Basic Remote Sensing and GIS

USAID
FROM THE AMERICAN PEOPLE

FOREST SERVICE
DEPARTMENT OF AGRICULTURE

বন অধিদপ্তর
পরিবেশ ও বন মন্ত্রণালয়

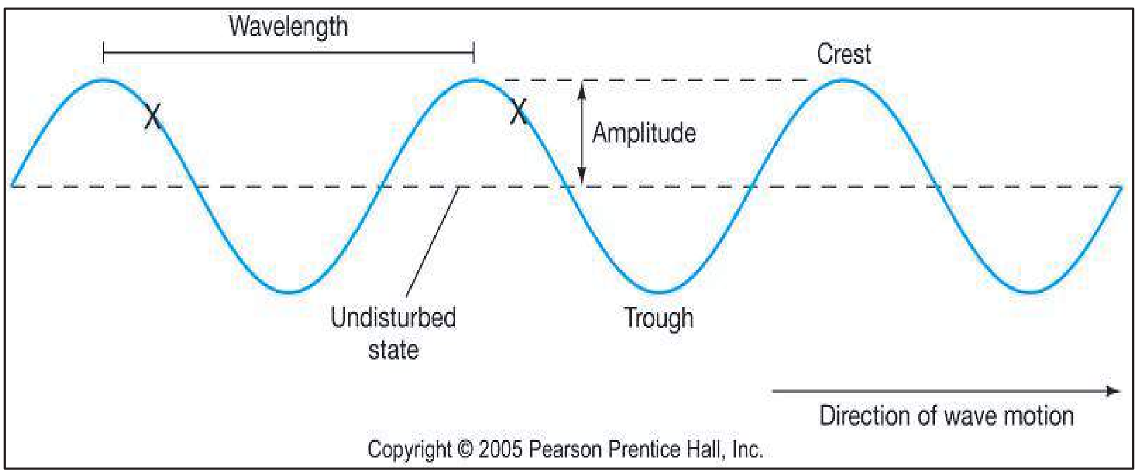
CEGIS

Wavelength and Frequency

The wavelength and frequency are two characteristics of electromagnetic radiation which are particularly important for understanding remote sensing and the information to be extracted from remote sensing data.

The wavelength is the length of one wave cycle, which can be measured as the distance between successive wave crests. It is represented by the Greek letter lambda (λ). It is measured in meters (m) or some factor of meters such as nanometers (nm, 10^{-9}metres), micrometers (10^{-6}metres) or centimeters (cm, 10^{-2}metres).

Frequency refers to the number of cycles of a wave passing a fixed point per unit of time. It is measured in hertz (Hz), equivalent to one cycle per second, and various multiples of hertz.

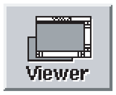


Wavelength and frequency of electromagnetic energy are inversely related to each other. The shorter the wavelength, the higher is the frequency and the longer the wavelength, the lower is the frequency. The following equation provides the relationship between wavelength and frequency of electromagnetic energy.

$$v = \frac{c}{\lambda}$$

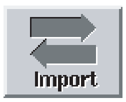
where, c = Wavelength and λ = Frequency

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.

Viewer 

The ERDAS IMAGINE Viewer is the "main window" for displaying raster, vector, and/or annotation data. An IMAGINE Viewer opens automatically when IMAGINE starts. Also, you may use the File > New menu to start a Viewer.

You may start additional Viewers of the default type by clicking the Viewer icon on the IMAGINE icon panel. Viewer can be resized by dragging a corner or side. Both viewers have a Main Toolbar that is always visible.

Import 

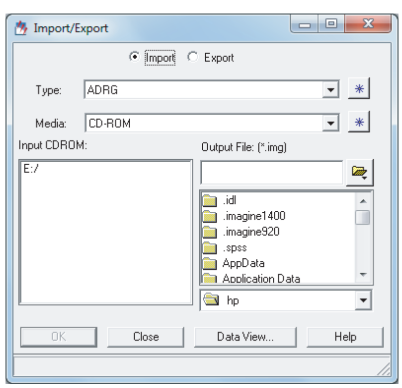
With the help of this menu a large number of data of raster and vector file formats are imported from file, CD-Rom or Tape into ERDAS IMAGINE and exported and ERDAS IMAGINE file into another format. This dialog enables you to import or export virtually any type of data to or from ERDAS IMAGINE.

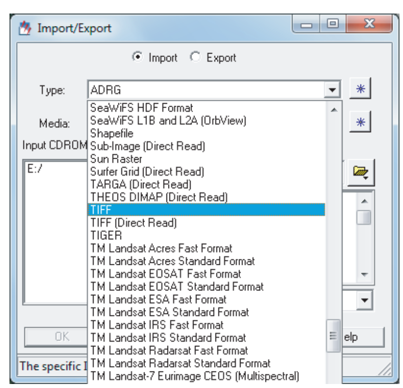
Import/Export Dialog Box

Import - Select this button if you are importing data into ERDAS IMAGINE

Export - Select this button if you are exporting an ERDAS IMAGINE file into another format.

Type: Click on this dropdown list and select the data type to import or export. When Import or Export is selected, the list of import or export data types display.





Media: Click this dropdown list to select the media from which you are importing: CD-ROM, Tape, or File. Not all data types can be imported from all media types. A warning displays when a Type-Media mismatch occurs.

Input File: Enter the name of the input file.

Output File: Enter the name for the output file (the name of the file in ERDAS IMAGINE).

Resolution

Resolution is used to describe the area on the ground that a pixel represents in an image file. Four distinct types of resolution must be considered :

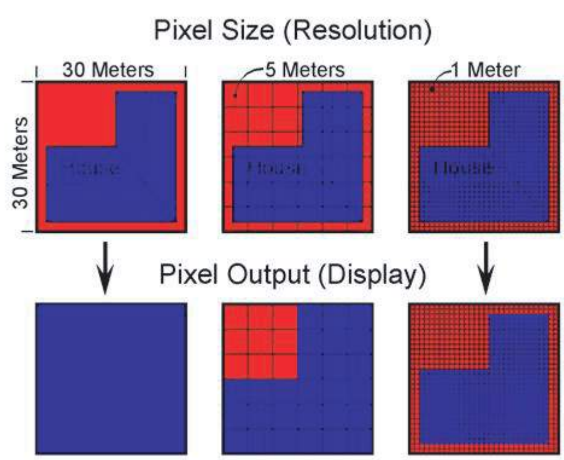
- Spatial - area on the ground represented by each pixel
- Spectral - specific wavelength intervals that a sensor can record
- Radiometric - number of possible data file values in each band
- Temporal - how often a sensor obtains imagery of a particular area.

These four domains contain separate information that can be extracted from the raw data.

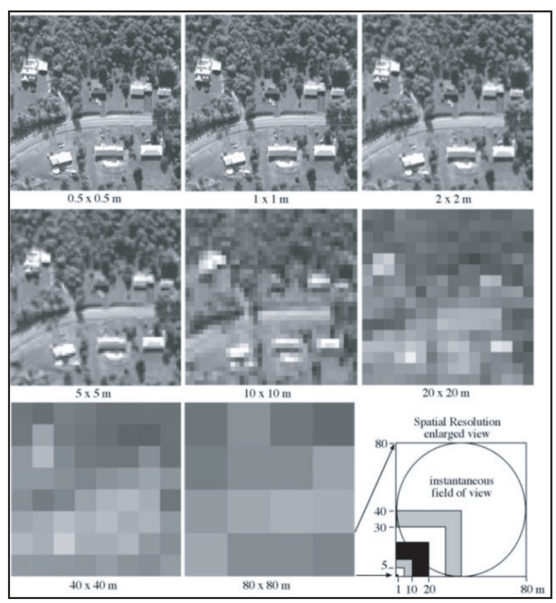
Spatial Resolution

Spatial resolution is a measure of the smallest object that can be resolved by the sensor, or the area on the ground represented by each pixel (Simonett et al, 1983).For a homogeneous feature to be detected, its size generally has to be equal to or larger than the resolution cell. If the feature is smaller than this, it may not be detectable as the average brightness of all features in that resolution cell will be recorded.

Large-scale in remote sensing refers to imagery in which each pixel represents a small area on the ground, such as SPOT data, with a spatial resolution of 10 m or 20 m. Small scale refers to imagery in which each pixel represents a large area on the ground, such as Advanced Very High Resolution Radiometer (AVHRR) data, with a spatial resolution of 1.1 km.

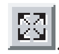


http://www.satimagingcorp.com/services/resources/characterization-of-satellite-remote-sensing-systems



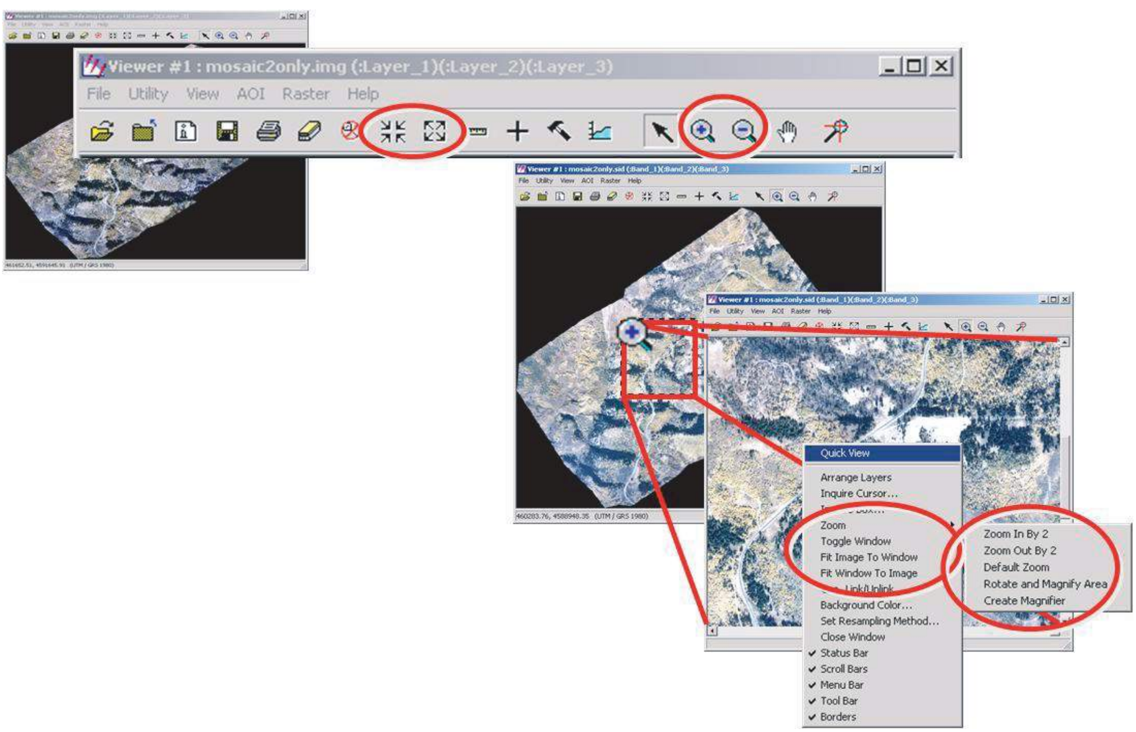
Zooming Tools

Zooming is the magnification or reduction of an image in the Viewer. Zooming has no effect on how the image is stored in a file.

The quick zoom buttons, and , enlarge and reduce the image without changing the center of the viewable area

The zoom tools, and, enlarge and reduce the image and also shift the image so that the clicked spot is in the center of the Viewer. When the tool is selected, you can drag a box around an area within the Viewer and when the mouse button is released, that area magnifies so that the enclosed area fits entirely within the Viewer. When the tool is selected and a box is dragged, the entire Viewer area is reduced so that it fits completely within the bounding box.

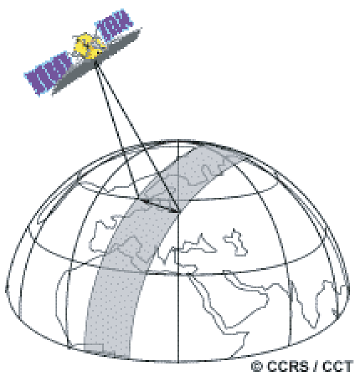
There are also options on the **View > Zoom** submenu (In By X... and Out By X...) that allow you to specify the exact zoom ratio (1.37 for example) and to specify or change the resample method.

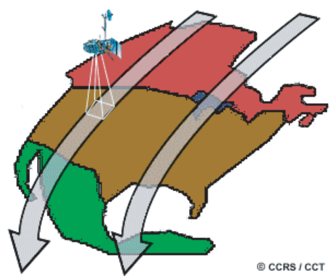


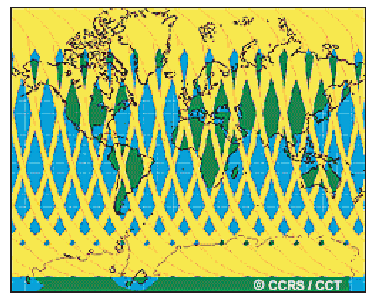
Source: ERDAS IMAGINE on line Help for the Zooming Tools

Satellite Swath

While satellite revolves around the Earth, the area imaged on the surface by satellite, is referred to as the swath. Imaging swaths for space borne sensors generally vary between tens and hundreds of kilometers wide. The satellite's orbit and the rotation of the Earth work together to allow complete coverage of the Earth's surface, after it has completed one complete cycle of orbits.







Multispectral Scanning

Many electronic remote sensors acquire data using scanning systems. A sensor with a narrow field of view sweeps over the terrain to build up and produce a two-dimensional image of the surface. When data is collected over a variety of different wavelength ranges, it is called a multispectral scanner (MSS). There are two main methods of scanning to acquire multispectral image data: Across-track scanners and Along-track scanners.

<u>Across-track scanners</u>

Across-track or whiskbroom scanners scan the Earth surface in a series of lines. Each line is scanned from one side of the sensor to the other, using a rotating mirror and the lines are oriented perpendicular to the direction of motion of the sensor platform. As the platform moves forward over the Earth, successive scans build up a two-dimensional image of the Earth´s surface.

<u>Along-track scanners</u>

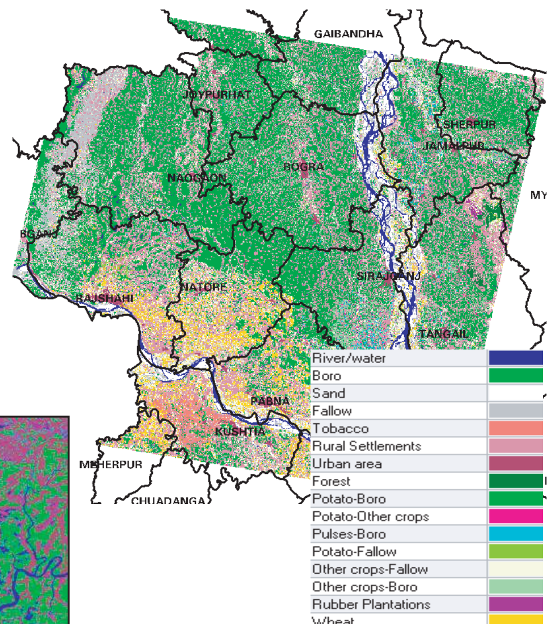
Along-track scanners also use the forward motion of the platform to record successive scan lines and build up a two-dimensional image, perpendicular to the flight direction. However, instead of a scanning mirror, they use a linear array of detectors located at the focal plane of the image formed by lens systems, which are "pushed" along in the flight track direction (i.e. along track). These systems are also referred to as pushbroom scanners.

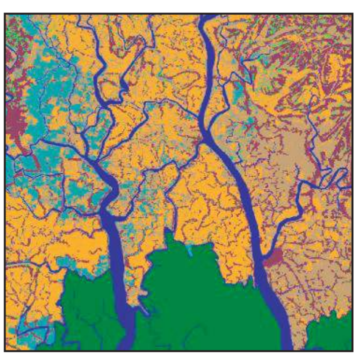
Agriculture Application

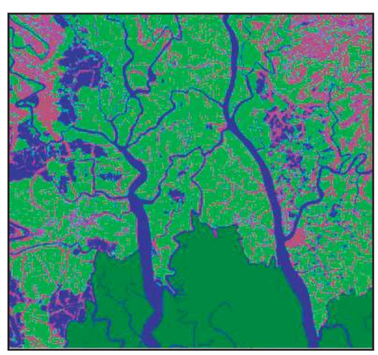
Agriculture plays a dominant role in economies of both developed and underdeveloped countries. Producing food in a cost-effective manner is the goal of every farmer, large-scale farm manager and regional agricultural agency. Satellite and airborne images are used as mapping tools to classify crops, examine their health and stress, and monitor farming practices.

Remote sensing offers an efficient and reliable means of collecting the information required, in order to map crop type and acreage. Optical remote sensing can see beyond the visible wavelengths into the infrared, where wavelengths are highly sensitive to crop health and stress and crop damage. Remote sensing can aid in identifying crops affected by too dry or wet conditions, affected by insect, weed or fungal infestations or weather related damage. Following are the lists of few remote sensing applications for agriculture:

- crop type classification
- crop yield estimation
- crop condition assessment
- mapping of soil characteristics
- mapping of soil management practices
- management practices



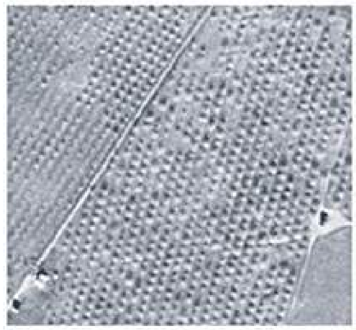




Pattern

Pattern means arrangement of individual objects into distinctive recurring forms that facilitate their recognition on imagery. The buildings in an industrial plant may have a distinctive pattern due to their organization to permit economical flow of materials through the plant, from receiving raw material to shipping of the finished product. The distinctive spacing of trees in an orchard arises from careful planting of trees at intervals that prevent competition between individual trees and permit convenient movement of equipment through the orchard.

Residential Neighborhood



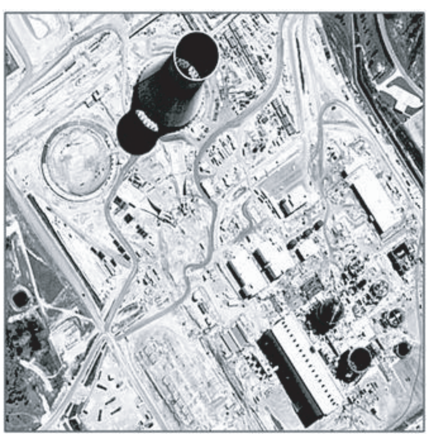
Orchard

Highway Interchange

Source:
Wynne, James B. Campbell, Randolph H. (2011). Introduction to remote sensing (5th ed.). New York: Guilford Press.

Association

Association takes into account the relationship between other recognizable objects or features in proximity to the target of interest. The identification of features that one would expect to associate with other features may provide information to facilitate identification. In the example given above, commercial properties may be associated with proximity to major transportation routes, whereas residential areas would be associated with schools, playgrounds, and sports fields.

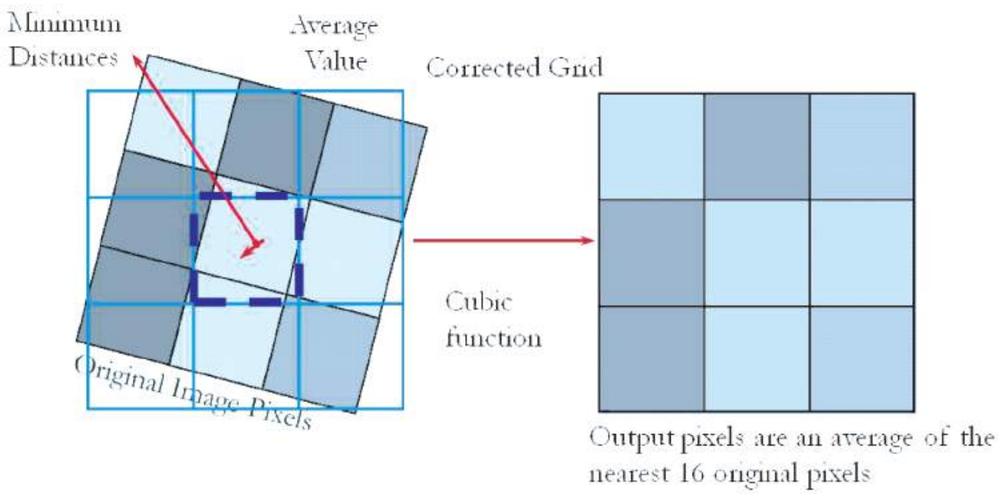


Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing

Cubic Convolution

Cubic convolution is similar to bilinear interpolation, except that a set of 16 pixels, in a 4 × 4 array, are averaged to determine the output data file value, and an approximation of a cubic function, rather than a linear function, is applied to those 16 input values. The effect of the cubic curve weighting can both sharpen the image and smooth out noise (Atkinson, 1985). The actual effects depend upon the data being used.

This method is recommended when you are dramatically changing the cell size of the data, such as in TM/aerial photo merges (i.e., matches the 4 × 4 window more closely than the 2 × 2 window).Data values may be altered. This method is extremely slow.



Problems: Original pixel value integrity lost; slowest

Benefits: Sharpen images and smooth noise

Uses: Resampling large cell size differences

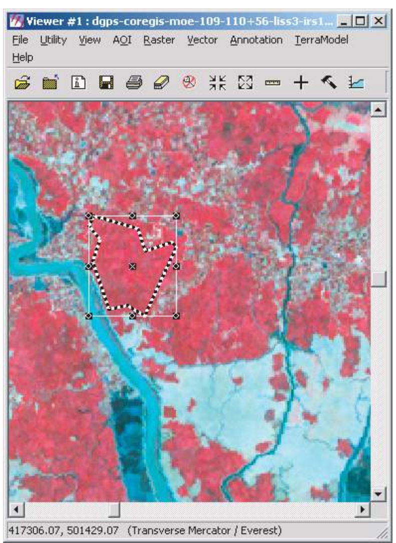
Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

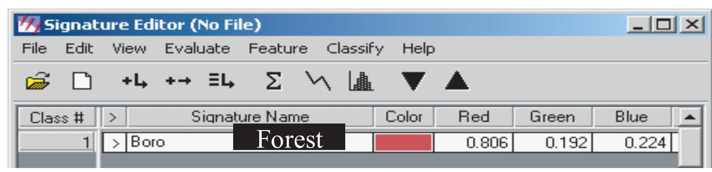
Rectification Summary

Rectification or geo-referencing is essential for almost all remote sensing projects. It allows image to correspond to real world map coordinates. It is required for combining imagery and GIS. It is essential for obtaining spatially accurate products—requires considerable care.

Collecting Signatures

- Draw a training sample for a potential class such as Forest
- After the AOI is created, click the Create New Signature(s) from AOI icon in the Signature Editor to add this AOI as a signature.
- In the Signature Editor, click inside the Signature Name column for the signature you just added.
- Change the name to the potential class, and then press Enter on the keyboard.
- In the Signature Editor, hold in the Color column next to the potential class and select a color.





Evaluating Training Samples

Selecting training samples is often an iterative process. To generate signatures that accurately represent the classes to be identified, you may have to repeatedly select training samples, evaluate the signatures that are generated from the samples, and then either take new samples or manipulate the signatures as necessary. Signature manipulation may involve merging, deleting, or appending from one file to another. It is also possible to perform at the known signatures, then mask out areas that are not classified to use in gathering more signatures.

There are tests to perform that can help determine whether the signature data are a true representation of the pixels to be classified for each class. Each signature can be evaluated with Signature Editor.

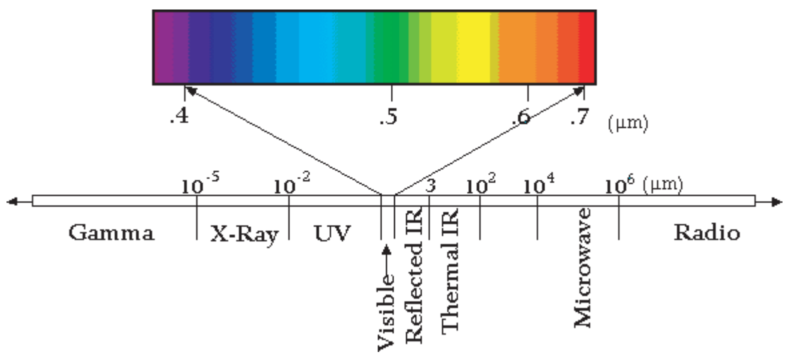
Basic
Remote Sensing and GIS

Training Manual Developed by CEGIS, USFS and BFD, 2014-15

Electromagnetic Spectrum

The electromagnetic spectrum consists of all the different wavelengths of electromagnetic radiation ranges from the shorter wavelengths (including Gamma and X-rays) to the longer wavelengths (including Microwaves and broadcast radio waves). There are several regions of the electromagnetic spectrum such as visible spectrum, infrared spectrum and microwave spectrum, which are useful for remote sensing.

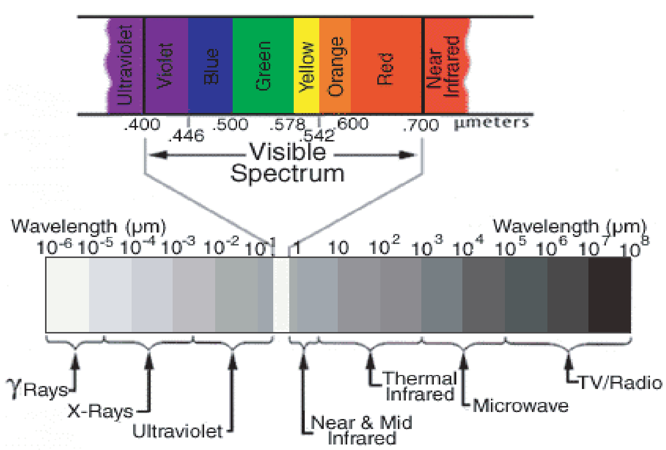
Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.



Source: http://ls7pm3.gsfc.nasa.gov/whatsRM/em.html

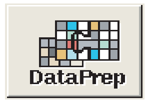
Visible Spectrum

The electromagnetic energy which our eyes can detect is part of the visible spectrum. The visible spectrum of electromagnetic energy covers a range of wave length from 0.4 to 0.7. The longest visible wavelength is red and the shortest is violet. There is a lot of electromagnetic energy around us which is "invisible" to our eyes, but can be detected by other sensors and used to our advantage.

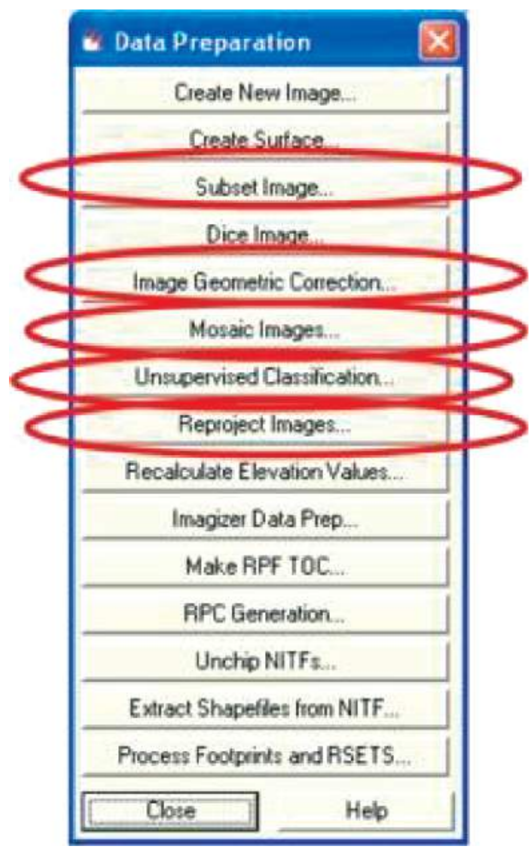


Source: http://www.faculty.virginia.edu/rwoclass/astr1210/121supps2-3.html

Data Preparation



This menu gives you access to a set of tools that are useful in general data preparation. This dialog opens when you click the **Data Prep** icon on the **ERDAS IMAGINE** icon panel



Subset Image Click to open the Subset dialog, which enables you to create and define a subset image.

Image Geometric Correction Click to open the Set Geo Correction Input File dialog, which is part of the Geometric Correction Tool. This dialog enables you to select the image you want to rectify.

Mosaic Images Click to open the Mosaic Tool, MosaicPro (PC Only), the Mosaic Wizard (PC Only), or the Mosaic Direct (PC Only), all of which enable you to mosaic two or more images together.

Unsupervised Classification Click to open the Unsupervised Classification dialog.

Reproject Images Select this option to resample an image into a different projection.

Source: ERDAS IMAGINE® Tour Guides™. (2006). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

Spectral Resolution

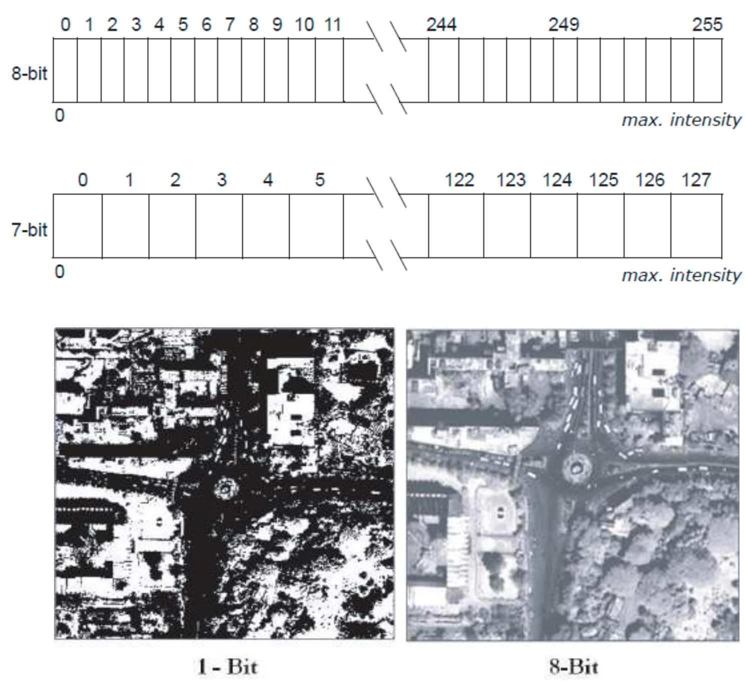
Spectral resolution refers to the specific wavelength intervals in the electromagnetic spectrum that a sensor can record (Simonett et al, 1983).

Wide intervals in the electromagnetic spectrum are referred to as coarse spectral resolution, and narrow intervals are referred to as fine spectral resolution. For example, the SPOT panchromatic sensor is considered to have coarse spectral resolution because it records EMR between 0.51 and 0.73. On the other hand, band 3 of the Landsat TM sensor has fine spectral resolution because it records EMR between 0.63 and 0.69 (Jensen, 1996).

Radiometric Resolution

Radiometric resolution refers to the dynamic range, or numbers of possible data file values in each band. This is referred to by the number of bits into which the recorded energy is divided. For instance, in 8-bit data, the data file values range from 0 to 255for each pixel, but in 7-bit data, the data file values for each pixel range from 0 to 128.

The sensor measures the EMR in its range. The total intensity of the energy from 0 to the maximum amount the sensor measures is broken down into256 brightness values for 8-bit data, and 128brightness values for 7-bit data.



Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

Linking Viewers

Select this option to link or unlink Viewer windows geographically so that the same image area opens in all linked Viewers. This type of link will not reflect changes in the arrangement of the layers, band combinations, or changes by other tools in the Viewer. Select this option again to unlink.

a) In the first Viewer, select View | Link/Unlink Viewers | Geographical.
   The Link/Unlink Instructions display.

b) Move your pointer to the second Viewer. The pointer becomes a Link symbol.

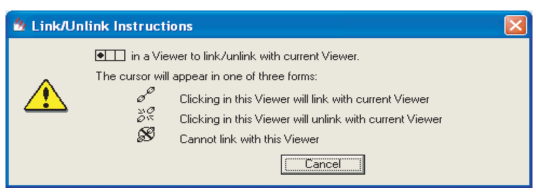
c) Move the pointer to the first Viewer.

d) The No Link symbol displays as the cursor in the first Viewer. Clicking in this Viewer discontinues the link operation.

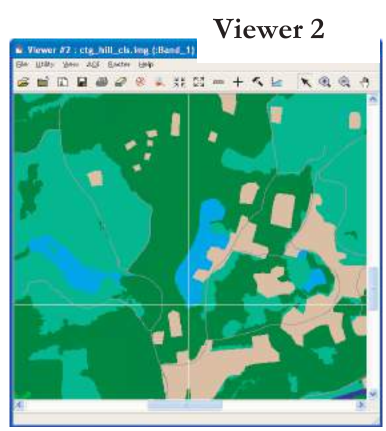
e) To link the Viewers, click anywhere in the second Viewer.

f) The two Viewers are now linked. A white cursor box opens over the image in the second Viewer, indicating the image area displayed in the first Viewer.

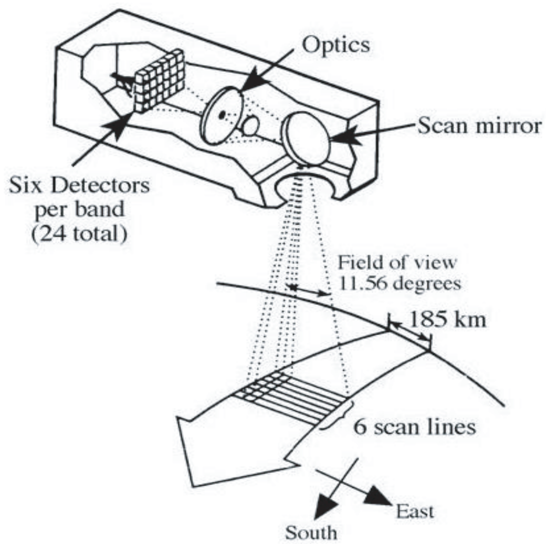
g) You can move and resize this cursor box as desired, and the image area in the first Viewer reflects each change. This is similar to the magnification box you used earlier.



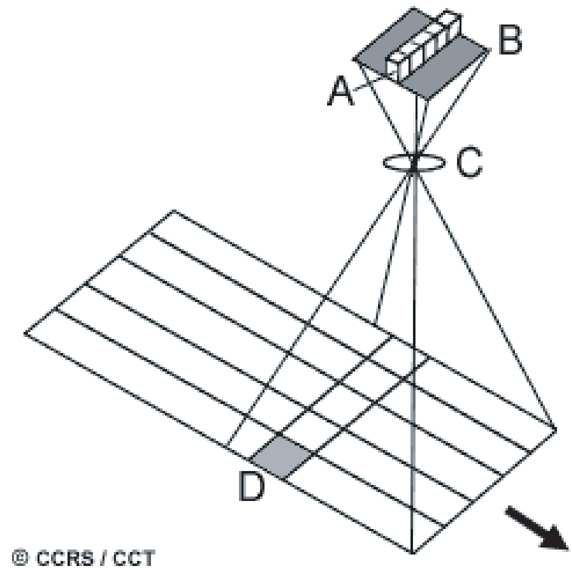
Two Viewers are Geographically linked



Source: ERDAS IMAGINE on line Help for the Link Viewers



Across-Track Scanner



Along Track Scanner

Different Types of Satellite

Satellites can be classified by their functions. Satellites are launched into space to do a specific job. The type of satellite that is launched to monitor cloud patterns for a weather station will be different than a satellite launched to take image of earth surface. The satellite must be designed specifically to fulfill its function.

A **communications satellite** is an artificial satellite for the purpose of telecommunications. They are used for communications to ships, vehicles, planes and hand-held terminals, and for TV and radio broadcasting. (Orbit: 22,300 miles above Earth's Equator)

Earth observation satellites are satellites specifically designed for Earth observation from orbit for non-military uses such as environmental monitoring, meteorology, map making etc. (Orbit: 90 to 300 miles above Earth)

The **weather satellite** is a type of satellite that is primarily used to monitor the weather and climate of the Earth. (Orbit: Geostationary -22,300 miles)

Navigational satellites use radio time signals transmitted to enable mobile receivers on the ground to determine their exact location. (Orbit: 90-300 mi)

Land use and Land Cover Mapping

Land use and cover studies are multidisciplinary and the participants involved in such work are numerous and varied, ranging from international wildlife and conservation foundations, to government researchers, and forestry companies. The land use and land cover information are used for planning, monitoring, and evaluation of development, industrial activity, or land reclamation. The impacts of land-use and land-cover change on carbon dynamics, hydrology, climate change, and biodiversity have been recognized. Changes in land cover will be examined by environmental monitoring researchers, conservation authorities, and departments of municipal affairs, with interests varying from tax assessment to reconnaissance vegetation mapping. Remote-sensing data play an important role in land use and land cover mapping and in land use and land cover modeling for construction, parameterization, and validation. Following is the list of applications of land use and land cover mapping:

- natural resource management
- wildlife habitat protection
- baseline mapping for GIS input
- urban expansion / encroachment
- routing and logistics planning for seismic / exploration / resource extraction activities
- damage delineation (tornadoes, flooding, volcanic, seismic, fire)
- legal boundaries for tax and property evaluation
- target detection - identification of landing strips, roads, clearings, bridges, land/water interface

Shape

Shape refers to the general form, structure, or outline of individual objects. It can be a very distinctive clue for interpretation. Straight edge typically represents urban or agricultural targets. On the contrary, natural features, such as forest edges, are generally, more irregular in shape. Agricultural fields irrigated by rotating sprinkler systems would appear as circular shapes.

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing

Size

It is important to assess the size of a target relative to other objects and the absolute size, to aid in the interpretation of that target. A quick approximation of target size can direct interpretation quickly. For example, large buildings such as factories or warehouses would suggest commercial property, whereas small buildings would indicate residential use.

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing

Lesson Review

- ✓ What is rectification
- ✓ When to rectify and georeferencing satellite images.
- ✓ Rectification steps
- ✓ Geo-referencing in ERDAS IMAGINE
- ✓ Resampling methods

Knowledge and Skills Practice 2: Satellite Image Rectification

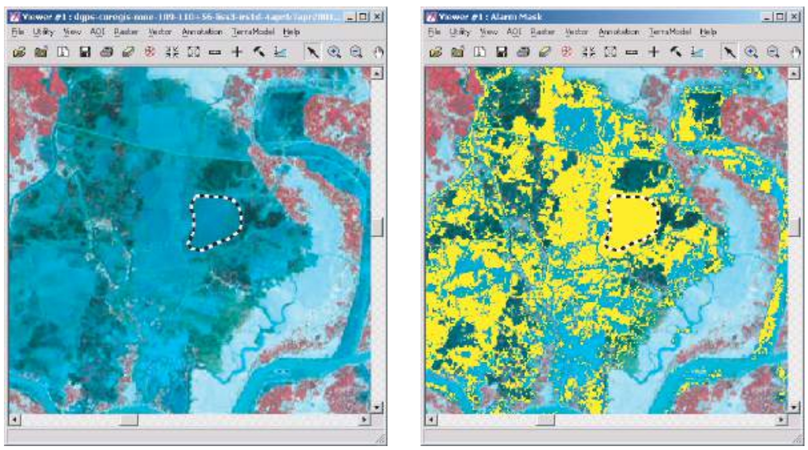
The details of this assignment and data are given in the attached CD of the manual. Please follow the **Knowledge and Skills Practice 2: Satellite Image Rectification.**

The commonly used evaluation methods in ERDAS IMAGINE include:

- **Alarm:** The Image Alarm allows user to quickly see which pixels in the entire image will be classified into a specific category.

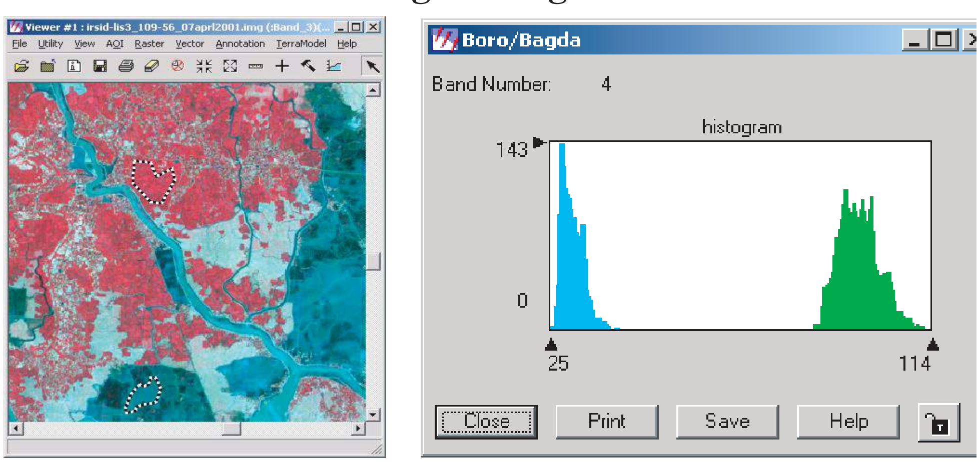
- **Statistics and histograms:** The Histogram Plot shows a frequency distribution of pixel values for a training sample in a one band or all bands at once.

Image Alarm



Select the Signature of Bagda Shrimp
Select Image Alarm from View menu

Image Histogram



Select the Signature of Forest and Bagda Shrimp signature
Select Histogram from View menu

Preface

In January 2013, the United States Agency for International Development (USAID), the Bangladesh Forest Department and the United States Forest Service (USFS) began a collaborative project to address capacity needs in geospatial skills for natural resources management for staff of the Bangladesh Forest Department. Through this project, the USFS, together with local partner Center for Environmental and Geographic information Services (CEGIS), developed and carried out a series of workshops and trainings. These manuals consolidate the coursework and materials from three of these trainings:

1) Global Positioning Systems (GPS) 1
2) GPS 2
3) Training of Trainers for GPS

These courses were developed jointly by CEGIS and the USFS and taught by CEGIS. The initial course provided an introduction to maps and hands-on instruction in the use of GPS units. GPS 2 went more in-depth into the GPS technology, providing training in GPS unit operation, data collection, maps, navigation and data storage. The Final course, Training of Trainers, taught a selected group of Bangladesh Forest Department staff how to teach GPS use to their colleagues, with the plan to replicate this training nationwide.

This series of three manuals has been consolidated by CEGIS with input from the Remote Sensing Applications Center (RSAC) and the Flathead National Forest of the USFS. In addition to the course work, the manuals also include valuable reference materials. They can be used as a refresher for participants in these workshops or other workshops on GPS. Students who want to teach themselves about these subjects can also use these manuals as self-guided teaching materials. Finally, these manuals can be used by instructors to teach foresters or others about GPS tools and their applications.

We hope that these manuals are useful to you to refresh and further develop your GPS skills for management and monitoring of natural resources.

Valids Mezainis
Director, International Programs Office
United States Forest Service

Janina Jaruzelski
Mission Director
United States Agency for International Development / Bangladesh

Md Waji Ullah
Executive Director
Center for Environmental and Geographic Information Service

Primary Colors

Blue, green, and red are the primary colors or wavelengths of the visible spectrum. No single primary color can be created from the other two primary colors, but all other colors can be formed by combining blue, green, and red in various proportions. The sunlight is actually composed of various wavelengths of radiation in primarily the ultraviolet, visible and infrared portions of the spectrum.

Violet	0.400 - 0.446 µm
Blue	0.446 - 0.500 µm
Green	0.500 - 0.578 µm
Yellow	0.578 - 0.592 µm
Orange	0.592 - 0.620 µm
Red	0.620 - 0.700 µm

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.

Infrared Spectrum

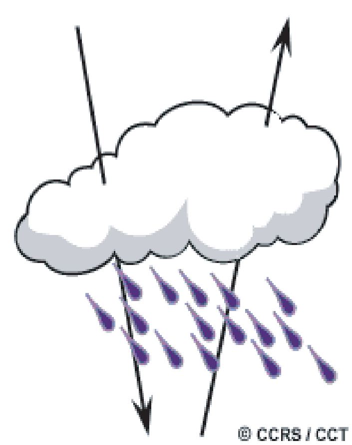
The infrared spectrum region covers the wavelength range from approximately 0.7µm to 100µm. This region can be divided into reflected IR and emitted or thermal IR based on the irradiation properties.

The reflected IR region covers wavelengths from approximately 0.7µm to 3.0µm. This region is further divided into near IR (0.7µm–1.3µm) and mid IR (1.3µm–3µm). The near IR records energy related to vegetation health, while the mid IR is more related to moisture.

The thermal IR covers wavelengths from approximately 3.0µm to 100µm. The energy in this

Microwave Spectrum

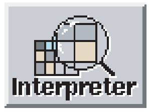
This microwave spectrum covers the longest wavelengths of electromagnetic energy used for remote sensing. It covers the wavelength range from 1mm to 1m. The shorter wavelengths have properties similar to the thermal infrared region while the longer wavelengths approach the wavelengths used for radio broadcasts.



Because of their long wavelengths, microwaves have special properties that are important for remote sensing. Longer wavelength microwave radiation can penetrate through cloud cover, haze, dust, and all but the heaviest rainfall. This property allows detection of microwave energy under almost all weather and environmental conditions so that data can be collected at any time.

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.

Image Interpreter



This menu provides access to the ERDAS IMAGINE Image **Interpreter** functions. It opens when you click the **Interpreter** icon in the ERDAS IMAGINE icon panel

Spatial Enhancement Click to access functions for enhancing images using the values of individual and surrounding pixels. The Spatial Enhancement menu displays.

Radiometric Enhancement Click to access functions for enhancing images using the values of individual pixels within each band. The Radiometric Enhancement menu displays.

Spectral Enhancement Click to access functions for enhancing images by transforming the values of each pixel on a multiband basis. The Spectral Enhancement menu displays.

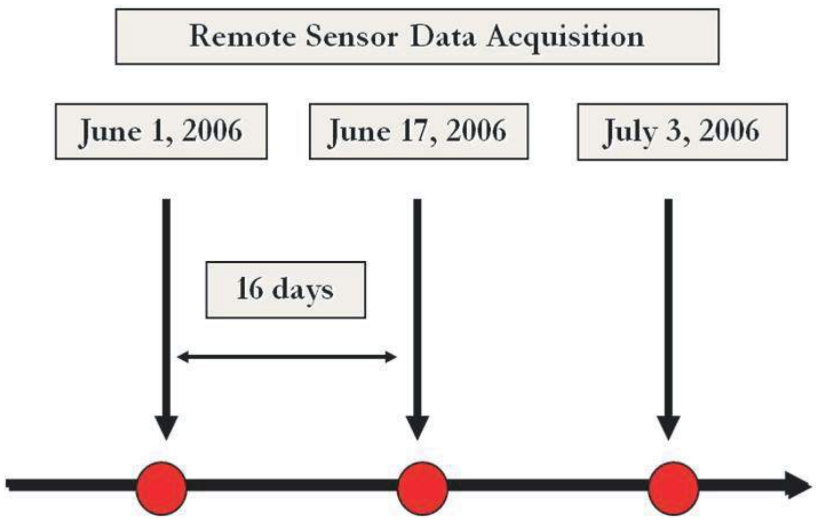
GIS Analysis Click to access functions for use on thematic data layers. The GIS Analysis menu displays.

Utilities... Click to access some common utilities used on raster layers. The Utilities menu displays.

Source: ERDAS IMAGINE® Tour Guides™. (2006). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

Temporal Resolution

Temporal resolution refers to how often a sensor obtains imagery of a particular area. For example, the Landsat satellite can view the same area of the globe once every 16 days. SPOT, on the other hand, can revisit the same area every three days. Temporal resolution is an important factor to consider in change detection studies.



Jensen 20007

Digital Image Format in Remote Sensing

Satellite image data is available in the following four different formats:

TIFF: It stands for Tagged Image File Format. It is one of the most popular and flexible of the current public domain raster file formats. In TIFF files, information about the file structure is stored in so-called "tags".

GeoTIFF: is an emerging standard for storing georeferenced image data. It is widely supported in remote sensing and GIS software such as ERDAS Imagine, ENVI, ArcGIS etc.

The Hierarchical Data Format (HDF) is a multi-object file format for sharing scientific data in a distributed environment.

MrSid: It is a powerful wavelet-based compressor. This data enable instantaneous viewing and manipulation of massive images locally and over networks, while maintaining maximum image quality and manageability.

Raster Attribute Editor

The Raster Attribute Editor provides access to the properties saved in the Descriptor Table for each layer of a raster file. The Descriptor Table is part of the .img file. The Raster Attribute Editor allows you to edit, add, or delete attributes as well as perform functions with them. The changes effected by these operations can be saved with the image file.

There are several ways to access the Raster Attribute Editor:

Select **Tools > Edit Raster Attributes...** from the ERDAS IMAGINE icon panel.

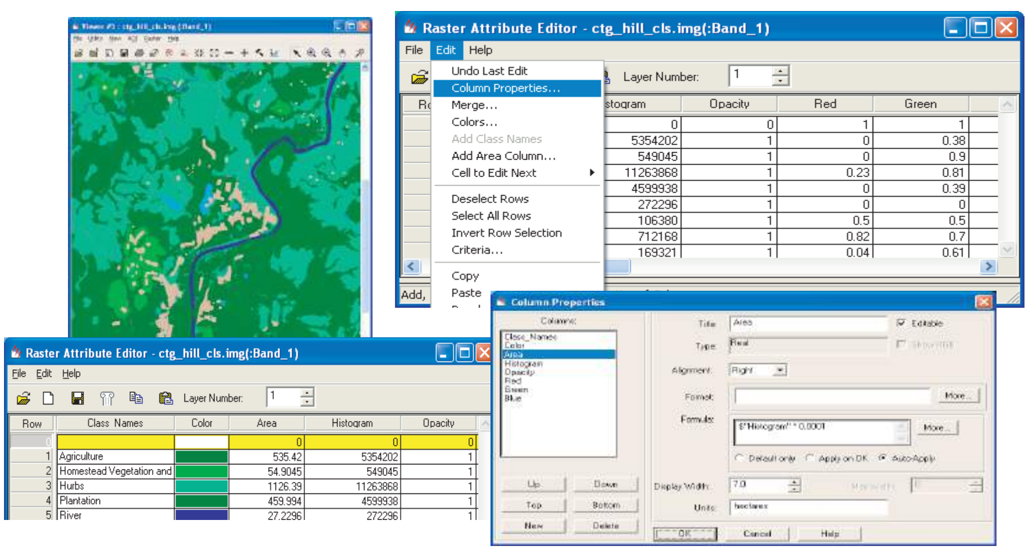
Select **Edit > Raster Attribute Editor...** from the ImageInfo menu bar. This method allows access to any layer of any .img file.

Select **Raster > Attributes...** from the Viewer menu bar. This method operates on the layer open in ImageInfo.

<u>Edit Column Properties</u>

This dialog enables you to add, remove, and rearrange attribute columns. You may change the alignment and format of data and the width of columns.

Click **Edit > Column Properties...** on the Raster Attribute Editor menu bar, or click the  icon on the toolbar to access this dialog.



Source: ERDAS IMAGINE on line Help for the Raster Attribute Editor

Earth Observation Satellites

Earth Observation satellites vary according to the type of orbit they have, the payload they carry, and, from the point of view of imaging instruments, the spatial resolution, spectral characteristics and swath width of the sensors. A high resolution sensor would be required for mapping of buildings destroyed by an earthquake, planning for transmission lines, roads and railroads and detail mapping of natural resources. Such a sensor would generally have a narrow swath and be on a satellite at Low Earth Orbit, called LEO (such as 600 km above the Earth in the case of the QuickBird satellite).

Satellite	Owner/maintained by	Launched on
WorldView - 2	DigitalGlobe, USA	8-Oct-09
GeoEye - 1	GeoEye, USA	6-Sep-08
WorldView - 1	DigitalGlobe, USA	18-Sep-07
Cartosat 2	ISRO, India	10-Jan-07
KompSat - 2	Korea	28-Jul-06
ALOS	JAXA, Japan	24-Jan-06
Cartosat 1	ISRO, India	5-May-05
FormoSat - 2	NSPO, China (Taiwan)	19-May-04
OrbView 3	ORBIMAGE, USA	26-Jun-03
SPOT5	Spot Image, France	4-May-02
QuickBird	DigitalGlobe, USA	18-Oct-01
IKONOS	GeoEye, USA	24-Sep-99

Geology

Geology involves the study of landforms, structures, and the subsurface, to understand physical processes creating and modifying the Earth's crust. Remote sensing is used as a tool to extract information about the land surface structure, composition or subsurface. Information on lithology or rock composition may be extracted from multispectral images based on spectral reflectance. Radar provides information of surface topography and roughness, and it is extremely valuable when integrated with another data source to provide detailed relief. Application of Remote Sensing in the field of Geology may include:

- lithological mapping
- structural mapping
- sand and gravel (aggregate) exploration/ exploitation
- mineral exploration
- hydrocarbon exploration
- environmental geology
- baseline infrastructure
- sedimentation mapping and monitoring
- event mapping and monitoring
- geo-hazard mapping

Hydrology

Abilities of remote sensing technology in hydrology are to measure spatial, spectral, and temporal information and provide data on the state of the earth's surface. It provides observation of changes in hydrological states, which vary over both time and space that can be used to monitor hydrological conditions and changes. Both active sensors that send a pulse and measure the return pulse (like radar, microwave etc.) and passive sensors that measure emissions or reflectance from natural sources (like Sun, thermal energy of the body) are used. Sensors can provide data on reflective, thermal and dielectric properties of earth's surface.

Remote sensing techniques indirectly measure hydrological variables, so the electromagnetic variables measured by remote sensing have to be related to hydrological variables empirically or with transfer functions. Application of remote sensing in the field of hydrology:

- wetlands mapping and monitoring,
- soil moisture estimation,
- snow pack monitoring / delineation of extent,
- measuring snow thickness,

Lesson Review

- ✓ Knowledge for Image Interpretation
- ✓ Elements of Image Interpretation like Image Tone, Image Texture, Shadow, Patterns, Association, Shape, Size and their significance.

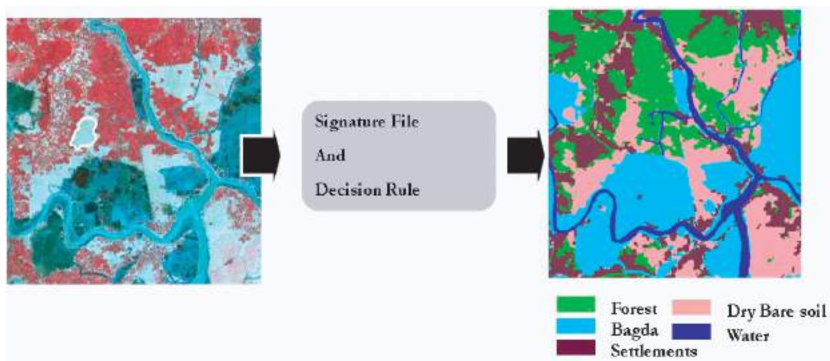
Perform Classification Process

Once a set of reliable signatures has been created and evaluated, each pixel is compared to each signature, according to a decision rule, or algorithm. In general, 3 methods are used to make decisions regarding pixel assignments:

- Parallelepiped
- Minimum distance
- Maximum likelihood

(See Advanced Training Manual for more detailed description of the decision rules.)

Pixels that pass the criteria which are established by the decision rule are then assigned to the class for that signature

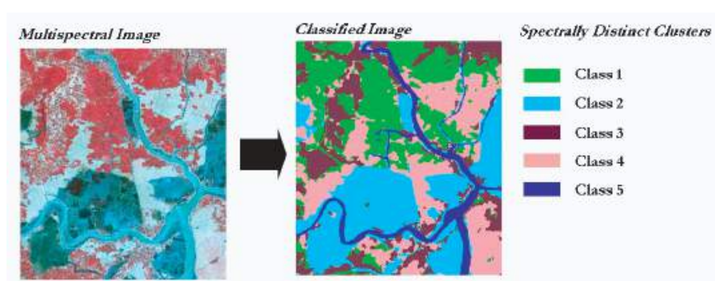


Unsupervised Classification

In Unsupervised classification, spectral classes are grouped first, based solely on the numerical information in the data, and are then matched by the analyst to information classes.

In ERDASR Imagine, ISODATA clustering algorithm is used to determine statistical groupings or structures in the data. Usually, the analyst specifies how many groups or clusters are to be looked for in the data. The analyst also specifies parameters related to the separation distance among the clusters and the variation within each cluster.

The final result of this iterative clustering process may result in some clusters that the analyst will want to subsequently combine, or clusters.
Steps of Unsupervised Classification:



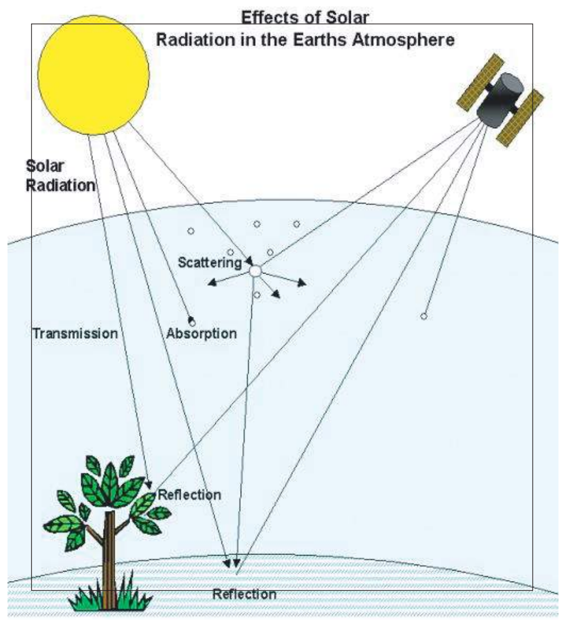
1. Run ISODATA algorithm
2. Evaluating and assign names to classes
3. Recoding or merging classes

Source:
Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.
ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

Table of Contents

Interactions with the Atmosphere

When electromagnetic energy passes through atmosphere, it is scattered or absorbed mainly by particles and molecules of several gases (for example water vapor, carbon dioxide, and ozone) in the Earth's atmosphere. Some radiation, such as visible light, largely passes through the atmosphere.



Atmospheric Scattering

Atmospheric scattering occurs when particles (aerosols and dust particles) or large gas molecules in the atmosphere interact with electromagnetic radiation and cause it to be redirected from its original path. The amount of scattering depends on the wavelength of the radiation, the abundance of particles or gases, and the travel distance of the radiation.

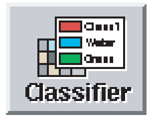
Types of Scattering

Scattering is a function of the wavelength of the electromagnetic energy, the size of the gas molecule, dust particle and water vapor droplet encountered. There are three types of scattering:

Rayleigh scattering: Such phenomena occur when electromagnetic radiation interacts with particles which are very small compared to the wavelength of the radiation. Such particles are very small dust or nitrogen and oxygen molecules. In this process, shorter wavelengths of energy are scattered much more than longer wavelengths. It is the dominant scattering mechanism in the upper atmosphere.

Mie scattering: Such phenomena occur when electromagnetic radiation interacts with particles which are about the same size as the wavelength of the radiation. It occurs in the lower portions of the atmosphere where larger particles are abundant, and dominants when cloud conditions are overcast.

Image Classification



Classification is the process of sorting pixels into a finite number of individual classes, or categories of data, based on their data file values. If a pixel satisfies a certain set of criteria, then the pixel is assigned to the class that correspond the set of criteria.

For the first part of the classification process, the computer system must be trained to recognize patterns in the data. Training is the process of defining the criteria by which these patterns are recognized. The result of training is a set of signatures, which are criteria for a set of proposed classes.

There are two ways to classify pixels into different categories: supervised and unsupervised Many of the Classification tools can also be accessed through the Signature Editor.

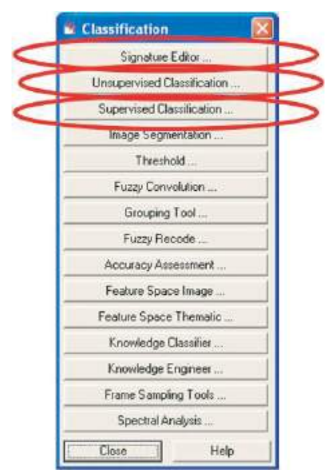
This menu displays when you click the Classifier icon on the ERDAS IMAGINE icon panel.

Signature Editor click to open the Signature Editor. This utility allows you to create, manage, evaluate, edit, and classify signatures.

Unsupervised Classification Click to open the Unsupervised Classification dialog. This utility lets you perform an unsupervised classification on an .img file using the ISODATA algorithm. This utility can also be accessed from the Signature Editor.

Supervised Classification Click to open the Supervised Classification dialog. This utility allows you to perform a supervised classification on an .img file using various decision rules. This utility can also be accessed from the Signature Editor.

Source: ERDAS



Source: IMAGINE® Tour Guides™. (2006). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

Introduction to IMAGINE Viewer

The ERDAS IMAGINE Viewer is the "main window" for displaying raster, vector, and/or annotation data. You can open as many Viewers as your window manager supports. Following are the IMAGINE viewer functions:

Using Utility Menu Options	The Utility menu on the Viewer enables you to access four separate groups of functions; inquiry functions, measurement tool, layer viewing and information. Each function group is separated by a line in the pull down menu.
Viewing Menu Options	The Viewing menu on the Viewer enables you to access Arrange Layers, Zooming and Linking Viewers functions.
Using Raster Menu Options	The Raster menu is available whenever a raster view pane is active.
Using the Raster Attribute Editor	The Raster Editor enables you to edit portions of the displayed image using various tools in the Viewer Raster menu. When a specific raster editing tool is in use, that tool locks the Viewer, therefore, work with one tool must be completed before opening another one.
Using Profile Tools	The spectral profile display is fundamental to the analysis of hyper-spectral data sets. As the number of bands increases and the band widths decrease, the remote sensor is evolving toward the visible/infrared spectrometer. The reflectance (DN) of each band within one (spatial) pixel can be plotted to provide a curve approximating the profile generated by a laboratory scanning spectrometer

Source: ERDAS IMAGINE on line Help file on Viewer

Spectral Profile Tools

This dialog enables you to select which Profile Tool to open. It opens when you click the icon on the Viewer toolbar, , or when you select **Raster > Profile Tools...** from the Viewer menu bar.

Select the Profile you want to view.

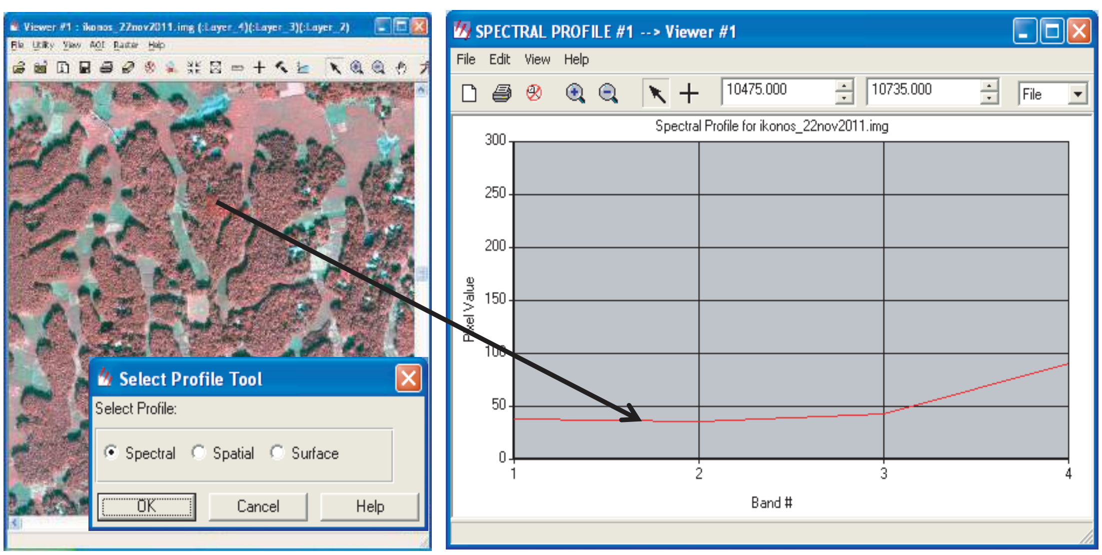
Spectral - Select this option to open the Spectral Profile dialog.

Spatial - Select this option to view the Spatial Profile dialog.

Surface - Select this option to view the Surface Profile dialog.

OK - Click to view the selected profile and close this dialog.

Cancel - Click to cancel this process and close this dialog.



Source: ERDAS IMAGINE on line Help for the Spectral Profile Tools

WorldView-2

DigitalGlobe's WorldView-2 satellite sensor, launched in October 8, 2009, provides 0.46m Panchromatic (B&W) mono and stereo satellite image data. The WorldView-2 sensor provides a high resolution Panchromatic band and eight (8) Multispectral bands, full-color images for enhanced spectral analysis, mapping and monitoring applications, land-use planning, disaster relief, exploration, defense and intelligence, and visualization and simulation environments.

Image Copyright © DigitalGlobe

Sensor Characteristics

Orbit Altitude	770 kilometers
Orbit Type	Sun synchronous
Sensor Bands	Panchromatic 8 Multispectral (4 standard colors: red, blue, green, near-IR), 4 new colors: red edge, coastal, yellow, near-IR2
Sensor Resolution GSD	Ground Sample Distance Panchromatic: 0.46 meters GSD at Nadir, 0.52 meters GSD at 20° Off-Nadir Multispectral: 1.84 meters GSD at Nadir, 2.4 meters GSD at 20° Off-Nadir
Dynamic Range	11-bits per pixel
Swath Width	.4 kilometers at nadir

Burma, Ragoon, Myanmar
Shwedagon Pagodas

Bin Kaneh, Iran
Destroyed Missile Facility

Dubai, UAE
Palm Jumeirah Island

Source: http://www.satimagingcorp.com/satellite-sensors/worldview-2/

- determining snow-water equivalent,
- river and lake ice monitoring,
- flood mapping and monitoring,
- glacier dynamics monitoring (surges, ablation)
- river /delta change detection
- drainage basin mapping and watershed modelling
- irrigation canal leakage detection
- irrigation scheduling

Source: http://ces.iisc.ernet.in/energy/monograph1/Gispage7.html

Coastal Monitoring

The coastal zone is a region subjected to increasing stress from human activity and natural disasters. Government agencies concern with the impacts of human activities and natural disasters in this region need new data sources for monitoring erosion and accretion, loss of natural habitats, urbanization, land use and land cover, effluent sand offshore pollution. Many of the changes in the coastal region and dynamics of the open ocean can be mapped and monitored using remote sensing techniques. Major application includes:

Oil spill

- mapping and predicting oil spill extent and drift
- strategic support for oil spill emergency response decisions
- identification of natural oil seepage areas for exploration

Fish stock and marine mammal assessment

- water temperature monitoring
- water quality
- ocean productivity, phytoplankton concentration and drift

Intertidal zone

- tidal and storm effects
- delineation of the land /water interface
- mapping shoreline features / beach dynamics
- coastal vegetation mapping
- human activity / impact

Satellite Image Rectification

Objective

By the end of this lesson, through the knowledge and skills practice the participants will be able to:

1. Define rectification.
2. Explain when to rectify and geo-referencing satellite images.
3. Explain the Rectification steps
4. Geo-reference the satellite images using ERDAS Imagine software.
5. Tell and describe the four resampling methods and explain their significance.

Satellite Image Classification

Objective

By the end of this lesson, through the knowledge and skills practice the participants will be able to:

1. Explain what is classification and its significance
2. Delineate the classification process
3. Classify the image using supervised and unsupervised methods.

Lesson Review

- ✓ Classification and its processes
- ✓ Classification scheme
- ✓ Methodology of supervised and unsupervised classification

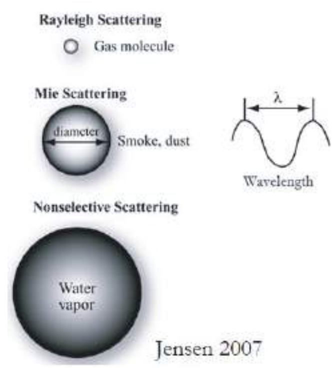
Knowledge and Skills Practice 3: Satellite Image Classification

The details of this assignment and data are given in the attached CD of the manual. Please follow the **Knowledge and Skills Practice 3: Satellite Image Classification.**

Nonselective scattering: Such phenomena occur when electromagnetic radiation interacts with particles which are much larger (water droplets and large dust particles) than the wavelength of the radiation. In this process, all wavelengths are scattered about equally.

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.

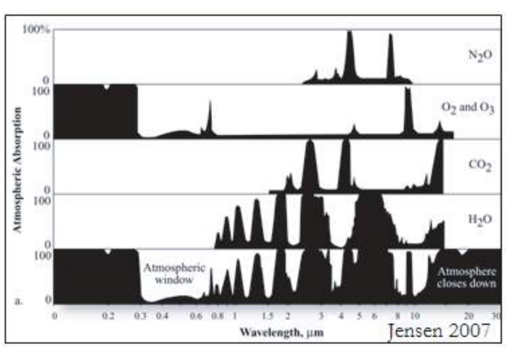
The figure shows the relative size of the atmospheric particles that are responsible for various scattering of the electromagnetic radiation in the atmosphere.

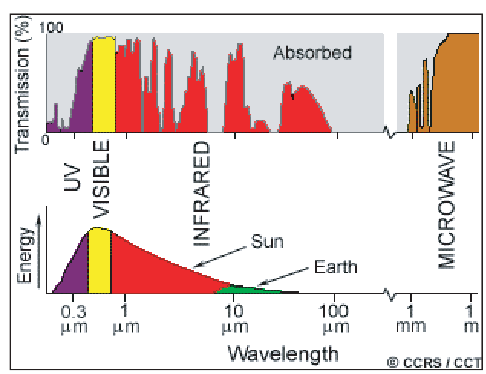


Atmospheric Absorption

Absorption causes molecules in the atmosphere to absorb electromagnetic energy at various wavelengths when it interacts with the atmospheric constituents. Ozone, carbon dioxide, and water vapor are the three main atmospheric constituents which absorb electromagnetic energy. Ozone absorbs the harmful ultraviolet radiation from the sun. Carbon dioxide, referred to as a greenhouse gas, absorbs radiation strongly in the far infrared portion of the electromagnetic spectrum which serves to trap this heat inside the atmosphere. The incoming long wave infrared and shortwave microwave radiation (between 22 and 1m) are absorbed by water vapor in the atmosphere.

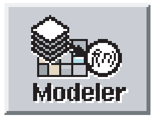
Atmospheric windows: The regions of the electromagnetic spectrum, which are not severely influenced by atmospheric absorption and useful to remote sensing, are called atmospheric windows.





Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.

Spatial Modeler



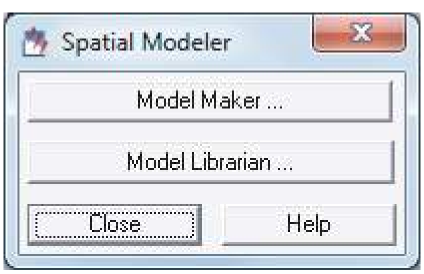
Spatial Modeler enables you to create and run models for image processing and GIS analysis. It is a highly flexible tool that uses Model Maker and the Spatial Modeler Language.

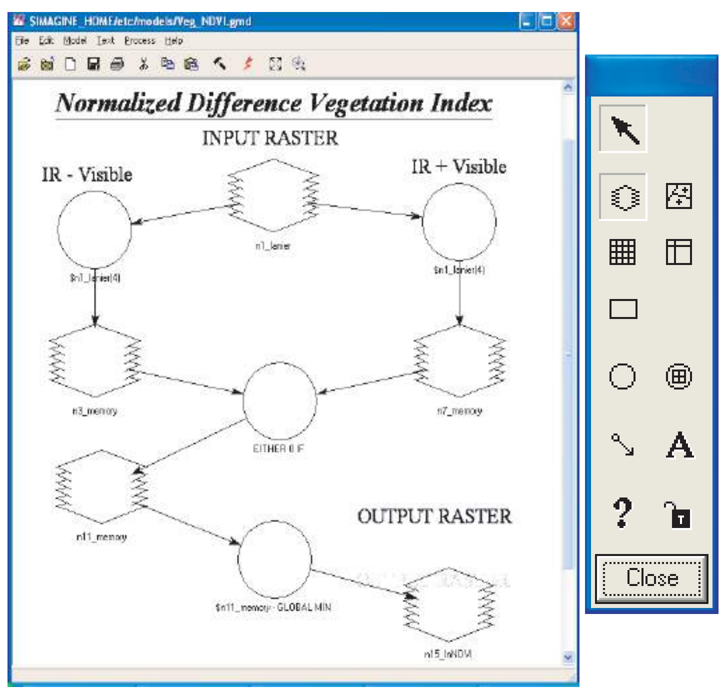
The Spatial Modeler Language is a modeling language that is used internally by Model Maker to execute the operations specified in the graphical models that you create. You can also use the Spatial Modeler Language directly to write your own script models.

Click this icon on the ERDAS IMAGINE icon panel to access Spatial Modeler:

Model Maker Click to open the Model Maker window and the Model Maker Tool palette. This window allows you to work with graphical models. You can view or edit existing models and create new models.

Script Librarian Click to open the Model Librarian dialog. This dialog lists all the existing script models in the system. Using this option, you can view, edit, create, and delete script models.

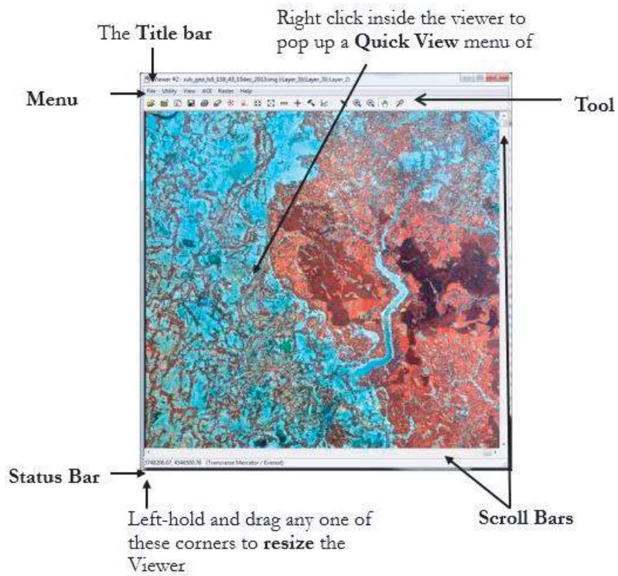




Source: ERDAS IMAGINE® Tour Guides™. (2006). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

Parts of Viewer Window

The parts of the Viewer window are explained in the following illustration. Left - hold and drag any one of these corners to resize the Viewer.



Title bar The **Title Bar** shows the number of the Viewer, which is referred to in other operations

Menu bar Left-hold on Viewer **Menu Bar** item for list of operations to perform on the displayed data

Tool bar The **Tool Bar** consists of icons to provide rapid access to frequently used operations

Status Bar Information about the button under the cursor is displayed in this **Status Bar**.

Scroll Bars Use **Scroll Bars** to scroll the data. The size of the bar in the panel shows how much of the data area you are viewing now.

Quick View Menu Right click inside the viewer to pop up a **Quick View Menu** of frequently used functions.

Help for Viewer Select this option to see this On-Line Help document

Source: ERDAS IMAGINE on line Help file on Viewer

AOI Tools

The AOI Tools enable you to select, create, and edit areas of interest (AOIs). An AOI is a point, line, or polygon that is selected as a training sample or as the image area to be used in an operation. They are often used as input to the Signature Editor prior to image classification.

This tool palette opens when you select **AOI -> Tools**... from the Viewer menu bar.


Click to select, move, and resize AOI elements.


Click to select all AOI elements that fall within the boundary of the rectangular marquee that you draw.


Click to create a rectangular AOI.

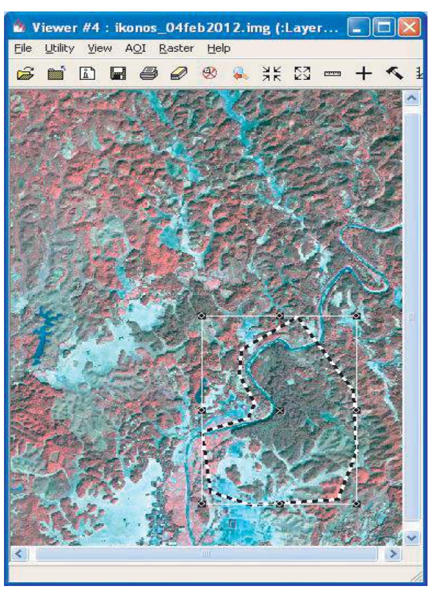

Click to create an elliptical AOI.

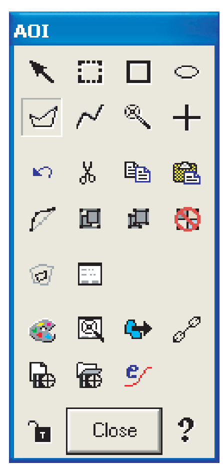

Click to create a polygonal AOI. Click to add each vertex. Double-click to close the polygon.


Click to create a polyline AOI. In the Viewer, click to add each vertex. Double-click to end the polyline.


Click to select a single pixel from which an AOI grows.


Click to create a point AOI.





AOI Tools

Source: ERDAS IMAGINE on line Help for the AOI Tools

SPOT

SPOT is a commercial high-resolution optical imaging Earth observation satellite system operating from space. It is run by Spot Image, based in Toulouse, France. It has been designed to improve the knowledge and management of the Earth by exploring the Earth's resources, detecting and forecasting phenomena involving climatology and oceanography, and monitoring human activities and natural phenomena. The SPOT system includes a series of satellites and ground control resources for satellite control and programming, image production, and distribution.

Image Copyright © AIRBUS Defense & Space

History of SPOT Satellites

- SPOT 1 launched February 22, 1986 with 10 meter panchromatic and 20 meter multispectral picture resolution capability. Withdrawn on December 31, 1990.
- SPOT 2 launched January 22, 1990 and deorbited in July 2009.
- SPOT 3 launched September 26, 1993. Stopped functioning in November 14, 1997.
- SPOT 4 launched March 24, 1998. Stopped functioning in July, 2013.
- SPOT 5 launched May 4, 2002 with 2.5 m, 5 m and 10 m capability.

<u>More about SPOT 5</u>

SPOT 5 has the goal to ensure continuity of services for customers and to improve the quality of data and images by anticipating changes in market requirements. SPOT 5 has two high resolution geometrical (HRG) instruments that were deduced from the HRVIR of SPOT 4.

They offer a higher resolution of 2.5 to 5 meters in panchromatic mode and 10 meters in multispectral mode (20 m on short wave infrared 1.58 – 1.75 µm).

SPOT 5 also features an HRS imaging instrument operating in panchromatic mode. HRS points forward and backward of the satellite. Thus, it is able to take stereo pair images almost simultaneously to map relief.

Lesson Review

- ✓ Information about sensors, platforms, satellite orbit, satellite swath and multispectral scanning
- ✓ Different types of satellites and their use
- ✓ Different Earth Observation satellites and their significance.
- ✓ Different applications of satellite image

Rectification

Rectification is the process of transforming the data from one grid system into another grid system using a geometric transformation. To be able to compare separate images pixel by pixel, the pixel grids of each image must conform to the other images in the data base.

Registration is the process of conforming an image to another image. For example, if image A is not rectified and it is being used with image B, then image B must be registered to image A so that they conform to each other.

Geo-referencing refers to the process of assigning map coordinates to image data. The image data may already be projected onto the desired plane, but not yet referenced to the proper coordinate system.

Rectification involves geo-referencing, since all map projection systems are associated with map coordinates. Image-to-image registration involves geo-referencing only if the reference image is already georeferenced. Geo-referencing, by itself, involves changing only the map coordinate information in the image file. The grid of the image does not change.

When to Rectify ?

There are several reasons for rectifying image data:

comparing pixels scene to scene in applications, such as change detection or thermal inertia mapping (day and night comparison)

developing GIS data bases for GIS modeling identifying training samples according to map coordinates prior to classification

creating accurate scaled photomaps and overlaying an image with vector data, such as ArcInfo

comparing images that are originally at different scales

extracting accurate distance and area measurements

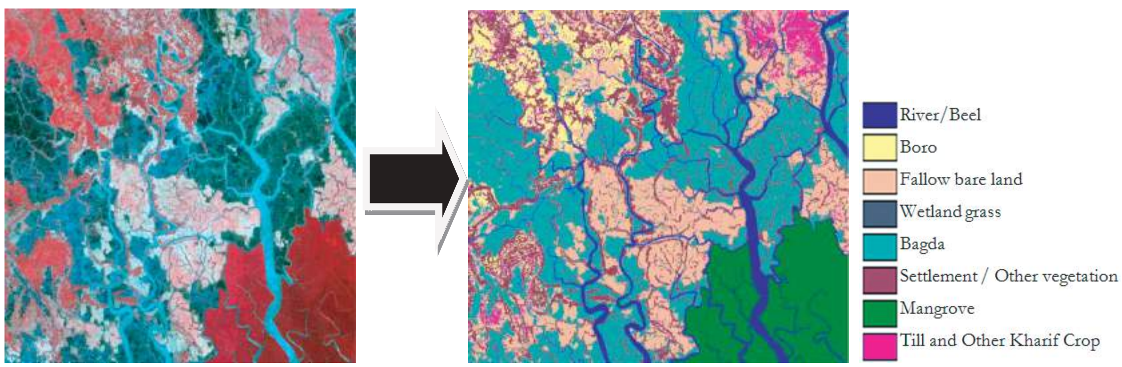
mosaicking images and performing any other analyses requiring precise geographic locations

Before rectifying the data, you must determine the appropriate coordinate system for the data base.

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

What is Classification ?

Classification is the process of sorting pixels into a finite number of individual classes, or categories of data, based on their data file values. If a pixel satisfies a certain set of criteria, the pixel is assigned to the class that corresponds to those criteria. The objective of image classification is to assign all pixels in the image to particular classes or themes (e.g. forest, water, settlements, fallow land, etc.). The resulting classified image is a thematic "map" of the original image.



Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

Information Class and Spectral Class

It is important to distinguish between information classes and spectral classes.

Information classes are those classes that the analyst is actually trying to identify from analysis of images, such as different forest types or tree species, different kinds of crops, different geologic units or rock types, etc.

Spectral classes are groups of pixels which are similar or near similar with respect to their brightness values in the different spectral bands of the data. The objective is to match the spectral classes in the data to the information classes of interest.

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing

Introduction

The manual on Basic Remote Sensing and GIS is for the trainees and trainers with different objectives.

This manual has been designed as a resource tool for those who would be using remote sensing and GIS in their area of work. It is expected that the Basic Remote Sensing and GIS manual will substantially enhance the capacity of those who will be imparting information and knowledge on the same as Trainers, and develop the capacity of those Trainees to whom these information and knowledge will be imparted.

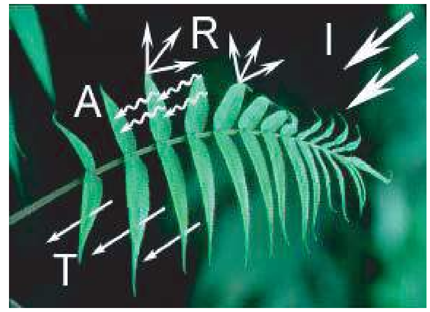
The Trainees or the participants of the training on RS & GIS will go –post training-through the manual in order to reinforce their learning of the fundamentals of the remote sensing processes, use of GIS and to apply the learnt skills, effectively.

The Trainers will go through this manual to make an assessment of their own knowledge and understanding of the subject, fill their own knowledge gaps on this subject matter, if found any, and decide on the suitable approach to present/facilitate knowledge and skills learning to the trainees, effectively. They may use this manual a support material for conducting sessions.

The contents of the manual are organized under 9(Nine) sections or Lessons. Each Lesson comprises a lecture [composed of several topics that cover the main subject of the Lecture] and an end-of-lesson knowledge and skills practice session wherever required. In addition, key objectives to be achieved after completion of each Lesson, have been stated clearly so that the user is focused on the learning being transferred through each lesson. Topic-wise detailed notes have also been included as supplementary information. Moreover, notes also include additional reference links. Knowledge and skills practice session is given with a view to help the users to assess what they learn from each lesson and explore the significance of ERDAS Imagine software and ArcGIS software in Remote Sensing and GIS.

In overall, this RS & GIS manual is intended to assist in developing human resource capacity for Bangladesh Forest Department through a clear understanding of and practice on basics of Remote Sensing and GIS concepts and their different applications.

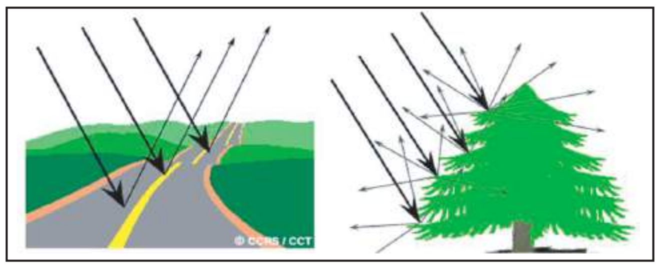
Interaction with Targets



When energy incident upon the surface, three forms of interaction take place: absorption (A); transmission (T); and reflection (R).The proportions of each depends on the wavelength of the energy and the material and condition of the feature.

Absorption (A) occurs when energy is absorbed into the target. Transmission (T) occurs when radiation passes through a target and Reflection (R) occurs when radiation "bounces" off the target. In remote sensing, the radiation reflected from targets is measured.

There are two extreme ends of the way in which energy is reflected from a target: **specular reflection** and **diffuse reflection**.



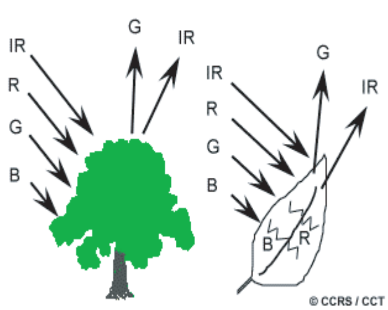
Specular Reflection: When a surface is smooth we get specular or mirror-like reflection where almost all of the energy is directed away from the surface in a single direction.

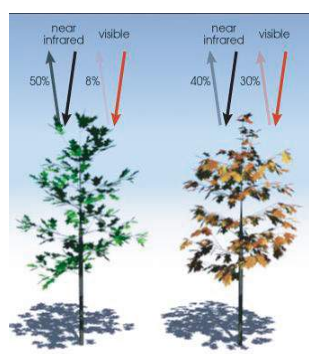
Diffuse reflection: such reflection occurs when the surface is rough and the energy is reflected almost uniformly in all directions.

Interactions with Vegetation

Chlorophyll in leaves strongly absorbs radiation in the red and blue wavelengths but reflects greenwavelengths. That is why leaves appear green. It appears "greenest" in the summer, whenchlorophyll content is at its maximum. In autumn, there is less chlorophyll in the leaves, so there isless absorption and proportionately more reflection of the red wavelengths, making the leavesappear red or yellow.

The internal structure of healthy leaves act as excellent diffuse reflectors of near-infrared wavelengths. Measuring and monitoring the near-IR reflectance in remote sensing, one can determine how healthy (or unhealthy) vegetation may be.





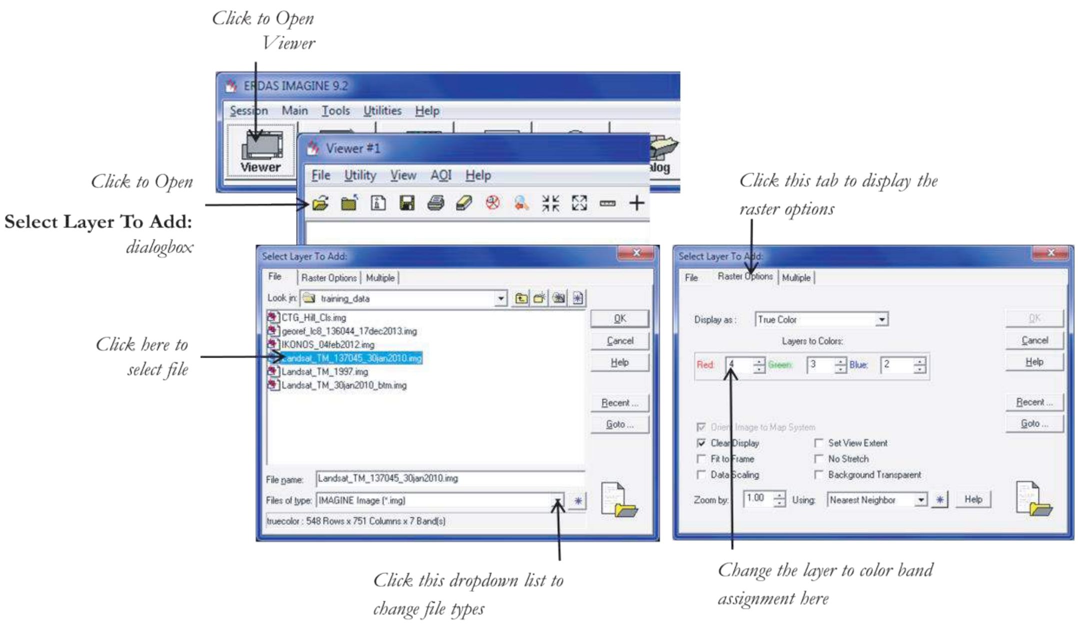
http://earthobservatory.nasa.gov/Features/Measuring Vegetation/measuring_vegetation_2.php

Lesson Review

- ✓ Remote Sensing and its Process
- ✓ Electromagnetic energy and different regions of Electromagnetic spectrum
- ✓ Interaction of Electromagnetic energy with Atmosphere and targets.
- ✓ Passive and Active Remote Sensing
- ✓ Data Reception, Transmission and Processing
- ✓ Information about different image processing software
- ✓ Introduction to ERDAS IMAGINE software

Displaying an Image

In the Viewer menu bar, select **File | Open | Raster Layer** or Click  to open raster layer.



Select Layer to Add : Select file type from **File of Type** dropdown list and select the raster data to open.

Raster Options : Click on Raster Options and choose following raster options:

Display as :
True Color - appropriate for most interval or ratio multiband images; Pseudo Color - appropriate for nominal or ordinal images in one band; Gray Scale - appropriate for a single band of interval or ratio data.

Layer to color: Red :
Enter the band to display in the red color channel; **Green**: Enter the band to display in the green color channel; **Blue**: Enter the band to display in the blue color channel.

Clear Display- When this checkbox is enabled, and a new image is loaded, the image currently displayed in the Viewer is removed. Disable this checkbox to overlay images.

Fit to Frame- If this checkbox is enabled, the image is magnified or reduced to fit the Viewer window at its current size.

No Stretch- Click to display data without applying the normal two standard deviation stretch.
Using - Use one of the following resampling methods: Nearest Neighbor, Bilinear Interpolation, Cubic Convolution, and Bi-cubic Spline.

Lesson Review

- ✓ Satellite Image Data
- ✓ Bands
- ✓ Multispectral Satellite Image
- ✓ Different types of Raster Layer
- ✓ Different types of Resolution and their significance
- ✓ Different format of Digital Images
- ✓ Introduction of Image Viewer and its different functions.

Knowledge and Skills Practice 1: Satellite Image Characteristics and Viewer Functions

The details of this assignment and data are given in the attached CD of the manual. Please follow the **Knowledge and Skills Practice 1: Satellite Image Characteristics and Viewer Functions.**

RapidEye

The RapidEye constellation of five Earth Observation satellites has been in operation since February 2009. The system images a 77 kilometer wide swath, which produces more than five million square kilometers of earth every day for its archive and over one billion km2 every year.RapidEye's sensors produce imagery in five spectral bands (Red, Green, Blue, Red Edge and Near Infrared).

BlackBridge satellites include the Red-Edge band, which is sensitive to changes in chlorophyll content. Several studies have suggested that the transition between the red absorbance and the Near-Infrared (NIR) reflection is able to provide additional information about vegetation and its characteristics.

Five Constellation Satellites (Image Copyright © BlackBridge)

Satellite Specification

Number of Satellites: 5
Orbit Altitude: 630 km in Sun-synchronous orbit
Sensor Type: Multi-spectral push broom imager
Global Revisit Time: 1 Day
Pixel size (ortho-rectified): 5 m
Swath Width: 77 km
Revisit time: Daily (off-nadir) / 5.5 days (at nadir)
Dynamic Range: 12 bit

Burghausen, Germany

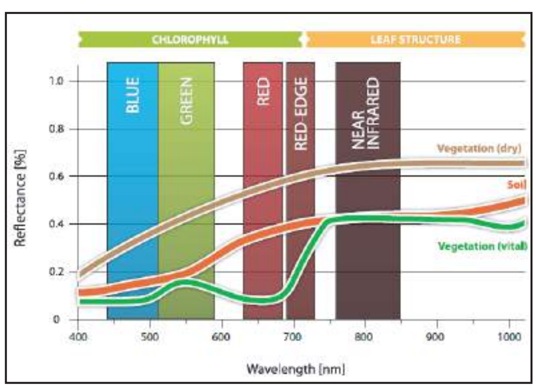
Oahu, Hawaii

Source : http://www.satimagingcorp.com/satellite-sensors/other-satellite-sensors/rapideye/

Source: BlackBridge. WHITE PAPER The RapidEye Red Edge Band
https://earth.esa.int/web/guest/missions/3rd-party-missions/current-missions/rapideye
http://www.satimagingcorp.com/satellite-sensors/other-satellite-sensors/rapideye/

Spectral Bands

440 – 510 nm (Blue)
520 – 590 nm (Green)
630 – 685 nm (Red)
690 – 730 nm (Red Edge)
760 – 850 nm (Near IR)



Typical spectral reflectance curves of selected surfaces inrelation to the RapidEye spectral bands

Source: BlackBridge. WHITE PAPER The RapidEye Red Edge Band.

Satellite Image Interpretation

Objective

By the end of this lesson, the participants will be able to:

1. Explain the knowledge for interpretation of satellite image
2. Explain fully the elements of image interpretation.

When to Geo-reference ?

Scanning and digitizing produce images that are planar, but do not contain any map coordinate information. These images need only to be georeferenced. In many cases, the image header can simply be updated with new map coordinate information. This involves redefining the:

· map coordinate of the upper left corner of the image

· cell size (the area represented by each pixel)

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

Disadvantages of Rectification

During rectification, the data file values of rectified pixels must be resembled to fit into a new grid of pixel rows and columns. Although some of the algorithms for calculating these values are highly reliable, some spectral integrity of the data can be lost during rectification. If map coordinates or map units are not needed in the application, then it may be wiser not to rectify the image. An unrectified image is more spectrally correct than a rectified image

Classification

Some analysts recommend classification before rectification, since the classification is then based on the original data values. Another benefit is that a thematic file has only one band to rectify instead of the multiple bands of a continuous file.

On the other hand, it may be beneficial to rectify the data first, especially when using GPS data for the GCPs. Since these data are very accurate, the classification maybe more accurate if the new coordinates help to locate better training samples.

Thematic Files

Nearest neighbor is the only appropriate resampling method for thematic files.

Rectification Steps

Usually, rectification is the conversion of data file coordinates to some other grid and coordinate system, called a reference system. Rectifying or registering image data on disk involves the following general steps, regardless of the application.

1. Locate GCPs.
2. Compute and test a transformation.
3. Create an output image file with the new coordinate information in the header. The pixels must be resampled to conform to the new grid.

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

Classification Process

Digital image classification uses the spectral information represented by the digital numbers in one or more spectral bands, and attempts to classify each individual pixel based on this spectral information. This type of classification is termed spectral pattern recognition. The computer system must be trained to recognize spectral patterns in the data. The result of training is a set of signatures that defines a training sample or cluster. After the signatures are defined, the pixels of the image are sorted into classes. This sorting is based on the signatures by use of a classification decision rule. The classification rule is a mathematical algorithm by which, using data contained in the signature, performs the actual sorting of pixels into distinct class values.

Source :
Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing
ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

Pattern Recognition

Pattern recognition is the science—and art—of finding meaningful patterns in data, which can be extracted through classification.

By spatially and spectrally enhancing an image, pattern recognition can be performed with the human eye; the human brain automatically sorts certain textures and colors into categories.

In a computer system, spectral pattern recognition can be more scientific. Statistics are derived from the spectral characteristics of all pixels in an image. Then, the pixels are sorted based on mathematical criteria. The classification process breaks down into two parts: training and classifying (using a decision rule).

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

Training

Training is the process of defining the criteria by which these patterns are recognized (Hord, 1982). Training can be performed with either a supervised or an unsupervised method, asexplained below.

Supervised Training

Supervised training is closely controlled by the analyst such as you. In this process, you select pixels that represent patterns or land cover features that you recognize, or that you can identify with help from other sources, such as aerial photos, ground truth data, or maps. Knowledge of the data, and of the classes desired, is required before classification. By identifying patterns, you can instruct the computer system to identify pixels with similar characteristics.

Introduction to GIS Concept and its Application

Objective

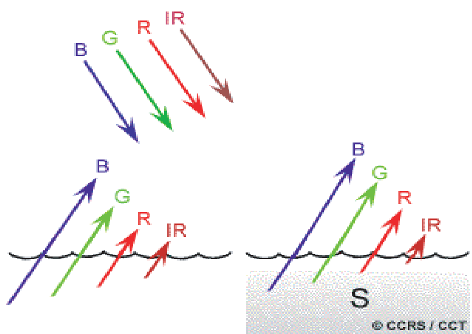
By the end of this lesson, through the knowledge and skills practice the participants will be able to:

1. Define what GIS is and its components.
2. Explain how data is organized in GIS.
3. Explore ArcGIS software and its capabilities.
4. Explain the application of GIS.
5. Open the different tools of ArcCatalog and ArcMap viewer.

Interactions with Water

Water absorbs longer visible wavelength and near infrared radiation than shorter visible wavelengths. That is why water typically looks blue or blue-green due to stronger reflectance at shorter visible wavelengths, and darker if viewed at red or near infrared wavelengths.

Because of more absorption of the blue wavelengths and reflection of the green wavelengths by chlorophyll in algae, the water appears greener in color when algae are present in water. If there is suspended sediment in the upper layers of the water body, this will allow higher reflectivity and a brighter appearance of the water.



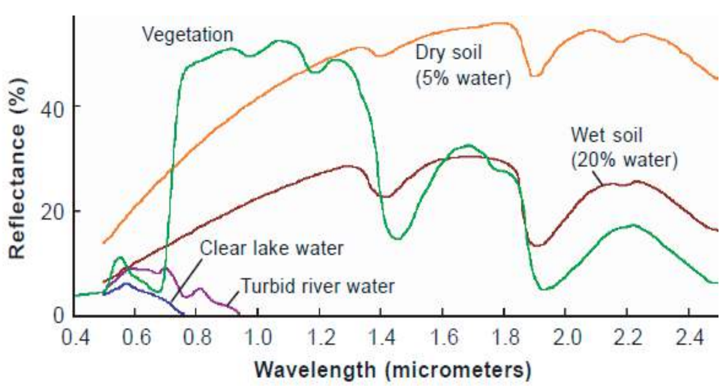
Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.

Spectral Response

A spectral response for an object can be built up by measuring the energy that is reflected or emitted from the object on the Earth's surface over a variety of different wavelengths.

By comparing the response patterns of different features over a variety of different wavelengths, it is possible to distinguish between them. For example, water and vegetation may reflect somewhat similarly in the visible wavelengths but are almost always separable in the infrared.

Spectral response for the same target type can be quite variable even it can vary temporally and spatially. Understanding the factors, which influence the spectral response of the object of interest, are critical to correctly interpreting the interaction of electromagnetic radiation with the object.



Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.

Inquiry Cursor Function

You can query a displayed image for information about each pixel using the inquiry functions.

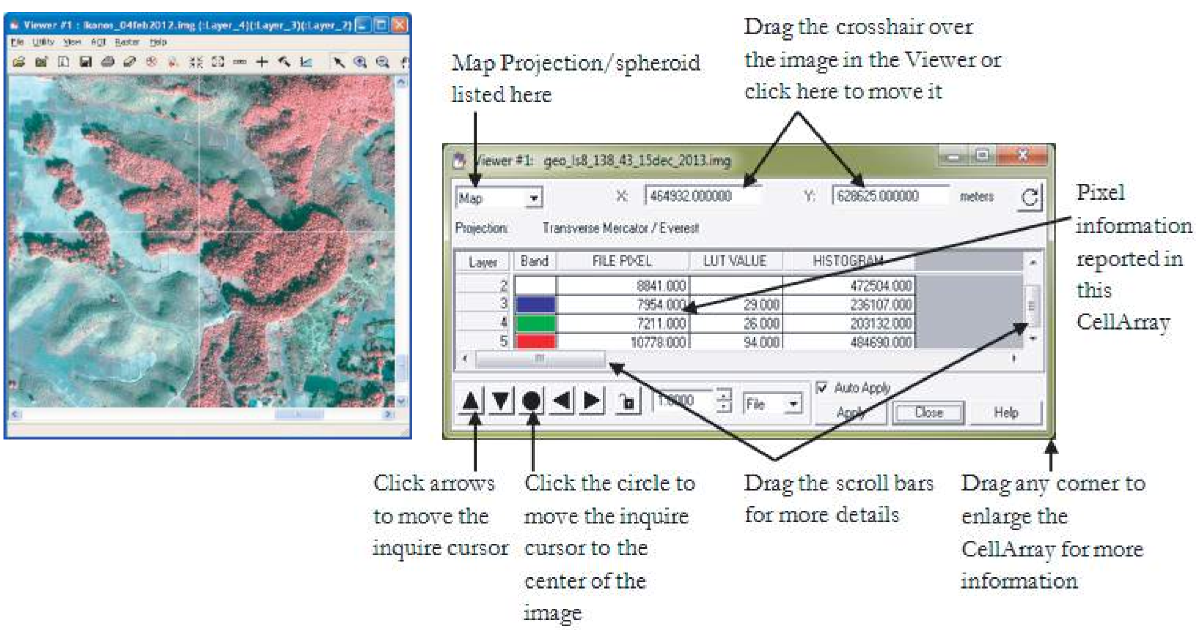
1. Select **Utility | Inquire Cursor** from the Viewer menu bar.

   A white crosshair displays in the Viewer and the Inquire Cursor dialog opens.

   There are three methods when using the Inquire Cursor in the Viewer;

   Drag the white crosshair over the image and, enter new coordinates into the Cell Array of the Inquire Cursor dialog. The Inquire Cursor moves when you move the mouse cursor back into the Viewer. As the crosshair is moved, the information in the Inquire Cursor dialog automatically updates.

2. The Cell Array in the Inquire Cursor dialog reports a variety of pixel information. Drag on the horizontal scroll bar (or enlarge the Inquire Cursor dialog by dragging any corner) to show all of the pixel information available in the Cell Array.



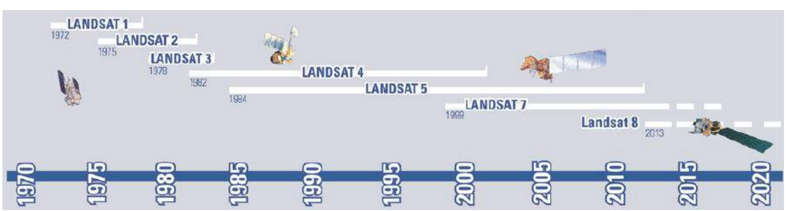
Source: ERDAS IMAGINE on line Help for the Inquire Cursor

LANDSAT 8

LANDSAT 8 satellite sensor is part of the Landsat Data Continuity Mission was successfully launched on February 11, 2013 from Space Launch Complex-3, Vandenberg Air Force Base in California and will join LANDSAT 7 satellite in orbit.

LANDSAT 8 satellite has two main sensors: the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS).OLI will collect images using nine spectral bands in different wavelengths of visible, near-infrared, and shortwave light to observe a 185 kilometer (115 mile) wide swath of the Earth in 15-30 meter resolution covering wide areas of the Earth's landscape while providing sufficient resolution to distinguish features like urban centers, farms, forests and other land uses.

TIRS was added to the satellite mission when it became clear that state water resource managers rely on the highly accurate measurements of Earth's thermal energy obtained by LDCM's predecessors, LANDSAT 5 and LANDSAT 7, to track how land and water are being used. With nearly 80 percent of the fresh water in the Western U.S. being used to irrigate crops, TIRS will become an invaluable tool for managing water consumption.



Spectral bands	Wavelength (micrometers)	Resolution (meters)	Use
Band 1–coastal/aerosol	0.43–0.45	30	Increased coastal zone observations.
Band 2–blue	0.45–0.51	30	Bathymetric mapping; distinguishes soil from vegetation; deciduous from coniferous vegetation.
Band 3–green	0.53–0.59	30	Emphasizes peak vegetation, which is useful for assessing plant vigor.
Band 4–red	0.64–0.67	30	Emphasizes vegetation slopes.
Band 5–near IR	0.85–0.88	30	Emphasizes vegetation boundary between land and water, and landforms.
Band 6–SWIR 1	1.57–1.65	30	Used in detecting plant drought stress and delineating burnt areas and fire-affected vegetation, and is also sensitive to the thermal radiation emitted by intense fires; can be used to detect active fires, especially during nighttime when the background interference from SWIR in reflected sunlight is absent.
Band 7–SWIR-1	2.11–2.29	30	Used in detecting drought stress, burnt and fire-affected areas, and can be used to detect active fires, especially at nighttime.
Band 8–panchromatic	0.50–0.68	15	Useful in ‘sharpening’ multispectral images.
Band 9–cirrus	1.36–1.38	30	Useful in detecting cirrus clouds.
Band 10–TIRS 1	10.60–11.19	100	Useful for mapping thermal differences in water currents, monitoring fires and other night studies, and estimating soil moisture.
Band 11–TIRS 2	11.50–12.51	100	Same as band 10.

Source: http://www.satimagingcorp.com/satellite-sensors/other-satellite-sensors/landsat-8/

Image Interpretation

Image Interpretation is "The examination of images for the purpose of identifying objects and judging their significance". (McClone, 2004).

We must apply a specialized knowledge to translate images into information. The specialized knowledge forms the field of image interpretation and we can apply this knowledge to derive useful information from the images. Image interpretation involves the identification of various targets (environmental or artificial features) from images which consist of points, lines, or areas.

Targets may be defined in terms of the way they reflect or emit radiation. This radiation is measured and recorded by a sensor, and ultimately is depicted as an image product such as an air photo or a satellite image.

Source:
Wynne, James B. Campbell, Randolph H. (2011). Introduction to remote sensing (5th ed.). New York: Guilford Press.
Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.

Knowledge for Interpretation

Proficiency of image interpretation is formed by three separate kinds of knowledge:

Subject
Knowledge of the subject of interpretation is the heart of the interpretation. Accurate interpretation requires familiarity with the subject of the interpretation. For example, interpretation of geologic information requires education and experience in the field of geology. Yet narrow specialization is a handicap, because each image records a complex mixture of many kinds of information, requiring application of broad knowledge that crosses traditional boundaries between disciplines.

Geographic Region
Knowledge of the specific geographic region depicted on an image can be equally significant. Every locality has unique characteristics that influence the patterns recorded on an image. In unfamiliar regions the interpreter may find it necessary to make a field reconnaissance or to use maps and books that describe analogous regions with similar climate, topography, or land use.

Remote Sensing System Subject
Different instruments use separate portions of the electromagnetic spectrum, operate at different resolutions, and use different methods of recording images. The image interpreter must know how each of these variables influences the image to be interpreted and how to evaluate their effects on his or her ability to derive useful information from the imagery.

Source:
Wynne, James B. Campbell, Randolph H. (2011). Introduction to remote sensing (5th ed.). New York: Guilford Press

Ground Control Points

GCPs are specific pixels in an image for which the output map coordinates (or other output coordinates) are known. GCPs consist of two X,Y pairs of coordinates:

Source Coordinate

Usually data file coordinates in the image being rectified is known as Source Coordinates

Reference Coordinate

The coordinates of the map or reference image to which the source image is being registered is known as Reference Coordinates

GCP in ERDAS IMAGINE

Any ERDAS IMAGINE image can have one GCP set associated with it. The GCP set is stored in the image file along with the Raster layers.

In the Cell Array of GCP data that displays in the GCP Tool, one column shows the point ID of each GCP. The point ID is a name given to GCPs in separate files that represent the same geographic location. Such GCPs are called corresponding GCPs.

A default point ID string is provided (such as GCP #1), but you can enter your own unique ID strings to set up corresponding GCPs as needed. Even though only one set of GCPs is associated with an image file, one GCP set can include GCPs for a number of rectifications by changing the point IDs for different groups of corresponding GCPs.

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

Entering GCPs

Select many GCPs throughout the scene. The more dispersed the GCPs are, the more reliable the rectification is. GCPs for large-scale imagery might include the intersection of two roads, airport runways, utility corridors, towers, or buildings. For small scale imagery, larger features such as urban areas or geologic features may be used. Landmarks that can vary (e.g., the edges of lakes or other water bodies, vegetation, etc.) should not be used.

The source and reference coordinates of the GCPs can be entered in the following ways:

- They may be known as priori, and entered at the keyboard.
- Use the mouse to select a pixel from an image in the Viewer. With both the source and destination Viewers open, enter source coordinates and reference coordinates for image-to image registration.
- Use a digitizing tablet to register an image to a hardcopy map.

Unsupervised Training

Unsupervised training is more computer-automated. It enables you to specify some parameters that the computer uses to uncover statistical patterns that are inherent in the data. These patterns do not necessarily correspond to directly meaningful characteristics of the scene, such as contiguous, easily recognized areas of a particular soil type or land use. They are simply clusters of pixels with similar spectral characteristics. Unsupervised training is dependent upon the data itself for the definition of classes. This method is usually used when less is known about the data before classification. It is then the analyst's responsibility, after classification, to attach meaning to the resulting classes (Jensen, 1996). Unsupervised classification is useful only if the classes can be appropriately interpreted.

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

Signatures

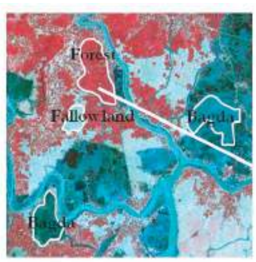
The result of training is a set of signatures that defines a training sample or cluster. Each signature corresponds to a class, and is used with a decision rule (explained below) to assign the pixels in the image file to a class. Signatures in ERDAS IMAGINE can be parametric or nonparametric.

Parametric Signature

A parametric signature is based on statistical parameters (e.g. mean and covariance matrix) of the pixels that are in the training sample or cluster. Supervised and unsupervised training can generate parametric signatures. A set of parametric signatures can be used to train a statistically-based classifier (e.g., maximum likelihood) to define the classes

Nonparametric Signature

A nonparametric signature is not based on statistics, but on discrete objects (polygons or rectangles) in a feature space image. These feature space objects are used to define the boundaries for the classes. A nonparametric classifier uses a set of nonparametric signatures to assign pixels to a class based on their location either inside or outside the area in the feature space image. Supervised training is used to generate nonparametric signatures (Kloer, 1994).



- Min., Max., and mean vector
- Standard deviation
- Covariance matrix
- Number of bands
- Pixel number

Forest Class Signature

	Class	Min	Max	Mean	SD	Covariance Matrix		
Band1	Forest	23	26	24	1.4	2	4	5
Band2		35	55	45	1.7	4	3	3
Band3		73	144	90	1	5	3	1

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

What is GIS? (Geographic Information System)

GIS is the acronym for geographic information system. It is an integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes. A GIS provides a framework for gathering and organizing spatial data and related information so that it can be displayed and analyzed.

Example:

- Information about places on the Earth's surface.
  – e.g. population of a country
- Knowledge about where something is
  – e.g. locations of fishing villages
- Knowledge about what is at a given location
  – e.g. bio-diversity of habitats

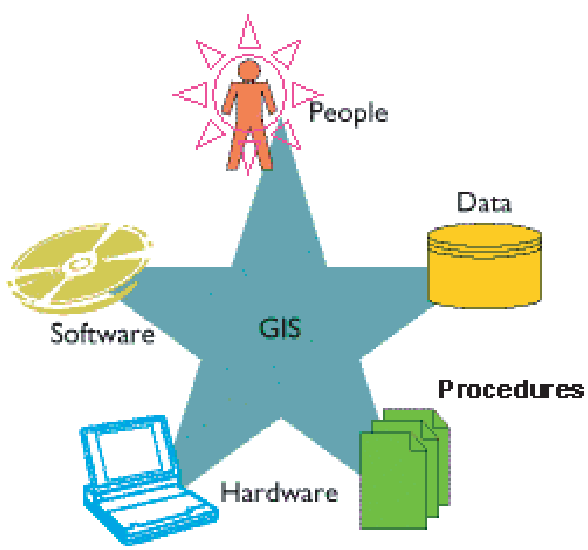
Characteristics of geographic information

- Can be very detailed e.g. individual trees in a forest
- Can be very coarse e.g. climate of a region
- Mostly static e.g. natural and manmade features does not change rapidly
- Can be moving e.g. vehicles, ships, aero planes

Sources:
http://en.wikipedia.org/wiki/Geographic_information_system
http://resources.arcgis.com/en/help/

Components of a GIS

Hardware : Hardware is the computer on which a GIS operates. Today, GIS runs on a wide range of hardware types, from centralized computer servers to desktop computers used in stand-alone or networked configurations.



Software : GIS software provides the functions and tools needed to store, analyze, and display geographic information. Key software components are

a database management system (DBMS)
tools for the input and manipulation of geographic information

tools that support geographic query, analysis, and visualization

a graphical user interface (GUI) for easy access to tools

Introduction to Remote Sensing and ERDAS IMAGINE

Objective

By the end of this lesson, the participants will be able to:

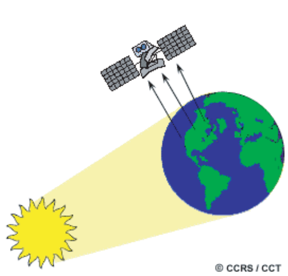
1. Define Remote Sensing and describe its process, correctly.
2. Identify and interpret the different region of Electromagnetic spectrum, correctly.
3. Explain the interaction of electromagnetic energy with atmosphere and targets.
4. Interpret the Spectral response pattern of different features of earth surface.
5. Delineate the Recording of energy by the sensor.
6. Recognize the different image processing software
7. Give an outline of the different functions of ERDAS IMAGINE software.

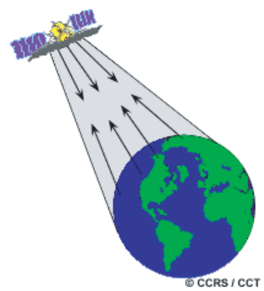
Recording of Energy by the Sensor

The sun is a convenient source of energy for remote sensing. The sun's energy is either reflected, as it is for visible wavelengths, or absorbed and then reemitted, as it is for thermal infrared wavelengths.

Passive Remote Sensing : In passive remote sensing systems, the reflected and emitted energy that is naturally available are measured by sensors. The reflected energy is available during the time when the sun is illuminating the Earth and naturally emitted energy such as thermal infrared is available at day or night for remote sensing.

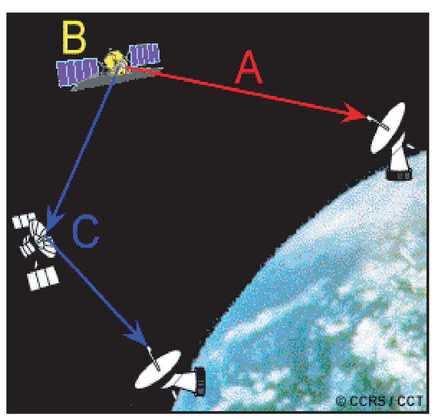
Active Remote Sensing : active remote sensing system, the energy that is required for remote sensing is provided by its own energy source. The sensor transmits energy toward the target to be investigated and the energy reflected from that target is detected and measured by the sensor. Some examples of active sensors are laser fluorescence and synthetic aperture radar (SAR).





Data Reception, Transmission, and Processing

Data acquired from satellite platforms are electronically transmitted to the Earth. There are three main options for transmitting data acquired by satellites to the surface. The data can be directly transmitted to Earth if a Ground Receiving Station (GRS) is in the line of sight of the satellite or the data can be recorded on board the satellite (B) for transmission to a GRS at a later time. Data can also be relayed to the GRS through the Tracking and Data Relay Satellite System (TDRSS) which consists of a series of communications satellites in geosynchronous orbit.



Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing

Satellite Image Characteristics and Viewer Functions

Objective

By the end of this lesson, through the knowledge and skills practice the participantswill be able to:

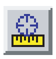
1. State what is Satellite Image data, Bands ?
2. Explain how multispectral image are formed.
3. Differentiate between different types of raster layer.
4. Describe different types of resolution and its significance.
5. Identify digital image format in remote sensing.
6. Explore the Image viewer and its different functions using ERDASIMAGINE software.

Measurement Tools

This dialog gives you tools for taking many kinds of measurement in a Viewer.

Select **Utility > Measure...** from the Viewer menu bar or click the icon in the Viewer tool bar to open this tool.

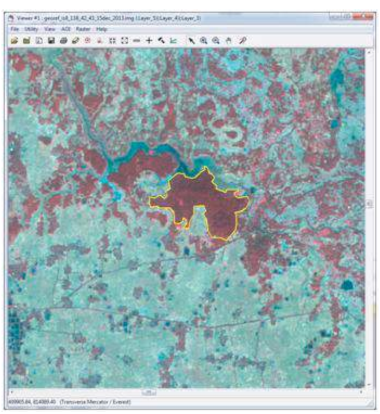
Click to disable the current Measurement Tool.

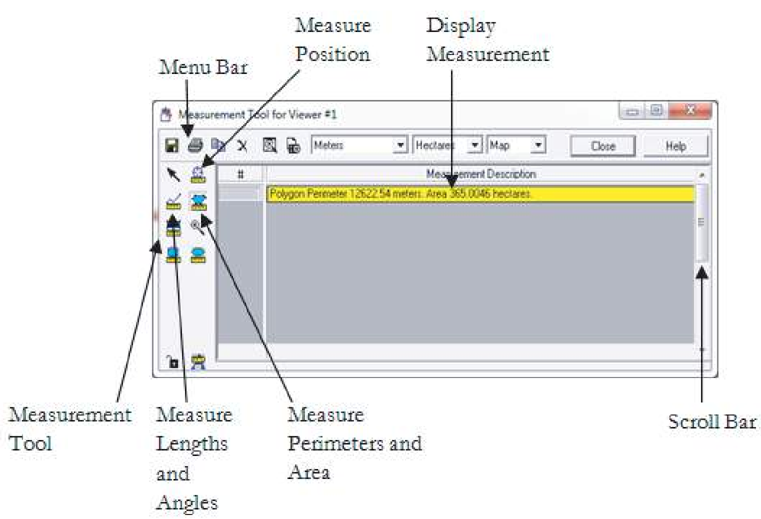


Click to measure points in the displayed image. Click in the Viewer to designate the point. The point coordinates are reported in the text window.

Click to measure lengths and angles in the displayed image. Click in the Viewer to add each vertex. Double-click or middle-click (depending upon how your preferences are set) to end the polyline. The polyline length and azimuth (heading) are reported in the text window.

Click to measure perimeters and areas in the displayed image. Click in the Viewer to add each vertex. Double-click or middle-click (depending upon how your preferences are set) to close the polygon. The polygon perimeter and area are reported in the text window.





Source: ERDAS IMAGINE on line Help for the measurement tools

Satellite Sensors and Platform and Application

Objective

By the end of this lesson, the participants will be able to:

1. Define what a Sensor is.
2. Define what are Platforms, Satellite Orbit, Satellite Swath, and Multispectral Scanning.
3. Delineate different types of satellite and its uses.
4. Talk about all the Earth Observation Satellites introduced in the lesson.
5. State different application of satellite images

Forestry Application

Forests are a valuable resource providing food, fuel, shelter, wildlife habitat and daily supplies. It plays an important role in balancing the Earth's CO_2 supply and exchange. The main issues concerning forest management are depletion due to natural causes or anthropogenic activity, and monitoring of health and growth for effective commercial exploitation and conservation.

Remote Sensing applications in forestry include sustainable forest resources development, biodiversity, monitoring deforestation and reforestation, and managing commercial logging operations, watershed protection, biophysical monitoring and other environmental concerns

- **Reconnaissance mapping:**
  - forest cover type discrimination
  - agroforestry mapping

- **Commercial forestry:**
  - clear cut mapping / regeneration assessment
  - burn delineation
  - infrastructure mapping / operations support
  - forest inventory
  - biomass estimation
  - species inventory

- **Environmental monitoring**
  - deforestation (rainforest, mangrove colonies)
  - species inventory
  - watershed protection (riparian strips)
  - coastal protection (mangrove forests)
  - forest health and vigour

Image Interpretation Tasks

The image interpreter must routinely conduct several kinds of tasks, many of which maybe completed together in an integrated process. Nonetheless, for purposes of clarification, it is important to distinguish between these separate functions

<u>Classification</u>

Classification is the assignment of objects, features, or areas to classes based on their appearance on the imagery.

<u>Enumeration</u>

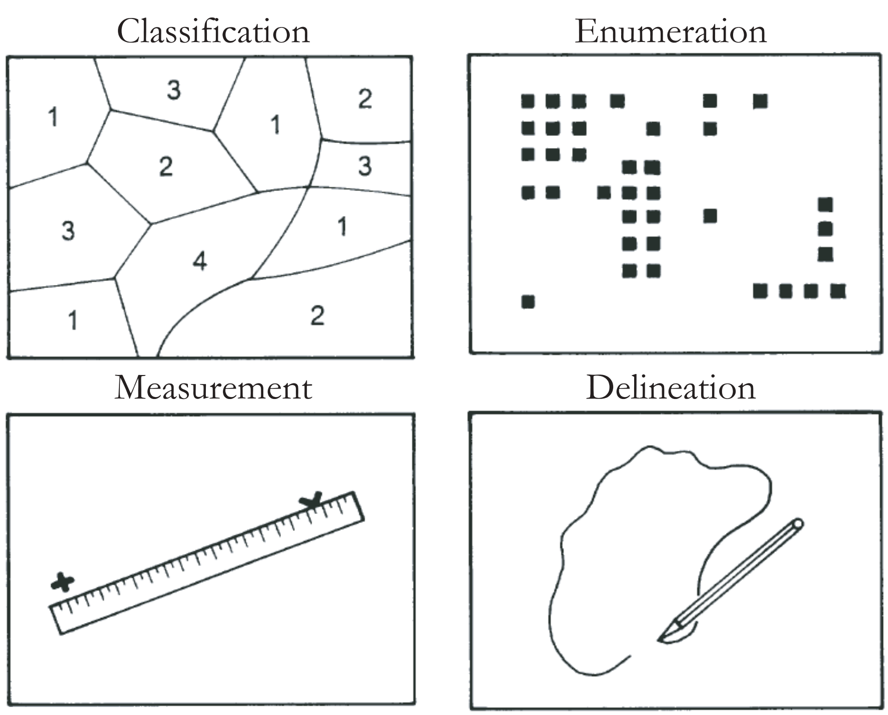
Enumeration is the task of listing or counting discrete items visible on an image.

<u>Measurement</u>

Measurement is the task of measuring distance and height and, by extension, of volumes and areas as well. A second form of measurement is quantitative assessment of image brightness.

<u>Delineation</u>

Separate distinct areal units that are characterized by specific tones and textures and to identify edges or boundaries between separate areas. Typical examples include delineation of separate classes of forest or of land use—both of which occur only as aerial entities (rather than as discrete objects).



Source:
Wynne, James B. Campbell, Randolph H. (2011). Introduction to remote sensing (5th ed.). New York: Guilford Press

Ponds and airport runways Buildings intersection of two roads

Polynomial Transformation

Polynomial equations are used to convert source file coordinates to rectified map coordinates. The order of transformation is the order of the polynomial used in the transformation. ERDAS IMAGINE allows 1st- through nth-order transformations. Usually, 1st-order or 2nd-order transformations are used.

Transformation Matrix

A transformation matrix consists of coefficients is computed from the GCPs. The goal in calculating the coefficients of the transformation matrix is to derive the polynomial equations for which there is the least possible amount of error when they are used to transform the reference coordinates of the GCPs into the source coordinates.

Linear Transformations

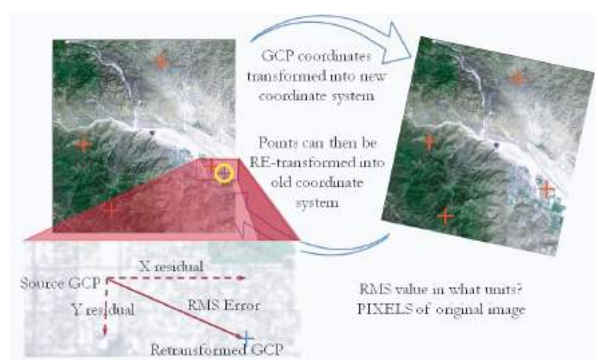
A 1st-order transformation is a linear transformation

Nonlinear Transformations

Transformations of the 2nd-order or higher are nonlinear transformations. These transformations can correct nonlinear distortions.

RMS Error

RMS error is the distance between the input (source) location of a GCP and the retransformed location for the same GCP. In other words, it is the difference between the desired output coordinate for a GCP and the actual output coordinate for the same point, when the point is transformed with the geometric transformation.



RMS error is expressed as a distance in the source coordinate system. If data file coordinates are the source coordinates, then the RMS error is a distance in pixel widths. For example, an RMS error of2 means that the reference pixel is 2 pixels away from the retransformed pixel.

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

Decision Rule

After the signatures are defined, the pixels of the image are sorted into classes based on the signatures by use of a classification decision rule. The decision rule is a mathematical algorithm that, using data contained in the signature, performs the actual sorting of pixels into distinct class values.

Parametric Decision Rule

A parametric decision rule is trained by the parametric signatures. These signatures are defined by the mean vector and covariance matrix for the data file values of the pixels in the signatures. When a parametric decision rule is used, every pixel is assigned to a class since the parametric decision space is continuous (Kloer, 1994).

Nonparametric Decision Rule

A nonparametric decision rule is not based on statistics; therefore, it is independent of the properties of the data. If a pixel is located within the boundary of a nonparametric signature, then this decision rule assigns the pixel to the signature's class. Basically, a nonparametric decision rule determines whether or not the pixel is located inside of nonparametric signature boundary.

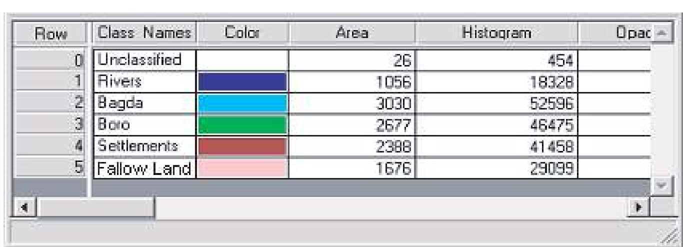
Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

Output File

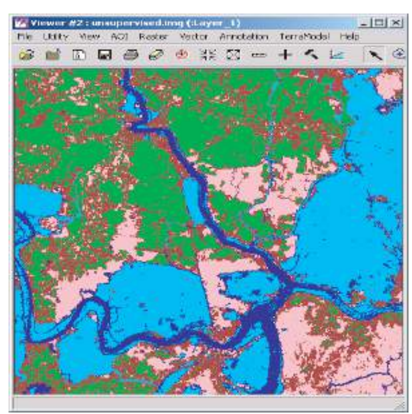
When classifying an image file, the output file is an image file with a thematic raster layer. This file automatically contains the following data:

class values
class names
color table
statistics
histogram

The image file also contains any signature attributes that were selected in the ERDAS IMAGINE Supervised Classification utility.



Row	Class Names	Color	Area	Histogram	Opac
0	Unclassified		26	454	
1	Rivers		1056	18328	
2	Bagda		3030	52596	
3	Boro		2677	46475	
4	Settlements		2388	41458	
5	Fallow Land		1676	29099	



- Thematic Layer is associated with a Raster Attribute Table
- Each pixel is associated with a class value
- Each category is assigned a specific color

Data: Maybe the most important component of a GIS is the data. Geographic data and related tabular data can be collected in-house or bought from a commercial data provider. Most GISs employ a DBMS to create and maintain a database to help organize and manage data.

People: GIS technology is of limited value without the people who manage the system and to develop plans for applying it. GIS users range from technical specialists who design and maintain the system to those, who use it for their everyday works.

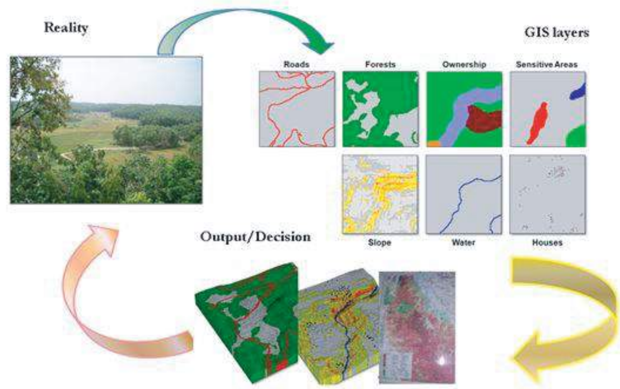
Procedures: A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization.

Presentation: Presentation is the final output of any GIS analysis. Anybody can present their GIS data both in paper map or digital format.

Source: http://slideplayer.com/slide/5682848/

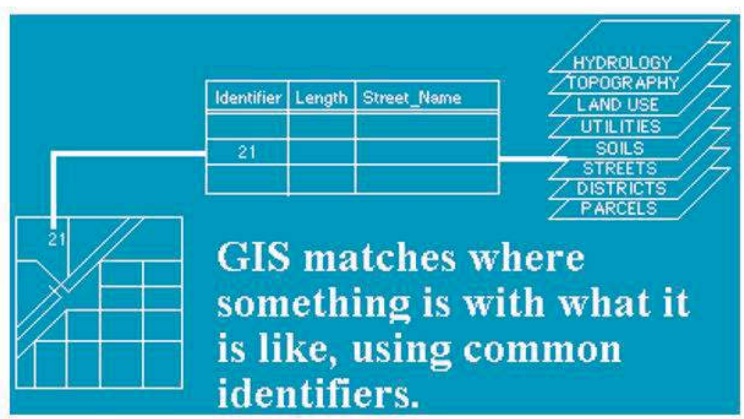
GIS Concepts

GIS is used to represent the real world. For example, in reality a place is stacked by different layers like Roads, Forests, Water and Houses. This layer has different characteristics like dense forest or less dense forest, ownership of house etc. Using GIS, you can extract this layer with its characteristics. Finally, you can represent all layers in a map



Source:http://www.innovativegis.com/basis/BeyondMappingSeries/BeyondMapping_IV/Topic8/BM_IV_T8.htm

<u>**Attribute**</u>: Attribute is spatial or nonspatial information about a geographic feature in GIS, usually stored in a tabular form and linked to the feature by a unique identifier. For example, attributes of a river might include its name, length, and sediment load at a gauging station. In Raster datasets, information associated with each unique value of a Raster cell.



Source: http://resources.arcgis.com/en/help/

What is Remote Sensing ?

Remote sensing is the science and art of acquiring information about the Earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy from earth surface and processing, analyzing, and applying that data.

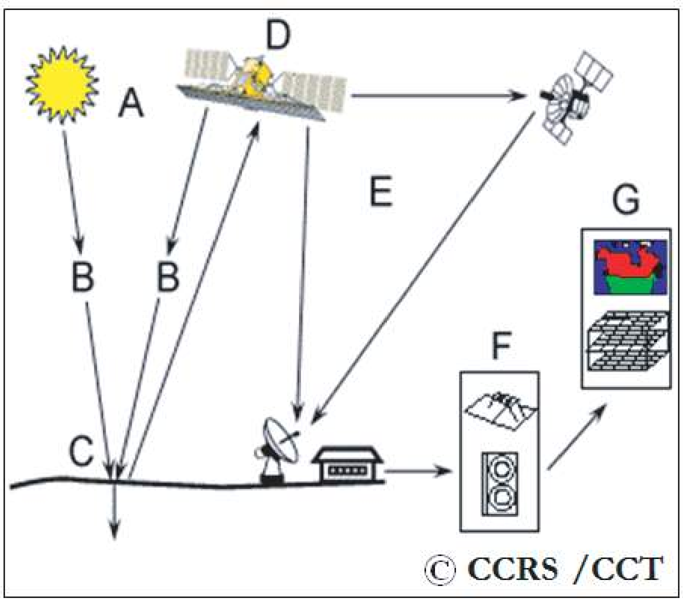
“Remote sensing is the practice of deriving information about the earth’s land and water surface using images acquired from an overhead perspective, using electromagnetic radiation in one or more regions of the electromagnetic spectrum, reflected or emitted from the earth’s surface.” (Campbell et.al., 2011)

Satellite Technology is an example of remote sensing.

Of our five senses, sight, hearing and smell, may be considered as forms of remote sensing.

Remote Sensing Process

The remote sensing process involves an interaction between incident radiation and the targets of interest. The following seven elements as shown in the figure are involved with the process.



Energy Source or Illumination (A)

The first requirement for remote sensing is to have an energy source which illuminates or provides electromagnetic energy to the target of interest.

Radiation and the Atmosphere (B)

The energy will come in contact with and interact with the atmosphere, as the energy travels from its source to the target.

Image Processing Software

There are different types of software that are used in Remote Sensing to Process image, image interpretation, geo-referencing, classification, image enhancement and also data analyzing, as well as map composing. The following software is usually used in remote sensing:

ERDAS IMAGINE It is the world's best leading geospatial data authoring software. ERDAS IMAGINE is a remote sensing application with raster graphics editor abilities designed by ERDAS for geospatial applications.

ENVI has the latest processing and analysis tools that help to extract meaningful information to make better decision using panchromatic, LiDAR, SAR and multispectral or hyperspectral imagery.

eCognition
eCognition Developer is a powerful development environment for object-based image analysis. It is used in earth sciences to develop rule sets for the automatic analysis of remote sensing data

ArcGIS Esri's ArcGIS is a geographical information system (GIS) for working with maps and geographic information. It is used for creating and using maps, on screen digitization, compiling geographic data, analyzing mapped information, sharing and discovering geographic information, using maps and geographic information in a range of applications and managing geographic information in a database.

Introduction to ERDAS Imagine

ERDAS IMAGINE is a remote sensing application with raster graphics editor abilities designed by ERDAS for geospatial applications. ERDAS IMAGINE is aimed primarily, at geospatial raster data processing and allows the user to prepare, display and enhance digital images for mapping use in geographic information system (GIS) or in computer-aided design (CAD) software. It is a toolbox allowing the user to perform numerous operations on an image and generate an answer to specific geographical questions.

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

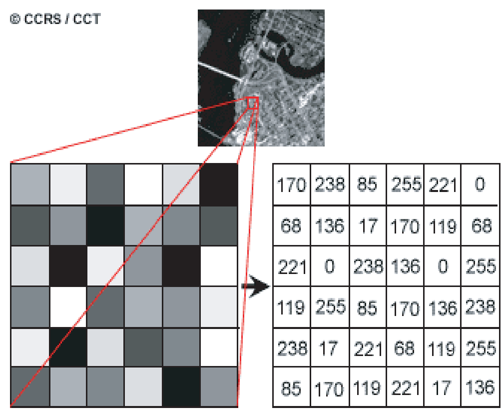
Satellite Image Data

An image is a digital picture or representation of an object on the Earth Surface. Image data are stored in image files on magnetic tapes, computer disks, or other media. The data consist only of numbers. These representations form images when they are displayed on a screen or are output to hardcopy.

Pixel and Digital file value

Each number in an image file is a data file value, which are sometimes referred to as pixels. The term pixel is abbreviated from picture element. It is the smallest part of a picture with a single value. The data file value is the measured brightness value of the pixel at a specific wavelength.

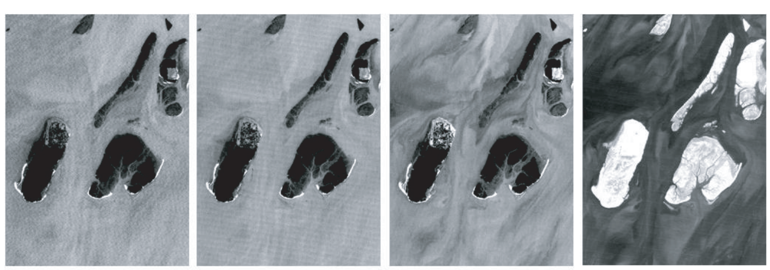
Raster image data are arranged in a grid similar to the squares on a checkerboard. Each cell of the grid is represented by a pixel, also known as a grid cell. In remotely sensed image data, each pixel represents an area of the Earth at a specific location. The data file value assigned to that pixel is the record of reflected radiation or emitted heat from the Earth's surface at that location. Data file values may also represent elevation, as in digital elevation models (DEMs).



Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

Bands

Image data may include several bands of information. Each band is a set of data file values for aspecific portion of the electromagnetic spectrum of reflected light or emitted heat (red, green, blue, near-infrared, infrared, thermal, etc.) or some other user-defined information created by combiningor enhancing the original bands, or creating new bands from other sources.

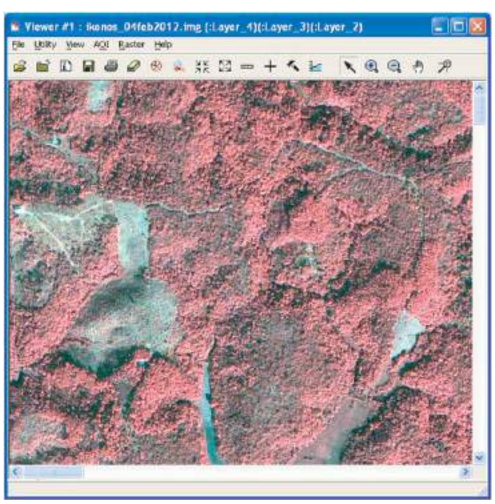


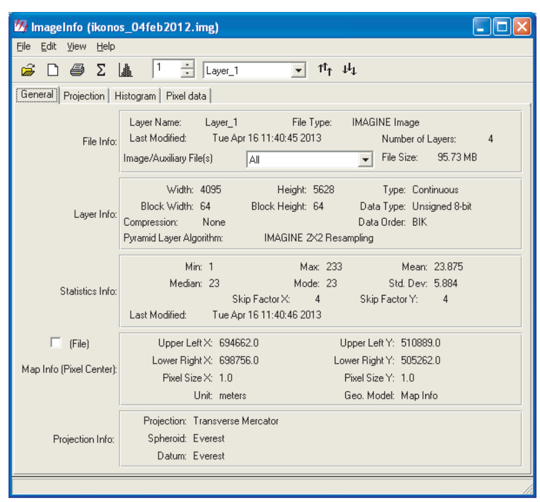
Band 1 BLUE 450-520nm | Band 2 GREEN 520-600nm | Band 3 RED 630-690nm | Band 4 NIR 796-900nm

Layer Info

This dialog enables you to view and edit many elements of a raster image file (*.img), including statistics, map information, and projection information. Select **Utility > Layer Info...** from the Viewer menu bar to access this dialog. This dialog may contain one or more of the following tabs:

General	This tab contains the File info, Layer info, Statistics info, Map info and Projection info.
Projection	This tab displays the projection information if it is present in the image.
Histogram	This tab shows the image histogram without the need to open a second dialog.
Pixel data	This tab contains a table showing the pixel values for the current data band
File History	This tab contains user comments describing changes to the image.
Elevation Info	This tab contains the elevation information for the image.
GCP Table	This tab displays the ground control points collected from a TIFF file an used to populate the tag.
TIFF Info	This tab allows you to view the values of the tags associated with key associated with a TIFF file.
	This information should be modified with caution because of ERDAS IMAGINE programs.





What is a Sensor ?

A sensor is a device that measures and records electromagnetic energy. Sensors can be divided into two groups Sensors can be divided into two groups:

- Passive Sensor
- Active Sensor

Passive Sensor
Passive sensors depend on an external source of energy, usually the Sun (although sometimes the Earth itself). The group of passive sensors covers the electromagnetic spectrum in the range from less than 1picometer (gamma rays) to over 1 meter (micro and radio waves).

Active Sensor
Active sensors have their own source of energy. Measurements by active sensors are more controlled because they do not depend upon the (varying) illumination conditions. Active sensors include the laser altimeter (using infrared light) and radar.

Platforms

In remote sensing, the sensor is mounted on a platform and it may be situated on the ground, on an aircraft, or on a satellite outside of the Earth's atmosphere.

Ground-based sensors are often used to record detailed information about the surface which is compared with information collected from aircraft or satellite sensors.

Aerial platforms are primarily stable wing aircraft. Aircraft are often used to collect very detailed images and facilitate the collection of data over virtually any portion of the Earth's surface at any time.

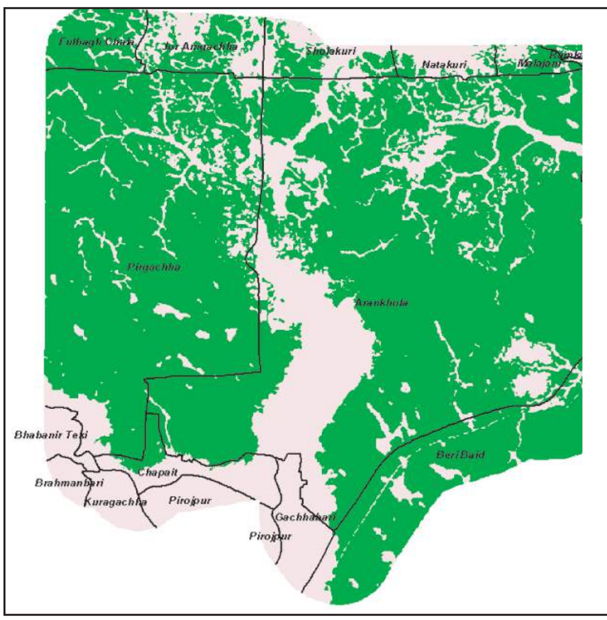
In **satellite platforms**, sensors are mounted on satellites which revolve around the Earth. Due to revolving around the earth satellite based remote sensing permits repetitive coverage of the Earth's surface on a continuing basis.

Deforestation

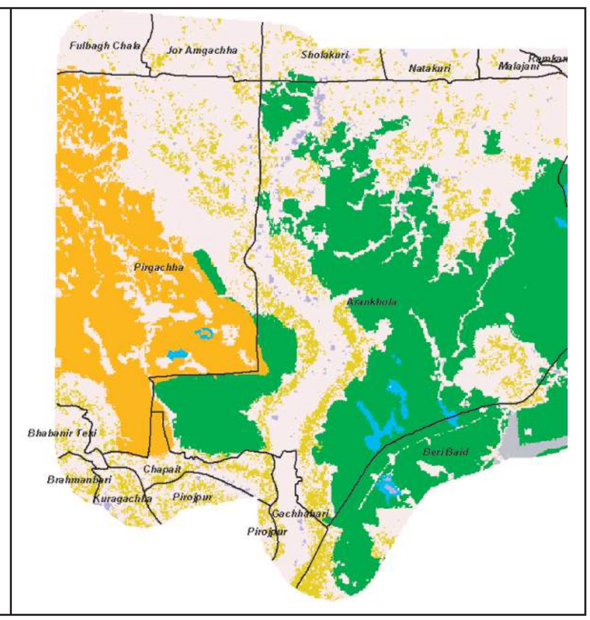
Deforestation increases soil erosion, river siltation and deposition, affecting navigation, fisheries, wildlife habitat, and drinking water supplies, as well as farming productivity and self-sufficiency. It also affects the genetic diversity of species, which controls our intrinsic ability to adapt to changing conditions and environment.

The rate and extent of deforestation and monitoring regeneration can be measured by remote sensing technology. Using multi-temporal satellite data, forest cover change detection analyses can be carried out. Radar, merged with optical data, can be used to efficiently monitor the status of existing clear cuts or emergence of new ones, and even assess regeneration condition. Remote sensing data provide a view of areas which are remote and inaccessible.

Deforestation between 1967 and 2007



Derived from Corona Image acquired in 1967



Derived from IRS P6 LISS III Satellite Image acquired in 2007

Forest Cover Area

Rubber Plantation

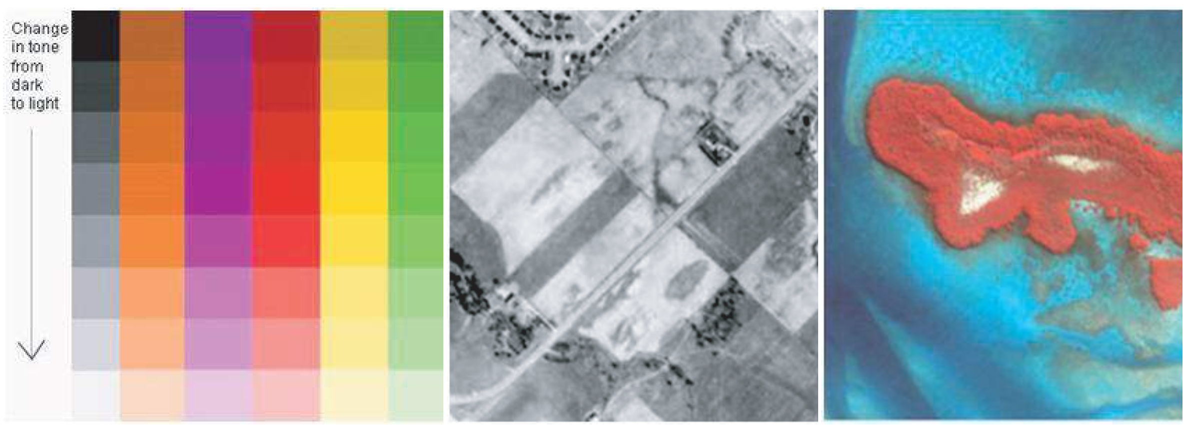
Elements of Image Interpretation

Observing the differences between targets and their backgrounds involves comparing different targets based on any, or all, of the visual elements of Image Tone, Image Texture, Shadow, Pattern, Association, Shape, Size and Site. Identifying targets in remotely sensed images based on these visual elements allows us to further interpret and analyze.

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing

Image Tone

Tone refers to the relative brightness or color of objects in an image. It is the fundamental element for distinguishing between different targets or features and variations in tone allows the elements of shape, texture, and pattern of objects to be distinguished. For black-and-white images, tone may be characterized as "light," "medium gray," "dark gray," "dark," and so on, as the image assumes varied shades of white, gray, or black. For color or CIR imagery, image tone refers simply to "color," described informally perhaps in such terms as "dark green," "light blue" or "pale pink".



Source:
Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing
Wynne, James B. Campbell, Randolph H. (2011). Introduction to remote sensing (5th ed.). New York: Guilford Press.

Resampling Methods

Since the grid of pixels in the source image rarely matches the grid for the reference image, the pixels are resampled so that new data file values for the output file can be calculated.

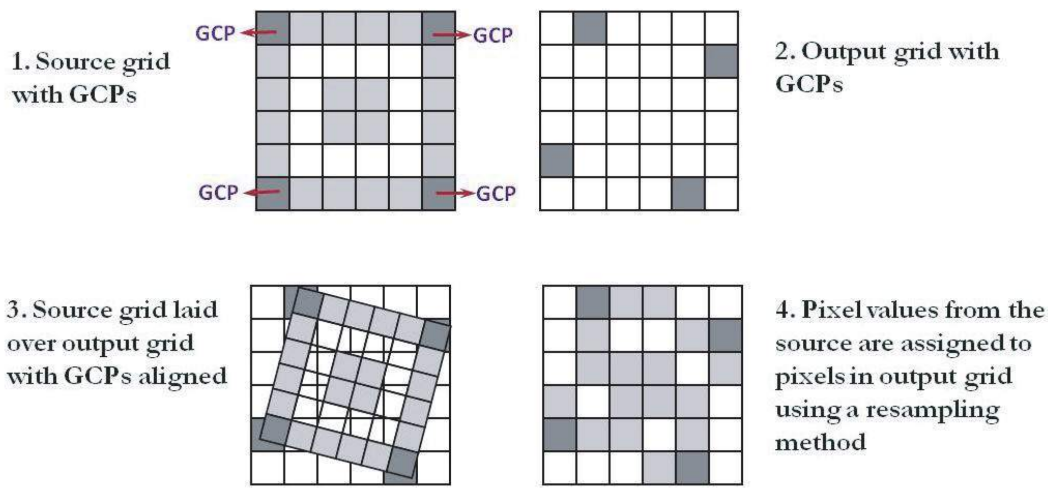
The following resampling methods are supported in ERDASIMAGINE:

Nearest Neighbor - uses the value of the closest pixel to assign to the output pixel value.

Bilinear Interpolation - uses the data file values of four pixels in a 2 × 2 window to calculate an output value with a bilinear function.

Cubic Convolution - uses the data file values of sixteen pixels in a 4 × 4 window to calculate an output value with a cubic function.

Bicubic Spline Interpolation - fits a cubic spline surface through the current block of points.



Nearest Neighbor

To determine an output pixel's nearest neighbor, the rectified coordinates of the pixel are retransformed back to the source coordinate system using the inverse of the transformation. The pixel that is closest to the retransformed coordinates is the nearest neighbor. The data file value(s) for that pixel become the data file value(s) of the pixel in the output image.

Transfers original data values without averaging them as the other methods do. This is an important consideration when discriminating between vegetation types, locating an edge associated with a lineament, or determining different levels of turbidity or temperatures in a lake (Jensen, 1996).

This method is suitable for using before classification. This is the easiest of the three methods to compute and the fastest to use.

Classification Scheme

Usually, classification is performed with a set of target classes in mind. Such a set is called a classification scheme (or classification system).

The purpose of such a scheme is to provide a framework for organizing and categorizing the information that can be extracted from the data (Jensen et al, 1983).

A number of classification schemes have been developed by specialists who have inventoried a geographic region. A classification scheme should possess the following characteristics:

- Must be useful
- Must be detectable using the data you have
- Should be hierarchical
- Categories must be mutually exclusive
- Require explicit definitions of each class

Supervised Classification

Supervised classification requires a priori (already known) information about the data, such as:

What types of classes need to be extracted? Soil type? Land use? Vegetation? What classes are most likely to be present in the data? That is, which types of land cover, soil, or vegetation (or whatever) are represented by the data ?

In supervised training, you rely on your own pattern recognition skills and a priori knowledge of the data to help the system determine the statistical criteria (signatures) for data classification. To select reliable samples, you should know some information—spatial or spectral—about the pixels that you want to classify. The location of a specific characteristic, such as a land cover type, may be known through ground truthing.

<u>Ground Truthing</u>
Ground truthing refers to the acquisition of knowledge about the study area from field work, analysis of aerial photography, personal experience, etc. Ground truth data are considered to be the most accurate (true) data available about the area of study. They should be collected at the same time as the remotely sensed data, so that the data correspond as much as possible. However, some ground data may not be very accurate due to a number of errors and inaccuracies.

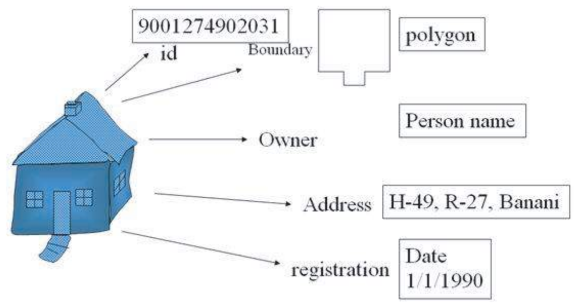
Steps of Supervised Classification

- Selecting Training Samples
- Collecting Signatures from Training Samples
- Evaluating Signatures
- Perform classification process

Source: ERDAS Field Guide™. (2005). Norcross, Georgia:Leica Geosystems Geospatial Imaging, LLC.

Representation of Objects in GIS

The following figure gives an idea how you represent an object like a house in GIS. If you draw the boundary of this house then it gives the spatial location of this house in this space. Now you can add additional information within the attribute of this feature (house) like house ID, owner, address, registration date etc.



GIS Applied: Two Big Questions

Following are the two big questions that can be answered by GIS:

a) Where is what? (Obtain information from a location)

For Example, Bariyadala is one of the ranges of Chittagong North Division. If you know the spatial location of Bariyadala Range, you will find detailed information of this Range. You will explore lots of information like number of Beats in this Range, total plantation area, plantation year, open spaces etc.

b) What is where? (Query information to find location)

Similarly, you have a GIS dataset of Forest Administrative Unit. Now, you know there is a Range by the name Bariyadala and it falls within the Chittagong North Division but you do not know the location of this Bariyadala Range. If you query Bariyadala Range within the GIS datasets of Forest Administrative Unit using the above information, you will find the spatial location of Bariyadala Range.

Probable Fields of GIS Application Urban planning :

Especially for area monitoring (both on a sectoral and integral basis), regional potential and feasibility analyses and site selection studies, land management and land use planning issues.

Environmental Science: Monitoring environmental risks, management of watersheds, floodplains, wetlands, aquifers, groundwater modeling and contamination tracking, hazardous or toxic facility siting.

Utility planning and civil engineering: Geographic information system (GIS) technology provides the tools for creating, managing, analyzing, and visualizing the data associated with developing and managing infrastructure.

Business: Business network design, location based services, ESRI BIS Portfolio software run reports, make maps and profile your customers from your desktop with the versatile combination of data and software.

Interaction with the Target (C)

After traveling through atmosphere, the energy interacts with the target depending on the properties of both the target and the radiation.

Recording of Energy by the Sensor (D):

We require a remote sensor to collect and record the electromagnetic radiation after the energy has been scattered by, or emitted from the target. Transmission, Reception, and Processing (E):

After recording energy by the sensor, it is transmitted to a receiving and processing station where the data are processed into an image.

Interpretation and Analysis (F)

The image is visually or digitally interpreted to extract information about the target which was illuminated.

Application (G)

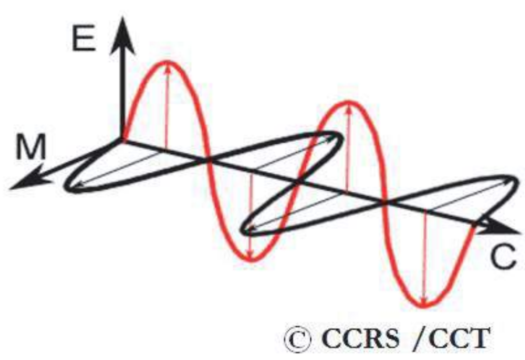
We apply the extracted information in order to better understand it, reveal some new information, or assist in solving a particular problem.

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.

Electromagnetic Radiation

Electromagnetic Radiation is a form of energy that is reflected or emitted from objects in the form of electrical and magnetic waves. It can travel through space. The electromagnetic radiation has fundamental properties and behaves in predictable ways according to the basics of the Wave Theory.

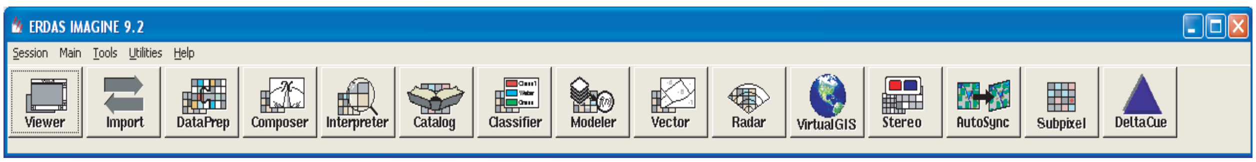
Electromagnetic radiation consists of an electrical field (E) and magnetic field (M). The electric field varies in magnitude in a direction perpendicular to the direction in which the radiation is traveling. The magnetic field (M) oriented at right angles to the electrical field. Both these fields travel at the speed of light (C).



Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.

ERDAS IMAGINE Icon Panel

The main icon panel comes up when you start ERDAS IMAGINE. All functions in ERDAS IMAGINE are launched from this icon panel, or from the Viewer that also opens when ERDAS IMAGINE starts. The words Session, Main, Tools, Utilities, and Help display on the icon panel menu bar that lead to the ERDAS IMAGINE Session Manager, IMAGINE tools, general utilities, and On-Line Help



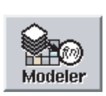
Click to create a new Viewer. A Viewer is a visualization tool for displaying raster, vector, AOI, and annotation layers.

Click to import raster and vector data into ERDAS IMAGINE, or to export ERDAS IMAGINE files. The Import/Export dialog opens

Click to display the Data Preparation menu which provides ao a set of tools that are useful in general data preparation. This includes Image Mosaicking, Image Rectification, Create Surface

Click to bring up the Image Interpreter dialog. Many common image enhancement and manipulation operations are available in Image Interpreter, including spatial enhancement, radiometric enhancement, spectral enhancement, GIS analysis, and various utilities.

Click to access the ERDAS IMAGINE Classification capabilities, enabling you to perform supervised or unsupervised image classification.

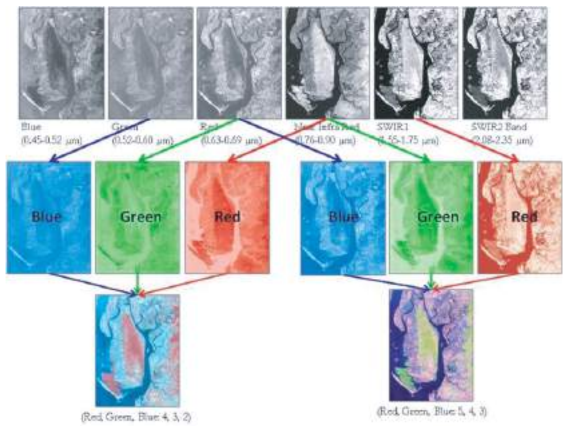


Click to bring up the Spatial Modeler dialog. The Spatial Modeler allows you to perform many GIS algebra and GIS modeling operations using Model Maker and the Spatial Modeler Language.

Source: ERDAS IMAGINE® Tour Guides™. (2006). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

Multispectral Image

We can combine and display bands or channels of information digitally using the three primary colors (blue, green, and red). The data from each channels represented as one of the primary colors and, depending on the relative brightness of each pixel in each channel, the primary colors combine in different proportions to represent different colors.



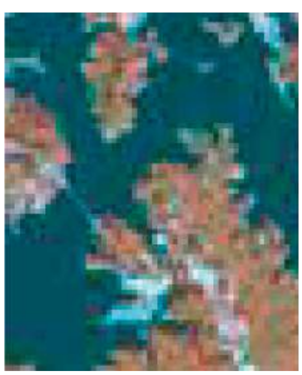
Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

Raster Layers

When data are imported into ERDAS IMAGINE image files, they can contain two types of raster layers.

Continuous raster layers contain quantitative (measuring a characteristic on an interval or ratio scale) and related, continuous values. It can be multiband (e.g. Landsat TM data) or single band (e.g., SPOT panchromatic data).The following types of data are example.

Thematic data are raster layers that contain qualitative, categorical information about an area. Thematic layers lend themselves to applications in which categories or themes are used. Thematic raster layers are used to represent data measured on a nominal or ordinal scale, such as soils, land use, land cover, roads, and hydrology etc.



Continuous Raster Layers

Thematic Raster Layers

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

Arrange Layers
This dialog is an interactive 'stacker' tool for arranging multiple layers that are opened in a Viewer, or map frames and map annotation in a map composition.

Each opened layer is represented by a bar in a scrolling list. The top of the stack represents the top, or most visible layer in the Viewer. Lower layers are obscured by any opaque regions in higher layers.

This dialog opens when you select **View > Arrange Layers** from the Viewer menu bar or Map Composer menu bar.

(stacker) Left-hold on any bar in the stack, and drag it to a new location in the stack. The following options are used with any layer in the stacker.

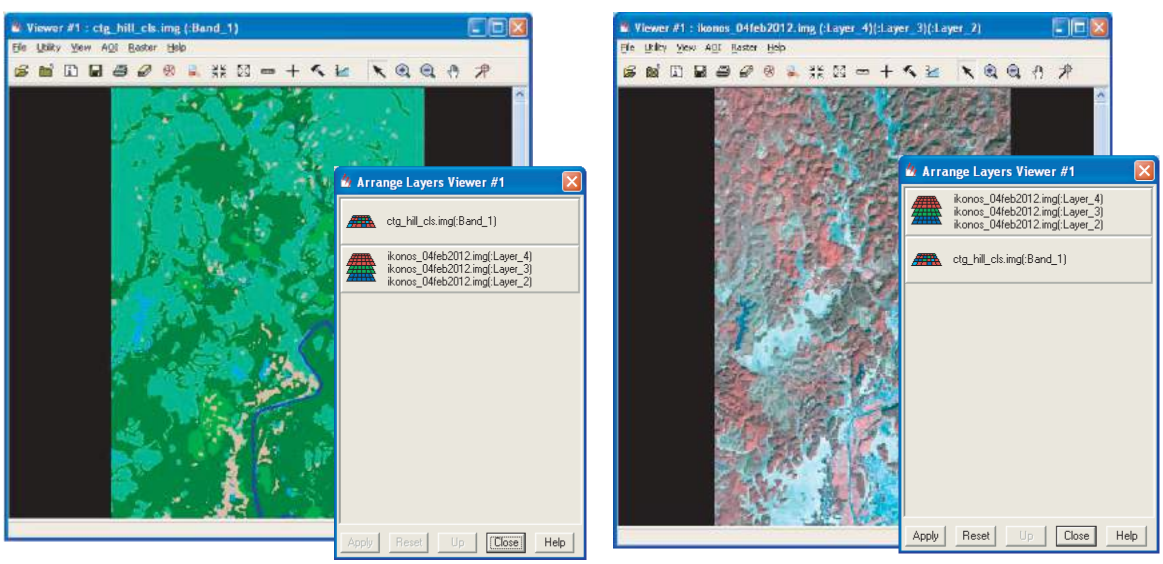
Apply - Click to change the arrangement of layers in the Viewer or Map Composer according to your changes in this dialog. This button is disabled until you have edited the stack.

Reset -Click to reset the layers to their original positions. This button is disabled until you have edited the stack.

Up - This button is not enabled until you select Frame Options > Descend Into in a map frame layer. It allows you to move up out of the map frame level and into the default state of the Arrange Layers dialog.

Close - Click to close this dialog without arranging layers.

Help - Click to see this On-Line Help document.



Source: ERDAS IMAGINE on line Help for the Arrange Layers

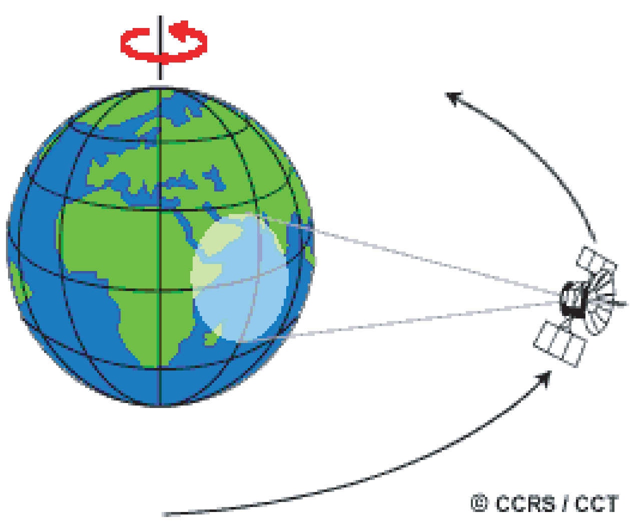
Satellite Orbits

The path followed by a satellite is referred to as its orbit. Orbit selection can vary in terms of altitude (their height above the Earth's surface) and their orientation and rotation relative to the Earth.

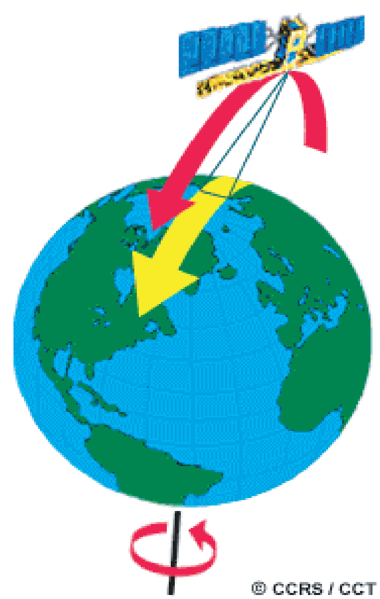
Geostationary orbits are at altitudes of approximately 36,000 kilometers and geostationary satellites view the same portion of the Earth's surface at all times.

Many remote sensing platforms are designed to follow a **near-polar orbit** (basically north-south) which, in conjunction with the Earth's rotation (west-east), allows them to cover most of the Earth's surface over a certain period of time.

Many of these satellite orbits are also **sun-synchronous** such that they cover each area of the world at a constant local time of the day called local sun time. This is an important factor for monitoring changes between images or for mosaicking adjacent images together, as they do not have to be corrected for different illumination conditions.



Geostationary Orbits

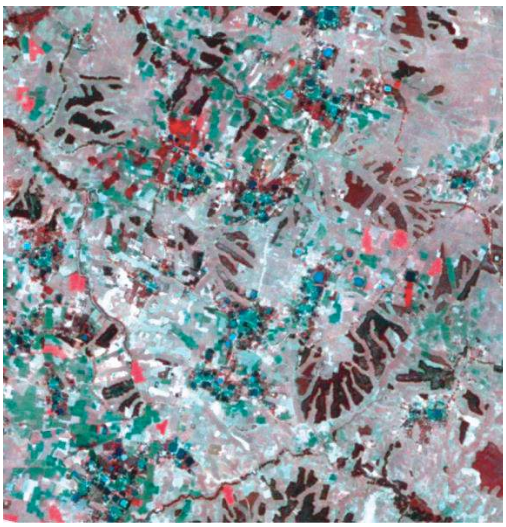


Near-polar Orbits (Sun-Synchronous)

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing.

Forest Cover Typing and Species Identification

Forest cover types and species identification are critical to both forest conservation managers and forestry companies interested in their supply inventory. Remote sensing technology provides a means of quickly identifying and delineating various forest types, a task that would be difficult and time consuming using traditional ground surveys. Both imagery and the extracted information can be incorporated into a GIS to further analyze. Hyperspectral imagery can provide a very high spatial resolution and extremely fine radiometric resolution data. This can be used to generate signatures of vegetation species and certain stresses on trees.



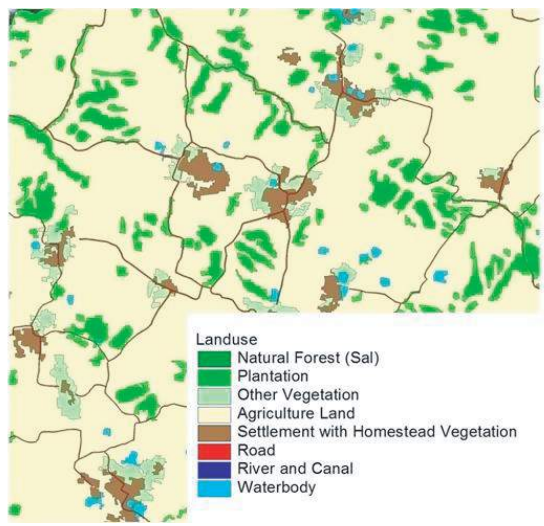


Image Texture

Texture refers to the arrangement and frequency of tonal variation in particular areas of an image. Smooth textures are most often the result of uniform, even surfaces, such as fields, asphalt, or grasslands. A target with a rough surface and irregular structure, such as a forest canopy, results in a rough textured appearance. Texture is one of the most important elements for distinguishing features in radar imagery.

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing

Shadow

Shadow is helpful in interpretation relative height of a target or targets. It is also useful for enhancing or identifying topography and landforms, particularly in radar imagery. It can be used to distinguish clouds and snow.

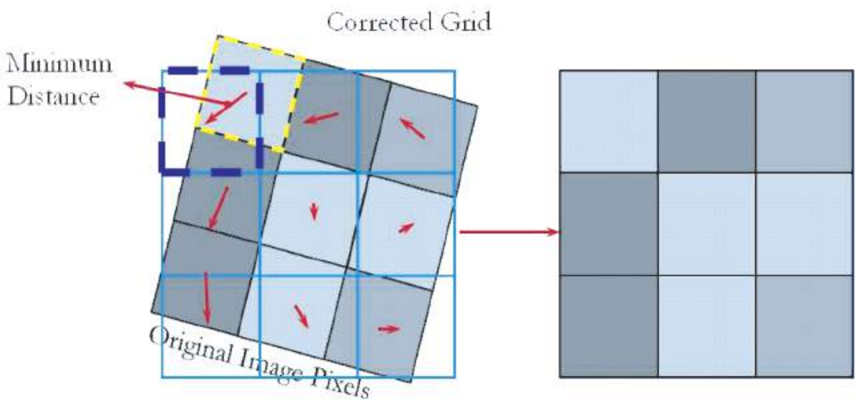
It can reduce interpretation in their area of influence, since targets within shadows are much less or not at all discernible from their surroundings.

Source: Canada Centre for Remote Sensing. 2007. Tutorial: Fundamentals of Remote Sensing

Problems : Pixel duplication and drop-out

Benefits : Original pixel value maintained

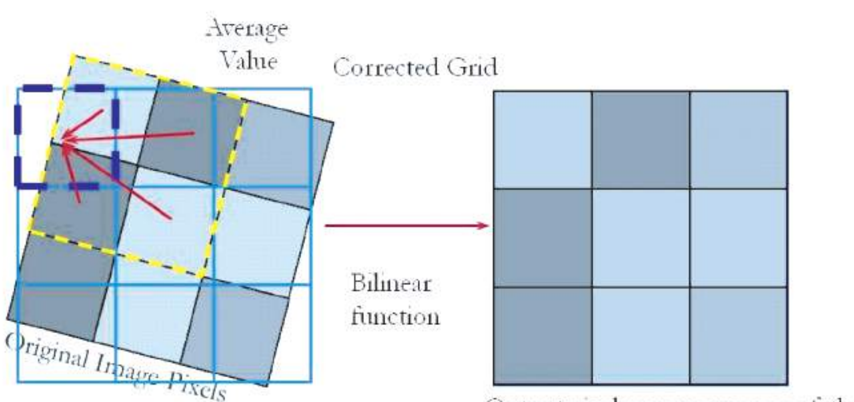
Uses : Urban areas; data to be classified; thematic data



Bilinear Interpolation

In bilinear interpolation, the data file value of the rectified pixel is based upon the distances between the retransformed coordinate location and the four closest pixels in the input (source) image. Output pixels are an average of the nearest 4 original pixels. Results in output images that are smoother, without the stair stepped effect that is possible with nearest neighbor.

Since pixels are averaged, bilinear interpolation has the effect of a low frequency convolution. Edges are smoothed, and some extremes of the data file values are lost.



Problems : Original pixel value integrity lost; slower

Benefits : More spatially accurate; smooth transitions

Uses : Natural landscapes and environments

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC

Selecting Training Samples

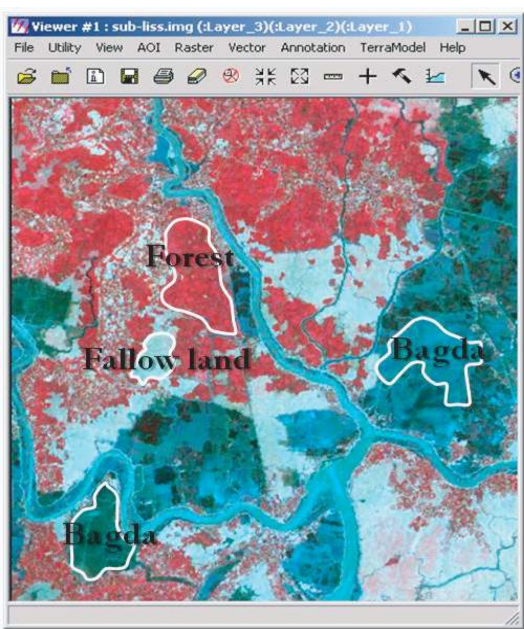
Training samples (also called samples) are sets of pixels that represent what is recognized as a discernible pattern, or potential class. The system calculates statistics from the sample pixels to create a parametric signature for the class.

Training sample and Training field

Training sample is a set of pixels selected to represent a potential class. Training field, or training site, is the geographical AOI in the image represented by the pixels in a sample.

The selection of training samples depends largely upon your knowledge of the data, of the study area, and of the classes that you want to extract. ERDAS IMAGINE enables you to identify training samples using one or more of the following methods:

- using a vector layer
- defining a polygon in the image
- identifying a training sample of contiguous pixels with similar spectral characteristics
- identifying a training sample of contiguous pixels within a certain area, with or without similar spectral characteristics
- using a class from a thematic raster layer from an image file of the same area (i.e., the result of an unsupervised classification)



– Locate the training samples for each potential class and define their boundaries.

– Two or more samples may be selected for one potential class.

Source: ERDAS Field Guide™. (2005). Norcross, Georgia: Leica Geosystems Geospatial Imaging, LLC.

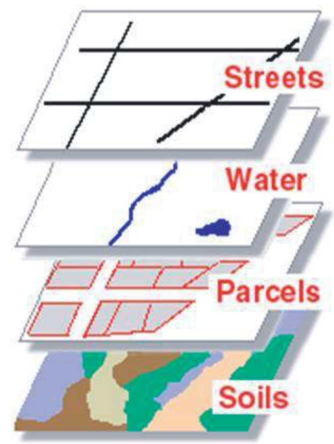
Health care: Develop a Web-based GIS for Emergency Health Care Service provisions for Specific region, epidemiological studies like tracking the source of diseases.

Real estate: GIS helps the real estate industry to analyze, report, map, and model the merits of one site or location over another.

Hydrology: GIS helps to delineate drainage network, identify catchment area, delineate waterlogged area, identify groundwater mining zone.

Others: GIS is also used in many other sectors like Radio planning in Telecommunication sector.

How Data is Organized in GIS



Geographic data is organized as

- collection of thematic layers linked by geographic coordinates
- each thematic layer contains attributes

Thematic layer describes any particular theme of any specific area like a land use or land cover data contain different thematic layers like water, vegetation, bare land etc.

The quantities of latitude and longitude which define the position of a point on the surface of the Earth with respect to the reference spheroid.

Source:
http://www.geography.hunter.cuny.edu/~jochen/GTECH361/lectures/lecture02/concepts/01%20How%20a%20GIS%20map%20is%20organized.html

Types of Geographic Data Representation

In GIS, geographic data can be represented by vector representation and raster representation

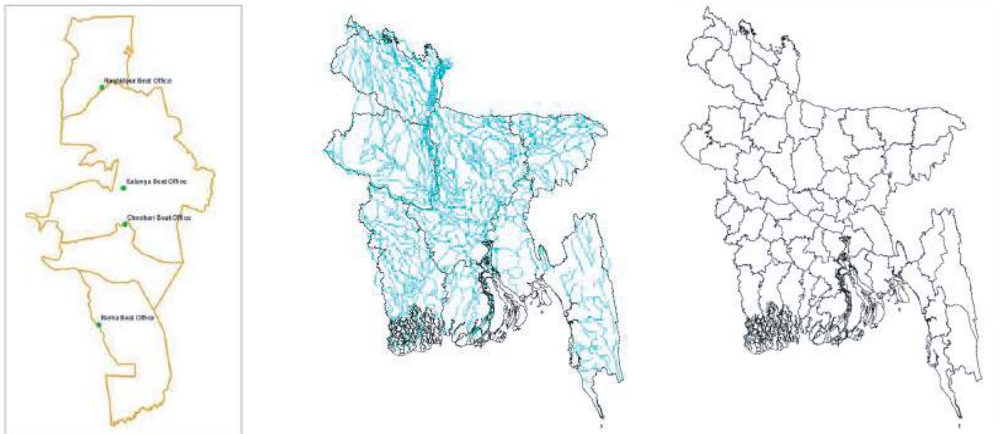
Raster representation

Represents any feature as a surface divided into regular grid of cells. Raster models are useful for storing data that varies continuously, as in an aerial photograph, a satellite image, a surface of chemical concentrations, or an elevation surface.

Vector representation

Represents any features using points, lines and polygons. Vector models are useful for storing data that has discrete boundaries, such as country borders, land parcels, and streets. Represents the geographic features similar to the way maps do. A geometric element defined by a pair of x and y coordinates.

On a map, a shape is defined by a connected series of unique x,y coordinate pairs. A line may be straight or curved. A closed shape is defined by a connected sequence of x,y coordinate pairs, where the first and the last coordinate pair are the same and all other pairs are unique. Various geographic features in vector representation are shown in the following figures:



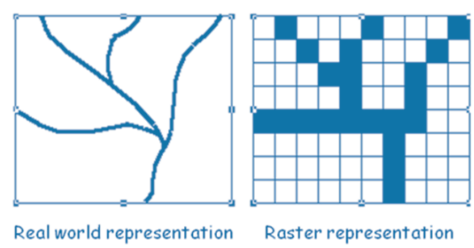
Point: Beat Office Line: River Network Polygon: Administrative Boundary

Types of geographic data by Vector Representation

Source: http://support.esri.com/en/knowledgebase/GISDictionary/search

Raster data may be:

- Discrete data, also called categorical data, as in land-use maps or soils maps;
- Continuous data, as in DEMs, rainfall maps, or pollutant concentration maps;
- Satellite images or digital pictures, which are usually used as base maps for digitization or registration, but rarely used in raster analyses.

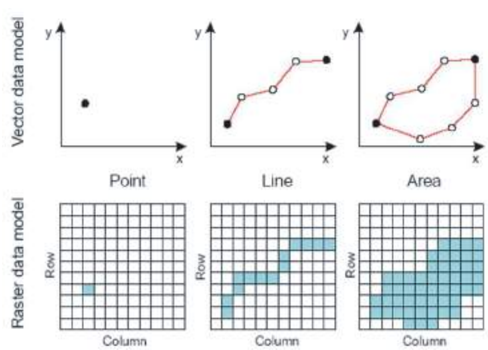


<u>Raster representation</u>

- o Raster represents the real world as a regular grid of cells called pixel.
- o Cells are laid out in a grid and each cell has a location and a value describing the feature

Discrete data and continuous data constitute the majority of raster data, which are also the main types of data resulted in raster analyses. In many ways, raster data complement vector data in GIS applications. Integration of both raster and vector data has therefore become a common feature in a GIS project.

This figure shows a comparison between the vector representation and raster representation of geographic data:



Both Vector and Raster data constitute of "latitudes and longitudes", only. The difference is in the way they are displayed. Latitudes and Longitudes in Vector data are displayed in the form of lines, points, etc. Latitudes and Longitudes in Raster data are displayed in the form of closed shapes where each pixel has a particular latitude and longitude associated with it.

Source: http://gis.stackexchange.com/questions/57142/what-is-the-difference-between-vector-and-raster-data-models

Introduction to ArcGIS

ArcGIS is professional GIS for desktop. Desktop GIS refers to a GIS that can be installed on a desktop computer. It aims to provide the user the GIS analysis, query with mapping facilities. Following is the list of some of the major capabilities of ArcGIS:

– Creates data and edits geographic and tabular data analysis and analyses map features

– Locates any map features from its attribute table

– Query and analyze data

– Examine and establish geographic relations between sets of data

– Reflects changes in maps when there are changes in the data

ArcGIS is Comprehensive, integrated, scalable system for a wide range of GIS users. It is a collection of software products that runs on desktop computers. There are 3 products in ArcGIS Desktop collection each having a higher level of functionality

- ArcView
- ArcEditor
- ArcInfo

ArcView:

ArcView is the entry level licensing level of ArcGIS Desktop, a geographic information system software product produced by ESRI. It is intended by ESRI to be the logical migration path from ArcView 3.x.

ArcEditor:

ArcEditor is the midlevel software suite designed for advanced editing of spatial data published in the proprietary ESRI format. It is part of the ArcGIS product. It provides tools for the creation of map and spatial data used in Geospatial Information Systems. ArcEditor is not intended for advanced spatial analysis, which can be performed using the highest level of ArcGIS, ArcInfo.

ArcInfo:

ArcInfo (formerly ARC/INFO) is a full-featured geographic information system produced by ESRI, and is the highest level of licensing (and therefore functionality) in the ArcGIS Desktop product line. It was originally a command-line based system. The command-line processing abilities are now available through the GUI of the ArcGIS Desktop product.

Source: http://resources.arcgis.com/en/help/

ArcCatalog

The ArcCatalog application provides a catalog window that is used to organize and manage various types of geographic information for ArcGIS for Desktop. The kinds of information that can be organized and managed in ArcCatalog include:

- Geodatabases
- Raster files
- Map documents, globe documents, 3D scene documents, and layer files
- Geoprocessing toolboxes, models, and Python scripts
- GIS services published using ArcGIS for Server
- Standards-based metadata for these GIS information items
- And much more …

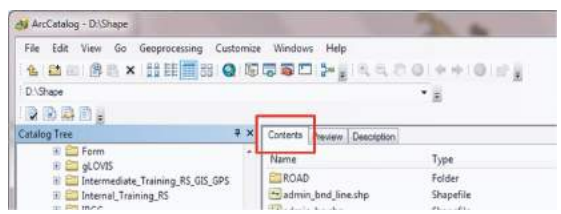
ArcCatalog is used to:

- Organize your GIS contents
- Manage geo-database schemas
- Search for and add content to ArcGIS applications
- Document your contents
- Manage GIS servers
- Manage standards-based metadata

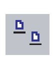
In ArcCatalog there are 3 tabs : Contents, Preview and Description.

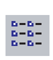
<u>Contents tab in ArcCatalog:</u>

The Contents tab shows a list of the selected items.



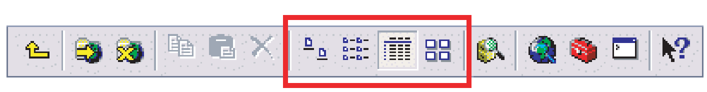
When you select items from the Catalog tree, the Contents tab lists the items they contain such as maps or tables. You can display the Contents list in several ways by using the buttons on the Standard toolbar to change its appearance. The view you are using is saved and used again after switching to a different tab or restarting ArcCatalog.

Large Icons view 

List view 

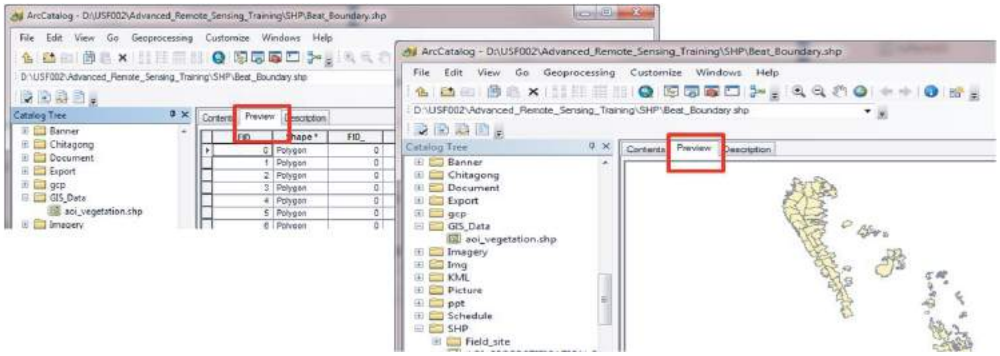
Details view 

Thumbnail view 

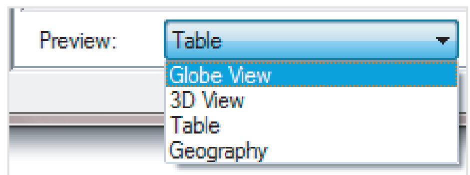


Source: http://resources.arcgis.com/en/help/

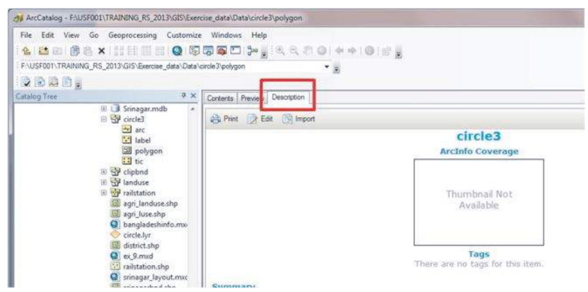
The Preview tab shows the data in both geographic and tabular view



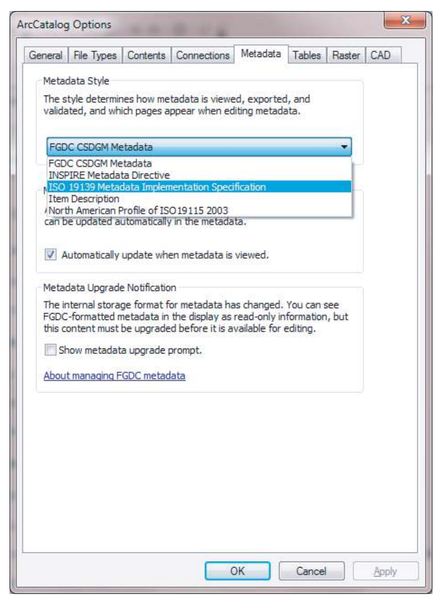
In ArcGIS 10.1 version, you will also see the data inGlobe View and 3D View.



The Description tab will give you access to documentation about the selected item. Using the Edit button, you can create, edit and view documentation of this data.



The Description tab contains the metadata of selected data. Information that describes items in ArcGIS is called Metadata. ArcGIS offers several different metadata styles. If you want to view more information about the item or describe it in more detail than you can with the default Item Description Style, choose a different Metadata Style.
Select Customize >ArcCatalog options

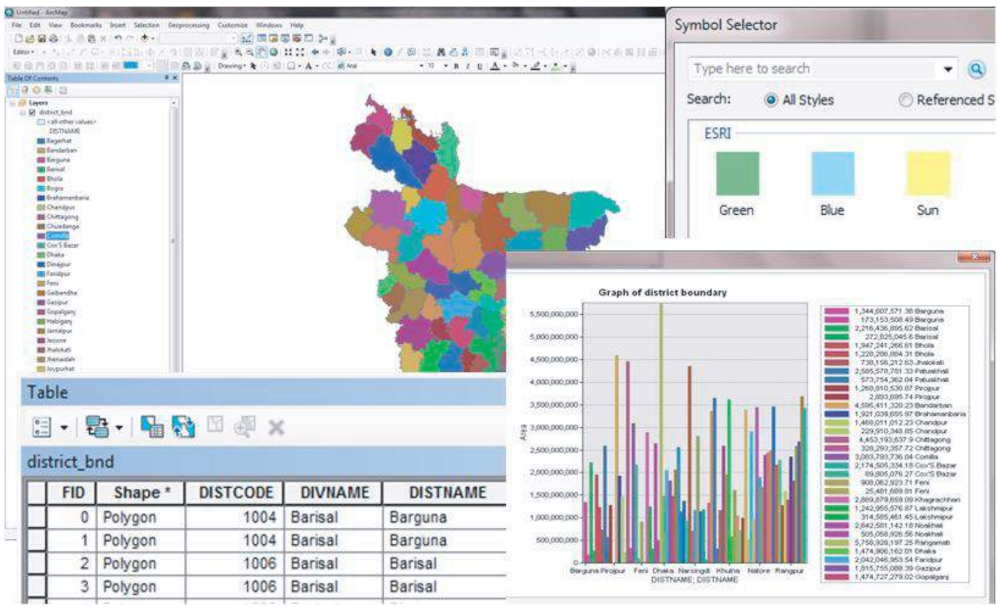


Source: http://resources.arcgis.com/en/help/

ArcMap

In ArcMap, you can create and manipulate data sets to include a variety of information. For example, the maps produced in ArcMap, generally include features such as north arrows, scale bars, titles, legends, etc. The software package includes a style-set of these features.

Maps created and saved within ArcMap will create a file on the hard drive with an **.mxd extension**. Once an **.mxd file** is opened in ArcMap, the user can display a variety of information, as long as it exists within the data set. At this time the user will create an entirely new map output and use the customization and design features to create a unique product. Upon completion of the map, ArcMap has the ability to save, print, and export files to PDF or any other format.



Editing — ArcMap user can edit their data using Editor toolbar. Editing includes different types of editing, like creating new file, cutting and splitting polygon, merging polygon. Editor toolbar edits both spatial data and tabular data.

Queries — ArcMap user can query any information using the attribute table of selected data.

Analysis — ArcMap user can analyze data using different spatial analysis toolbar from the Arc Toolbox.

Graphing — ArcMap user can create graph using the tabular data of any spatial datasets.

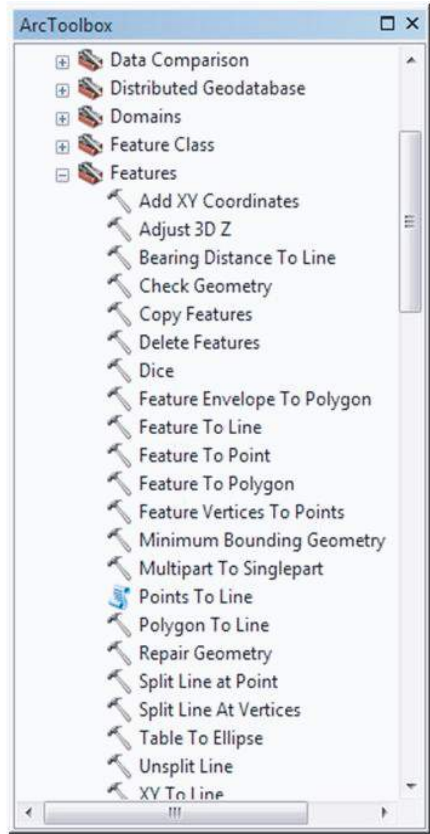
Reporting — A report lets user organize and display the tabular data that is associated with the geographic features.

The two native file formats for reports in ArcGIS are RDF (Report document file) and RLF(Report layout file)

Source: http://resources.arcgis.com/en/help/

ArcToolbox

- Used for advanced GIS analysis
- Used for geographic data processing
- Used for creating and integration of a variety of data formats
- Provides a powerful set of geoprocessing functions



ArcToolbox is an integrated application developed by Environmental Systems Research Institute (ESRI). It provides a reference to the toolboxes to facilitate user interface in ArcGIS for accessing and organizing a collection of geoprocessing tools, models and scripts.

A Tool box is a container which contains all the tools required to perform any advanced task in a particular domain. Similarly, ArcToolbox is a container in which all the tools required to facilitate advanced Geoprocessing tasks are organized in a logical way. All the Toolboxes, Toolsets and Tools within the ArcToolbox are sorted alphabetically.

Common toolboxes present within ArcToolbox are:

- Analysis Toolbox
- Cartography Toolbox
- Conversion Toolbox
- Coverage Toolbox
- Data Management Toolbox
- Geocoding Toolbox
- Linear Referencing Toolbox
- Spatial Analyst Toolbox

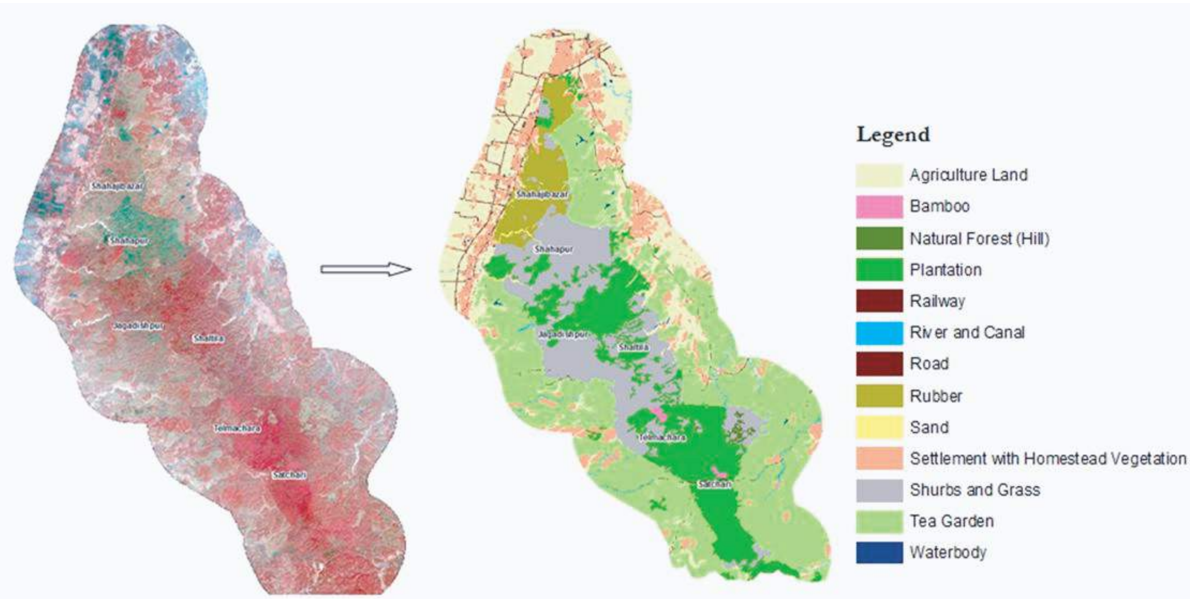
Source: http://resources.arcgis.com/en/help/

Application of GIS

<u>Mapping</u>

- Land use/Land cover map of any forest area is very much useful to see the spatial distribution of the forest area. With the help of GIS software like ArcGIS, you can easily extract these classes from Satellite Images or Aerial Photo.

- For example, RapidyEye Image is a multispectral satellite image. Its spatial resolution is 5 meter. Now you can easily identify the different classes like plantation, shrub and grass etc. The user can verify this classes using Ground Truth data and prepared a land use/land cover map of this area



RapidEye Image   Land Use/Land Cover Map

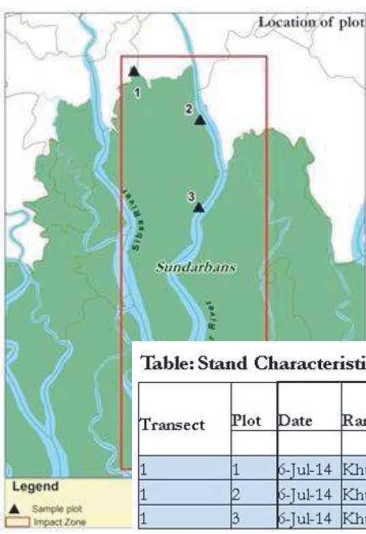
Forest Monitoring

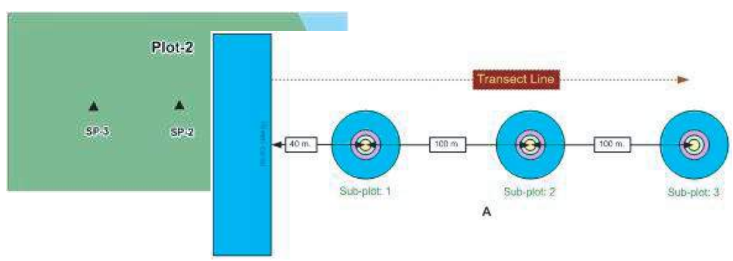
A coal based thermal plant will be established near Mongla port in Bagherhat district, Bangladesh. The coal is to be transported through the Passur River. It may create negative impact around the forest area of this transportation route. For that reason it is necessary to monitor the forest health of specific plots within the forest area. These plots were selected based on distance from proposed project, coal transportation route, protection of the permanent sample plot and cover the maximum vegetation types.

There are four sites to monitor the forest health.
Waypoints of these sites were collected by GPS.
After that Shapefile was created using ArcGIS software.
The different observation was included as an attribute of this Shapefile.

The attribute table of mean value of Canopy Cover (%), Aboveground Carbon, Basal area, Seedling density, Pneumatophore, Lichen (%),Top Dying <50 %, Top Dying > 50 %, Timber Damage <50 %, Timber Damage >50 % with 95% confidence interval of one transact site given in two separate tables.

You can easily add field and insert value of subsequent monitoring data in this attribute table. This will help to evaluate the relative attribute value of this temporal data





Location of Plot

Profile of Transect line

Table: Stand Characteristics of Monitoring site 1 (Sutarkhali Forest Station)

Transect	Plot	Date	Range	Comp.	Site Cat.	Canopy Cover %		Aboveground Carbon		Basal Area		Seedling density		Pneumatophore	
						Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
1	1	6-Jul-14	Khulna	32	Forest	96.464	1.248361	113.3	38.80968	20.32	7.21358	37666.7	23414.98	228339.5	18474.41
1	2	6-Jul-14	Khulna	32	Forest	96.464	1.248361	113.3	38.80968	20.32	7.21358	37666.7	23414.98	228339.5	18474.41
1	3	6-Jul-14	Khulna	32	Forest	96.464	1.248361	113.3	38.80968	20.32	7.21358	37666.7	23414.98	228339.5	18474.41

Table: Pest and Damage of Monitoring site 1 (Sutarkhali Forest Station)

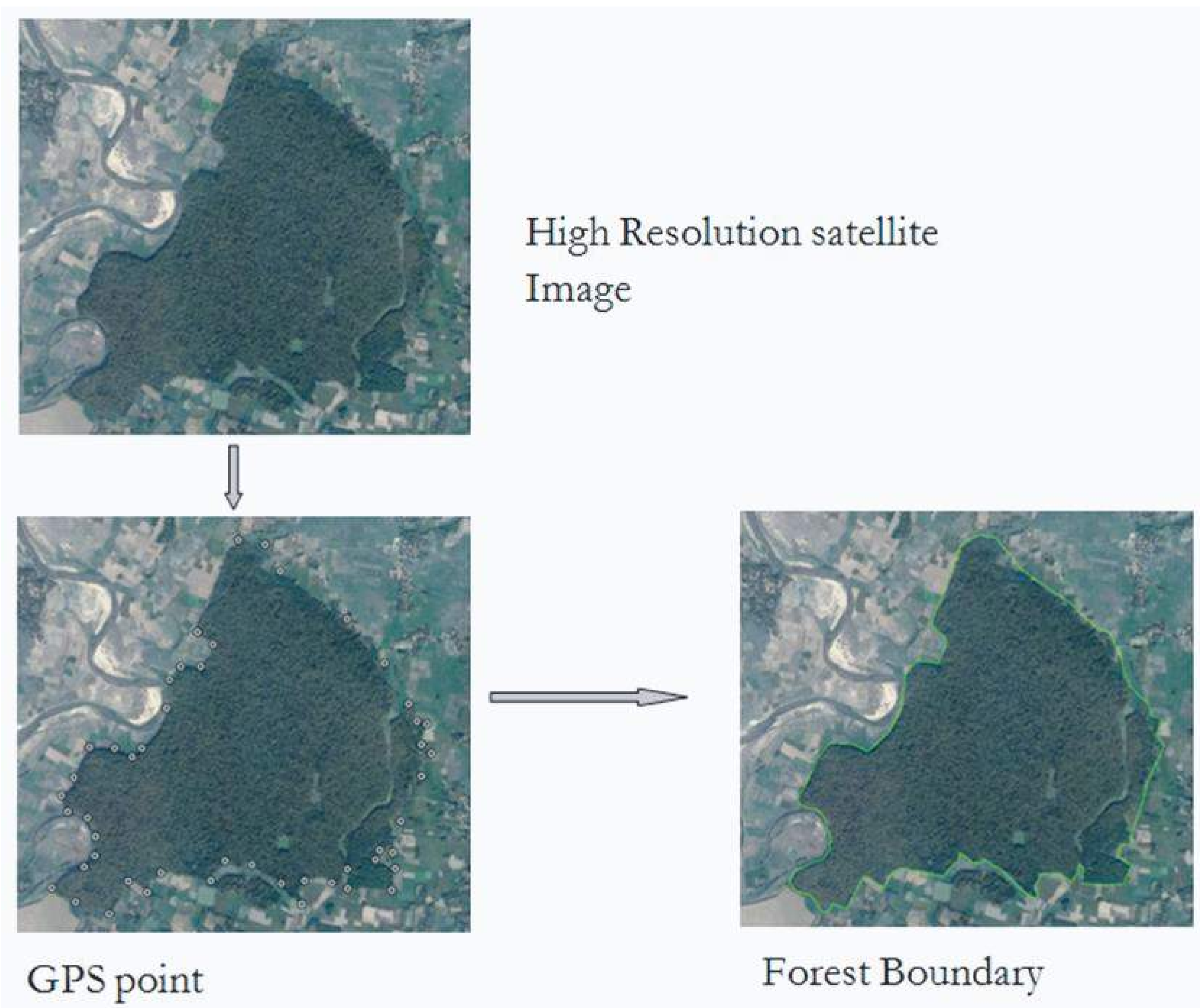
Transect	Plot	Date	Range	Comp.	Site Cat.	Lichen %		Top Dying <50 %		Top Dying > 50 %		Timber Damage <50 %		Timber Damage >50 %	
						Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
1	1	6-Jul-14	Khulna	32	Forest	20.25627	2.636451	0.22	0.44	0	0	2.30504	1.99623	0.55244	0.47843
1	2	6-Jul-14	Khulna	32	Forest	20.25627	2.636451	0.22	0.44	0	0	2.30504	1.99623	0.55244	0.47843
1	3	6-Jul-14	Khulna	32	Forest	20.25627	2.636451	0.22	0.44	0	0	2.30504	1.99623	0.55244	0.47843

Delineate Forest Boundary

Delineating boundary of any feature is a challenging task. If you have any satellite image or aerial photo of any forest area, you can delineate the forest boundary.

At first identify the boundary corner of this forest area. \

Now, you can collect GPS or DGPS (Differential Global Positioning System) of this corner and extract the polygon boundary according to the GPS or DGPS point.



Lesson Review

- ✓ GIS and its components
- ✓ Organization of data in GIS
- ✓ Introduction of ArcGIS
- ✓ Application of ArcGIS
- ✓ Application of GIS

Knowledge and Skills Practice 4: Introduction to GIS Concept and its application

The details of this assignment and data are given in the attached CD of the manual. Please follow the **Knowledge and Skills Practice 4: Introduction to GIS Concept and its application.**

Spatial and Tabular Data Model

Objective

By the end of this lesson, through the knowledge and skills practice the participants will be able to:

1. Practice the different elements of ArcMap interface and its application.
2. Select GIS features using different selection methods and tools.
3. Manipulate the feature attribute table using ArcGIS software.

Elements of ArcMap Interface

Different elements of ArcMap Interface are discussed below

Menu Bar A horizontal bar, typically located at the top of the screen below the title bar, containing drop-down menus.

Title Bar A horizontal bar at the top of a window, bearing the name of the program and typically the name of the currently active document like Map document name.

Standard Toolbar The standard toolbar is the toolbar at the top of your screen. It allows you to access the crucial features, such as file, edit and your printer. It functions as an easy way to get to the functions you use most commonly.

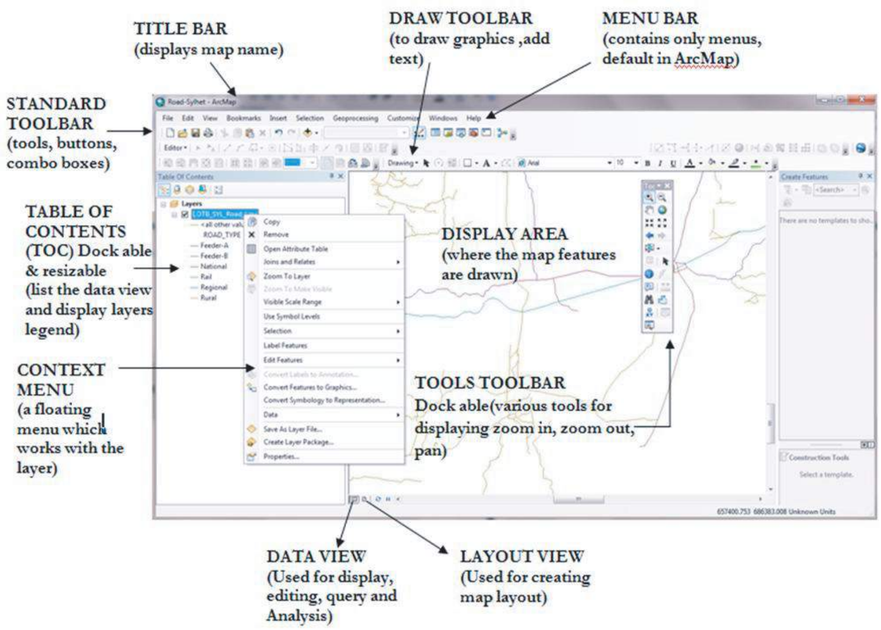
Table of Contents In ArcGIS, a tabbed list of data frames and layers (or tables) on a map that shows how the data is symbolized, the source of the data, and whether or not each layer is selectable.

Context Menu A context menu (also called contextual, shortcut, and popup or pop-up menu) is a menu in a graphical user interface (GUI) that appears upon user interaction, such as a right-click mouse operation.

Draw Toolbar Toolbar that supports functionality to create new geometries by drawing them: points, lines, polygons, or rectangles.

Data View An all-purpose view in ArcMap and ArcReader for exploring, displaying, and querying geographic data. This view hides all map elements, such as titles, north arrows, and scale bars.

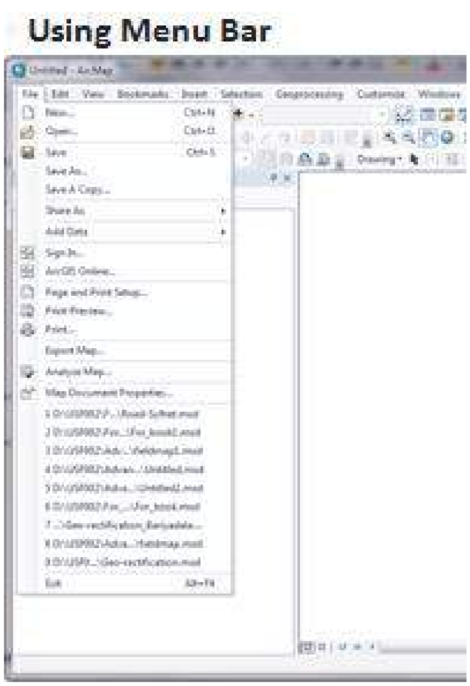
Layout View In ArcMap and ArcReader, a view that shows the virtual page upon which geographic data and map elements, such as titles, legends, and scale bars, are placed and arranged for printing.

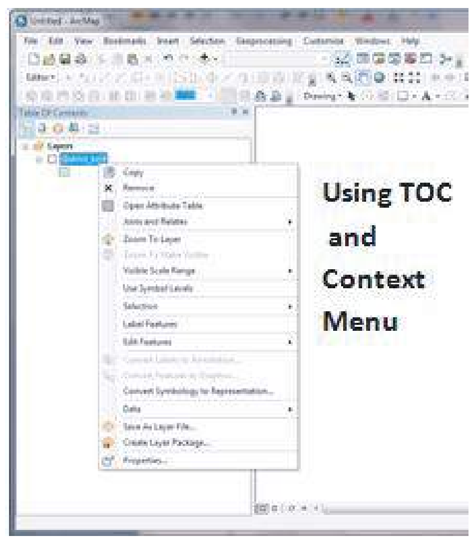


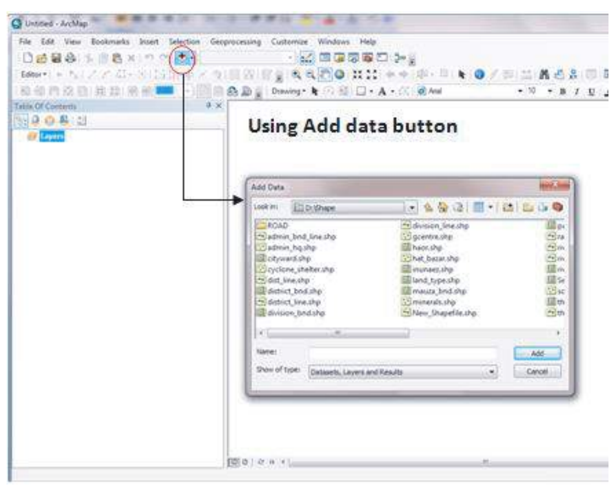
Adding Data

Data in ArcMap can be adding through using either of the following ways:

1. Using ArcCatalog
    a. Drag data from ArcCatalog to ArcMap
2. Using ArcMap
    a. From Menu Bar use File > Add Data,
    b. From Standard Toolbar use the Add Data button
    c. From Table of Contents use Context Menu







Zoom in and Zoom out

In ArcMap, tools are available to explore the map

- Zoom in and zoom out
- Pan the display
- Full extent
- Back or forward one display

Zoom in and zoom out

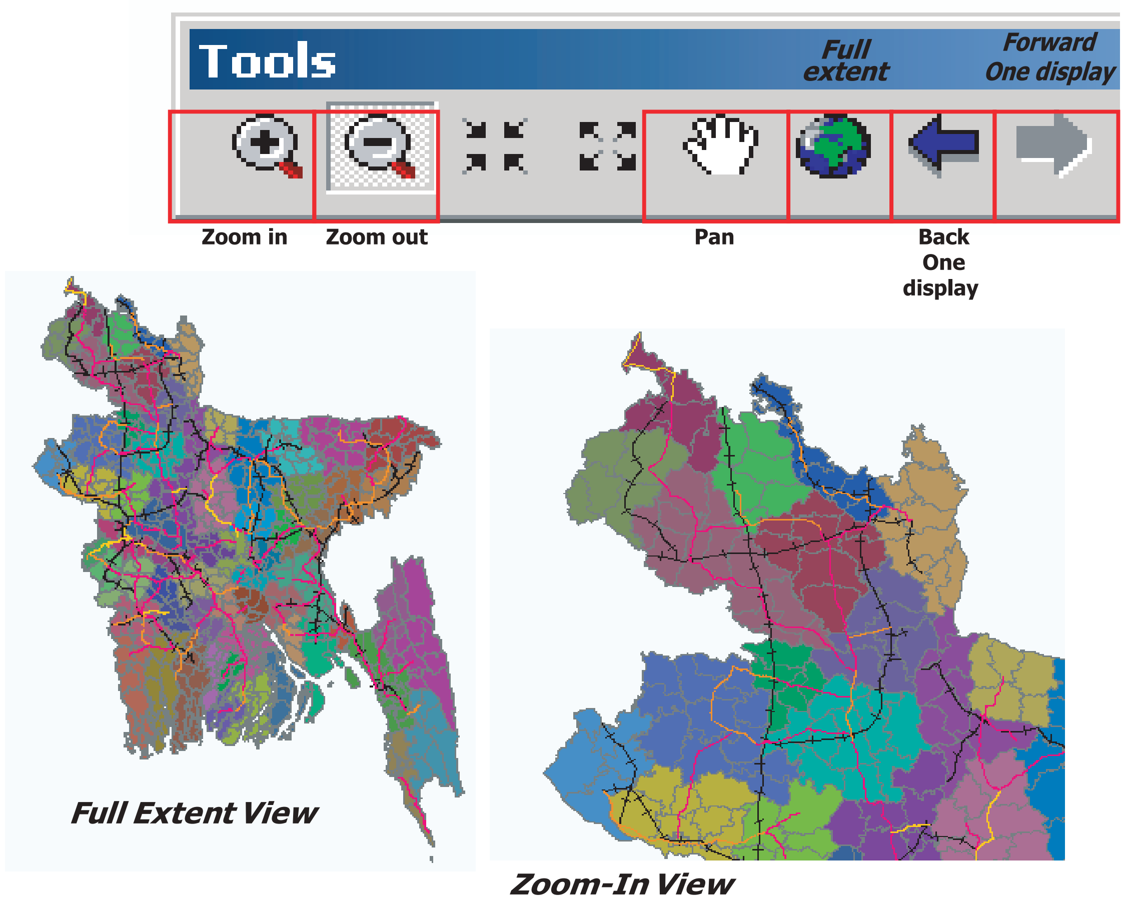
Zoom in button is used to explore the specific area in more detail. **Zoom out** button is used to explore the specific area in less detail. Zoom in and Zoom out buttons also indicates the scale of any area. When you zoom in any area, its scale becomes larger. However, when you zoom out any area, its scale becomes smaller.

Pan

To shift a map image relative to the display window without changing the viewing scale

Full Extent

Full extent button helps to view the entire extent of the selected layer.



Managing Data

Used to record a layer description, set credits, and specify scale-dependent drawing properties. ArcMap layer properties has the following options:

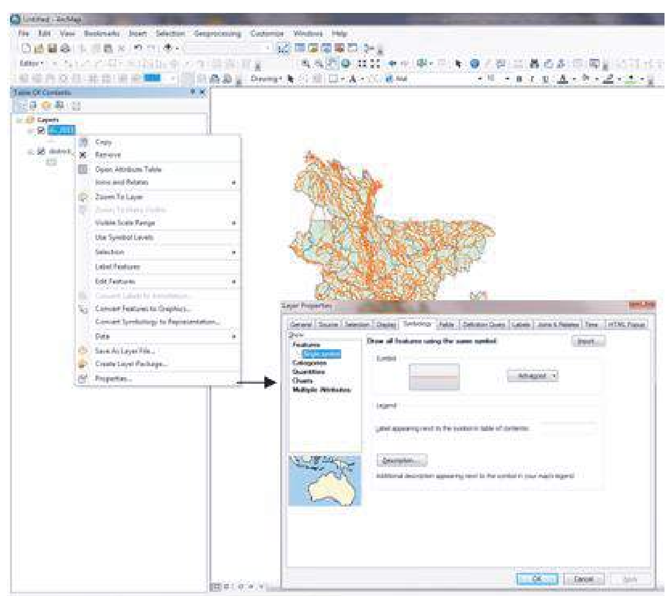
Source
Allows you to view the extent of your data. You can view and change the source of your data from this tab.

Selection
Allows you to set how features in a specific layer are highlighted when they are selected. Selection property changes in a specific layer override the default Selection Options settings.

Display
Controls how your data is displayed as you move in the view. Options include making a layer transparent, adding MapTips and hyperlinks, and restoring excluded features.

Symbology
Provides options for assigning map symbols and rendering your data. Options include drawing all features with one symbol; using proportional symbols; using categories based on attribute values; the use of quantities, color ramps, or charts based on attributes; or the use of representation rules and symbols.

Fields
Used to set characteristics about attribute fields. You can also create aliases, format numbers, and make fields invisible. An important aspect is to set Alias names for visible fields that make it easier for your users to work with feature attributes.



Definition query
Allows you to specify that a subset of the features will be used in the layer. With the Query Builder dialog box, you can create an expression to select particular features of a dataset to be used in your layer.

Labels
Allows you to turn on a layer's labels, build label expressions, manage label classes, and set up the labeling options for label placement and symbology. Alternatively, you can set labeling properties for all layers within the map using the Label Manager.

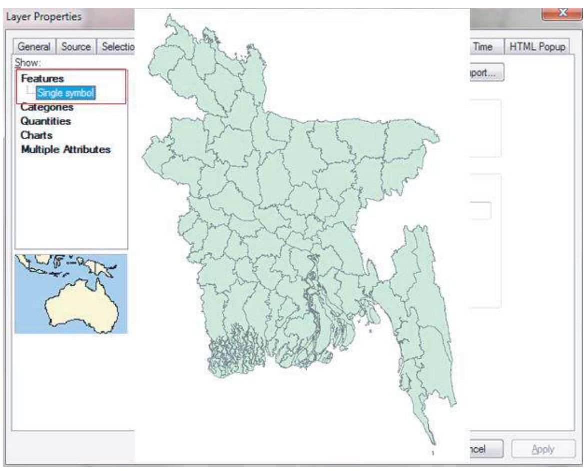
Source: http://resources.arcgis.com/en/help/

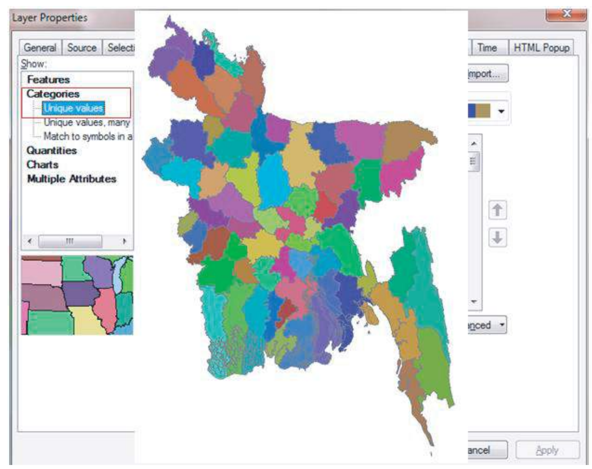
Symbolizing Data

Drawing properties (color, line, width, shade) can be set during symbolizing data from layer properties dialog

Dataset can be symbolized by using same symbol for all feature (single symbol) or Symbol can be set based on attribute values.

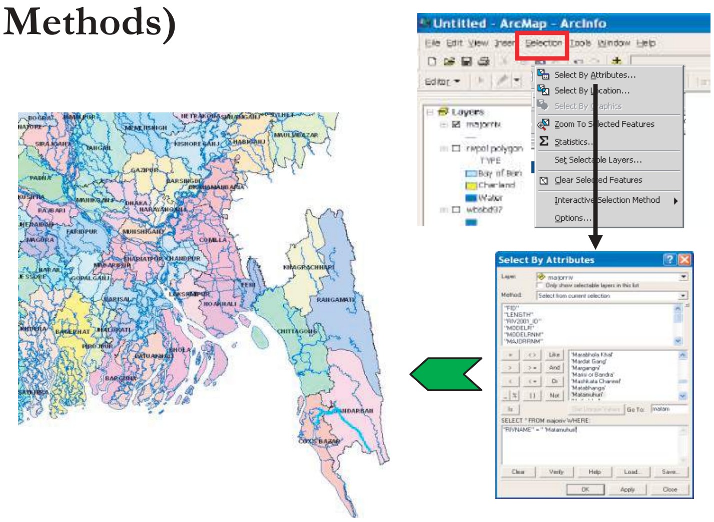
Map is the final output of any GIS analysis. Proper symbol of any map helps this map to be more meaningful to the user. Different map with different symbol can be generated from the attribute data of the map layers.





Interactive Display (Selection Methods)

Selection method is useful to show any data from the large spatial database. For example, you have a river database of Bangladesh. The attribute table contains different information of river like width, type, off take and outfall. Now you wish to see, which river's width is greater than 100 meter. You can do this by using 'Select By Attributes' method from the Attribute Table.



Source: http://resources.arcgis.com/en/help/

Selection Methods

There are four selection methods:

Select by Attributes:
You can use Select by Attribute to select features using an attribute query.

Select by Location:
The Select by Location tool lets you select features based on their location relative to features in another layer. For instance, if you want to know how many homes were affected by a recent flood, you could select all the homes that fall within the flood boundary.

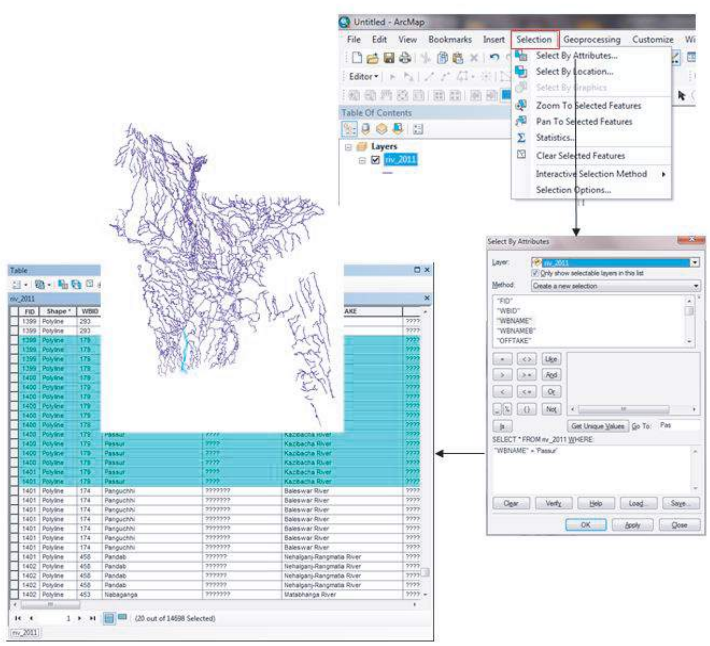
Select by Graphics:
The Select By Graphics command allows you to select features (from all selectable layers) that intersect a selected graphic element.

Interactive Selection:
Two different tools like Identify and Find button allows you to identify and find features from the spatial database.

Select by Attributes

You want to know the spatial location of the Passur river and its attributes. You have a River Shape file with large database. There are numerous major and minor rivers comprising the drainage network of Bangladesh. If you open the attribute table and explore the Passur River from the database, it takes longer time than if you go to **Selection> Select by Attributes**.

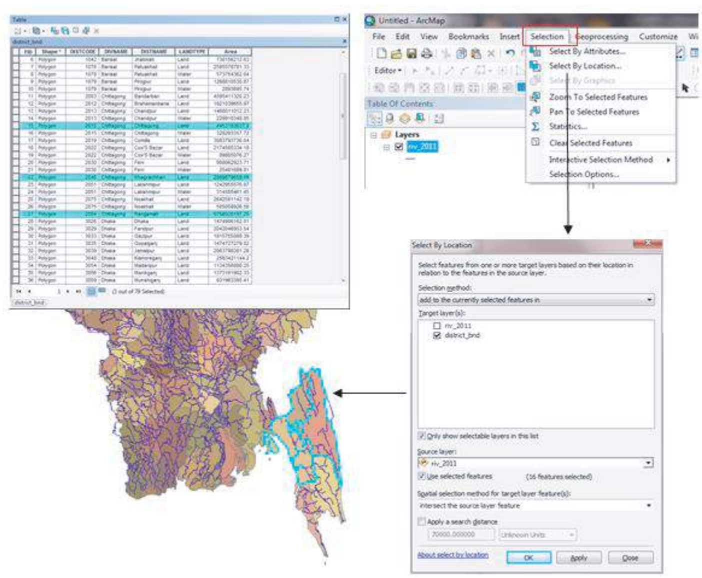
Open Select by Attributes tool. Now select Layer, Method and Query to find Passur River. The Passur River will be selected in ArcMap viewer. Its attribute also selected in the attribute table.



Select by Location

Select by Location tool helps to user locate any feature from the two GIS Shape files. You can use features in one layer to select features in another layer. For example, you have two different shape files, one is polygon shape file of Range boundary and other is point shape file of illegal cutting places. If you want to identify the illegal cutting places that are within the Range boundary, select Target Layer as illegal cutting places and Source Layer as Range boundary, Spatial selection method for Target Layer Features (s) 'are within the source layer feature'. Illegal cutting places within the Range boundary will be selected. The selection procedures includes:

- Select features from
- Add to the currently selected features
- Remove from the currently selected features
- Select from the currently selected features

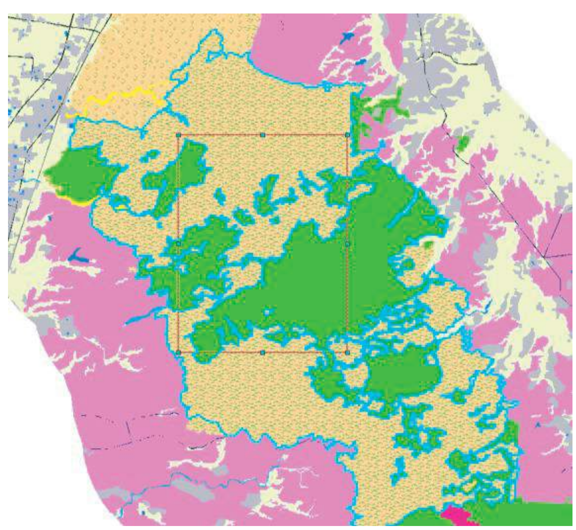


Select By Location offers various method

- Intersect
- Are within a distance of
- Completely contain
- Are completely within
- Have their center in
- Share a line segment
- Are identical to
- Contain
- Are contain by
- Touch the boundary of

Select by Graphics

This tool helps to select the area according to the different shape of Graphics like Rectangle, Polygon, Circle, Ellipse, Line, and Curve. For example, you have land use/land cover map of any forest area, now you can select any area according to your area of interest. To draw a graphic to an ArcMap display you need to use the drawing toolbar. Once the graphic has been added to the display, Select by Graphics option will be activated on the Selection menu.



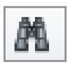
Source: http://resources.arcgis.com/en/help/

Interactive Display

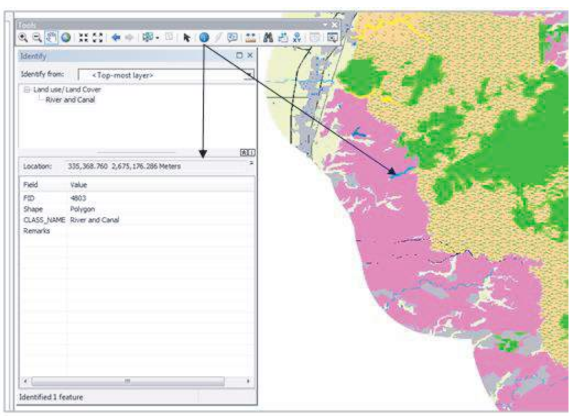
There are two tools for interactive display, namely: Identity tool and Find tool.

Identity Tool: 

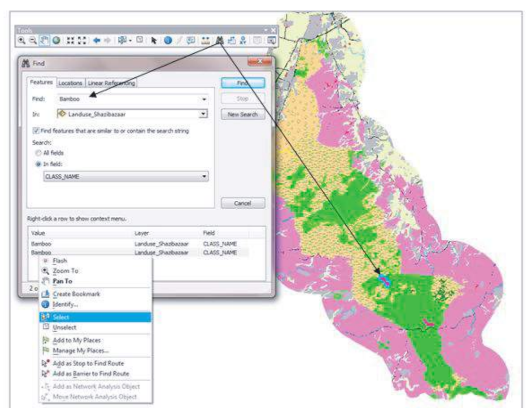
This Identify Tool when clicked, allows display of the attributes for any feature. You can just use identity tool and click any feature. You will see information of this feature. For example, A linear feature was found within forest area of land use/land cover map. If you want to know the detailed information of this linear feature, select Identity Tool and click in the Linear feature.

Find Tool: 

This tool allows you to find the feature from the large database. You can just click in Find Tool. Find Tool appeared and enter the information that you want to find in the Findrow and select the layer where you find this feature from the Inrow. Select Field from In Field and click Find. The finding information will be displayed. Right click of the information, a context menu appears with the different options like flash, zoom to feature, identify features, set bookmarks, select features and unselect features etc.



Application of Identify tool



Application of Find tool

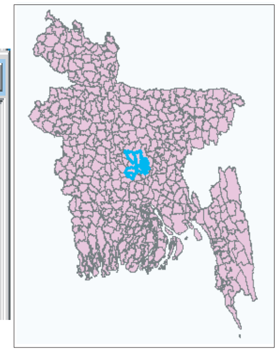
Select Tool

Select Features Tool  will be found in Tools of Arc Map viewer. Highlighted color of feature can be changed from Selection > Selection Options. Highlighted color of attribute table can be changed from Customize >ArcMap Options> Tables.

By choosing the "Select" tool, click to select one feature. Hold shift and click with mouse to select many features. For the Layer, selection will be highlighted with cyan color and for the Table, Records are highlighted with yellow/cyan color

Attributes of thana490

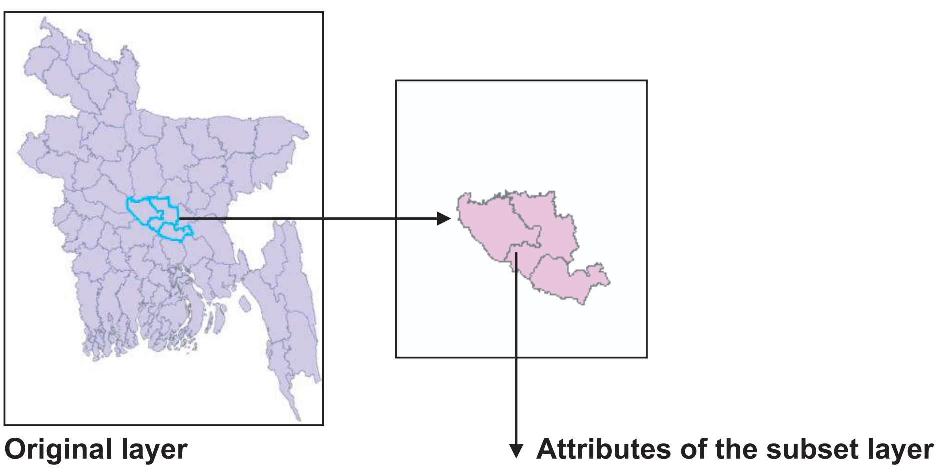
DISTNAME	THANA_NAME	AREA_SQKM	DISTRICT	GEOCODE_1
DHAKA	DEMRA	47.21	DHAKA	32612
DHAKA	KERANIGANJ	178.78	DHAKA	32638
DHAKA	MOHAMMADPUR	10.47	MAGURA	45566
DHAKA	TEJGAON	9.63	DHAKA	32690
DHAKA	RAMNA	8.29	DHAKA	32666



Creating a Selection Layer

You can create an individual Selection Layer to export the selected feature. To export the selected feature, you have to select the feature then follow the instruction below:

Right mouse click of the Layer > Data > Export Data. In this method, a subset of the original layer is created and the source layer is not affected

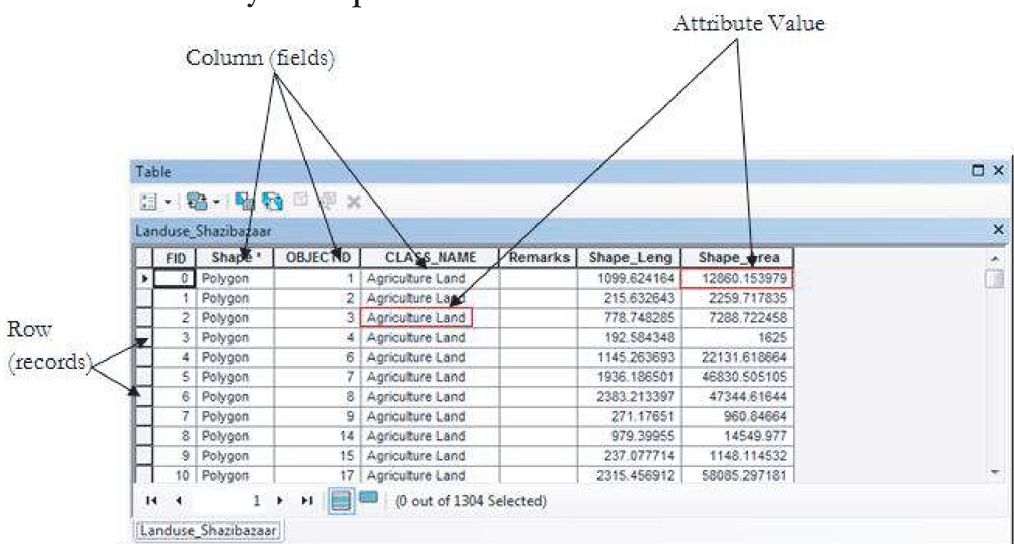


FID	Shape*	AREA	PERIMETER	DISTRICT_	DISTRICT_I	DISTNAME	FLAG	POP81	POP91	AREA_HEC	AREA_SQK	POPDENS81	POPDENS91
0	Polygon	1519781000	311569.3	32	14	DHAKA	14	5438221	6235554	151978.1	1519.78	3578.29	4102.93
1	Polygon	1374454000	238174.1	33	36	MANIKGANJ	36	1058992	1213446	137445.4	1374.45	770.48	882.86
2	Polygon	931826700	176815	44	39	MUNSHIGANJ	39	1015051	1221952	93182.67	931.83	1089.31	1311.35

Feature Attribute Table

Each Layer has an associated table known as Feature Attribute Table (FAT), which contains descriptive information about the features. The Feature Attribute Table consists of fields (column or item). Each row (known as Record) contains the attributes of one geographic feature in the dataset. Each field represents one type of descriptive information. Users can open the attribute table by following the instruction below-

Right mouse click of the **Layer > Open Attribute Table**



Source: http://resources.arcgis.com/en/help/

Attribute Table Manipulation

In ArcCatalog and ArcMap many operations (sort, select, freeze etc) can be done to manipulate a table. The following options are available:

- in ArcMap or Preview in ArcCatalog
  - Sort ascending or descending
  - Freeze / Unfreeze columns
  - Statistics
- In Arc Map
  - Select records
  - Edit the table record values
- In Arc Catalog
  - Create new tables
  - Delete fields for existing tables

Sorting ascending or descending:
Sorting ascending or descending the rows in a table helps to derive information more easily about it contents. In ascending order values are ordered from A to Z. In descending order values are ordered from Z to A. When you want these options, just right click the selected column and select this option.

Freeze /Unfreeze columns:
There are many ways that you can tailor the organization of the table to make your attribute information easier to work with. Freezing a column is a helpful way to see how attributes for the same feature are related with respect to one or more key fields (that are frozen). When you freeze a column, that column is always displayed even when scrolling horizontally in the table. When you want to unfreeze columns, right click the Selected Column and select this options.

Statistics:
Statistics of any column in attribute table gives count, minimum, maximum, sum, mean, standard deviation, null information of values.

Select Records/Edit the Table Record Value:
Attribute table contains the records of all features. When you select any row from attribute table, it will display the Select Record information below the attribute table. You can edit the record using the Start Editing button from the Editor toolbar.

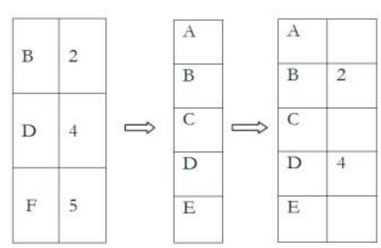
Create new tables/Delete fields for existing table in Arc Catalog:
You can easily add table in Arc Catalog and delete fields from the existing table. To add Table follow the instruction below-
Table Options > Add Table.
To delete field**, Select Column > right click> Delete field**

Source: http://resources.arcgis.com/en/help/

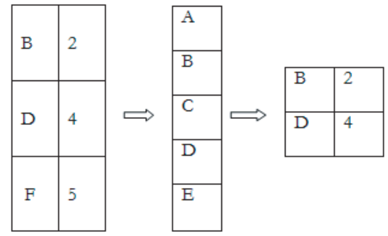
Connecting Tables

Attributes can be stored in the feature attribute table or separate table. Two tables can be connected, if there is a similar field in each table containing common values. ArcMap provides two methods to associate data stored in different tables of a geographic feature: JOIN and RELATE

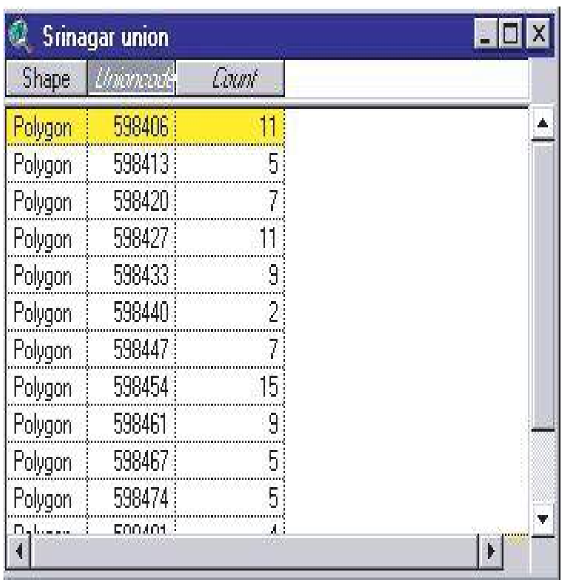
Join appends the attributes from one table onto the other table. Join can work when the data in the tables have one-to-one or many-to-one relationship. Once the tables are connected, query, symbolization, analysis can be done to the new table based on the joined values. ArcMap Join does not permanently connect tables.



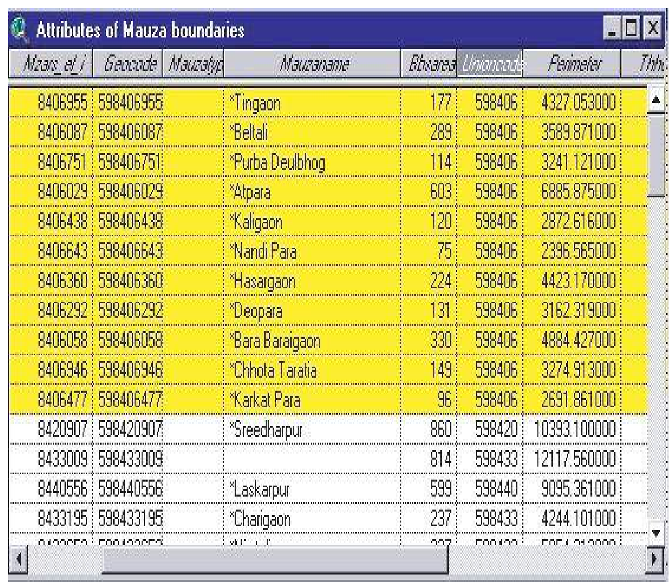
Tables are dynamically linked together in ArcMap, so that you can remove or add them whenever you want. When joining tables, the default option is to keep all records. When you select only matching record from Joint options, the joint table look like the figure on the right side.



Unlike joining tables, relating tables simply defines a relationship between two tables. The associated data is not appended to the Layer's attribute table like it is with a Join. Instead, you can access the related data when you work with the layer's attributes. Tables can be related like One to many, many to many relationships.


Srinagar union

Shape	Unioncode	Count
Polygon	598406	11
Polygon	598413	5
Polygon	598420	7
Polygon	598427	11
Polygon	598433	9
Polygon	598440	2
Polygon	598447	7
Polygon	598454	15
Polygon	598461	9
Polygon	598467	5
Polygon	598474	5


Attributes of Mauza boundaries

Mzars_el_i	Geocode	Mauzatyp	Mauzaname	Bbsarea	Unioncode	Perimeter	Thh
8406955	598406955		*Tingaon	177	598406	4327.053000	
8406087	598406087		*Beltali	289	598406	3589.871000	
8406751	598406751		*Purba Deulbhog	114	598406	3241.121000	
8406029	598406029		*Atpara	603	598406	6885.875000	
8406438	598406438		*Kaligaon	120	598406	2872.616000	
8406643	598406643		*Nandi Para	75	598406	2396.565000	
8406360	598406360		*Hasargaon	224	598406	4423.170000	
8406292	598406292		*Deopara	131	598406	3162.319000	
8406058	598406058		*Bara Baraigaon	330	598406	4884.427000	
8406946	598406946		*Chhota Taratia	149	598406	3274.913000	
8406477	598406477		*Karkat Para	96	598406	2691.861000	
8420907	598420907		*Sreedharpur	860	598420	10393.100000	
8433009	598433009			814	598433	12117.560000	
8440556	598440556		*Laskarpur	599	598440	9095.361000	
8433195	598433195		*Charigaon	237	598433	4244.101000	

Lesson Review

- ✓ Elements of ArcMap Interface
- ✓ Different selection methods and tools
- ✓ Feature Attribute Table and its significance.

Knowledge and Skills Practice 5: Spatial and Tabular Data Model

The details of this assignment and data are given in the attached CD of the manual. Please follow the **Knowledge and Skills Practice 5: Spatial and Tabular Data Model**

Spatial Analysis

Objective

By the end of this lesson, through the knowledge and skills practice the participants will be able to:

1. Define and explain Geoprocessing and Geoprocessing execution tools
2. Practice different spatial analysis tools of ArcGIS software.

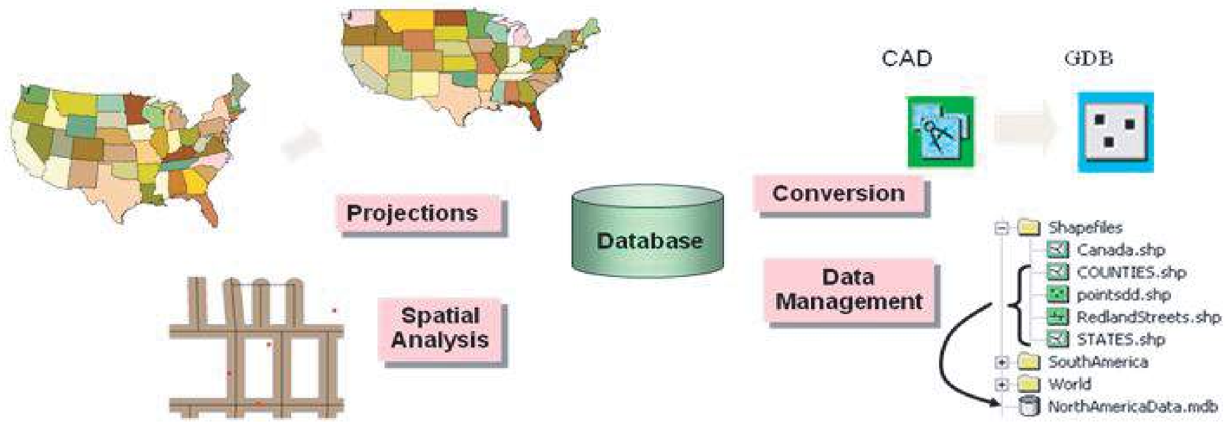
Geoprocessing and GIS

Geoprocessing implies performing a variety of geographic based tasks which accepts an input and creates an output. Such task includes overlay, buffering, data conversion, spatial reference management, data management.

Geoprocessing provides a large suite of tools for performing GIS tasks that range from simple buffers and polygon overlays to complex regression analysis and image classification.

The kinds of tasks to be automated can be mundane—for example, wrangling herds of data from one format to another.

Or the tasks can be quite creative, using a sequence of operations to model and analyze complex spatial relationships—for example, calculating optimum paths through a transportation network, predicting the path of wildfire, analyzing and finding patterns in crime locations, predicting which areas are prone to landslides, or predicting flooding effects of a storm event.

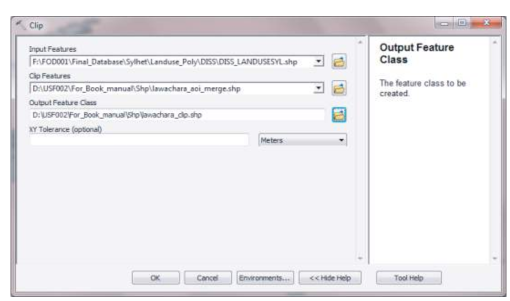


Source: http://resources.arcgis.com/en/help/

Geoprocessing Executing Tools

There are different analysis tool in Arc Toolbox. Users can explore these tools from Geoprocessing>Arc Toolbox. 

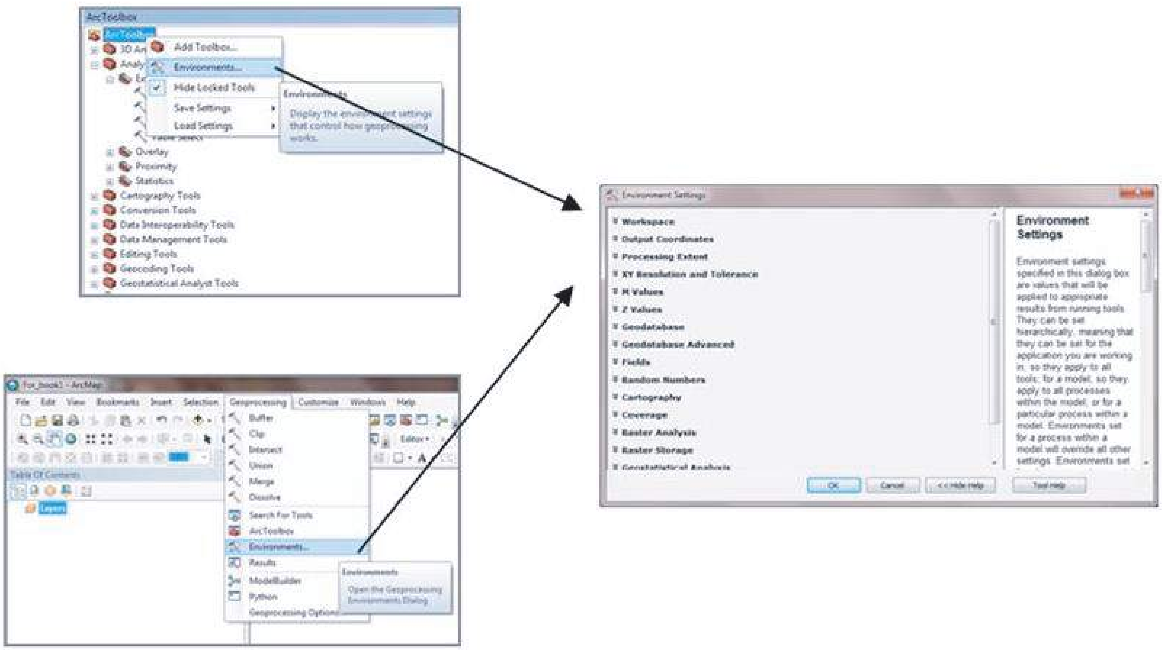
Clip is one of the analysis tools to use clip any features.



When this analysis is completed, it shows Result window.

Environment Setting

- ✓ Common parameters can be applied to many tools within a geoprocessing session
- ✓ Settings persist through all tools (models, scripts, custom tools)
- ✓ Settings can be changed, if required

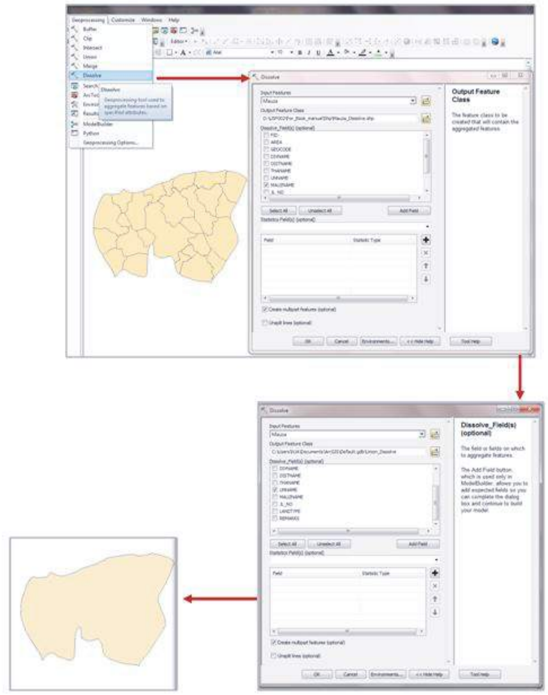


Models: a set of rules and procedures for representing a phenomenon or predicting an outcome. In geoprocessing in ArcGIS, one process or a sequence of processes connected together, that is created in Model Builder

Scripts: a set of computing instructions, usually stored in a file and interpreted at run time

Custom tools: in Geoprocessing, a tool created by a user and added to a toolset and/or toolbox. Custom tools may only be added to custom toolsets and/or toolboxes

Spatial Analysis



Dissolve

The Geoprocessing tool 'Dissolve' Simplify or aggregate adjacent features based on a specified attribute that have the same attribute. Dissolve can be performed on polygon or line feature classes. The Output of the Dissolve tool contains the same feature type as input feature type. The merging of polygons with this tool is the counterpart of intersecting polygons in overlays. Dissolve will remove the boundaries. The input file may contain information concerning many feature attributes. The output Dissolve file contains information only about the dissolve item.

Source: http://resources.arcgis.com/en/help/

Clip

Clip operation is allows to cut out one theme using another theme as a cookie cutter. Clip is particularly useful for creating a new layer that contains a geographic subset of the features in another larger layer. The layer that is having its features clipped can contain points, lines or polygons. The Clip Features can be points, lines, and polygons, depending on the Input Features type.

When the Input Features are polygons, the Clip Features must also be polygons. When the Input Features are lines, the Clip Features can be lines or polygons. When clipping line features with line features, only the coincident lines or line segments are written to the output. When the Input Features are points, the Clip Features can be points, lines, or polygons. When clipping point features with point features, only the coincident points are written to the output, as shown in the graphic below. When clipping point features with line features, only the points that are coincident with the line features are written to the output. The Output Feature Class will contain all the attributes of the Input Features.

Polygon file to be clipped Clip Feature Output Feature

Proximity analysis

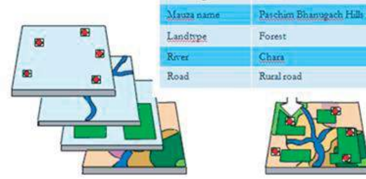
It is a kind of analysis in which geographicfeatures (points, lines, polygons, or raster cells) are selected based on their distancefrom other features or cells using a buffer.Finding the nearest feature

Locate those forest offices within 1 km from the Road

Overlay analysis

A spatial operation in which two or more maps or layers registered to a common coordinate system are superimposed, either digitally or on a transparent material, for the purpose of showing the relationships between features that occupy the same geographic space.

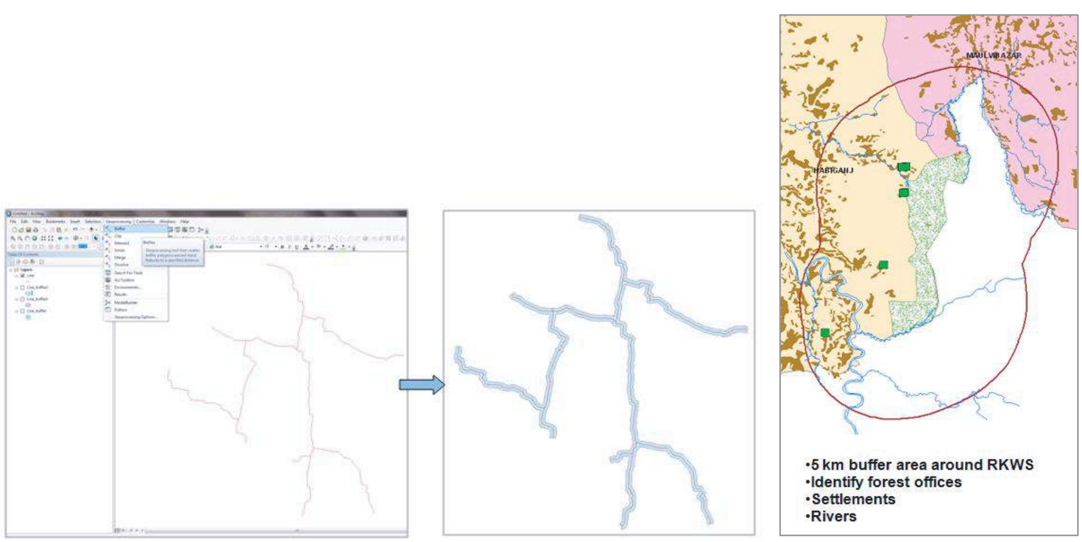
Layers	Description
Type of office	TNO, PS, beat office, guest house etc
Easting	680383.41
Northing	689706.22
Mauza name	Paschim Bhanugach Hills R.
Landtype	Forest
River	Chara
Road	Rural road



Buffering

Buffering is a distance analysis tool for points, lines and areas. It allows to buffer shapefiles, coverages and featureclass of geodatabases. A distance has to be provided around the input features that will be buffered. Distances can be provided as either a value representing a linear distance or as a field from the input features that contains the distance to buffer each feature. If linear units are not specified or are entered as Unknown, the linear unit of the input features' spatial reference is used.

A zone (polygon) created around features which are based on a specified distance.



Source: http://resources.arcgis.com/en/help/

Finding the Nearest Feature

Near:

Computes the distance from each point in the input layer to the nearest point, or poly line, in the near layer

The following two fields will be added to the attribute table of the input features. The field values are updated if the fields already exist.

- NEAR_FID — Stores the feature ID of the nearest feature.
- NEAR_DIST—Stores the distance from the input feature to the nearest feature. The value of this field is in the linear unit of the input's coordinate system.

Both input features and near features can be point, multipoint, line, or polygon. The Near Features can include one or more feature classes of different shape types. The same dataset can be used as both Input Features and Near Features. When an input feature's nearest feature is itself (NEAR_DIST is 0), this feature is ignored from the calculation and the next nearest feature is searched.

Point Distance:

Computes the distances between point features in one layer to all points in a second layer
Results in output table

This tool creates a table with distances between two sets of points. If the default search radius is used, distances from all input points to all near points are calculated. The output table can be quite large. For example, if both input and near features have 1,000 points each, then the output table can contain one million records.

The results are recorded in the output table containing the following information:

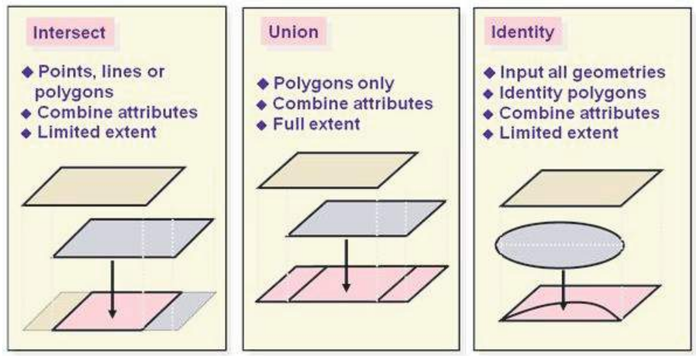
- INPUT_FID: The feature ID of the input features
- NEAR_FID: The feature ID of the near features
- DISTANCE: The distance from the input to near feature. The value of this field is in the linear unit of the input features coordinate system.

Both Input Features and Near Features can be the same dataset. In that case, when the input and near features are the same record, that result will be skipped so as not to report that each feature is 0 units from itself.

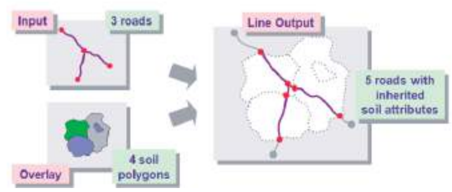
Source: http://resources.arcgis.com/en/help/

Overlay Analysis Functions

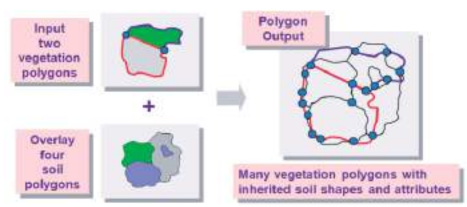
There are three types of overlay functions: Intersect, Union, and Identity. The following figures depict the basic operation of these three functions:



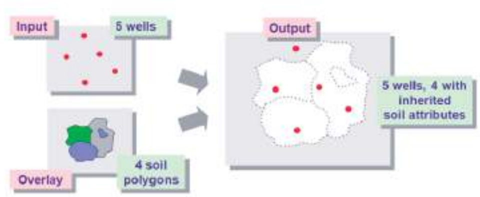
Intersect
This function computes a geometric intersection of the input features. Features or portions of features which overlap in all layers and/or feature classes will be written to the output feature class.



Union
This function creates a new layer from combined geometry of two input layers. Both input and overlay layers must be polygons



Identity
Create new layer with spatial extent of initial input layer. Input layer can be points, lines or polygons, and overlay layer must be polygons.



Lesson Review

- ✓ Introduction to Geoprocessing and geoprocessing execution tools
- ✓ Environments settings for Geoprocessing
- ✓ Spatial analysis tools and their application

Knowledge and Skills Practice 6: Spatial Analysis

The details of this assignment and data are given in the attached CD of the manual. Please follow the **Knowledge and Skills Practice 6: Spatial Analysis**

Summary

This manual is a resource for basic understanding and application of the processes of remote sensing and GIS. It covers all the essential topics which presented both in theoretical and practice formats, enabling the user apply those to his/her relevant field. Where required reference links to relevant websites have also been given with the Lectures.

One may not always need to apply all the concepts discussed in this manual. However, having gone systematically through the material in this manual, one at least now knows what can be done with different tools of remote sensing and GIS. That is important.

We hope all the participants have enjoyed this lesson, knowledge and skills practice session. Best of luck.

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