CHAPTER - 1

Remote Sensing (RS)

Learning Objectives

By the end of this chapter students would be able to:

1.1 Understand Introduction to Remote Sensing

1.2 Understand Spectral Reflectance Signature of various earth features

1.3 Learn about Digital Image Processing

1.4 Understand the Visual Interpretation of Satellite data

1.5 Know Aerial Photo and Its Interpretation

1.6 Learn about Advanced Remote Sensing Technologies

1.7 Understand the Advantages and Benefits of RS

1.1 Introduction

We have learnt in class XI, that Remote sensing (RS) is the observation of an object, surface or phenomenon through the use of a variety of recording devices that are wireless, or not in physical or intimate contact with the object. An aircraft, spacecraft, satellite or ship may be used for this purpose and equipped with recording devices such as camera, laser, radar, sonar etc.

> Remote sensing deals with inventory, monitoring and assessment of natural resources through analysis of data obtained from remote sensing platform.

Remote Sensing measures energy such as ultra-violet, infrared, microwave,which that cannot be reached by human vision. Remote sensing data has a unique advantage of multidisciplinary application.

> - Sun is the principal source of EM energy
> - Earth receives only 1/50 millionth of total solar energy
> - 46% of solar energy reaching the earth falls in the visible region of EM spectrum

The same RS data can be used by researchers / workers in different disciplines such as geology, forestry, land use, agriculture, hydrology etc. It offers wide regional coverage and good spectral resolution.

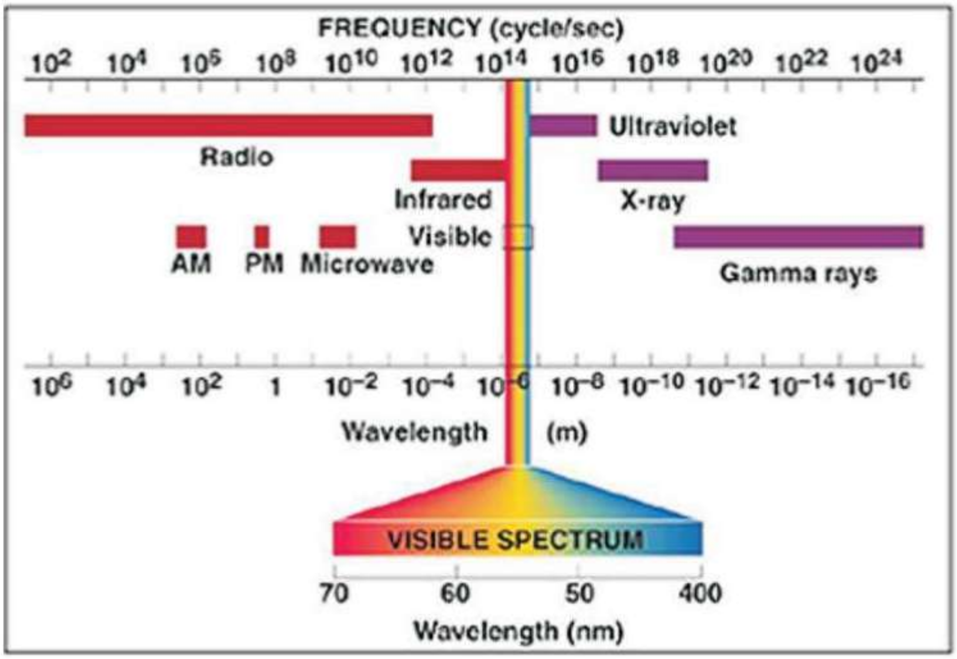


Fig. 1

Electro Magnetic Spectrum

The basic principle involved in remote sensing is that different objects reflect or emit radiations in different wavelengths and intensities depending upon properties of the objects serves as

Stages in Remote Sensing

- A source of electromagnetic energy
- Transmission of Energy from the source to the surface of earth
- Interaction with the intervening atmospheres
- Interaction of EMR with the earth's surface
- Transmission of Energy from the surface to the remote sensor
- Sensor Data output
- Data transmission , Processing and Analysis

the main communication link between the sensor and the objects. All object matter that have temperature higher than absolute zero 0° emit EMR continuously.

The intensity of the emitted radiation depend upon the composition and temperature of the body. A blackbody is an ideal body that absorbs all radiation incidents on it without any reflection. It represents a continuous spectral emission curve, in contrast to natural bodies that emit only at separate spectral bands. Temperature plays great role on the intensity of blackbody emitted radiation. This relationship is called Wien's displacement Law. Law represent as: ? max = A / T where ? max is the wavelength (cm) where highest radiation occurs. A is constant (= 0.29 cm K) and T is the temperature (K) of the object. Using this law it can estimate the temperature of objects by measuring the wavelength of peak radiation.

The above figure shows spectral distribution of energy radiated from black bodies of various temperatures such as sun, incandescent lamp, fire and Earth. For the Sun max occurs at 0.48 µm, which measures the temperature of the Sun approx. as 6000 K similarly for the earth, the ambient temperature is 3000 K and max occurs at 9.7µm. The ambient temperature of fire is 5000 K and for incandescent lamp it is 4000 K.

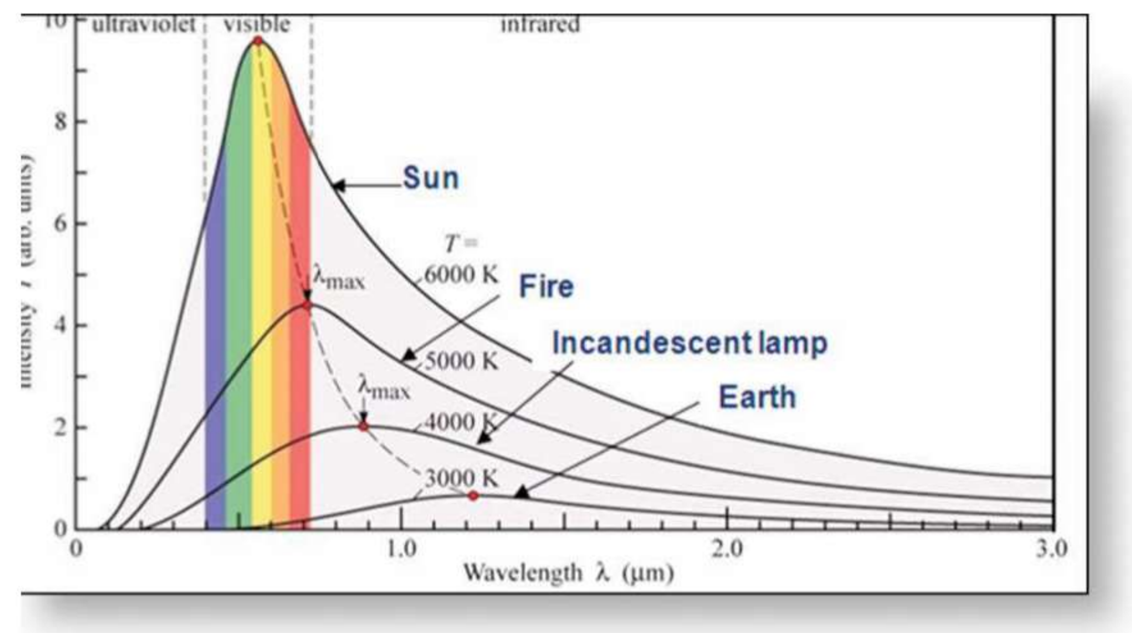


Fig. 2

Spectral distribution of energy by a black body

Black body is an ideal body which absorbs all radiation without any reflectance. Whereas white body completely reflects incident radiation and absorbs nothing

Most useful regions of the EMR are visible, Infra red and thermal and microwave for carrying out RS activities. The human eye can detect energy in the visible portion of the electromagnetic spectrum. Photographic cameras are sensitive to broader range of wavelength ranges from 0.3 μm – 0.9 μm, the near ultraviolet to the near infrared. Thermal scanners operate in the thermal infrared portion of the spectrum. Multispectral scanners operate over a broad range of wavelengths from ultraviolet to thermal infrared. Passive microwave and active radar systems operate in microwave portion of the electromagnetic spectrum.

In case of dust, cloud, fog all wavelengths are equally scattered so they all look white. Natural uneven (rough) surface scattered in multiple directions.

Shorter wavelengths are scattered more than longer wave lengths. This type of scattering is seen more in ultraviolet and blue. That is why the sky would appear blue otherwise it would appear as dark space.

The Sun is primary source of energy. When these solar rays arrive at the Earth, the atmosphere absorbs or backscatters a part of them and transmits the rest. When rays striking the land, ocean surface and atmosphere target, such as air, moisture, and clouds the incoming radiation go through various modes of energy-interaction response for example transmission, absorption, reflection and scattering as shown in both the figures given below (fig. 3 & 4).

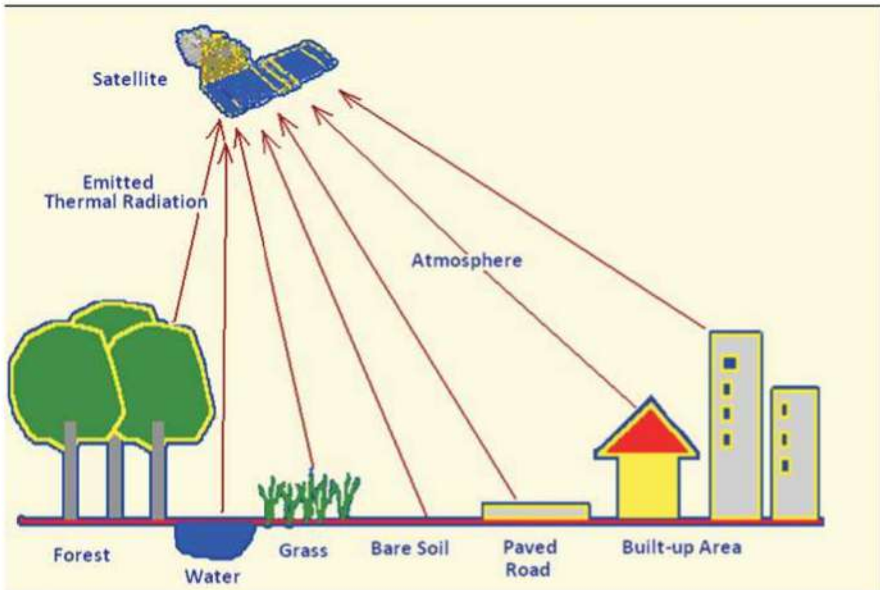


Fig. 3

Remote Sensing System Source: CRISP

Various Interaction Responses of Sun rays.

Transmittance - The radiation penetrates into certain surface materials such as water and if the material is transparent, it transmits 100% of energy.

Absorption – It occurs when EMR passes through an opaque medium;

Reflectance– Reflection occurs when incident EMR bounces off from a smooth surface

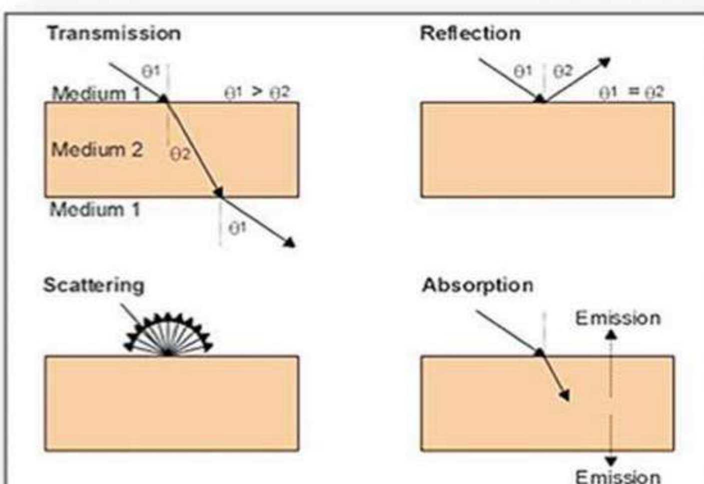


Fig. 4

Various modes of energy Interaction response of incoming radiation

Scattering – It occurs when EMR disbursed in all the direction from a rough surface. In this picture the energy interaction with red roof, glass window & black soil are shown. When incident energy strikes on red roof it reflects in red band, so roof appears red. Similarly the black soil absorbs all the energy therefore it appears in black color. When the energy passes through glass window it transmits all energy that is why it appears transparent in color.

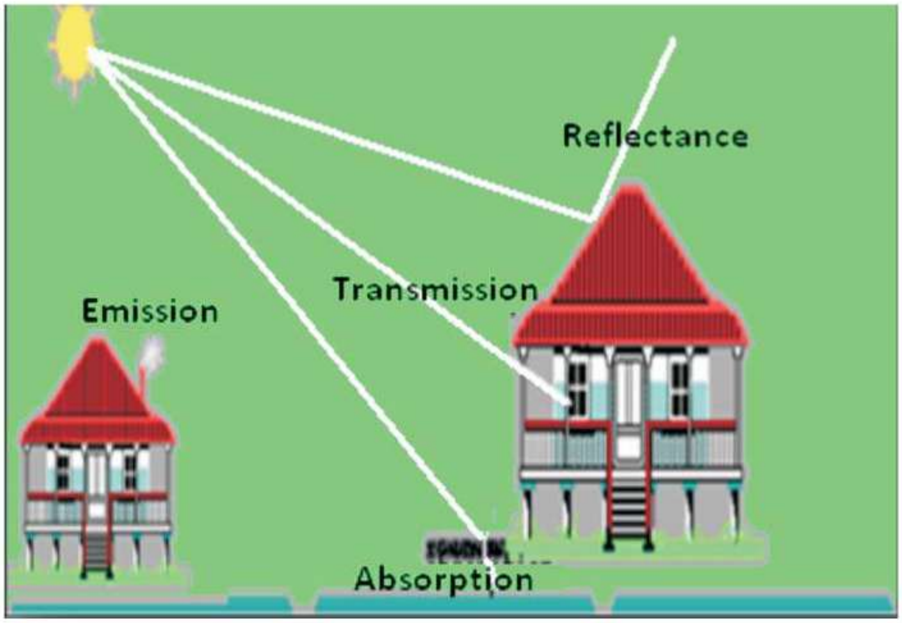


Fig. 5

Energy Interaction with Window, Roof and Soil

1.2 Spectral Reflectance Signature

The reflectance characteristics of the different features of the earth surface are measured by the incident energy that is reflected by the surface. This spectral reflectance of natural features are collected and stored by satellite sensors. Spectral reflectance of any object usually varies according to the wavelength of the EMR. A graph showing the spectral reflectance of an object for various wavelengths is known as a Spectral Reflectance Curve. It helps in selecting the wavelength bands for identifying the object.

> The radiation reflected as a function of the wavelength is called the spectral signature of the surface.

Spectral reflectance characteristics are the most important aspect for feature classification in any satellite imagery. Typical spectral reflectance curve for soil, vegetation, water are shown in above graph. Details of spectral behaviors of soil, water and vegetation are discussed below separately.

- Radiation reflected or emitted from earth surface is converted to signal (Digital Numbers- DN)
- The reflectance from a feature depends on the atmospheric conditions, seasons, time of a day, physical and chemical characteristics of the feature
- Secular reflectance from smooth surfaces e.g. water, paved roads is lower than that from rough surfaces.

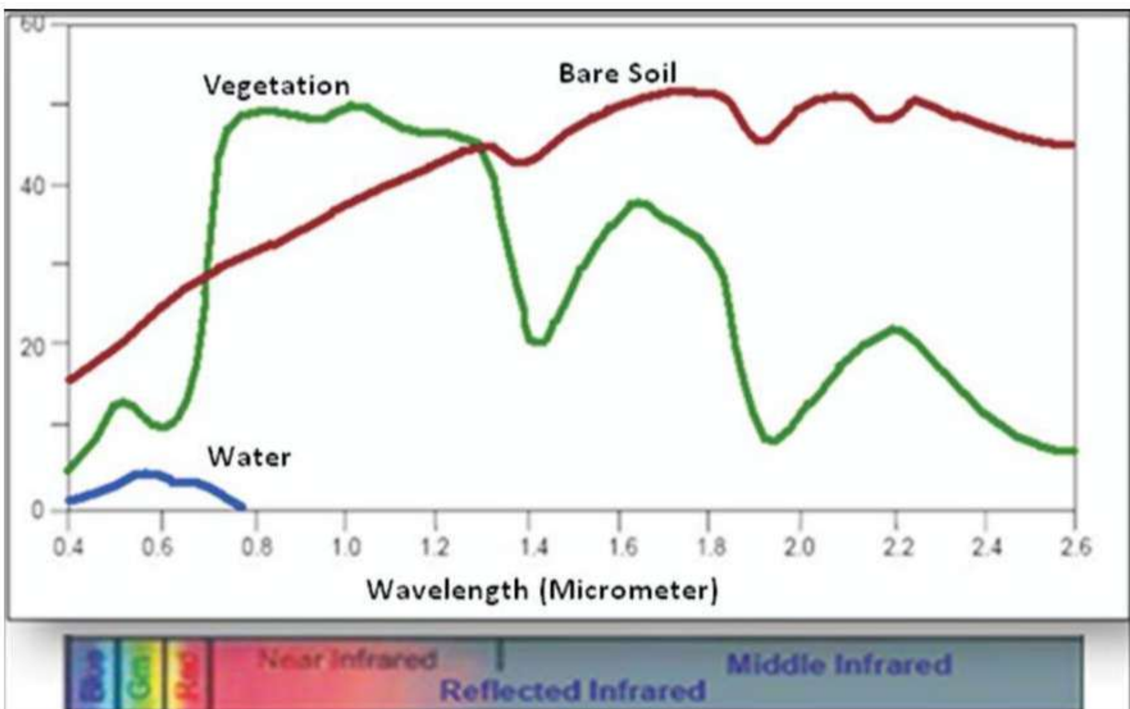


Fig. 6

Spectral Reflectance curve for Vegetation and Water Soil

The graph fig. 6 shows the reflectance of water in blue band, vegetation in green and infrared band where as bare soil shows linear reflectance in visible and infrared bands.

In the figure below (fig. 7) vegetation reflects in green band and the red roof reflects the energy in red band therefore the color appears as green and red respectively.

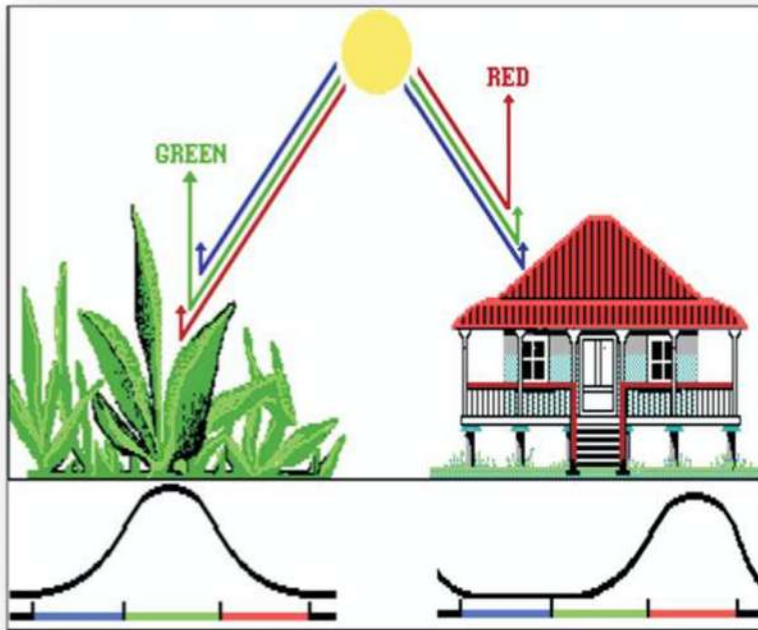


Fig. 7

Reflectance from roof and vegetation

1. Soil

Reflectance characteristics of soil are depending on the various factors:

- Soil moisture content
- Sand, silt & clay Composition
- Soil texture, color & grain size
- Surface roughness
- Mineral composition.

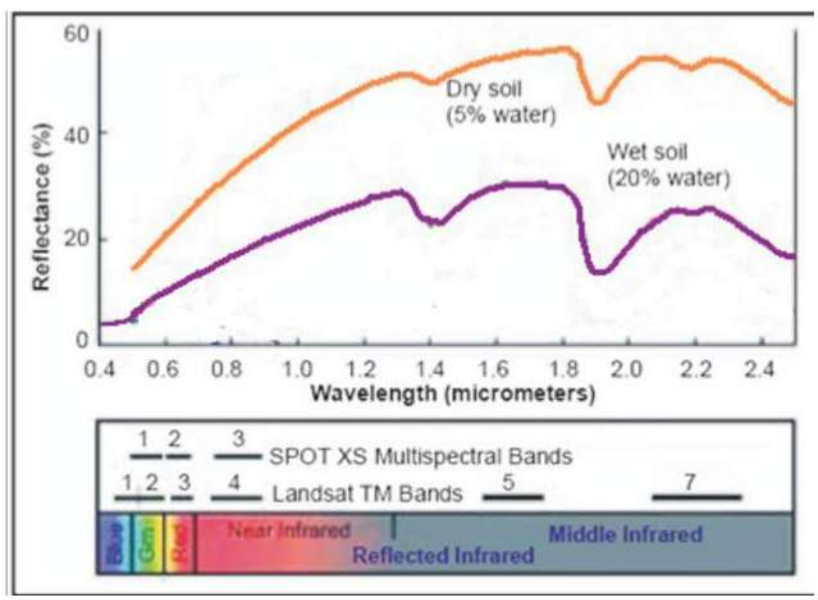


Fig. 8

Reflectance curve based on soil moisture

A typical reflectance curve for various soils is shown in two graphs. First graph shows spectral behavior of dry and wet soil. The presence of moisture in soil will decrease the reflectance in the visible and near-infrared regions. Dry soil increases reflectance in visible and near infrared wavelength as compare to wet soil due to less moisture content. Second graph shows reflectance curve for soil based on soil texture.

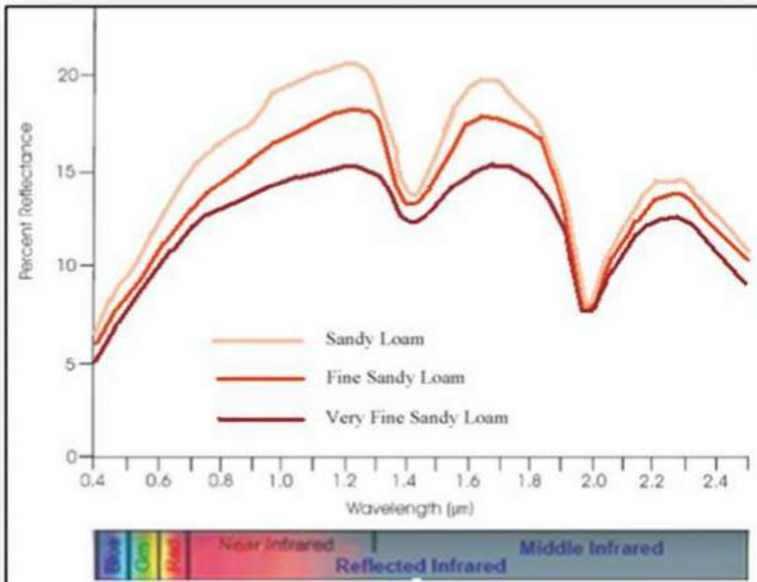


Fig. 9

Reflectance curve for soil based on soil texture

There is high reflectance in visible and infrared band, for sandy loam as compare to fine sandy loam and very fine sandy load due to its fine texture soil. The presence of iron oxide in soil will also decreases the reflectance in visible wavelength.

2. Vegetation

Healthy growing vegetation appears green because of Chlorophyll content. The reflectance from vegetation depends on various factors:

- Leaf pigmentation
- Leaf cell structure
- Leaf moisture
- Crown architecture
- Plant physiology

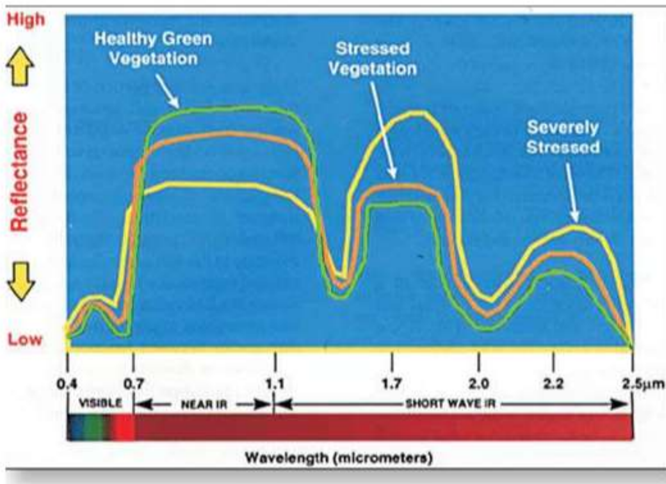


Fig. 10

Reflectance curve of vegetation based on health
Source: rst.gsfc.nasa.gov

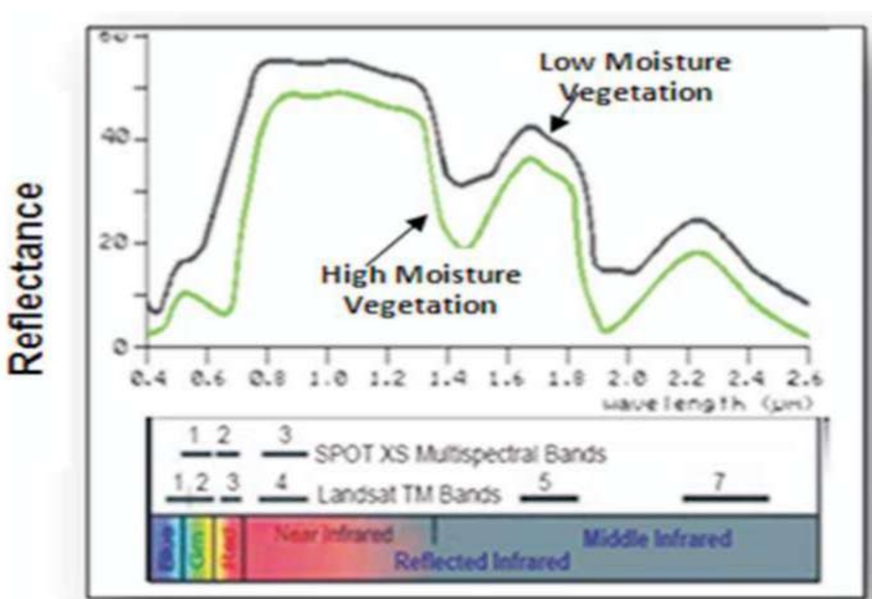


Fig. 11

Reflectance curve for low and high moisture vegetation

The reflectance of healthy green vegetation is shown in graph above. In the visible band of EMR the healthy vegetation will have absorption in the blue and red bands because of the presence of chlorophyll. This wavelength ranges from 0.45 ìm and 0.65 ìm. If the plant is turned to yellow it results in less chlorophyll so there will be less absorption in blue and red band. As we move from visible to near infrared portion of the spectrum which is about 0.74 ì m to 1.3 ì m the plant leave reflects 40 to 50% of the energy incident upon it. If the moisture is low in leaves of the plants then it reflects more energy in all the bands compared to the leaves with high moisture as shown in the graph (Fig 11).

The plant stress in graph shows, decrease absorption in NIR as compared to the healthy vegetation. Due to less moisture, disease, and pest contents the crops reflectance are more.

3. Water

The reflectance from water depends on various factors

- Depth
- Suspended particles in water
- Floating vegetation
- Sun angle

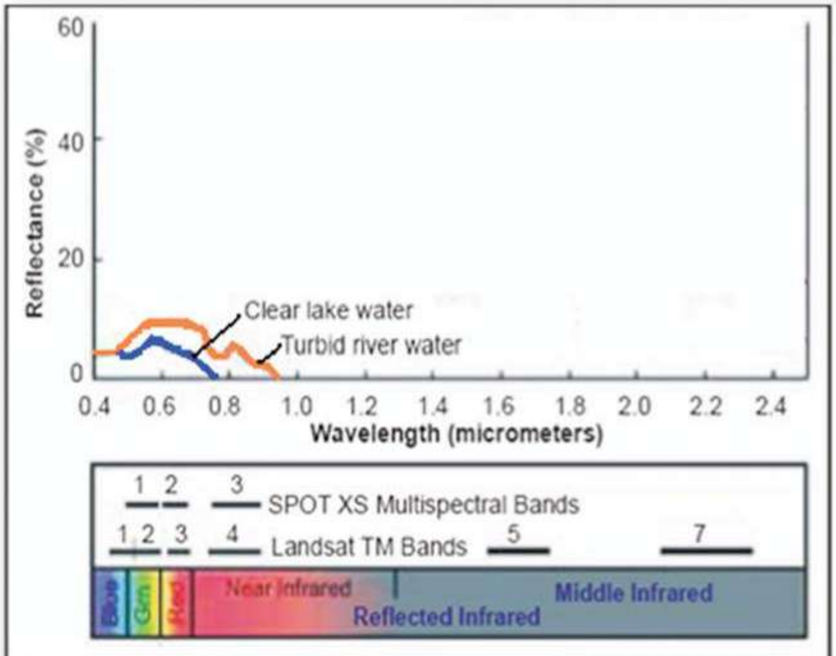


Fig. 12

Reflectance curve for clear lake and turbid river water

Pure clear water has a relatively high reflectance in the visible wavelength ranges from 0.4 and 0.6 ì m. There is no reflectance in the near-infrared (0.7 ìm) and higher wavelengths. So in infra red Image shows the water body in dark color. Clear water absorbs little energy in 0.6 ì m. If the water contains of suspended sediments it has higher reflectance in visible as compared to clear water.

Heavy sediments load (high turbidity) prevent radiation penetrating water bodies. So it reflects the energy. In Near Infra Red (NIR) and Middle Infra Red (MIR) wavelengths water strongly absorbs radiation and very little energy will be reflected or transmitted. The presence of algae in water affects the spectral response of the water. The chlorophyll contents of algae increases the reflectance of water body in the green band as shown in the figure below reduces the reflectance in red and blue band, therefore water looks green.

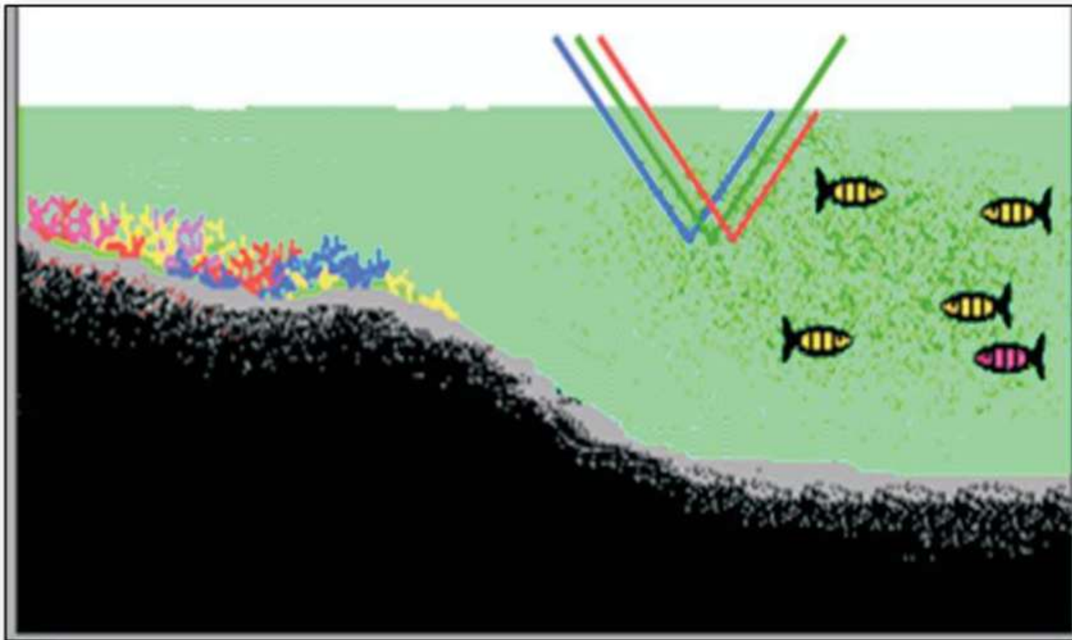


Fig. 13

Reflectance in green band due the presence of algae in water body

4. Rock

The rock constitutes of different minerals and textural properties. The absorption and reflectance basically depends on mineral composition in rocks. Different rocks such as biotile granites and granite have less water contents therefore, they reflect more in infrared. The rock which contains more water content will absorb more. The rocks which contains Iron will exhibit more absorption in ultraviolet and blue band and reflection in infrared band. This is due to the contents of metals such as Iron Manganese, Copper, Nickel and Chromium. The other factors which affect the reflectance of the rock are;

- Nature of the rock
- Top cover
- Topography / shadow
- Surface roughness

Curve given below shows reflectance behavior of various rocks such as Concrete, Asphalt, Bare soil, Gravel, and Shingles.

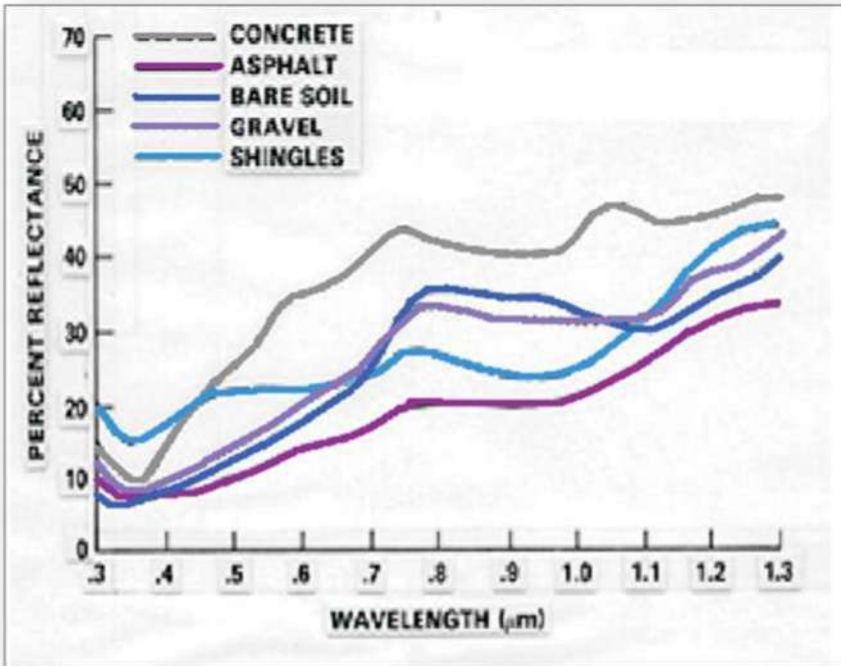


Fig. 14

Reflectance curve for various rock types

Source: rst.gsfc.nasa.gov

The reflectance of all the rock types is gradually increasing in all wavelengths such as with Visible, NIR, and MIR. Concrete is light and bright in color as compared to asphalt. Therefore it shows higher reflectance as compared to all rocks. The shingles are bluish in color so it reflects more in 0.4 to 0.5 μm

Resolution:

Resolution is defined as the ability of the sensor to detect the information at the smallest meaningful element, in terms of distance (spatial), wavelength band of EMR (spectral), time (temporal) and radiation quantity (radiometric). There are four types of resolutions which are listed below;

(i) Spatial,

(ii) Spectral,

(iii) Radiometric,

(iv) Temporal.

(i) Spatial Resolution: It is the minimum element area that the sensor can detect to measure. Spatial resolution is classified into three types. High spatial resolution which covers (0.6 – 4m), medium spatial resolution covers from 4-30 m & low spatial resolution covers 30 > 1000 m. This resolution element is called Pixel. The various examples and pictures of spatial resolution are given below.

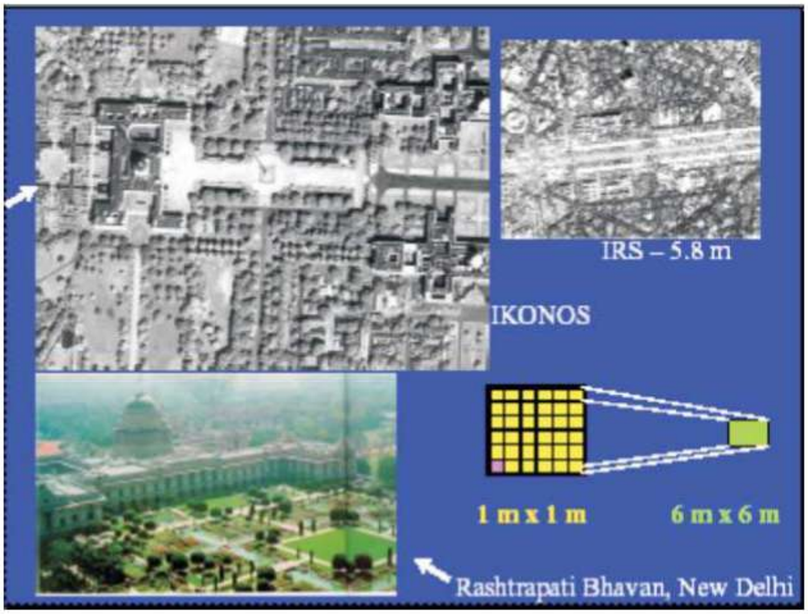


Fig. 15

Example for Pixel

LISS III Band 2 to 4	23.5 m
Band 5	70.5 m
WiFS	188.3 m
AWiFS	56 m
LISS III + PAN	5.8 m
LISS IV	2.5 m
IKONOS	1 m
Cartosat -2	0.8 m
SPOT- MSS	30 m, 80 m

Table : 1

Spatial resolution of various Satellites

Fig. 16

10 m Resolution Pixel size 10 m

Fig. 17

30 m Resolution Pixel size 30 m

Fig. 18

80 m Resolution Pixel size 80

Fig. 19

1 m Pan (IKONOS)

Source: NRSC Hyderabad

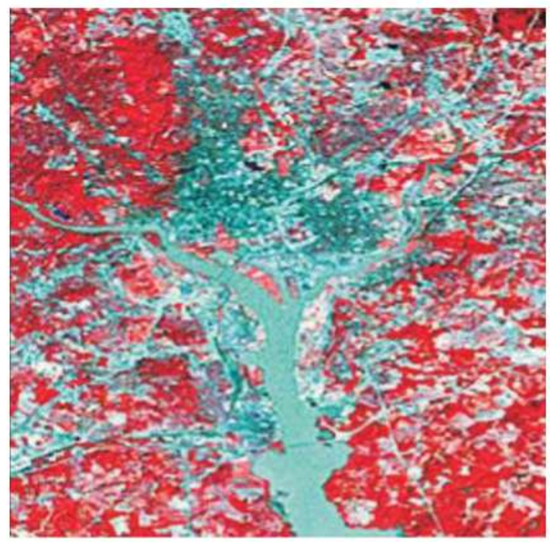


Fig. 20

30 m Multispectral (LandSat)

Source: NRSC Hyderabad

(ii) Spectral Resolution: It refers to the sensing and recording power of the sensor in the different bands of EMR. The sensor can observe object separately in different bands and colors or in one band which is panchromatic (Black-White). For example, Landsat MSS - 7 Bands, SPOT – 4 Bands, IRS - 4 Bands.

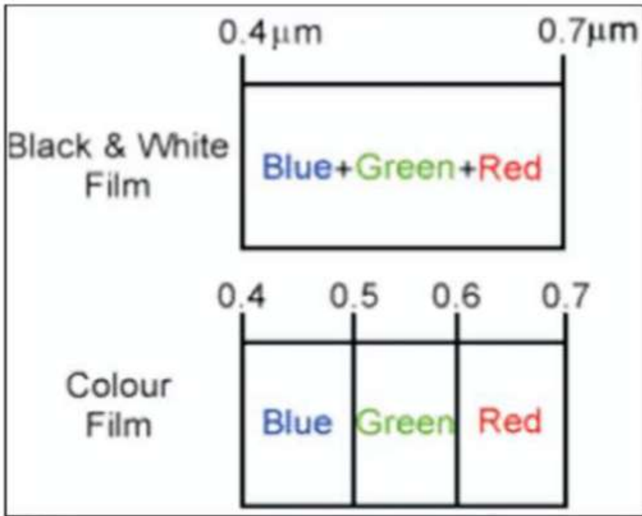


Fig. 21

LISS III	
Bands	**Wavelengths**
Band 2	0.52-0.59 µm
Band 3	0.62-0.68 µm
Band 4	0.77-0.86 µm
Band 5	1.55-1.70 µm
PAN	0.5-0.75 µm

Spectral Resolution of various Satellites

The spatial resolution specifies the pixel size of satellite images covering the Earth Surface.

(iii) Radiometric Resolution: It is determined by the number of discrete levels into which signals may be divided. It is recorded in Digital Number (DN) for different bands of Satellites. In another words it is dividing the total range of the signal output of the sensor into a large number of distinct colors to enable distinguish ground features which are differing slightly in a radiance or reflectance. The various examples are given in below table:

Table : 2

Sensor	Radiometric Resolution	Color
LISS III	7 bit / 128 levels	0 -1 27 Colors
WiFS	7 bit / 128 levels	0 - 127 Colors
PAN	6 bit / 64 levels	0 - 63 Color
AWiFS	10 bit/1024 levels	0 -1023 Color
Cartosat-1	10 bit/1024 levels	0 -1023 Color

Radiometric Resolution of various Satellites

Radiometric resolution describes the ability of a sensor to discriminate very light differences in energy. The finer the radiometric resolution of a sensor more sensitive it is to detect small differences in reflected or emitted energy.

(iv) Temporal Resolution: The ability to collect imagery of same area of the Earth's surface at different periods of time is one of the most important elements of RS. Temporal resolution is also called as the repetitive cycle which is the capability of the satellite to record the same area at the same viewing angle at different periods of time. Spectral characteristics of features may change over time & these changes can be detected by collecting & comparing multi-temporal imagery. For example, Spot revisits the same area in 26 days. Temporal imagery helps us to identify the change occurred over a period of time. The various examples are given in the table given below.

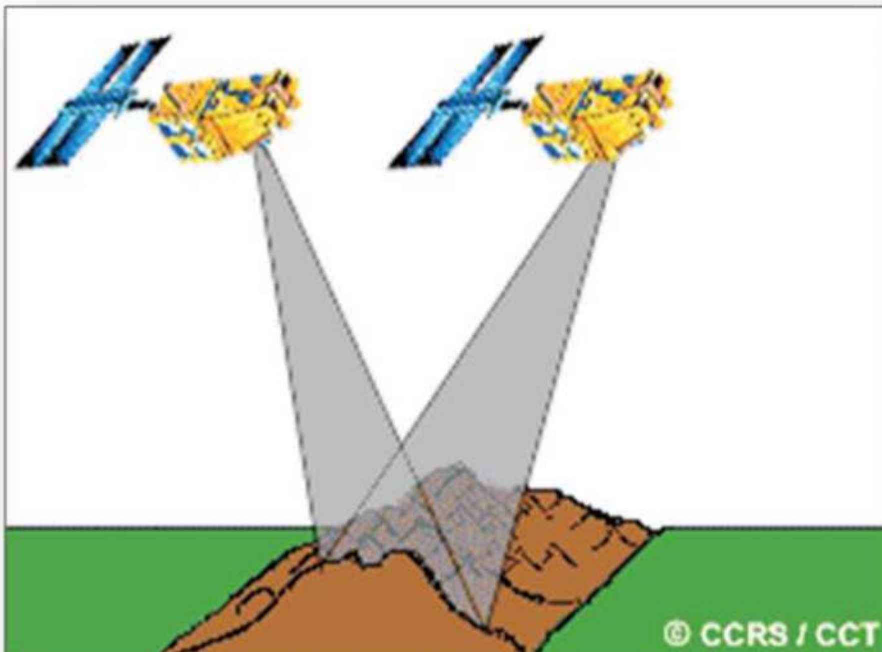


Fig. 22

Sensor	**Revisit Period (No of days)**
IRS 1A/1B	22
IRS 1C/1D	24
Pan	5
WiFS	3
AWiFS	5
Landsat	16 - 18

Table : 3

Temporal Resolution of various Satellites

1.3 Digital Image Processing (DIP)

The spatial data is acquired by remote sensing technology in the form of Images / Photographs. The raw data received from the imaging sensors on the satellite platforms contains inaccuracies. To overcome these inaccuracies it needs to undergo several steps of processing. Various techniques are used to enhance quality of the images. This technique is called as Digital Image processing. Digital processing has the greatest potential for preserving the correct radiometry and the maximum resolution of the images.

> DIP is the collection of algorithms processed by the computer system to enhance the quality of raw data in order to get enhanced Images for further process of iInterpretation and data extraction.

The steps involved in DIP.

A. Image restoration
B. Statistical analysis
C. Image enhancement
D. Image classification

A. Image Restoration

It refers to correct the distorted or degraded image to represent original scene. The steps included in image restorations are;

(i) Geometric correction (Image Rectification)
(ii) Radiometric correction
(iii) Noise removal

> Image restoration processes are designed to identify noise, geometric distortion introduced into the data during scanning, transmission & recording processes. The objective is to map the image resembled to original scene.

(i) Geometric Correction

The geometric errors in image occur due to perspective of the sensor, scanning system, the motion of platform and curvature & rotation of the Earth. Because of these the image exhibits some sorts of scaling, skewing, rotation errors. This correction procedure is called as geometric corrections or rectification.

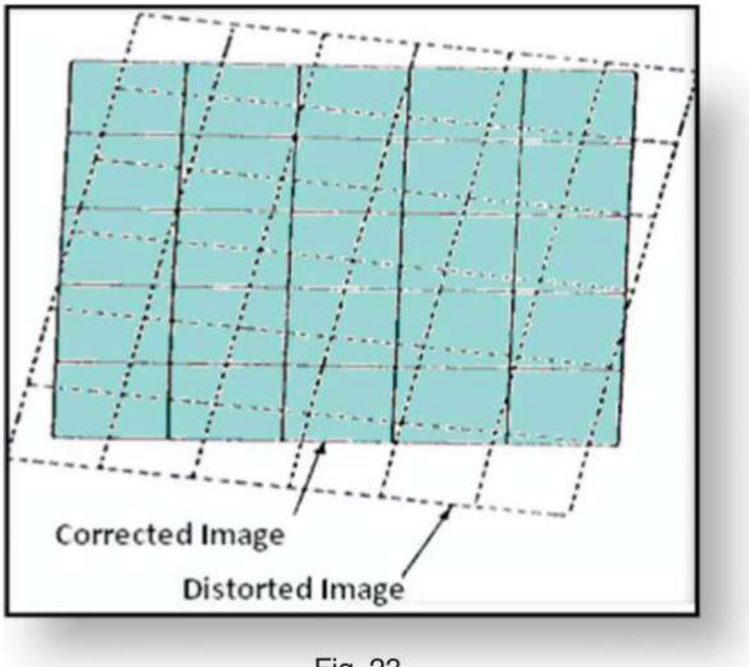


Fig. 23

An example for Geometric Correction

Rectification is the process of assigning the geo locations to the Image / Photograph to remove the geometric distortion. The figure shows an example of corrected and distorted image.

Geometric distortions include nonsystematic distortion such as variation in spacecraft altitude, velocity & altitude. These distortions must be corrected from ground control points.

(ii) Radiometric correction

The reflectance of the ground features varies as the time and location varies. While mosicking two different images acquired at different time and location it is necessary to apply sun elevation and earth sun distance corrections to normalize the reflectance of the images. This process is called radiometric corrections.

(iii) Noise Removal

Image noise is any unwanted disturbance in the image data due to limitation in the sensing instrument or data recording process. Resampling method is used to remove the noise from images.

Image enhancement processes consist of different techniques employed in the calibration of image data for the correction or reduction of errors occurring during capture or transmission of the data. It increases the ability of the analyst to recognize features of interest.

Raw Image
Source: nasa.gov

An example of Low Pass Filter
Source: nasa.gov

B. Statistical Analysis

Histogram

Histogram is a graph showing the number of pixels in an image at each different intensity value. For an 8-bit grayscale image there are 256 different possible intensities. Thus the histogram will graphically display the range from 0-255 numbers showing the distribution of pixels.

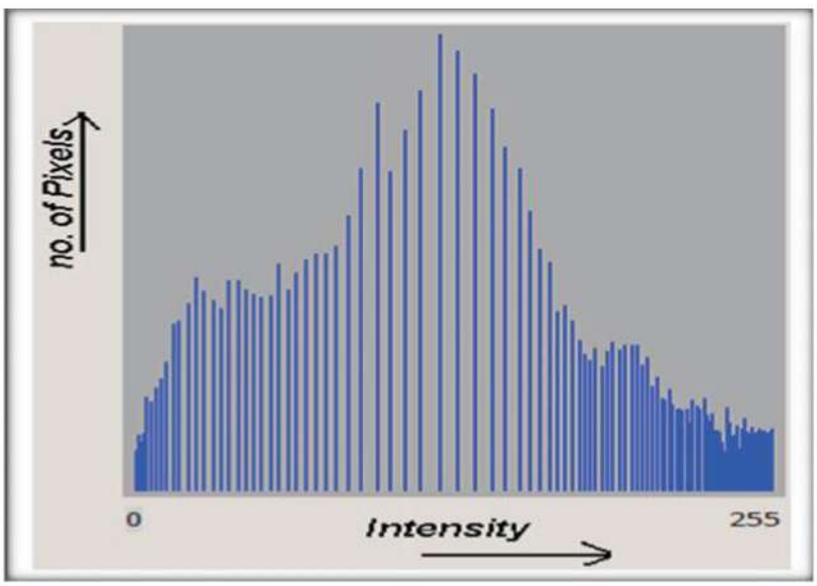


Fig. 24

Histogram Source: www.codersource.net

Histogram equalization is the technique by which the dynamic range of the DN values of an image is increased. Histogram equalization assigns the intensity values of pixels in the input image in such a way that the output image contains a uniform distribution of intensities. It improves contrast and obtains a uniform histogram. By modifying this histogram it enhances the image which is often called Contrast stretching or histogram normalization. It is a simple image enhancement technique that improves the contrast in an image by 'stretching' the range of intensity values. The examples are shown in the figure below. After applying the histogram manipulating techniques image looks clearer than the raw imege.

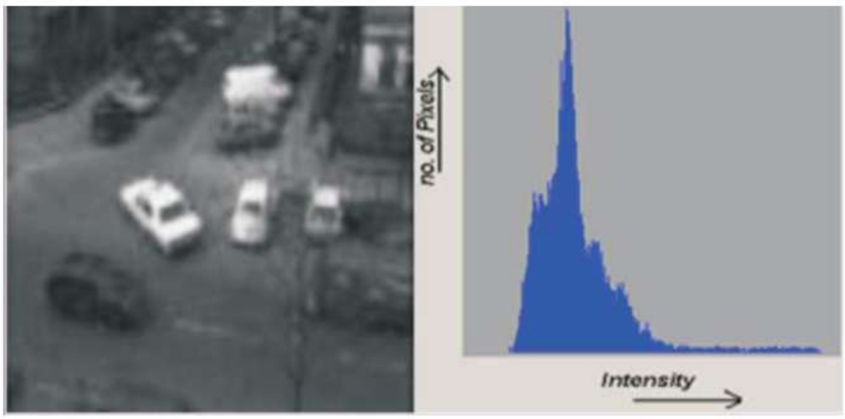


Fig. 25

Original image with Histogram

Source: www.codersource.net

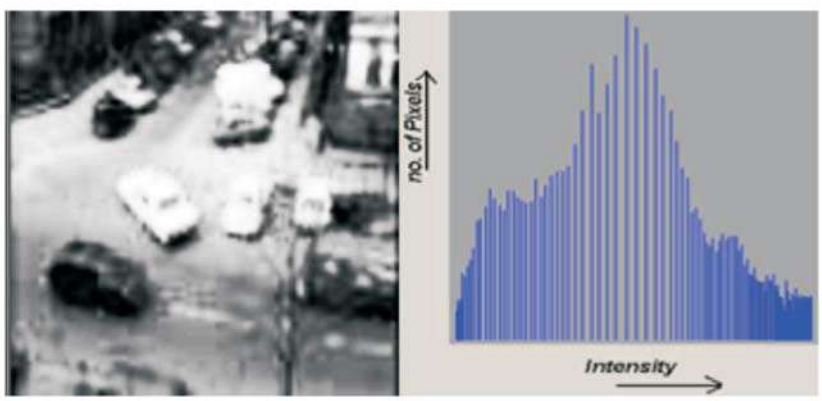


Fig. 26

Modified image after equalized histogram

Source: www.codersource.net

Histogram shows the number of pixels that correspond to each DN

Contrast generally refers to the difference in grey level values in an image. In other words it is the ratio of the maximum intensity to the minimum intensity over an image. Larger ratio makes easy interpretation of the image. Satellite images lack in adequate contrast and require contrast improvement. Contrast enhancement techniques expand the range of brightness values in an image so that the image can be efficiently displayed..

Linear Contrast Stretch is the simplest contrast stretch algorithm. The grey values in the original image and the modified image follow a linear relation. A density number in the low range of the original histogram is assigned to extremely black and a value at the high end is assigned to extremely white. The remaining pixel values are distributed linearly between these extremes. The features or details that were unclear on the original image will be clear in the contrast stretched image. Linear contrast stretch operation can be represented graphically as shown in the Figure given below.

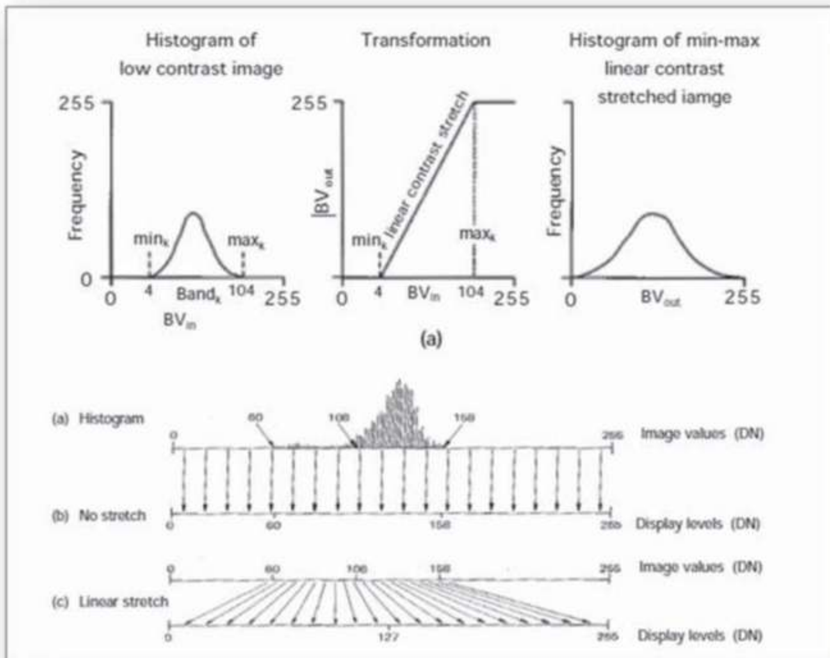


Fig. 27

Linear Contrast Enhancement Source: nasa.gov

Linear contrast greatly improves the contrast of the original brightness values but there is a loss of contrast at the extreme high & low ends of DN values.

In Non-linear contrast enhancement, the input and output data values follow a non-linear transformation. Non-linear contrast enhancement is defined by y = f (x), where x is the input data value and y is the output data value. The non-linear contrast enhancement techniques have been found to be useful for enhancing the color contrast between the nearby classes and subclasses of a main class.

Spatial filtering is another technique of digital processing functions. It is used to enhance the appearance of an image to derive valuable information. In the real world there are boundaries between features which cannot be seen in raw images. These boundaries can be emphasized using several computer algorithms. Algorithms for this purpose are called "filters". Spatial filters are designed to highlight or suppress specific features in an image based on their spatial frequency.

A low - pass filter blocks the high spatial frequency details. It is designed to emphasize larger, homogeneous areas of similar tone and reduce the smaller detail in an image. Low-pass filter generally serve to smooth the appearance of an image and reduce "salt and pepper" noise as shown in below figure. The most commonly used low pass filters methods are mean, median and mode

Fig. 28

Raw Image

Source: nasa.gov

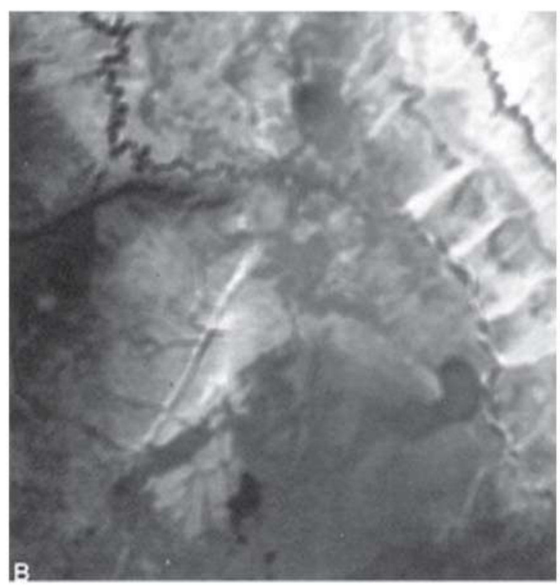


Fig. 29

An example of Low Pass Filter

Source: nasa.gov

High pass filet are used to emphasize fine details and edges. Figure given below shows the example for High pass filter in an Image. This filter enhances details and clear edges and abrupt discontinuities. Therefore rock joints, faults, field boundaries, and street patterns are clearly visible as compared to raw image

Fig. 30

Raw Image

Source: nasa.gov

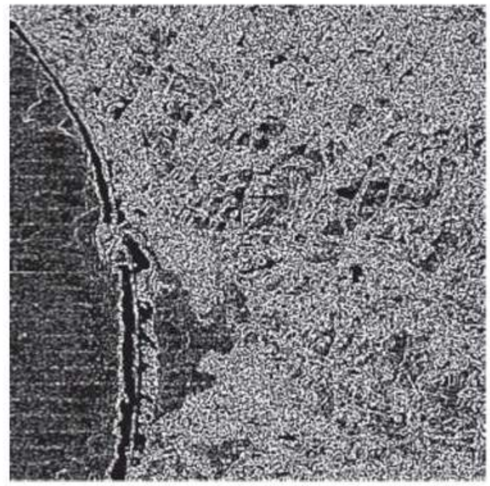


Fig. 31

An example of Low Pass Filter

Source: nasa.gov

c) Image Enhancement

Image enhancement techniques are applied to improve the quality of an image. Image enhancement is applied after correcting geometric and radiometric distortions. There are various types of techniques available to improve image quality for father analysis and interpretation. The contrast stretch, density slicing, edge enhancement, and spatial filtering are commonly used image enhancement techniques.

Band ratioing

Image division or spectral ratioing is one of the most common techniques applied to image data. Ratio Images are division of DN values of one spectral band by corresponding DN of another band. The ratio has been used to identify different features. For example the ratio of near-infrared / red is less than 1 it represents water and greater than 1 it represents vegetation. NIR / R images are used to identify vegetated area. Image ratioing highlights slight variations in the spectral responses of various surface features. Healthy vegetation reflects strongly in the near infrared portion of the spectrum while absorbing strongly in the visible red. Other surface types, such as soil and water, show nearly equal reflectance in both the near-infrared and red portions. A ratio image of Landsat MSS Band 7 (Near- Infrared - 0.8 to 1.1 mm) divided by Band 5 (Red - 0.6 to 0.7 mm) would result in ratios greater than 1.0 then it will

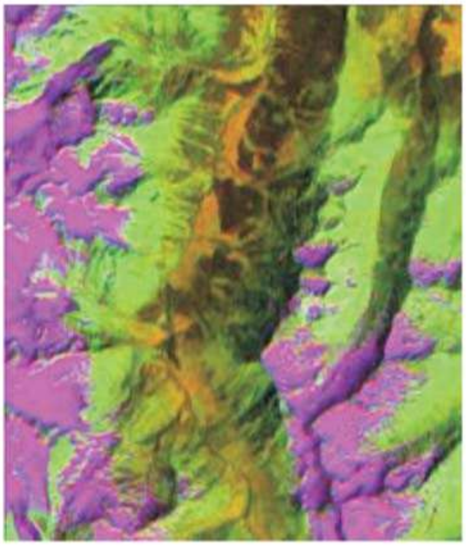


Fig. 32

Original Image

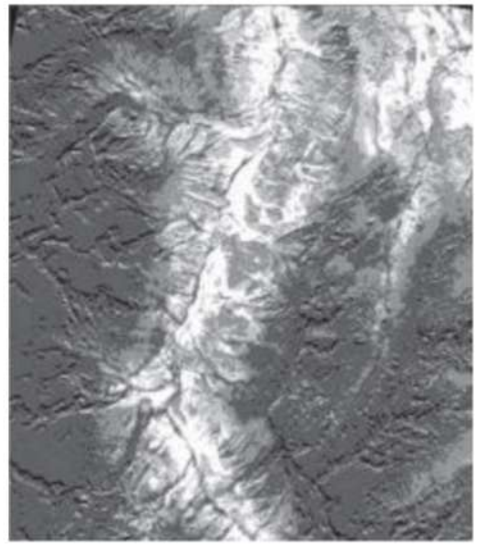


Fig. 33

NIR/R (TM4/TM3), with values ranging from 0 to 8, soil to vigorous vegetation, vegetated areas shown in white.

be easy to identify the vegetation, soil and water. This is the most common arithmetic operation applied to images in geological, ecological and agricultural applications of remote sensing.

Normalized Difference Vegetation Index (NDVI)

NDVI is used to assess, analyze and estimate live green vegetation, crop yields, pasture etc. NDVI is directly related to various parameters

- Ground cover
- Photosynthetic activity of the plant
- surface water
- Leaf area index.

Several algorithms are used to extract such information from remote sensing data, which are referred as vegetation indices. NDVI is a numerical indicator that uses the visible and near-infrared bands of the electromagnetic spectrum. Healthy vegetation absorb in visible band and reflects in near-infrared band. Unhealthy vegetation reflects more visible band and less in near-infrared band. On the other hand bare soils reflect moderately in both the red and infrared band of the electromagnetic spectrum. By knowing the behavior of plants across the electromagnetic spectrum NDVI information can be derived by using following formula. Near-infrared and red bands are most sensitive to deriving vegetation information by the sum of near-infrared and red bands.

$$NDVI = (NIR - RED) / (NIR + RED)$$

Where NIR - >Near Infrared band

RED - >Red band from visible range

The NDVI algorithm subtracts the red reflectance values from the near-infrared and divides it. NDVI values are represented as a ratio ranging from -1 to 1. Extreme negative values represent water; values around zero represent bare soil. The bigger the difference between the near-infrared and the red reflectance, healthy will be the vegetation. In the figure below the NDVI is calculated in Kharif Season in Punjab from May to November months. The dark green, yellow color shows less vegetation (May, June ,October) and dark red color shows healthy vegetation.

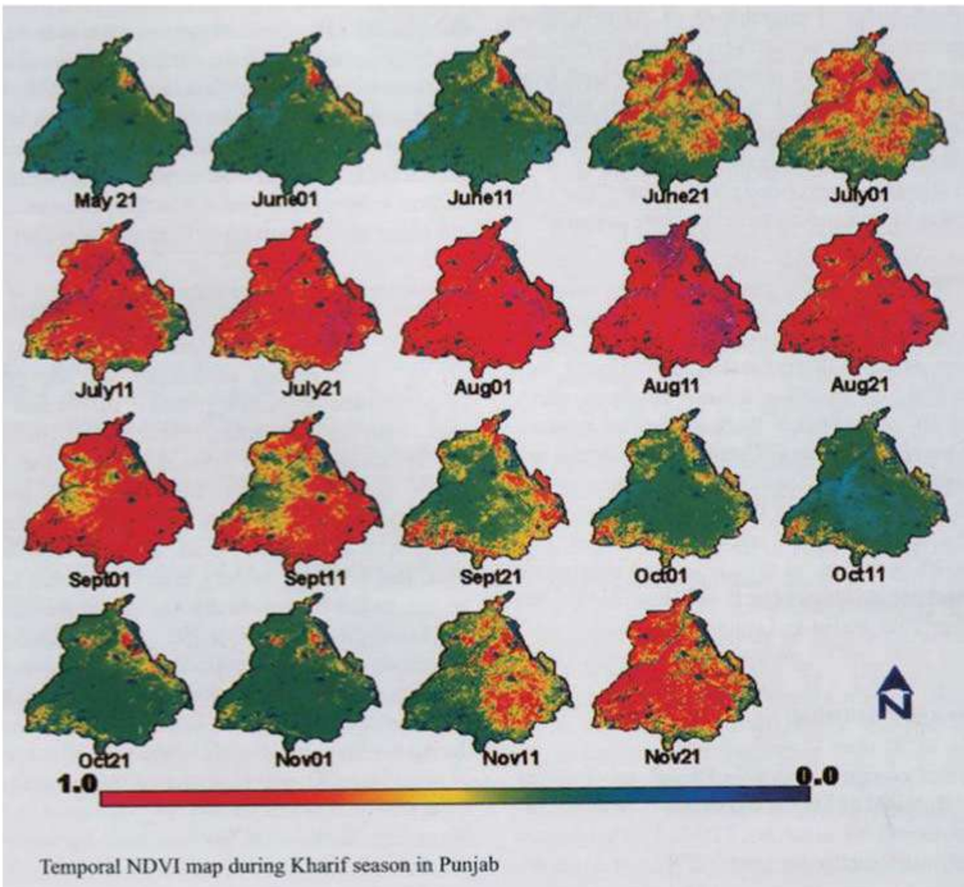


Fig. 34

NDVI Map for Punjab during Kharif Season Source: PRSE

Perpendicular Vegetation Index (PVI)

The plot of reflectance in the red and near infrared bands, of bare soil, under various degrees of wetness, is the baseline for the vegetation index. The illustration is shown in figure. PVI is measured perpendicularly from this soil baseline. Point A has a higher PVI than point B. mathematically this measure is represented below

Perpendicular vegetation index: $\sqrt{(soil^{R} - veg^{R})^2 + (soil^{IR} - veg^{IR})^2}$

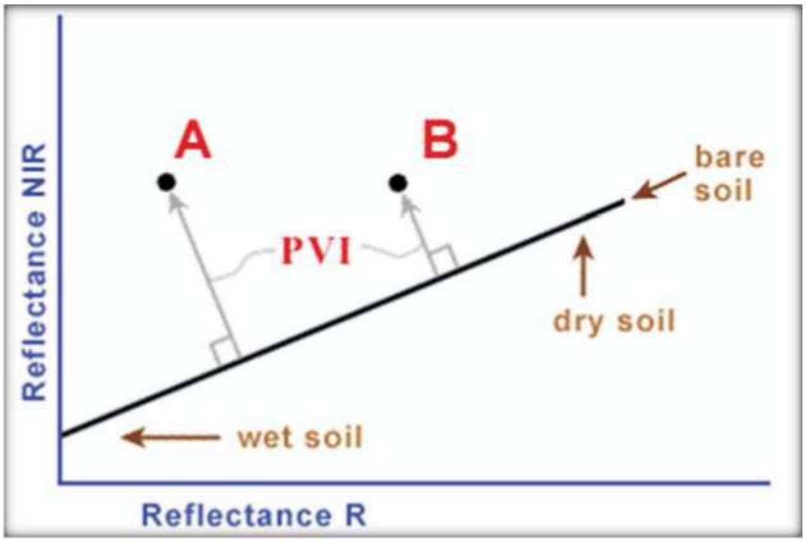


Fig. 35

D. Image Classification

Classification is a process to categorize all pixels in a digital image into one or several land cover classes, or "themes". Digital image classifications use the spectral information represented by the digital numbers in one or more spectral bands, and classify each individual pixel based on this spectral information. Classification techniques are generally applied to

> Image classification is a process of automatically categorization of all pixels in an image into different land cover classes or themes

the single-date image or series of multi-date images for change detection. Normally, multi-spectral data are used to perform the classification. Grouping of the pixels are based on their spectral information (DN) present within the data. The objective of image classification is to identify different features occurring in an image to identify different land features. These groups are called as classes. Based on DN values we can create the classes like Vegetation, Water body, Barren Land, Buildup Area etc. Broadly we can use two approaches for classification:

1. Unsupervised classification
2. Supervised classification

In Unsupervised classification spectral classes are grouped first, based on the numerical information in the data. Clustering algorithms are used to determine the natural classes in the data. Algorithms examine the unknown pixels in an image and group them into a number of classes. Unsupervised Classification method does not utilize training data as the basis for classification. Based on the reference data, area knowledge and experience, user compare the classified data and identify the features and name them as shown in the figure. There are numerous clustering algorithms that can be used to determine the natural spectral groupings present in data set. The most used algorithm is "K-means" approach also called as ISODATA (Interaction Self-Organizing Data Analysis Technique). Unsupervised classification is not complete without human involvement.

> Unsupervised classification is popular in industries involved in long term GIS database maintenance because it uses clustering procedures which are extremely fast.

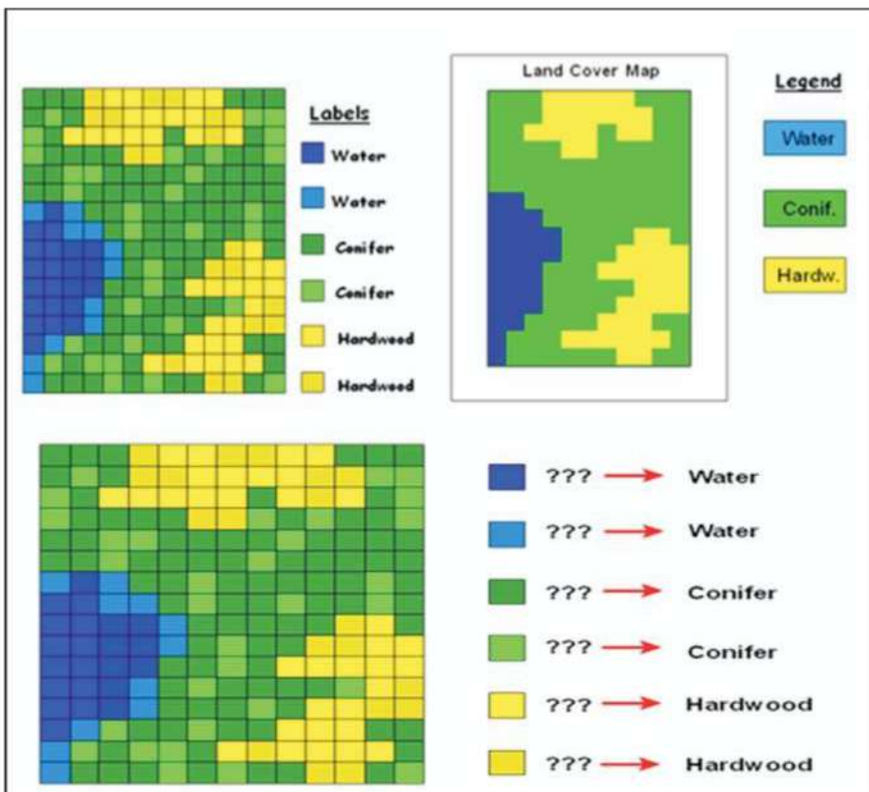


Fig. 36

Unsupervised Classification Process

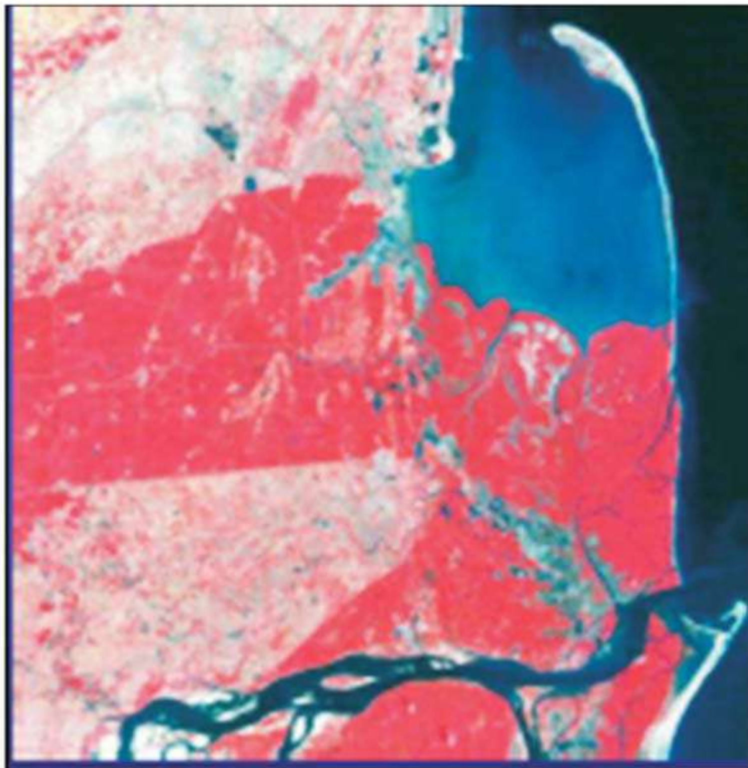


Fig. 37

Supervised classification is more accurate for mapping classes, but it depends heavily on the area knowledge and skills of the analyst. The analyst should recognize classes in an Image based on prior knowledge and assign them class names. These are called as training sites. The training sites areas representing known land cover category that appear homogeneous on the image. Image processing software categorizes of the reflectance of each class. This process is called "signature analysis". The entire image is classified based on this signature assigned. Most frequently used algorithms for supervised classification are parallelepiped, minimum distance and maximum likelihood. The basic steps involved in a typical supervised classification procedure are as given below.

(i) Defining training site

(ii) Featuring selection (signature analysis)

(iii) Selection of appropriate classification algorithm

(iv) Post classification smoothening

(v) Accuracy assessment

(vi) Classified Image (Result)

(vii) Statistical report generation for different landuse and landcover

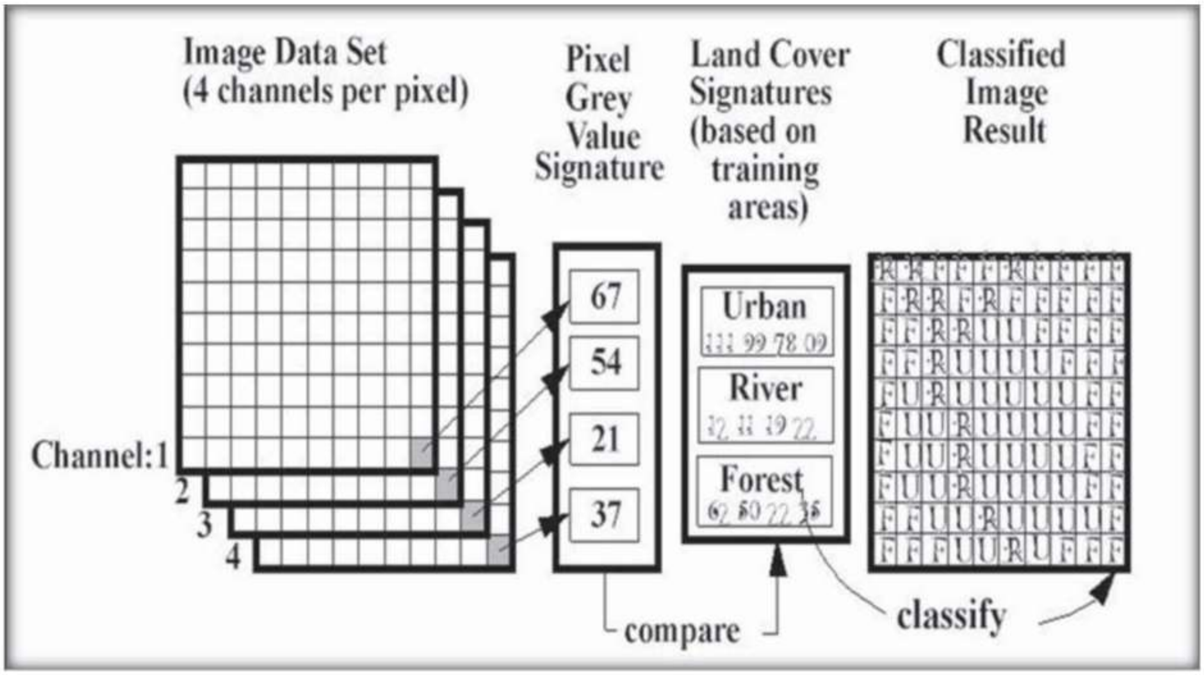


Fig. 38

Steps in Supervised Classification

Source: www.sc.chula.ac.th

In the figures given below the training sites are shown and names are assigned such as Turbid Water, Deep Water, Shallow Water, Wet Land, Barren Land, Agriculture and Forest. Based on these training sites the raw Image is classified and final output is shown fig. 40.

After classification the classified map needs to be compared with other maps of same area to assess and verify the accuracy. In areas of complex terrain, the unsupervised approach is preferable as compared to supervised classification. In such conditions if the supervised classification is used, the user will have difficulty in selecting training sites because of the variation of spectral response within each class. As unsupervised classification distinguishes classes based on spectral response, ground truthing requirements are reduced for some extent. Unsupervised classification reveals separate classes of unknown places without visiting the site.

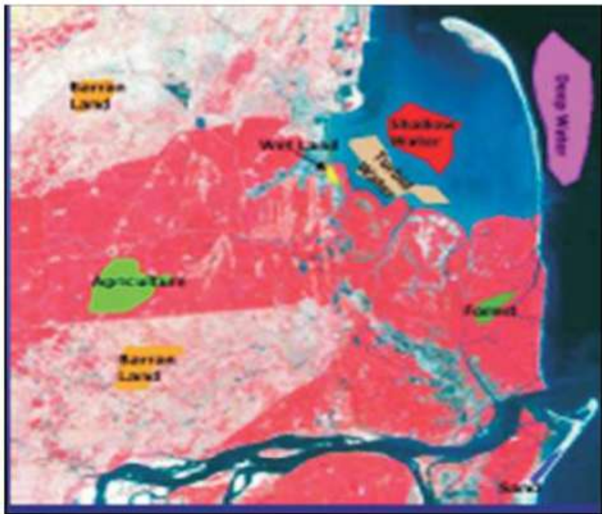


Fig. 39

Image with Training Sites

Source: NRSC Hyderabad

Fig. 40

Classified Image

Source: NRSC Hyderabad

1.4 Visual Interpretation of Satellite Data

Imagery obtained by remote sensing is used in various applications. By studying the qualitative and quantitative aspects of images one can derive useful information by having knowledge about the area for further interpretation and analysis. Image interpretation is the art and science of examining image to identify the objects and evaluates their significance. Identifying features in remotely sensed images are based on following;

a) Tone

b) Shape

c) Size

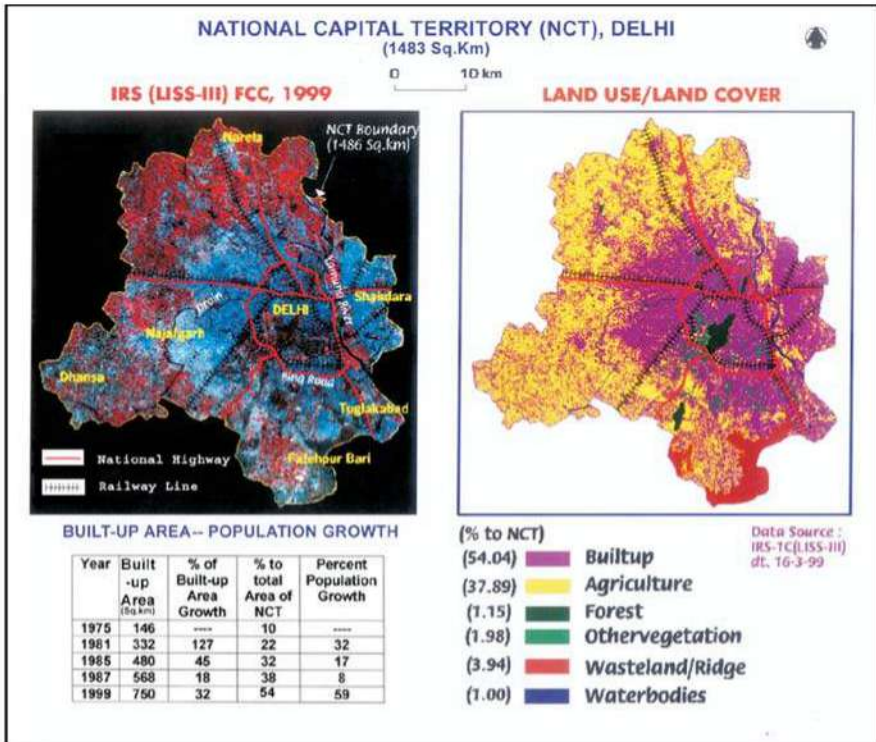
d) Pattern

e) Texture

f) Shadow

g) Association

Image interpretation is defined as examining images to identify objects and judge their significance.



Year	Built -up Area (Sq.km)	% of Built-up Area Growth	% to total Area of NCT	Percent Population Growth
1975	146	----	10	----
1981	332	127	22	32
1985	480	45	32	17
1987	568	18	38	8
1999	750	32	54	59

Fig. 41

An example for supervised classification along with the Statistical report on Land use/ Land covers (Source: ISRO Report)

a) Tone

Tone refers to the relative brightness (color) of objects in an image. The term is used for each distinguishable shade from black to white, such as dark, medium, light gray as shown in picture. Tone is the important element for identifying different features. Variations in tone also help identification of shape, texture, and pattern of objects. For example dry sand will appear in light shades of grey, while wet sand appears in dark shades of grey. In figure road looks brighter than the wet field.

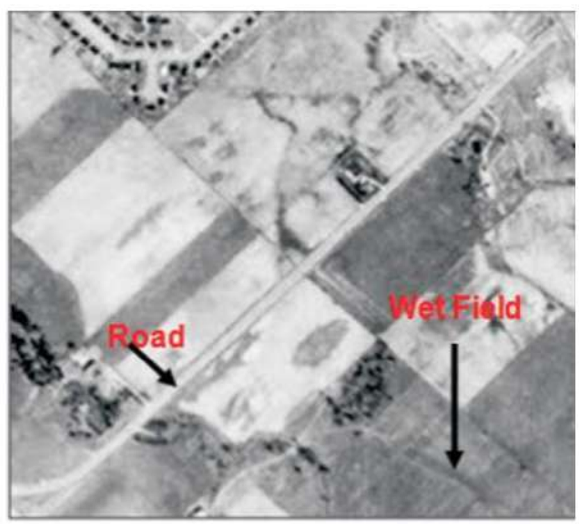


Fig. 42

Tonal Variation in an Image
Source: CCRS

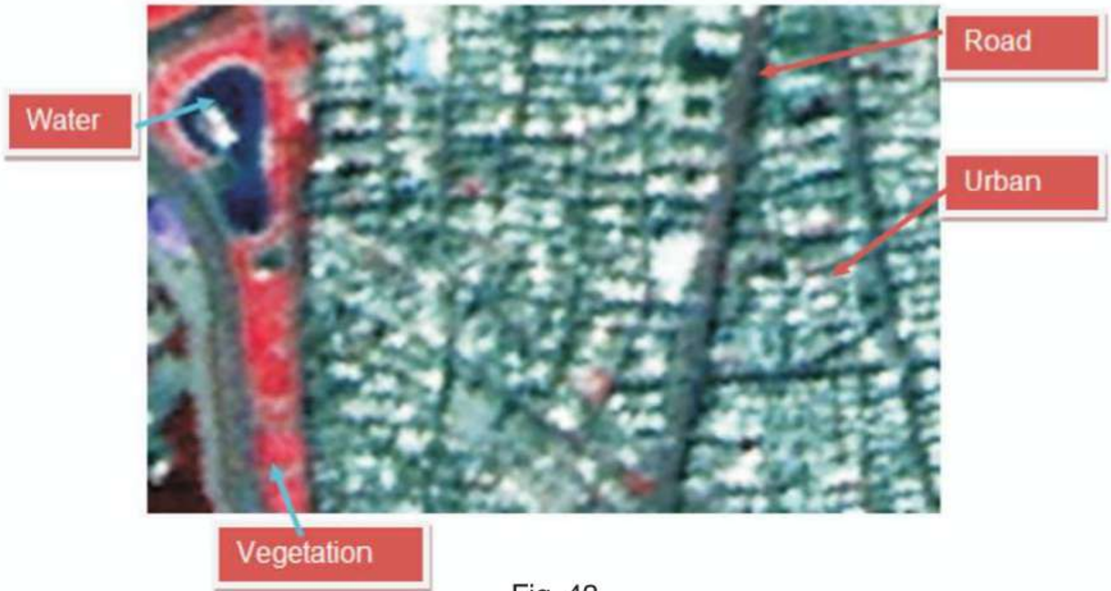


Fig. 43

Features indentified based on tonal Variation

b) Shape

Shape refers to the general form, structure, or outline of individual objects. Shape is an important element for interpretation. Straight edge shapes represent urban or agricultural fields. Natural features, such as forest edges, are generally more irregular in shape. Farm or cropland irrigated by rotating sprinkler systems would appear as circular shapes. Many geomorphologic shapes are identified, such as sand dunes lakes, volcanic cones etc. For example in the above figure (44) the tennis court is visible.

Fig. 44

Indentified feature based on Shape

Courtesy: J.M Piwowar

c) Size

The size of a feature is also significant element in image interpretation. Size of objects in an image is a function of scale. Size when considered along with shape and association, helps in easy identification of the features. For example in this figure large buildings such as factories or warehouses would suggest commercial property, whereas small buildings would indicate residential use.

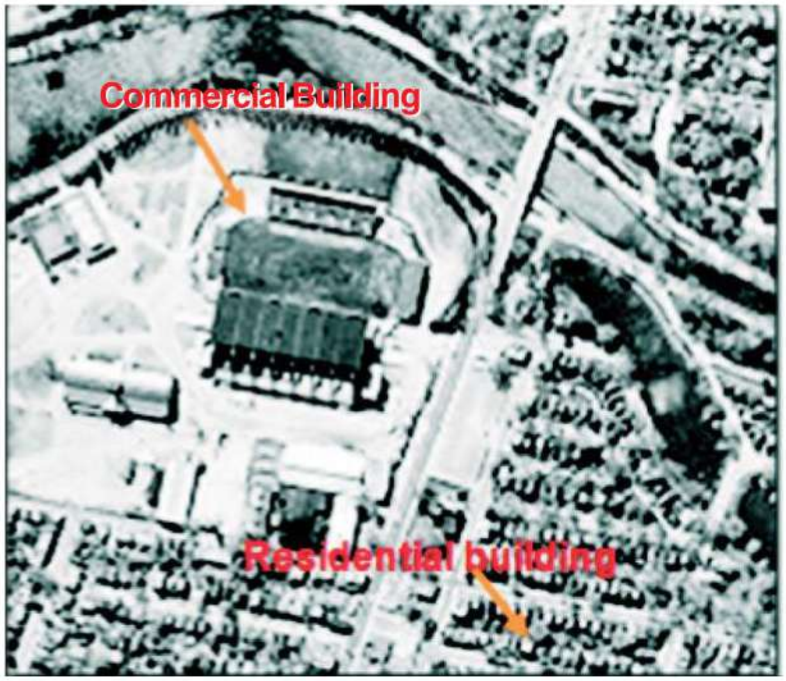


Fig. 45

Feature identified based on Size
Source: CCRS

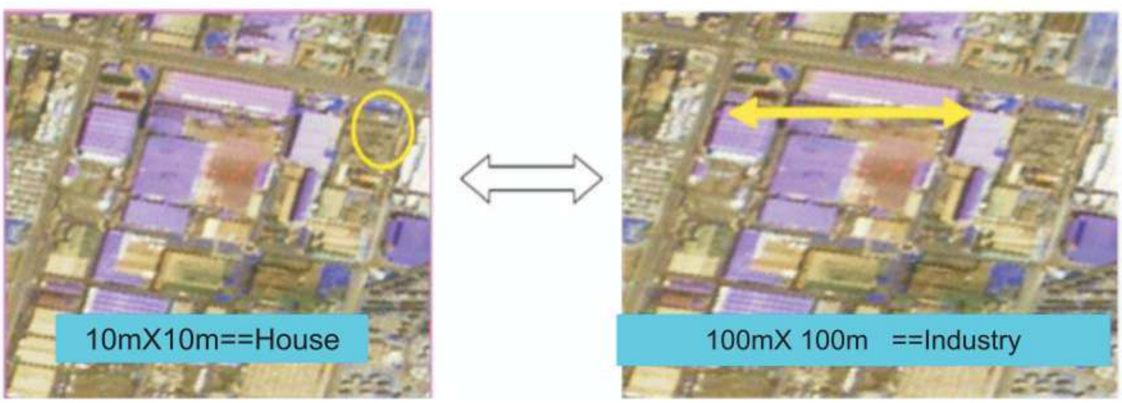


Fig. 46

Identification of House and Industries based on Size

d) Pattern

Pattern refers to the spatial arrangement of visibly separate objects. An orderly repetition of similar tones and textures will produce a distinctive and recognizable pattern. Urban streets with regularly spaced houses are good and orchards with evenly spaced trees as shown in figure are good examples of pattern.

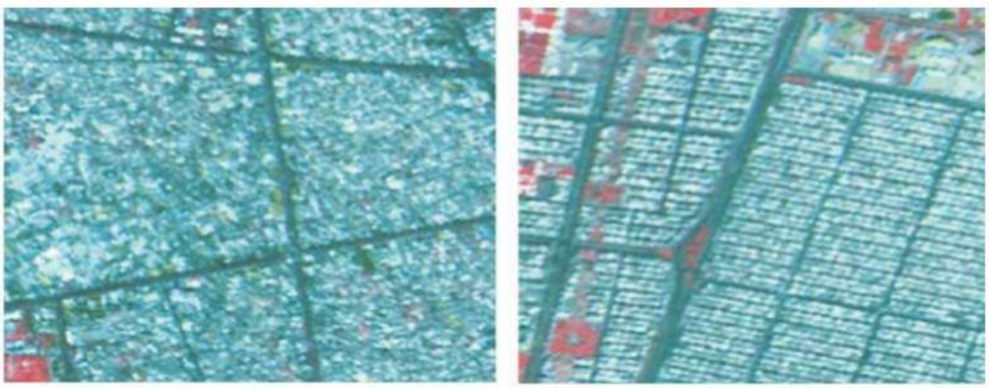


Fig. 47

Example of Planned and unplanned urban area based on pattern

e) Texture

Texture is closely associated with tone. This includes smooth, and rough surfaces. Rough surfaces have a spotted tone where the grey levels change abruptly in a small area. For example forest canopy shows rough texture in an image. Smooth surfaces have very little tonal variation. For example fields or grasslands appear smooth and uniform in image.

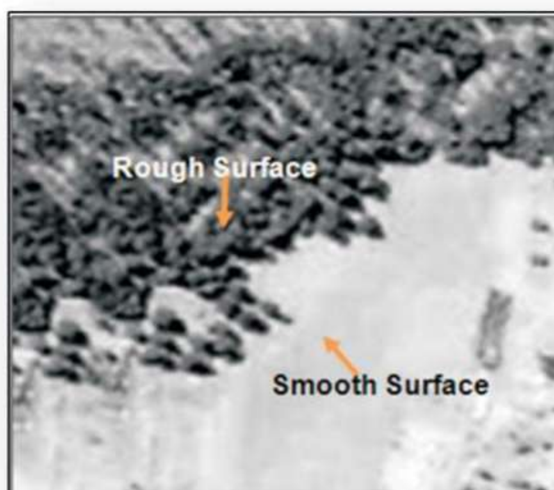


Fig. 48

Feature indentified based on Texture Source: CCRS

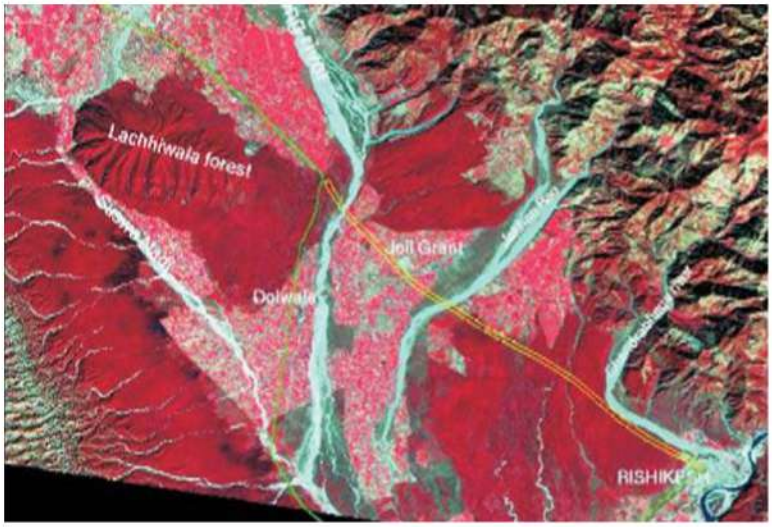


Fig. 49

Feature indentified based on Texture
(Source: RRSC North)

f) Shadow

Shadow is an important element for Image interpretation. It makes identification easier because it provides profile of the features. Shadow length can be used for height measurements. Shadows reduce interpretation in that area because of non visibility of features. Shadow is useful for identifying topography and landforms. Figure shows that the shadows of the tall building which covers the features from other side of the building which cannot be seen due to this information cannot be derived.

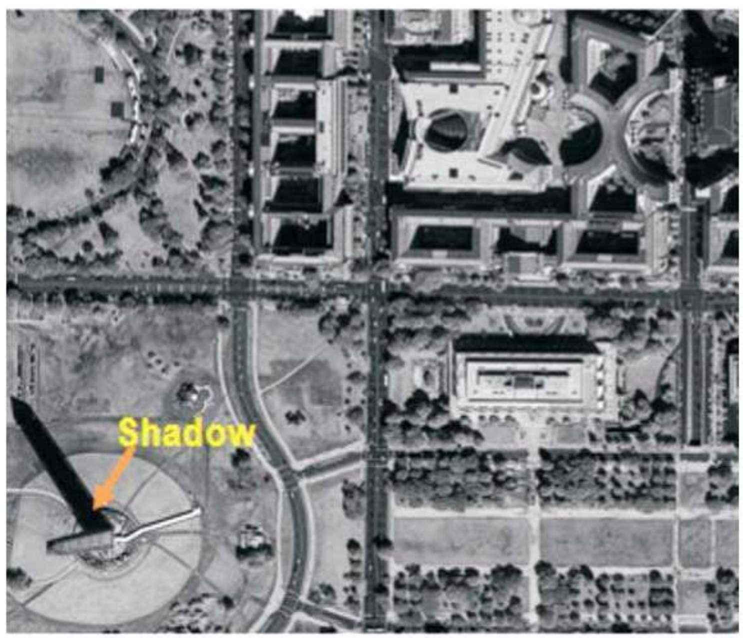


Fig. 50

Shadow in an Image

g) Association

Association of objects is one of the most important elements of image interpretation. It takes into consideration the relationship between other objects which are near to the target. For example commercial properties may be associated with major transportation routes, whereas in residential areas if we see an open space it would be associated with schools, playgrounds, and sports fields. In above figure, a lake is associated with boats, a marina, and adjacent recreational land.

Fig. 51

Features are indentified by their association
Source: CCRS

1.5 Aerial Photo and its Interpretation

Aerial photography is obtained by using aircraft as platforms. Aerial photographs give Bird's eye view of a large area enabling view of the earth is surface features which can not be possible to obtain through ground observation. Aerial photograph can record earth features in visible, ultra violet and near infrared in the form of a visible image. With proper selection of camera films and flight parameters it is able to record more spatial details on photographs as compared to human eye. With proper ground reference data it can obtain accurate measurements of positions, distances, directions, areas, heights, volumes and slope etc. Aerial photography is the permanent record of existing condition which can be studied whenever required. Single image can be used by a large number of users for different types of applications such as geology, agriculture, soil, crop study. Aerial photos are also useful to study dynamic phenomenon such as floods, wildlife population, traffic, oil spills and forest fires.

The films used in aerial camera are of two types

(i) Panchromatic (B & W) – It is cheap and commonly used in Photogrammetry.

(ii) Color- it is easy to interpret but fuzzy due to atmospheric scattering

A) Determining the Photo scale:

Scale of the Photo can be derived by the following formula

$$S = f / H$$

Where: S = Scale of Aerial Photograph

f = Focal length of Camera (normally 152 mm)

H = Flying height

If 1mm on a photograph represents 25 meter on the ground then the scale of photograph is represented as 1mm = 25 m (represents equivalents). If it is 1/25000 (it represents fraction) 1:25000 (represents the ratio).

Flights are usually scheduled between 10 am to 2 pm to have low wind, clear sky with maximum illumination and minimum shadow to obtain clear weather picture. February to April months is optimal period to acquire the aerial photographs. Aerial Photographs can be used for flood, vegetation mapping, and soils study

The various factors which affect the qualities of the aerial photos are:

(i) Clouds, haze, shadows/sun angle, snow

(ii) Distortion due to tip & tilt, relief distortion, radial distortion

(iii) Storage and handling can be a problem

(iv) Limited to 0.3 - 0.9 μm (UV-NIR)

Aerial Photographs are classified as follows:

i) Vertical

ii) Oblique

  a) High

  b) Low

iii) Stereo/3D

i) Vertical

Vertical photographs are made with the camera axis directed as vertically as possible. The photographs made by single lens frame camera. This is the most common type of aerial photography used in RS application. The vertical air photos with less than 3° tilt are considered as vertical photographs. To achieve this, it requires the special equipment to maintain the lens axis vertically and to the ground. Vertical photos are used for planning and redesigning industrial sites.

Fig. 52

An example of Vertical Photo

ii) Oblique

When the aerial photographs are taken with an intentional inclination of the camera axis is called oblique photographs. Oblique photographs are easy to understand because it allows identification of structural and topographic variation. It is easy and cost effective to acquire. The photographs with more than 3° tilt are considered as oblique. It is used to study commercial, residential, industrial, and transportation buildings and infrastructure.

There are two basic types of oblique aerial photography.

1. High angle oblique
2. Low angle oblique.

In a high angle oblique, the apparent horizon is shown, while in a low angle oblique the apparent horizon is not shown. In high oblique photo the camera inclination angle is from 30 to 60 degrees where in Low oblique the inclination angle is 5 to 30 degrees.

Fig. 53

An example of Low Oblique Photo
Source: www.heliphoto.net

Fig. 54

An example of High Oblique Photo
Source: www.aboveallphoto.com

iii) Stereo 3D

Stereo photography is a technique to make two photographs of the same subject, from slightly different positions. These two positions should differ approximately about 10 cm. These images are called stereo images and can be viewed using stereoscope or by stereo computer graphics devices. The resultant image appears to be 3 dimensional and depth can be seen. This depth can be controlled by increasing or decreasing the distance between photography locations.

> Stereo photography involves taking a photograph from two positions, which corresponds to two "eye" positions.

Photographs are taken generally with some percentage of overlaps. For stereoscopic coverage the general overlap is:

- Forward Overlap : 60% (for stereoscopic studies)
- Lateral Overlap : 20-30% (for edge matching)

B) Interpretation of Aerial Photo

The interpretation of aerial data is quite similar with Satellite images. The Interpretation keys for aerial photographs are listed below

- Shape
- Size
- Pattern

- Texture
- Shadow
- Association

The details about these keys are already discussed in Visual Interpretation of Satellite data.

Fig. 55

Aerial Photograph Panchromatic

1.6 Advanced Remote Sensing Technologies

a) Hyper Spectral Imagery

Hyper spectral sensors collect information as a set of 'images'. Each image represents a range of the electromagnetic spectrum and is also known as a spectral band. These 'images' are combined and form a three dimensional hyper spectral cube for processing and analysis. Hyper spectral cubes are generated from airborne sensors like the NASA's Airborne Visible/Infrared Imaging Spectrometer (AVIRIS), or from satellites like NASA's Hyperion. Hyper spectral imaging collects and processes information from visible as well as

Fig. 56

Hyper Spectral Images with multiple bands
Source: rst.gsfc.nasa.gov

from the ultraviolet to infrared band. These data can be used for application in agriculture, mineralogy, physics and surveillance.

Hyper spectral images are acquired at entire spectrum. So it does not require prior knowledge of sample data, and post-processing allows all available information from the dataset to be used. Hyper spectral allows preparing more accurate models and classification of image. The disadvantages of these data are cost & complexity. Fast computers, sensitive detectors, and large data storage capacities are needed for analyzing hyper spectral data.

b) Thermal Remote Sensing

Remote sensors cover two thermal intervals that are 3 - 5 μm and 8 - 14 μm broad bands. It allows sensing of thermal emissions from the land, water, ice and the atmosphere. Many of the meteorological satellites include at least one thermal channel. A thermal band is included on the Landsat Thematic Mapper.

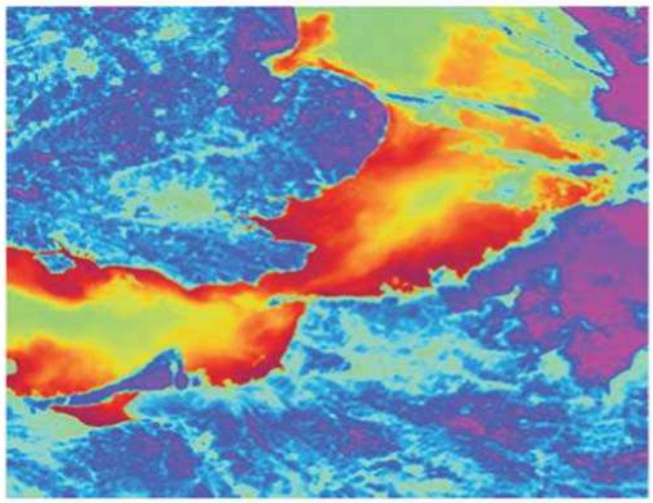
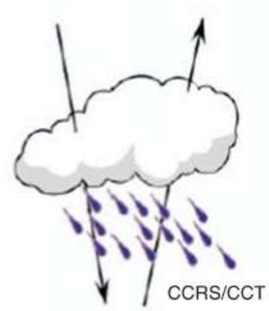


Fig. 57

Thermal Image Source: rst.gsfc.nasa.gov

c) Microwave Sensing

Microwave band in EMR radiation is used in remote sensing to provide useful information about the Earth's atmosphere, land and ocean. Microwave region in EMR ranges from 0.1 to 30 centimeters is called the. Because of their long wavelengths microwave radiation can penetrate through cloud cover, haze and dust. The microwave sensing detects microwave energy under



Penetration of microwave through clouds

Fig. 58

almost all weather and environmental conditions so that data can be collected at day and night both.

Microwave Remote Sensing is classified in two categories namely: active and passive microwave remote sensing.

- Passive microwaves Remote sensing uses emitted energy from thermally activated bodies of earth surface.
- Active remote sensing uses manmade device such as RADAR, SONAR, Lidar etc. Active microwave remote sensing system provides their own illumination.

The basic principle of the Imaging radar is to emit electromagnetic radiation towards the earth surface and record the quantity and time delay of energy backscattered.

Radar is also called as a distance measuring device.

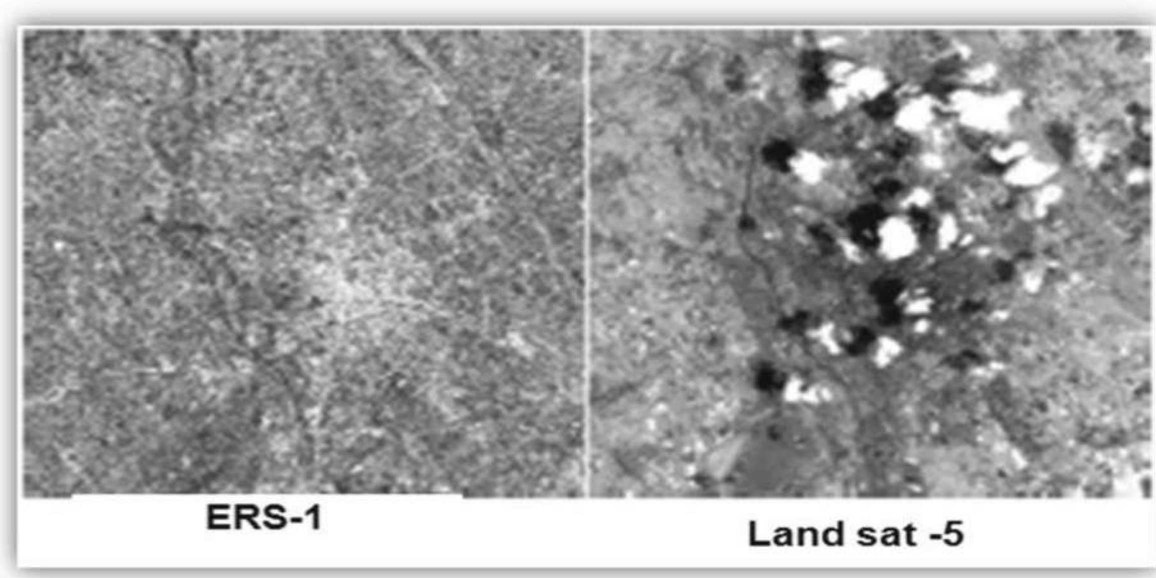


Fig. 59

The example for Radar images acquired by ERS-1 and Landsat-5 on the same date on the fourth of July 1998

(Source NRSC-Hyderabad)

Radio Detection and Ranging (Radar) is an active sensor system. It consists fundamentally of a transmitter, a receiver, an antenna, and an electronics system to process and record the data.

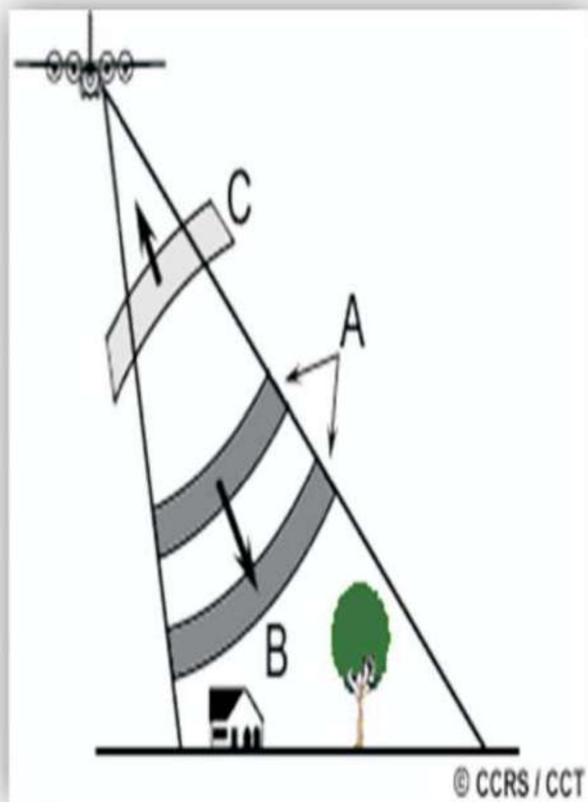


Fig. 60

RADAR Mechanism

It generates its own illumination to interact with the surface features. Some features backscattered the energy which is collected by radar antenna. The backscattered signal is measured to discriminate between different targets and the time delay transmitted and reflected energy. The transmitter generates successive pulses of microwave (A) at regular intervals which are focused by the antenna into a beam (B) as shown in the figure. The radar beam illuminates the surface at a right angle to the motion of the platform. The antenna receives a portion of the transmitted energy reflected / backscattered from various earth surface objects within the illuminated beam (C). The location of the object can be determined by measuring the time delay between the transmission of a pulse and the reception of the backscattered "echo" from different features. Thus it creates two-dimensional image of the surface.

Radar operates in part of the microwave region of the Electro Magnetic Specturm specifically in the frequency ranges from 40,000 to 300 megahertz (MHz) and higher frequencies of the broadcast-radio region. The table given below shows the frequencies and their corresponding wavelengths used in RADAR.

Table : 4

Sl. No	Band	Frequency	Wavelength Range
1	Ka	40,000-26,000 MHz	0.8-1.1 cm
2	K	26,500-18,500 MHz	1.1-1.67 cm
3	Ku	18,000 – 12,500 MHz	1.67-2.4 cm
4	X	12,500-8,000 MHz	2.4-3.8 cm

5	C	8,000-4,000 MHz	3.8-7.5 cm
6	S	4,000-2,000 MHz	7.5-15.0 cm
7	L	2,000-1,000 MHz	15.0-30.0 cm
8	P	1,000- 300 MHz	30.0-100.0 cm

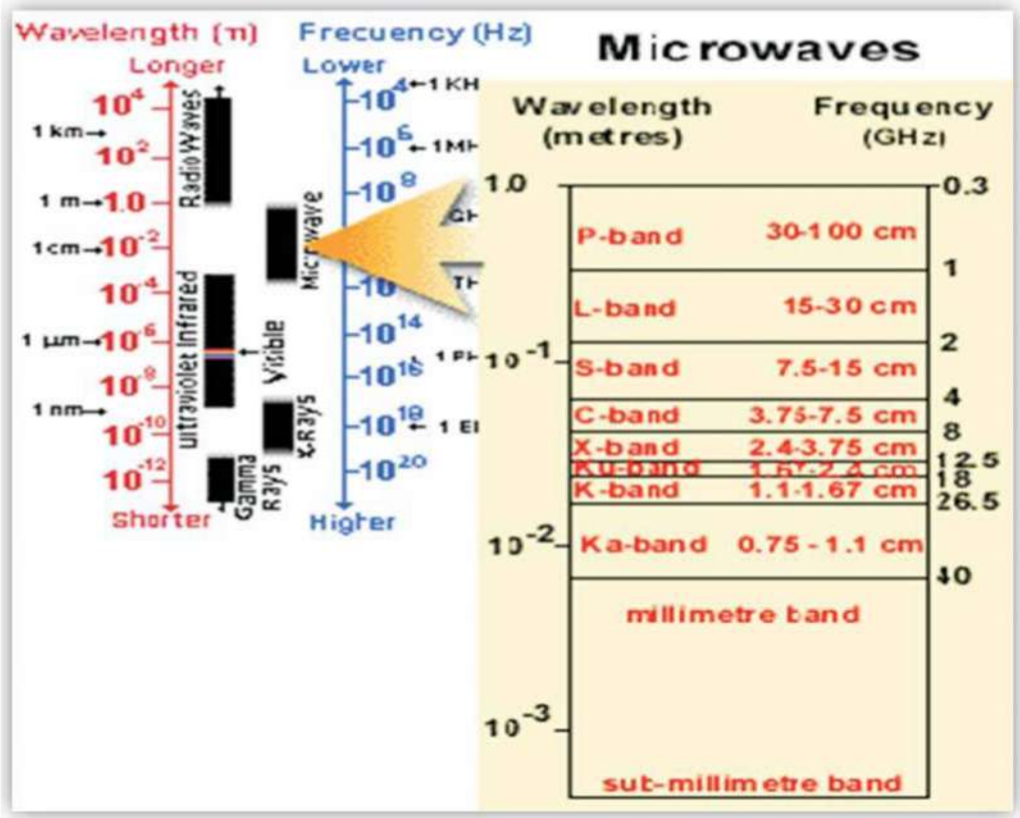


Fig. 61

This chart summarizes the above information on Bands in the Microwave segment of EM spectrum

Source: rst.gsfc.nasa.gov

d) Interaction between Microwaves and Earth's Surface

When microwaves strike a surface, the proportion of energy scattered back to the sensor depends on many factors:

- Physical factors such as the dielectric constant of the surface materials which also depends strongly on the moisture content

- Geometric factors such as surface roughness, slopes, orientation of the objects relative to the radar beam direction;
- The types of land cover (soil, vegetation or man-made objects).
- Microwave frequency, polarization and incident angle.

Microwave remote sensing used in various types of application such as meteorology, hydrology, and oceanology. Meteorologists can use microwave to measure atmospheric profiles and to determine water and ozone content in the atmosphere. Hydrologists use microwaves to measure soil moisture. Oceanographic applications include mapping sea ice, currents, and detection of pollutants, such as oil slicks.

e) Light Detection and Ranging (Lidar)

Lidar is an active remote sensing technique. This technology involves the use of pulses of laser light coming to ground measuring the time of pulse returning to sensor as shown in the figure. The return time of each pulse back to the sensor is processed to calculate the variable distance between the sensor and the object. There are three basic generic types of Lidar

- Range Finders
- Differential Absorption Lidar (DIAL)
- Doppler Lidars.

* Range finder Lidars are the simplest Lidars. They are used to measure the distance from the Lidar instrument to a solid or hard target.

* DIAL is used to measure chemical concentrations such as ozone, water vapor and pollutants in the atmosphere.

* Doppler Lidar is used to measure the velocity of a target. Lidar can create High-resolution DEMs with 10 cm accuracy. Lidar is also able to map bare earth elevations in dense canopy in forested or vegetated areas .

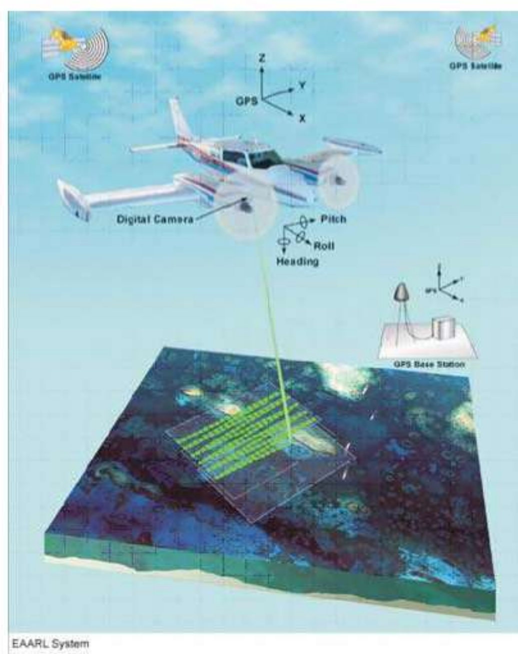


Fig. 62

LIDAR Remote Sensing
Source EAARL System

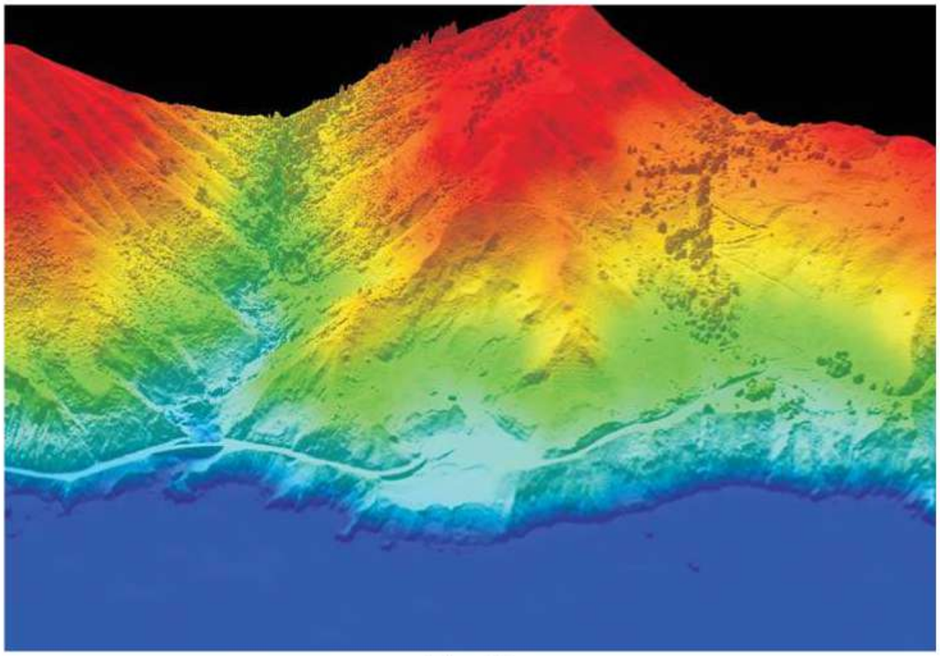


Fig. 63

DEM prepared by Lidar Data

1.7 Advantages and Benefits of Remote Sensing (RS)

During last two decades the satellite remote sensing has been effectively utilized in acquiring and analyzing valuable information about the earth resources. Remote sensing has dramatically enhanced men's capabilities for resource exploration, mapping and monitoring of the earth resources environment on local as well as global scales. It has brought tremendous changes both quantitative and quantitative in various areas such as communication, television, radio broadcast, meteorology, agriculture, education, disaster management, environmental monitoring and natural

Advantages of Remote Sensing

- Synoptic view
- Repetitive coverage
- Continuous acquisition of data
- Coverage of inaccessible areas
- Up-to-date information, accurate and reliable data
- Quantifiable data
- New information
- Multi disciplinary applications
- Time, manpower saving
- Quick assessment of resources
- Service as a large archive of historical data

resource inventory. These are important for strong database for planning, process and implementation of various programs and project both at the national and regional levels. Few benefits of Satellite remote sensing are listed below

Data collected using satellite remote sensing can be used for following purposes

- Assessing and observing vegetation types
- Conducting soil surveys
- Carrying out mineral exploration
- Map making to facilitate easy study of information
- Constructing thematic maps based on requirement
- Planning and monitoring water resources
- Carrying out urban planning
- Assessing crop yields and other agriculture management
- Assessing and managing natural disasters, etc.
- Studying the various spatial features in relation to each other and delineation of regional features trends, phenomenon etc.

Overview of Digital Imaging Softwares

Digital image processing softwares allows the use of algorithms for image processing to perform following processes:

- Image modification
- Pixelization
- Projection
- Image enhancement
- Linear filtering
- Classification
- Feature extraction
- Pattern recognition
- Principal components analysis
- Independent component analysis and many other spatial analysis and modeling

Some of the popular Image processing softwares are listed below;

Table : 5

Sl. No	Software Name	Vendors Name
1	Rolta Geomatica	Rolta India Ltd
2	Erdas Imagine	Erdas Inc
3	Image Analyst	Intergraph
4	ENVI	ITT Visual Information Solution

Important websites to get more information on Remote Sensing

- www.isro.org
- www.iirs-nrsc.gov.in
- www.india.gov.in
- www.esriindia.com
- www.gisdevelopment.net
- www.en.wikipedia.org/wiki/remote_sensing
- www.ias.ac.in
- www.nrsc.gov.in/
- www.ccrs.nrcan.gc.ca

Let us wrap up what we covered in this chapter

- Remote sensing is the process of acquiring the information about earth features without being into direct contact
- Remote sensing (RS) deals with inventory, monitoring and assessment of natural resources through the analysis of data obtained from remote sensing platforms.
- RS enables continuous acquisition and receives up-to-date information. The techniques also help in saving time and manpower.
- The energy emitted from is called as electromagnetic radiation.
- A blackbody is an ideal body which absorbs all radiation without any reflection.
- All object matter that has temperature higher than absolute zero or -273 degrees emits EMR continuously

- Sun is the primary source of energy. The incoming radiation goes through various modes of energy interaction, for example, transmission, absorption, reflection and scattering.
- In case of dust cloud and fog all wavelengths in the visible band are equally scattered, that is why all looks white in color.
- Uneven (rough) surface scatters in multiple direction.
- The shorter wavelengths are scattered more than longer wavelengths. These types of scattering are seen more in ultra violet and blue. That's why sky appears in blue.
- When energy passes through the glass windows it transmits all the energy so it appears transparent in color.
- The radiation reflected as function of the wavelengths is called as spectral signature of the surface.
- The reflectance from a feature depends on the atmospheric condition, season, time of a day, and physical & chemical properties of the feature.
- Smooth surface has low reflectance as compared to rough surface.
- The reflectance of the vegetation depends on various factors such as leaf pigmentation, leaf cell structure, moisture, and crown architecture and plant physiology.
- The healthy growing vegetation reflect in green band that's why color appears as green.
- The healthy vegetation will have abortion in blue and red band because of the presence of the chlorophyll.
- The reflectance of the soil depends on soil moisture, texture, color, grain size, sand, silt and clay composition and mineral composition.
- The reflectance from water depends on depth, suspended particles, floating vegetation
- Pure clear water has a relatively high reflectance in the visible wavelength bands between 0.4 and 0.6 ìm because it absorbs all the energy therefore, it appears darker in color.
- Heavy sediments in water prevents radiation penetration thats why it reflects the energy in NIR.
- The absorption and reflectance in rocks depend on the various factors such as nature of the rock, top cover, topography, shadow and surface roughness.
- Resolution is defined as the ability of the sensor to detect the information at the smallest meaningful element.

- There are four types of resolutions, these are, spatial, spectral, radiometric, and temporal
- The spatial resolution is the minimum element area that the sensor can measure. The resolution element is called pixel. For example LISS III has 23.5 m resolution, Pan 5.8 m
- Spectral resolution refers to sensing and recording power of the sensor in the different bands of EMR. For example Landsat – MSS 7 bands, IRS- 4 Bands.
- Radiometric resolutions recorded in digital number of different bands of sensors. For example LISS-III 7 bit (128 levels) color is 0-127 colors.
- Temporal resolution obtains the spatial and spectral data at a certain time interval. For example IRS-1A/1B revisits the same at 22 days, where as Pan revisits at 5 days.
- DIP is the collection of algorithm processed by the computer system to enhance the quality of the raw data for further interpretation and data extraction
- The steps involved in DIP are Image restoration, statistical analysis, Image enhancement and Image classification
- Image restoration includes geometric, radiometric & noise removal
- Geometric errors in the image is due to sensor, scanning system, motion of the platform, curvature and rotation of the earth
- Radiometric distortion is corrected by applying sun elevation and earth and sun distance corrections
- Resampling method is used to remove the noise from the images
- Image enhancement technique is used to improve the quality of the image
- Image enhancement technique includes histogram, histogram equalization, linear & non-linear contrast stretch, spatial filtering, band ratioing and NDVI
- Histogram is the graph showing the number of pixels in an image at different intensities
- Histogram equalization is the technique by which the dynamic range of the histogram of an image is increased
- Histogram manipulation improves appearance of the image
- Spatial filtering is used to enhance the appearance of the image to derive the valuable and detailed information
- Band rationing is used to dentify the various earth features such as healthy vegetation, soil, water

- NDVI is used to assess analyze and estimate green vegetation, crop yield etc
- NDVI is calculated as NIR-R / NIR+R
- NDVI values are represented as a ratio ranging from -1 to +1. Negative values represent water, zero represents bare soil
- Classification is the process of automatic categorization of all pixels in an image into different land cover classes or themes.
- Broadly there are two approaches of classification unsupervised and supervised.
- The basic steps involved in supervised classification are defining the training sites, feature selection, selection of classification algorithm, post classification, smoothening, accuracy assessment, final classified image and statistical report generation
- Visual Image interpretation is the art and science of examining image to identify the objects and evaluates their significance.
- The identification of the features is based on the shape, size, pattern, texture, shadow and association
- Aerial photographs give a bird's eye view of a large area enabling to view earth surface features which cannot be possible to obtain through ground observation
- Aerial photographs are categorized as vertical, low oblique, high oblique, and stereo 3D
- The photographs are taken generally with some percentage of overlaps for stereoscopic coverage
- Generally the forward overlap is about 60% and lateral overlap is about 20-30%
- There are two types of films used in aerial photographs, panchromatic, and color
- The scale of the photo can be calculated by formula s=f / H where s is photo scale and f is the focal length of camera and H is flying height
- The various factors that affect the quality of the aerial photographs are cloud, haze, sun angle and snow distortion due to relief, tilt, and radial
- Flights are usually scheduled between 10 am to 2 pm to have low wind, clear sky with maximum illumination and minimum shadow to obtain clear weather picture
- The interpretation keys for aerial photos are shape, size, pattern, texture, shadow, and association
- Advanced remote sensing technology includes, hyper spectral, thermal, microwave and Lidar

- Advantages of Remote sensing are synoptic view, repetitive coverage, continuous acquisition of data, coverage of inaccessible areas, up-to-date information, accurate and reliable data, Quantifiable data, new information, multi disciplinary applications, time, manpower saving, quick assessment of resources, service as a large archive of historical data

Questions

Vey Short Questions

1. Explain Wien's displacement law.
2. The radiation reflected as a function of wavelength called the spectral signature is true or false?
3. Heavy sediments in water transmit the radiation. True or false?
4. Why water looks green?
5. What is Resolution?
6. Name different types of resolution
7. List the steps involved in DIP
8. What is supervised classification?
9. What is unsupervised classification?
10. List down basic elements of image interpretation
11. Name the advanced remote sensing technology.
12. What are the basic Image Interpretation keys for aerial photographs?
13. How many types of films are used to take photograph?
14. Radar is passive sensor system? True or False
15. Radar operates in which part of electromagnetic region?
16. What is the microwave region?
17. Visible and infrared radiation can penetrate through cloud, haze and dust. True or false?
18. List down the application of microwave remote sensing
19. Which remote sensing system allows the study in all weather condition? And why?
20. What is full form of Lidar and RADAR?
21. What are the three basic types of Lidar?

Short Questions

1. Describe why dust cloud, and fog look white and sky looks blue?
2. Define the following
    a. Spectral Signature
    b. Transmission
    c. Absorption
    d. Reflection
    e. Scattering
3. What are the various factors effecting the reflectance of various earth feature?
4. Define the following with examples
    a. Spatial resolution
    b. Spectral resolution
    c. Radiometric resolution
    d. Temporal resolution
5. Define the following with examples
    a. Radiometric correction
    b. Geometric correction
    c. Image restoration
    d. Noise removal
    e. Image enhancement
6. Define the following with examples
    a. Low pass filter
    b. High pass Filet
    c. Supervised classification
    d. Unsupervised classification
7. What is Image classification?
8. What is the linear and nonlinear contrast stretch?
9. What are the basic elements of Image Interpretations keys for aerial photographs?

10. Why Stereo 3D is used? What is difference between normal and 3D photo?
11. Why stereoscopic coverage is taken with some percentage of overlaps? Explain.
12. Explain about photo scale of aerial photo with formula.
13. How many types of microwave remote sensing? Explain

Long Questions

1. Draw a curve for spectral distribution of energy by a black body
2. Solar rays strike the land and ocean and atmosphere targets the incoming radiation go through various modes of energy interaction, what are the different interaction mechanism? Explain with diagram
3. Describe the energy interaction mechanism for glass window, soil and roof and explain how the color of this objects effect?
4. Explain the about a typical spectral reflectance curve of different features wet soil, dry soil, turbid water, clean water and healthy vegetation, stressed vegetation and rock with graphs.
5. What is digital image processing? Why this technique is used? Explain the steps involve in DIP
6. What is histogram? Explain in detail with various techniques
7. Explain the various enhancement techniques to improve the quality of the image?
8. What is the purpose of filtering?
9. What are advantages and disadvantages of linear, non linear contrast stretch?
10. What is the difference between supervised and unsupervised classification?
11. What is NDVI? Explain with formula? Why it is used?
12. What are the difference between satellite images and Aerial photographs?
13. What are advantages of Remote Sensing?
14. Define the following elements used in visual interpretation of aerial and satellite data with examples

    a. Shape   e Shadow

    b. Size   f Association

c. Pattern

d. Texture

15. Explain benefits and applications of

    a. Satellite images

    b. Aerial Photographs

16. Discuss about the aerial photographs? Explain in details about types of aerial photographs?
17. What is difference between High and low angle oblique photographs?
18. What factors affect the qualities of aerial photograph? Explain.
19. What is microwave remote sensing system? Why it is used?
20. Explain about Radar Sensor?
21. Explain the frequency range of Microwave remote sensing system.