Remote Sensing Characteristics

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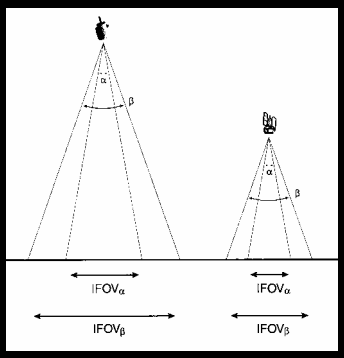
Resolutions

- Spatial Resolution
- Spectral Resolution
- Radiometric Resolution
- Temporal Resolution

Spatial Resolution

- This is a measure of the area or size of the smallest dimensions on the earth's surface over which an independent measurement can be made (pixel) by the sensor
  - Expressed by the size of the pixel on the ground in m
- A measure of size of pixel is given by the Instantaneous Field of View (IFOV), which is dependent on the altitude and the viewing angle of the sensor
  - A narrow viewing angle or a lower altitude produces a small IFOV
  - For a pushbroom system the number of detectors influences the spatial resolution
    - A system with 1,000 detectors that images a 50 km wide swath has a pixel size of 50 m whereas a system 5,000 detectors has a pixel size of 10 m

Spatial Resolution

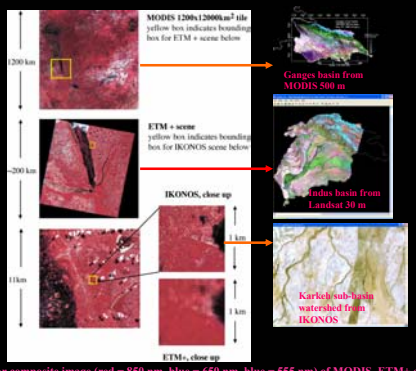


Spatial Resolution

Coarse Spatial Resolution

Fine Spatial Resolution

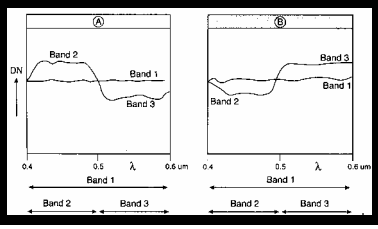
Data in a wide range of Pixel Resolutions (or scales), Radiometry, Bandwidths, and time-scales



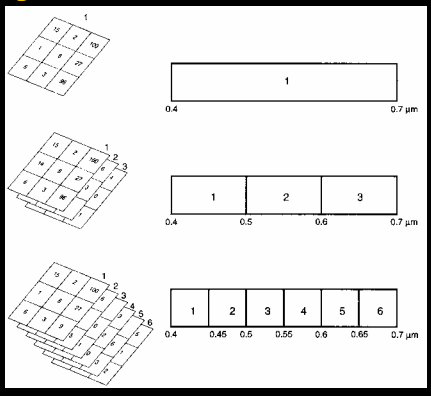
False color composite image (red = 850 nm, blue = 650 nm, blue = 555 nm) of MODIS, ETM+ and IKONOS imagery (Left image Courtesy: Morisette, 2002).

Spectral Resolution

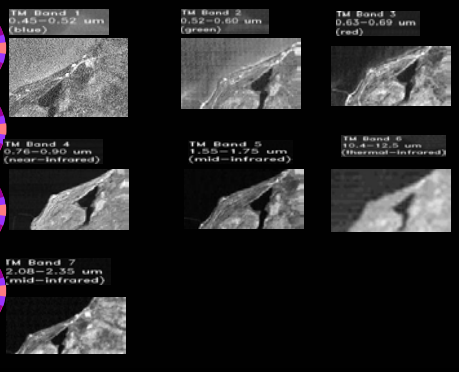
- The spectral resolution of a sensor characterizes the ability of the sensor to resolve the energy received in a spectral bandwidth to characterise different constituents of earth surface
- Spectral resolution is defined as the spectral band width of the filter and the sensitiveness of the detector
- Two different surfaces (A and B) are indistinguishable on a single band but can be differentiated in 2 bands



Spectral Resolution



Spectral Resolution (Contd..)



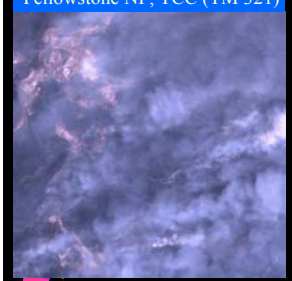
Spectral Resolution

Pan Image (Course)

Landsat TM RGB=543 (Fine)

Forest Fire (Yellowstone NP)

Yellowstone NP, TCC (TM 321)

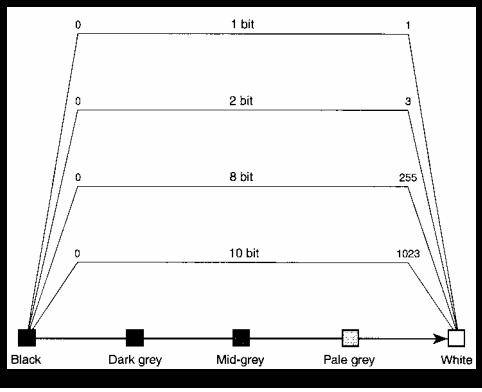


Yellowstone NP, FCC (TM 754)

Radiometric Resolution

- Radiometric resolution of a sensor is a measure of how many grey levels are measured between pure black (no reflectance) to pure white.
- Is measured in bits — Examples
  - 1 bit (2^1) – 2 levels
  - 7 bits (2^7) – 128 levels — IRS 1A & 1B
  - 8 bits (2^8) – 256 levels — Ladnsat TM
  - 11 bits (2^{11}) – 2048 levels — NOAA - AVHRR
- In a 8 bit system, black is measured as 0 and white is measured as 255.
- For comparison across bands, all the bands should have same radiometric resolution.

Radiometric Resolution



Radiometric Resolution

2 Bit Data (Coarse)

8 Bit Data (Fine)

Radiometric Resolution

- A RS system with a radiometric resolution of 6 bits assigns a DN of 28 to one surface and 47 to another. What would be the equivalent DNs for the same surfaces if the measurements were taken with a 3 bit system?
- The DNs recorded by the 3 bit system range from 0 to 7 and this range is equivalent to 0-64 for the 6 bit system
  - 0 1 2 3 4 5 6 7 (3 bit)
  - 0 9 18 27 36 45 54 63 (6 bit)

  Therefore a DN of 28 and 47 on the 6 bit system will be recorded as 3 and 5 on a 3 bit system.

Temporal Resolution

- Temporal resolution of a RS system is a measure of how often data are obtained for the same area
  - Applicable to satellite RS only
- Temporal resolution varies from less than one hour to approximately 30 days.

Importance of Temporal Resolution

- Change in Land Use/ Land Cover
- Temporal Variation
- Monitoring of a Dynamic Event
  - Cyclone
  - Flood
  - Volcano
  - Earthquake

Monitoring Mississippi Flood

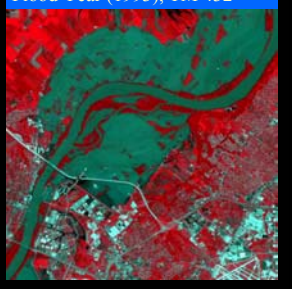
Non Flood Year (1988), TM 321

Flood Year (1993), TM 321

Monitoring Mississippi Flood

Non Flood Year (1988), TM 432

Flood Year (1993), TM 432



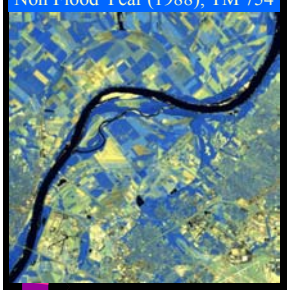
Monitoring Mississippi Flood

Non Flood Year (1988), TM 742

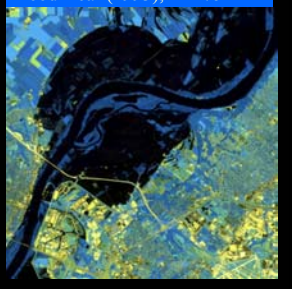
Flood Year (1993), TM 742

Monitoring Mississippi Flood

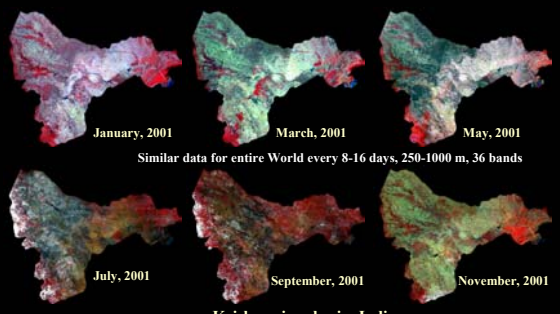
Non Flood Year (1988), TM 754



Flood Year (1993), TM 754



Continuous Streams of MODIS Data Products



Krishna river basin, India

FCC (RGB): 2,1,6 (NIR, red, MIR1)

Signal to Noise Ratio (SNR) …

- The data recorded on a sensor are composed of the signal (say reflectance) and noise from aberrations in the electronics, moving parts or defects in the scanning system (as they degrade over time)
- Increasing the spectral, spatial and radiometric resolutions of a system may decrease the SNR to such an extent that the data may not be reliable.
- SNR also depends on strength of signal available. To maintain uniform SNR, in IRS, first 3 bands have 0.1 μm band width while the 4th band has a band width of 0.3 μm.
- Dwell Time: The time for which sensor looks over the elemental area
  - *To burn a paper using a lens*

Storage Formats

- Format in which the digital data of MSS are arranged in a CCT
- BSQ – Band SeQuential. In this format information (DNs) of one band are stored line by line in an array for the entire image and then information about the second band and so on.
- BIL – In Band Interleaved by Line Format for an n-band system, the first n lines of data hold the DNs for the first line for all n bands.
- BIP – In this format, for an n-band system, the first n numbers are the DNs for the first pixel on the first line, the second set of n numbers are the DNs for the pixel 2 on line 1 and so on.
- Storage: Memory requirements
  - n-bands x no. of lines x no. of pixel per line x no. of bits per pixel