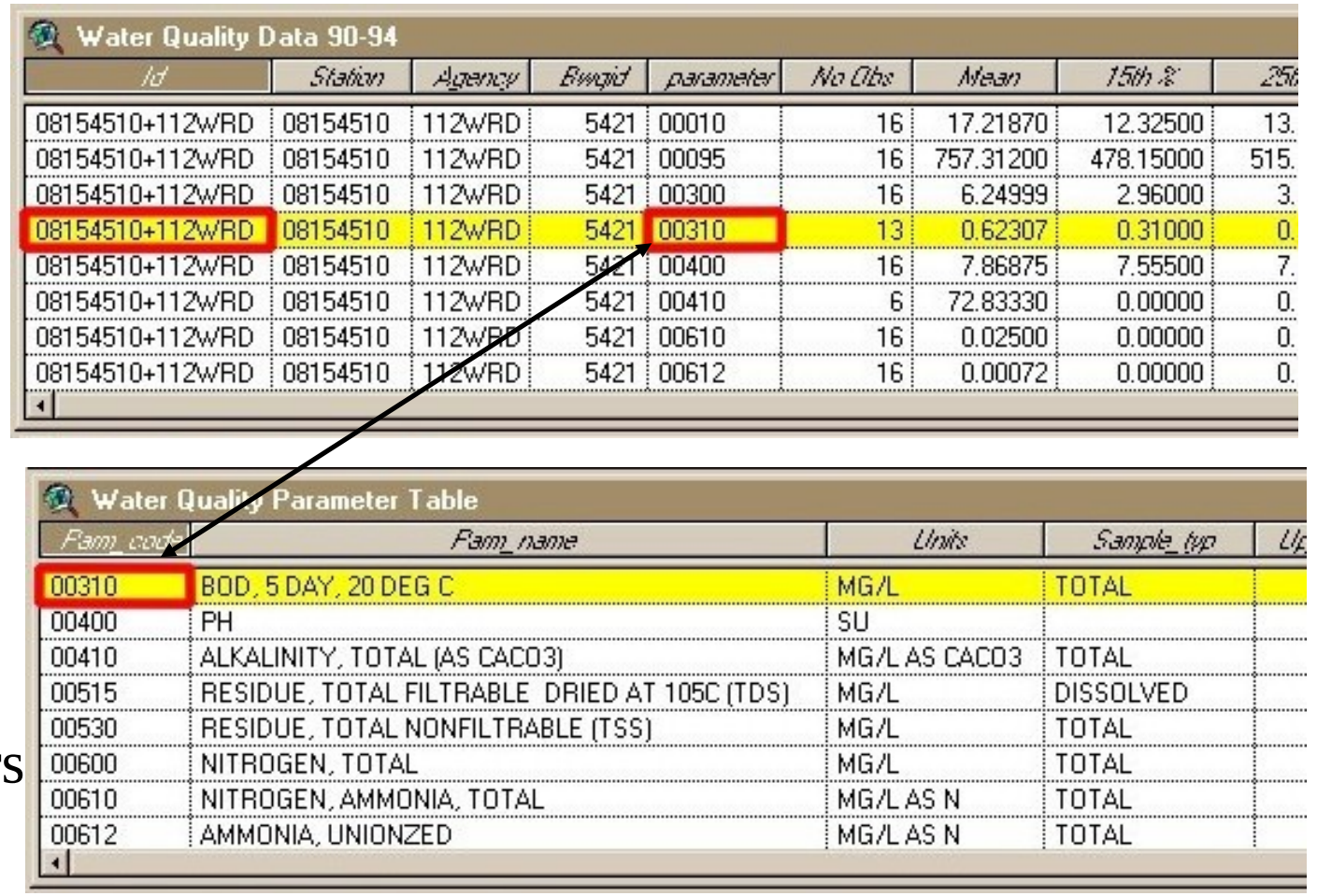
- A **relationship** is an association or link between two objects in a database.
- A relationship can exist between spatial objects (features in feature classes), non-spatial objects (objects in object classes), or between spatial and non-spatial objects.

Relationship

Relationship between non-spatial objects

Water Quality Data

Water Quality Parameters



Water Quality Data 90-94

Id	Station	Agency	Bmpid	parameter	No Obs	Mean	15th %	25t
08154510+112WRD	08154510	112WRD	5421	00010	16	17.21870	12.32500	13.
08154510+112WRD	08154510	112WRD	5421	00095	16	757.31200	478.15000	515.
08154510+112WRD	08154510	112WRD	5421	00300	16	6.24999	2.96000	3.
08154510+112WRD	08154510	112WRD	5421	00310	13	0.62307	0.31000	0.
08154510+112WRD	08154510	112WRD	5421	00400	16	7.86875	7.55500	7.
08154510+112WRD	08154510	112WRD	5421	00410	6	72.83330	0.00000	0.
08154510+112WRD	08154510	112WRD	5421	00610	16	0.02500	0.00000	0.
08154510+112WRD	08154510	112WRD	5421	00612	16	0.00072	0.00000	0.

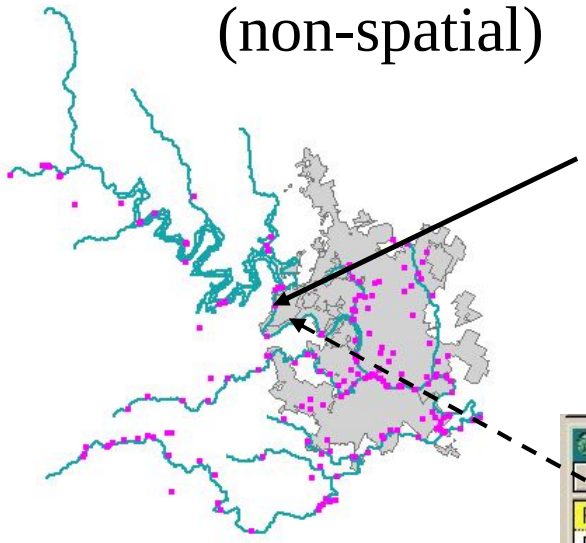
Water Quality Parameter Table

Parm_code	Parm_name	Units	Sample_typ	Up
00310	BOD, 5 DAY, 20 DEG C	MG/L	TOTAL	
00400	PH	SU		
00410	ALKALINITY, TOTAL (AS CACO3)	MG/L AS CACO3	TOTAL	
00515	RESIDUE, TOTAL FILTRABLE DRIED AT 105C (TDS)	MG/L	DISSOLVED	
00530	RESIDUE, TOTAL NONFILTRABLE (TSS)	MG/L	TOTAL	
00600	NITROGEN, TOTAL	MG/L	TOTAL	
00610	NITROGEN, AMMONIA, TOTAL	MG/L AS N	TOTAL	
00612	AMMONIA, UNIONZED	MG/L AS N	TOTAL	

Relationship

Relationship between spatial and non-spatial objects

Water quality data
(non-spatial)



Measurement station
(spatial)

Water Quality Data 90-94

Id	Station	Agency	Bwqid	parameter	No Obs	Mean	15th %	25t
08154510+112WRD	08154510	112WRD	5421	00010	16	17.21870	12.32500	13.
08154510+112WRD	08154510	112WRD	5421	00095	16	757.31200	478.15000	515.
08154510+112WRD	08154510	112WRD	5421	00300	16	6.24999	2.96000	3.
08154510+112WRD	08154510	112WRD	5421	00310	13	0.62307	0.31000	0.
08154510+112WRD	08154510	112WRD	5421	00400	16	7.86875	7.55500	7.
08154510+112WRD	08154510	112WRD	5421	00410	6	72.83330	0.00000	0.
08154510+112WRD	08154510	112WRD	5421	00610	16	0.02500	0.00000	0.
08154510+112WRD	08154510	112WRD	5421	00612	16	0.00072	0.00000	0.

Attributes of Water Quality Stations

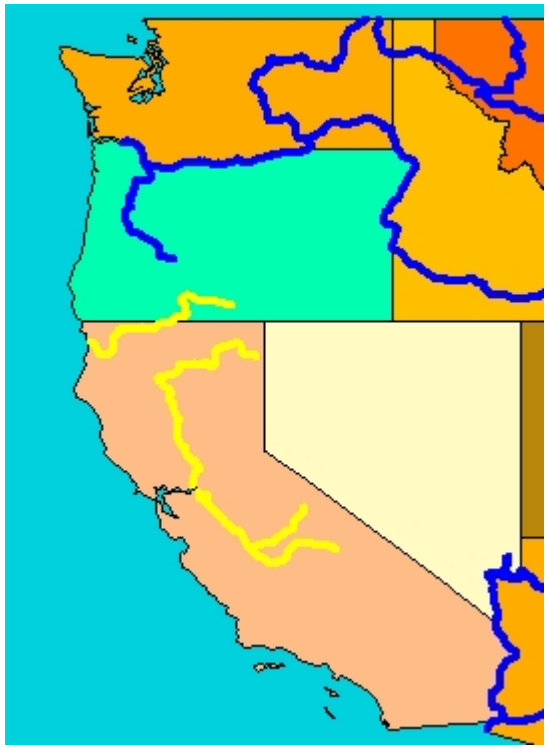
Shape	Id	Station	Agency	Location
Point	08154510+112WRD	08154510	112WRD	COLORADO RIVER BELOW MANSFIELD DAM, AUSTIN, T
Point	08154660+112WRD	08154660	112WRD	MAYFIELD CREEK AT ALTA VERDE DR AT AUSTIN TEX
Point	08154680+112WRD	08154680	112WRD	MAYFIELD CREEK AT STECK AVE AT AUSTIN TEX
Point	08154700+112WRD	08154700	112WRD	BULL CREEK AT LOOP 360 NR AUSTIN, TX
Point	08154750+112WRD	08154750	112WRD	WEST BULL CR AT LOOP360 NR AUSTIN,TEX(DISC)
Point	08154760+112WRD	08154760	112WRD	BULL CR AT FM2222,AUSTIN,TEX(DISC)
Point	08154900+112WRD	08154900	112WRD	LAKE AUSITN AT AUSTIN, TX

Relationship

Relationship between spatial objects

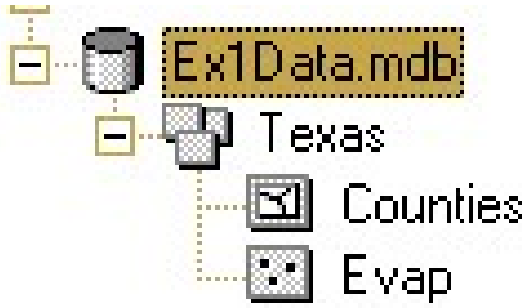
Rivers that lie within California

Two spatial objects: rivers and California



Geodatabase and Feature Dataset

- A **geodatabase** is a *relational database* that stores *geographic information*.
- A **feature dataset** is a collection of feature classes that share the same *spatial reference frame*.



Geodatabase and Feature Dataset

- *Why **geodatabases***?

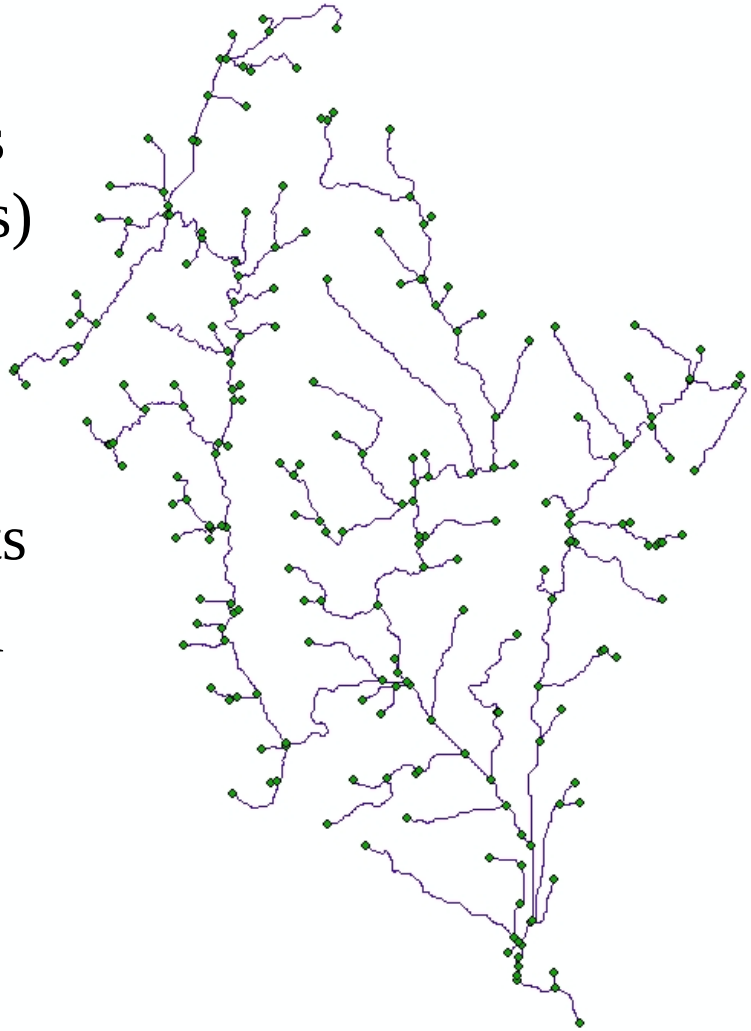
  To establish and store *relationships* based on tabular information.

- *Why **feature datasets***?

  To establish and store *relationships* based on geographic information.

Network

- A **network** is a set of edges (lines) and junctions (points) that are topologically connected to each other.
- Each edge knows which junctions are at its endpoints
- Each junction knows which edges it connects to

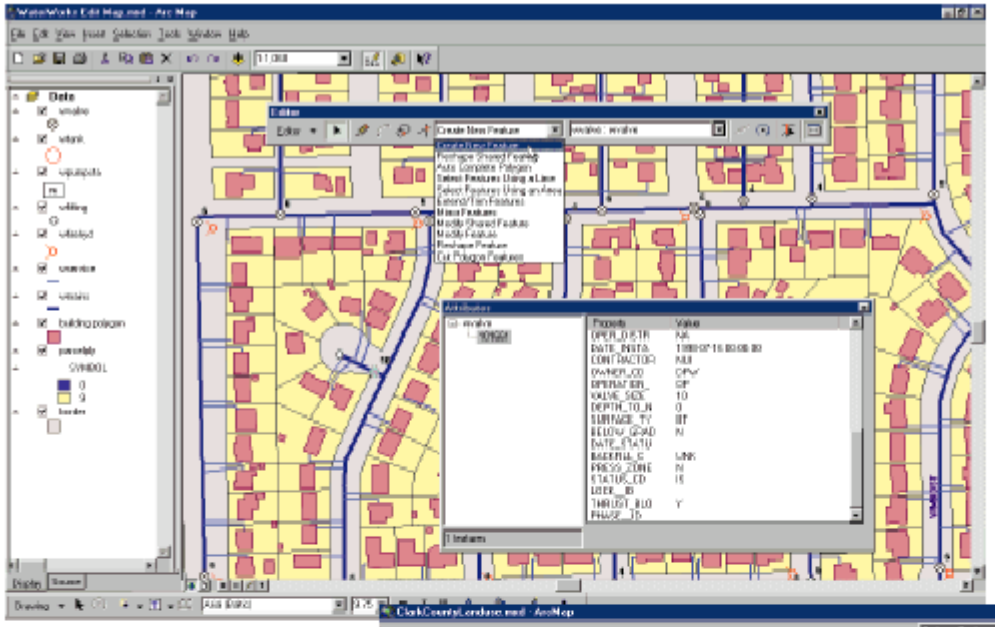


Introduction to ArcGIS

- How data are stored in ArcGIS
- *Components of ArcGIS – ArcMap, ArcCatalog and ArcToolbox*
- Extensions of ArcGIS – spatial analyst, geostatistical analyst and 3D analyst

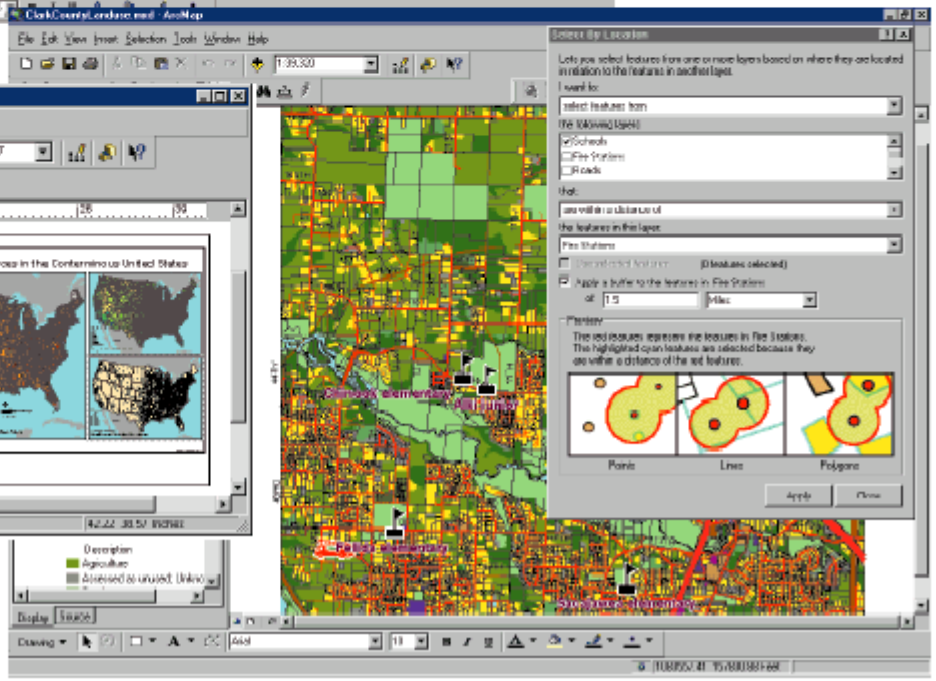
Arc Map

View and edit data



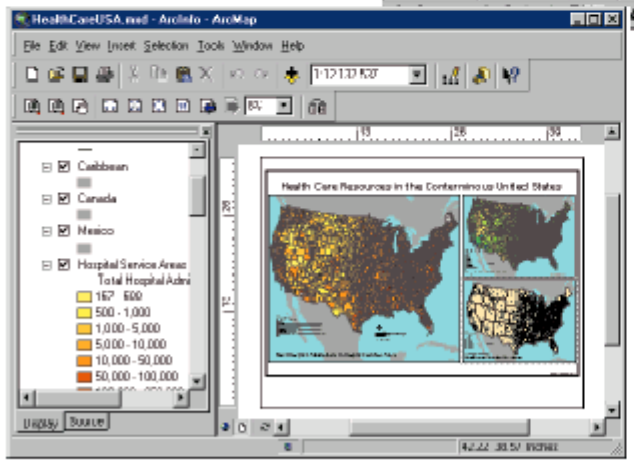
Edit data.

Analyze data (Geoprocessing)



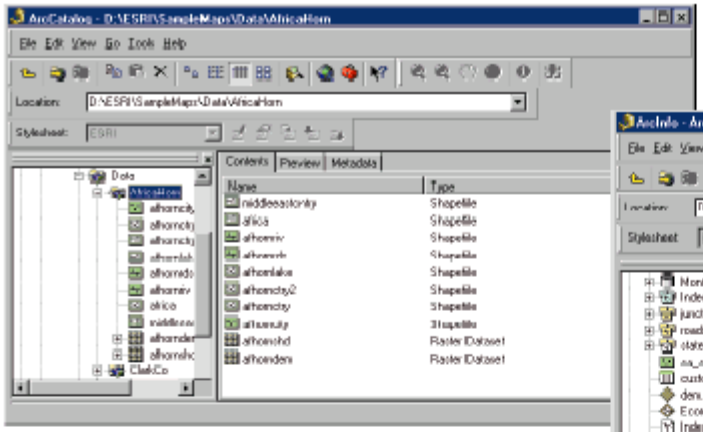
Analyze data.

Create maps



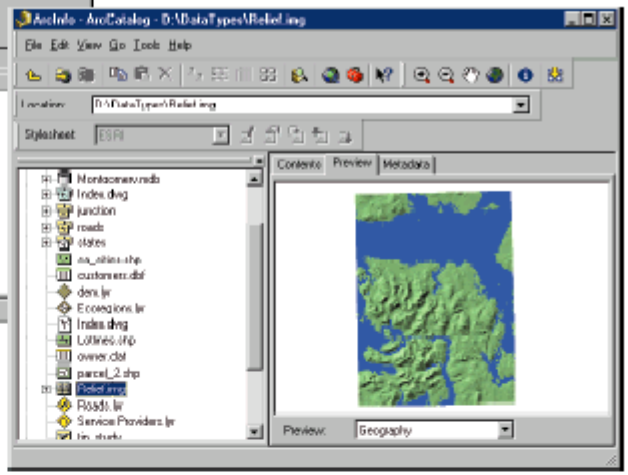
Design and create publication-quality maps.

Arc Catalog



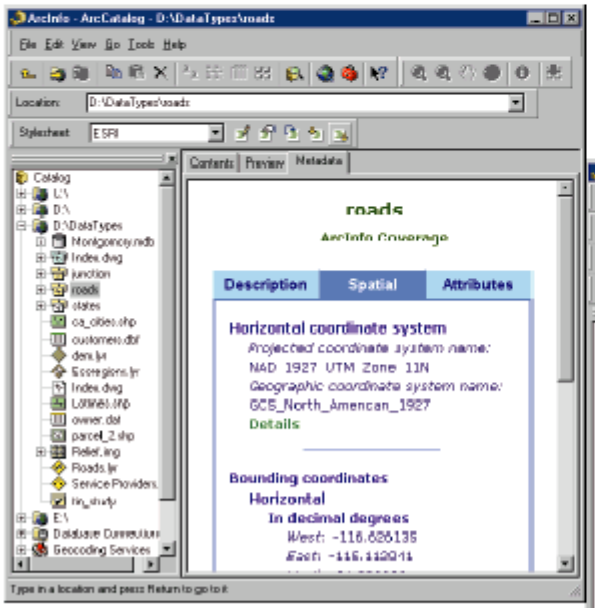
View your GIS data holdings.

View data
(like Windows Explorer)



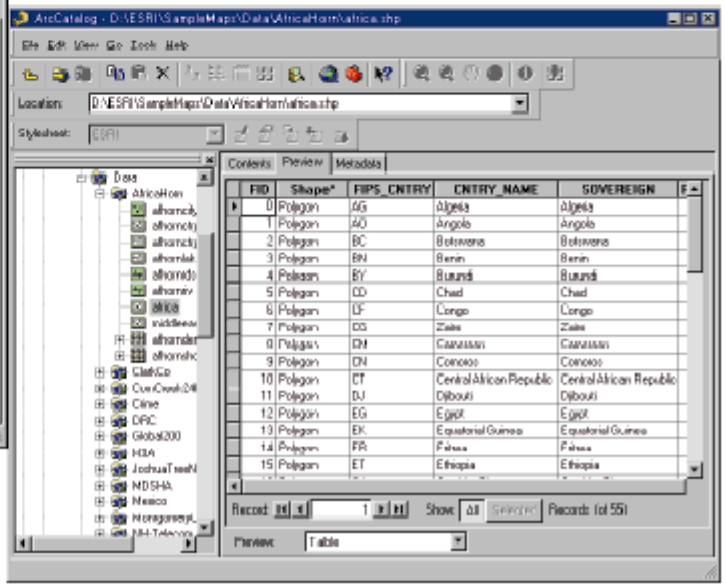
Preview geographic information.

Graphical previews



View and edit metadata.

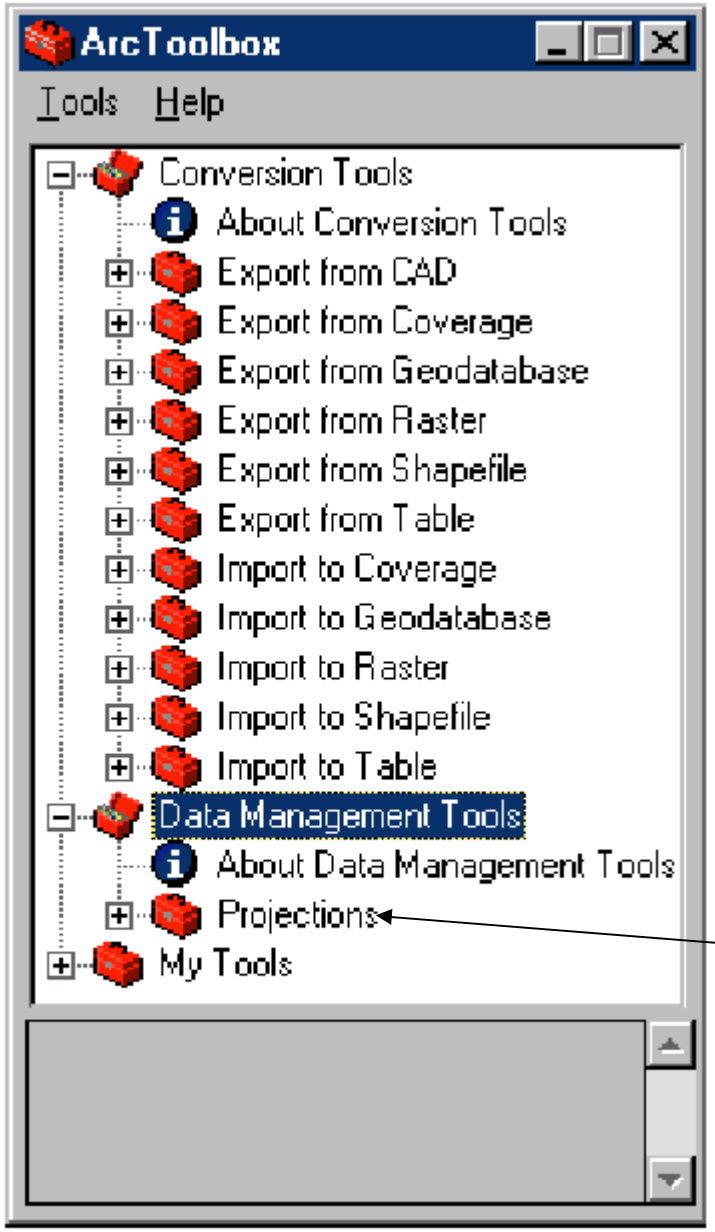
Metadata



Work with tables.

Tables

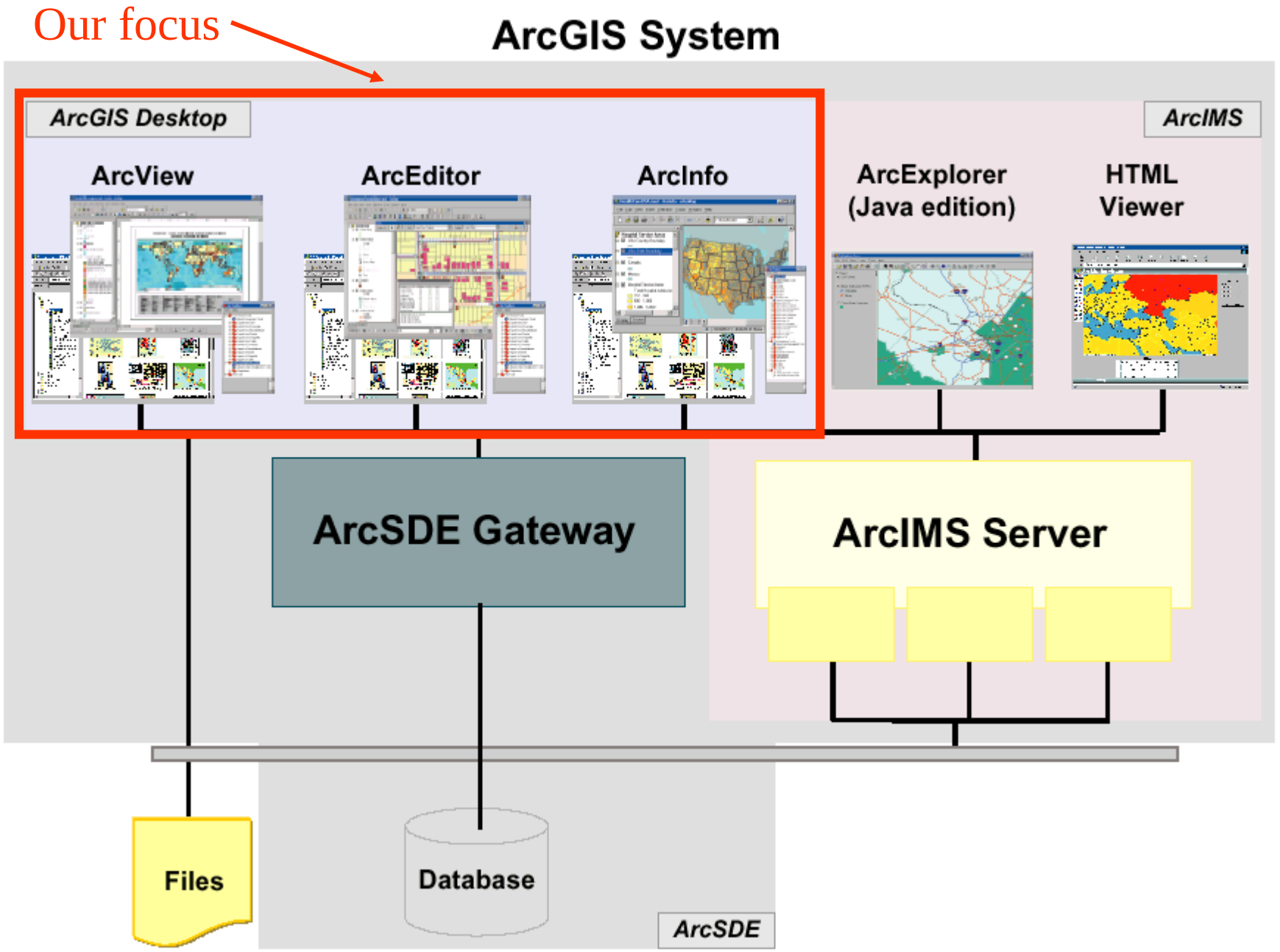
Arc Toolbox



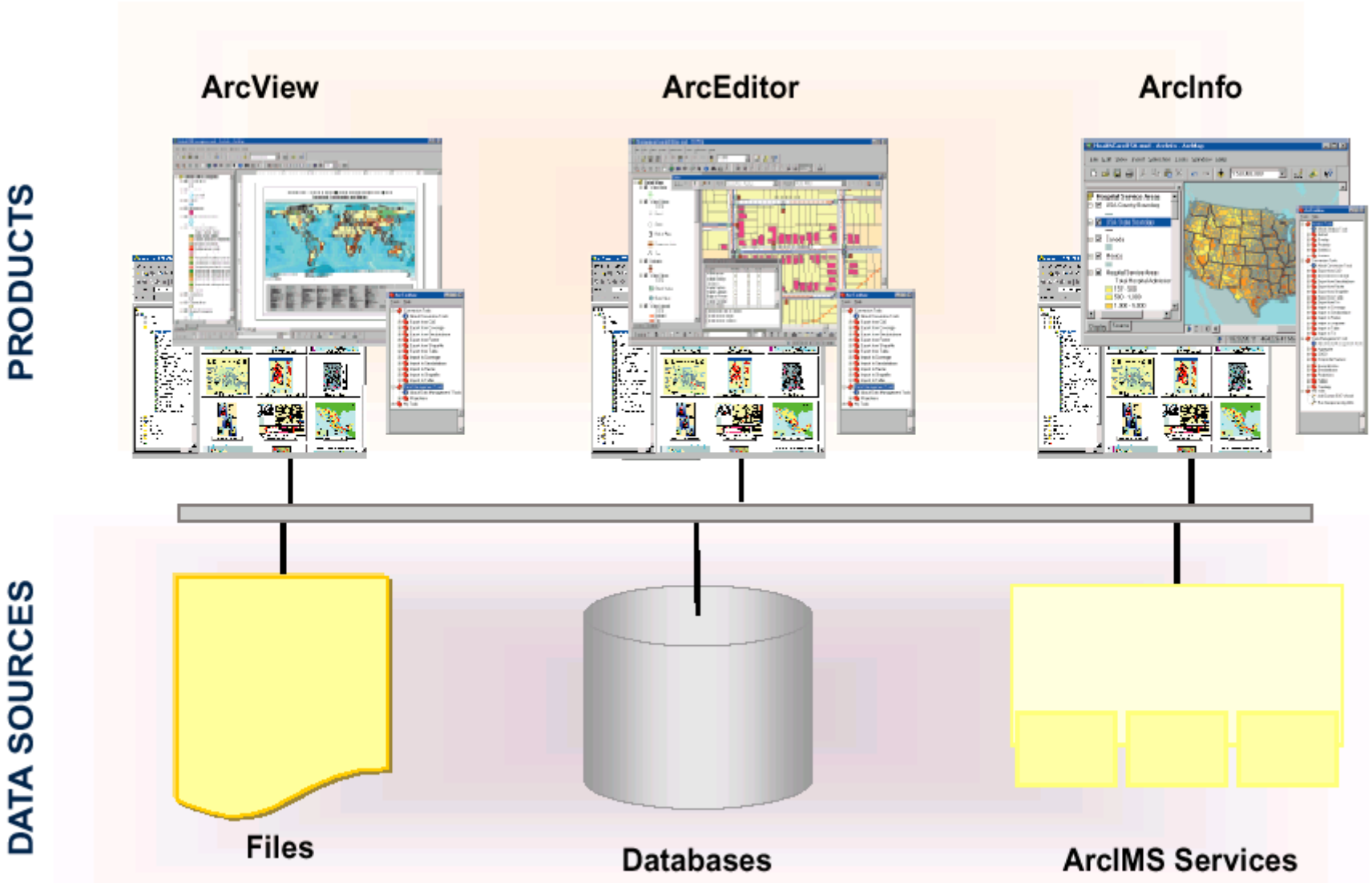
ArcToolbox for ArcView and ArcEditor contains over 20 commonly used tools for data conversion and management.

Map Projections

Tools for commonly used tasks


Our focus
ArcGIS System
ArcGIS Desktop
ArcIMS
ArcView
ArcEditor
ArcInfo
ArcExplorer
(Java edition)
HTML
Viewer
ArcSDE Gateway
ArcIMS Server
Files
Database
ArcSDE

ArcGIS Desktop

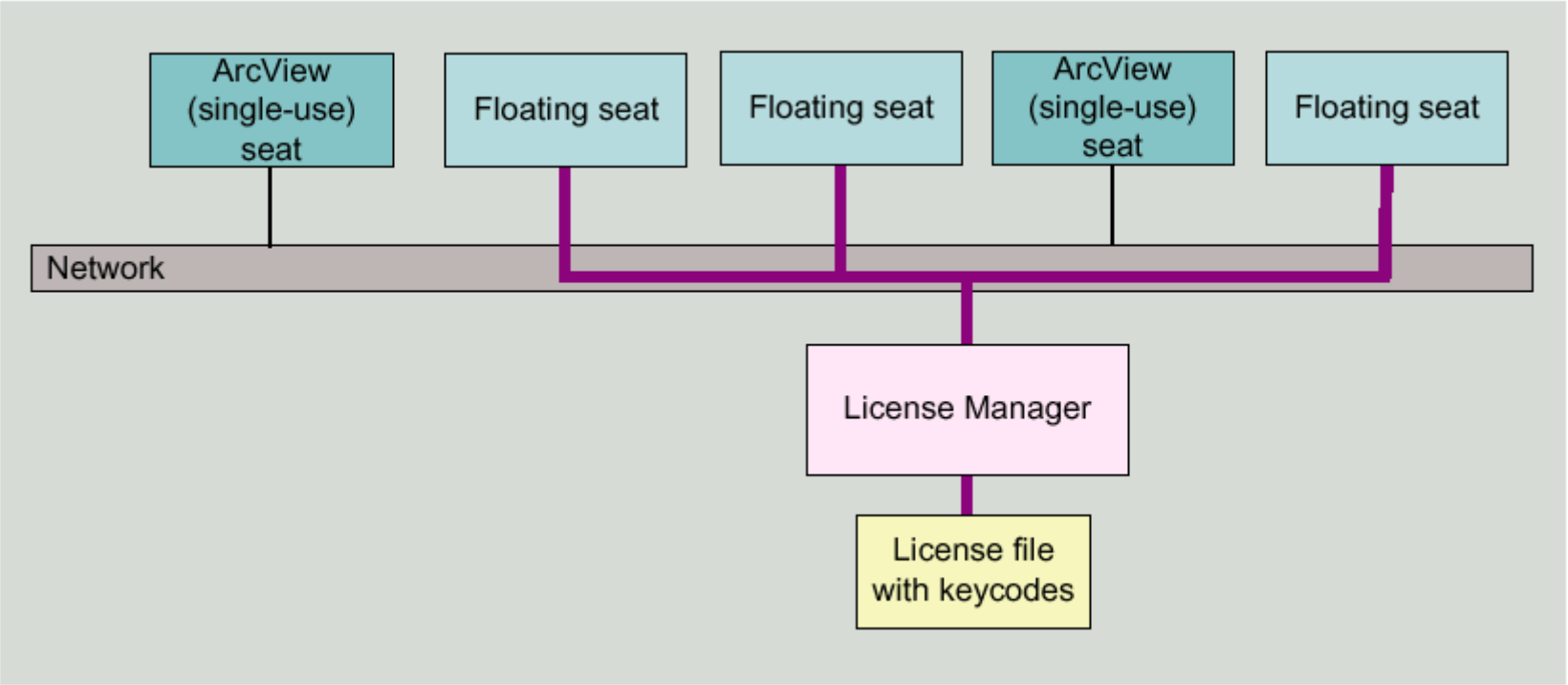


The ArcGIS Desktop is available in three options: ArcView, ArcEditor, and ArcInfo. All three share a common user interface and developer tools and work with the same data.

Levels of ArcGIS

- ArcView – View data and do edits on shape files and simple personal geodatabases
- ArcEditor – do more complex edits on enterprise geodatabases
- ArcInfo – the full system, with access to workstation ArcInfo (i.e. ArcInfo version 7) as well

Licenses and Keycodes



License manager keeps track of number of simultaneous users and limits them to allowable number. If you can't get an available license in LRC, ask the proctor to restart the ArcGIS license manager

Introduction to ArcGIS

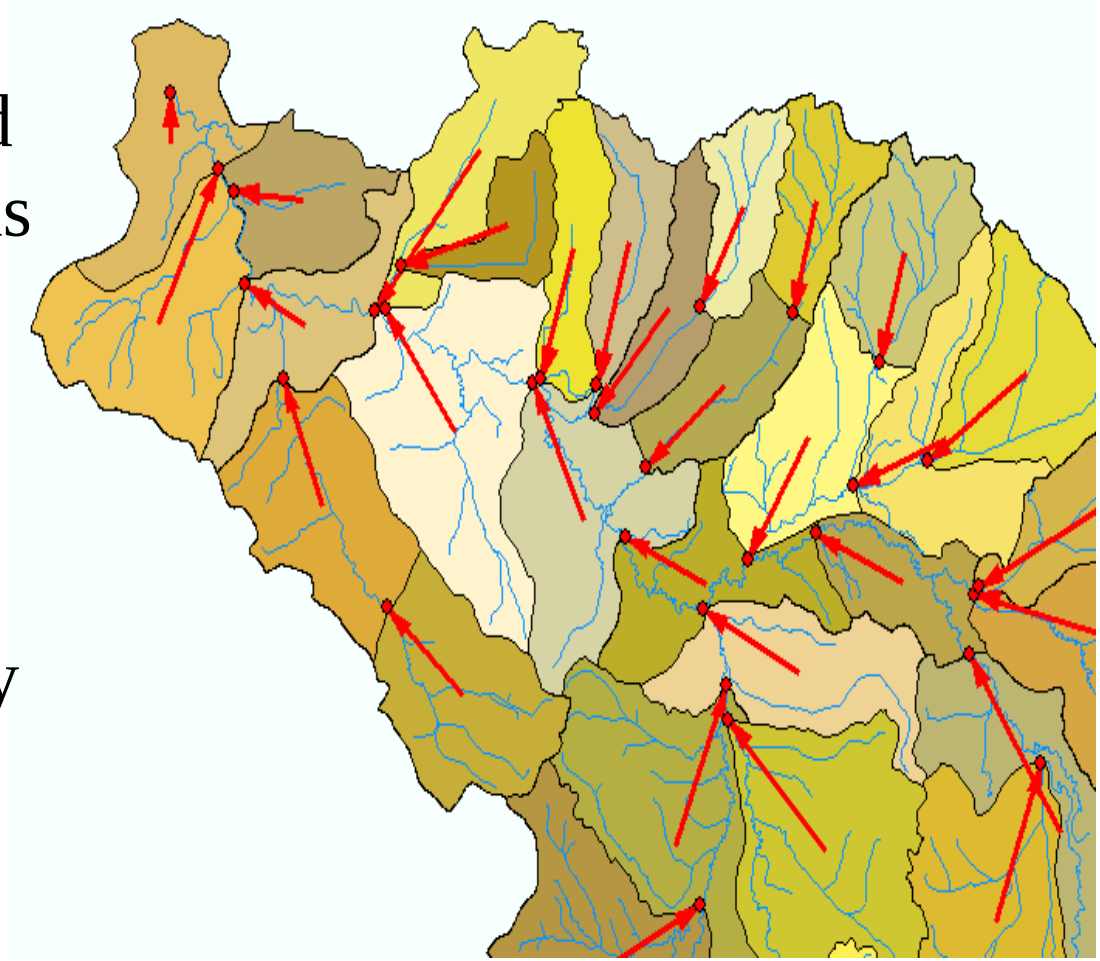
- How data are stored in ArcGIS
- Components of ArcGIS – ArcMap, ArcCatalog and ArcToolbox
- *Extensions of ArcGIS – spatial analyst, geostatistical analyst and 3D analyst*

ArcGIS Extensions

	ArcView, ArcEditor, and ArcInfo		ArcInfo only
ArcGIS Spatial Analyst	• Advanced raster modeling • ARC GRID calculator with ARC GRID algebra • VBA for raster analysis	+	• ARC GRID program in ArcInfo Workstation • ARC GRID commands in Arc program
ArcGIS 3D Analyst	• ArcScene™–real-time interactive three-dimensional scenes • Scene views in ArcCatalog • Three-dimensional modeling tools • ARC TIN tools	+	• ARC TIN™ commands in Arc program • Surfacescene command
Geostatistical Analyst	• Advanced kriging and surface modeling • Exploratory spatial data analysis tools • Probability, threshold, and error mapping		

Spatial Analyst

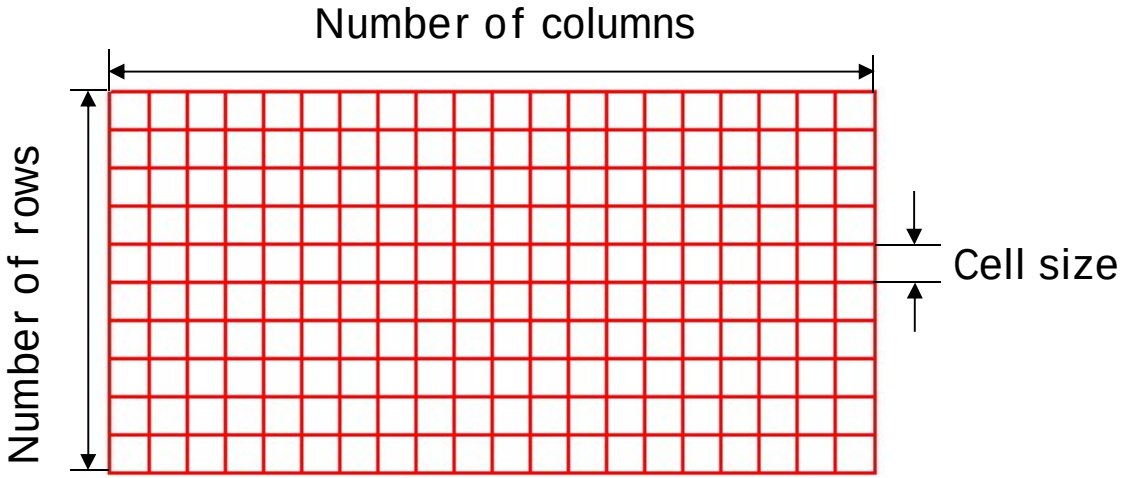
- Analysis of land surface terrain as a grid
- Key means of defining drainage areas and connectivity to stream network



Drainage network for Montgomery, AL

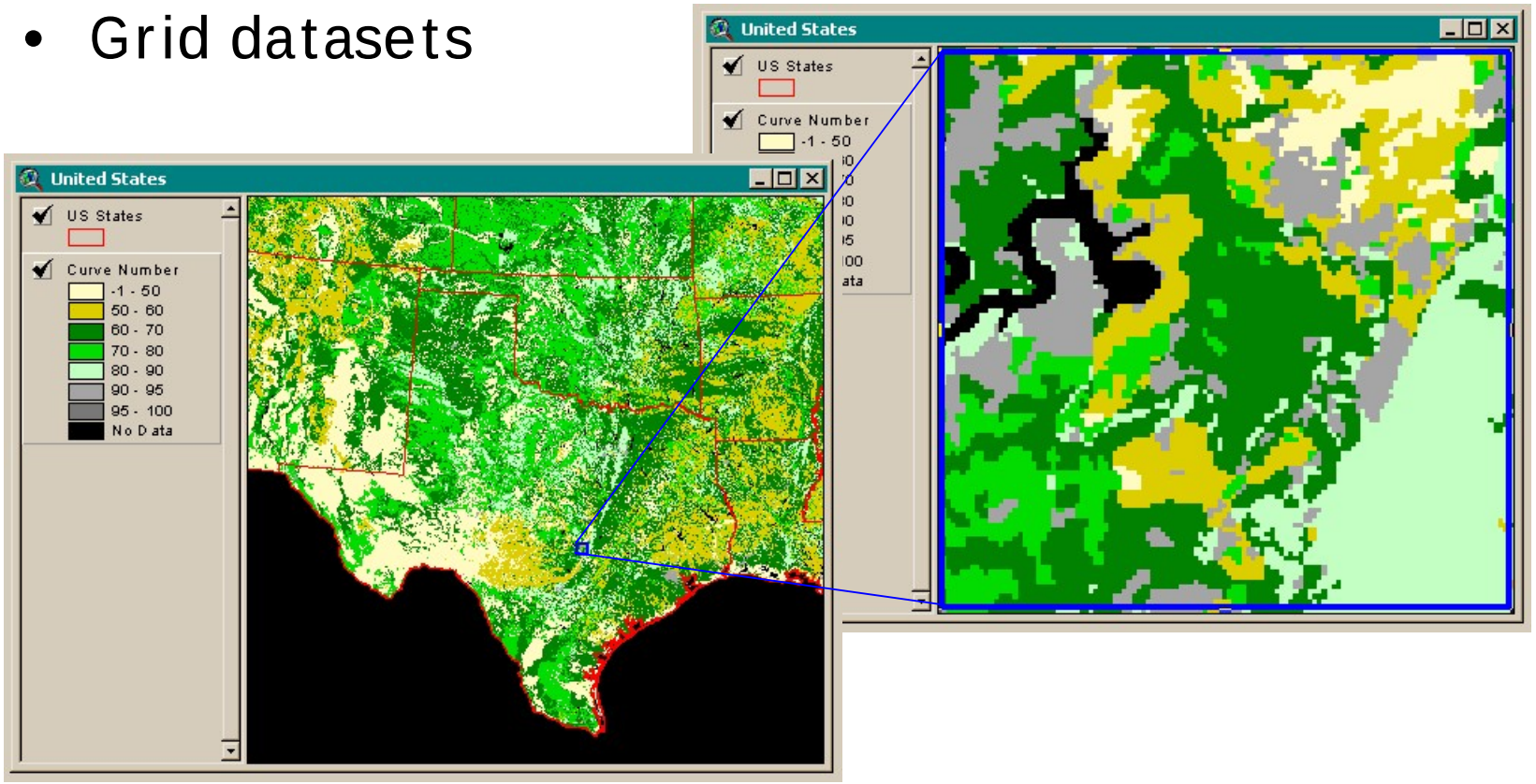
Grid Datasets

- Cellular-based data structure composed of *square cells of equal size* arranged in rows and columns.
- The grid cell size and extension (number of rows and columns), as well as the value at each cell have to be stored as part of the grid definition.



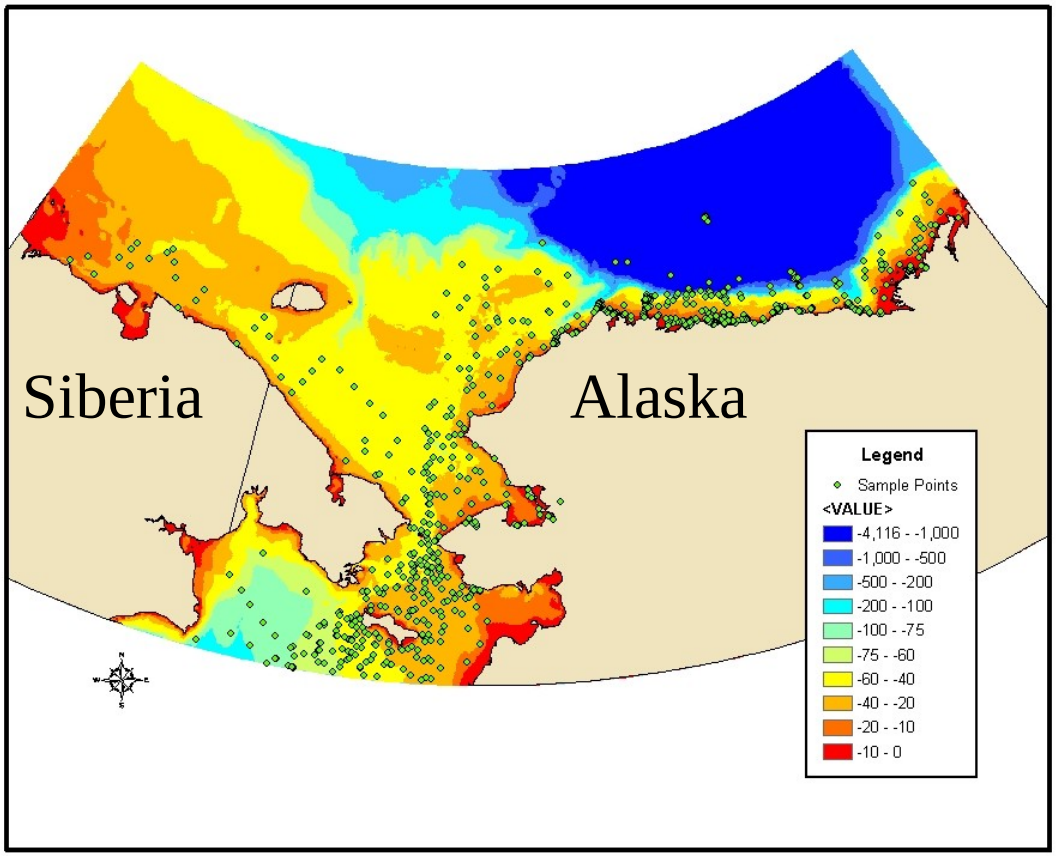
Grid Datasets

- Grid datasets



Geostatistical Analyst

- Interpolation of points to a grid using statistical correlation
- Produces a standard error of estimate of each map location



Biomass in the Arctic Ocean

Image Datasets

Digital Orthophotos and satellite imagery

- Image datasets

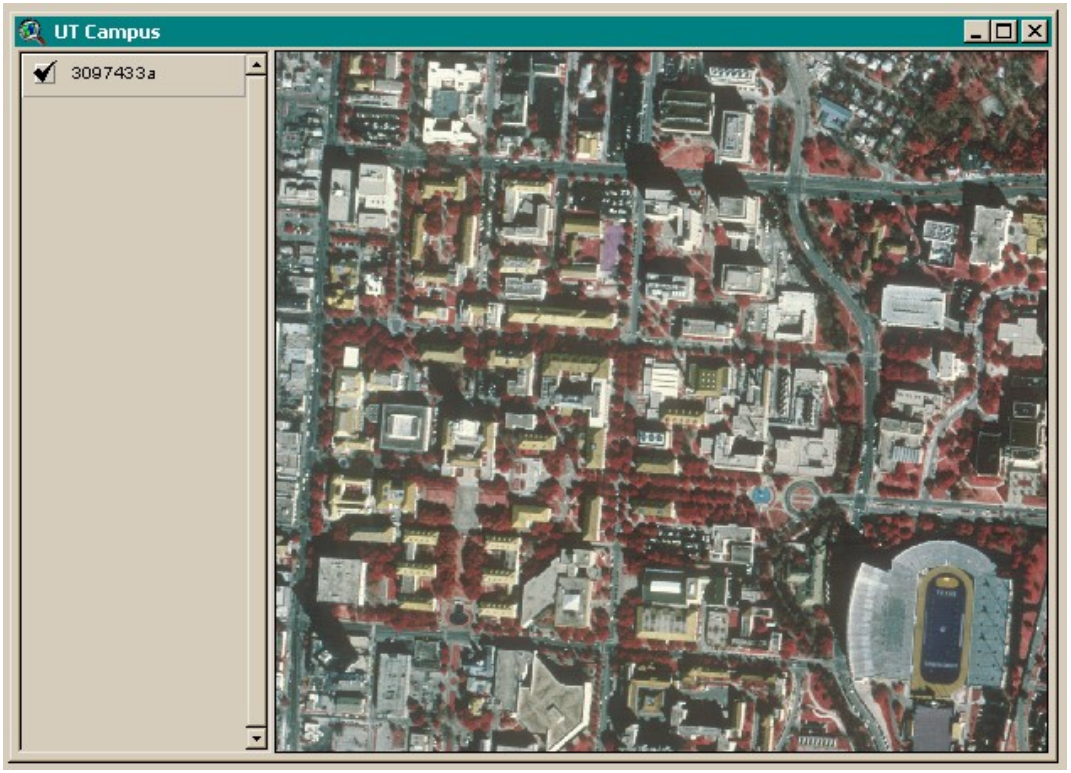
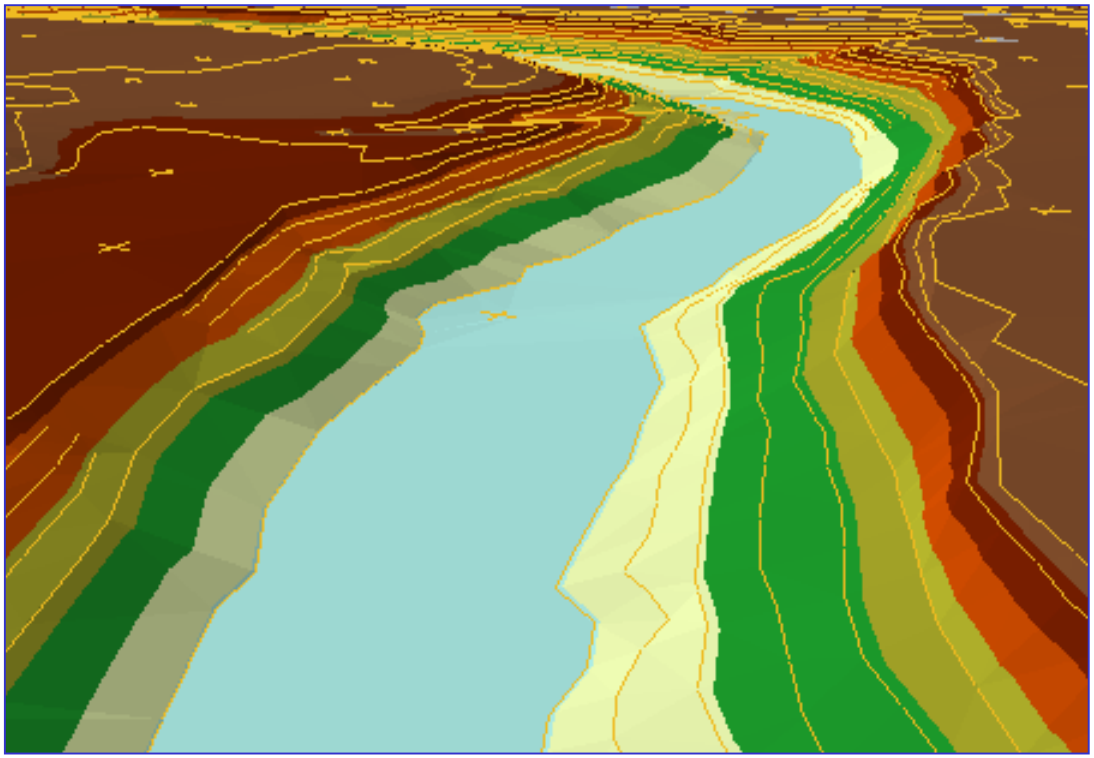


Image Datasets

- Supported image formats:
  - ARC Digitized Raster Graphics (ADRG)
  - Windows bitmap images (BMP) [.bmp]
  - Multiband (BSQ, BIL and BIP) and single band images [.bsq, .bil and .bip]
  - ERDAS [.lan and .gis]
  - ESRI Grid datasets
  - IMAGINE [.img]
  - IMPELL Bitmaps [.rlc]
  - Image catalogs
  - JPEG [.jpg]
  - MrSID [.sid]
  - National Image Transfer Format (NITF)
  - Sun rasterfiles [.rs, .ras and .sun]
  - Tag Image File Format (TIFF) [.tiff, .tif and .tff]
  - TIFF/LZW

3-D Analyst

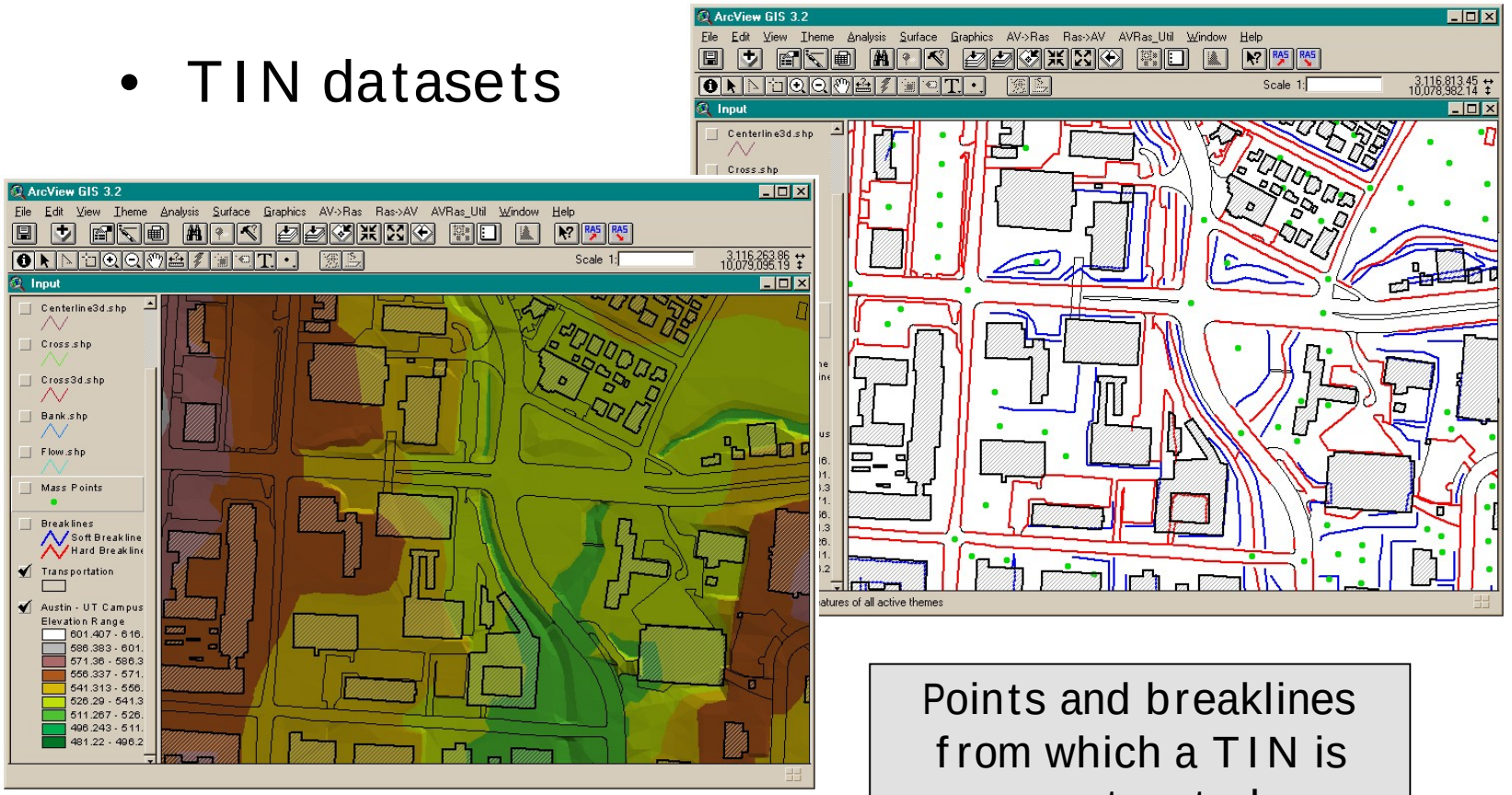
- Analysis of land surface terrain as triangulated irregular network (TIN)
- Visualization in 3-D using Arc Scene



Stream channel of Pecan Bayou, TX

TIN Datasets

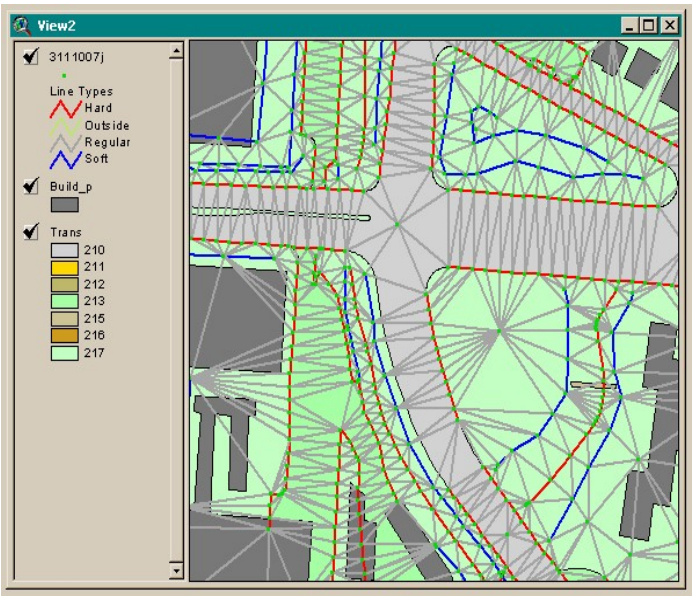
- TIN datasets

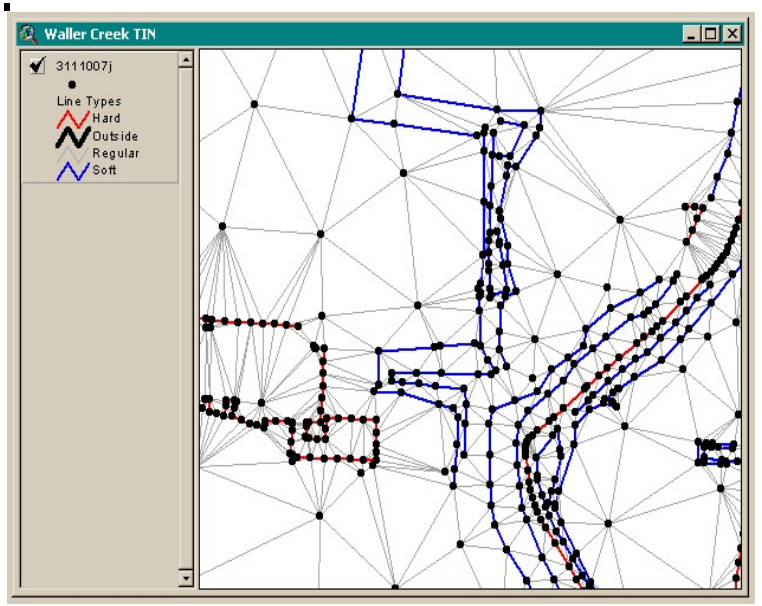


Points and breaklines from which a TIN is constructed.

TIN Datasets

- Triangle sides are constructed by connecting adjacent points so that the minimum angle of each triangle is maximized. Triangle sides cannot cross breaklines.





- The TIN format is efficient to store data because the resolution adjusts to the parameter spatial variability.

GIS

Experiment 3

DIGITAL DATABASE CREATION – POINT FEATURES, LINE FEATURES FEATURES, POLYGON

Feature classes are homogeneous collections of common features, each having the same spatial representation, such as points, lines, or polygons, and a common set of attribute columns, for example, a line feature class for representing road centerlines.

The four most commonly used feature classes are points, lines, polygons, and annotation (the geodatabase name for map text).

In the illustration below, these are used to represent four datasets for the same area: (1) manhole cover locations as points, (2) sewer lines, (3) parcel polygons, and (4) street name annotation.

Generally, feature classes are thematic collections of points, lines, or polygons, but there are seven feature class types. The first three are supported in databases and geodatabases. The last four are only supported in geodatabases.

- **Points:** Features that are too small to represent as lines or polygons as well as point locations (such as GPS observations).
- **Lines:**Represent the shape and location of geographic objects, such as street centerlines and streams, too narrow to depict as areas. Lines are also used to represent features that have length but no area, such as contour lines and boundaries.
- **Polygons:** A set of many-sided area features that represents the shape and location of homogeneous feature types such as states, counties, parcels, soil types, and land-use zones.
- **Annotation:** Map text including properties for how the text is rendered. For example, in addition to the text string of each annotation, other properties are included such as the shape points for placing the text, its font and point size, and other display properties. Annotation can also be feature linked and can contain subclasses.

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Problem: Gaps and dangles appear between lines or edges after editing features

Description

Editing features such as snapping a line, splitting a parcel, or clipping a polygon produces gaps (line undershoot) and dangles (line overshoot) when zooming in to a map scale of less than 1:1.

Cause

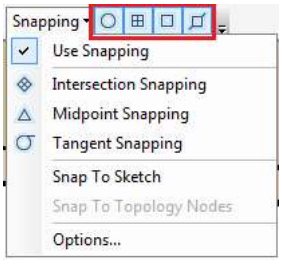
The problem occurs when zooming in to an unrealistic scale of less than 1:1. The software's limit is a scale of 1:1. At this scale, the screen display is equal to the real distance on the earth's surface. Hence, zooming in to a scale of less than 1:1 pushes the resolution tolerance past the maximum threshold, and produces visual artifacts such as gaps (line undershoot) and dangles (line overshoot).

Solution or Workaround

Use one of the following workarounds to edit features and ensure no gaps and dangles are produced:

Choosing the snapping types before snapping lines

In ArcMap, click the **Snapping** drop-down arrow, and select the **Use Snapping** command. Click the snapping types to activate the snapping cue. Each snapping type is represented by a visual cue that matches the icons in the **Snapping** toolbar. The snapping cue on the screen enables snapping between features.



Note:
For visual cues while snapping, navigate to **Snapping** > **Options**. Check the **Snap tips** check box, and other desired properties. **Snap tips** and snapping cue help to visualize the snapping location.

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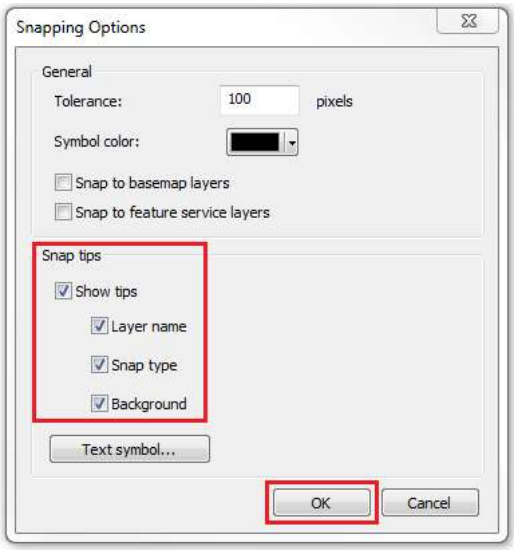
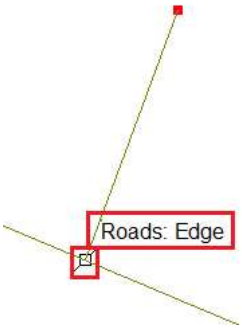


The image below shows the snapping cue (at the tip location where the two lines are about to connect) and the snap tip (represents the snapping properties).



Increasing the Snapping Tolerance value

Increasing the **Snapping Tolerance** value increases the possibility of snapping.

1. In ArcMap, click the drop-down arrow of the **Command** button, and select **Options**. This opens the **Snapping Options** dialog box.
2. In the **General** section, specify the **Tolerance** value in pixels.
3. Click **OK**.

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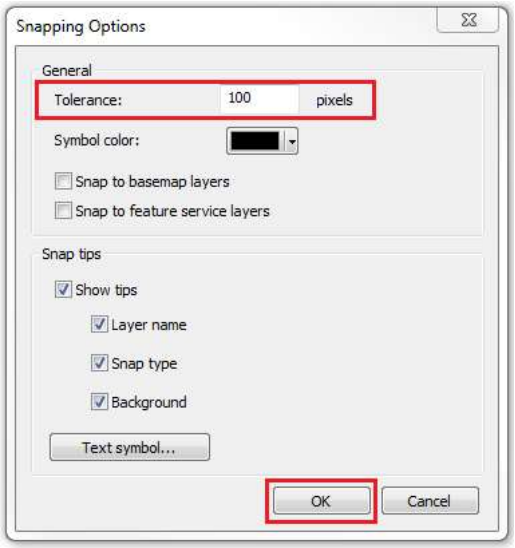
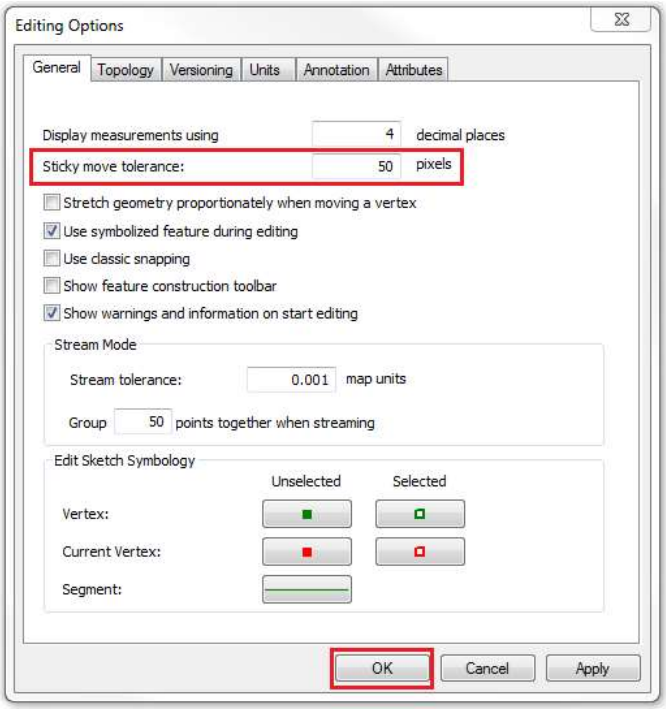


Increasing the Sticky move tolerance value

Sticky move tolerance prevents features from being accidentally moved. Increasing the **Sticky move tolerance** value increases the minimum number of pixels the pointer must move before moving a selected feature,thus reducing the possibility of accidentally creating gaps and dangles.

1. In ArcMap, click the **Editor** drop-down arrow, and click **Options**.
2. In the **General** tab, specify the **Sticky move tolerance** value in pixels.
3. Click **OK**.



Applying topology rules

Topology rules enable spatial relationships between features in a single feature class or between two feature cla
For more information on different topology rules, refer to ArcGIS Geodatabase Topology Rules. Topology rules
identify the occurrence of dangles.

1. In ArcCatalog, right-click the feature dataset, and select **New** > **Topology**. This opens the **New Topology** dia

Note:
All feature classes stored within a geodatabase must be transferred into a feature dataset before creating a new

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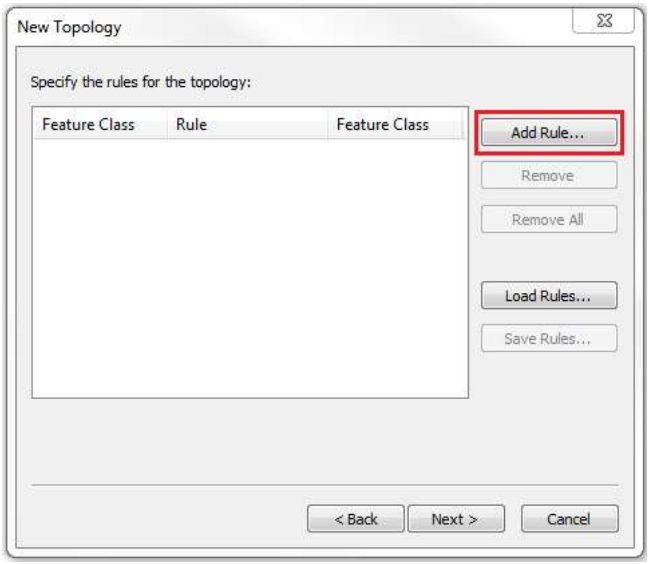
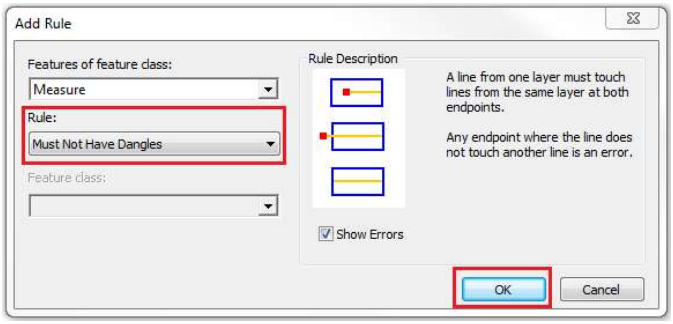
topology.

2. Accept the default settings and continue to click **Next** until the page to **Specify the rules for the topology** appears.
3. Click the **Add Rule** button. This opens the **Add Rule** dialog box.



4. Specify **Rule** as **Must Not Have Dangles**.



5. Click **OK**.
6. Add more rules by selecting from the **Add Rule** dialog box.
7. Click **Next** until the last page of the dialog box, and click **Finish**. Any dangle appearing on the layer is displayed in the map view.
8. Check for errors. If found, perform a quick fix by right-clicking the individual errors.

Measuring the offset distance against the XY Tolerance value

The default **XY Tolerance** in ArcMap is 0.001 m, which equals approximately 0.003 feet. A gap or dangle with a value of less than 0.003 feet is considered a coincident.

The image below shows the measurement of an offset distance between a shared boundary after a parcel is spl
scale of 1:0.05, the difference between the shared boundary is 0.001552 feet, which is less than 0.003 feet. Hen
considered a coincident.

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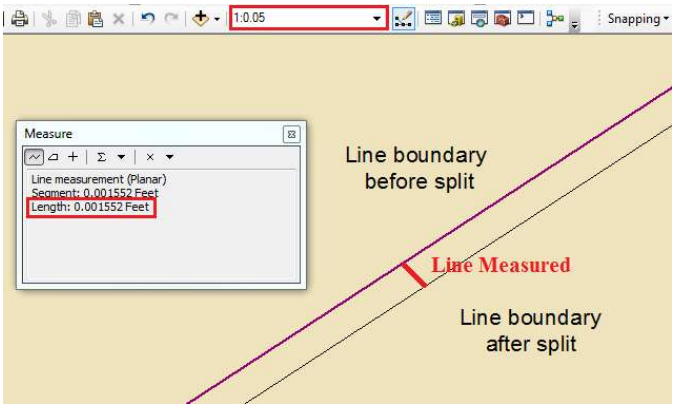

Ensuring data layers use the same coordinate system

Ensure the layers for editing use the same coordinate system. Using different coordinate systems for different layers projects the data differently on the map. Additionally, different coordinate systems or the presence of on-the-fly projection in the datasets can produce distance offsets, which may appear in the form of gaps and dangles.

Running the Find Dangles Check Properties tool from the Data Reviewer toolbar

Note:
This tool is available with a **Data Reviewer** license.

Running the **Find Dangles** check determines the presence of dangles in the dataset. For more information,refer to Finding dangles on line features.

For additional information on removing gaps for feature polygons, refer to Removing slivers or gaps between polygons.

Related Information

- ArcGIS Help: About snapping
- ArcGIS Help: Enabling snapping
- ArcGIS Help: Enabling snapping (classic snapping)
- ArcGIS Help: Geodatabase topology rules and topology error fixes
- ArcGIS Help: Finding dangles on line features
- ArcGIS Help: XY Tolerance (Environment Setting)
- GISGeography: Topology Rules in ArcGIS: How To Fix Digitizing Errors
- ArcGIS Geodatabase Topology Rules in PDF
- Problem: Snapping does not function while editing data in ArcMap

Last Published: 10/4/2018

Article ID: 000017053

Software: ArcMap 10.2.2, 10.2.1, 10.2

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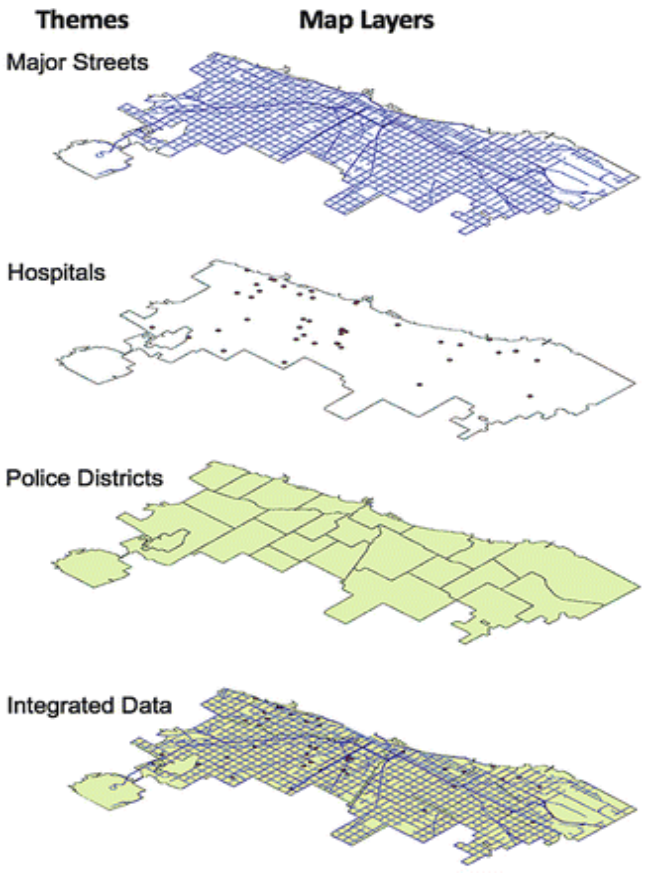
Exp 5

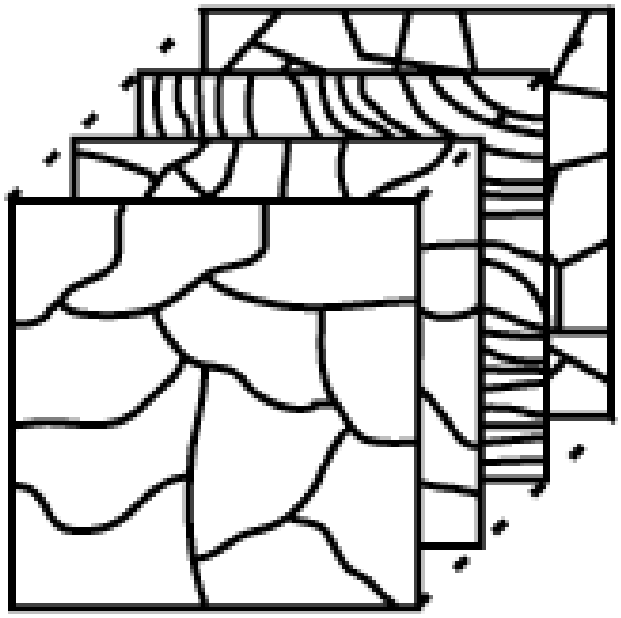
SPATIAL DATA INTEGRATION

Spatial data integration is a process in which different geospatial datasets, which may or may not have different spatial coverages, are made compatible with one another. The goal of spatial data integration is to facilitate the analysis, reasoning, querying, or visualization of the integrated spatial data. Figure 1 illustrates the integration of three layers or *themes*: major streets, hospitals, and police districts of the City of Chicago.



Combining data of different types and from different sources, such as we have described above, is the pinnacle of data integration and analysis. In a digital environment where all the data sources are geometrically registered to a common geographic base, the potential for information extraction is extremely wide. This is the concept for analysis within a digital **Geographical Information System (GIS)** database. Any data source which can be referenced spatially can be used in this type of environment.

A DEM/DTM is just one example of this kind of data. Other examples could include digital maps of soil type, land cover classes, forest species, road networks, and many others, depending on the application. The results from a classification of a remote sensing data set in map format, could also be used in a GIS as another data source to update existing map data. In essence, by analyzing diverse data sets together, it is possible to extract better and more accurate information in a synergistic manner than by using a single data source alone. There are a myriad of potential applications and analyses possible for many applications. In the next and final chapter, we will look at examples of various applications of remote sensing data, many involving the integration of data from different sources.

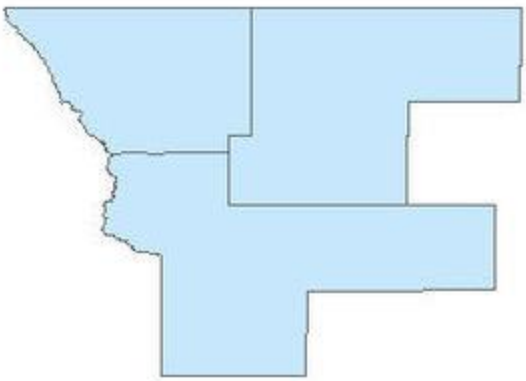


Exp 6

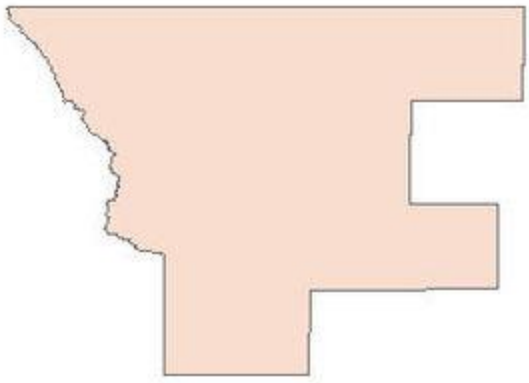
DISSOLVING AND MERGING

Dissolve is an application of the conceptual operators that aggregates features often referred to as 'Merge' or 'Amalgamation.' It is a process in which a new map feature is created by merging adjacent polygons, lines, or regions that have a common value for a specified attribute. In GIS, dissolve is one of the Data Management tools used for generalizing features. In choropleth maps, the dissolve operation eliminates the boundaries of enumeration units with a common value, depicting a much larger area holding the same common value. Thus, using the dissolve operator on multiple polygons with a common value will yield one new polygon, combining the dimensions of the original, dissolved polygons. Giving linear features a dotted appearance or connecting linked line segments into one larger line segment in a GIS is also considered a dissolve operation.

Dissolve has various applications in cartography and GIS. For example, road or river datasets often present the same linear feature in a number of segments. This can create problems for analysis or display, but dissolve can be used to combine them together and facilitate their intended use. Polygons are also commonly dissolved. For example, a cartographer or GIS user may desire to show several distinct polygon areas as one contiguous area, such as combining certain areas into one large region (for instance, merging east and west Germany into Germany).



Three polygons before the dissolve operation.



A single polygon after the dissolve operation

EXP 7

CLIPPING, INTERSECTION AND UNION

OVERLAY:

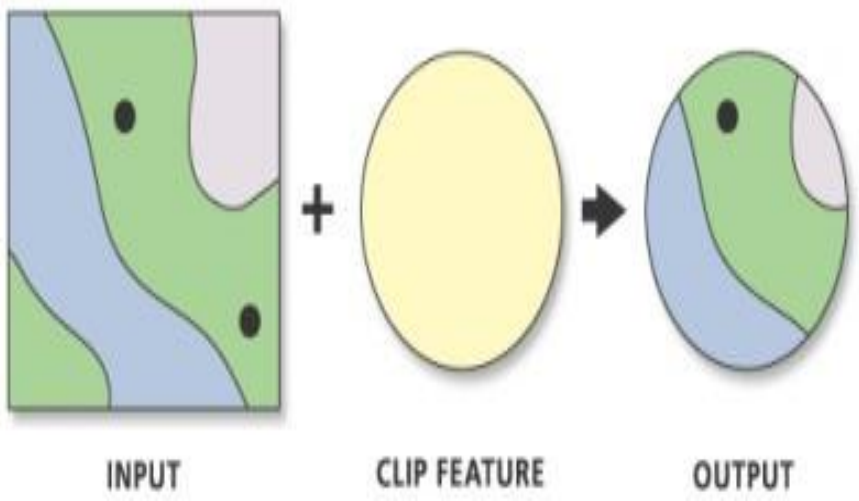
The Overlay toolset contains tools to overlay multiple feature classes to combine, erase, modify, or update spatial features in a new feature class. New information is created when overlaying one set of features with another.

There are different types of vector overlay operations; all involve joining two existing sets of features into a single set of features to identify spatial relationships between the input features.

Union, intersect, symmetrical difference, identify, clip and erase will be discussed. At the end of the chapter you will learn about the eliminate command, which is used to eliminate the unwanted sliver polygons, resulted by the overlay operations. The last subchapter will deal with raster overlay.

Clipping

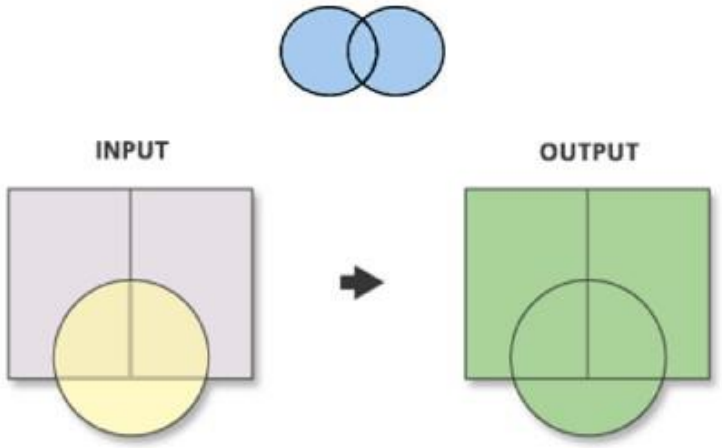
This command extracts input features that overlay the clip features.



The concept of the "clip" operation

Union

This tool builds a new feature class by combining the features and attributes of each feature class. **Union** computes a geometric intersection of the input features. All features will be written to the output feature class with the attributes from the input features, which it overlaps. The concept is shown below. Union is a spatial equivalent of "logical OR".

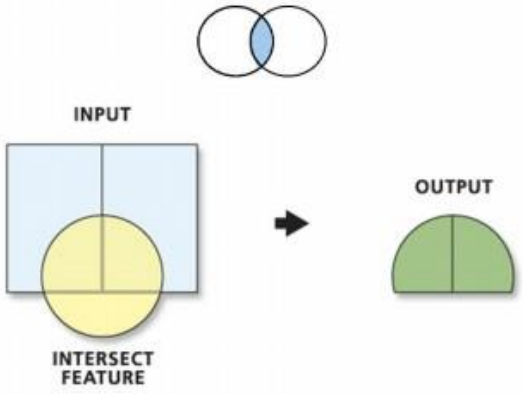


The concept of union operation

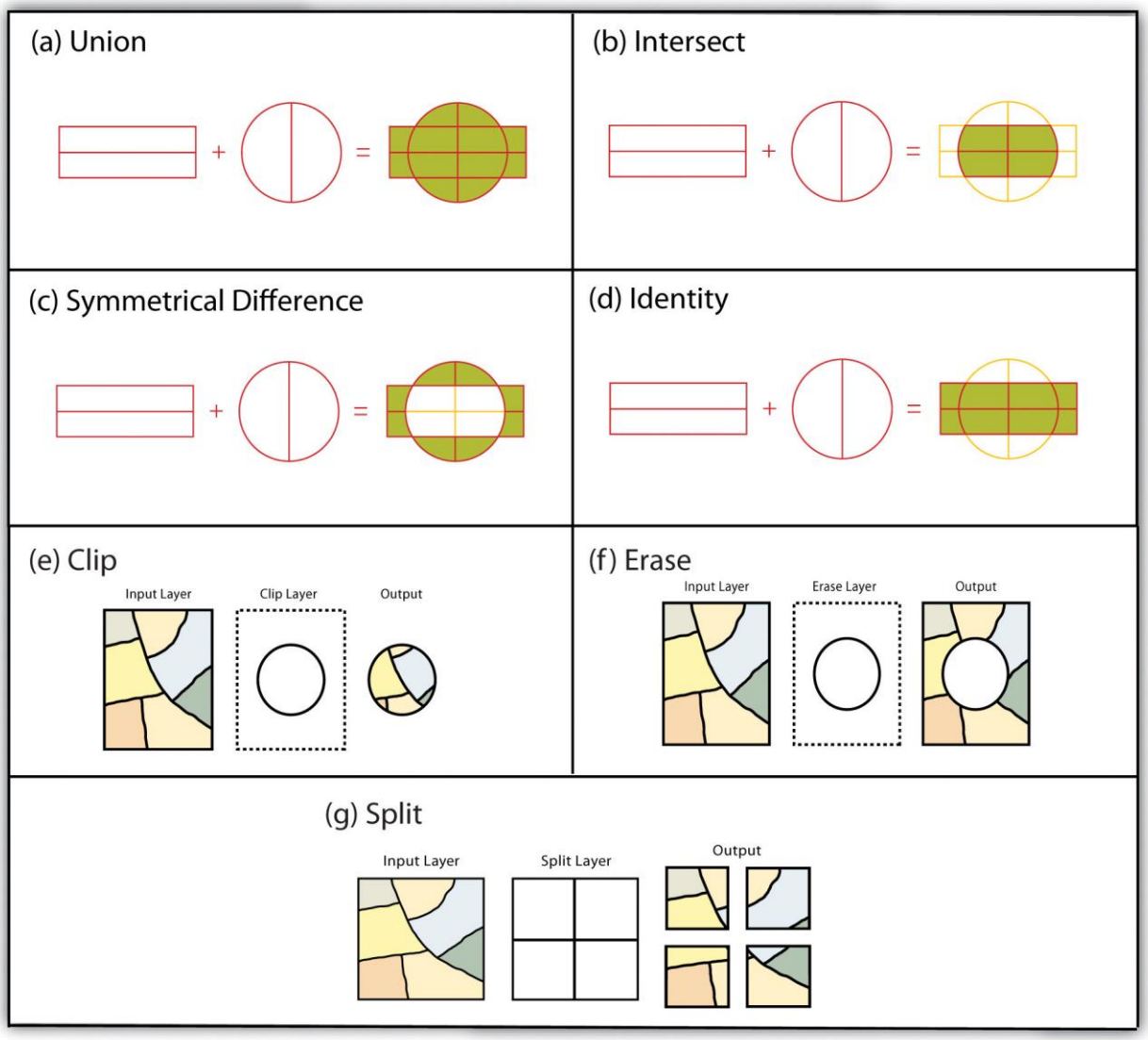
Intersect

This tool builds a new feature class from the intersecting features common in both feature classes. Union is a spatial equivalent of "logical AND".

The **intersect** operation computes a geometric intersection of the input features. Features or portions of features which overlap in all layers and/or feature classes will be written to the output feature class.



The concept of the intersect operation


(a) Union
(b) Intersect
(c) Symmetrical Difference
(d) Identity
(e) Clip
Input Layer
Clip Layer
Output
(f) Erase
Input Layer
Erase Layer
Output
(g) Split
Input Layer
Split Layer
Output

Exp 8

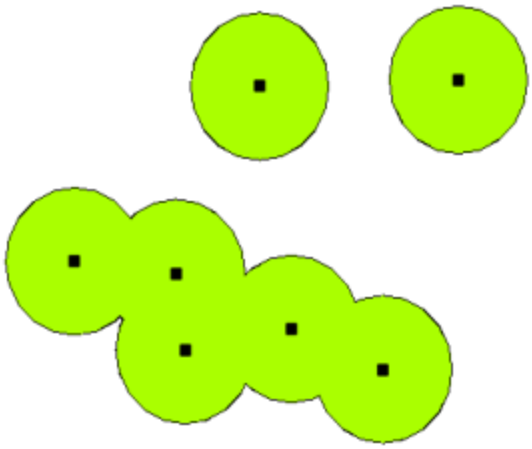
BUFFERING TECHNIQUES

Buffering usually creates two areas: one area that is **within** a specified distance to selected real world features and the other area that is **beyond**. The area that is within the specified distance is called the **buffer zone**.

A **buffer zone** is any area that serves the purpose of keeping real world features distant from one another. Buffer zones are often set up to protect the environment, protect residential and commercial zones from industrial accidents or natural disasters, or to prevent violence. Common types of buffer zones may be greenbelts between residential and commercial areas, border zones between countries, noise protection zones around airports, or pollution protection zones along rivers.

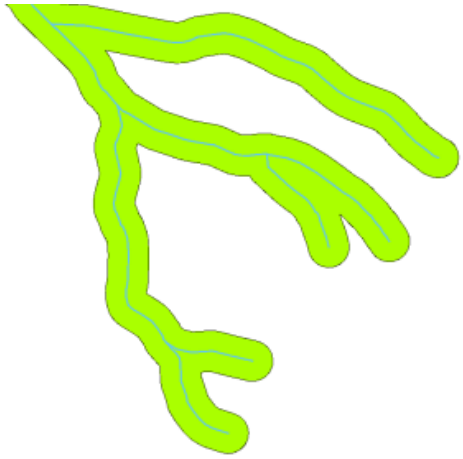
In a GIS Application, **buffer zones are** always represented as **vector polygons** enclosing other polygon, line or point features

1. Point buffer:



A buffer zone around vector points.

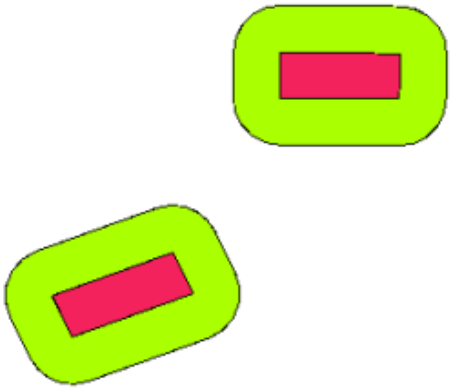
2. **Line Buffer**



A buffer zone around vector polylines.

3. **Polygon Buffer**

.



A buffer zone around vector polylines