SNS COLLEGE OF TECHNOLOGY

Vazhiyampalayam, Coimbatore, Tamil Nadu, 641035

An Autonomous Institution

Approved by AICTE New Delhi & Affiliated to Anna University Chennai

Accredited by NBA & Accredited by NAAC with "A++" Grade, Recognized by UGC

DEPARTMENT CIVIL ENGINEERING

19CEE303 – **REMOTE SENSING**

III YEAR / V SEMESTER

Unit 1 : Spatial and Spectral Resolutions

Remote Sensing Systems

(ii) Spatial and Spectral Resolutions

Introduction

- In remote sensing **resolution** means the **resolving power**
  - Capability to identify the presence of two objects
  - Capability to identify the properties of the two objects

- An image that shows finer details is said to be of finer resolution compared to the image that shows coarser details

Types of Resolution

- **4 types** of resolutions are defined for the remote sensing systems
  - ❖ Spatial resolution
  - ❖ Spectral resolution
  - ❖ Temporal resolution
  - ❖ Radiometric resolution

This lecture covers the details of the Spatial and Spectral resolutions

Spatial Resolution

- Spatial resolution: Size of the smallest dimension on the Earth's surface over which an independent measurement can be made by the sensor
  - Expressed by the size of the pixel on the ground in meters
  - Controlled by the Instantaneous Field of View (IFOV)

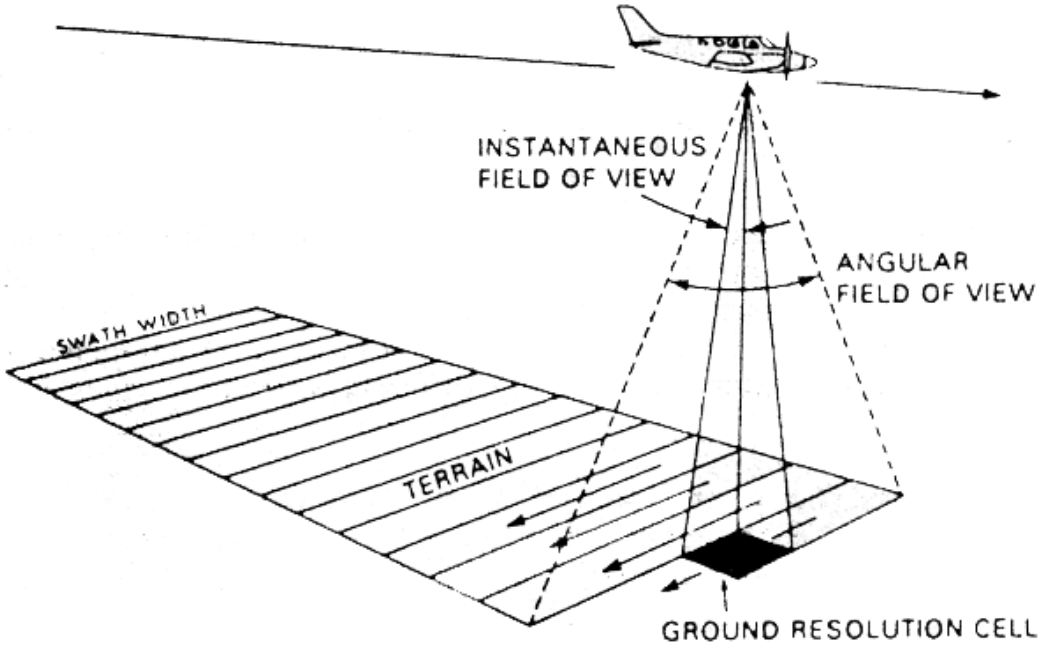
Coarse Spatial Resolution

Fine Spatial Resolution

Instantaneous Field of View

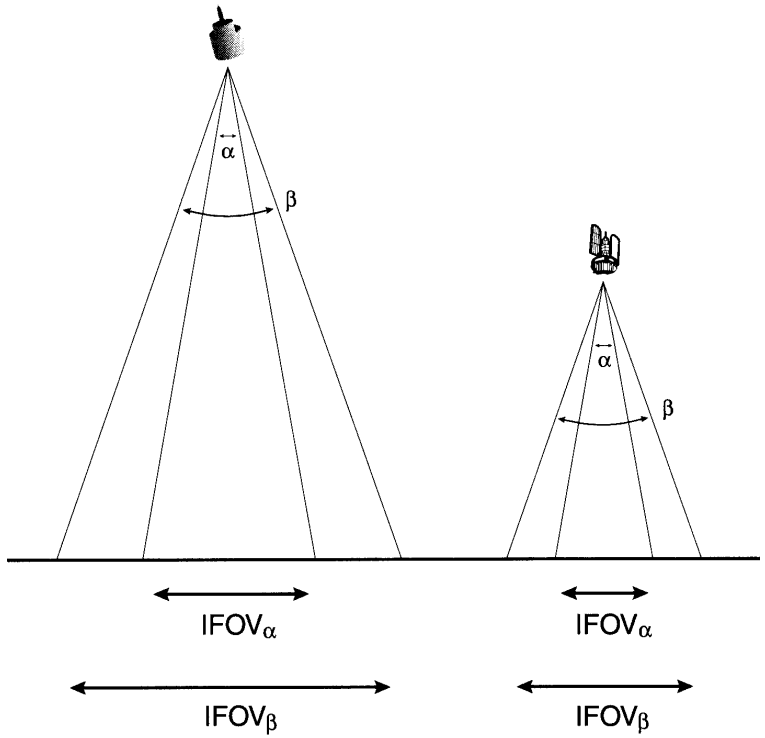
- **IFOV: Instantaneous Field of View**
  - Angular cone of visibility of the sensor
  - Area on the Earth's surface that is seen at one particular moment of time

- IFOV depends on
  - Altitude of the sensor above the ground level
  - Viewing angle of the sensor



Instantaneous Field of View…

- A narrow viewing angle produces a smaller IFOV
- IFOV increases with altitude of the sensor



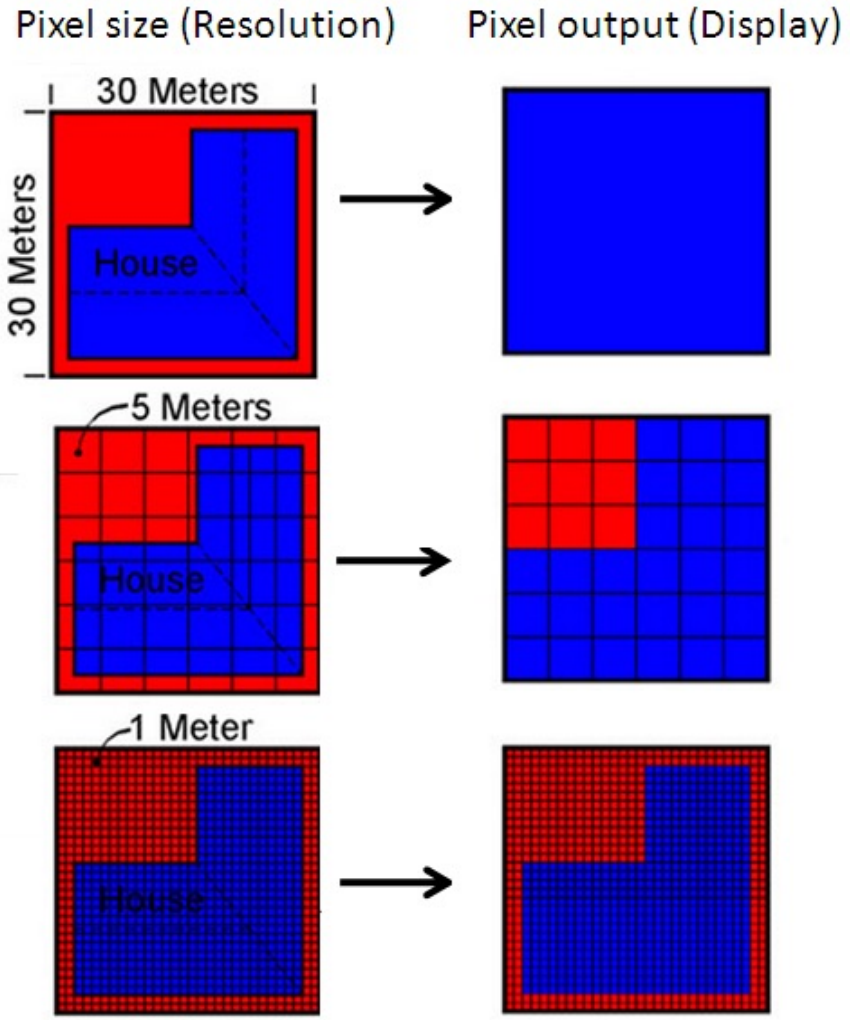
Ground Resolution Cell

- Ground Resolution or Ground Resolution Cell : Size of the area viewed by the sensor on the ground at one particular moment of time
- Depends on
  - Altitude of the sensor
  - IFOV of the sensor
- Obtained by multiplying the IFOV (in radians) by the distance from the ground to the sensor.
- It is also referred as the spatial resolution of the remote sensing system

Spatial Resolution and Feature Identification

- For a feature to be detected, its size generally has to be equal to or larger than the resolution cell
- If more than one feature is present within ground resolution cell, the signal response is a mixture of the signals from all the features
  - From the average brightness recorded, any one particular feature among them may not be detectable
  - Smaller features may sometimes be detectable if their reflectance dominates within a particular resolution cell

Spatial Resolution and Feature Identification…



Example

Signature from the “house” dominates for the cell and hence the entire cell is classified as “house”

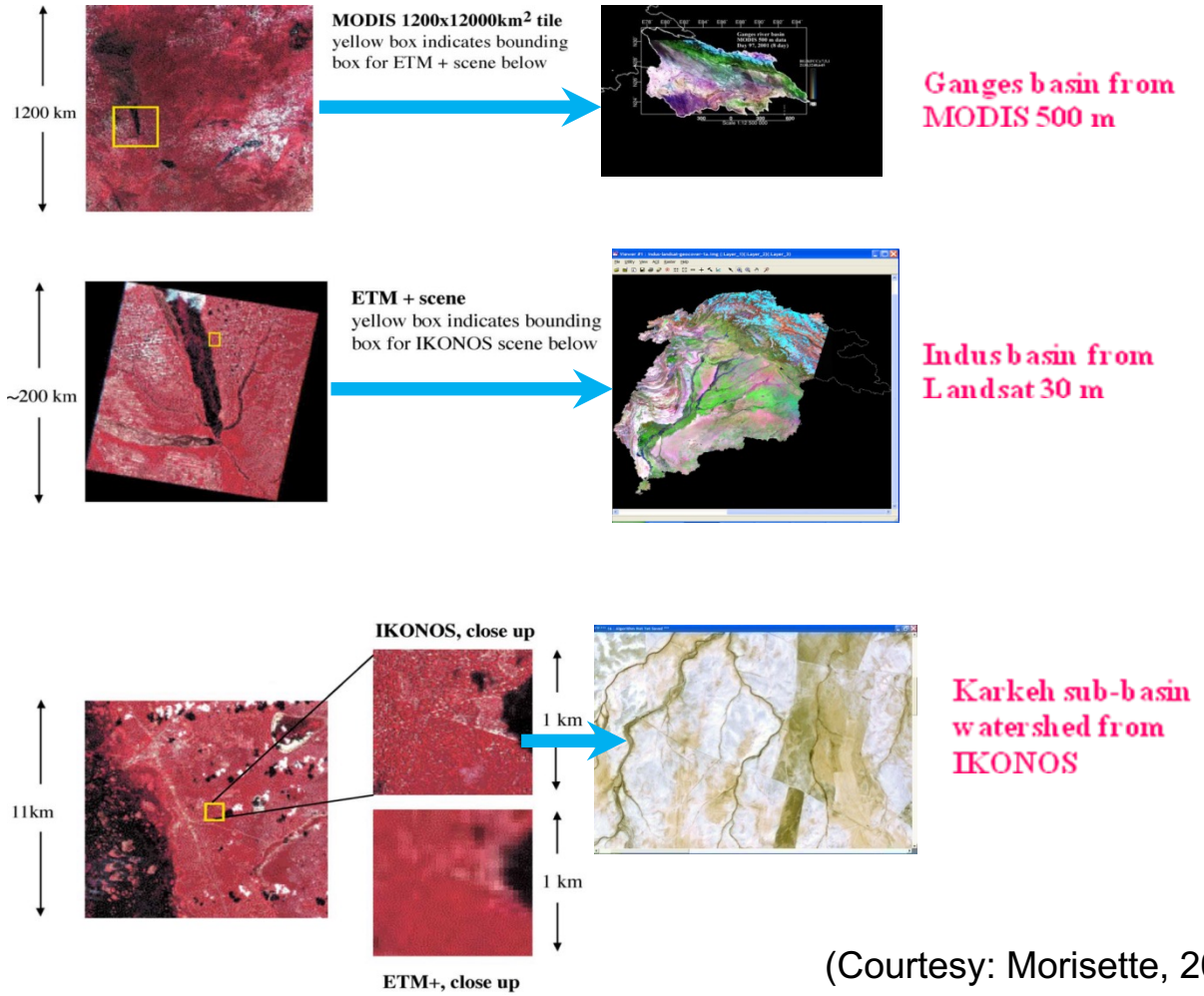
Shape and spatial extent of the feature is better captured. However, some discrepancy is present along the boundary

Feature shape and the spatial extent is more precisely identified

Classes of Spatial Resolution

- Low resolution systems
  - Spatial resolution > 1km
  - MODIS, AVHRR
- Medium resolution systems
  - Spatial resolution is 100m – 1km
  - IRS WiFS (188m), Landsat TM–Band 6 (120m), MODIS–Bands 1-7 (250-500m)
- High resolution systems
  - Spatial resolution approximately in the range 5-100m
  - Landsat ETM+ (30m), IRS LISS-III (23m MSS, 6m Panchromatic), IRS AWiFS (56-70m), SPOT 5(2.5-5m Panchromatic)
- Very high resolution systems
  - Spatial resolution less than 5m
  - GeoEye (0.45m for Panchromatic, 1.65m for MSS), IKONOS (0.8-1m Panchromatic), Quickbird (2.4-2.8 m)

Spatial Resolutions and Scale of Applicability



(Courtesy: Morisette, 2002)

Scale of an Image

- Scale : Ratio of distance on an image or map, to actual ground distance
- Maps or images with small "map-to-ground ratios" are referred to as small scale (e.g. 1:100,000), and those with larger ratios (e.g. 1:5,000) are called large scale.

- Example

  What is the actual length of an object which is 1cm long in a map of scale 1:100,000?

  Scale = 1:100,000

  Object length in map = 1cm

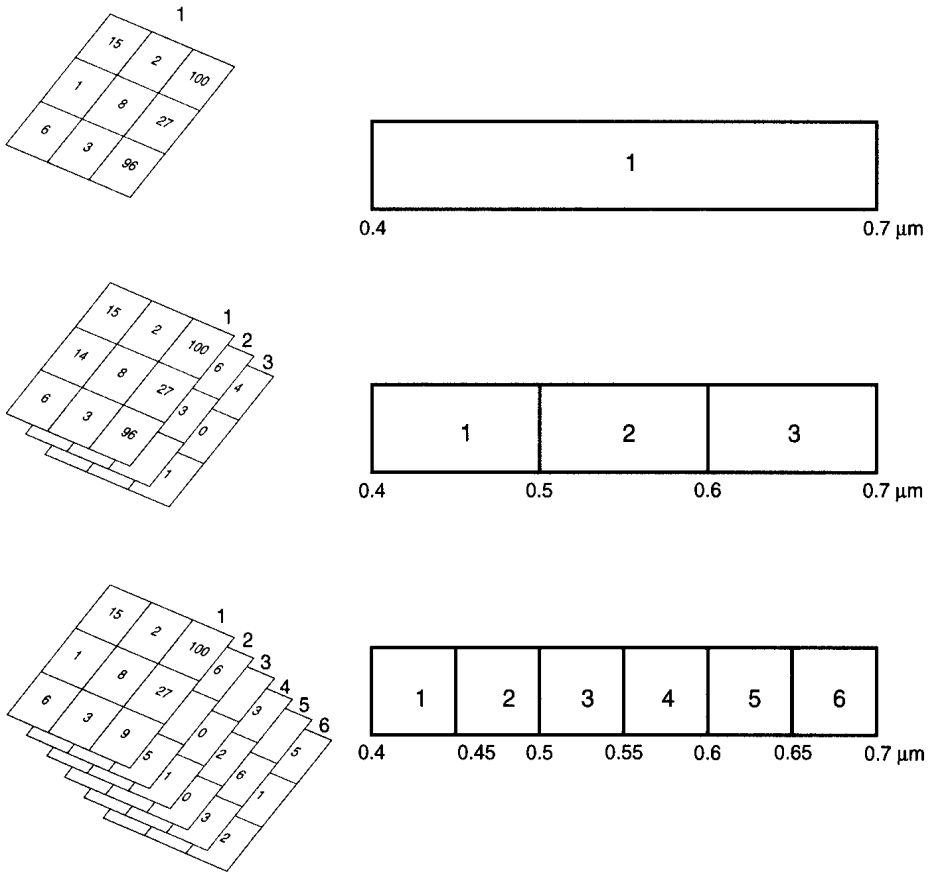
  Actual length on the ground = 1 cm x 100,000 = 100,000 cm = 1 km

Spectral Resolution

- **Spectral resolution**
  - ❖ Ability of a sensor to define fine wavelength intervals
  - ❖ Ability of a sensor to resolve the energy received in a spectral bandwidth to characterize different constituents of earth surface
- Depends on
  - ➢ Spectral band width of the filter
  - ➢ Sensitiveness of the detector
- The finer the spectral resolution, the narrower the wavelength range for a particular channel or band

Spectral Resolution…

Finer the spectral resolution, the narrower the wavelength range for a particular channel or band

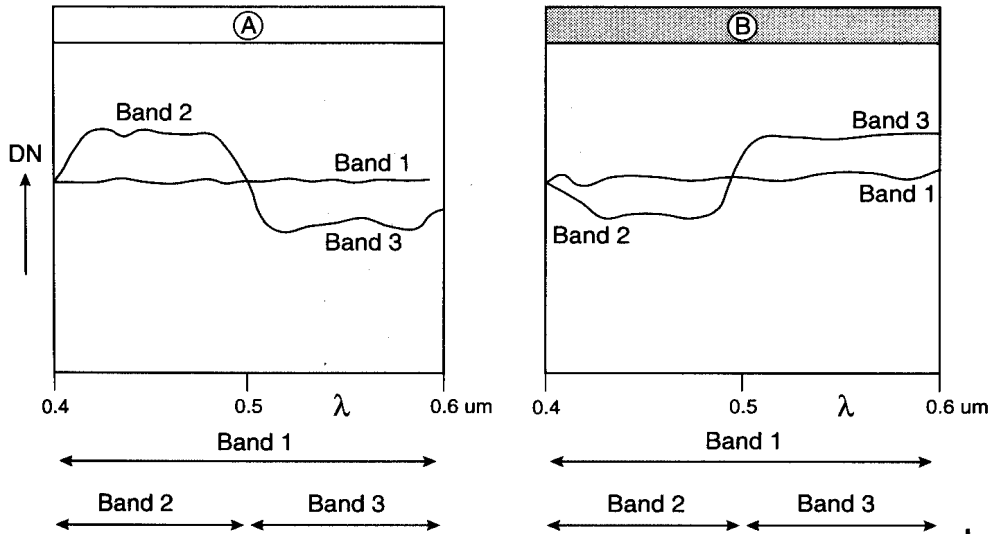


Spectral Resolution…

- Most of the remote sensing systems are multi-spectral, using more than one spectral band
- Spectral resolution of some of the remote sensing systems
  - IRS LISS-III uses 4 bands: 0.52-0.59 (green), 0.62-0.68 (red), 0.77-0.86 (near IR) and 1.55-1.70 (mid-IR).
  - The Aqua/Terra MODIS instruments use 36 spectral bands, including three in the visible spectrum.
  - Recent development is the hyper-spectral sensors, which detect hundreds of very narrow spectral bands

Spectral Resolution and Feature Identification

- Generally surface features can be better distinguished from multiple narrow bands, than from a single wide band



Using the broad wavelength band 1, the features A and B cannot be differentiated

Spectral reflectance of A and B are different in the narrow bands 2 and 3, and hence can be differentiated

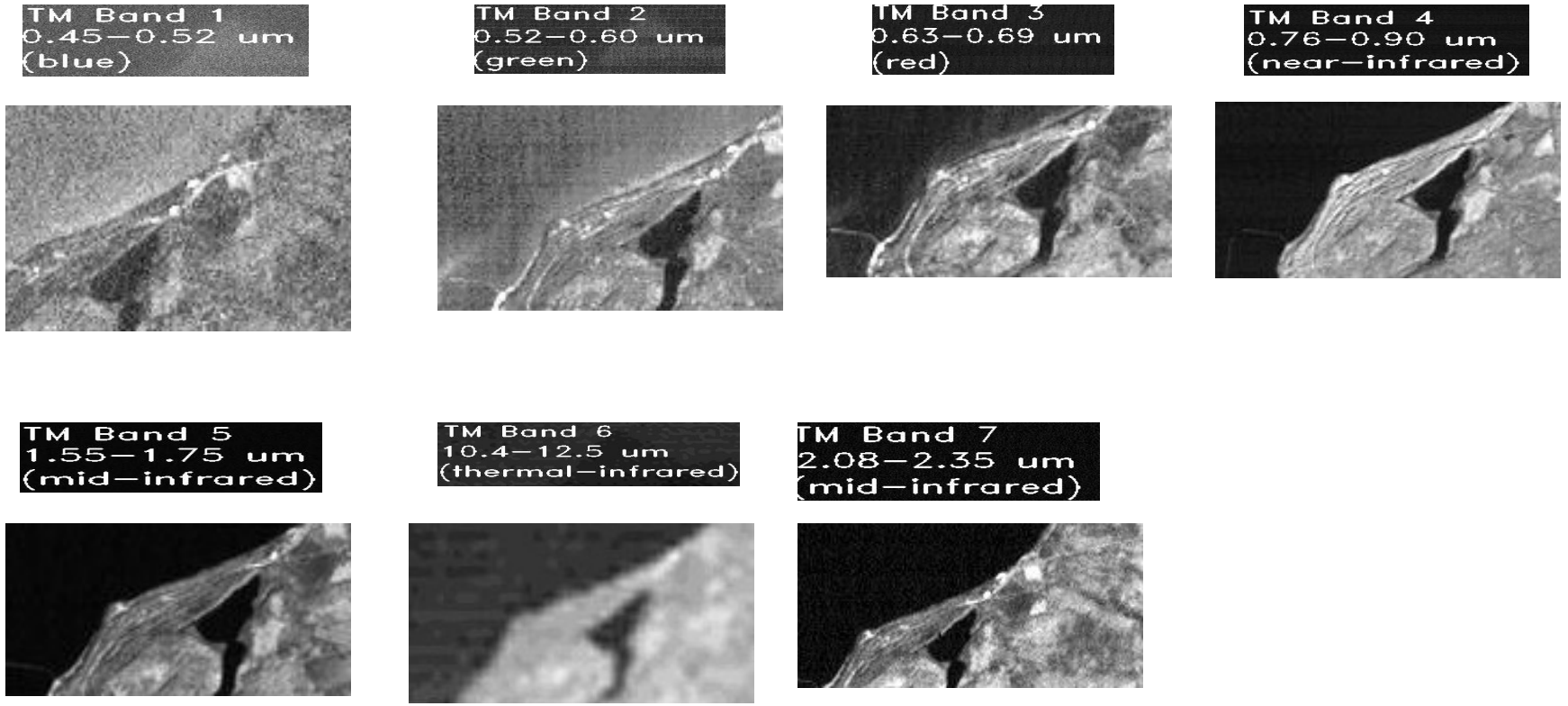
Spectral Resolution in Remote Sensing

- Different features are identified from the image by comparing their responses over different distinct spectral bands

- Broad classes, such as water and vegetation, can be easily separated using very broad wavelength ranges like visible and near-infrared

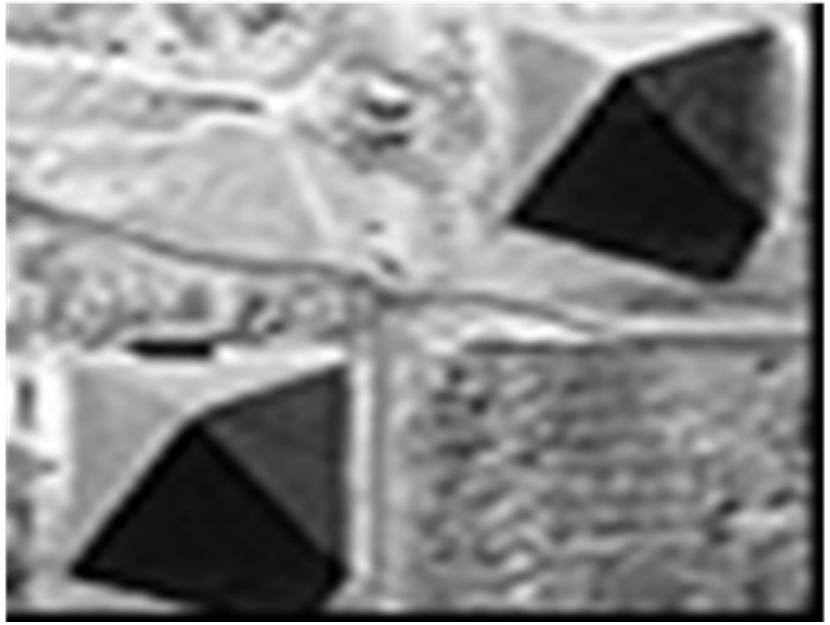
- For more specific classes viz., vegetation type, rock classification etc, much finer wavelength ranges and hence finer spectral resolution are required

Difference in the spectral responses of an area in different bands of Landsat TM image



Spectral Resolution…

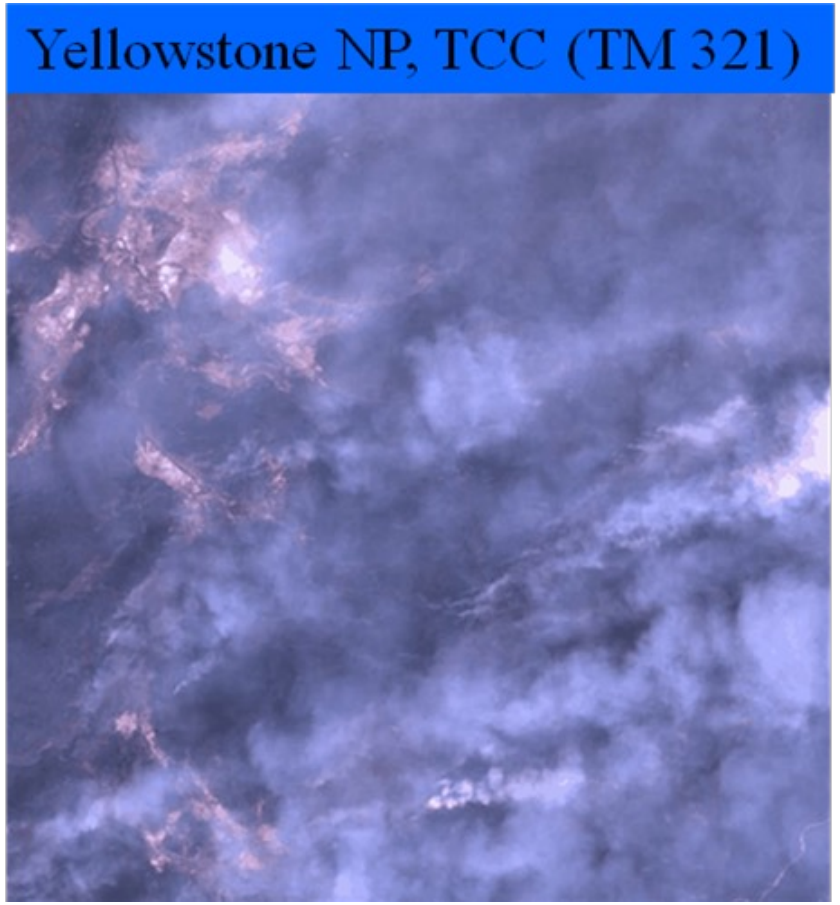
Pan Image (Course)

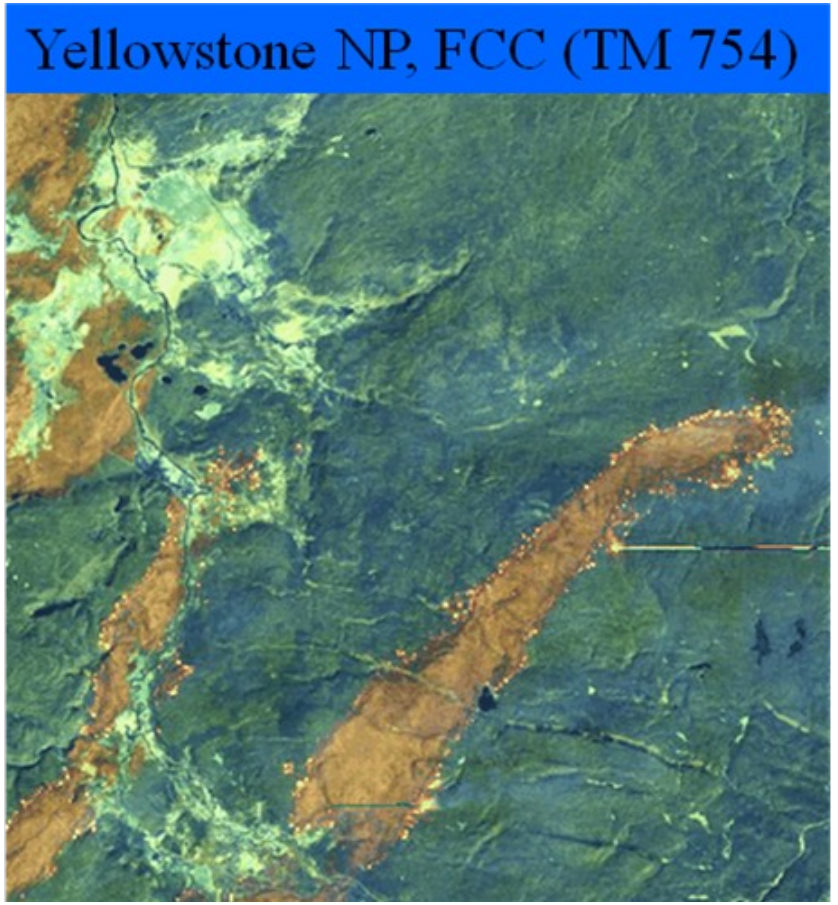


Landsat TM RGB=543 (Fine)

Spectral Resolution…

Forest Fire (Yellowstone NP)





THANK YOU