Satellite image characteristics

lecture 5

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Outlines

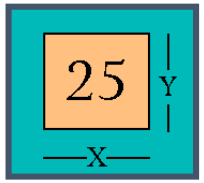
- Image characteristics (Structure)
- Resolution in Satellite images

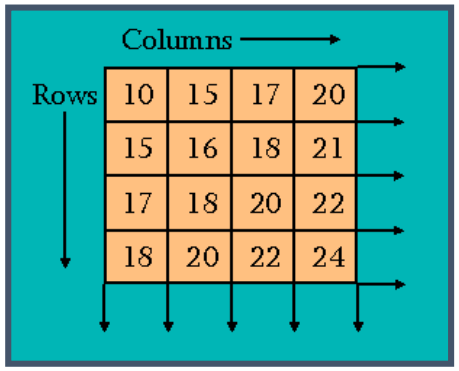
Raster Data

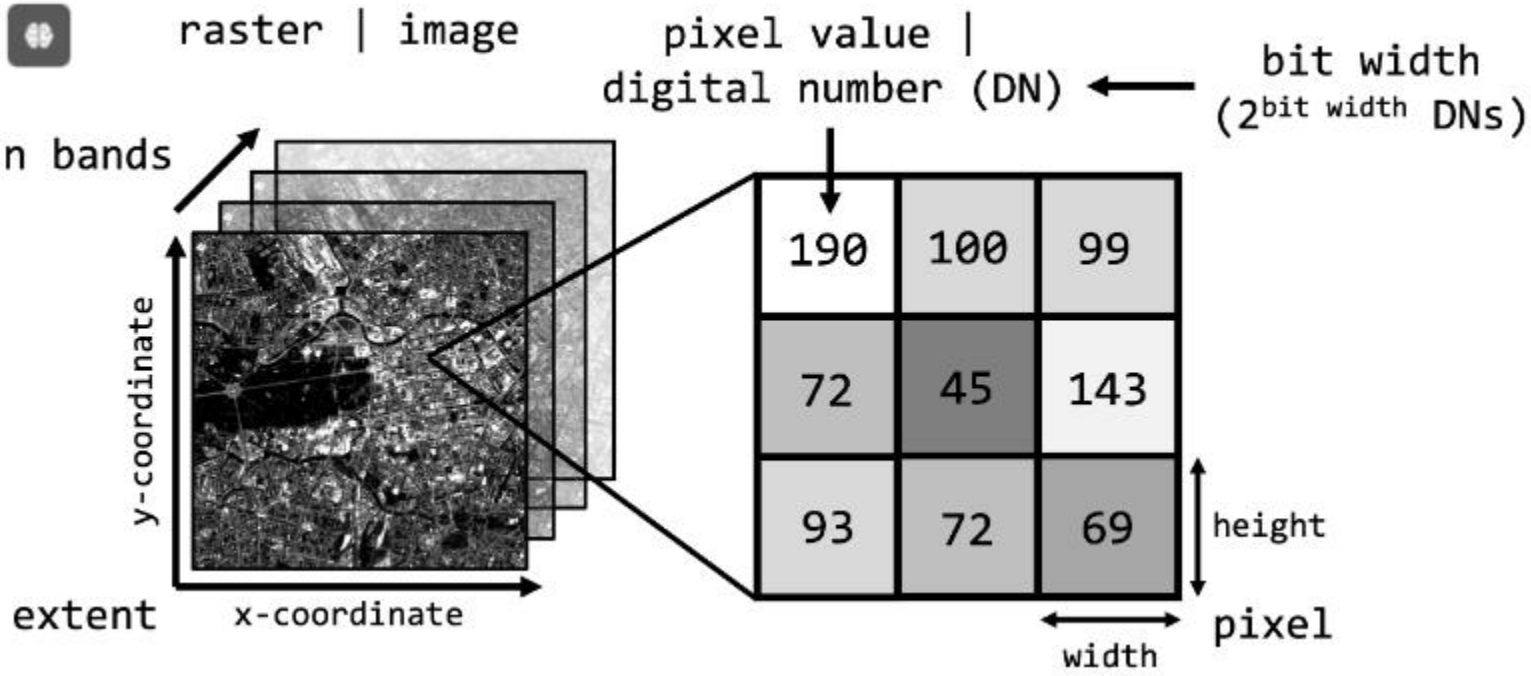
Digital images - including remote sensing imagery - are stored in Rasters.
A raster is a matrix of cells (pixels) organized into rows and columns

Pixels

- Picture elements represent a single brightness value or digital number in an image.
- Pixel has both spatial and spectral property







You are familiar with common image formats such as `.jpg` or `.png`. Generally, there are hundreds of different **image formats** (see gdal.org), most common image formats regarding digital remote sensing imagery are illustrated in the table below:

Format name	Extension	Description
GeoTIFF	.tif, .tiff, .gtiff	TIFF + geospatial reference
ENVI	, .bsq, .bil, .bip, .dat	generic, often used in imaging spectroscopy community; *Header file (.hdr) with meta data!*
JPEG2000	.jp2, .j2k	used by many data providers; usually for integer values only
HDF4, HDF5	.hdf, .h4, .hdf4, .h5, .hdf5	hierarchical data format, version 4 or 5; multi-resolution raster
netCDF		Network Common Data Format; multi-resolution raster
SAVE		Standard Archive Format for Europe e.g. Sentinel-1 and Sentinel-2

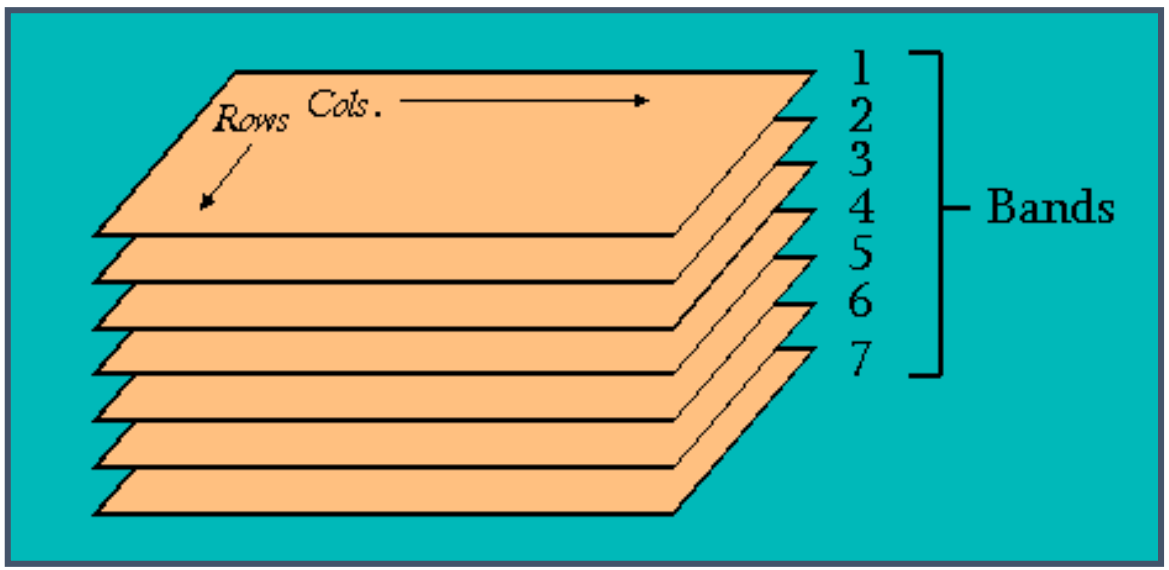
The by far most common format used is the geospatial Tagged Image File Format or **GeoTIFF**. What is important for data formats when dealing with geospatial raster data is the ability to store spatial metadata and (usually) to save the data lossless to disc, i.e. the original recorded data is not manipulated or lost due to heavy compression (e.g. `.jpg` is therefore not a suitable format for remotely sensed data).

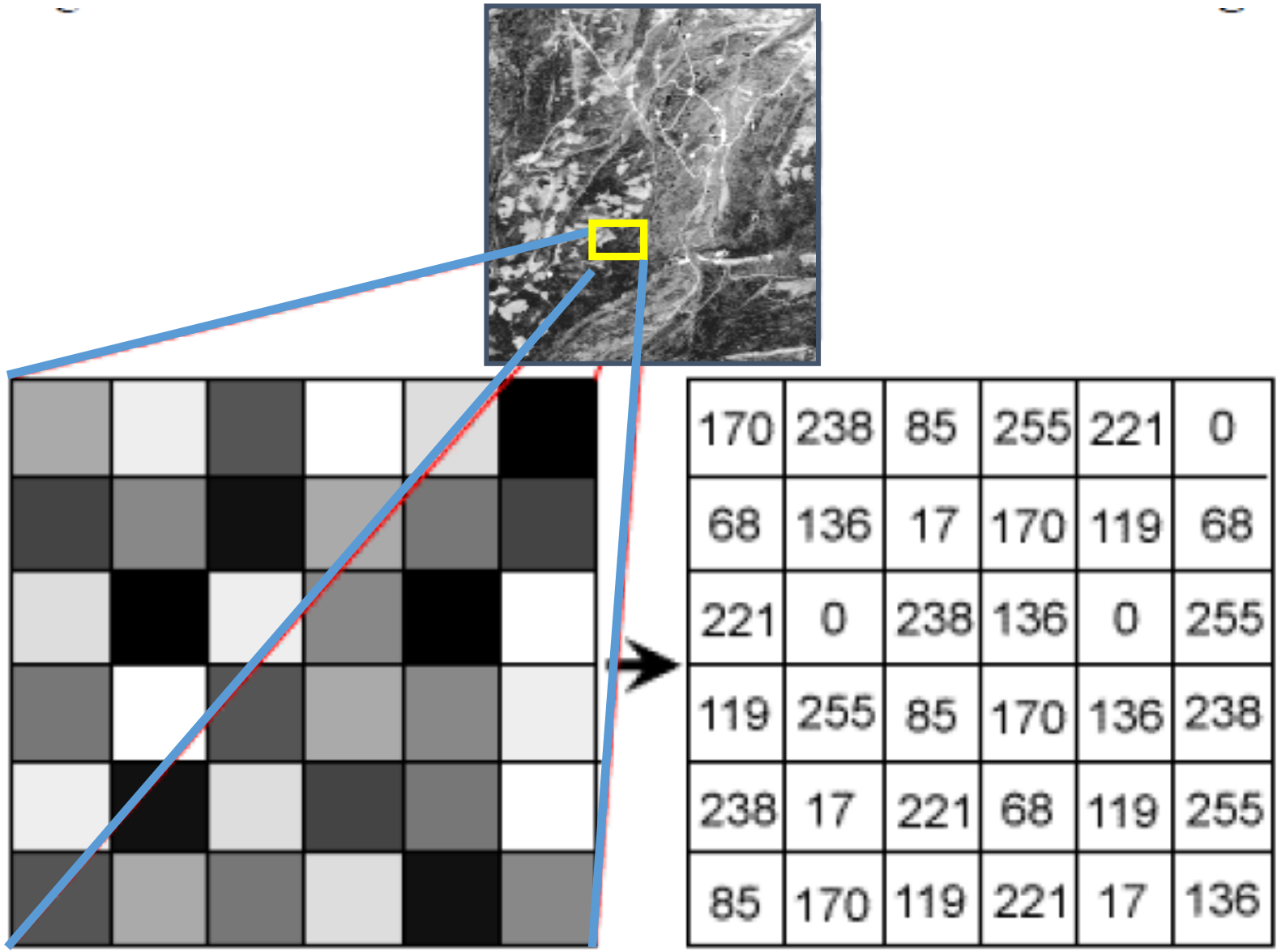
Multi-Spectral Imaging

- A multispectral image is one that captures image data from two or more ranges of frequencies along the spectrum, such as visible light and infrared energy.
- In multispectral images, the same spatial region is captured multiple times using different imaging modalities.

How can be used

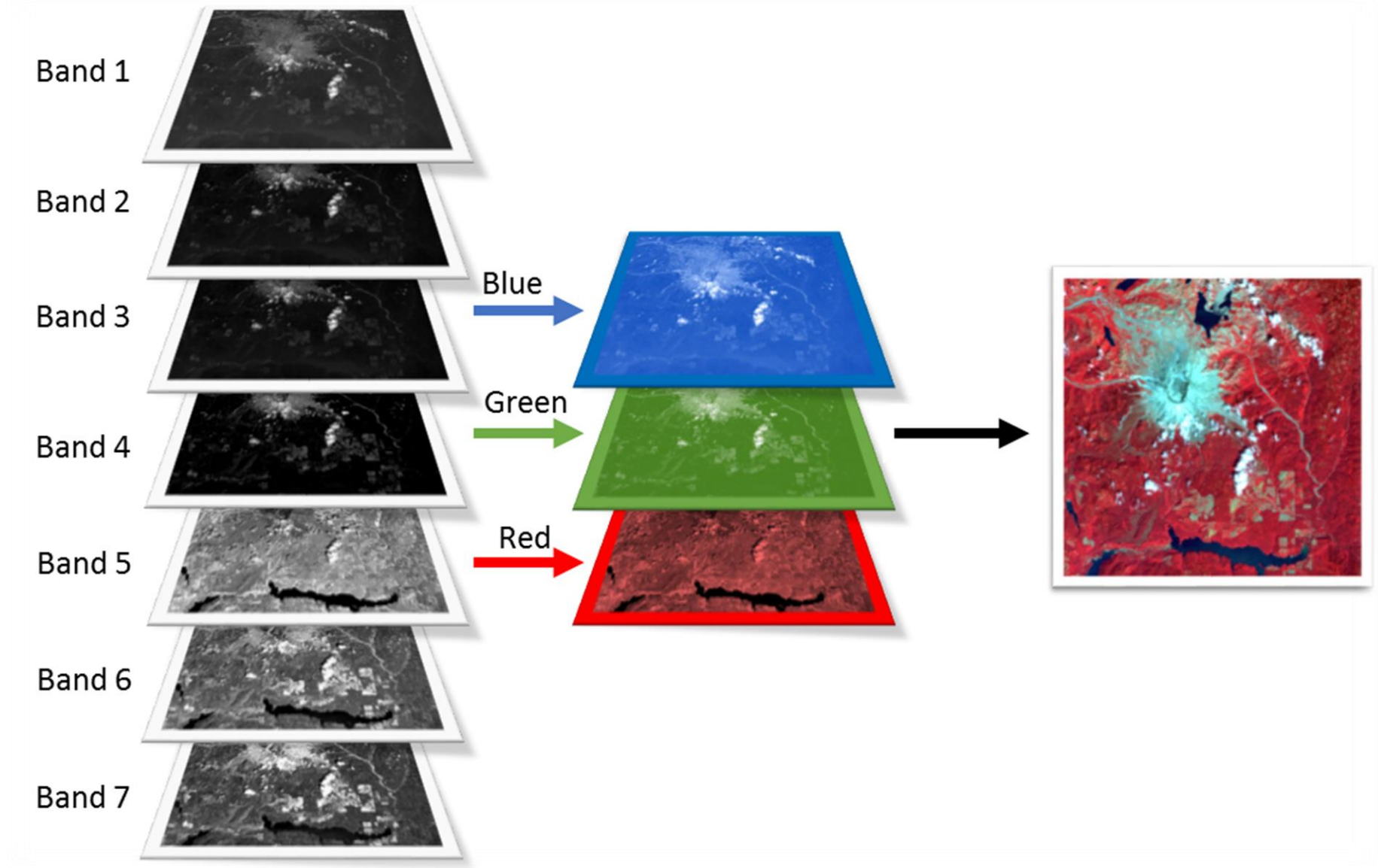
- Recording data from the visible spectrum showing an object as it is seen by the eye.
- Take images in area of spectrum infrared region (invisible).





170	238	85	255	221	0
68	136	17	170	119	68
221	0	238	136	0	255
119	255	85	170	136	238
238	17	221	68	119	255
85	170	119	221	17	136

FCC Composite دمج الألوان الكاذب



What is resolution?

In remote sensing the term resolution is used to represent the resolving power, which includes not only the capability to identify the presence of two objects, but also their properties. In qualitative terms resolution is the amount of details that can be observed in an image. Thus an image that shows finer details is said to be of finer resolution compared to the image that shows coarser details.

Types of Resolution

Four types of resolutions are defined for the remote

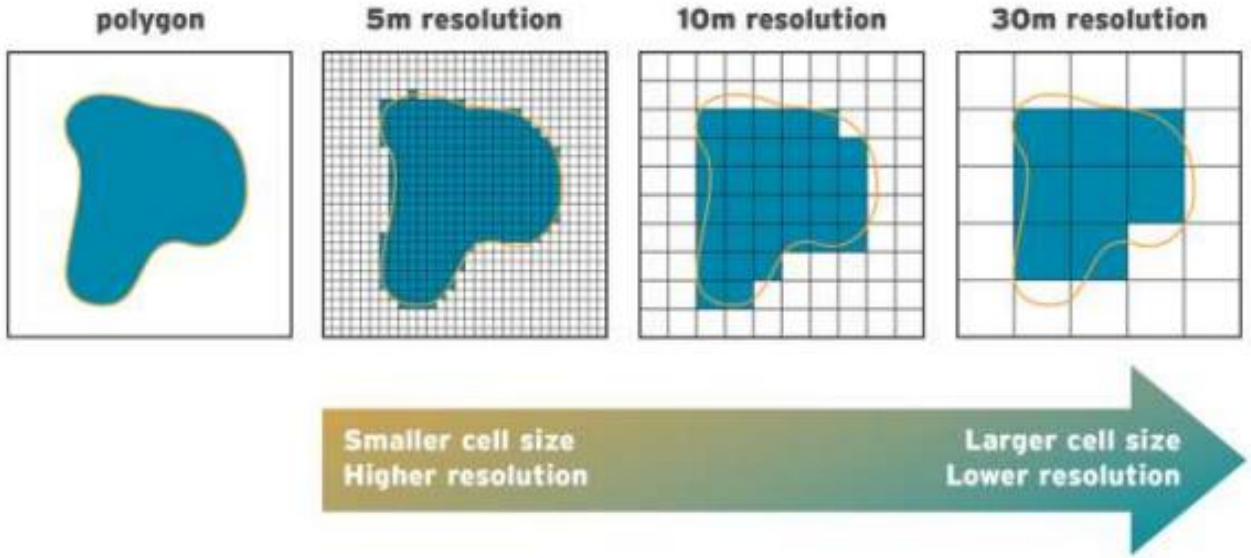
- Spatial resolution
- Spectral resolution
- Temporal resolution
- Radiometric resolution

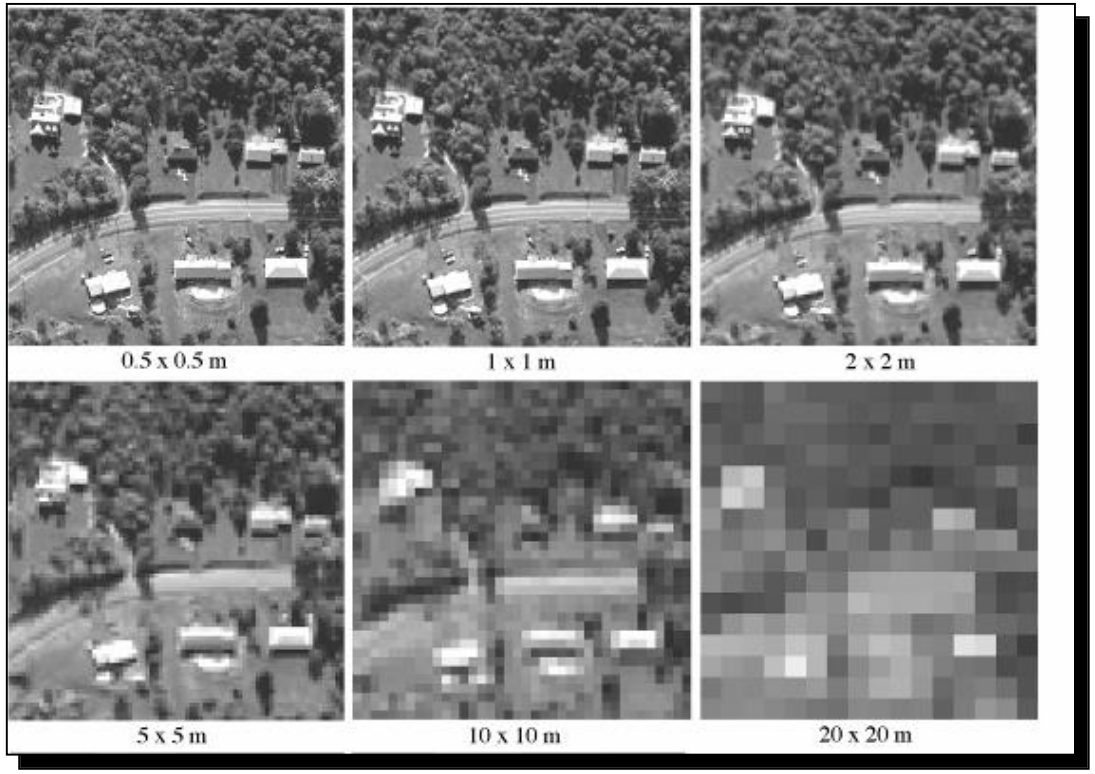
1. Spatial resolution

- A digital image consists of an array of pixels. Each pixel contains information about a small area on the land surface, which is considered as a single object. Spatial resolution is a measure of the area or size of the smallest dimension on the Earth’s surface over which an independent measurement can be made by the sensor.

Spatial Resolution

- **Spatial resolution** refers to the size of the smallest feature that can be detected by a satellite sensor or displayed in a satellite image. It is usually presented as a single value representing the length of one side of a square. For example, a spatial resolution of 250m means that one pixel represents an area 250 by 250 meters on the ground.

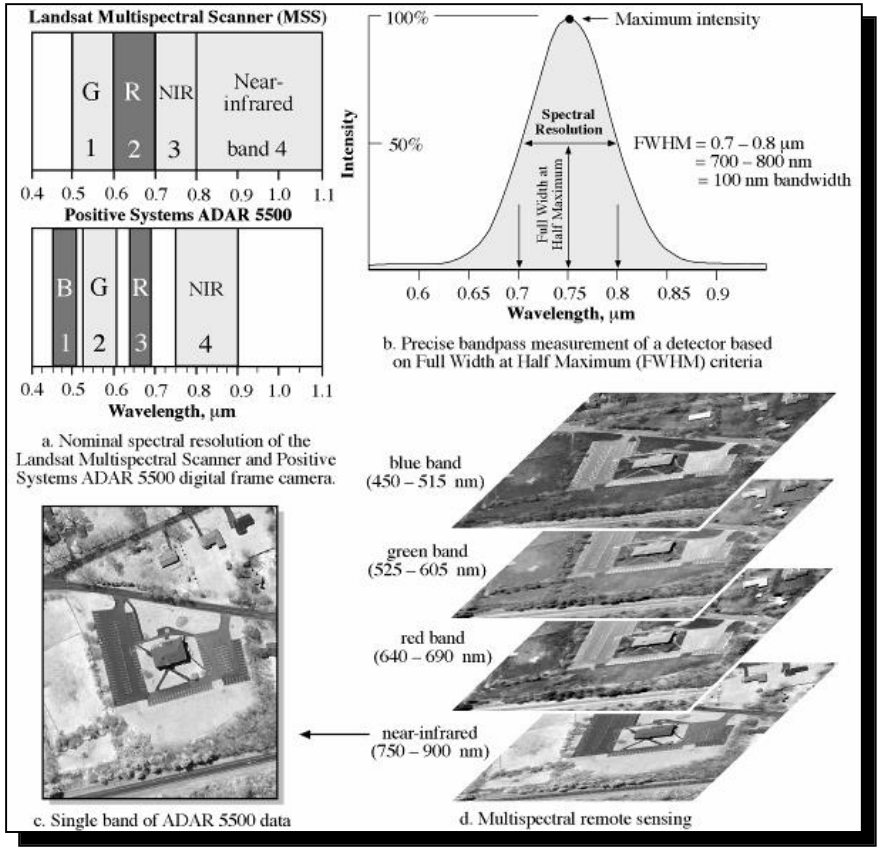


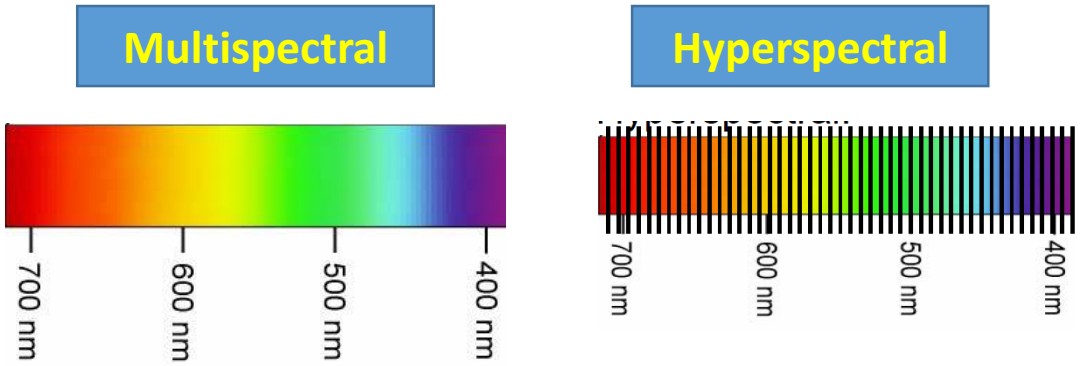


- Low resolution (>100 meter resolution)
  - MODIS, AVHRR, SPOT Vegetation
- Moderate resolution (15 – 100 meter resolution)
  - Landsat TM/ETM+, SPOT, ASTER, IRS
- High resolution (<15 meter resolution)
  - IKONOS, Quickbird, OrbViewIRS, SPOT, Corona

2. Spectral resolution

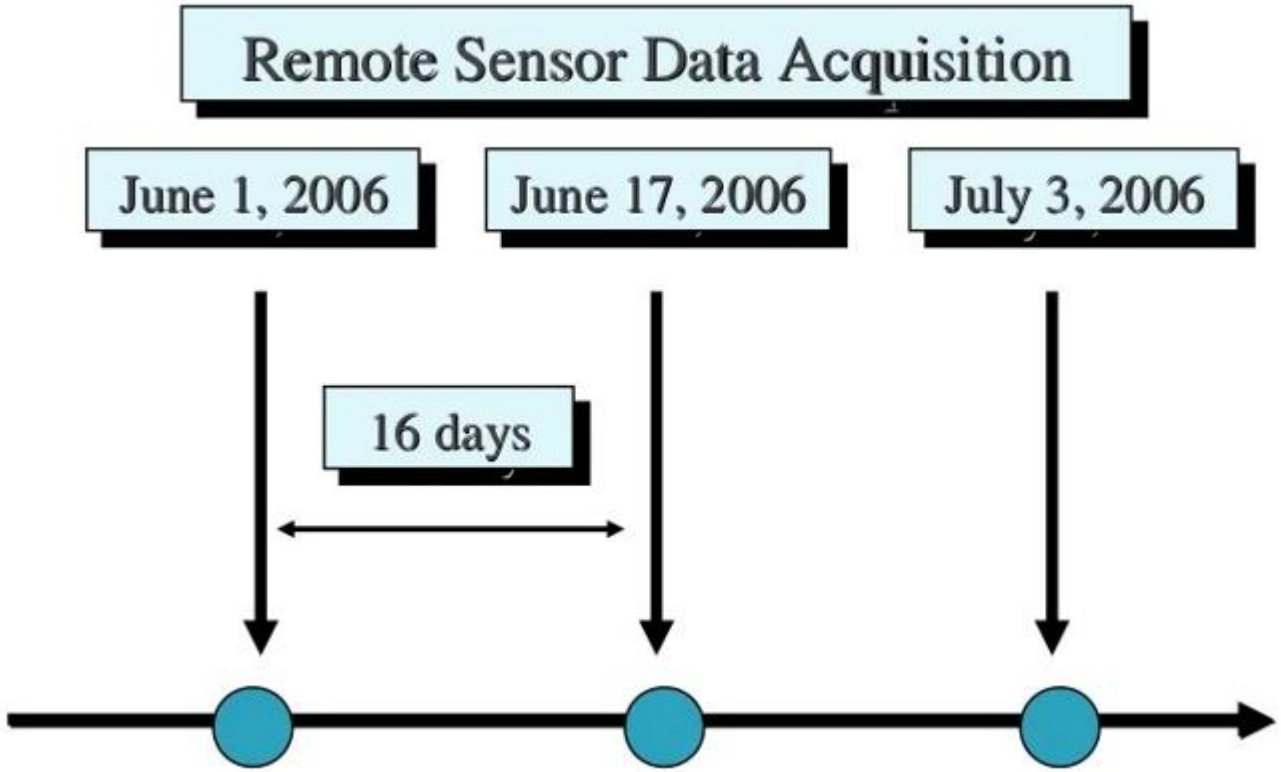
- **Spectral Resolution** refers to the ability of a satellite sensor to measure specific wavelengths of the electromagnetic spectrum.
  - The finer the spectral resolution, the narrower the wavelength range for a particular channel or band.
  - Spectral Resolution describes the ability of a sensor to define fine wavelength intervals
  - This refers to the number of bands in the spectrum in which the instrument can take measurements
  - Higher Spectral resolution = better ability to exploit differences in spectral signatures





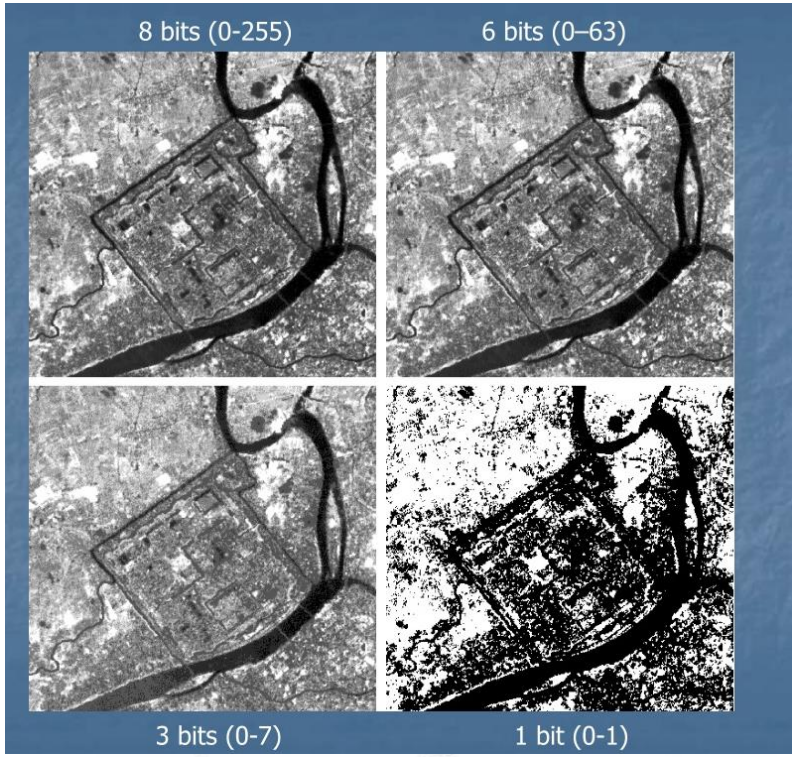
3. Temporal Resolution

- **Temporal resolution** refers to the time between images. The capability for satellites to provide images of the same geographical area more frequently has increased dramatically since the dawn of the space age.



4. Radiometric Resolution

- **Radiometric resolution** refers to the number of possible data file values in each band (indicated by the number of bits into which the recorded energy is divided).
  It is the ability of a sensor to detect differences in energy magnitude. Sensors with low radiometric resolution are able to detect only relatively large differences in the amount of energy received, sensors with high radiometric resolution are able to detect relatively small differences in the amount of energy received.



6-bit range

0 → 63

8-bit range

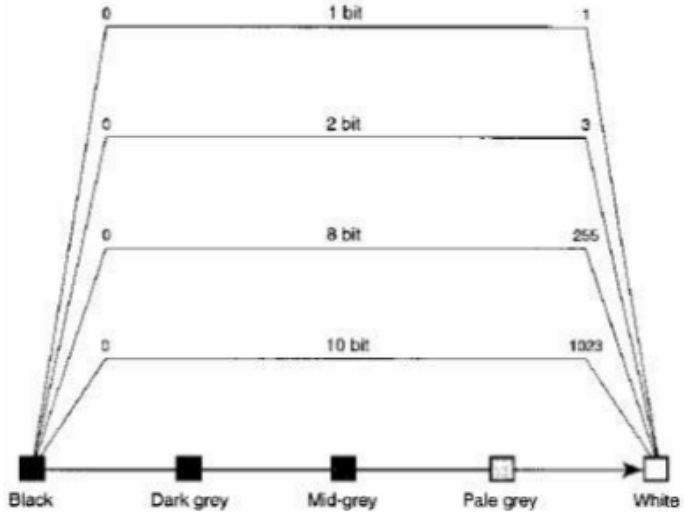
0 → 255

10-bit range

0 → 1023

8 bits ↓ 11 bits ↓

1	2	3	4	5	6	7	8	9	10	11	Number of bits
2	4	8	16	32	64	128	256	512	1024	2048	Maximum Values



- Thank you