Spatial Modelling and Analysis

Lecture 3
Raster Type and Compression Technique

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PNG University of Technology - 2022

Lecture Outline

1. Raster data type

2. Satellite Imagery Introduction

3. Digital Aerial photographs

4. Digital Elevation Model (DEM)

5. Binary Scanned Files

6. Raster Data Compression Technique in GIS

7. References

1. Raster data type

Raster data are classified into various :

1. Satellite Imagery (Lansat and SPOT, Quick bird, Geoeye)
2. Digital aerial photographs (from drone, Plane and Helicopter)
3. Digital Elevation Model
4. Scanned Maps
5. Digital Graphics Files,
6. NETCDF Files (Satellite data)

1.2. Raster type

Firstly to understand type of raster in common:

1. <u>Image Raster</u>

 - Satellite images
- Aerial/Air Images
- Scan raster

2. <u>Thematic Raster</u>

Contains map data:

- LULC,
- Temperature,
- Rainfall,
- Soil

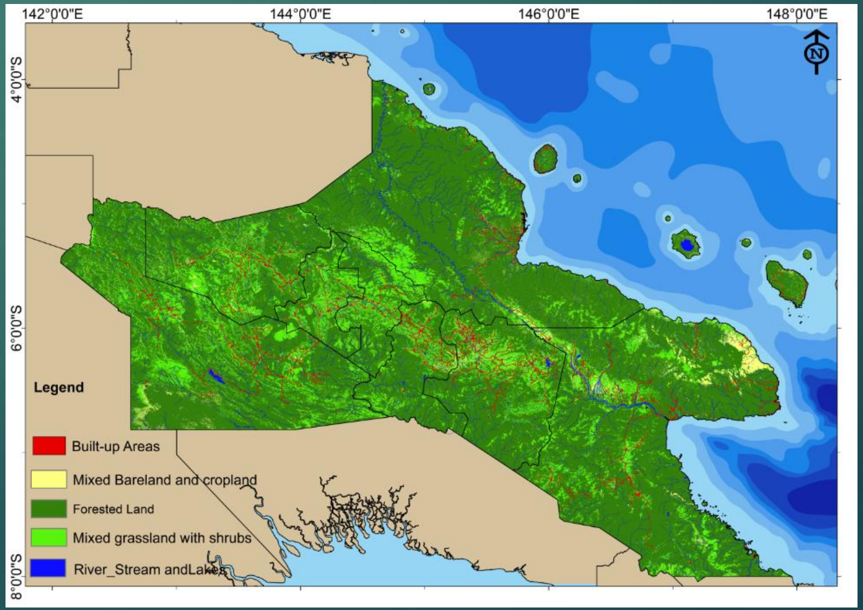


Image Source: T.Sekac (2022)

2. Satellite Imagery Introduction

The satellite data are captured and Recorded in raster format.

The pixel value in the satellite image Captured denotes and Represents of ground feature entities/objects.

The pixel values in the satellite image are the representation of the EMR that are reflected or emitted from the earth surface.

During image processing system, Many raster products can be prepared And classified including creating vector data from it like:

- LULC,
- NDVI/Indices preparation.
- High Resolution satellite image for Feature digitize and geodatabase creation.
- Other…

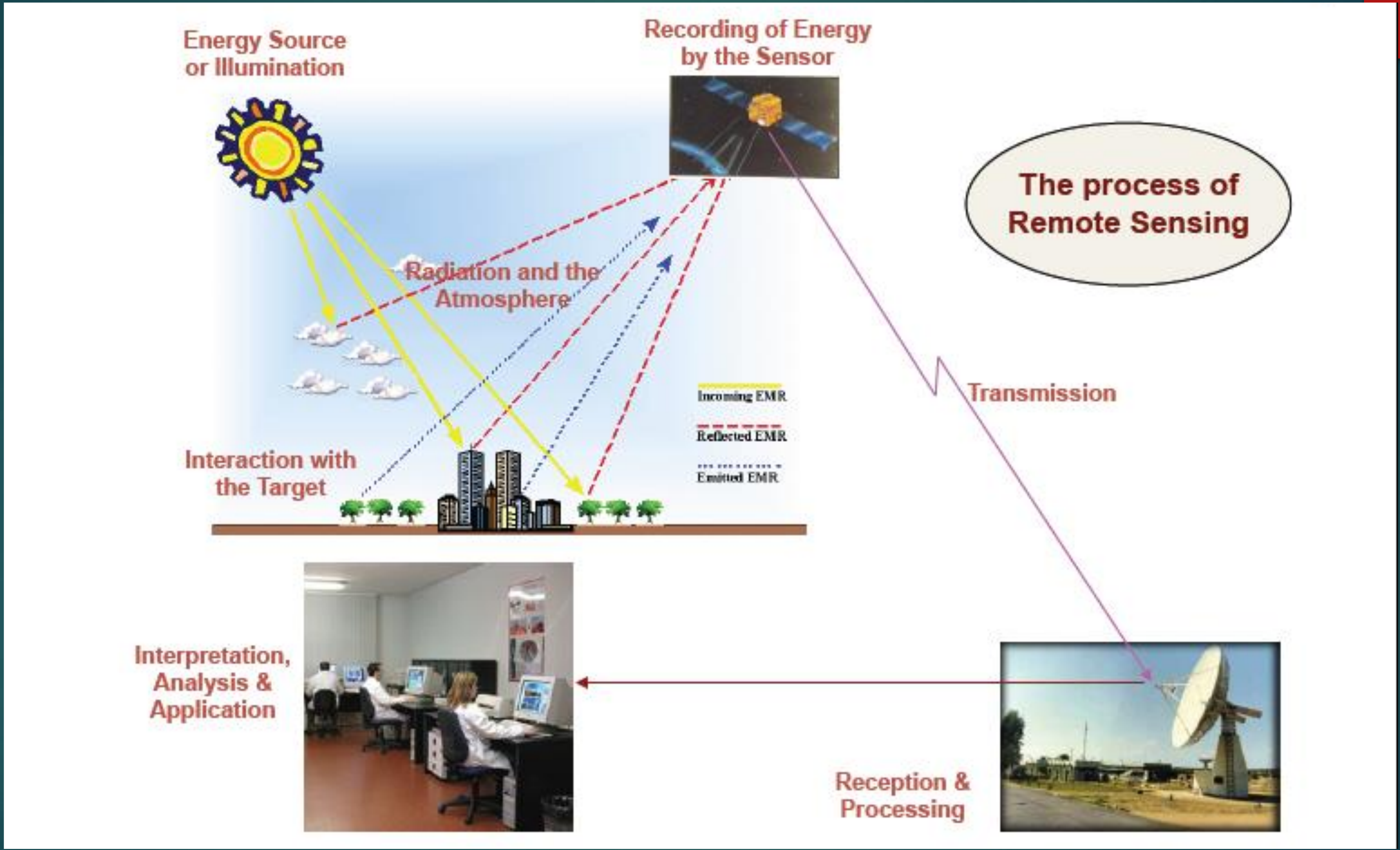
2.1. Satellite Imagery Resolution Type

Satellite Imagery can be Both High Resolution, and Medium to Low Resolution.

The Resolution can be in terms of:

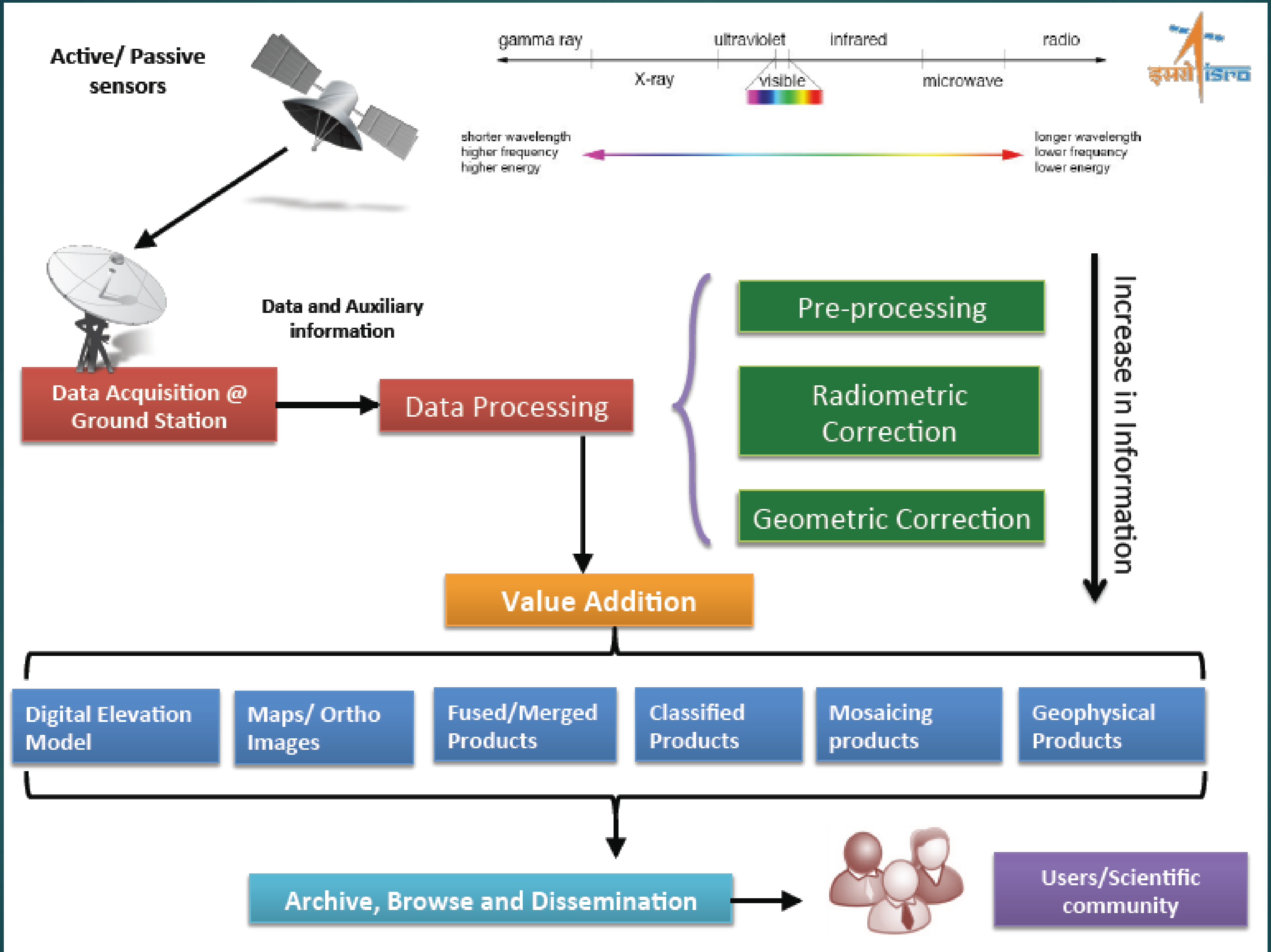
- Spectral Resolution
- Spatial Resolution
- Rediometric Resolution
- Temporal Resolution

2.2. Principle of Satellite Image Sensing



Source: RSBDAM_18,ISI,Kolkata,24-01-2018

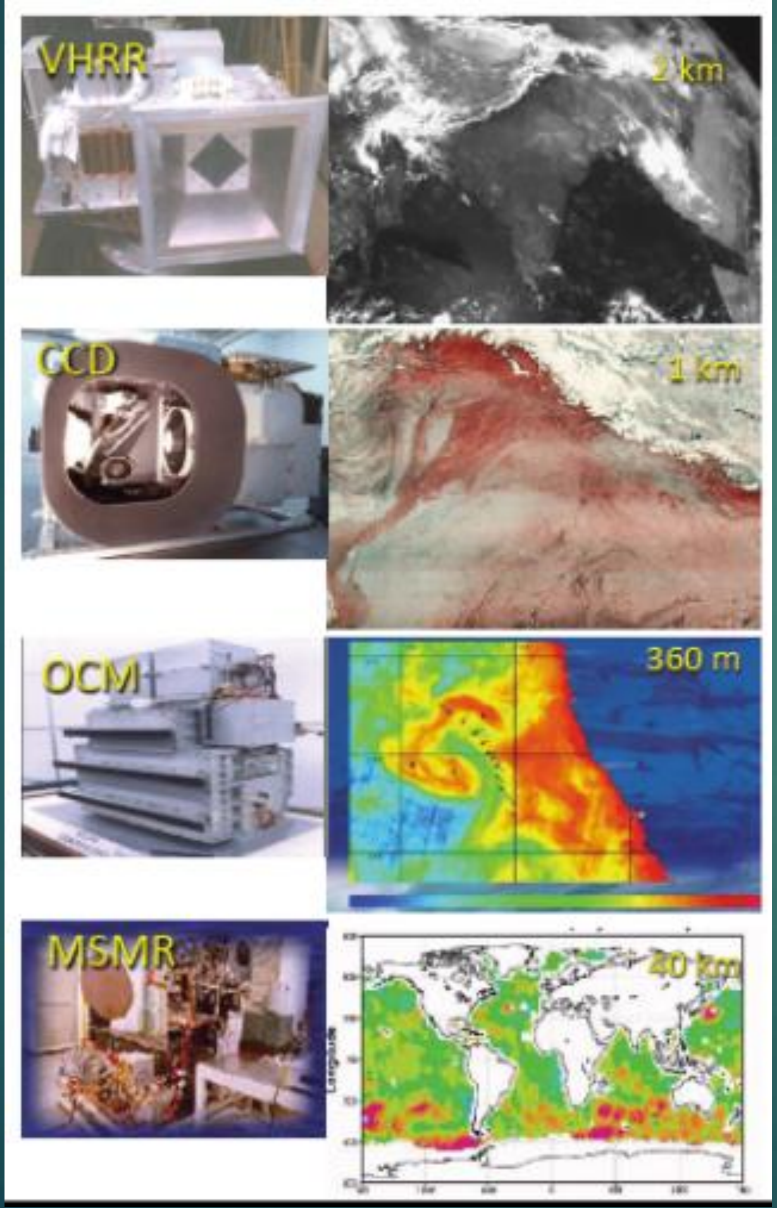
2.3. Principle of Satellite Image Sensing



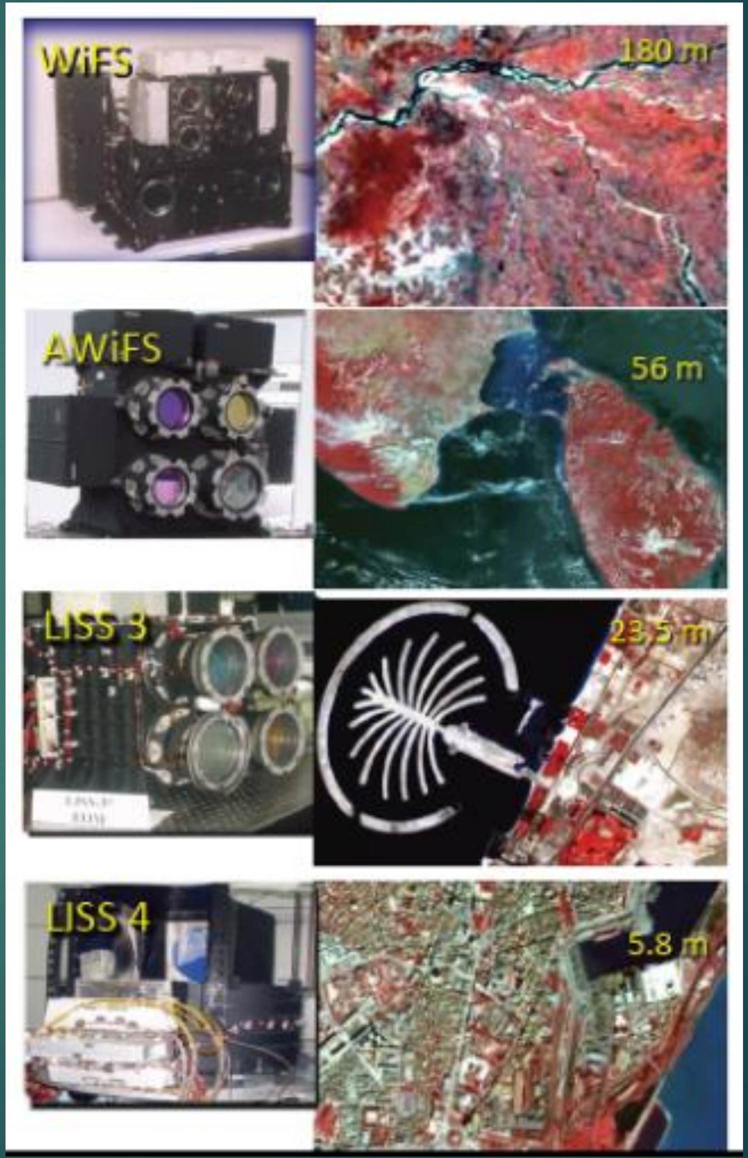
Source: RSBDAM_18,ISI,Kolkata,24-01-2018

2.4. Imaging Sensors for Earth Observation

Atmosphere and Ocean

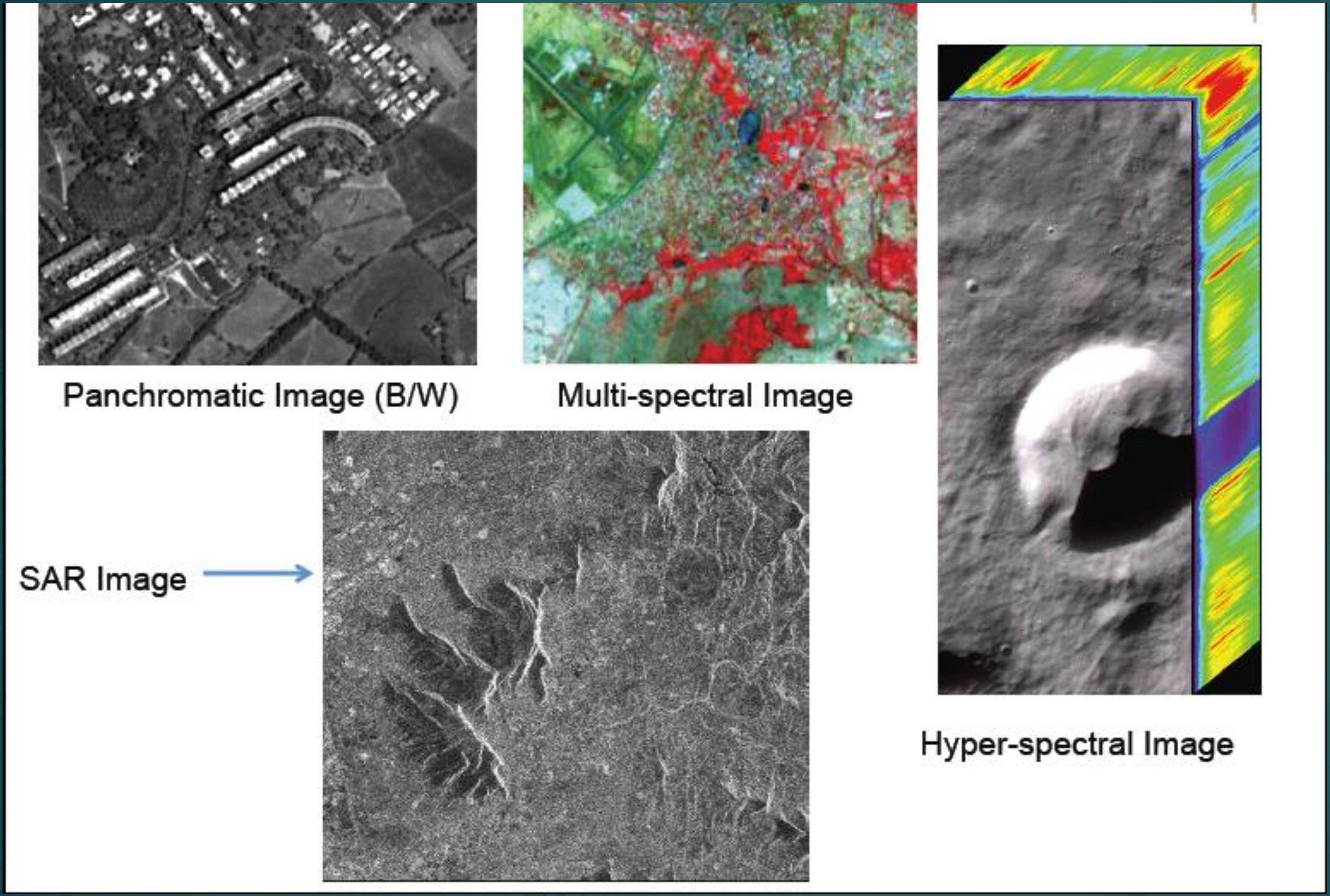


Land and Water



Source: RSBDAM_18,ISI,Kolkata,24-01-2018

2.5. Types of Satellite Image in terms of Spectral



Hyperspectral Image Has High Spectral Resolution

Compared to multi-Spectral Image

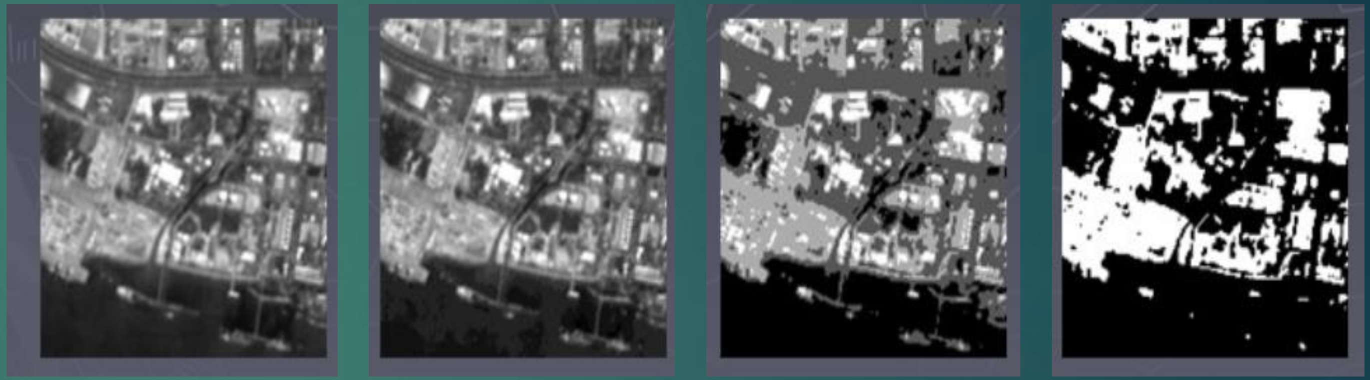
Source: RSBDAM_18,ISI,Kolkata,24-01-2018

2.6. Radiometric Resolution

- The sensitivity of a detector to

Differences in signal strength as it records the radiant flux reflected or emitted from the earth surface

- Common DN ranges are 0-255 (8-bit) and 0-1023 (10-bit)



8 bits (0-255) 4 bits (0–63) 2 bits (0-7) 1 bit (0-1)

Wells, 2021

2.7. High Spatial Resolution Satellite Image

Quick bird Satellite Image of academic Buildings
At PNG UNITECH – captured 2017
3 meter spatial resolution

Birdview Satellite Image of Part of Port Morseby City
captured 2010 – 20 cm spatial resolution

3. Digital Aerial photographs

Drone Image

Kangarua Village in Finchhafen Disctrict
3 cm spatial resolution

Digital Orthophotos - LiDaR

Sir Ignatius Kilage Stadium,Lae, Morobe Province
20 cm spatial resolution

Image Source: T.Sekac (2022)

3.1. Digital Aerial photographs

Aerial photography is a type of photography in which image is captured from distance, from **in the air**.

Aerial photograps are used in many filed, for example such as:

military reconnaissance,
geology,
agriculture,
and more.

Different means of technology such as;
- drones,
- helicopters,
- airplanes.

are used.

When we Say orthorphograph:

Instead of just an ordinary image, orthophotography **gives it real-world coordinates** by stretching, scaling, and skewing it into physical space.

Source: GISGeography, 2022

4. Digital Elevation Model (DEM)

Each pixel value contains altitude information

From DEM, different products are generated example:

- Watershed
- Stream line
- Slope
- Hillshade
- Etc…

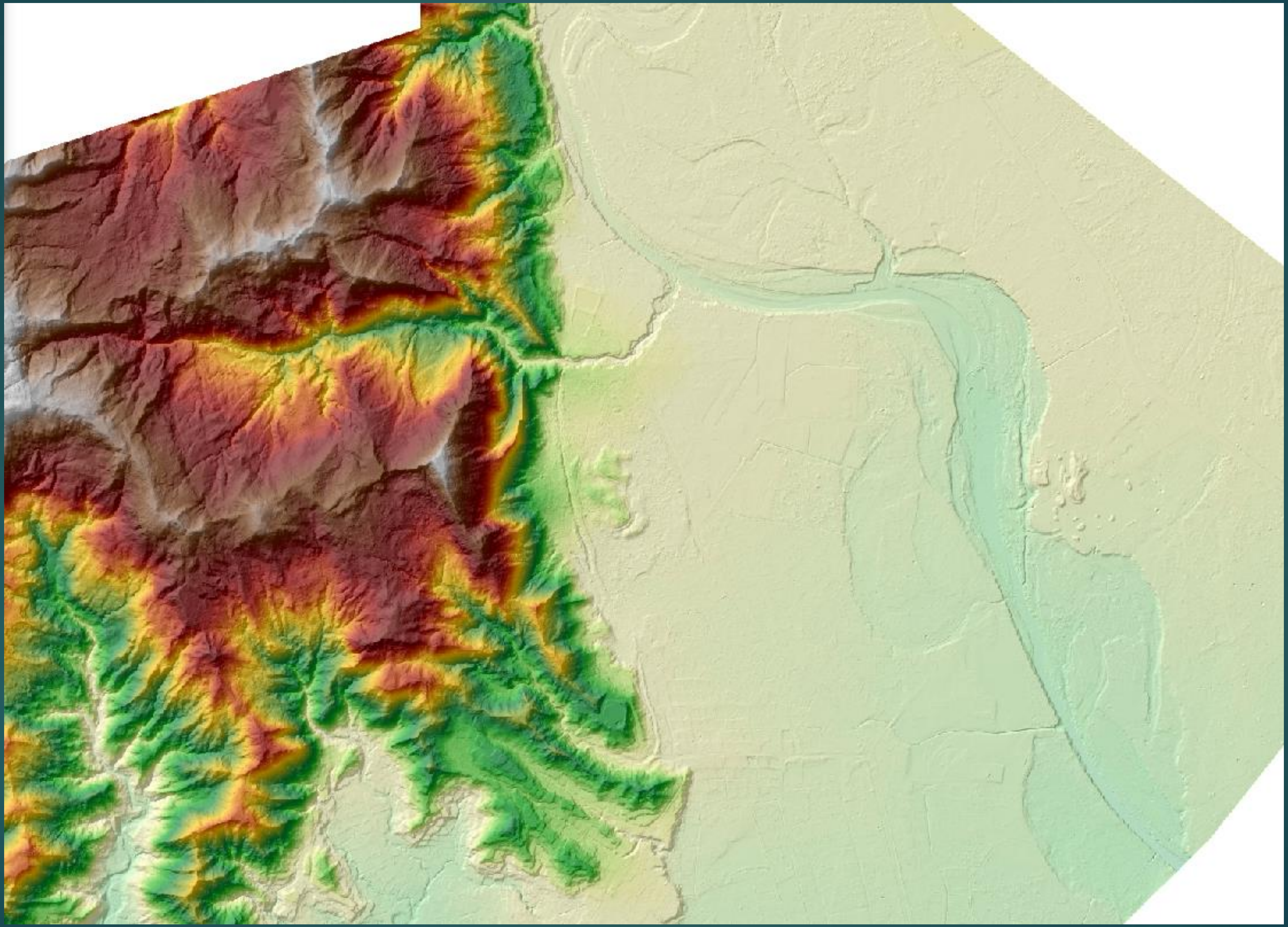
Different ways DEM are produce:

DEM is produce from a stereo plotter with overlapping aerial phograph zones

From many research centers, SRTM DEM are produce

DTM, DSM from Areal platform like Drone and Helichopter (LiDaR)

4.1. LiDaR DTM

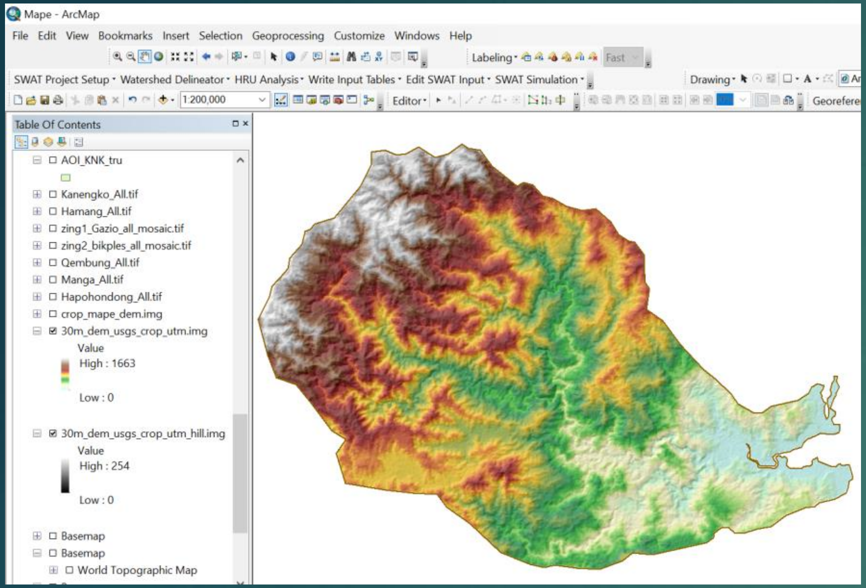


3-D detail of the Bumbu river, Lae city, from LIDAR.

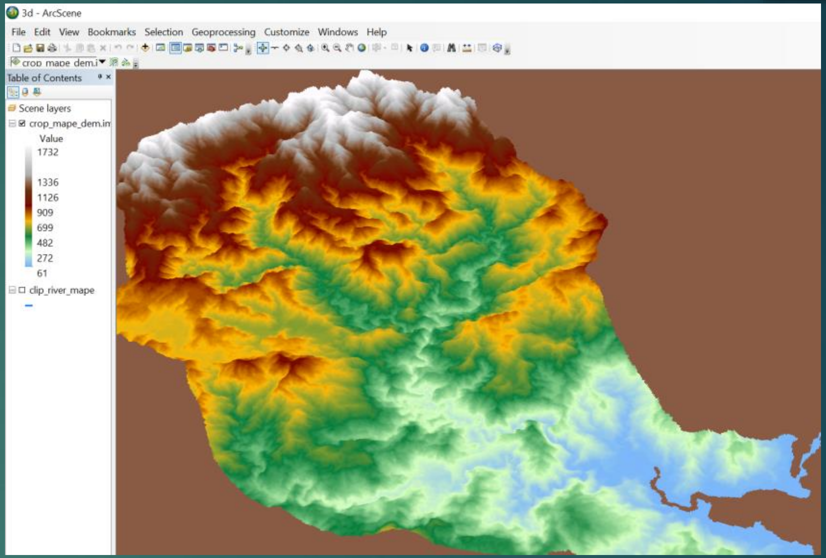
Image Source: T.Sekac (2022)

4.2. SRTM (DEM) Product

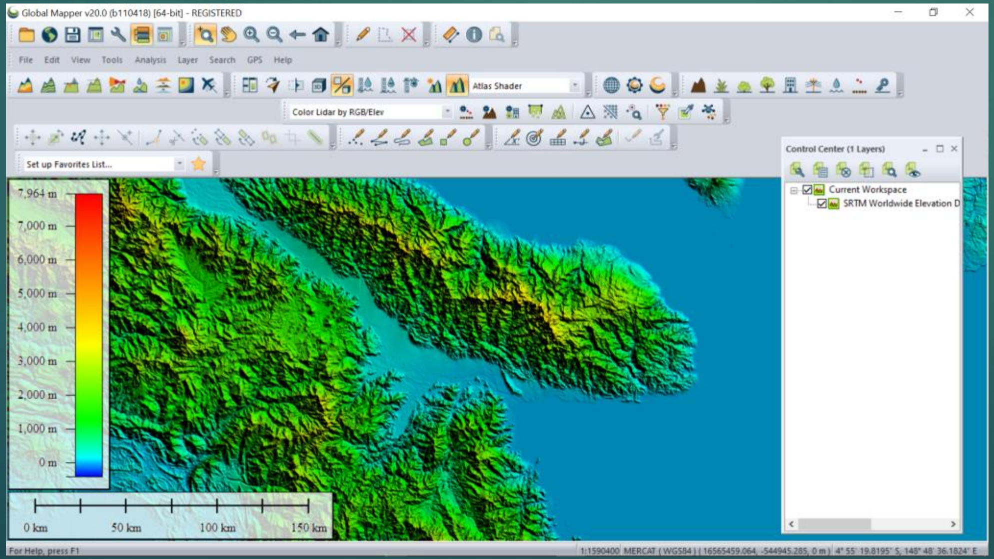
Different visualization platform to visualized SRTM DEM



Viewing In ArcMap



Viewing In ArcScene



Viewing In Global Mapper

Image Source: T.Sekac (2022)

4.3. SRTM (DEM) Product - History

The Shuttle Radar Topography Mission (SRTM) was flown aboard the space shuttle between date 11th to 22nd, 2000.

It is an international research effort between NASA and NGA that create and obtained first of its kind digital elevation models on a near-global scale through utilizing RADAR technology (USGS, 2018).

The SRTM was flown on an 11-day mission of the Space Shuttle Endeavour in February 2000 (Wikipedia, 2021)

4.4. Stereo Plotters

A stereo plotter uses stereo photographs **to determine elevations**.

It has been the primary method to plot contour lines on topographic maps since the 1930s


Aircraft


Aerial Photo


Stereo Plotter

Map Production

Scan and Tag

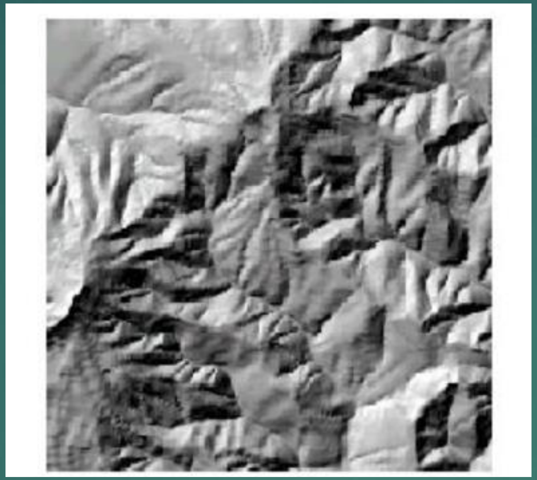
LT4X

Source: Blake, 2021

4.5. LT4X

30 meter vs 10 meter DEM - Hills hade comparison

30 meter created from LINETRACE



10 meter created from LT4X

10 meter DEM created from Contours using TOPOGRID

This came from the USFS.

L4TX, like LINETRACE, creates DEMs by interpolating elevations between contour lines.

There's a lot more detail in the 10-meter DEM than in the 30-meter DEM or the resampled 10-meter DEM.

Source: Hatfield, 2002

5. Binary Scanned Files

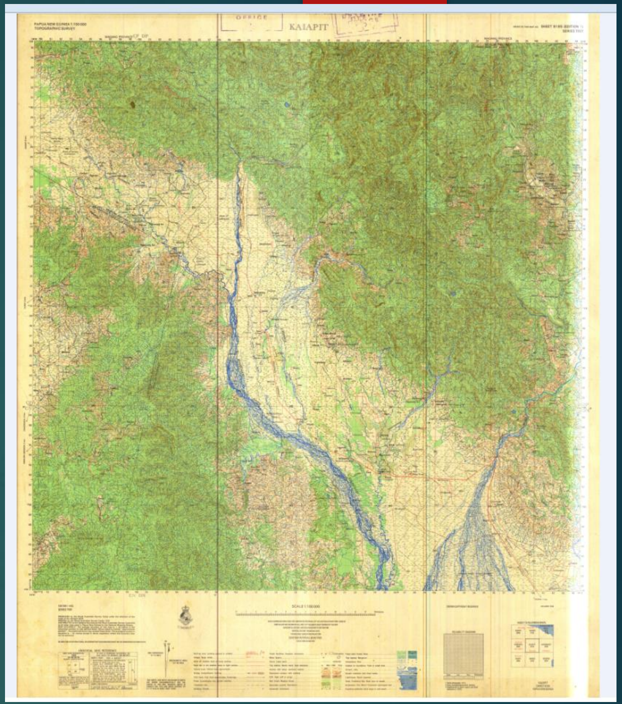
The scanning process converts the paper map (example Topographical map) into digital format.

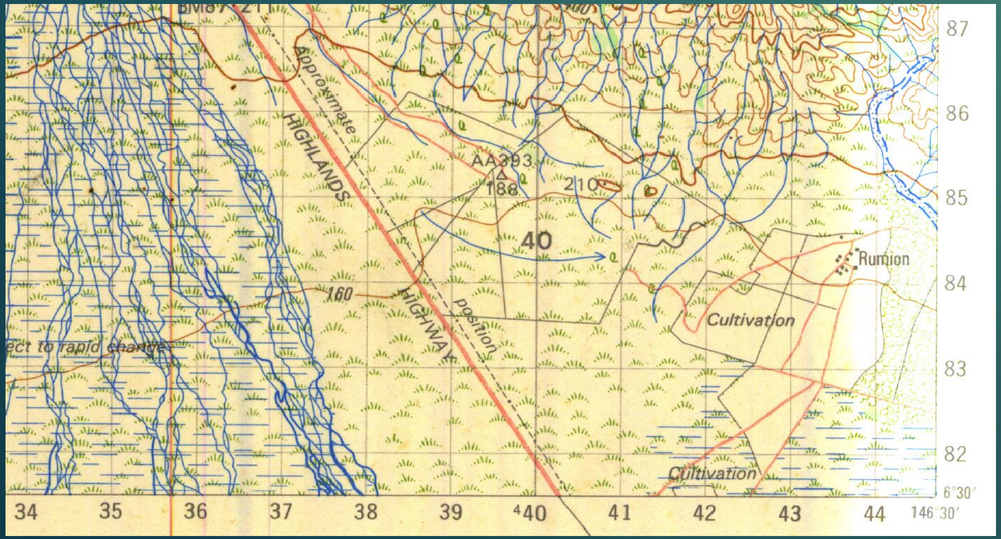
During scanning, the features are captured individually as pixels and finally automating them to an raster image format.

It can be saved as tif, img, jpg, etc…

Scanned image containing values of 1 and 0.

Maps to be digitized are typically scanned at 300 or 400 dpi





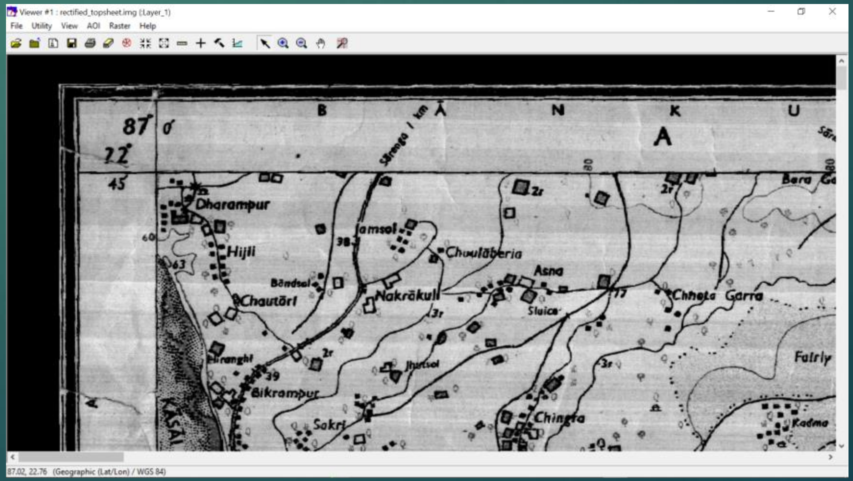


Image Source: T.Sekac (2022)

6. Raster Data Compression Technique in GIS

Raster Data compression technique is defined within Raster data structure.

This is to make sure the raster data are structure and stored in a computer system in such a way to easily handle and user friendly in GIS environment.

Raster when stored in a raw state with no compression can be extremely inefficient in terms of computer storage space.

The way to improving raster space efficiency is data compression.

Five (5) main Raster data compression techniques are;

1. Cell-by-Cell Encoding
2. Run Length Encoding
3. Chain Encoding
4. Block Encoding
5. Quad Tree Encoding

6.1. The concept of Raster Data Compression Technique in GIS

- ✓ The aim is to make sure Information are kept intact while doing compressing.

- ✓ Utilize different algorithm

- ✓ Compression algorithms can be:

1. Lossless
- This is where no information is lost
2. Lossy compression
- where some information is lost.

- ✓ Lossy algorithm is generally not applied to thematic data , but largely applied when image data is considered.

- ✓ The lossy compression technique are mostly applied to discrete raster data algorithms.

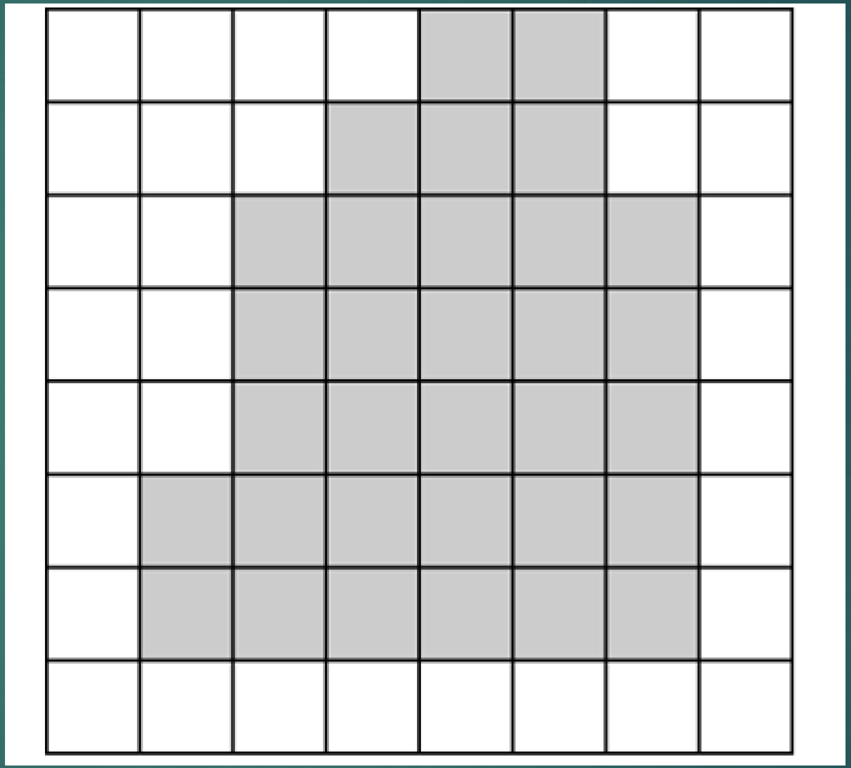
6.2. The Cell by cell encoding method

The cell-by-cell data structure records each cell value by row and column.

Ideal to store the cell values that change continuously, e.g.,DEM.

For multi-spectral satellite image, each cell has more than one value, data are stored in either of the following formats:

1. Band Interleaved by Pixel (BIP)
2. Band Interleaved by Line (BIL)
3. Band Sequential (BSQ)



Row 1: 0 0 0 0 1 1 0 0
Row 2: 0 0 0 1 1 1 0 0
Row 3: 0 0 1 1 1 1 1 0
Row 4: 0 0 1 1 1 1 1 0
Row 5: 0 0 1 1 1 1 1 0
Row 6: 0 1 1 1 1 1 1 0
Row 7: 0 1 1 1 1 1 1 0
Row 8: 0 0 0 0 0 0 0 0

1. Campbell, and Shin, (2011)
2. AGS 722

6.2.1. Band Interleaved by Line (BIL)

Band	Row	Column 1	Column 2	Column 3
Band 1	1	6	3	8
Band 1	2	5	4	9
Band 1	3	7	2	8
Band 2	1	6	9	8
Band 2	2	4	5	7
Band 2	3	3	1	8
Band 3	1	9	8	7
Band 3	2	5	6	4
Band 3	3	7	2	6

1st row band1, 1st row band2, 1st row band3; 2nd row band1, 2nd row band2, 2nd row band3; 3rd row band1, 3rd row band2, 3rd row band3

Ex: 6 3 8, 6 9 8, 9 8 7; 5 4 9, 4 5 7, 5 6 4; 7 2 8, 3 1 8, 7 2 6.

Source: RGS 603 Module on Digital Image Processing

6.2.2. Band Interleaved by Pixel (BIP)

Column

Band 1

Row	1	2	3
1	6	3	8
2	5	4	9
3	7	2	8

Band 2

Row	1	2	3
1	6	9	8
2	4	5	7
3	3	1	8

Band 3

Row	1	2	3
1	9	8	7
2	5	6	4
3	7	2	6

1st row 1st columnband1,

1st row 1st columnband2,

1st row 1st columnband3;

1st row 2ndcolumnband1,

1st row 2ndcolumnband2

1st row 2ndcolumnband3;

1st row 3rd columnband1,

1st row 3rd columnband2,

1st row 3rd columnband3

Ex: 6 6 9, 3 9 8, 8 8 7; 5 4 5, 4 5 6, 9 7 4; 7 3 7, 2 1 2, 8 8 6.

Source: RGS 603 Module on Digital Image Processing

6.2.3. Band Sequential (BSQ)

Column

Row	1	2	3	
R 1	6	3	8	Band 1
o 2	5	4	9	
w 3	7	2	8	
R 1	6	9	8	Band 2
o 2	4	5	7	
w 3	3	1	8	
R 1	9	8	7	Band 3
o 2	5	6	4	
w 3	7	2	6	

1st row band1, 2nd row band1, 3rd row band1;

1st row band2, 2nd row band2, 3rd row band2;

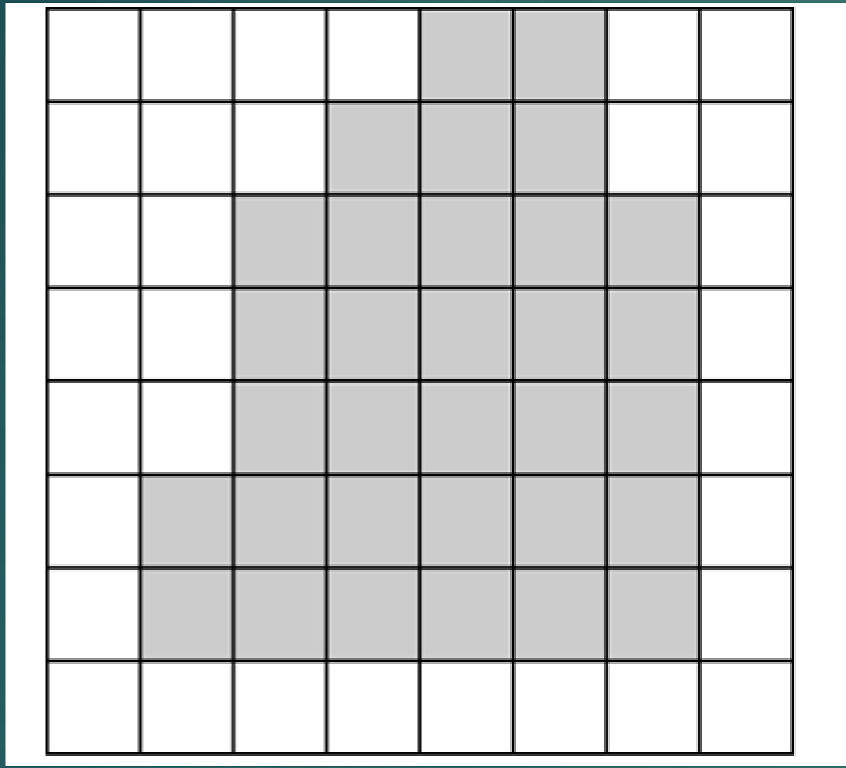
1st row band3, 2nd row band3, 3rd row band3

Ex: 6 3 8, 5 4 9, 7 2 8; 6 9 8, 4 5 7, 3 1 8; 9 8 7, 5 6 4, 7 2 6.

Source: RGS 603 Module on Digital Image Processing

6.3. The Run-length encoding method

Run length encoding (RLE) counts the runs of equal values in cells in the image and stores the counts. It is a loss less technique and works well for simple blocky patterns.



The run length encoding method records the cell values in runs.

Row 1, for example, has two adjacent cells in columns 5 and 6 that are gray or have the value of 1. Row 1 is therefore encoded with one run, beginning in column 5 and ending in column 6. The same method is used to record other rows.

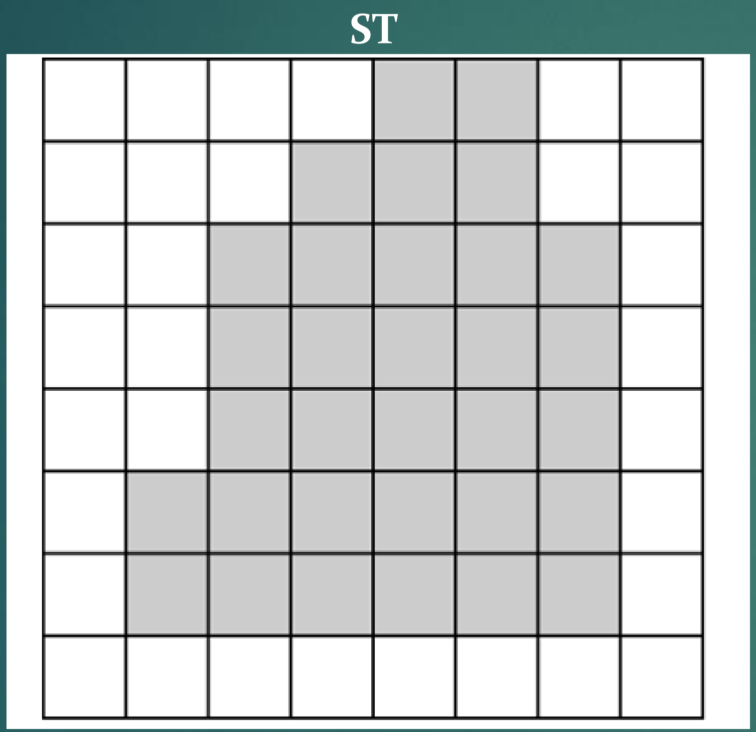
==

Row 1------- 5,6
Row 2------- 4, 5, 6
Row 3............3,4,5,6,7
....
...

1. Campbell, and Shin, (2011)
2. AGS 722

6.4. The Chain encoding method

Chain codes represent the raster boundary of a region by giving a starting point and the cardinal direction (east, north, west, south) to follow as we progress around the boundary



ST= Starting point
S=South
N= North
E= East
W= West

RESULT
E2, S2, E1, S5, W6, N2, E1, N3, E1, N1, E1, N1

The Chain encoding method records the boundary cell values

1. https://www.kau.edu.sa/Files/0053593/files/33286_GIS%20Lecture%20Six-1.pdf

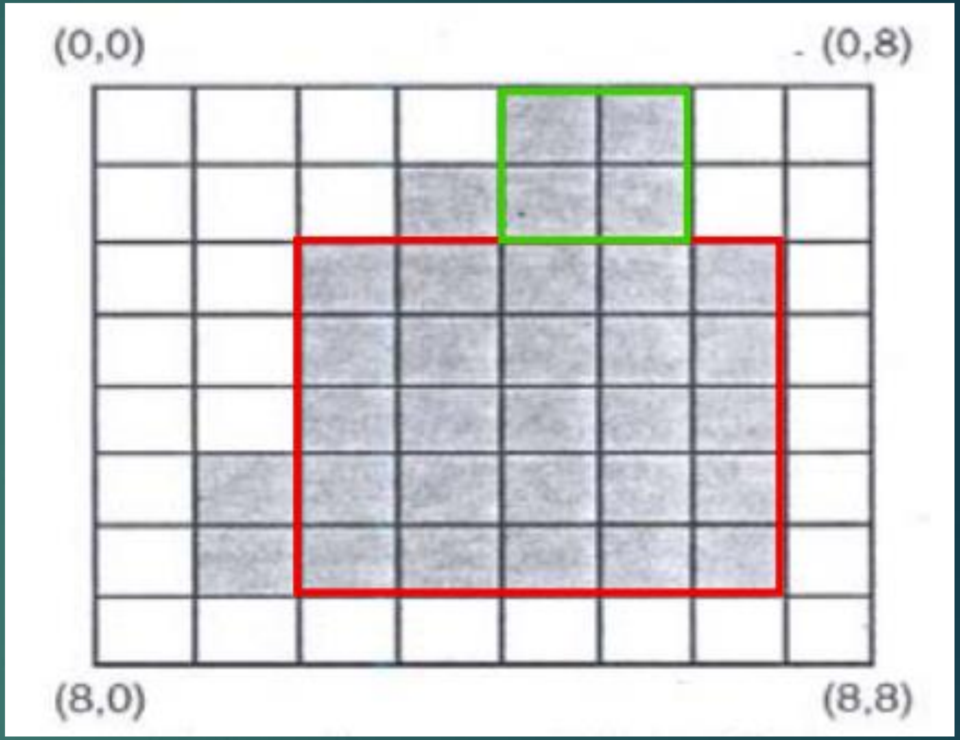
2. Campbell, and Shin, (2011)

6.5. The Block encoding method

Uses square blocks to represent the region:

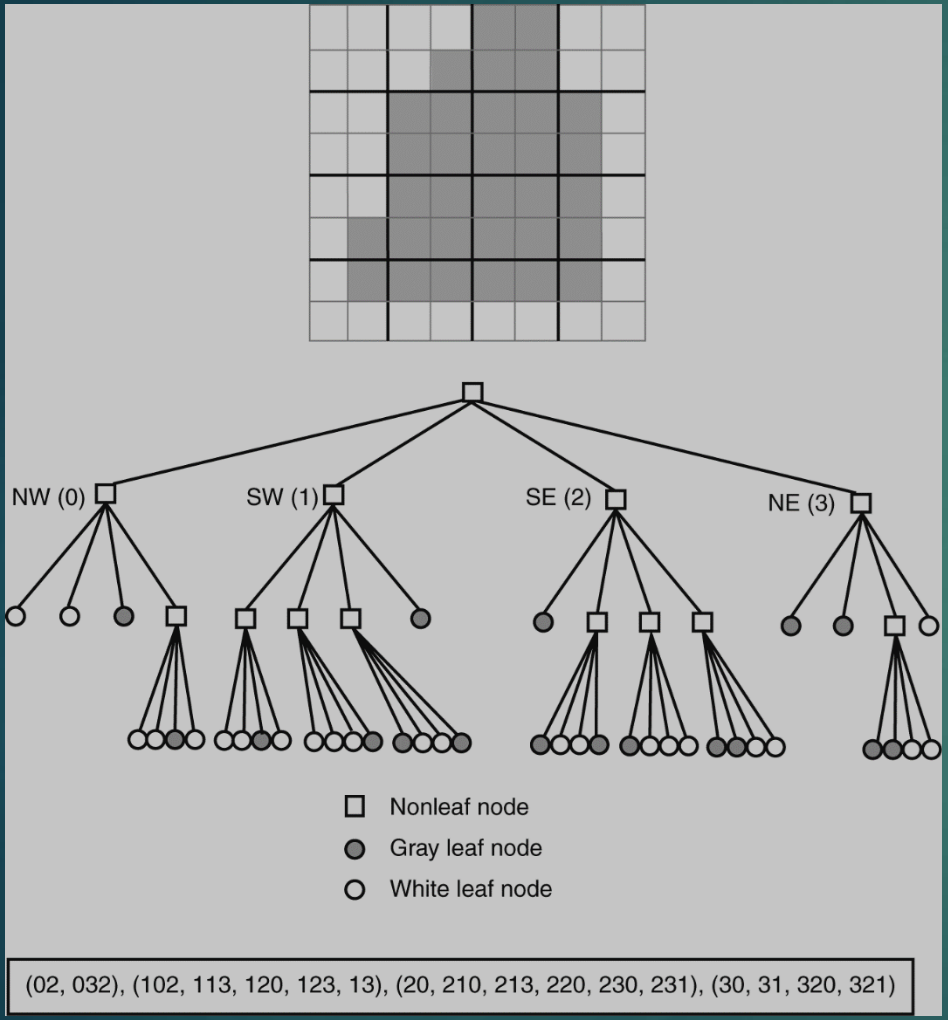
A unit square represents 1 cell.
4-square block represents 2 x 2 cells
9-square block represents 3 x 3 cells, and so on.

Each square block is coded only with the location of a cell (lower left of the block), and the side length of the block.



Three unit squares: (7,1; 6,1; 2,3
One 4 squares: (2,4)
One 25-squares: (7,2)

6.6. The Quadtree encoding method



The regional quad tree method divides a raster into a hierarchy of quadrants.

The division stops when a quadrant is made of cells of the same value (gray or white).

A quadrant that cannot be subdivided is called a leaf node.

In the diagram, the quadrants are indexed spatially: 0 for NW, 1 for SW, 2 for SE, and 3 for NE.

Using the spatial indexing method and the hierarchical quad tree structure, the gray cells can be coded as 02, 032, and so on. See text for more explanation.

1. https://www.kau.edu.sa/Files/0053593/files/33286_GIS%20Lecture%20Six-1.pdf

2. Campbell, and Shin, (2011)

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