DIGITAL IMAGE PROCESSING

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What is an Image?

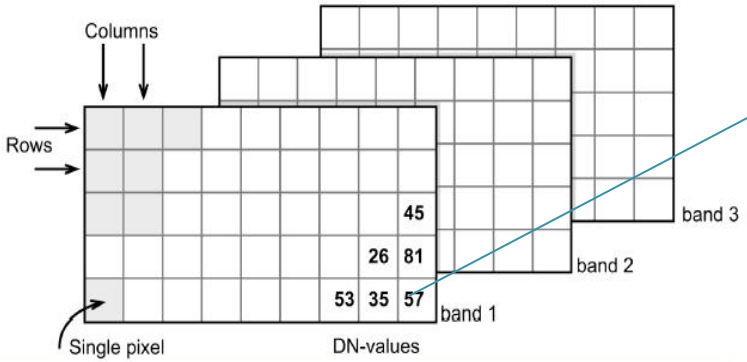
- Image is a pictorial representation of an object or a scene.
- Image can be analog or digital.

ANALOG IMAGES

A digital image is made up of square or rectangular areas called pixels. Each pixel has an associated pixel value which depends on the amount reflected energy from the ground.

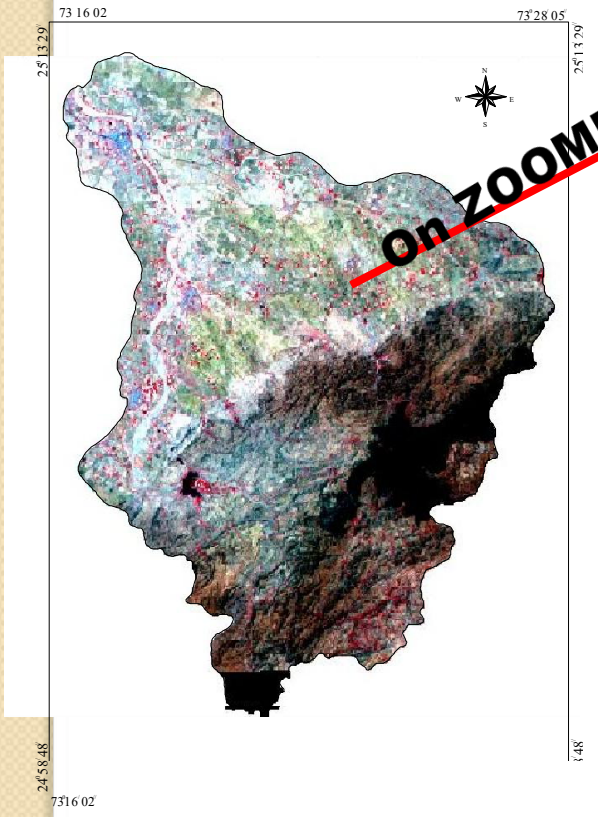
What is a Digital Image ?

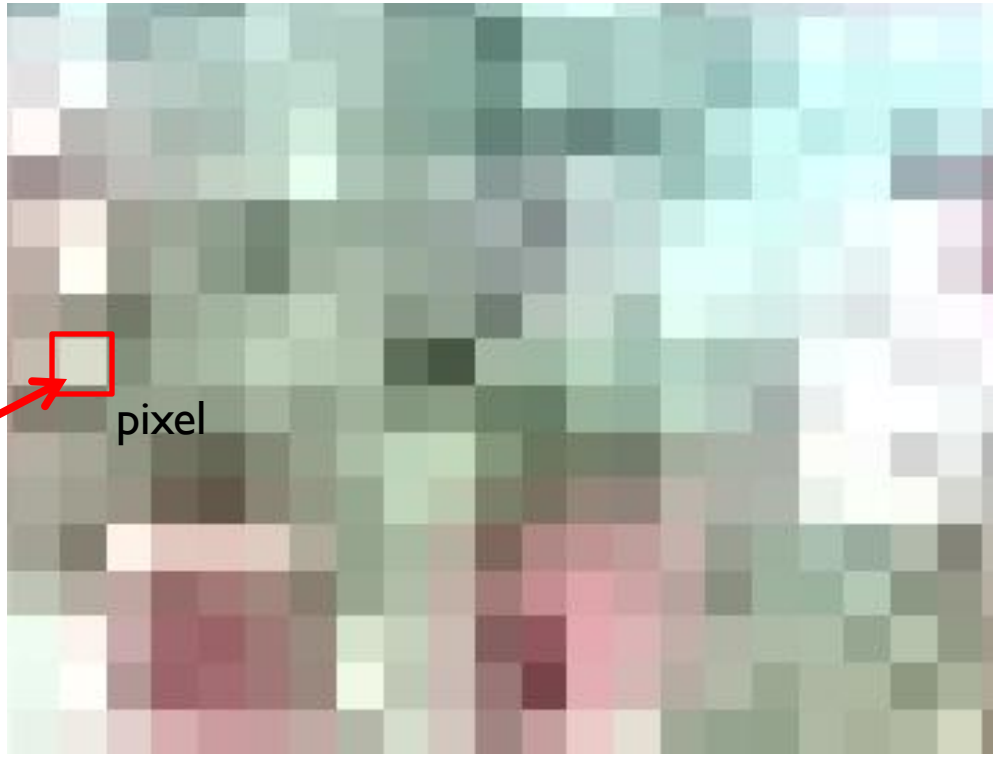
- Produced by Electro optical Sensors
- Composed of tiny equal areas, or picture elements abbreviated as pixels or pels arranged in a rectangular array
- With each pixel is associated a number known as Digital Number (DN) or Brightness value (BV) or gray level which is a record of variation in radiant energy in discrete form.
- An object reflecting more energy records a higher number for itself on the digital image and vice versa.



Digital Number/Digital values

Image file
Image architecture made up of "picture elements" PIXELS





A pixel is referred by its column, row, band number.

DIGITAL IMAGE

Digital Number

- A pixel is referred by its column, row, band number.
- In an image the energy is recorded and represented by Digital Number (DN), The DN in an image may vary from 0 to a maximum value, depending upon the number of gray levels that the system can identify i.e. the radiometric resolution.
- Thus in addition to the energy received, in a coarse resolution image (that can record less number of energy level) a lower value is assigned to the pixel compared to a fine resolution image (that can record more number of energy level)

256-2048 Brightness Levels

• 0 – Darkest, • 255/2047 - Brightest

Digital Image Processing

- Digital image processing can be defined as *the computer manipulation of digital values contained in an image for the purposes of image correction, image enhancement and feature extraction.*

- *A digital image processing system consists of computer Hardware and Image processing software necessary to analyze digital image data.*

- *Digital image processing* involves manipulation and interpretation of the digital image so as to extract maximum information form the image.
- *Utilizes the decision making capability of computers to recognize and classify pixels on the basis of their signatures*
- Image enhancement is required to enhance the display of image so that various features can be recognized and differentiated.
- The basic operations in a digital image processing system includes acquisition, storage, processing, communication and display

1. Data Acquisition/Restoration

Compensates for data errors, noise and geometric distortions introduced in the images during acquisitioning and recording i.e Preprocessing (Radiometric and Geometric)

2. Image Enhancement

- {Alters the visual impact of the image on the interpreter to improve the information content}

Image Pre-processing -WHY

- Remote sensing systems do not function perfectly. Also, the Earth's atmosphere, land, and water are complex and do not lend themselves well to being recorded by remote sensing devices that have constraints such as spatial, spectral, temporal, and radiometric resolution.
- Consequently, error creeps into the data acquisition process and can degrade the quality of the remote sensor data collected. The two most common types of error encountered in remotely sensed data are radiometric and geometric (cosmetic appearance). Hence it is important to rectify these images before starting their interpretation
- Image pre-processing is done before enhancement, manipulation, interpretation and classification of satellite images.

Image Pre-processing

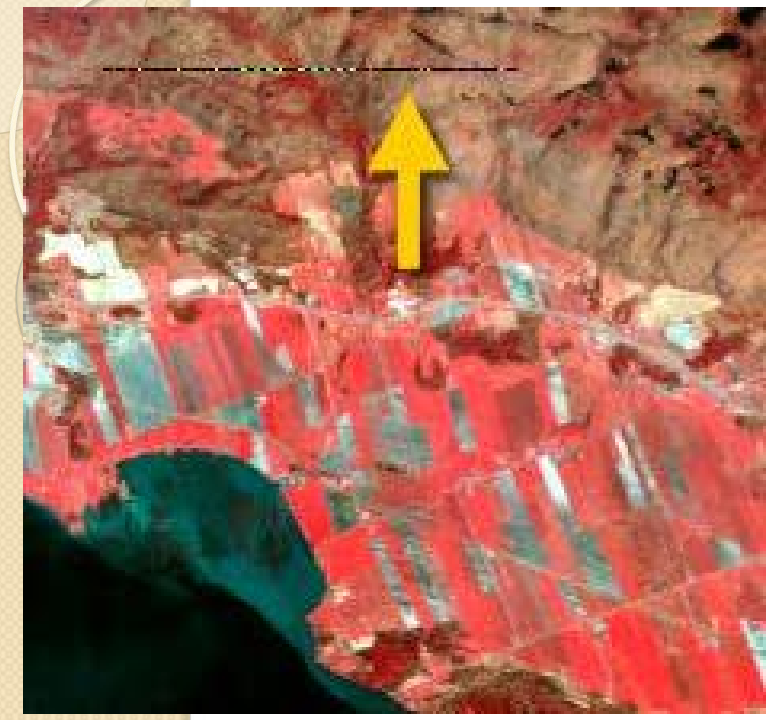
- Radiometric and geometric correction of remotely sensed data are normally referred to as pre-processing operations because they are performed prior to information extraction.
- Image pre-processing hopefully produces a corrected image that is as close as possible, both radiometrically and geometrically, to the true radiant energy and spatial characteristics of the study area at the time of data collection.
- Correct distorted or degraded image data to create a more faithful representation of the original scene (usually pre-processing operations).
- Radiometric errors affect the Digital Number (DN) stored in an image
- Geometric errors change the position of a DN value

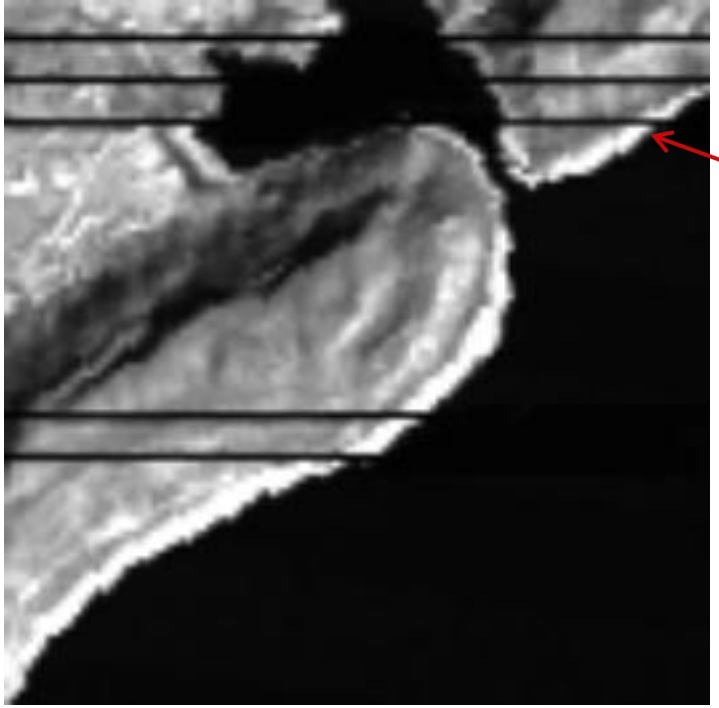
Radiometric errors- Causes

- Radiometric errors are caused by detector imbalance and atmospheric deficiencies.
- Radiometric corrections are also called as cosmetic corrections and are done to improve the visual appearance of the image.

Radiometric errors- Reasons

- Several of the more common remote sensing system–induced radiometric errors are:
- Periodic line or column drop-outs,
- line or column striping.
- random bad pixels (shot noise),
- partial line or column drop-outs

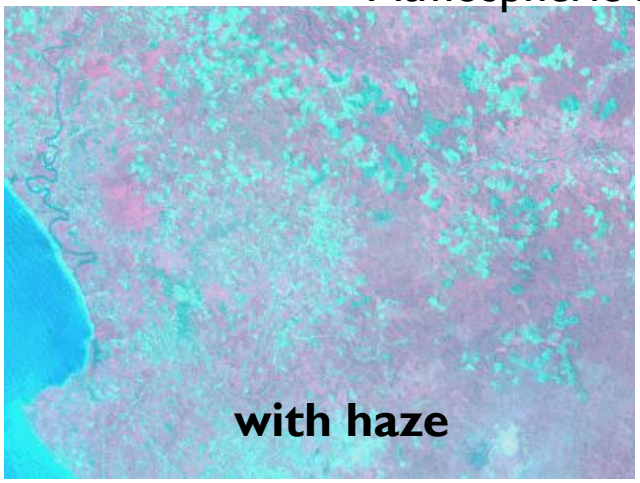




Line dropouts in image

Atmospheric Haze

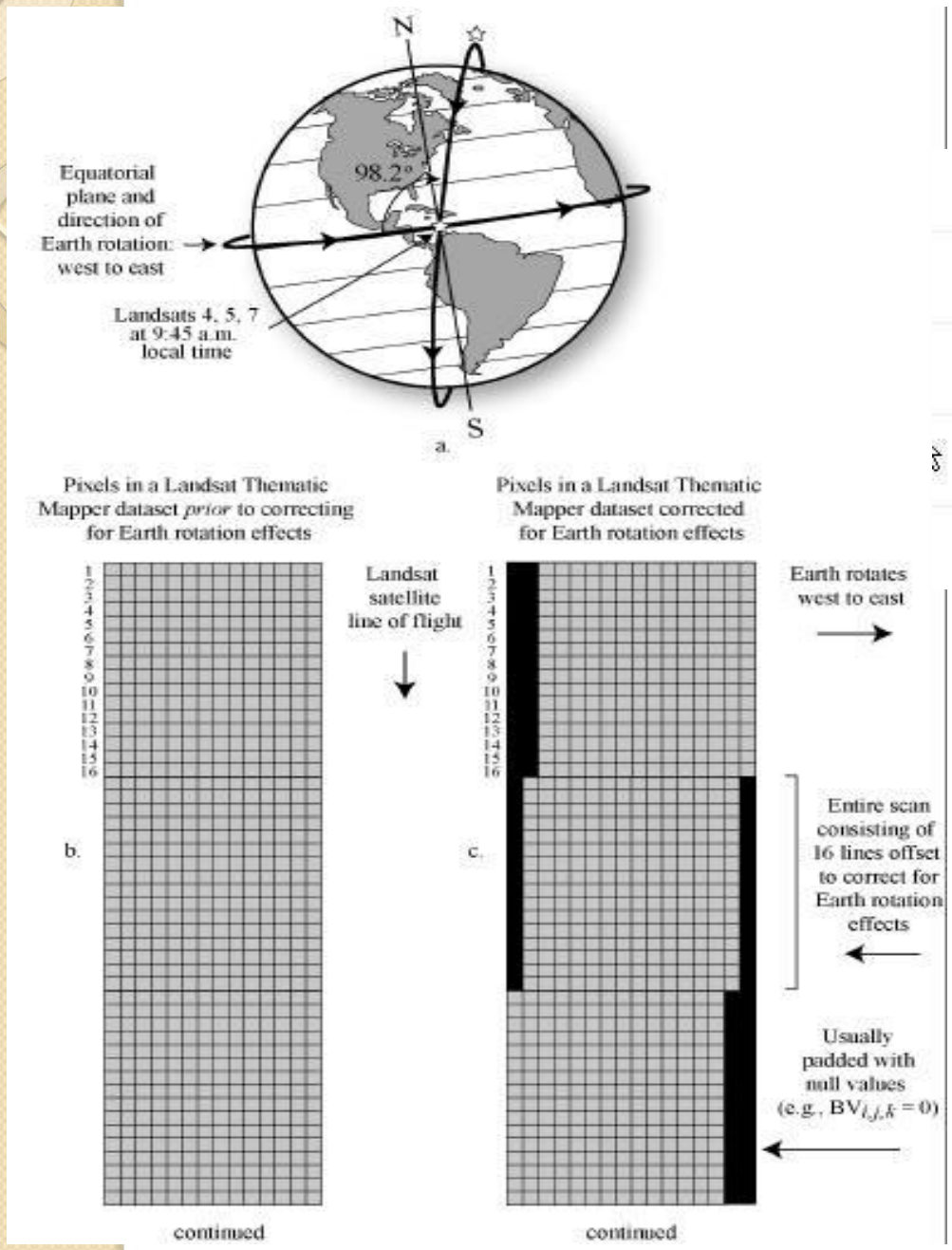
Possible cause:
– failure of a detector
– bad transmission
– storage defect
– processing defect

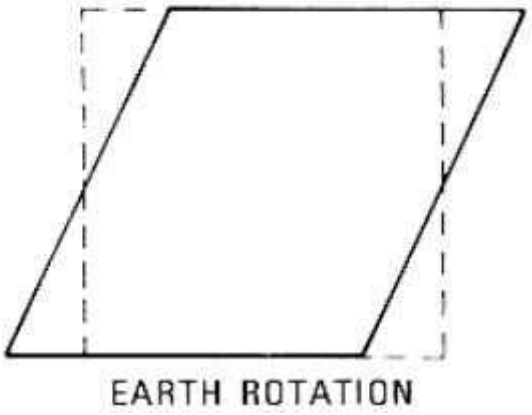


Courtesy: Minakshi,PRSD,I

Geometric Correction

- The transformation of remotely sensed images so that it has a scale and projections of a map is called geometric correction.
- It allows image to correspond to real world map coordinates
- Critical for combining imagery and GIS
- Essentially for obtaining spatially accurate products
- Image rectification is the process by which geometry of an area is made planimetric
- Whenever accurate area, direction and distance measurements are required, image rectification should be performed.

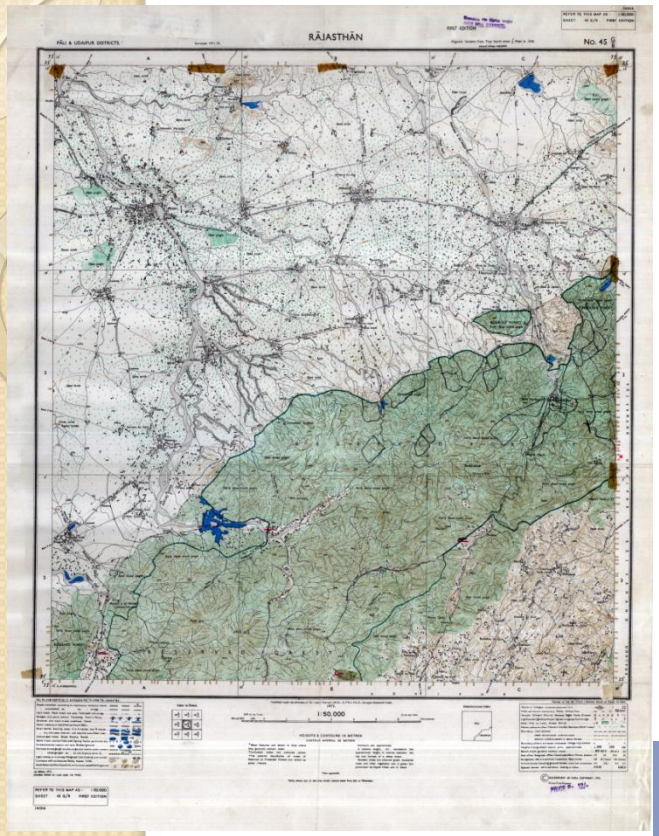




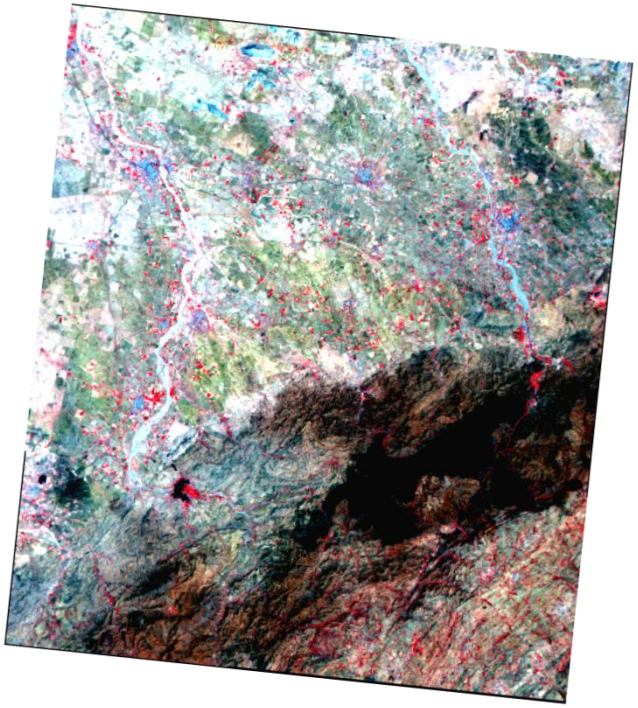
Dashed line indicate shape of distorted image

Solid line indicates restored image

- Ground control points (known landmarks e.g., cross roads, railways)
- The true ground coordinates (Lat/ long) are taken from toposheets, maps etc.
- Using GIS software's the distorted geometry of an acquired image is matched with known points (Lat/long) of image.
- This rectification process is also known as Georeferencing because it fits the original coordinates of Earth with image

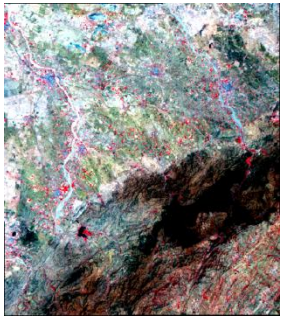


Toposheet of pali area, Rajasthan



IRS LISS III image of same area, Unrectified –with geometric distortion

AFTER PROCESESSING using GCPs (Ground control points) from toposheet – Image is rectified/georefrenced i.e, image now will have the same lat/long of toposheets



Major Commercial Digital Image Processing Systems

- ERDAS IMAGINE
- ENVI
- IDRISI
- ER Mapper
- PCI Geomatica
- eCognition
- MATLAB
- Intergraph