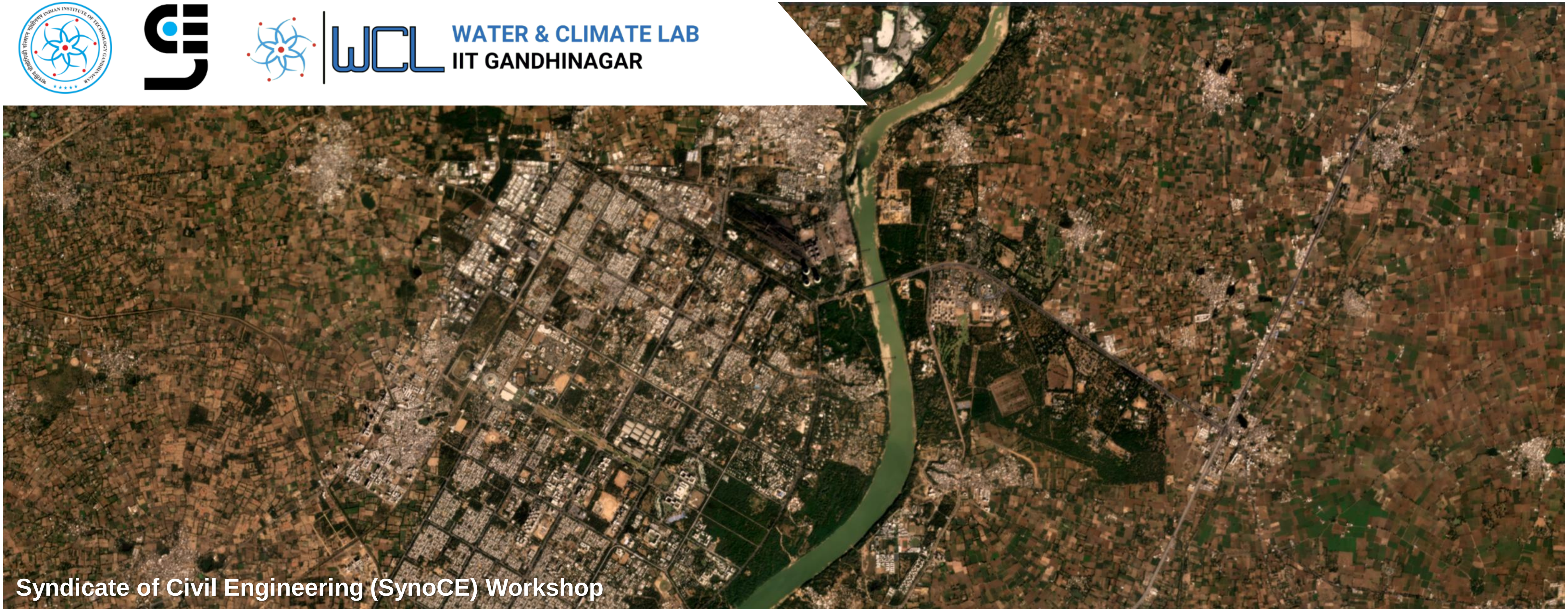
WATER & CLIMATE LAB
IIT GANDHINAGAR



Getting Started with Google Earth Engine (GEE)

Hiren Solanki
PhD Scholar, Earth Sciences
Indian Institute of Technology Gandhinagar.

2024-12-31 00:00 - 2024-12-31 23:59, Planet NICFI Basemaps, Planet Medres Visual 2024-12 Mosaic

Remote Sensing

- The art, science, and technology of obtaining reliable information about physical objects and the environment, through the process of recording, measuring, and interpreting imagery and digital representations of energy patterns derived from noncontact sensor systems. (Colwell, 1997)

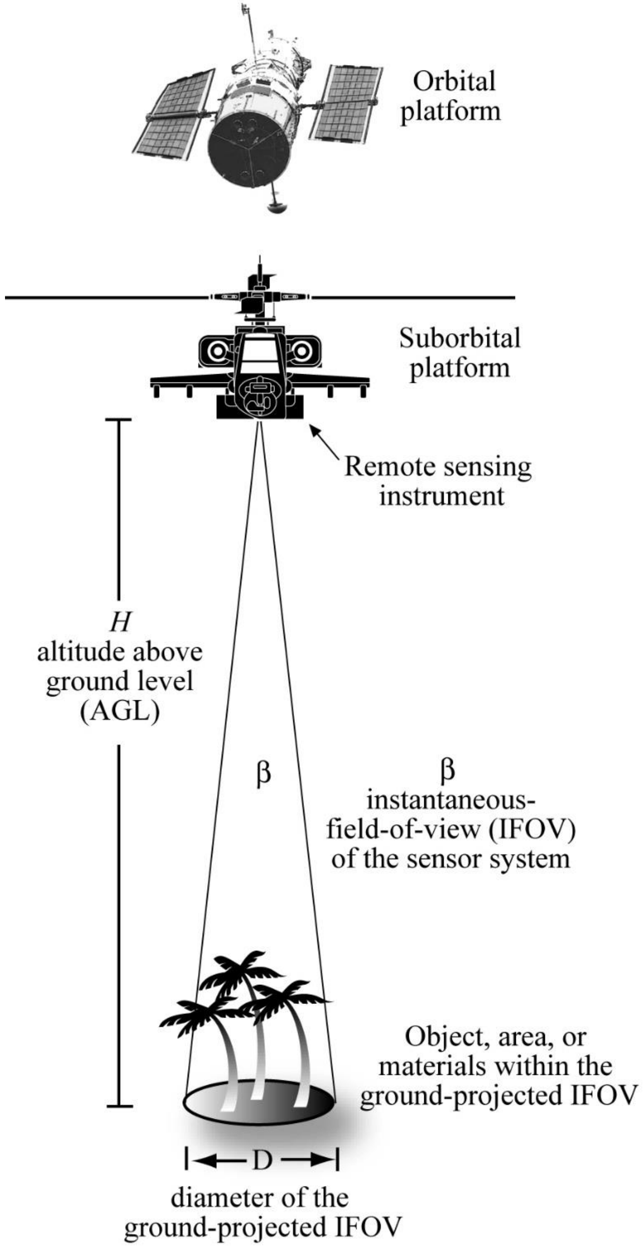


Figure. Remote Sensing System (Jensen, 2004)

Remote Sensing System

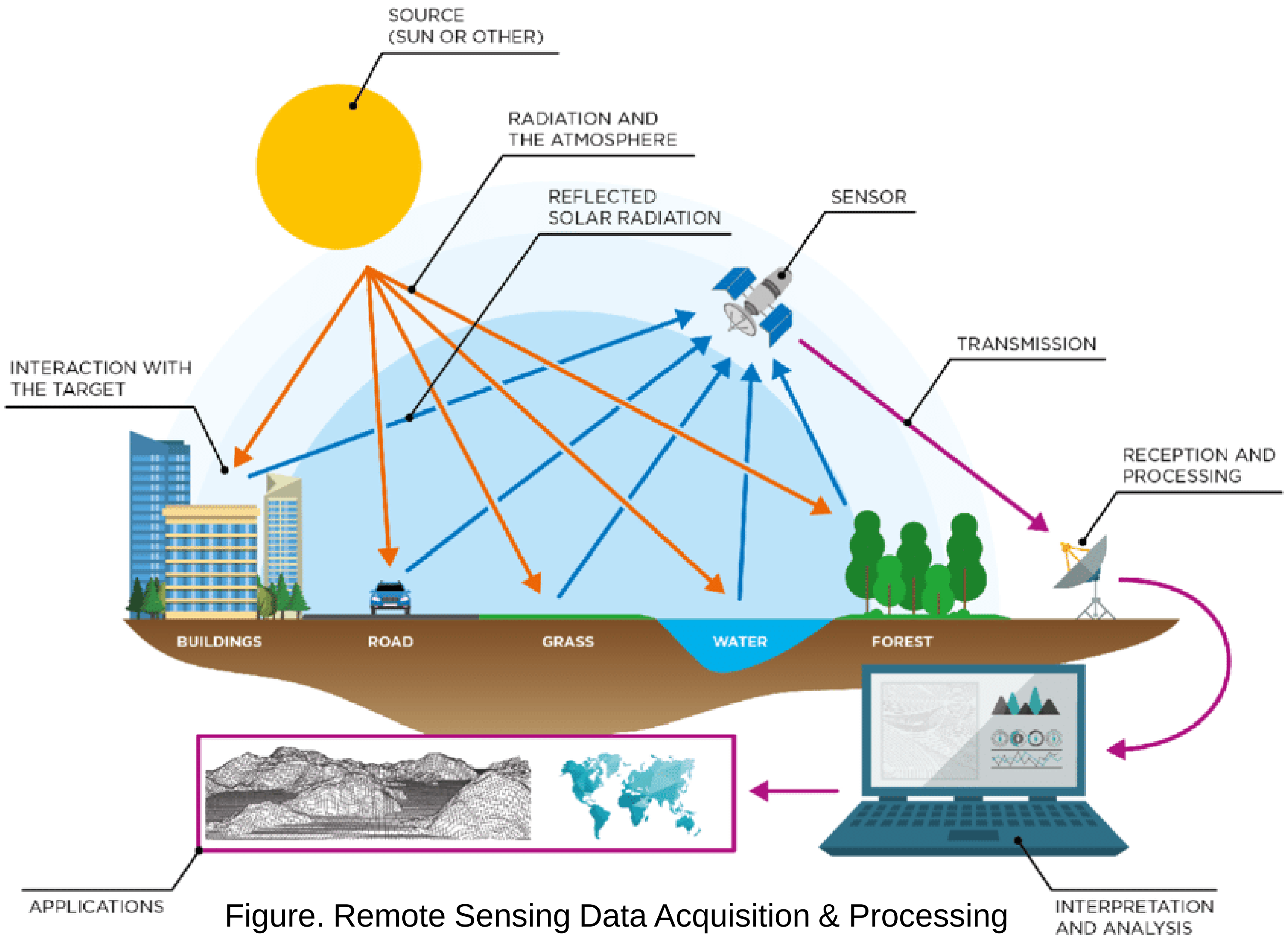


Figure. Remote Sensing Data Acquisition & Processing

In situ Measurements

Figure. Ground Truth Validation of Remote Sensing data

Platforms

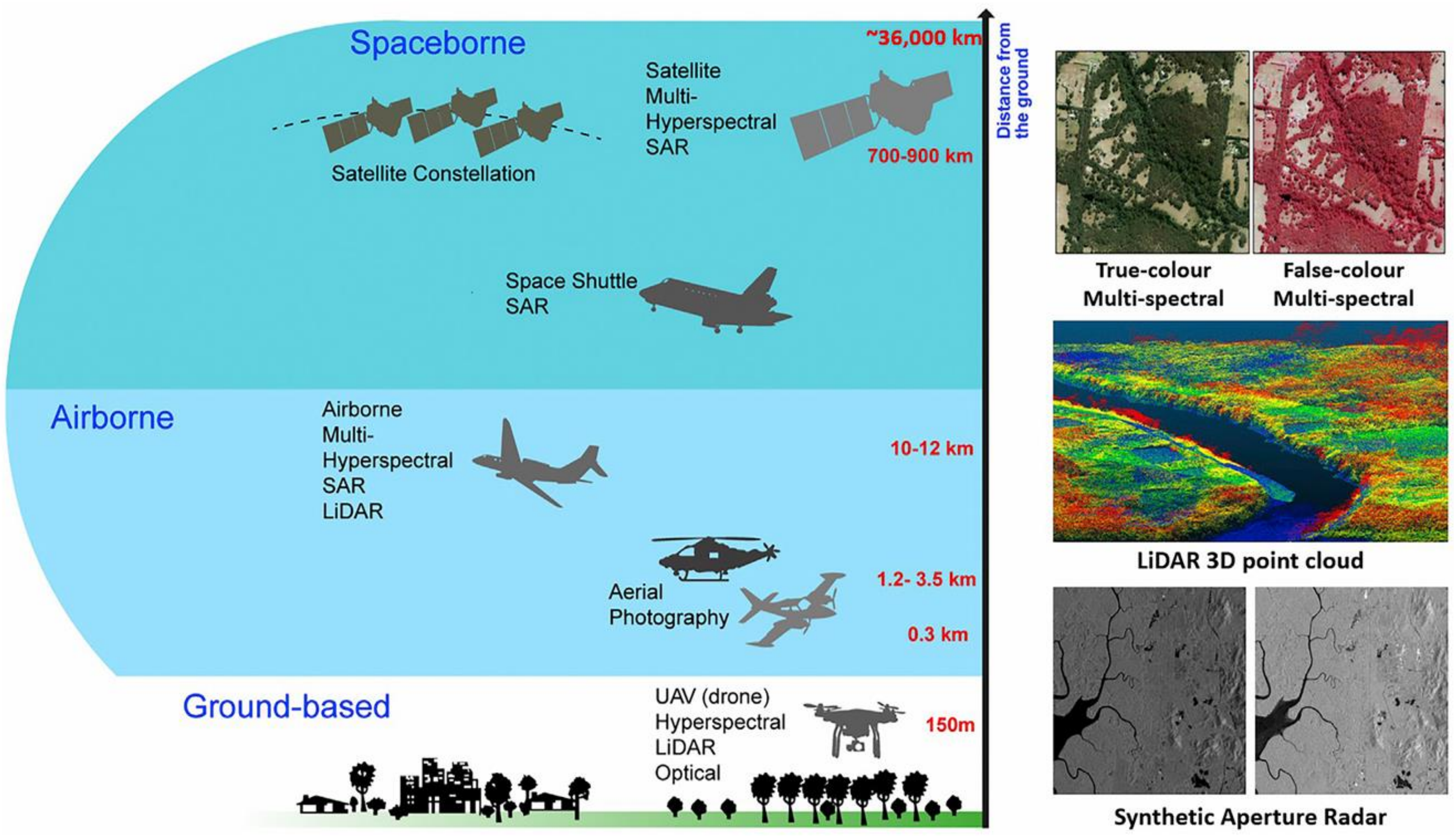


Figure. Common Remote-Sensing Platform and Sensor Combinations and Remote-Sensing Data (Lechner et al., 2020)

Science or Art?

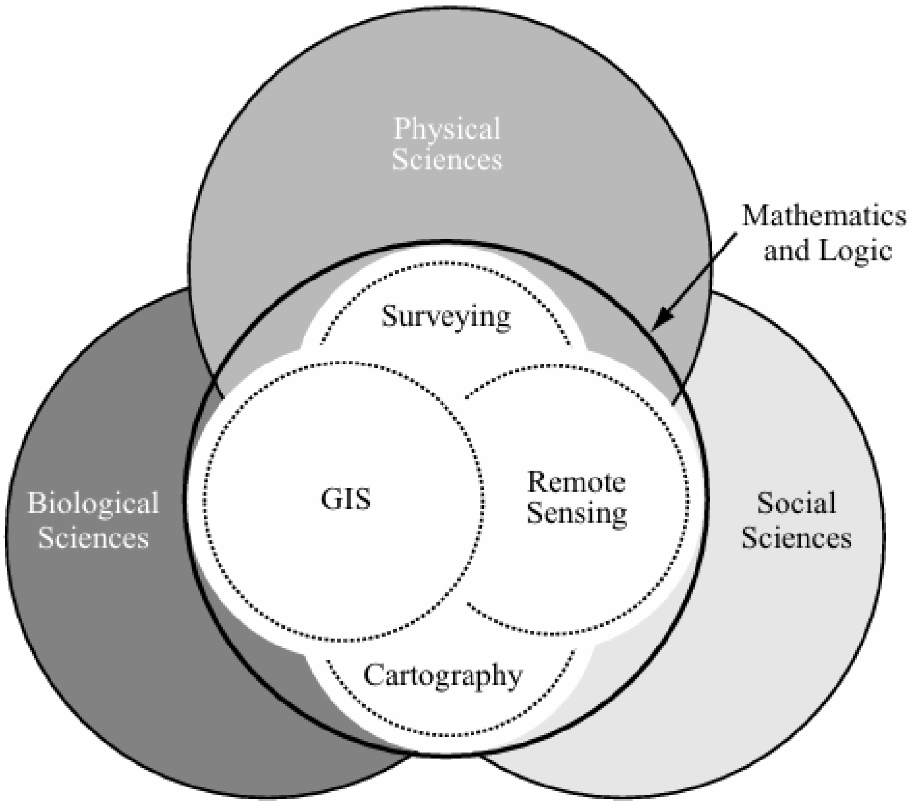


Figure. Interaction model depicting the relationship of the geographic information sciences (remote sensing, geographic information systems, cartography, and surveying) as they relate to mathematics and logic and the physical, biological, and social sciences.

Analysis

- Classification
- Change Detection
- Time Series Analysis

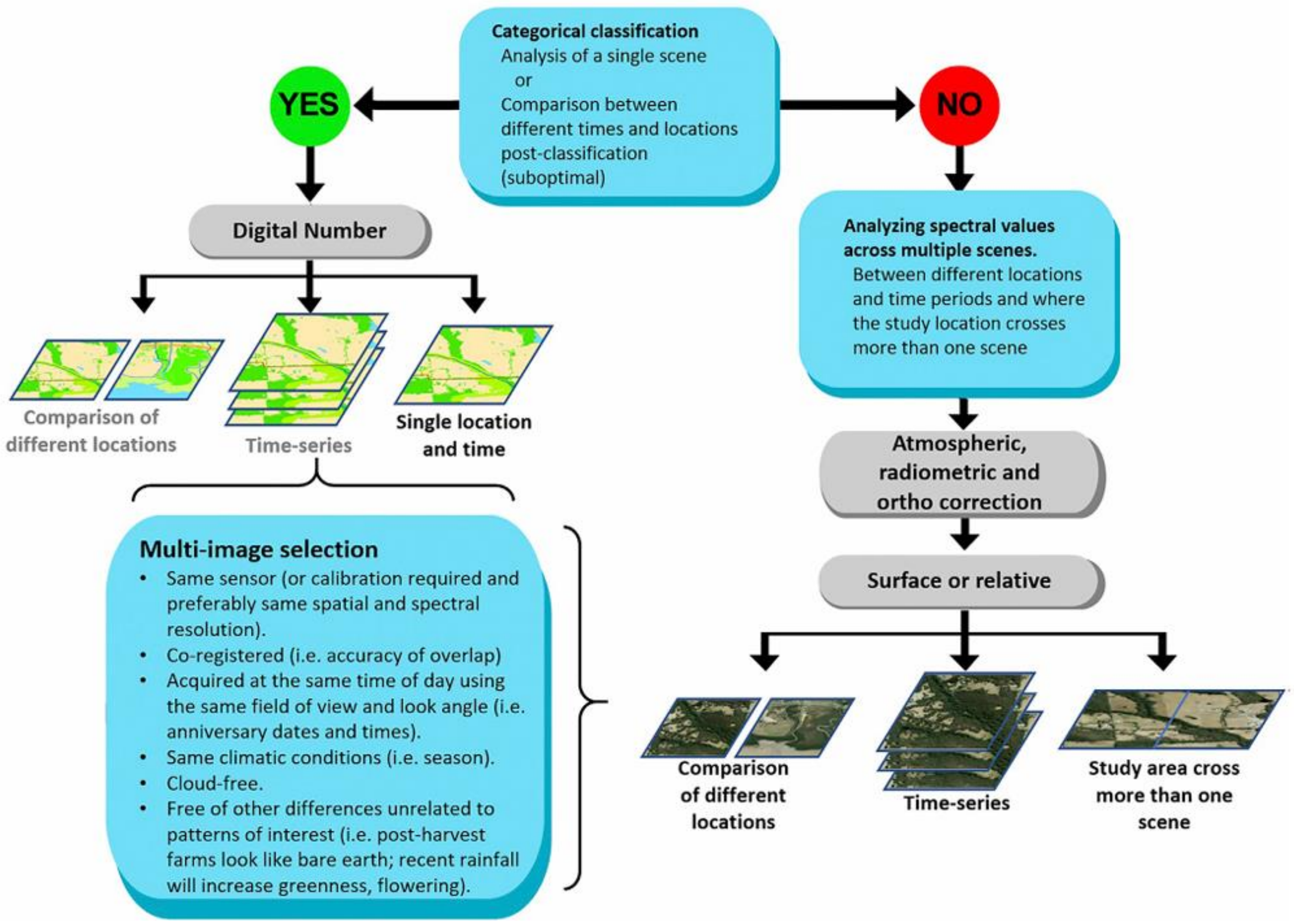
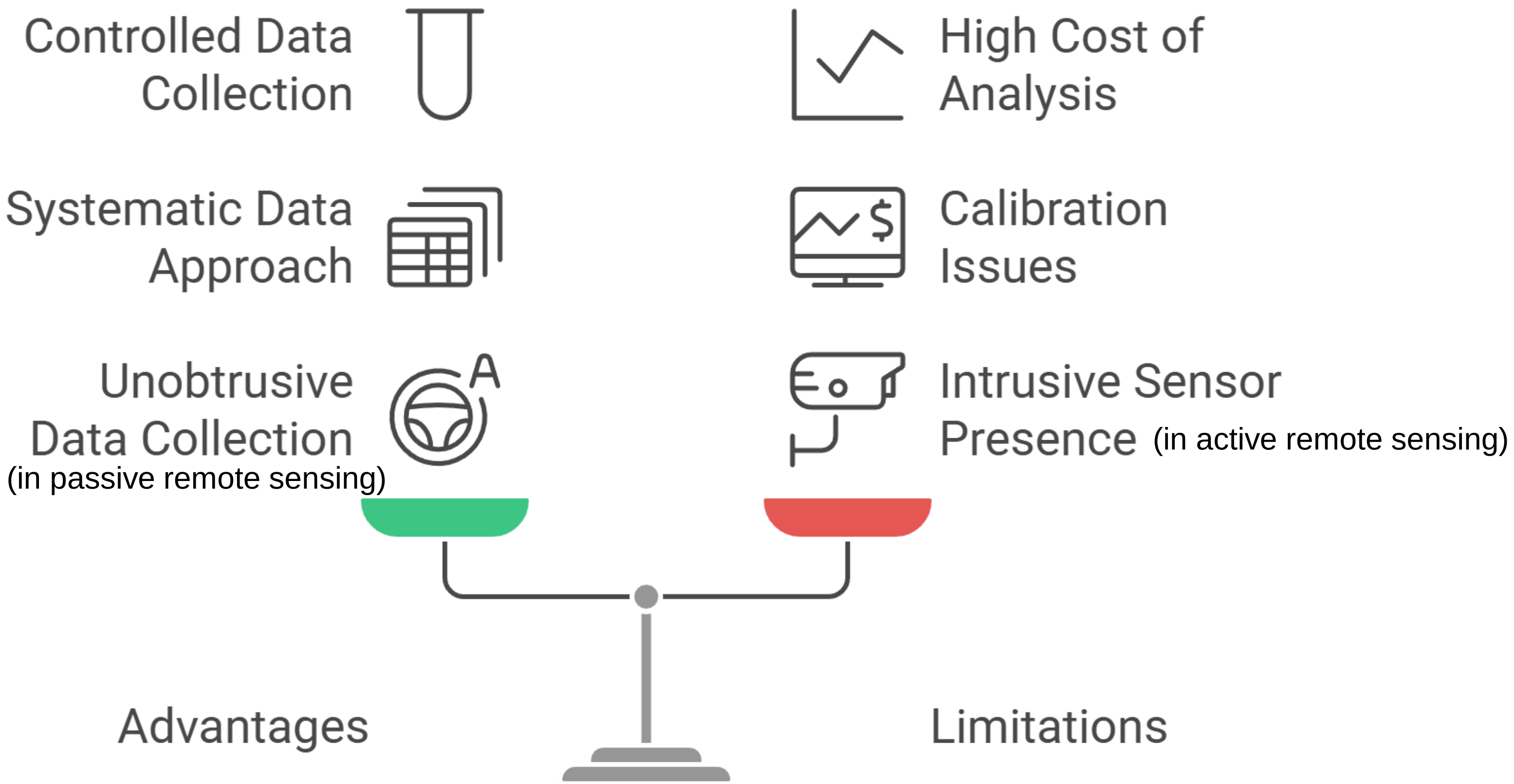


Figure. Image Selection and Pre-processing Decision Tree (Lechner et al., 2020)

Pros & Cons


Controlled Data Collection
Systematic Data Approach
Unobtrusive Data Collection
(in passive remote sensing)
High Cost of Analysis
Calibration Issues
Intrusive Sensor Presence
(in active remote sensing)
Advantages
Limitations

Remote Sensing Resolutions

Spatial Resolution:

This refers to the level of detail in an image captured by a remote sensing system. Think of it like the sharpness or clarity of a picture. Higher spatial resolution means finer details can be distinguished, like being able to see individual trees or buildings from space.

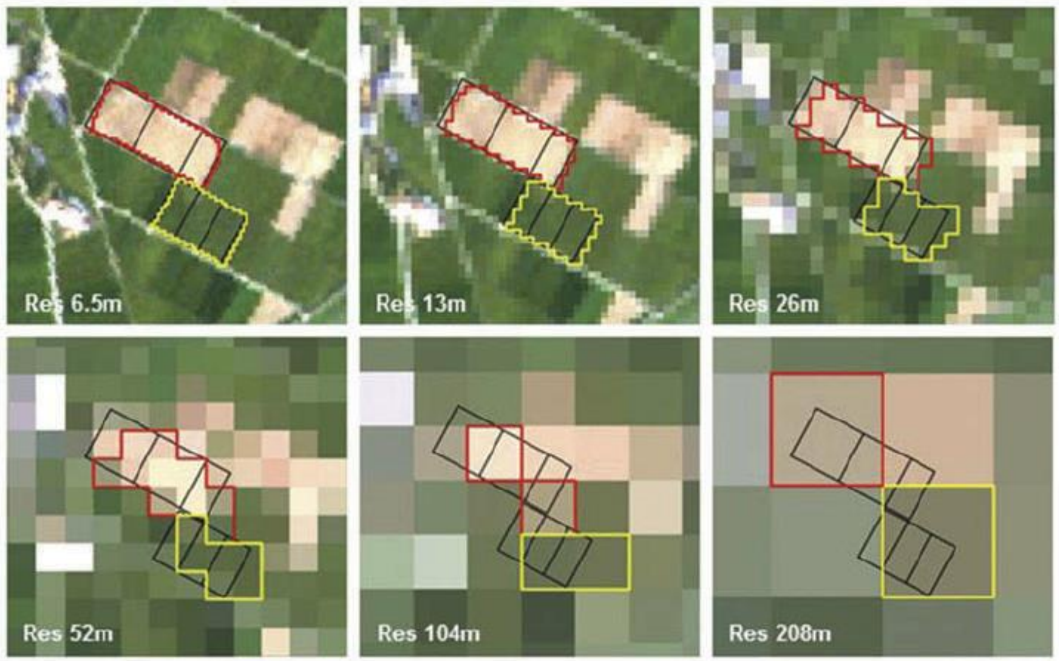


Figure. Paddy field detection

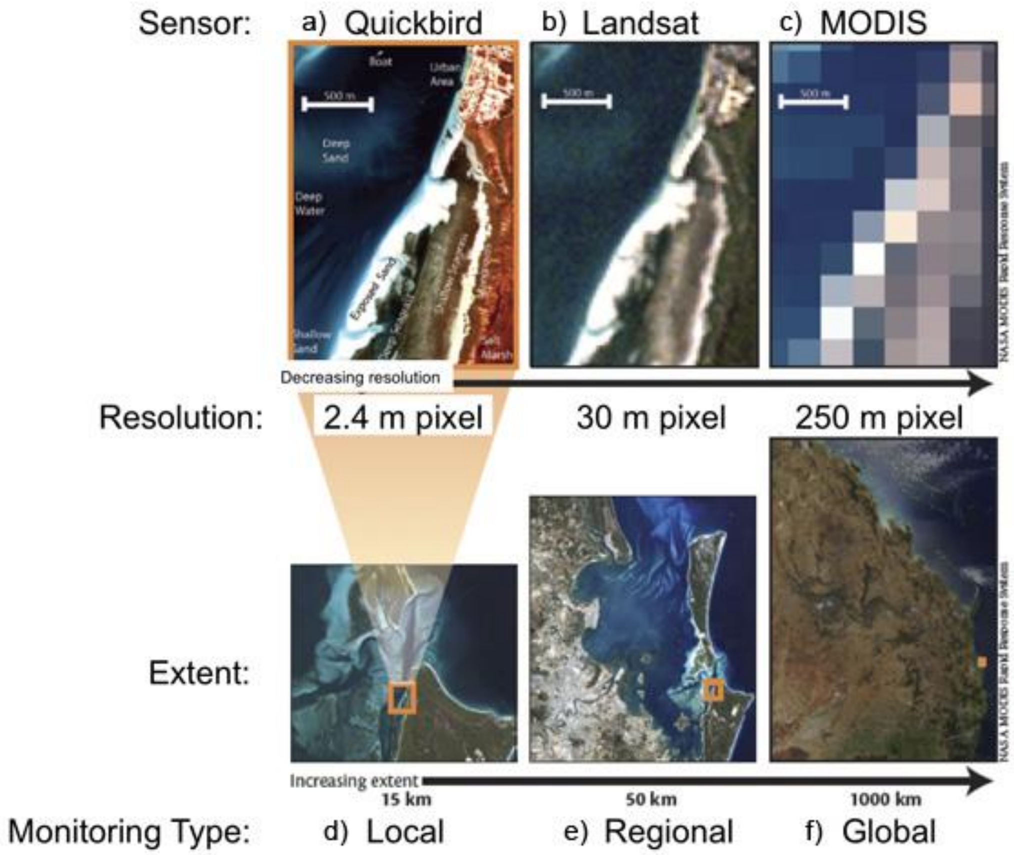
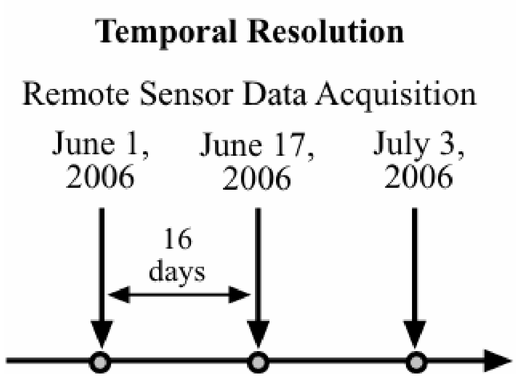


Figure. water-seagrass-mangrove-urban area in Moreton Bay, Australia

Remote Sensing Resolutions

Temporal Resolution:

Temporal resolution is the frequency at which a remote sensing system can revisit and capture images of the same area over time. It's like how often you take a picture of something. Higher temporal resolution means more frequent updates, which can be useful for monitoring changes like crop growth or urban development.



Cyclone Michaung 2023

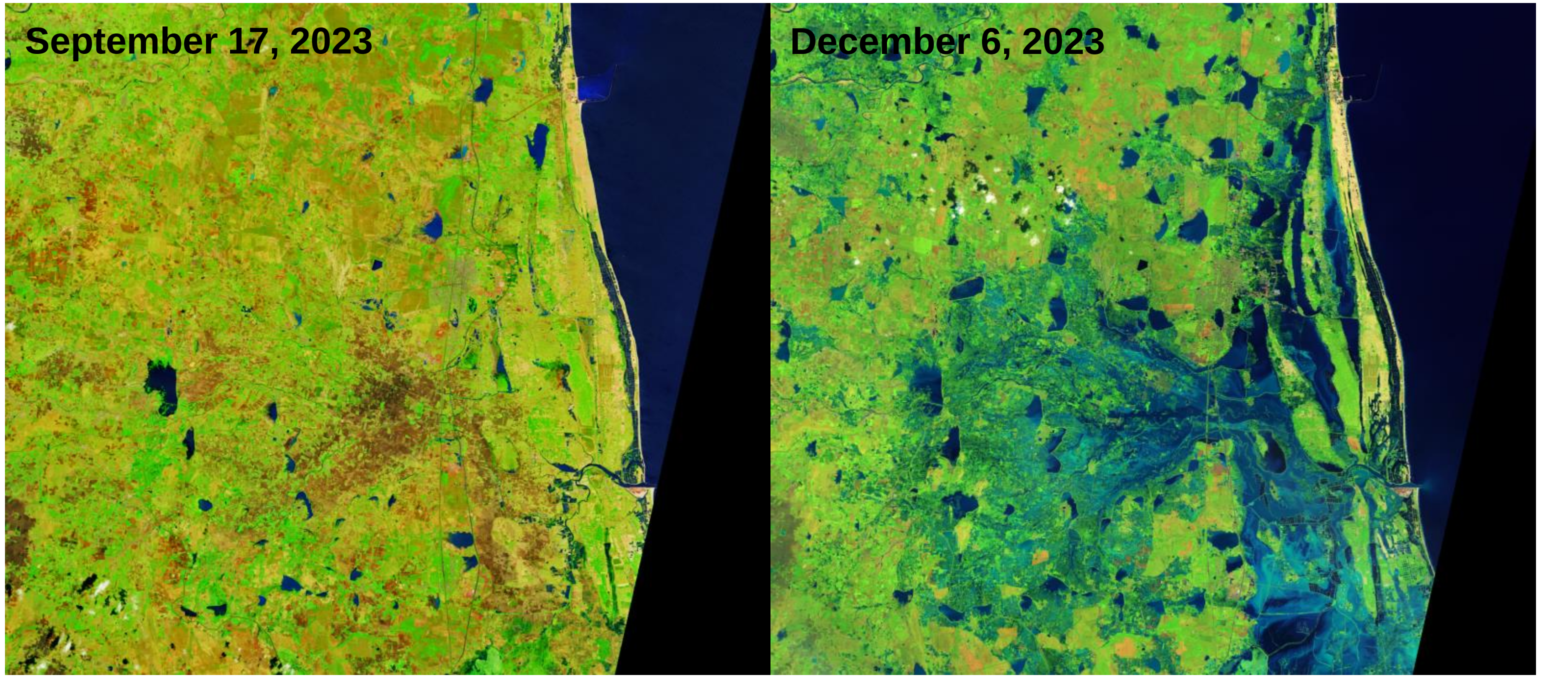
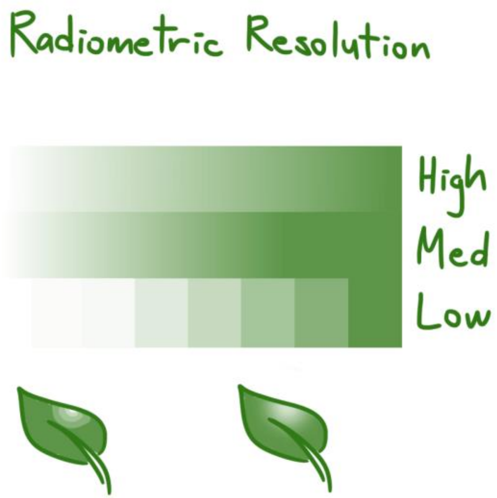


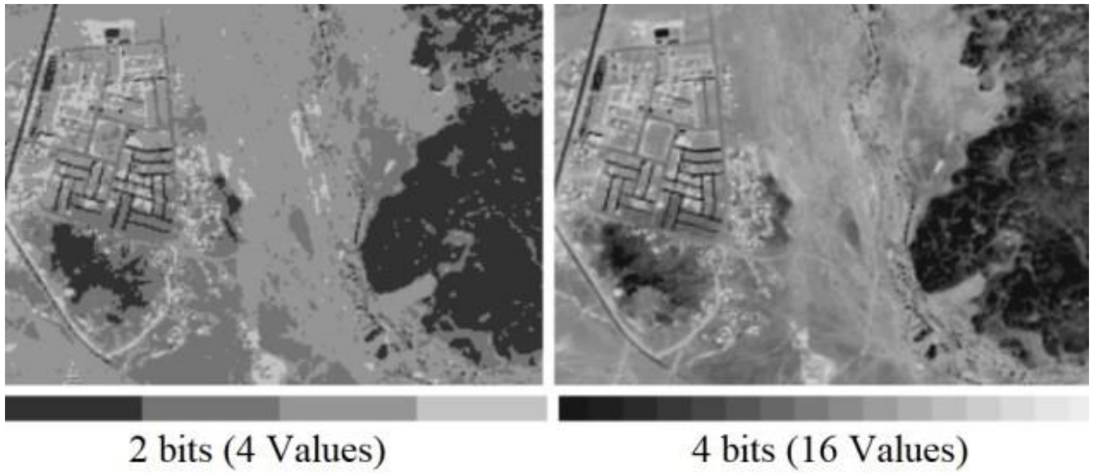
Figure. Cyclone Michaung 2023 (NASA Earth Observatory)

Remote Sensing Resolutions

Radiometric Resolution:

Radiometric resolution refers to the sensitivity of a remote sensing system to variations in brightness or intensity within an image. It's like the number of shades of gray between black and white in a photograph. Higher radiometric resolution means more subtle differences in brightness can be detected, which can be important for distinguishing between different types of land cover or detecting subtle changes in the environment.





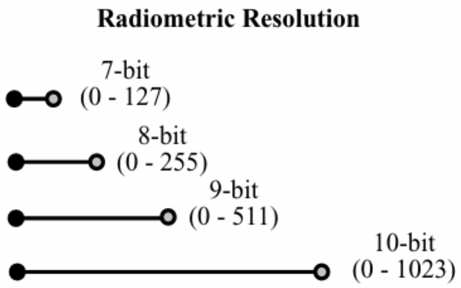


Figure. Concept of Radiometric Resolution

Remote Sensing Resolutions

Spectral Resolution:

Spectral resolution involves the ability of a remote sensing system to distinguish between different wavelengths or colors of light. Just like how a prism breaks white light into its constituent colors, spectral resolution allows us to see different parts of the electromagnetic spectrum, which is important for identifying different materials or features on the Earth's surface.

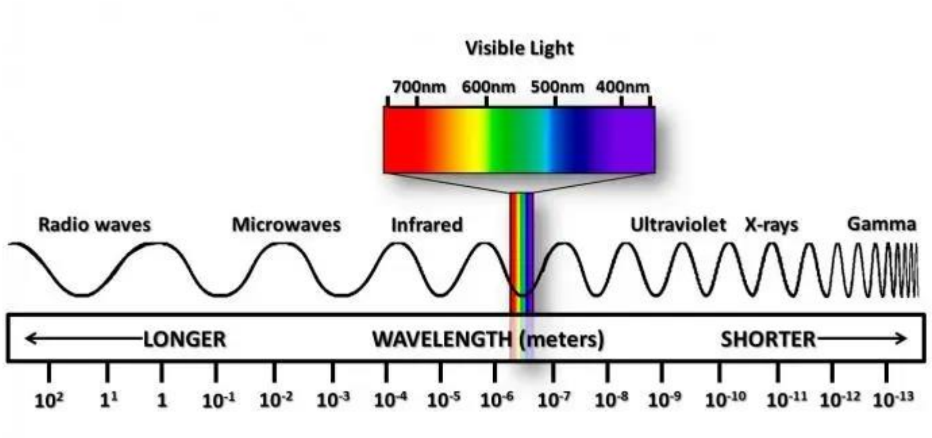


Figure. EM Spectrum

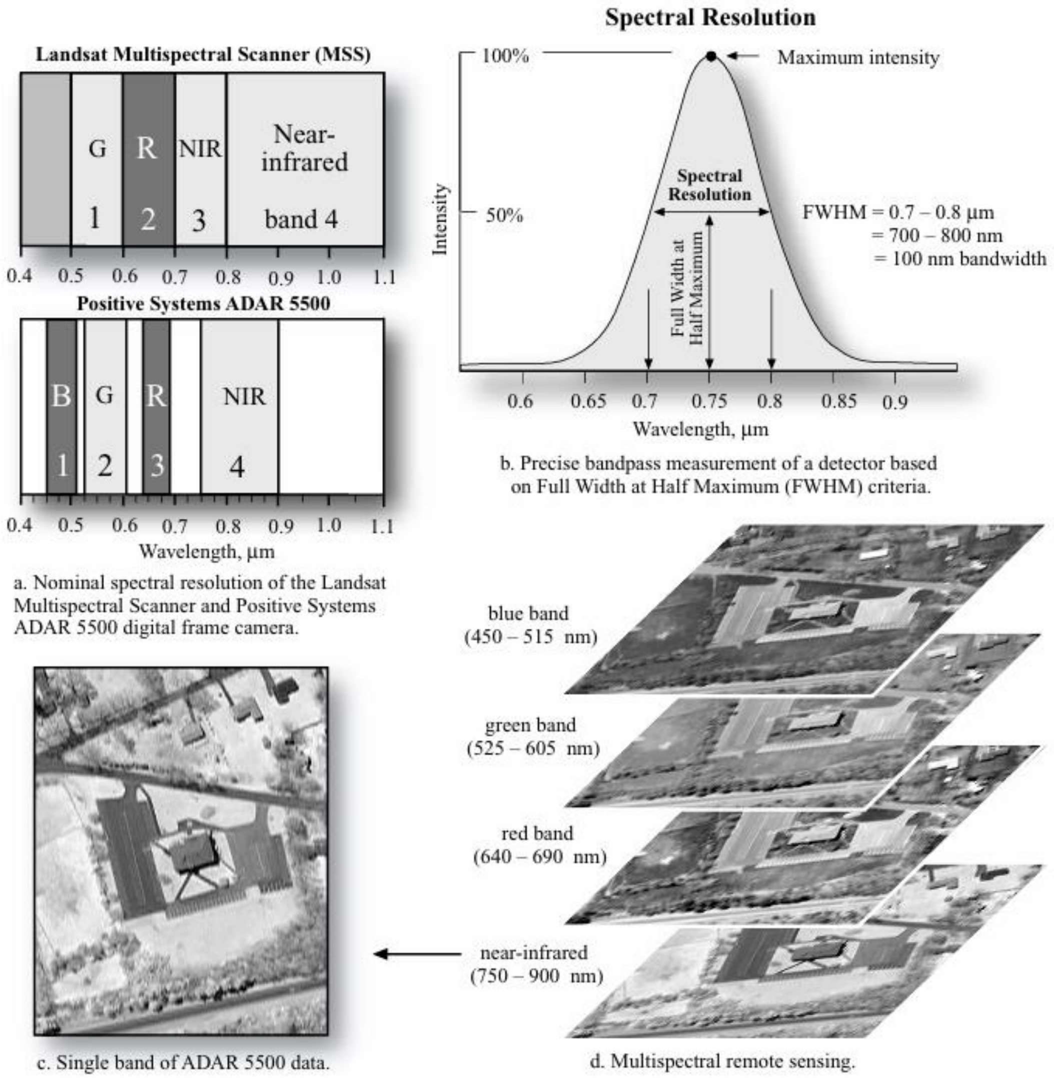
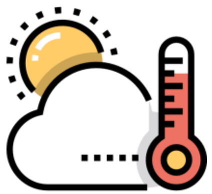


Figure. Spectral bands

Remote Sensing Resolutions

Forest Cover Mapping
30 to 100 m; 1 to 2 year

Forest Fire
30 to 500 m; 12 hr to 2 day



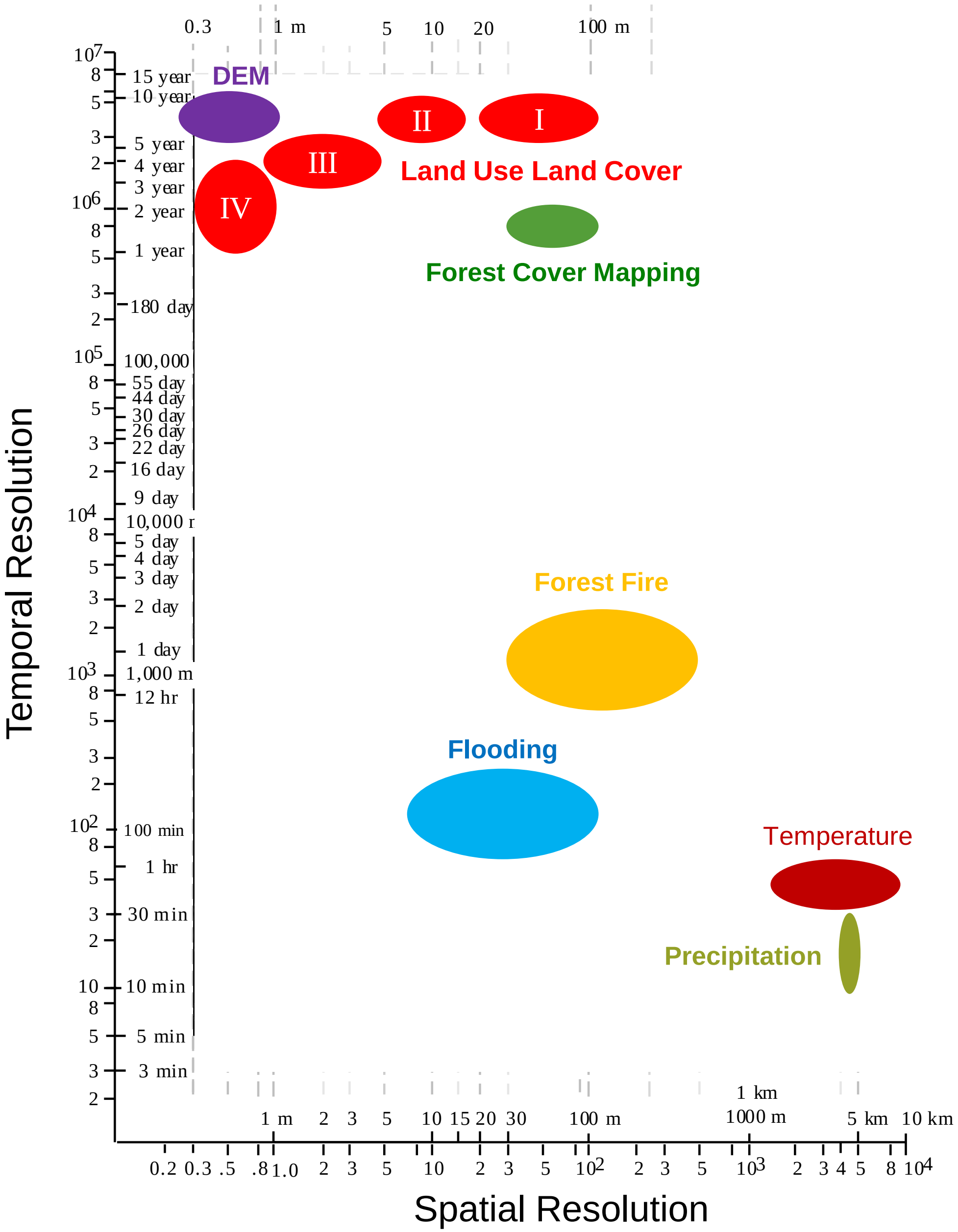
Temperature
30 min - 1 hr
1-8 km
Precipitation
10 - 30 min
4 km

Flooding
10 to 100 m; 1 to 6 hr

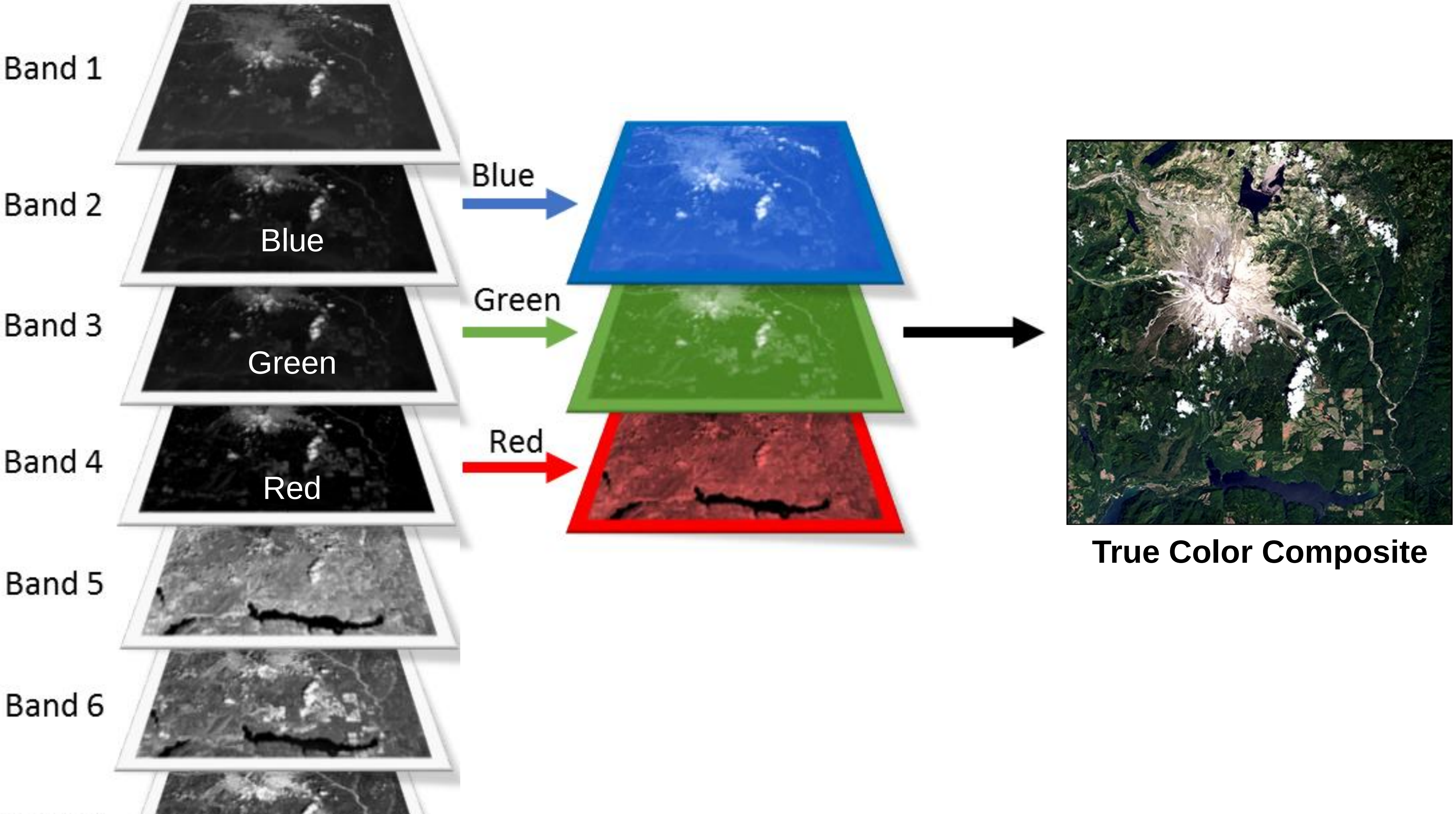
Land Use Land Cover

L1 - USGS Level I	5 - 10 years	20 - 100 m
L2 - USGS Level II	5 - 10 years	5 - 15 m
L3 - USGS Level III	3 - 5 years	1 - 5 m
L4 - USGS Level IV	1 - 3 years	0.3 - 1 m

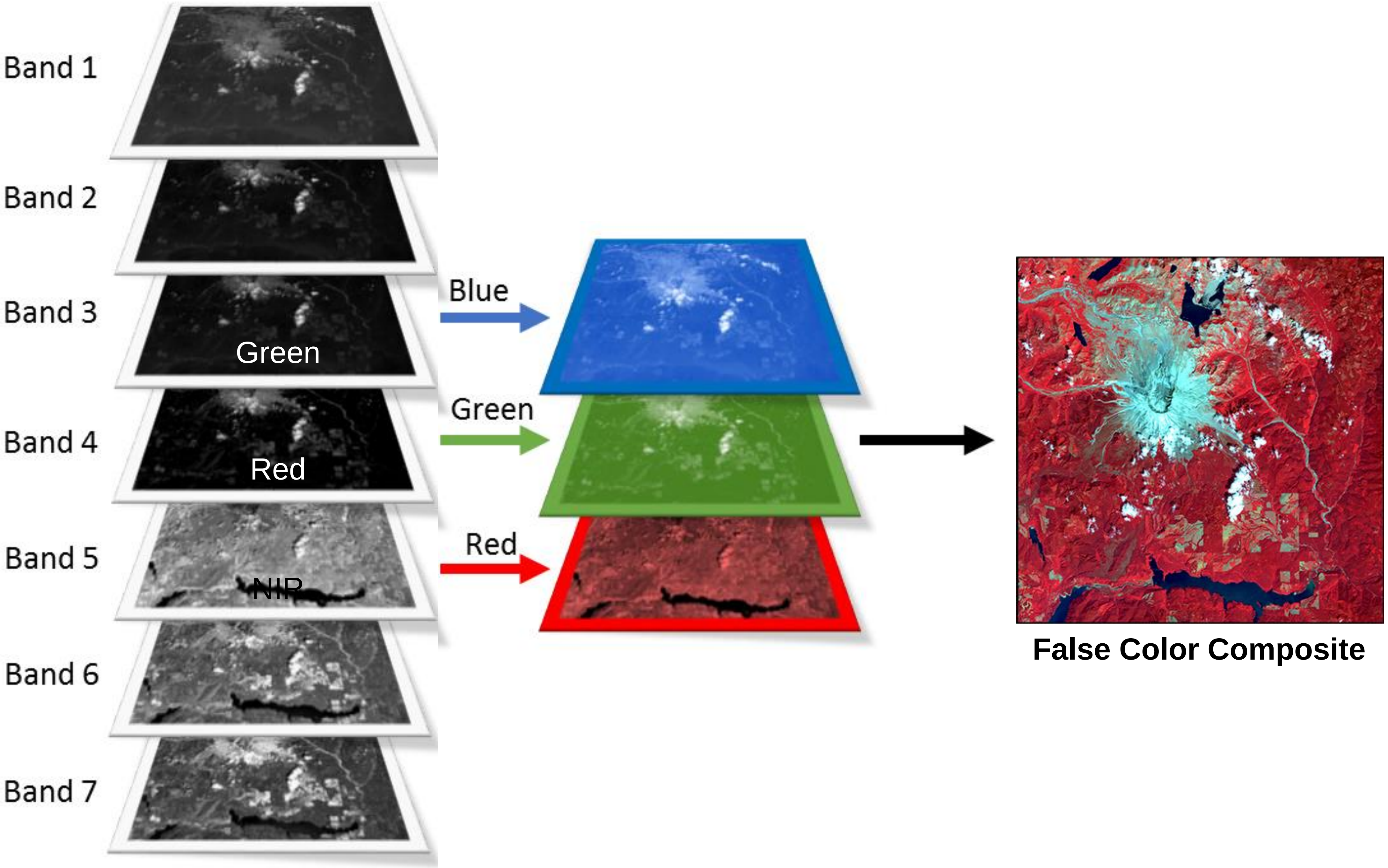
DEM
0.3 to 1 m; 5 to 10 year



Color Composite



True Color Composite


Band 1
Band 2
Band 3
Green
Band 4
Red
Band 5
NIR
Band 6
Band 7
Blue
Green
Red
False Color Composite

Spectral Signature

Spectral signature refers to the unique pattern of light reflectance or emission exhibited by an object or surface at different wavelengths across the electromagnetic spectrum. Essentially, it's like a fingerprint for different materials or features based on how they interact with light.

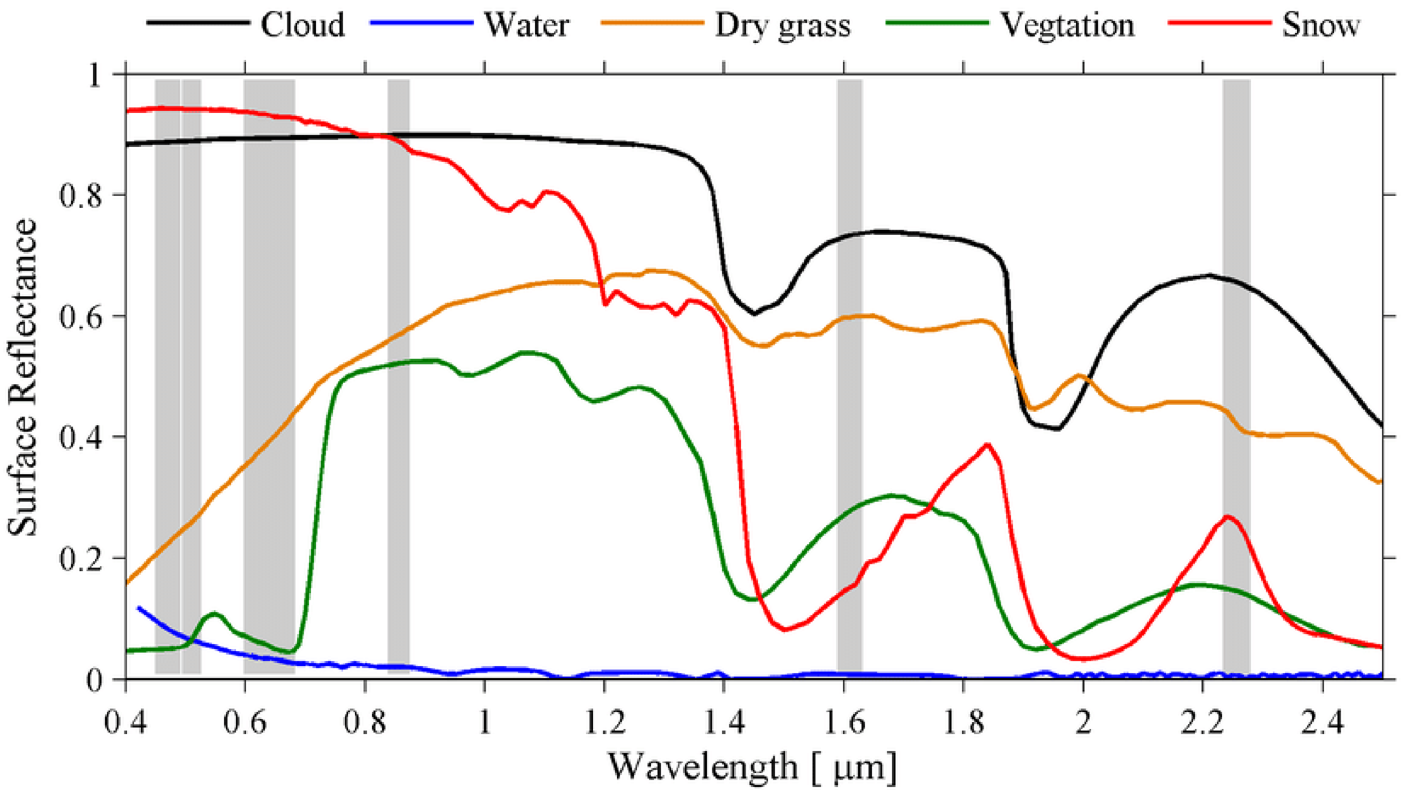
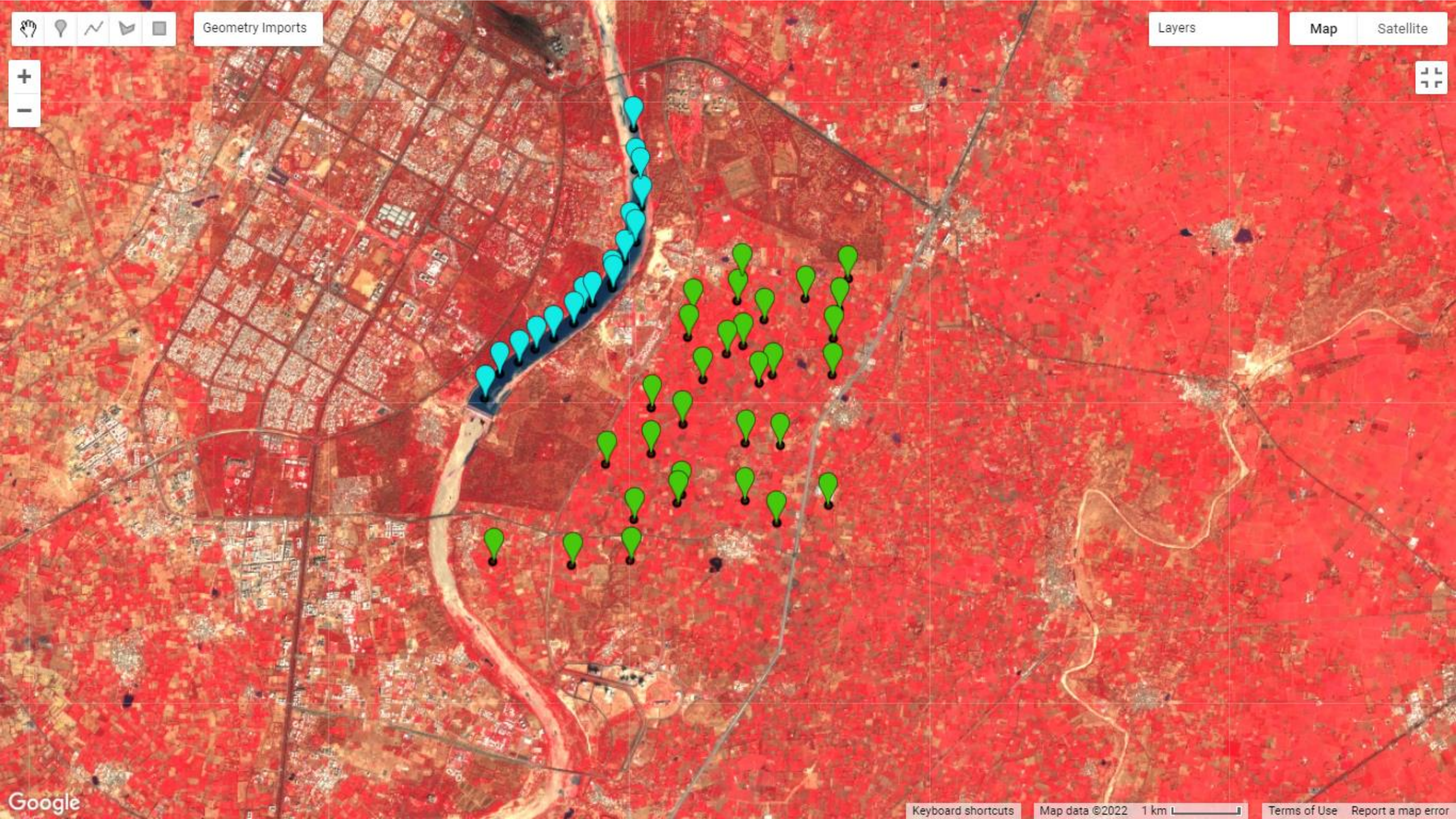


Figure. Spectral signature of various objects


Geometry Imports
Layers
Map
Satellite
Google
Keyboard shortcuts
Map data ©2022
1 km
Terms of Use
Report a map error

NDVI

Property	Wavelength (nm)	Band Name	Reflectance (%) Water	Vegetation
B1	443.9	Aerosols	4.9	4.4
B2	496.6	Blue	5.8	4.9
B3	560	Green	8.6	7.7
B4	**664.5**	**Red**	**5.5**	**5**
B5	703.9	Red Edge 1	6.1	11
B6	740.2	Red Edge 2	3.7	30.6
B7	782.5	Red Edge 3	3.8	36.9
B8	**835.1**	**NIR**	**3.4**	**38.5**
B8A	864.8	Red Edge 4	3.1	38.1
B9	945	Water Vapor	3.3	36.8
B11	1613.7	SWIR 1	3.6	20.2
B12	2202.4	SWIR 2	2.9	12.8

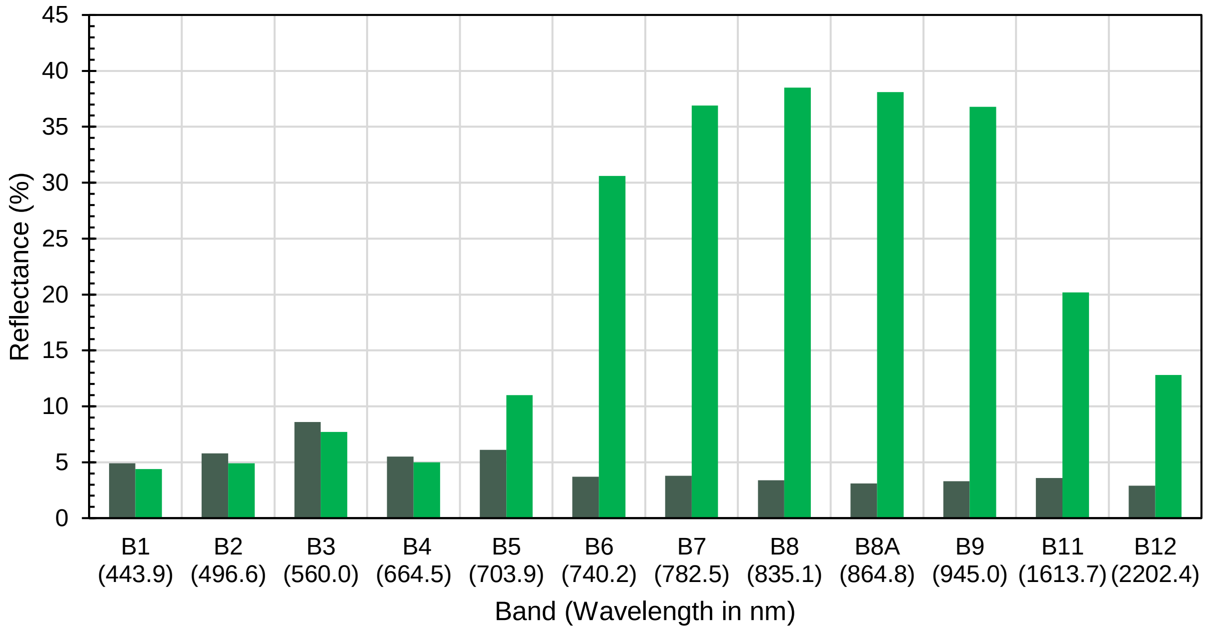


Figure. Response of water and vegetation under different bands

Normalized Difference Vegetation Index (NDVI)

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

$$NDVI\ (Water) = \frac{3.4 - 5.5}{3.4 + 5.5} = -0.24$$

$$NDVI = \frac{B8 - B4}{B8 + B4}\ (Sentinel\ 2)$$

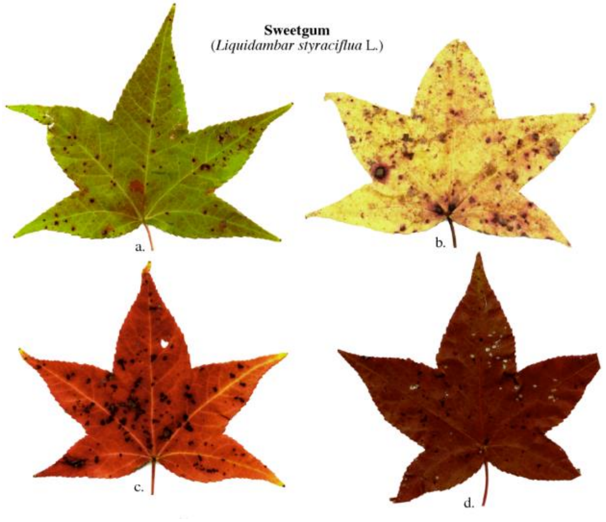
$$NDVI(Vegetation) = \frac{38.5 - 5}{38.5 + 5} = 0.77$$

NDVI

Normalized Difference Vegetation Index (NDVI)

$$NDVI = \frac{NIR\ - RED}{NIR + RED}$$

- NDVI or Normalized Difference Vegetation Index is a remote sensing method that uses the reflectance of light in the visible and near-infrared (NIR) wavelengths to determine the amount and health of vegetation in an area.
- NDVI is widely used in agriculture, forestry, and ecology to monitor the growth and health of vegetation and to identify areas of stress or damage.
- NDVI values can also be used to map and classify vegetation types, and to detect changes in vegetation cover over time.



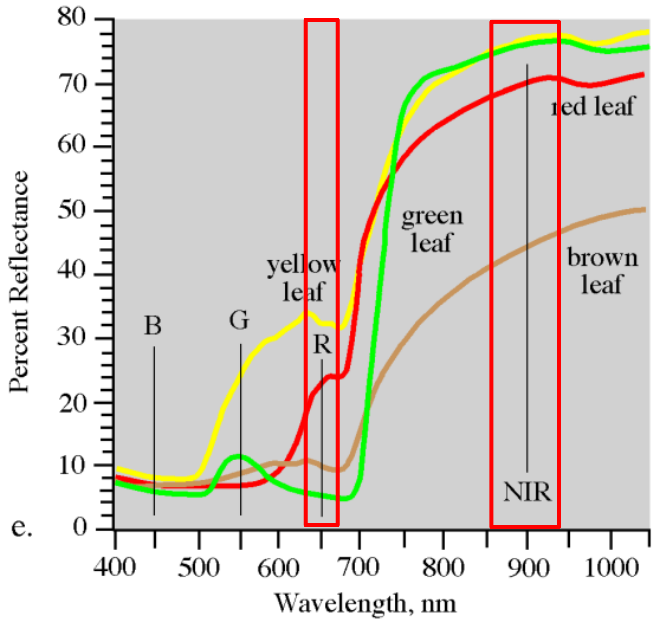
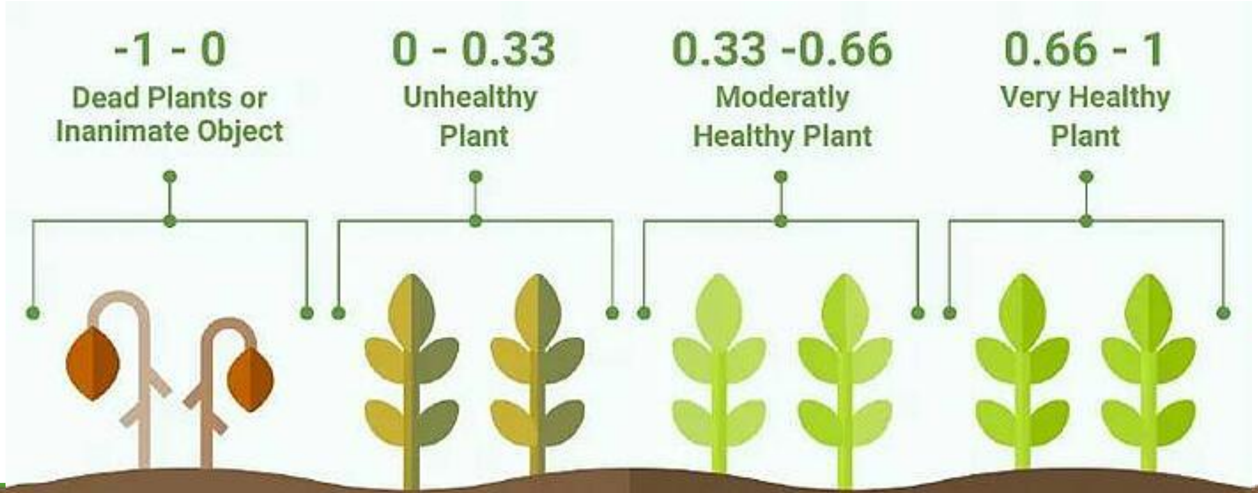


Figure. Spectral Reflectance Characteristics of Sweetgum Leaves (Jensen, 2004)



NDVI

Figure. NDVI variation over Gujarat for the year of 2023

Analysis

- Classification
- Change Detection
- Time Series Analysis

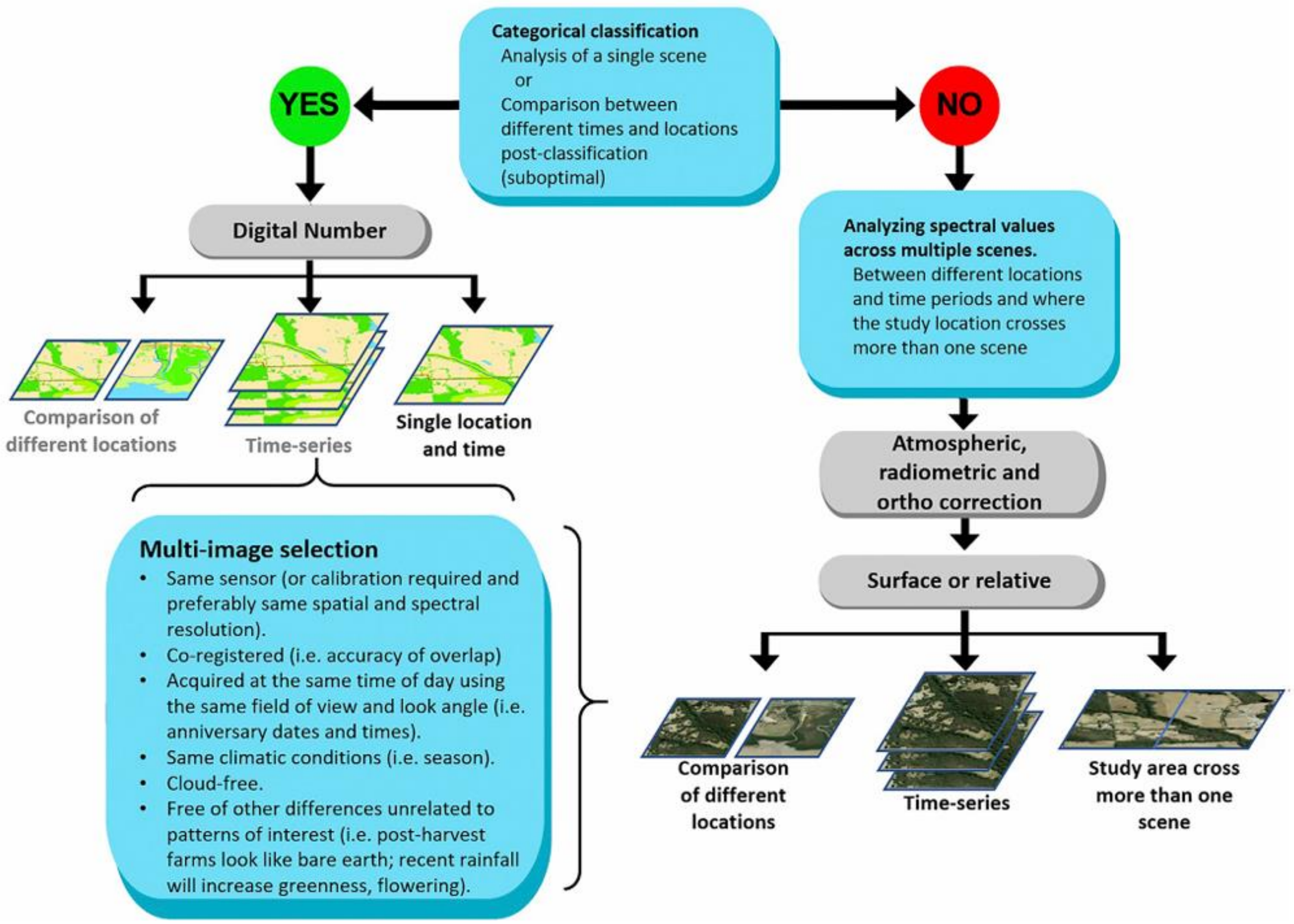


Figure. Image Selection and Pre-processing Decision Tree (Lechner et al., 2020)

Classification

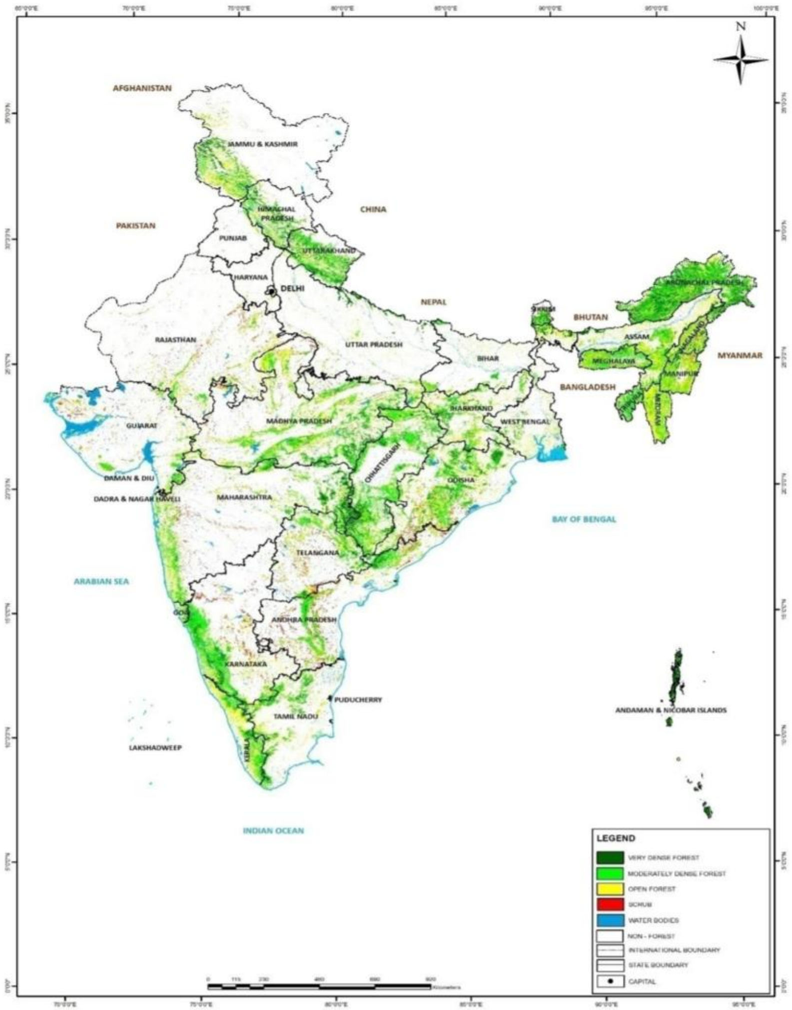
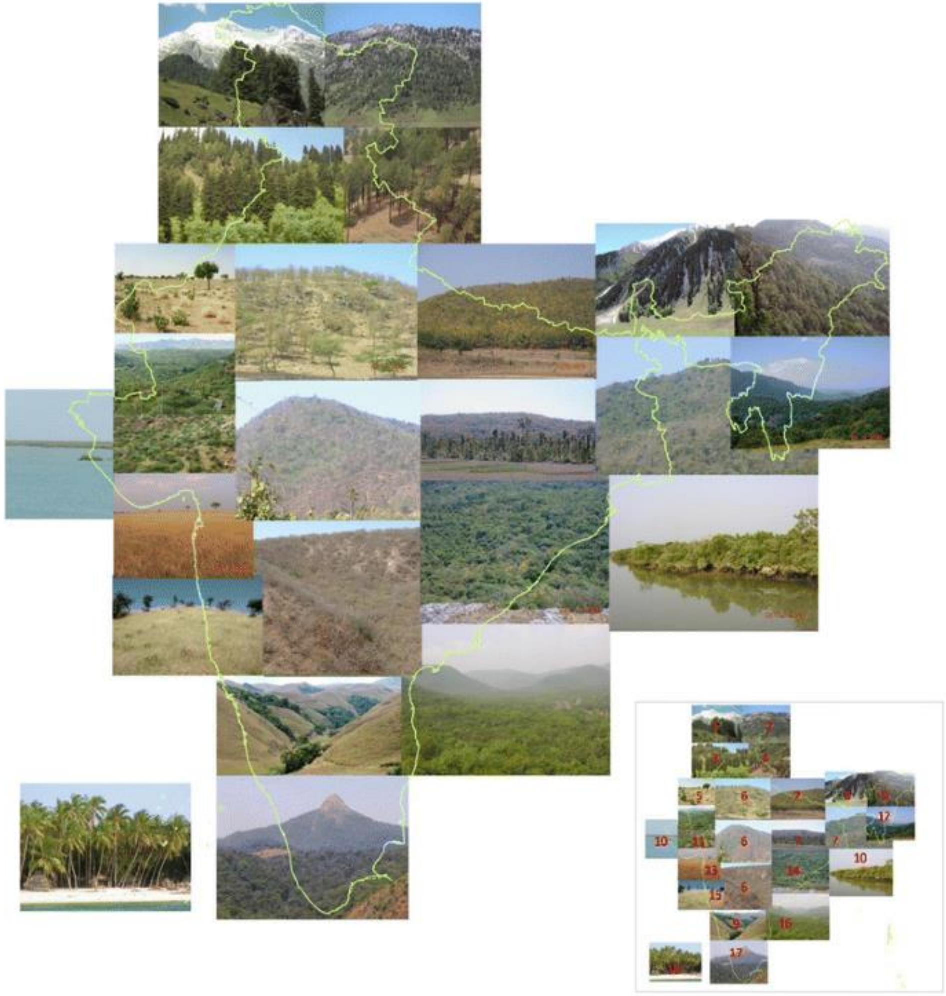


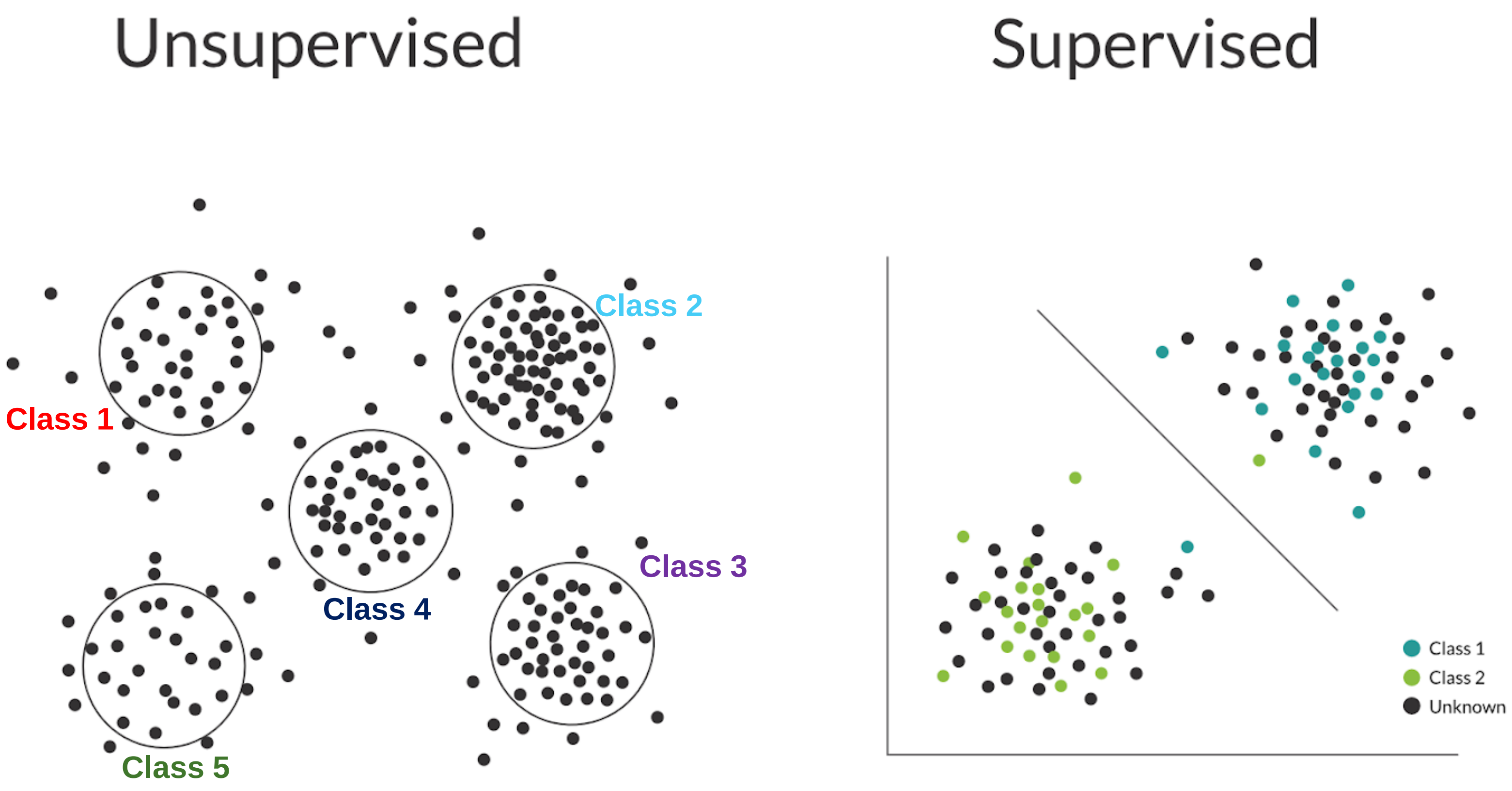
Figure. Forest Cover Map of India 2019



1. Himalayan Dry temperate forest 2. Moist Alpine Scrub 3. Himalayan Moist temperate forest
4. Subtropical Pine forest 5. Tropical dry scrub 6. Tropical Dry Deciduous forest
7. Tropical Moist Deciduous forest 8. Sub Alpine forest 9. Montane wet temperate forest
10. Littoral and Swamp forest (Mangroves) 11. Tropical Thorn forest 12. Subtropical broadleaved hill forest
13. Grassland 14. Tropical Semi evergreen forest 15. Savanna 16. Tropical Dry evergreen forest
17. Tropical Wet Evergreen forest 18. Plantations

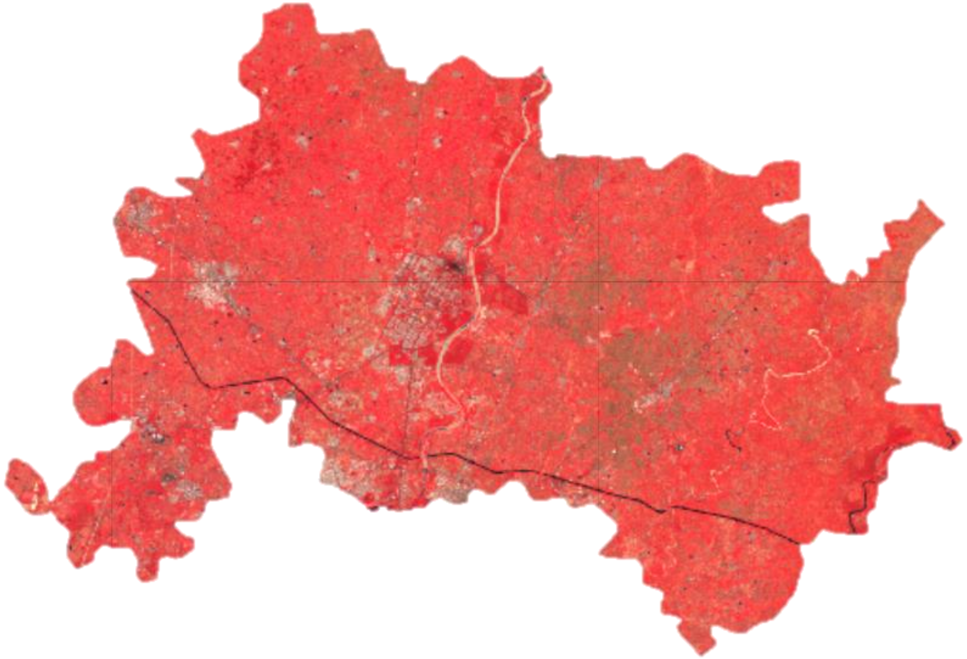
Figure. Indicative locations of major vegetation types of India based on predominance and ecological uniqueness (Reddy et al., 2015)

Classification



Classification

FCC Composite



LULC Classification

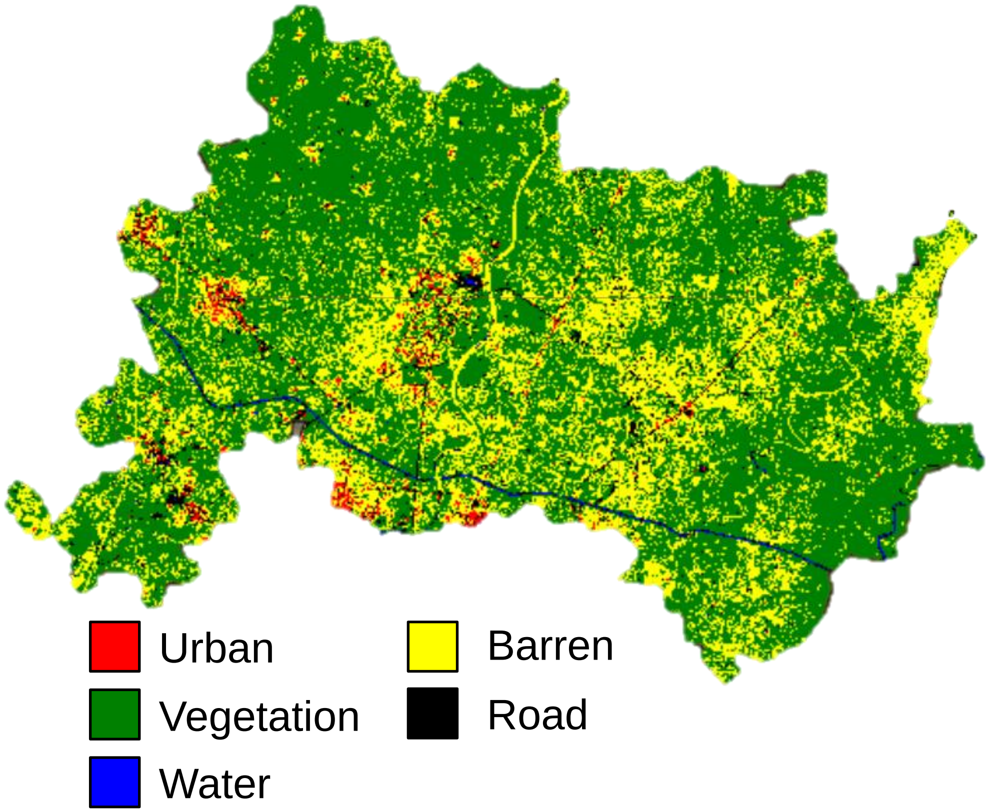


Figure. LULC Classification of Gandhinagar city

Change Detection

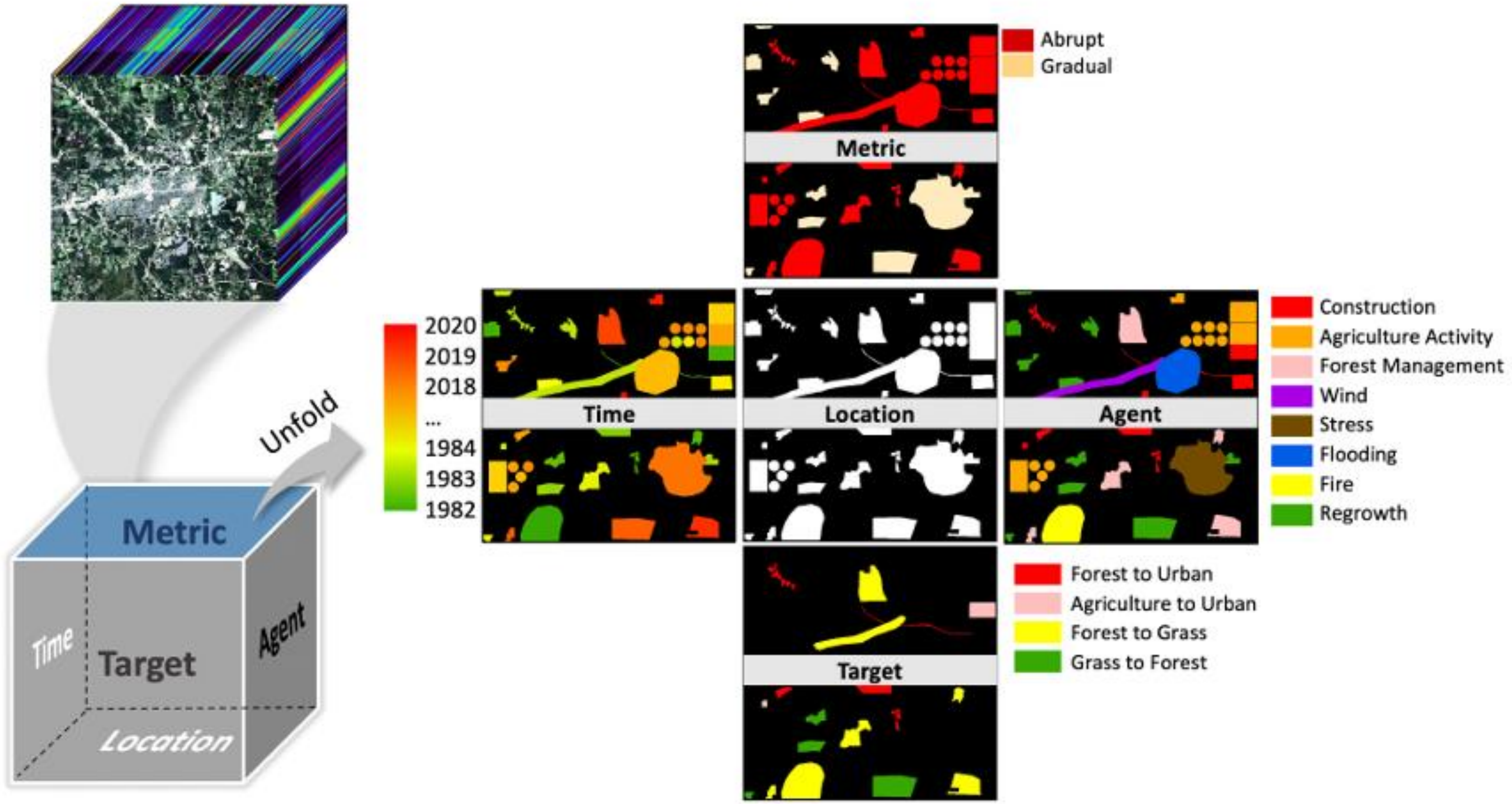


Figure. The five facets of change detection (Zhu et al., 2022)

Change Detection

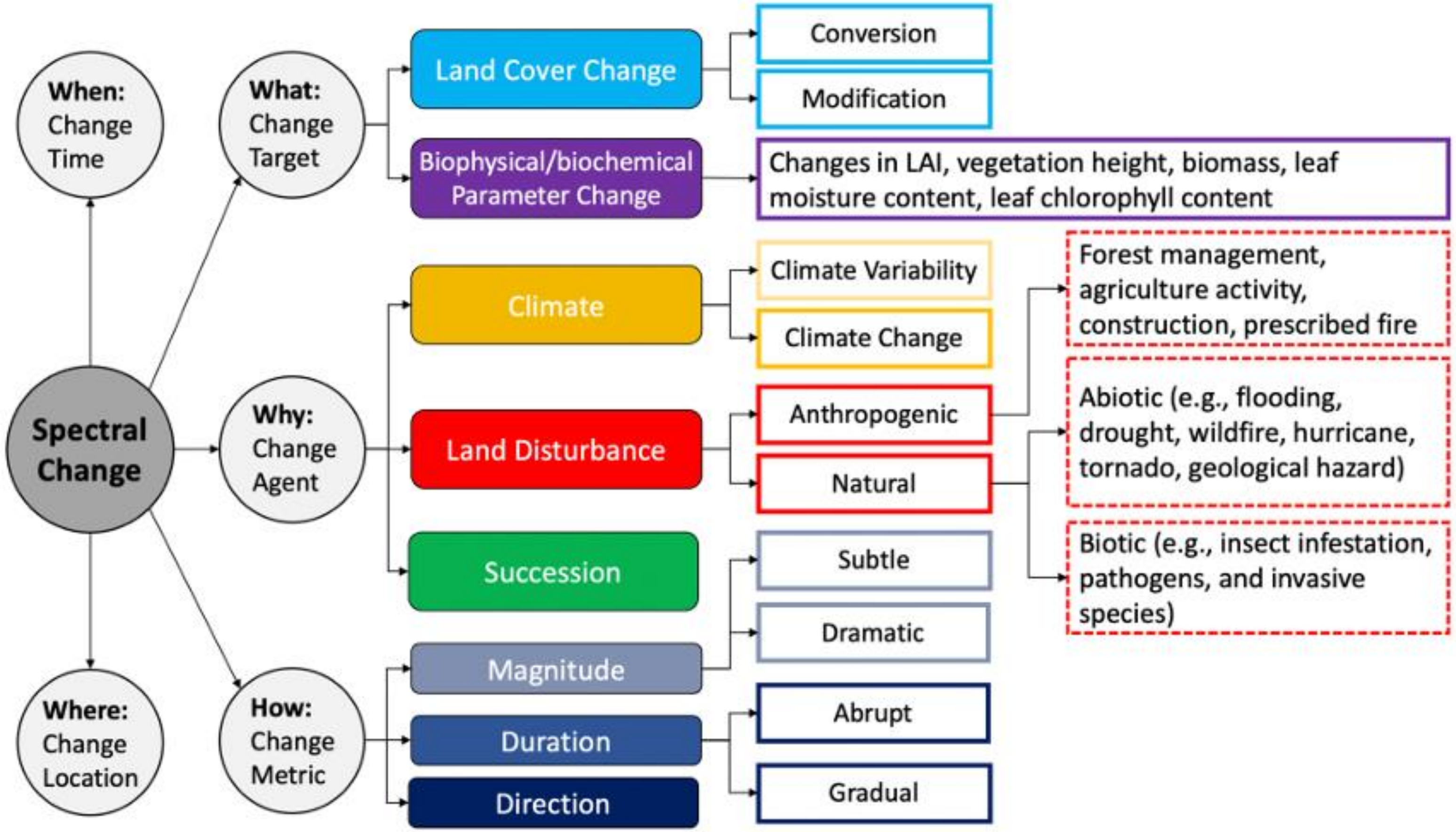


Figure. Hierarchical classification system for the five facets of land change (Zhu et al., 2022).

Change Detection

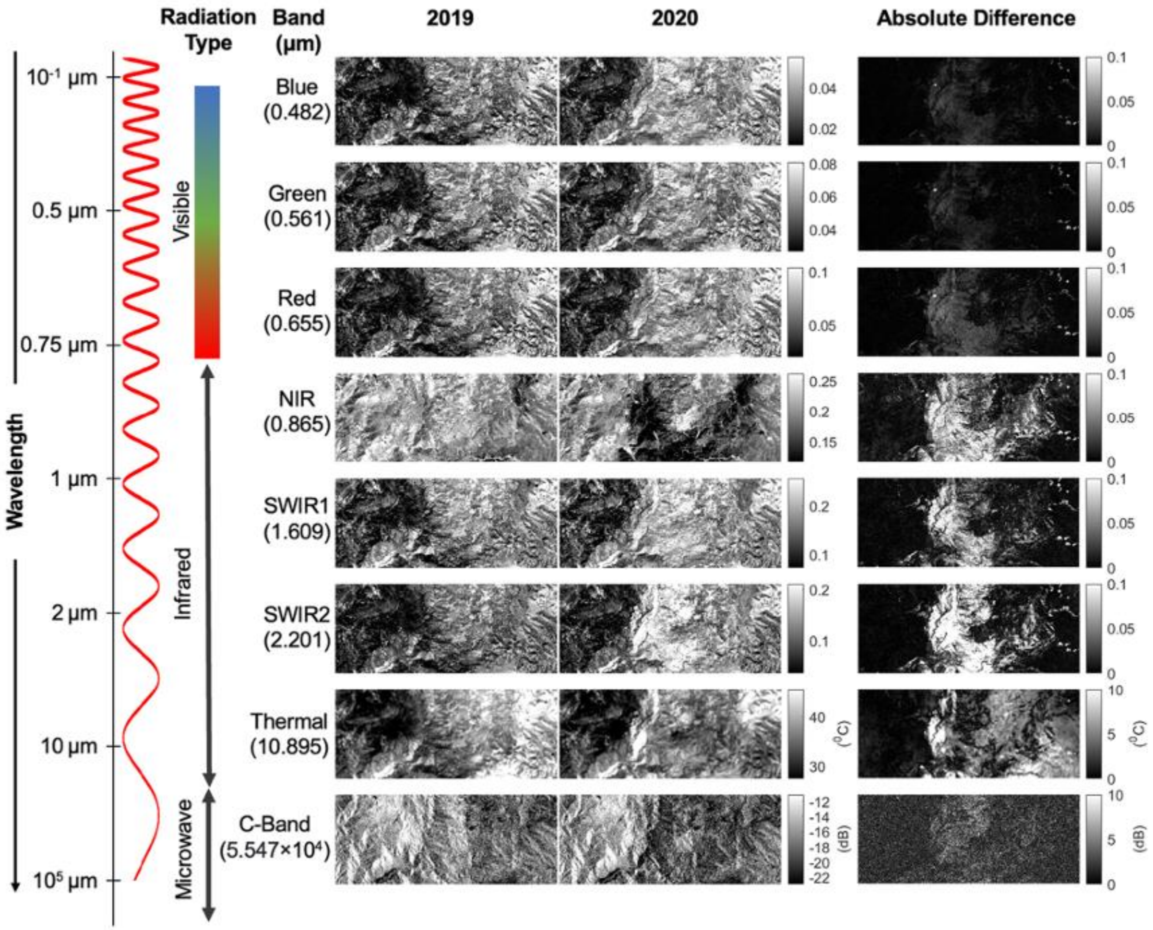


Figure. Spectral change at different band wavelengths induced by a fire disturbance (Zhu et al. 2022).

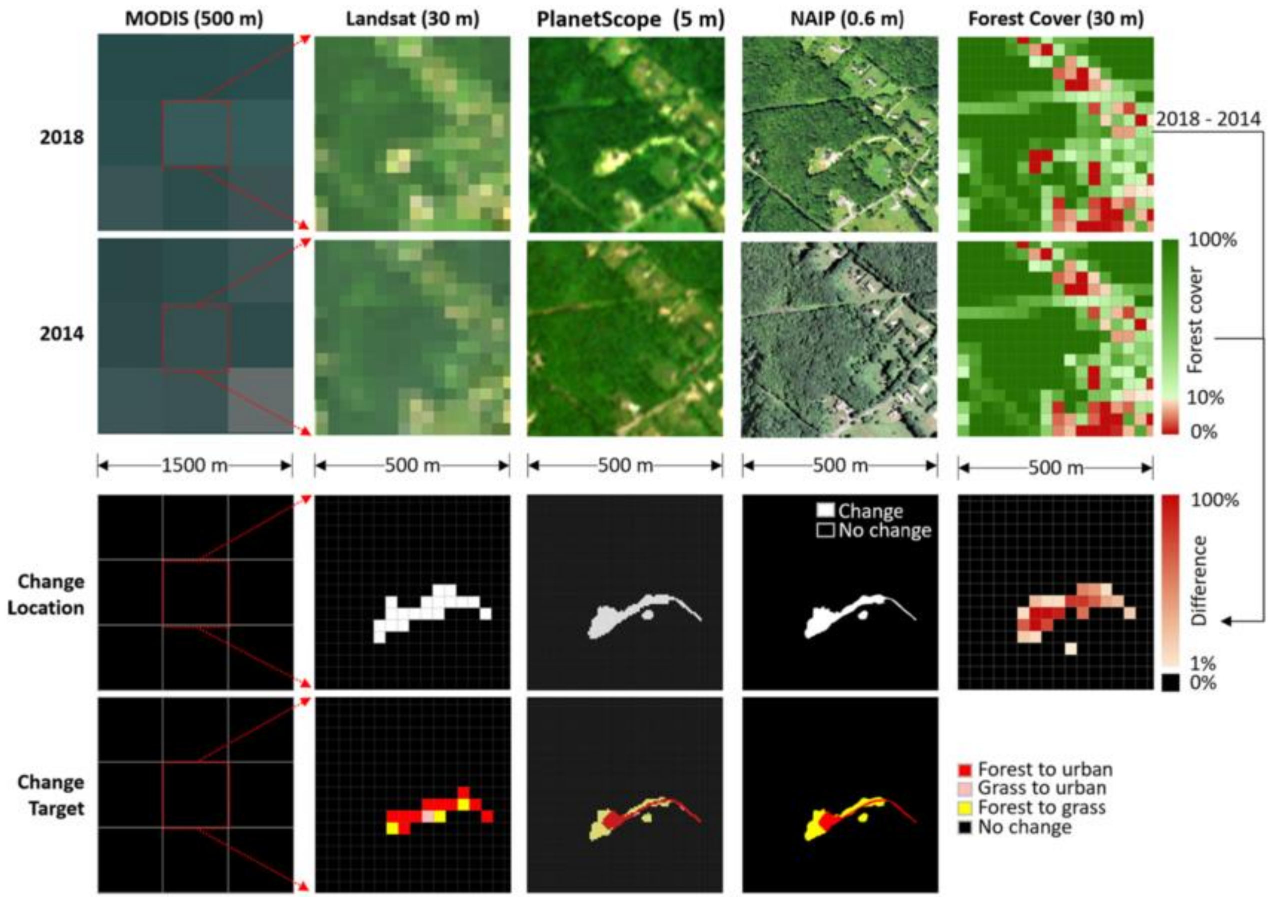
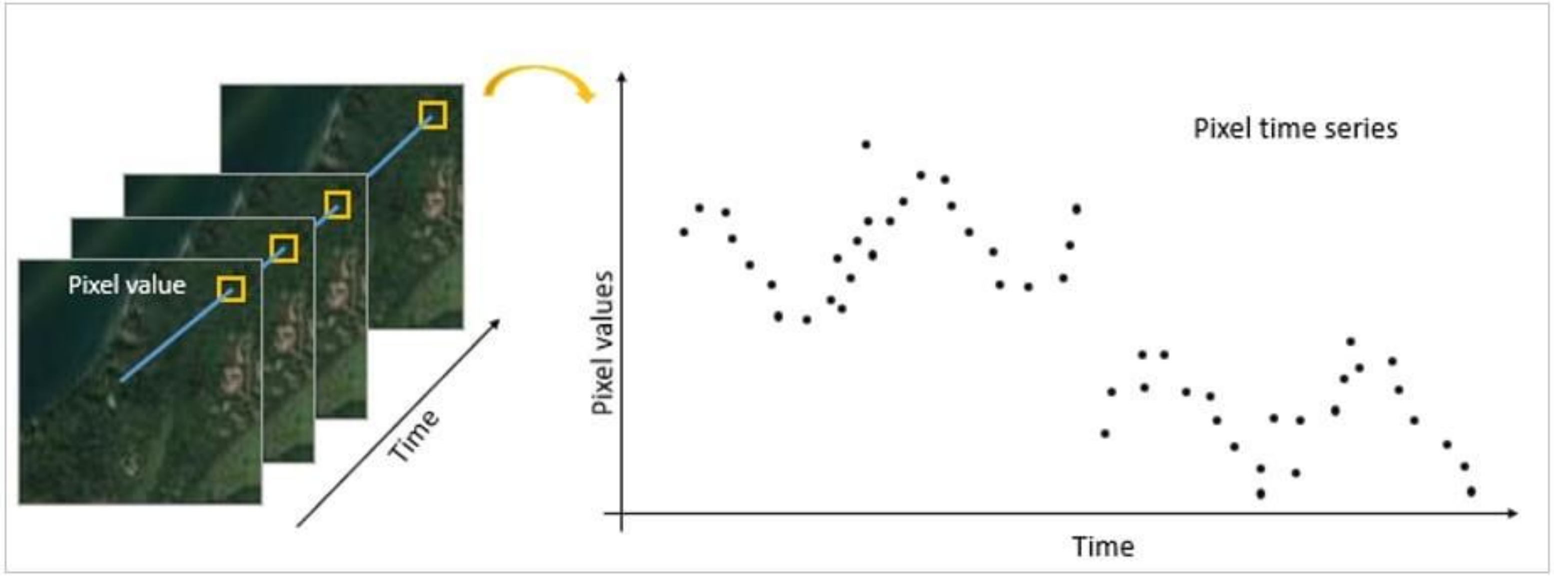


Figure. The impacts of spatial resolution on mapping change location and change target between 2014 and 2018 (Zhu et al. 2022).

Time Series Analysis



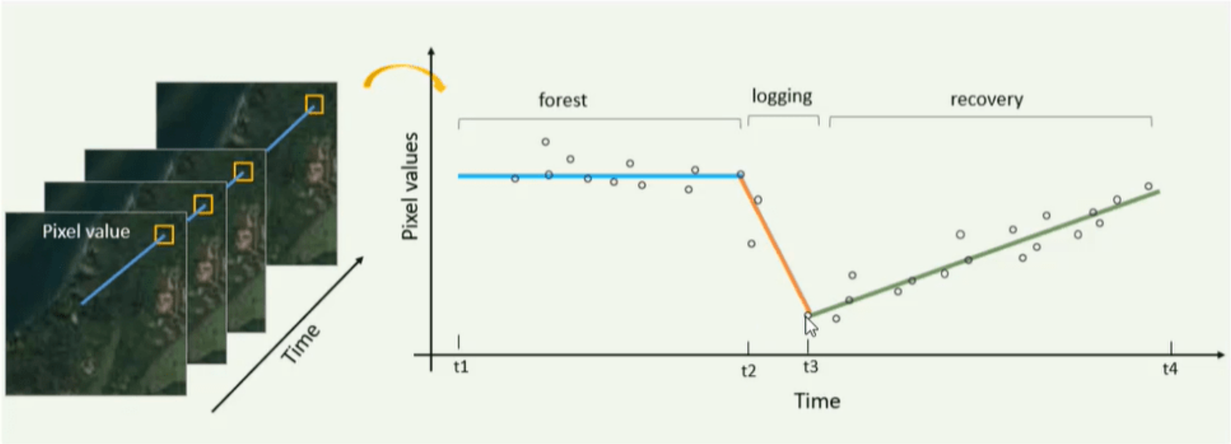
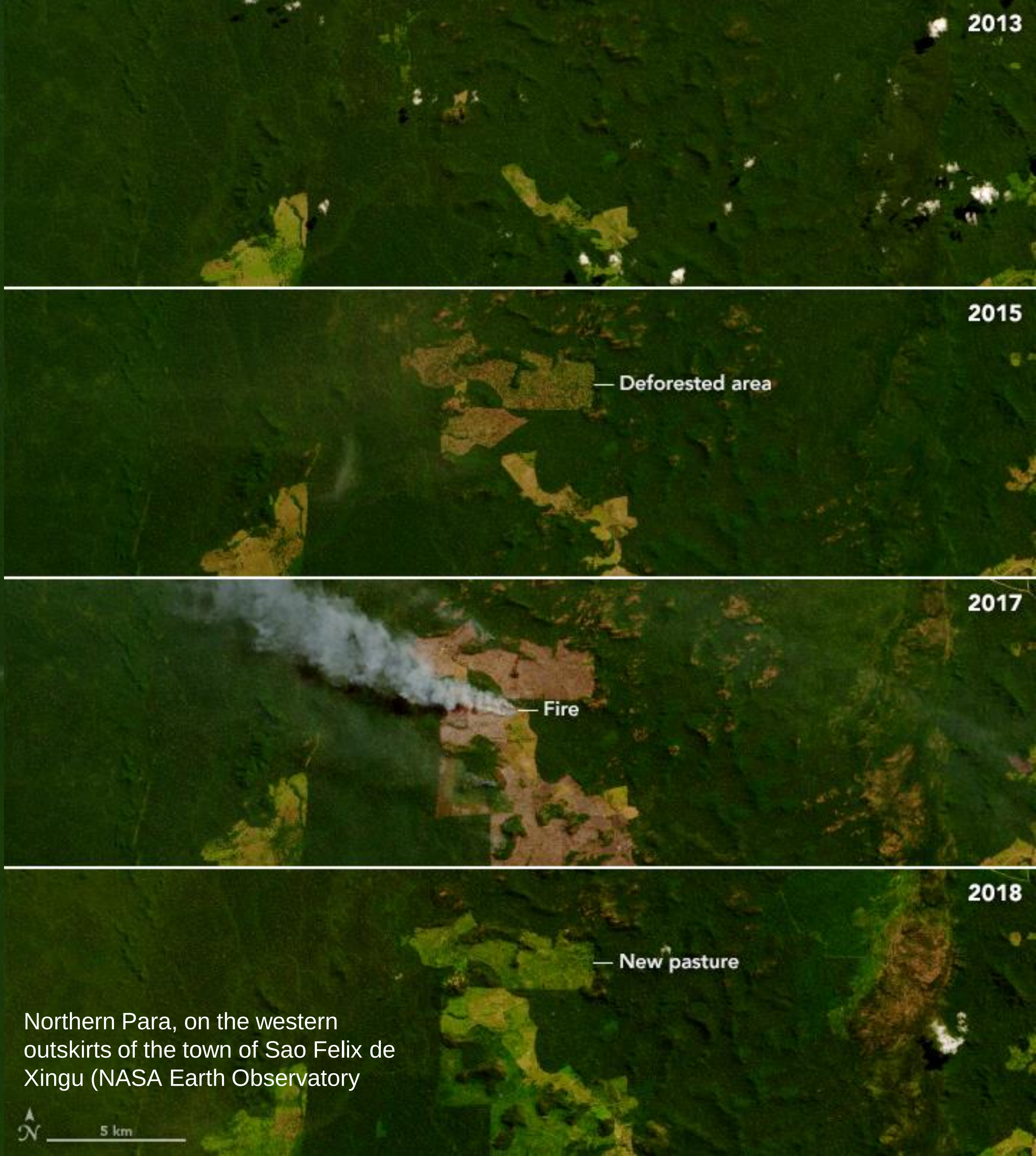


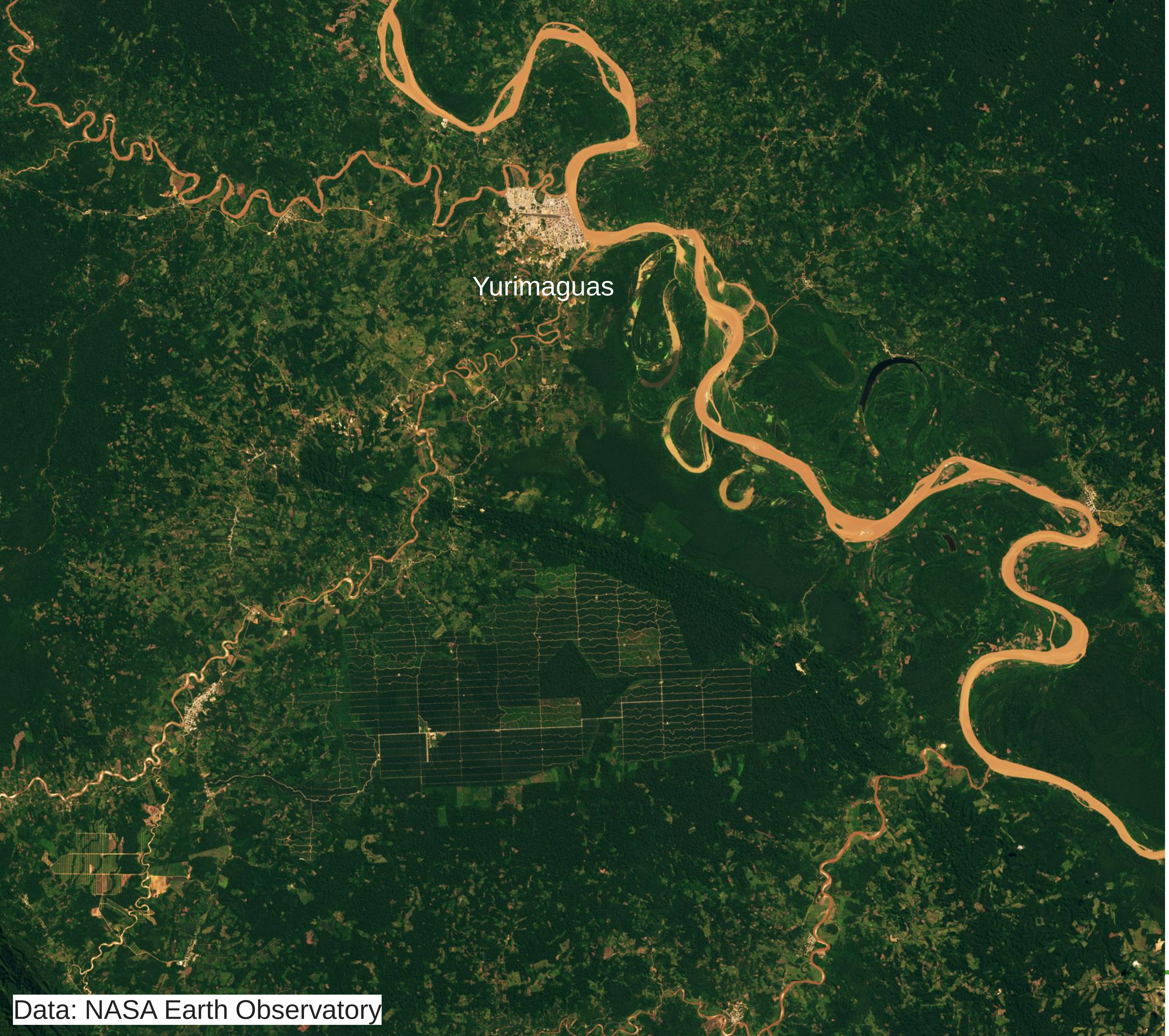
Figure. Time Series Analysis for forest monitoring (ESRI, 2021)

Year of Forest Loss
2001
VENEZUELA
GUYANA
SURINAME
FRENCH GUIANA
COLOMBIA
ECUADOR
BRAZIL
PERU
BOLIVIA

BR-163, Highway in Brazil (NASA Earth Observatory)

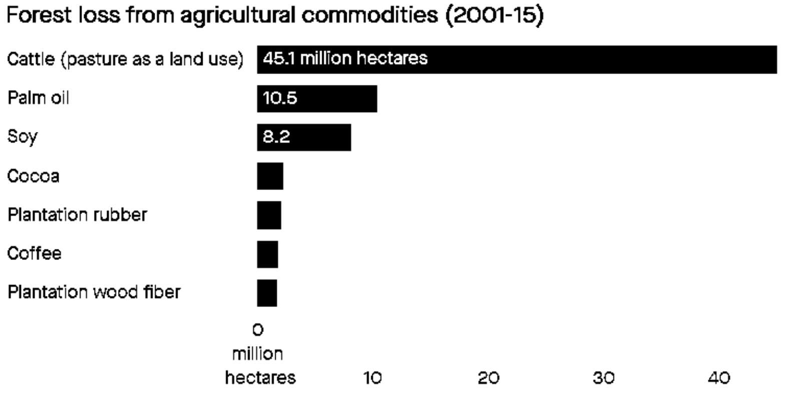


Northern Para, on the western outskirts of the town of Sao Felix de Xingu (NASA Earth Observatory



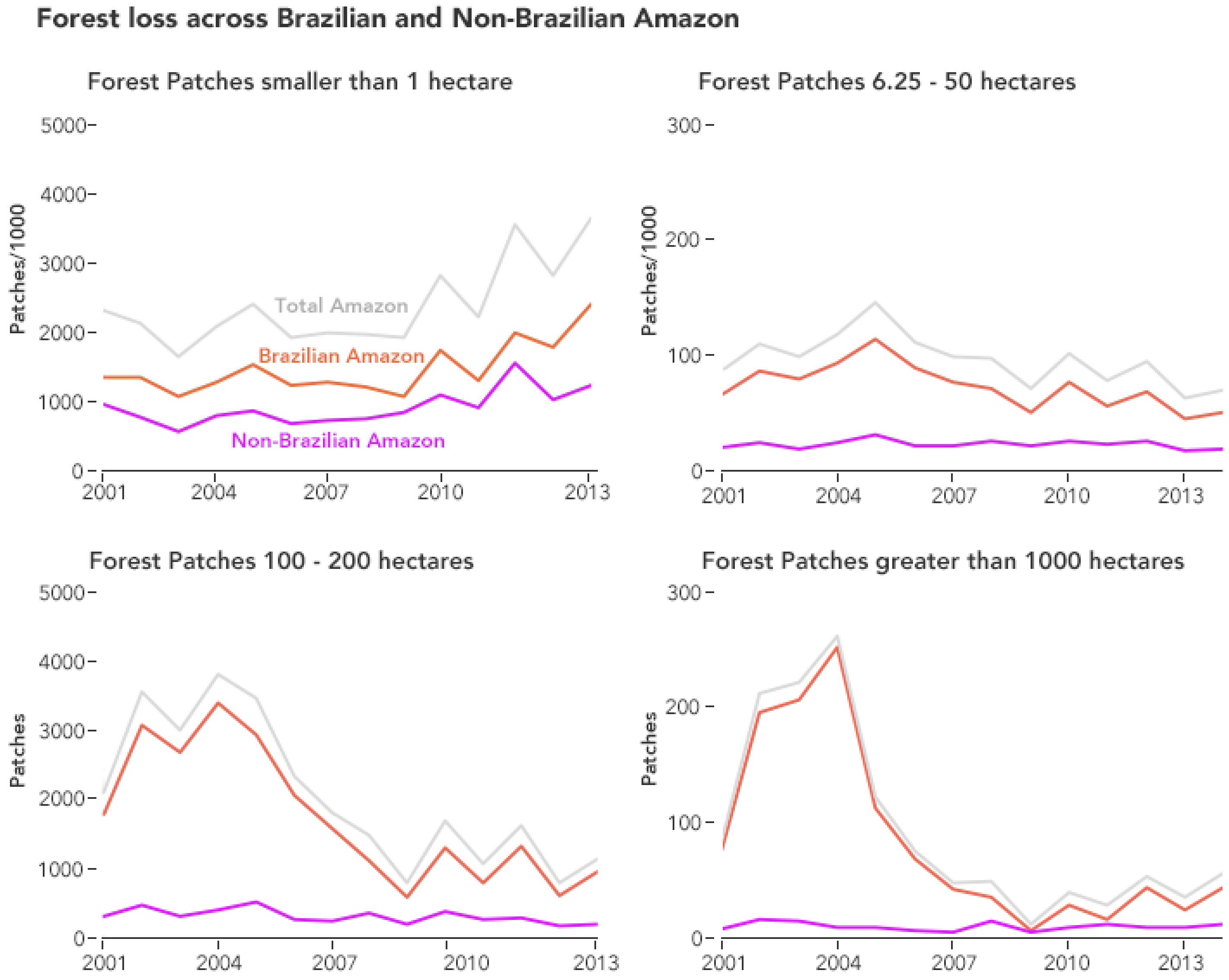
Data: NASA Earth Observatory

Forest Loss from Agriculture



Data: WRI

Amazon Deforestation



Time Series Analysis

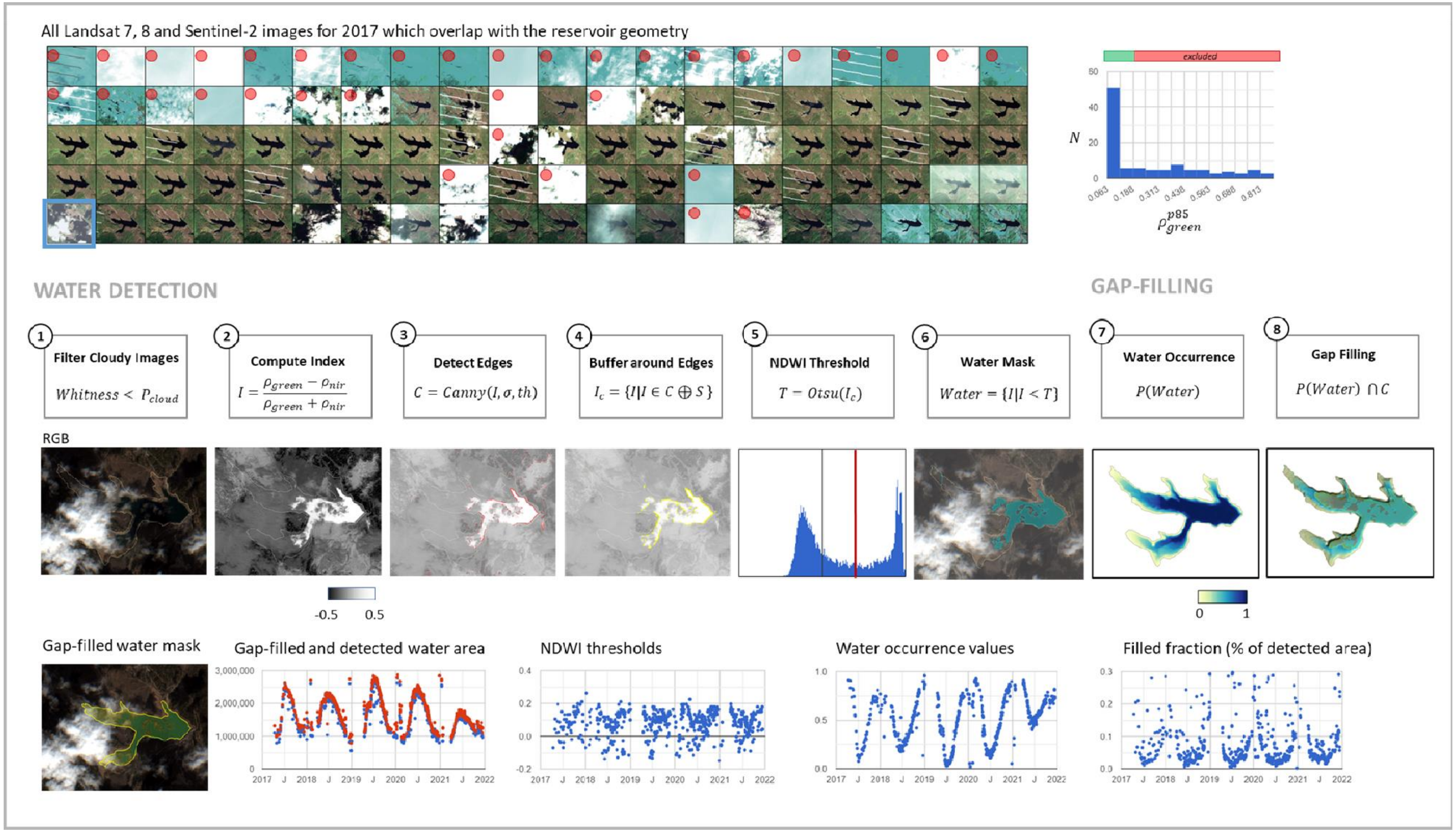
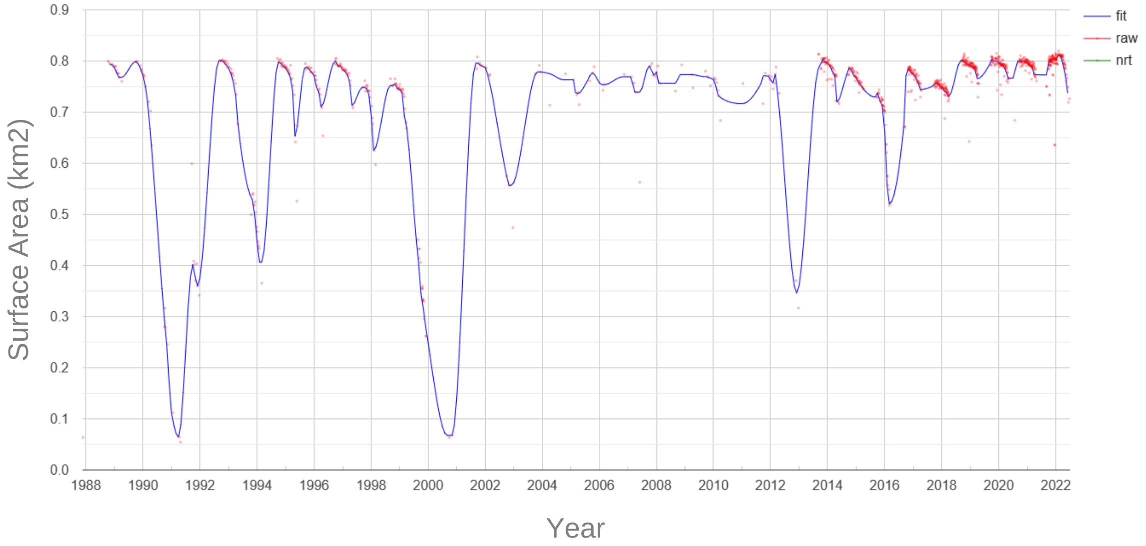


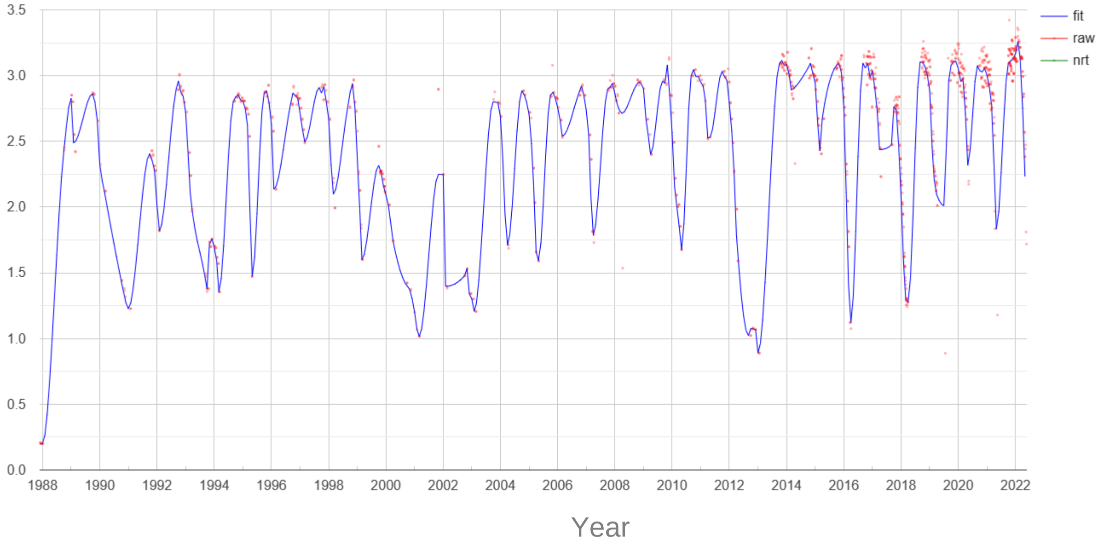
Figure. Method of surface water area detection for reservoirs (Donchyts et al., 2022).

Time Series Analysis

Kamleshwar Dam

Shingoda Dam





Active Remote Sensing

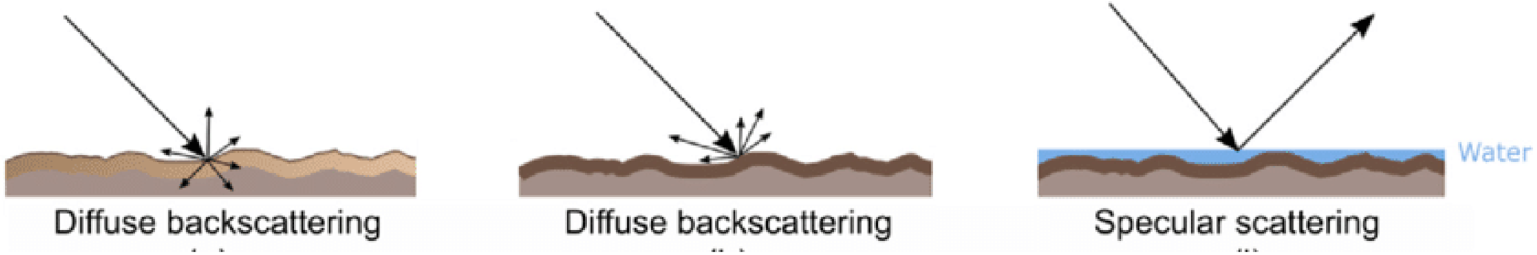
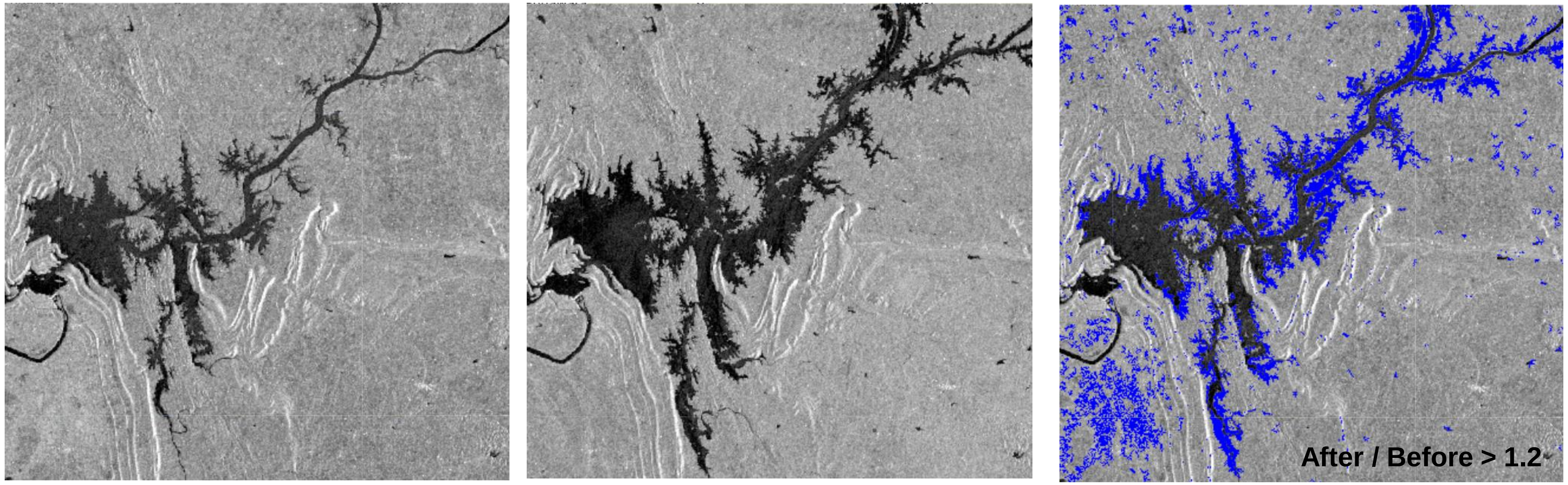


Figure. The concept of backscattering



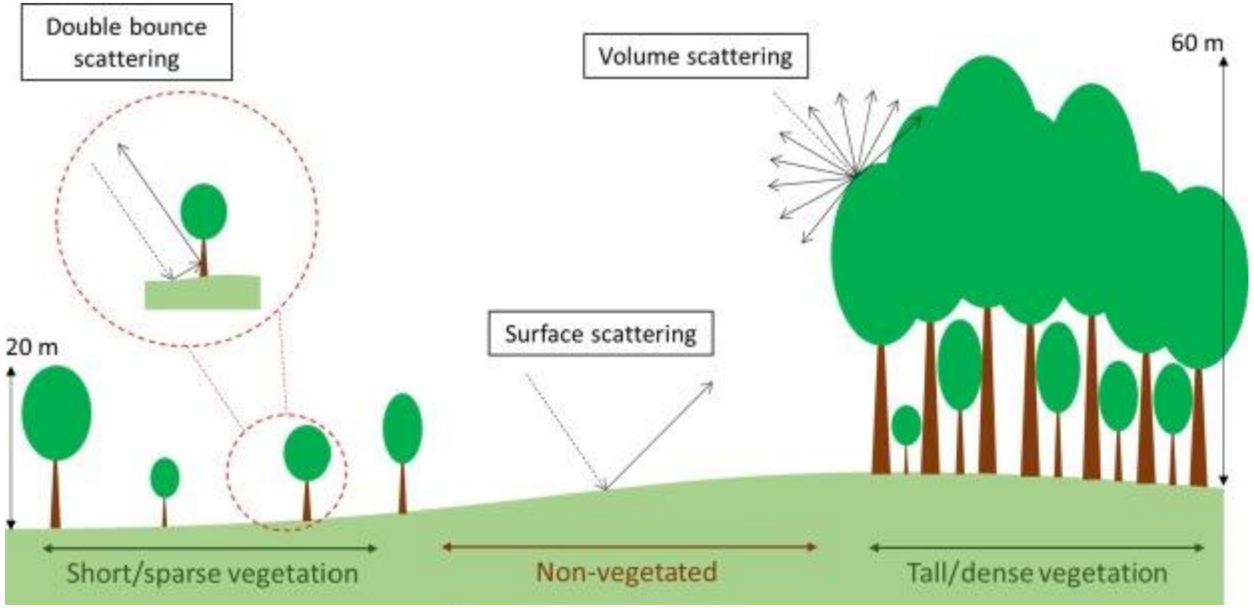
Before event

After event

Difference

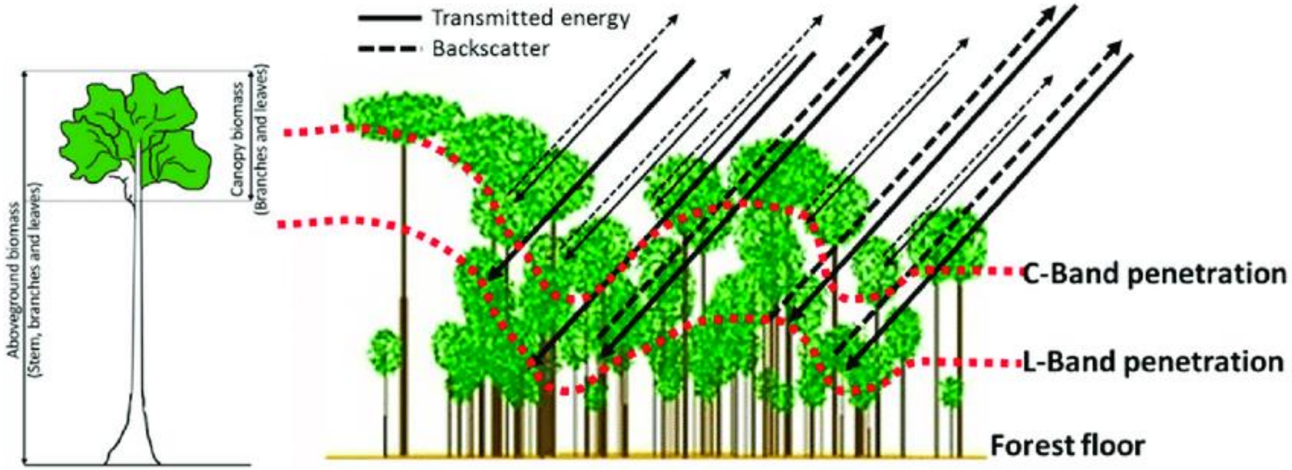
Figure. Detection of flooded area using SAR data

Other Applications

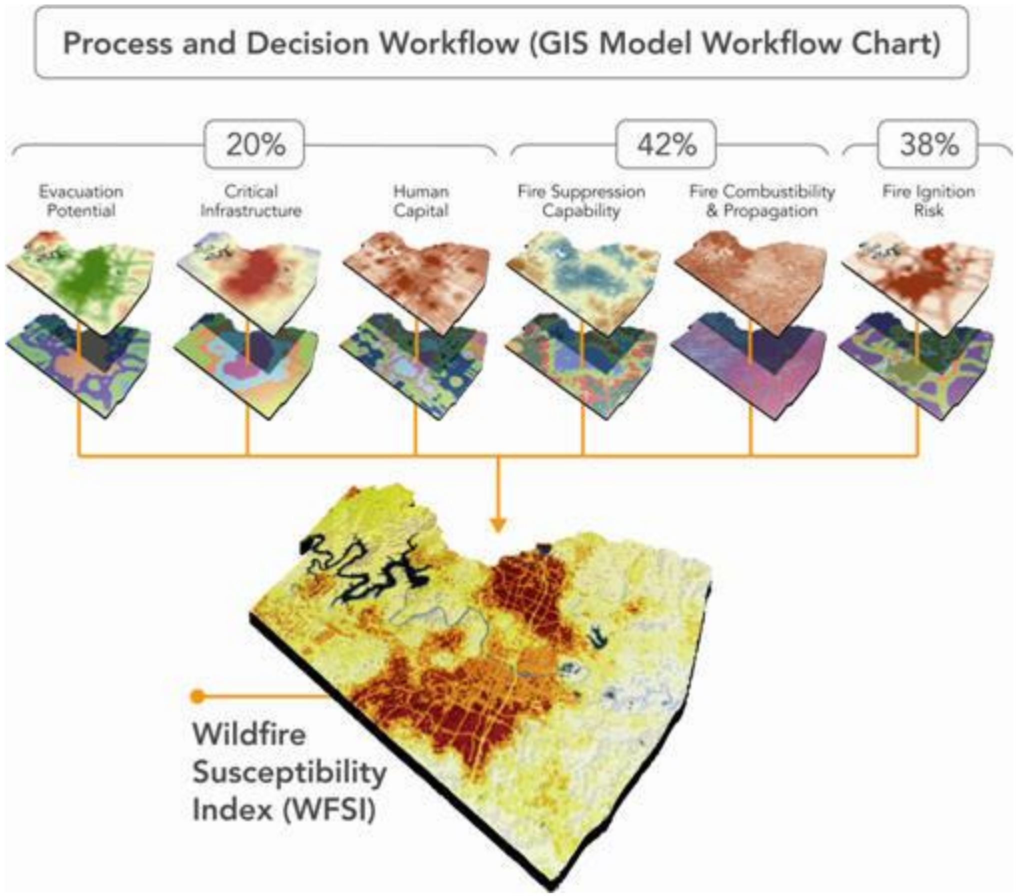


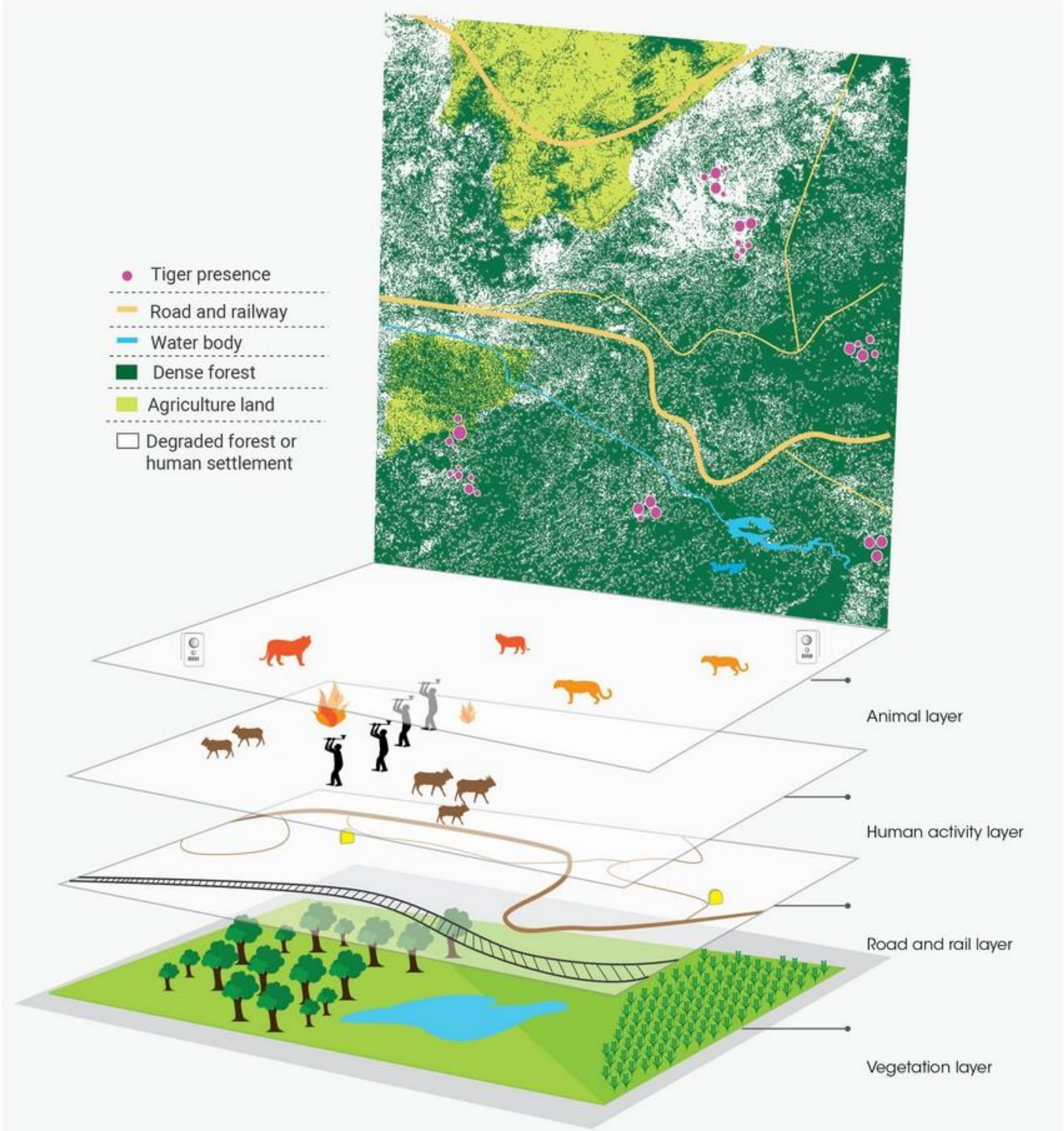
Microwaves Frequency Bands

Band	Frequency range
HF Band	3 to 30 MHz
VHF Band	30 to 300 MHz
UHF Band	300 to 1000 MHz
L Band	1 to 2 GHz
S Band	2 to 4 GHz
C Band	4 to 8 GHz
X Band	8 to 12 GHz
Ku Band	12 to 18 GHz
K Band	18 to 27 GHz
Ka Band	27 to 40 GHz
V Band	40 to 75 GHz
W Band	75 to 110 GHz
mm Band	110 to 300 GHz



GIS Integration






thank you!