Basic concepts of remote sensing and GIS

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UNITED NATIONS
Office for Outer Space Affairs

Satellite images and geospatial information for damage and loss assessment

Remote Sensing images

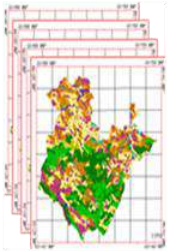
- Fast access to images (tools like DigitalGlobe Firstlook
- Prioritise which images to be analysed first
- Rapid anaylsis of disaster extent and impact

Integration in GIS

Building infrastructure data

Integrating with prices/values data

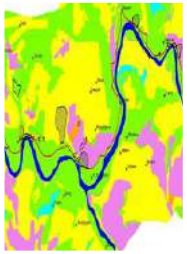
Demography data



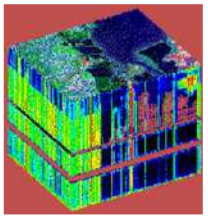
Evidence based inputs for damage and loss assessment

Agriculture crop loss
Housing and infrastructure
Demography
Insurance

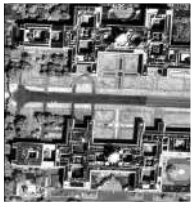
Earth Observation from Space



Spatially extensive mapping

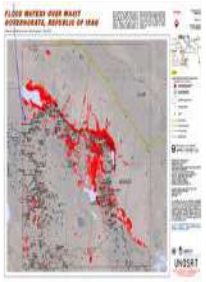


Beyond ‘human eye’ capability

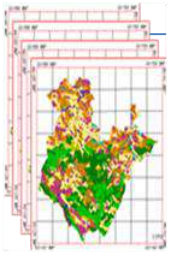


Localised event detection

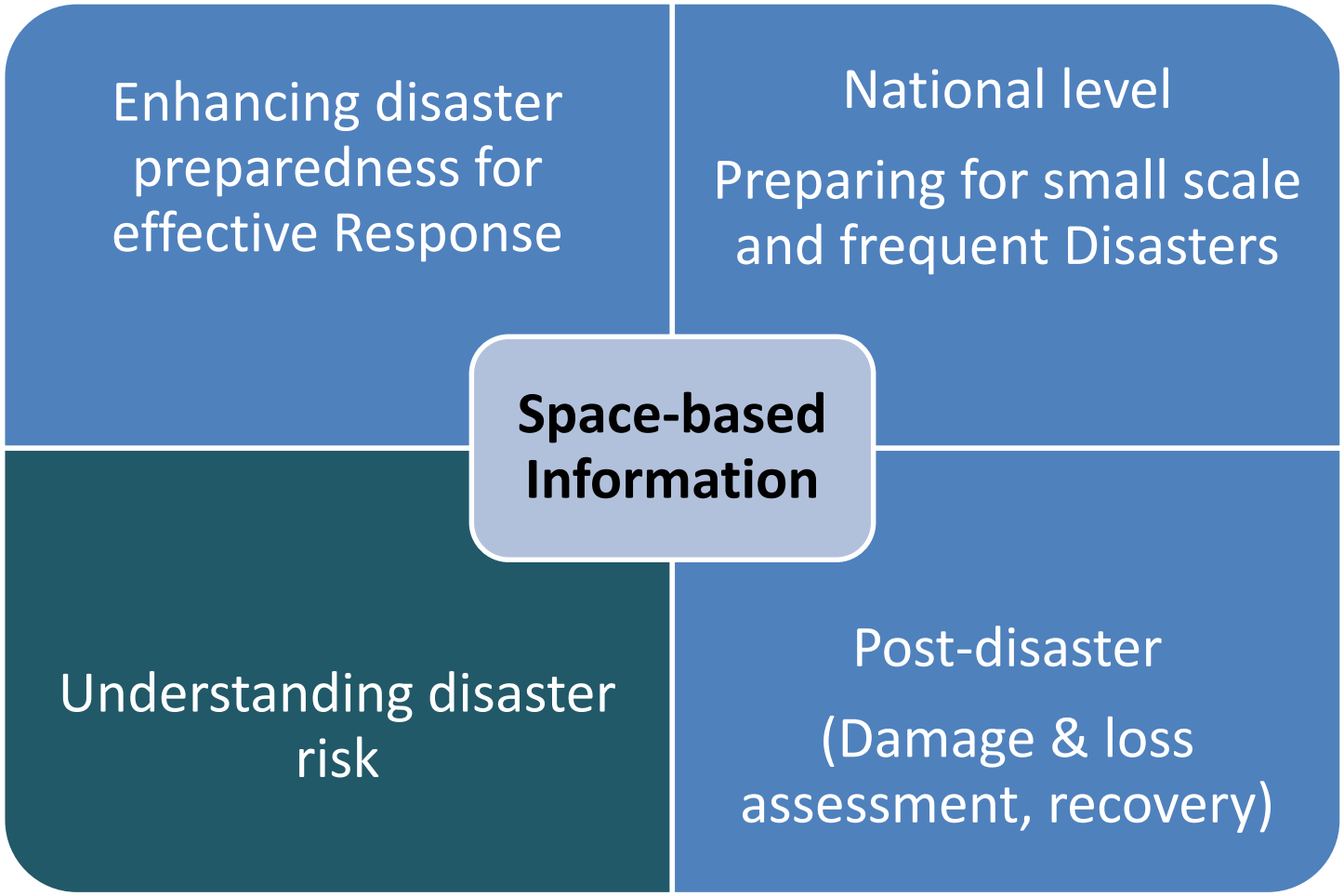
Access difficult or dangerous sites



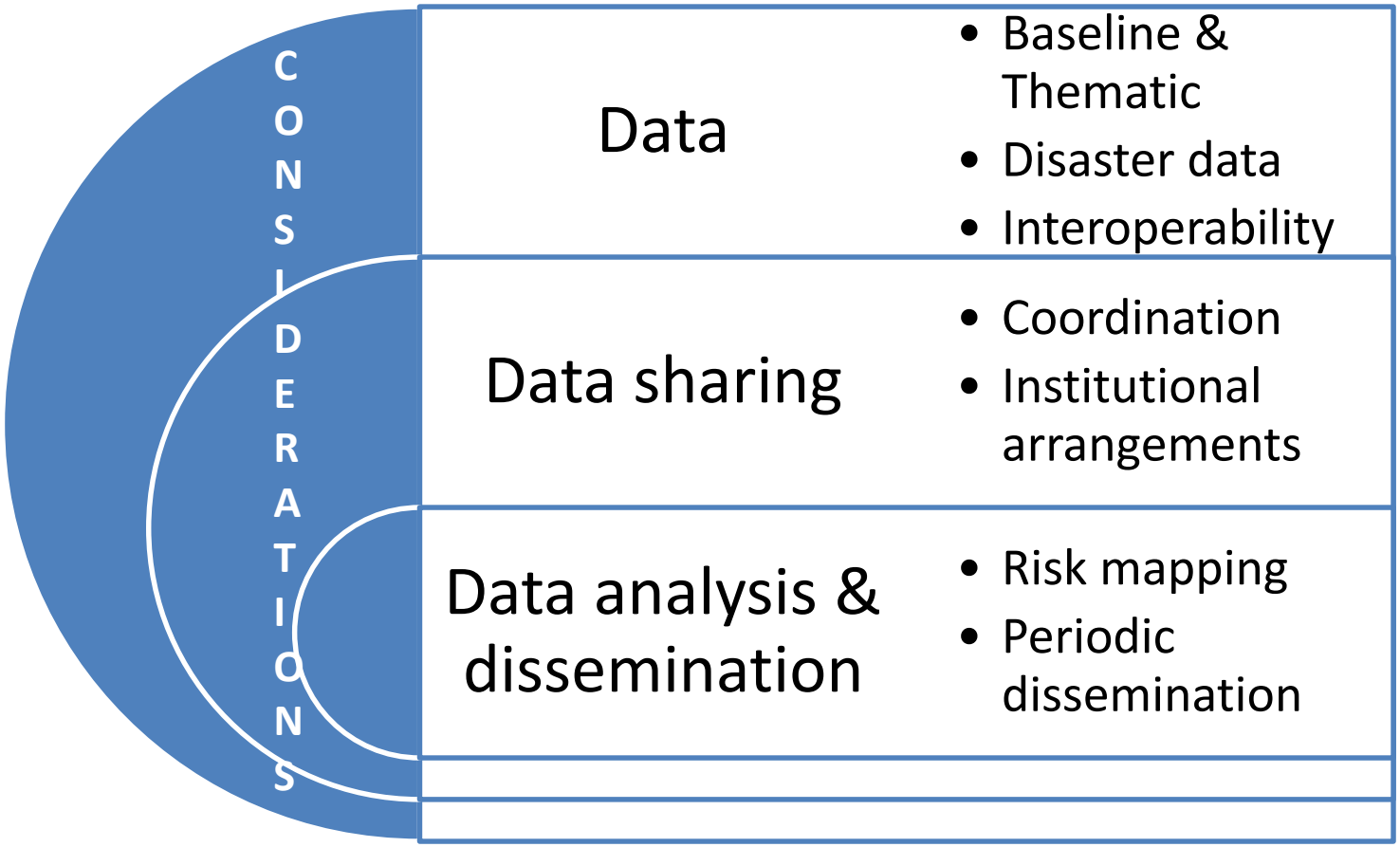
Near real time response

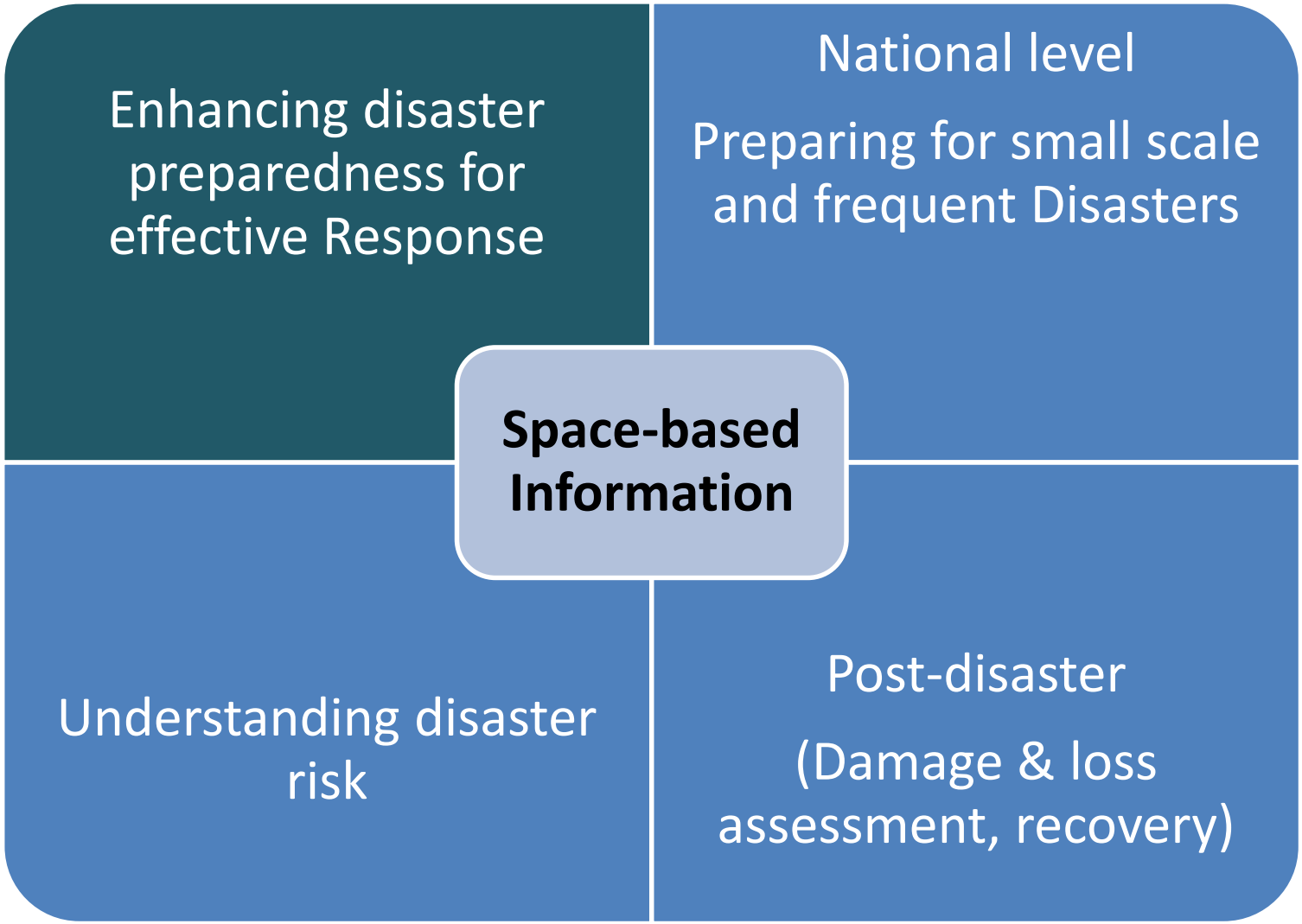


Geo-referenced and calibrated


Enhancing disaster preparedness for effective Response
National level
Preparing for small scale and frequent Disasters
Space-based Information
Understanding disaster risk
Post-disaster
(Damage & loss assessment, recovery)

Understanding disaster risk

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Enhancing disaster preparedness for effective Response

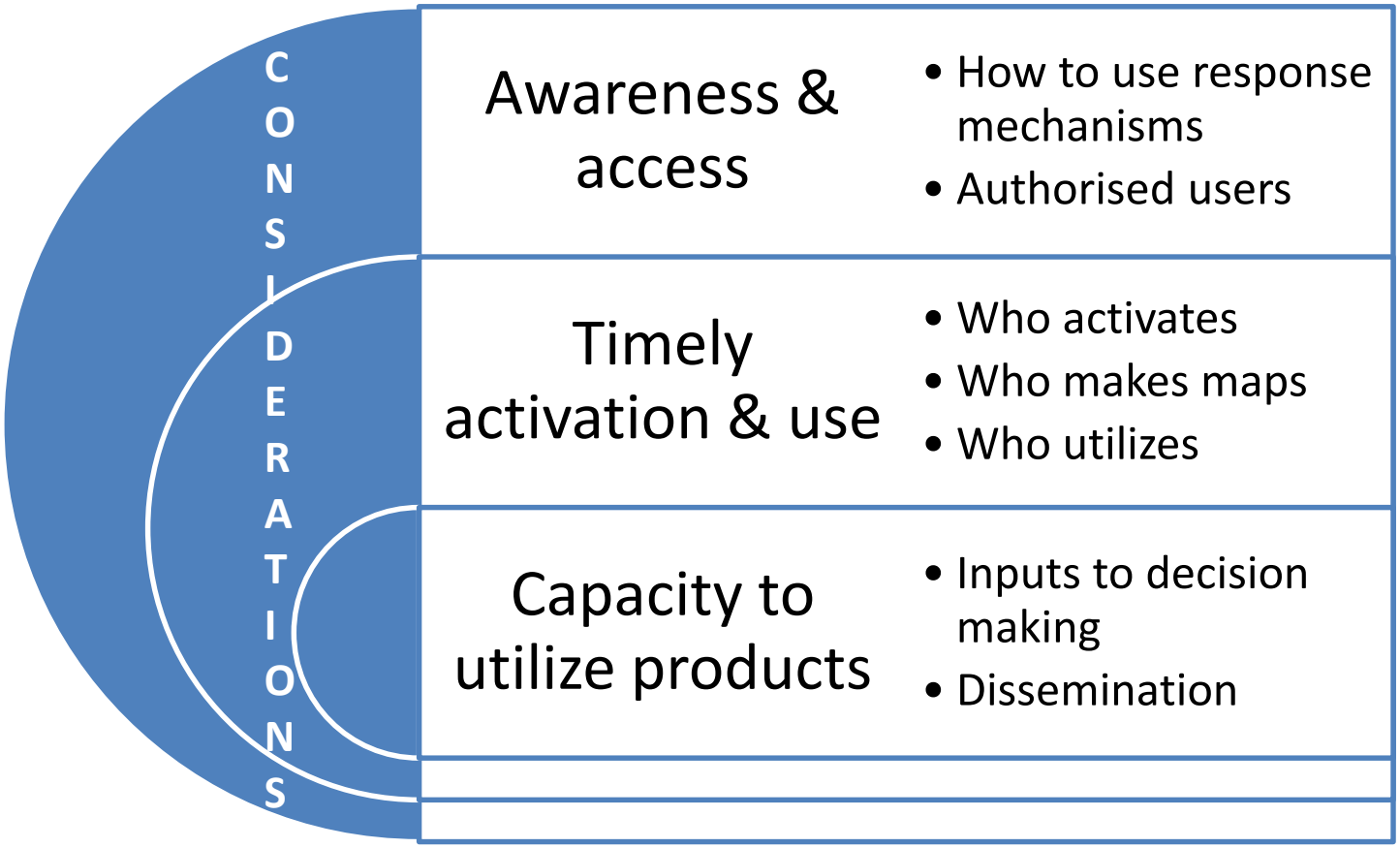
- International Charter Space and Major Disasters

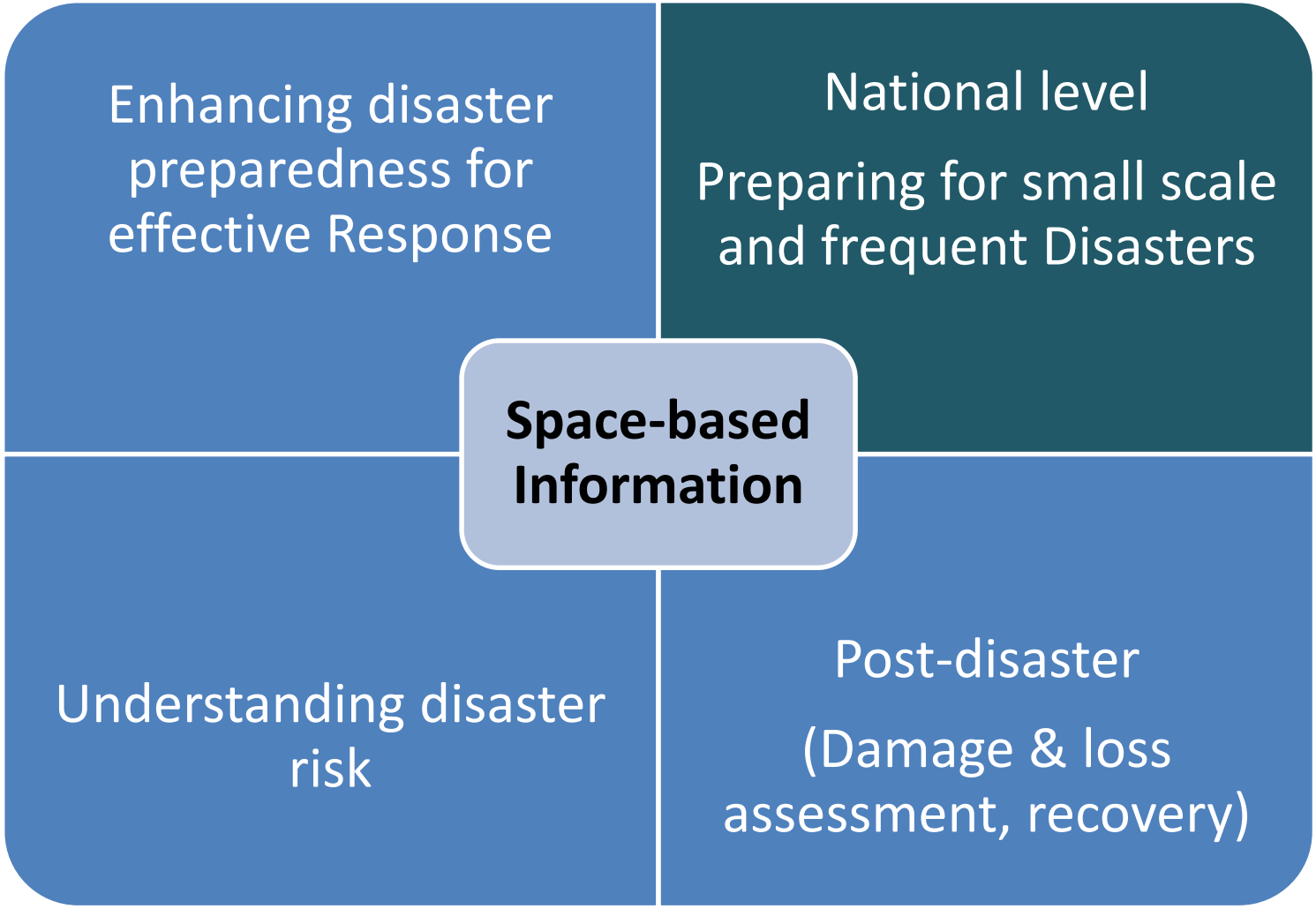
- Sentinel Asia

- COPERNICUS-Emergency Management System

UN-SPIDER

Enhancing disaster preparedness for effective Response




Enhancing disaster preparedness for effective Response
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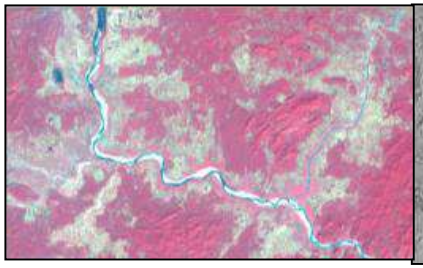
Preparing for small scale and frequent Disasters

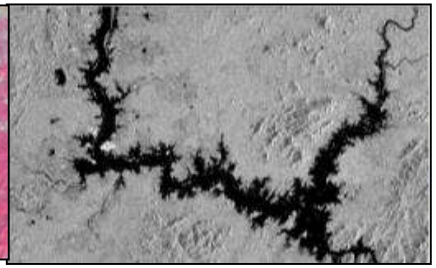
Charter activation (2002 to 2014)

- Indonesia - 15 times
- Myanmar - 6 times
- Vietnam - 14 times
- Philippines – 16 times
- South Korea – 2 times

These countries might have faced many more disasters

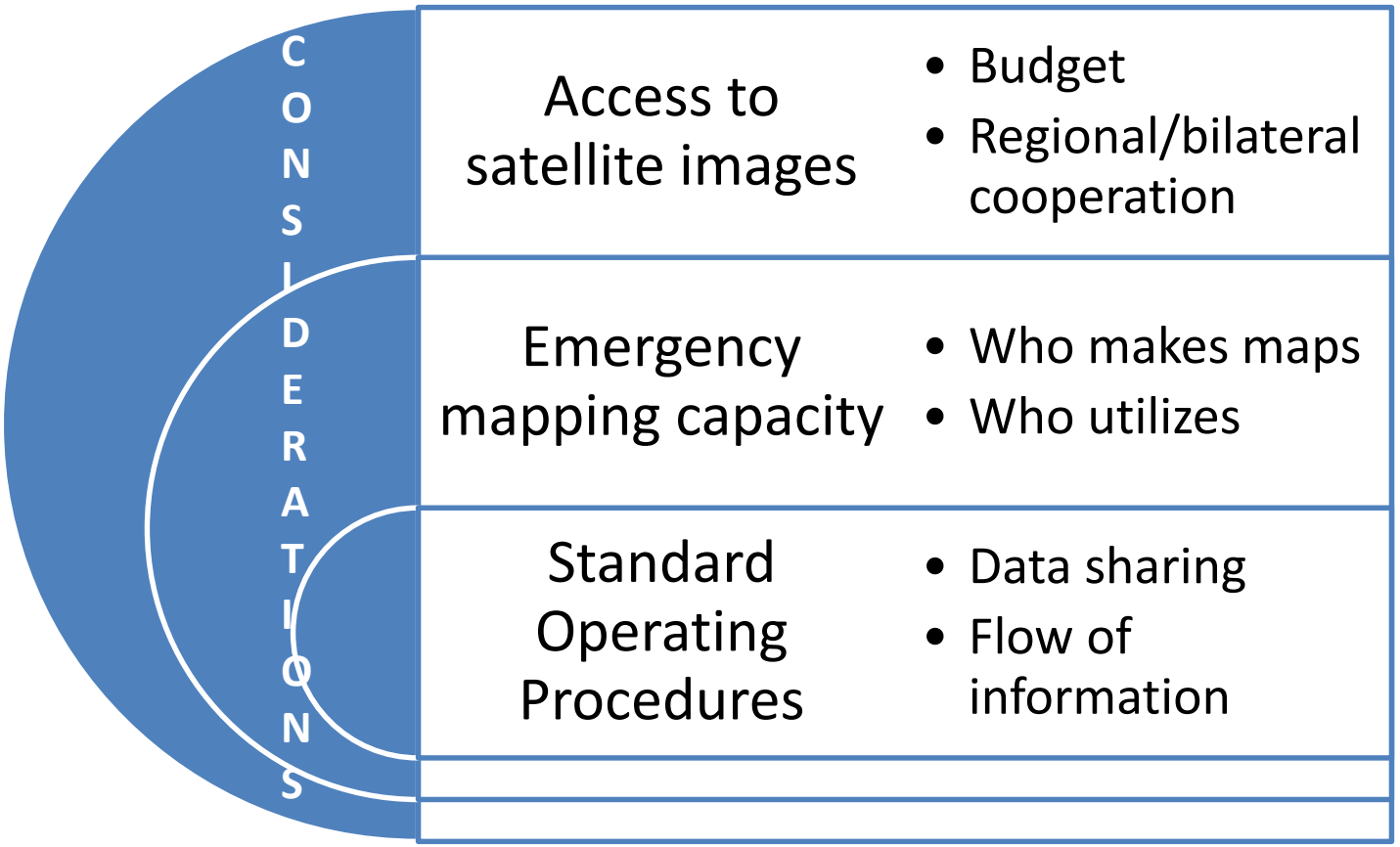


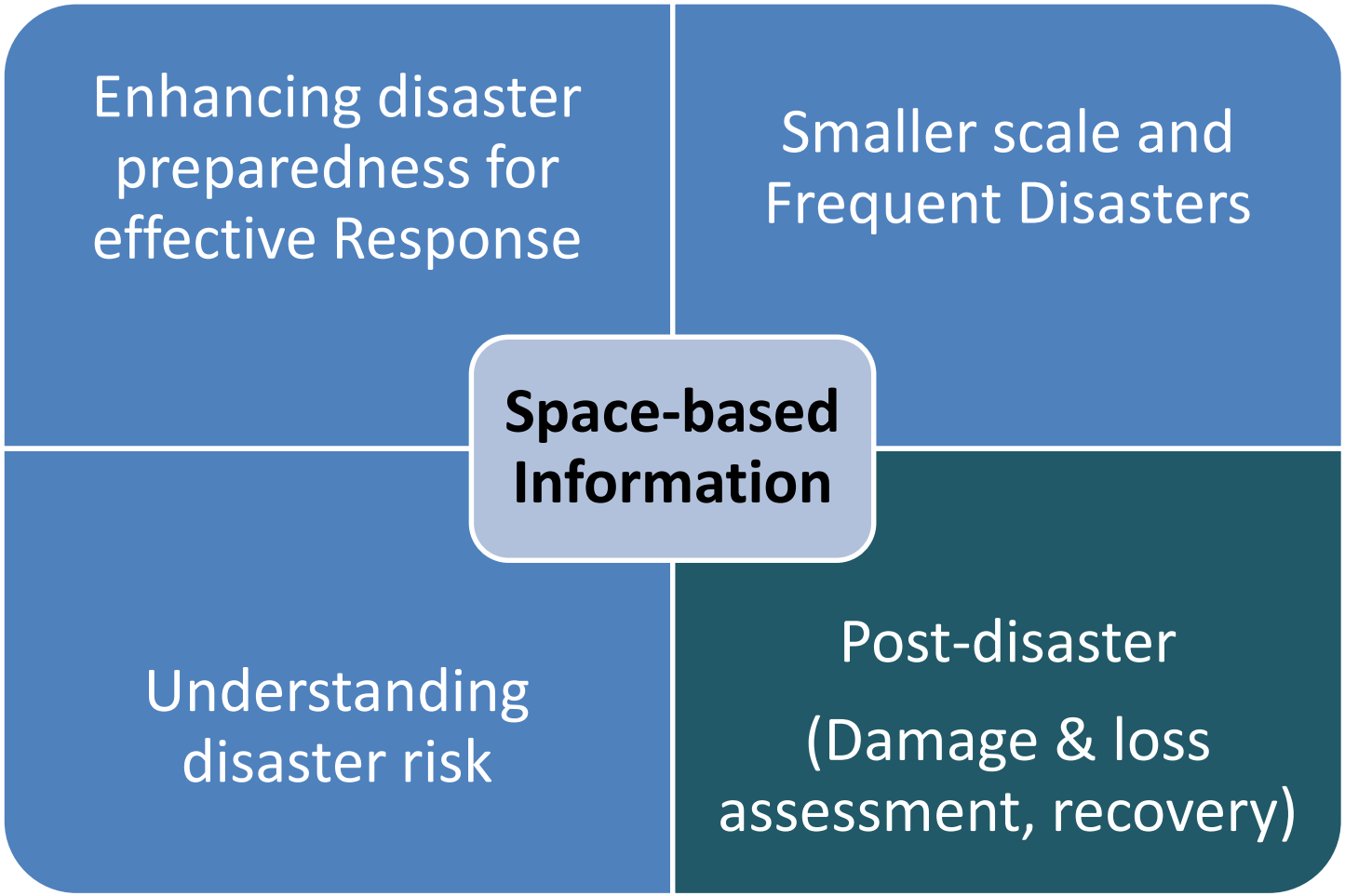
Pre-Flood



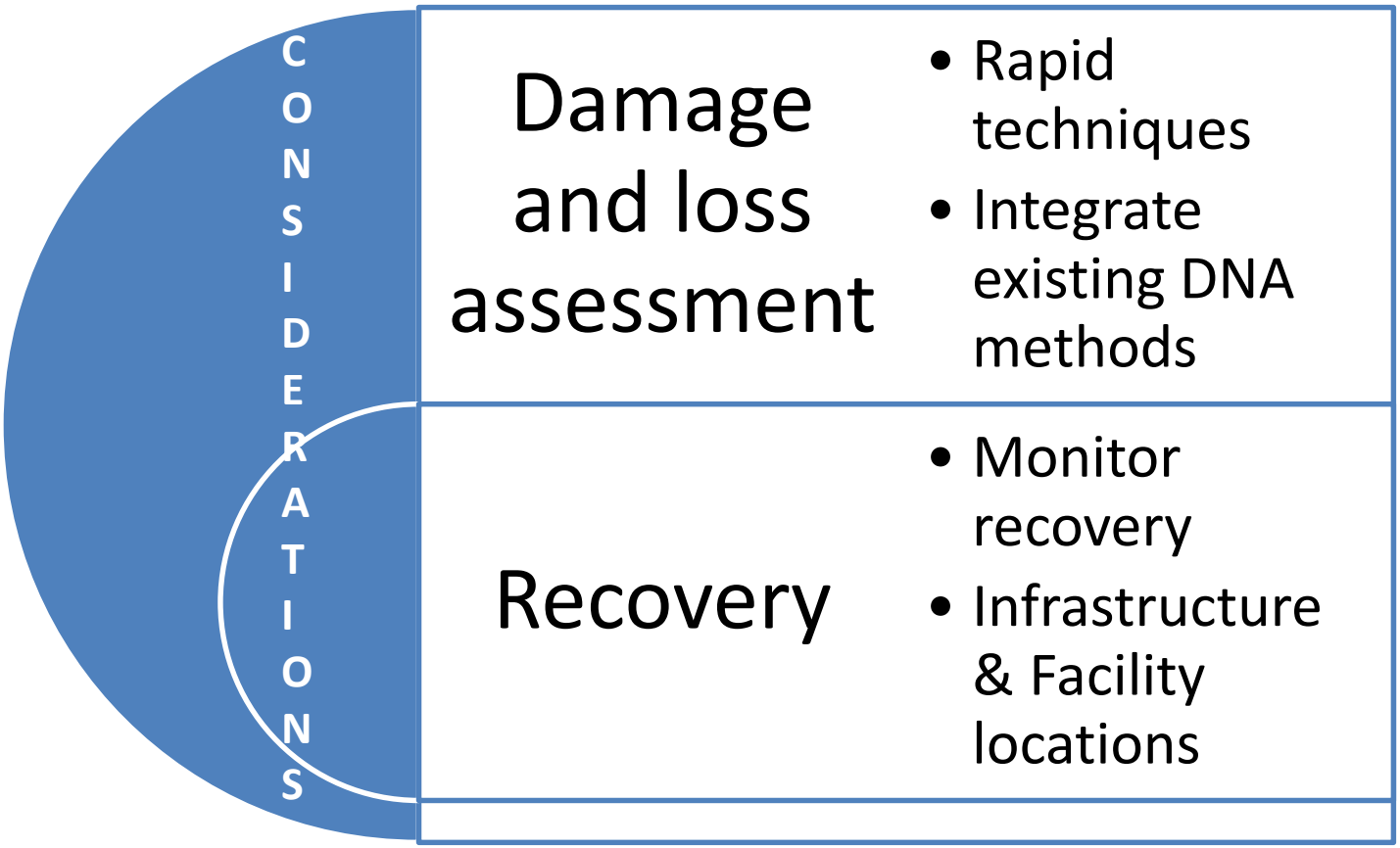
During-Flood

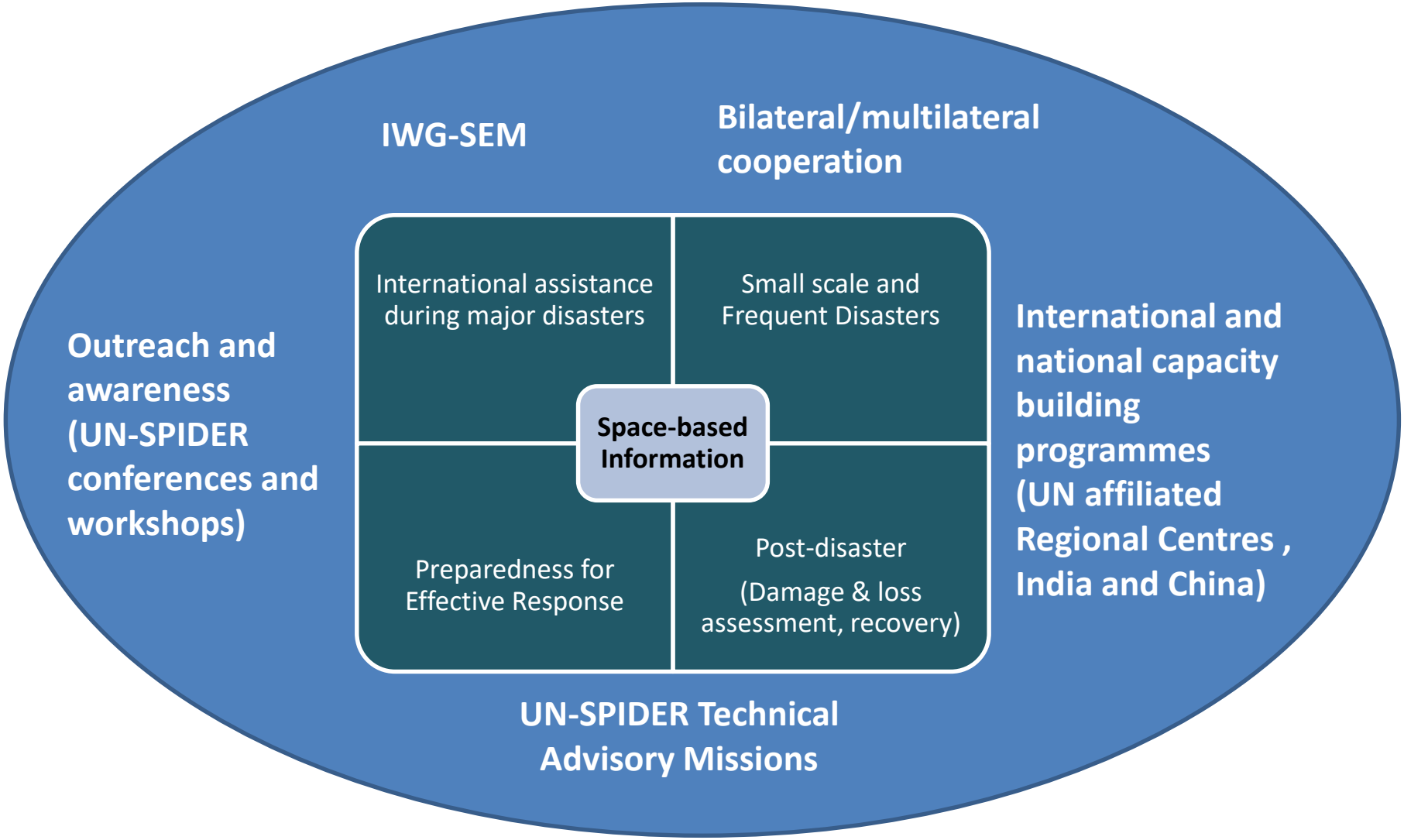
Smaller scale & frequent disasters




Enhancing disaster preparedness for effective Response
Smaller scale and Frequent Disasters
Space-based Information
Understanding disaster risk
Post-disaster
(Damage & loss assessment, recovery)

Post-disaster (Damage & loss assessment, recovery)




IWG-SEM
Bilateral/multilateral cooperation
International assistance during major disasters
Small scale and Frequent Disasters
Space-based Information
Preparedness for Effective Response
Post-disaster
(Damage & loss assessment, recovery)
Outreach and awareness (UN-SPIDER conferences and workshops)
International and national capacity building programmes (UN affiliated Regional Centres , India and China)
UN-SPIDER Technical Advisory Missions

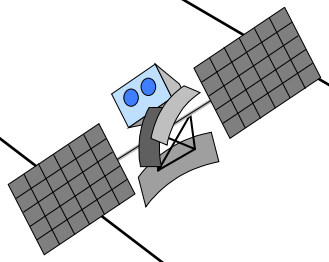
Basic terminologies in remote sensing

- Electromagnetic spectrum
- Spectral reflectance curve
- Digital number
- Multispectral bands
- False colour composite (FCC)
- Resolution (spatial, radiometric, temporal)
- Image interpretation
- Digital image processing
- Satellite derived indices
- Normalised Difference Vegetation Index (NDVI)
- Image classification

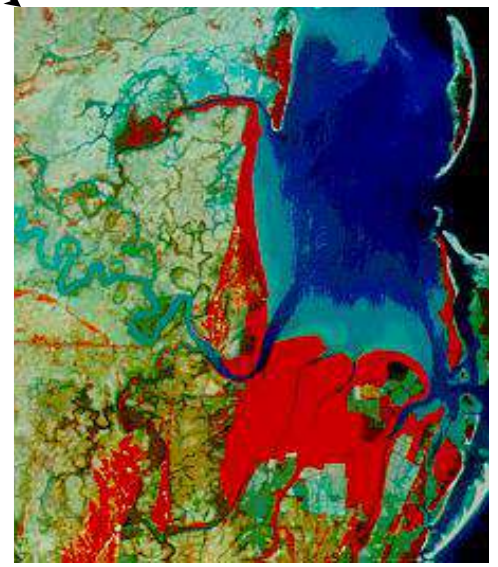
10 $^{-4}$ um .4 - .7 um 1 mm 1 m *Wavelength*

Electromagnetic spectrum

X-Ray Visible Infra Red Microwave TV & Radio



Photograph



False color composite Image

Electromagnetic Spectral Bands

Band	Wavelength
Gamma rays	<0.03 nm
X-ray	0.003 to 3 nm
Ultraviolet , UV	3 nm to 0.4 um
Photographic UV	0.3 to 0.4 um

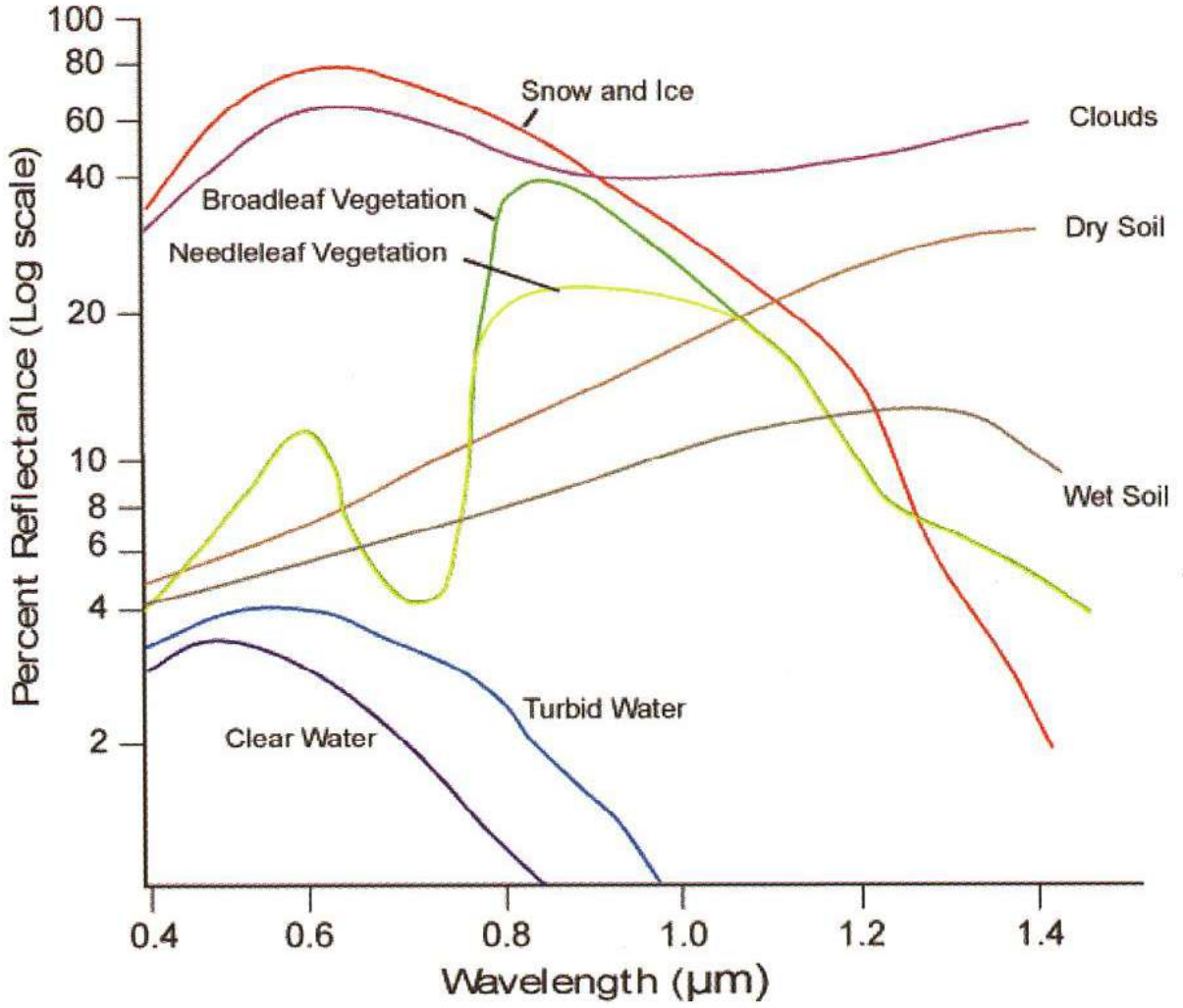
Optical R.S.

Visible	0.4 to 0.7 um
Infrared, IR	0.7 to 300 um
Reflected IR	0.7 to 3 um
Thermal IR	3 to 5 um
	8 to 14 um

Microwave R.S.

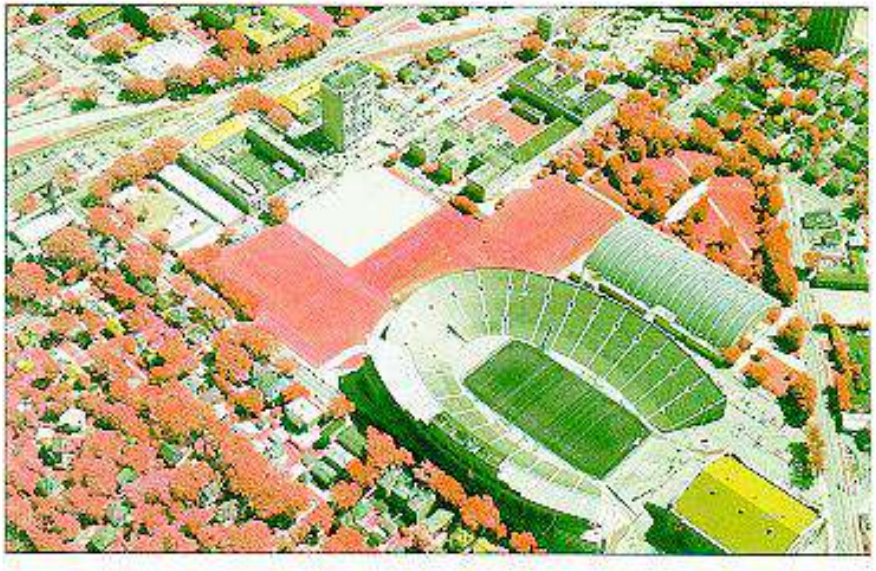
Microwave (Passive R.S.)	0.3 to 300 cm
Radar (Active RS)	0.3 to 300 cm

Spectral Signature of Major land cover Features



Normal aerial photograph

Infra-red photograph

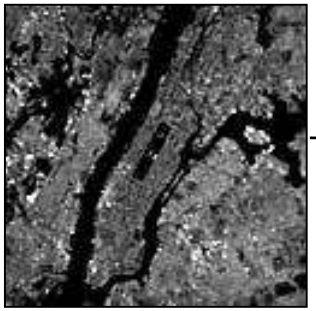


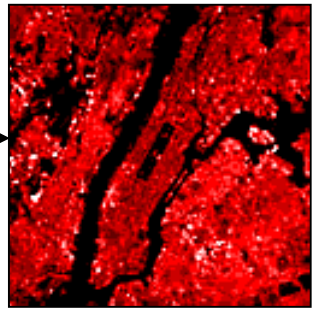
Individual Landsat Bands

Applied to Color Guns

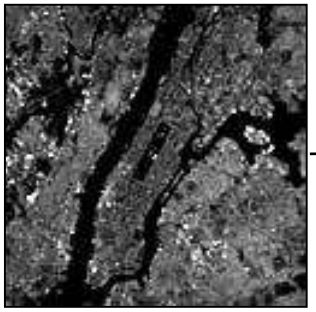
Resulting Image

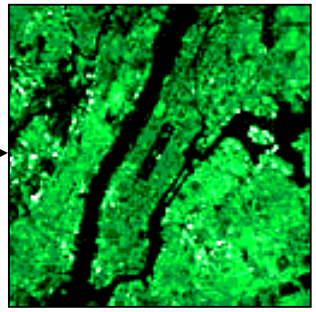
Band 3
Visible Red



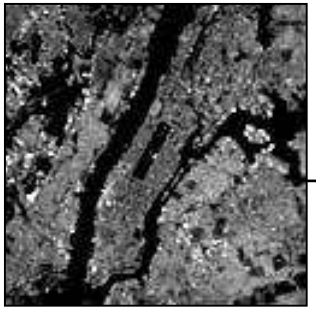


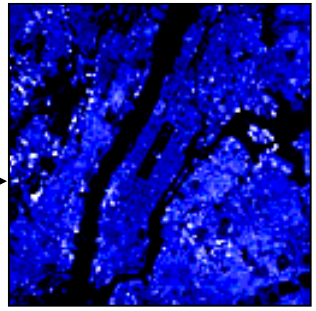
Band 2
Visible Green





Band 1
Visible Blue

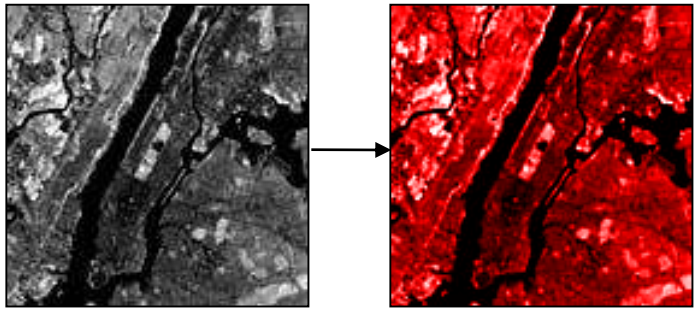




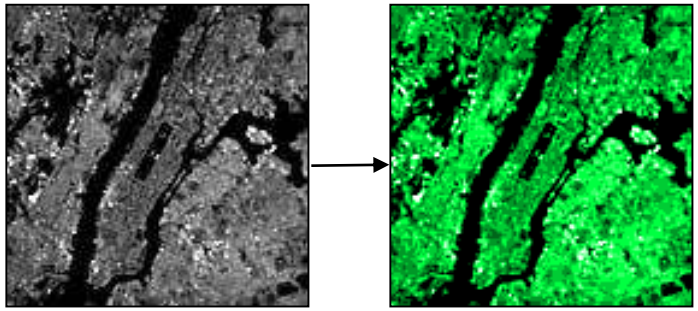
Individual Landsat Bands

Applied to Color Guns

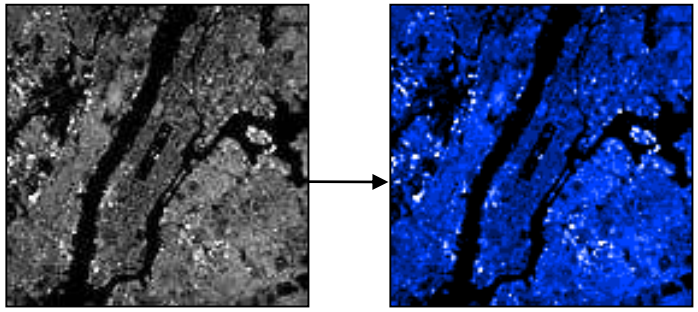
Band 4
Near Infrared



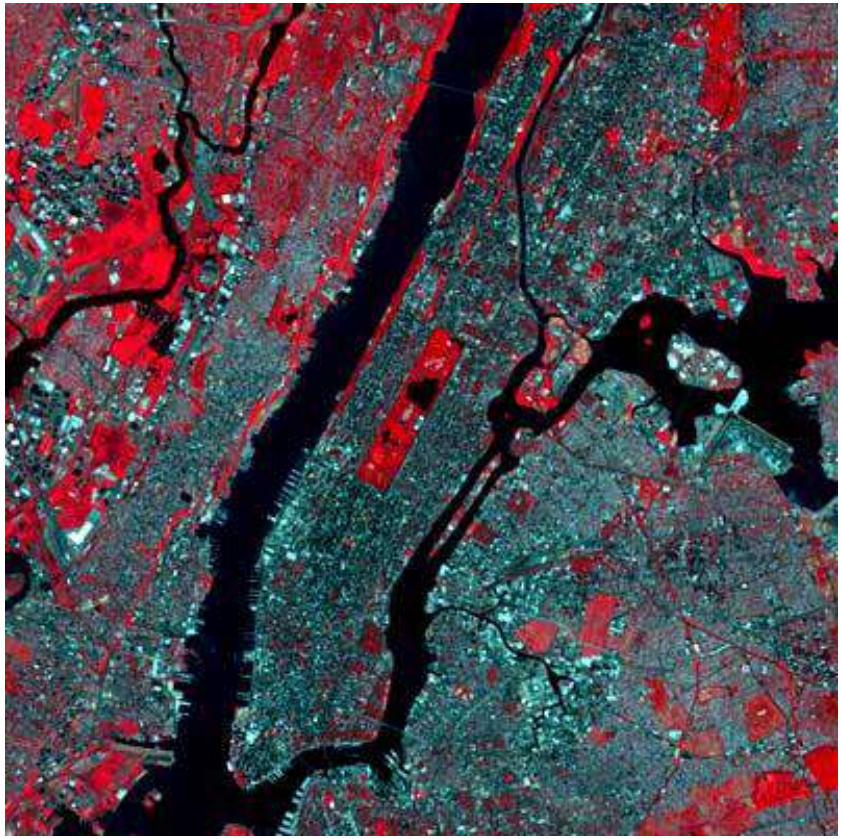
Band 3
Visible Red

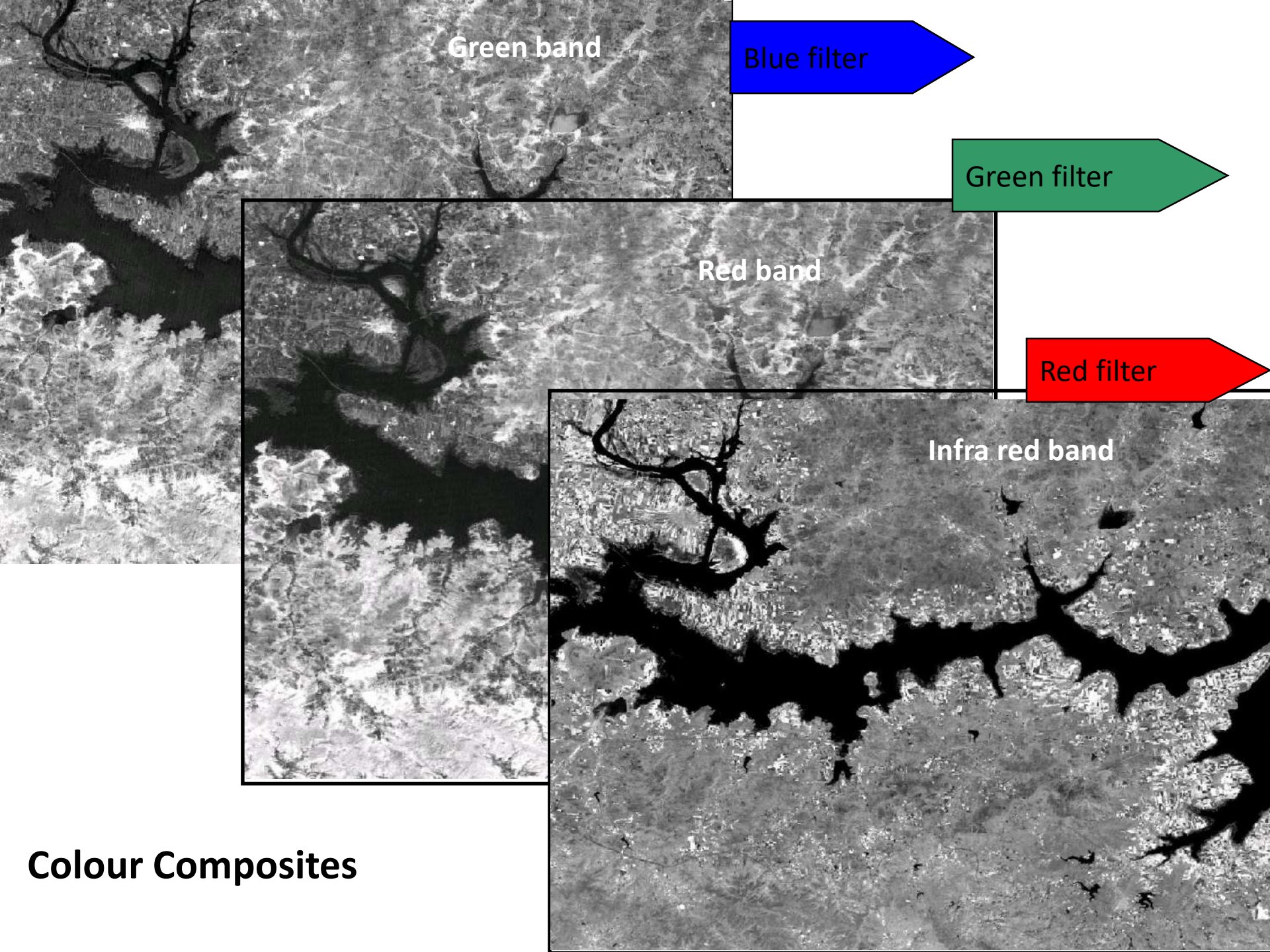


Band 2
Visible Green



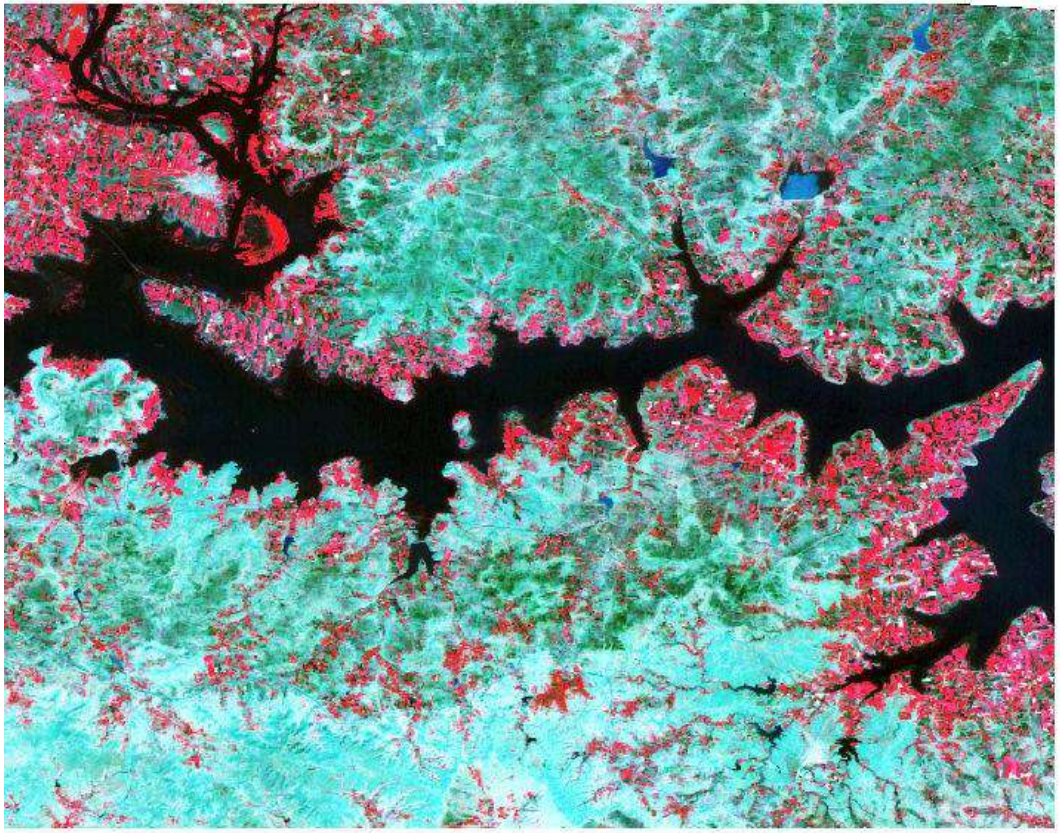
Resulting Image





Colour Composites

Why standard false color composite ?

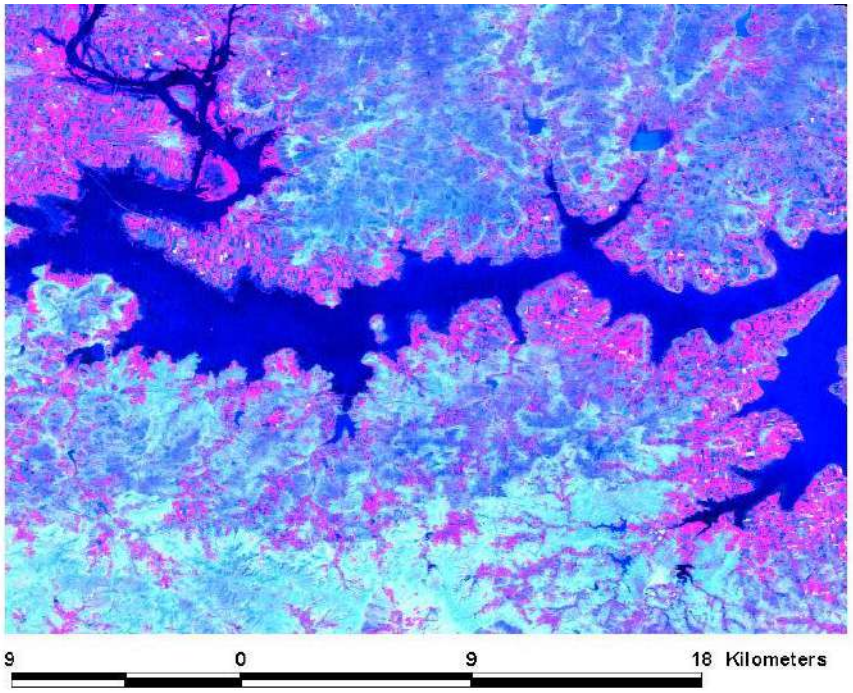


Standard False Color Composite

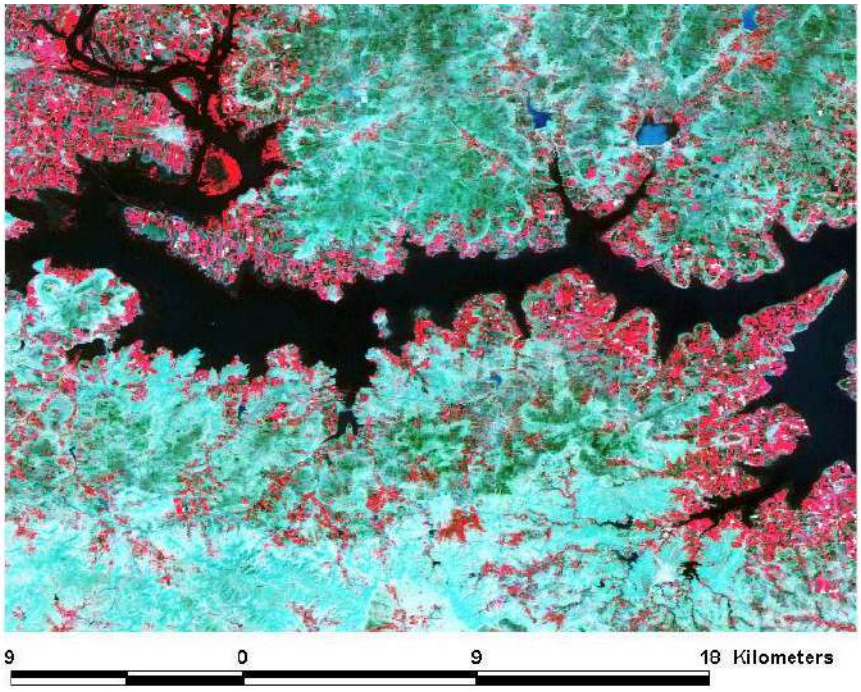
Hybrid Color Composite

Image enhancements

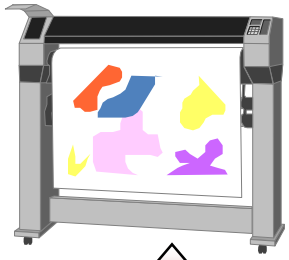
Stretching for enhancement of water bodies

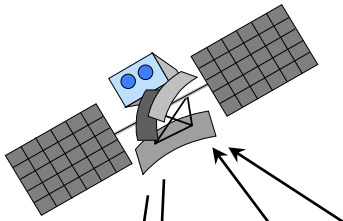


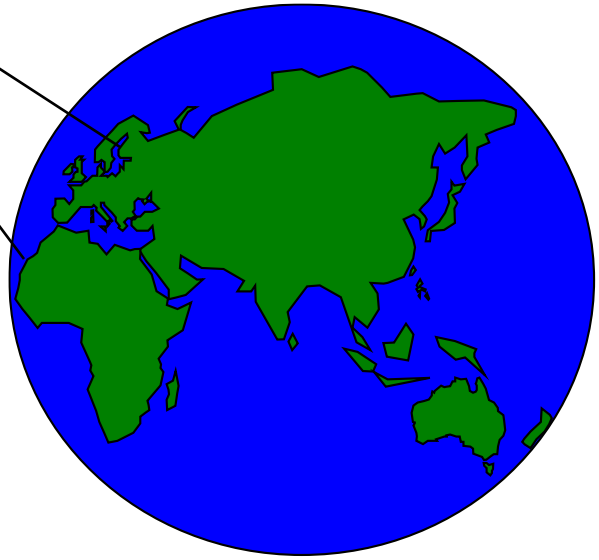
Histogram stretching



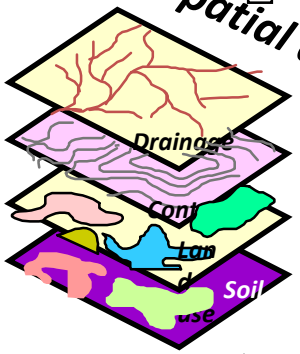
Multi-thematic information for Resources Management



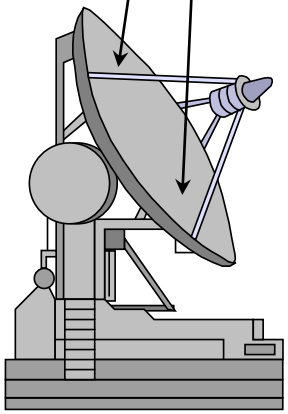


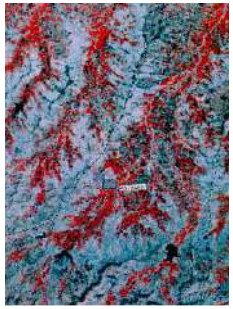


Spatial data



Interpretation & analysis





Data Acquisition → **Storage** → **Image** → **Visual** → **Digital**

Interpretation Techniques

Image Interpretation

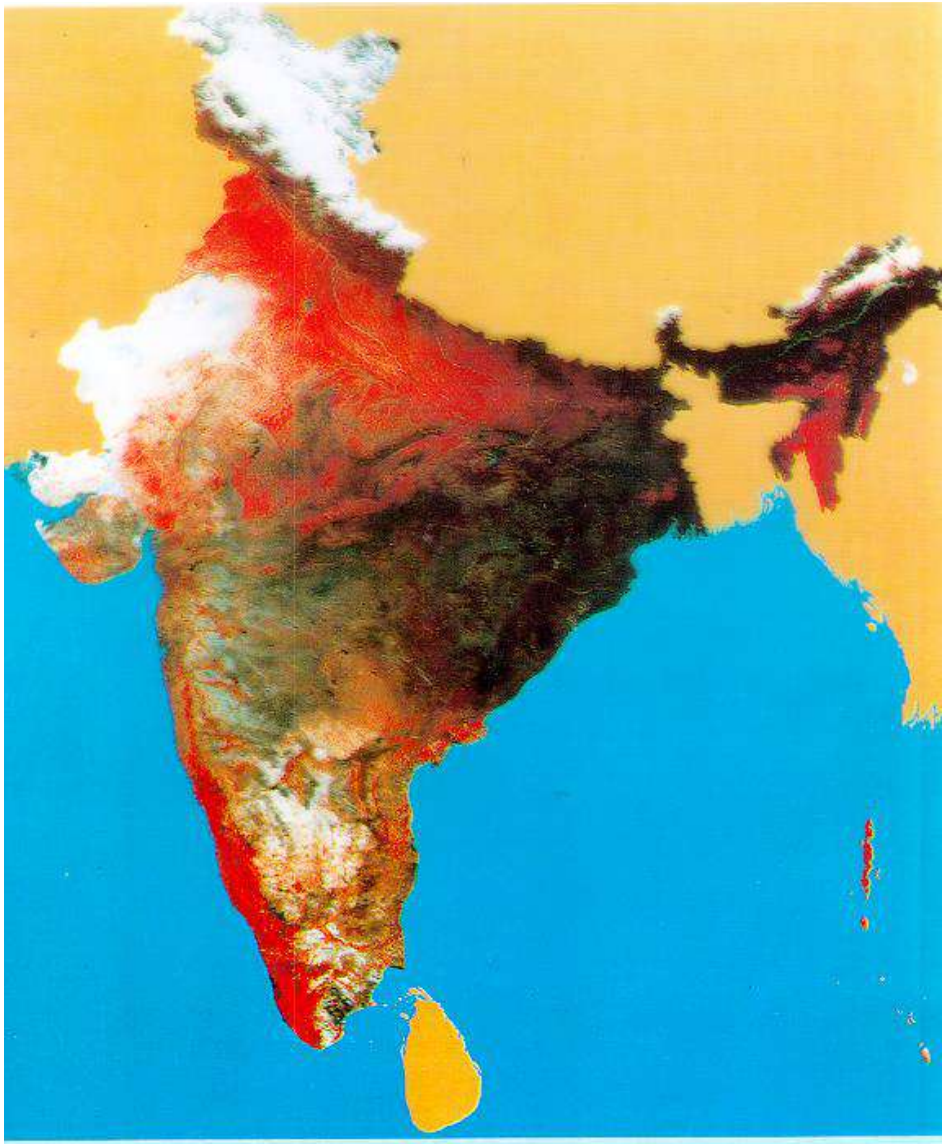
↓

Identifying objects

↓

Judging significance

- Sound background of basic subject
- Development of skills through long hours of Practice with image coupled with ground checks



WiFS Image

Interpretation Elements

- Absolute & relative size
- Shape
- Shadow
- Tone or Colour
- Texture
- Pattern
- Location, association, convergence of evidence

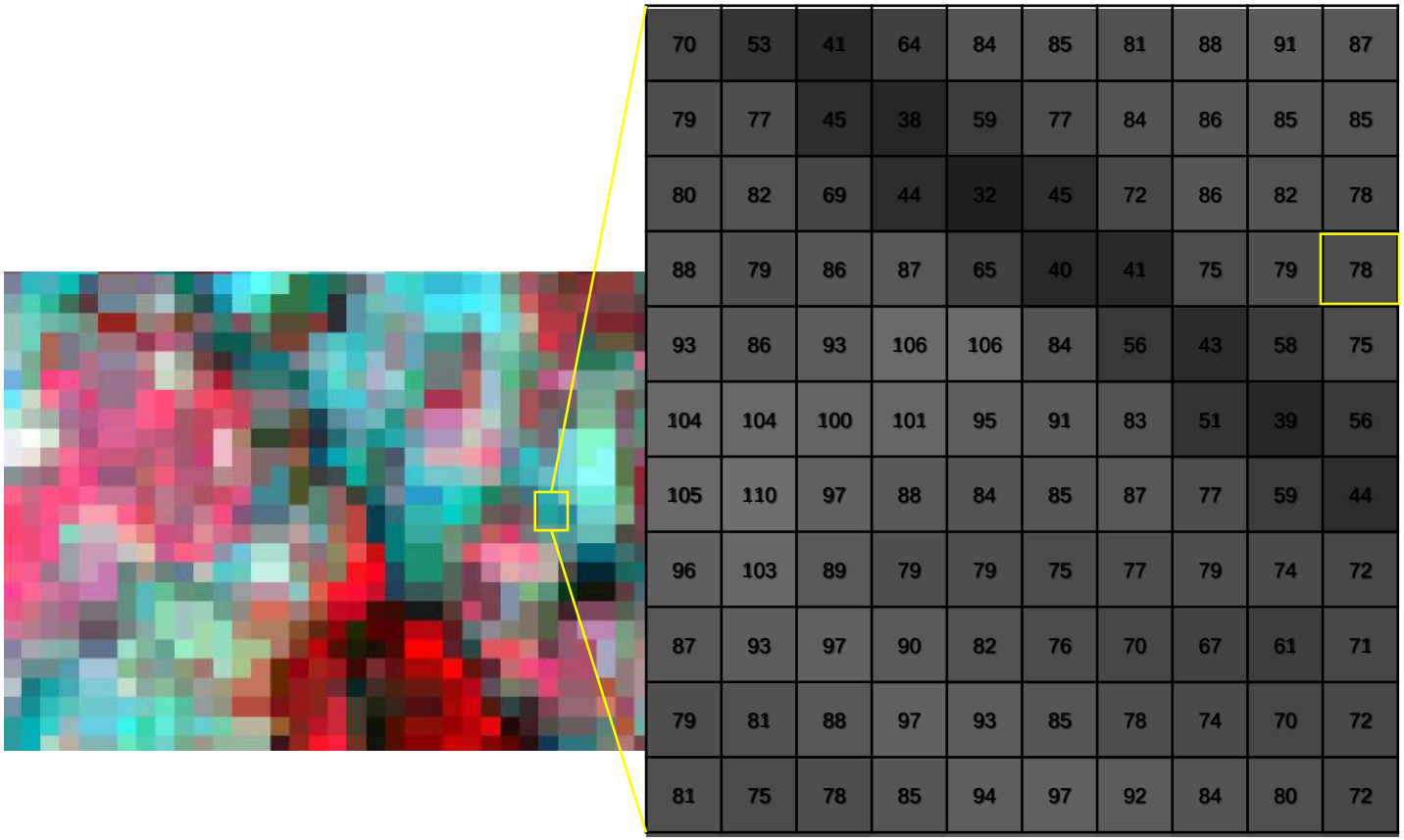
Forest

Urban Area

Agricultural Land

What is a Digital Image?

- Grid cells or pixels
- Each pixel has a digital number (DN) which represents: Spectral Reflectance Value



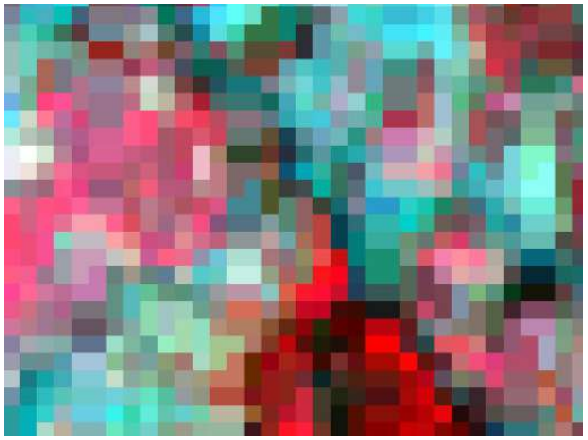
Sensor Resolution

Ability of the system to render the information at the **smallest discretely separable quantity** in terms of distance (spatial), wavelength band of EMR (spectral), time (temporal) and radiation (radiometric)

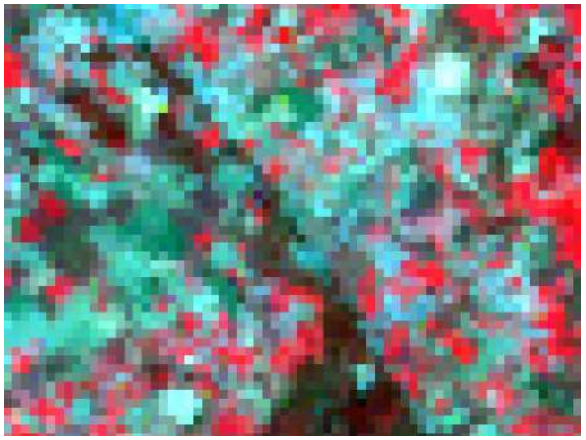
The Four Resolutions of Remote Sensing

- Spatial
- Spectral
- Temporal
- Radiometric

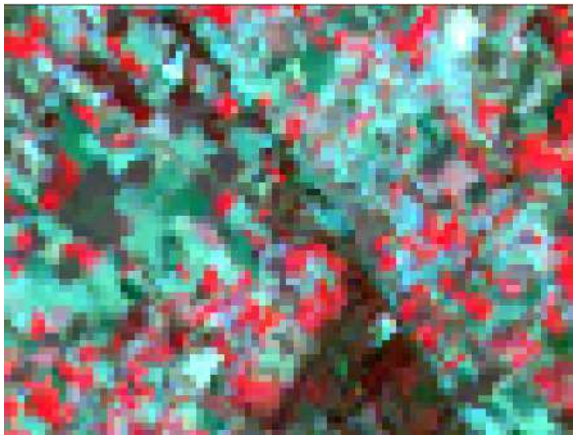
AWIFS (56 m)



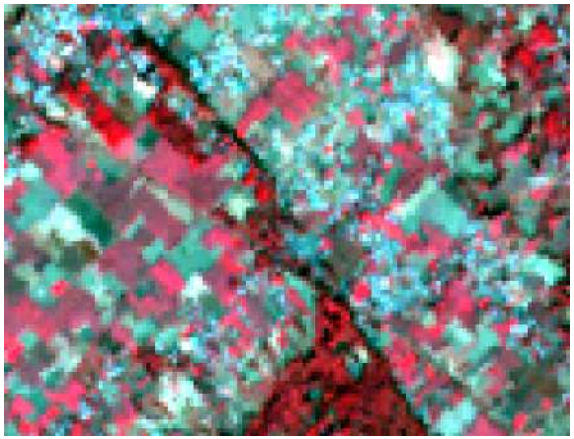
ETM 30m



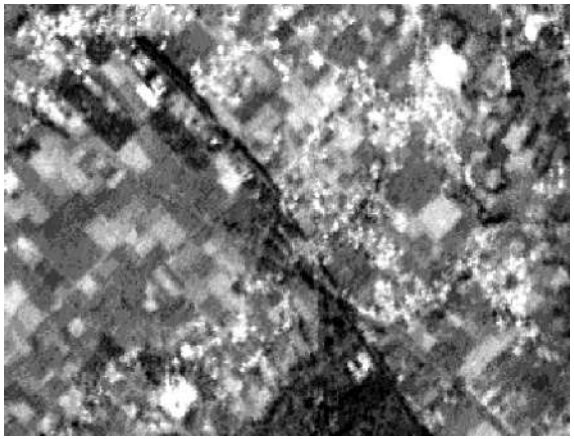
IRS LISS III 23.5 m



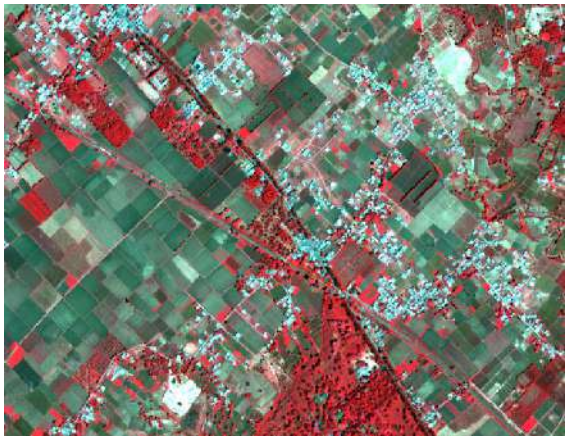
ASTER 15 m



IRS PAN 5.8 m



IKONOS MSS 4 m

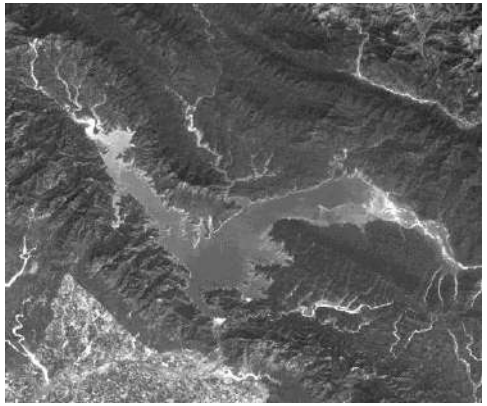


IKONOS PAN
1m

Spatial Resolution

Smallest discernible detail in an image

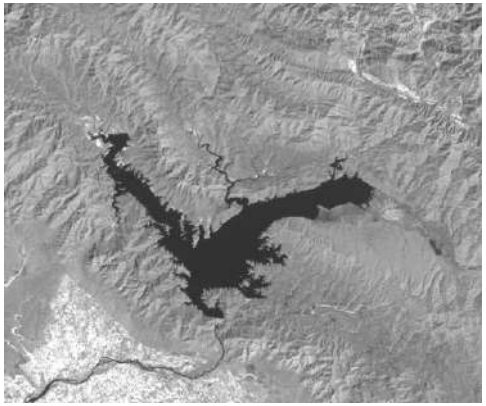
Spectral Resolution



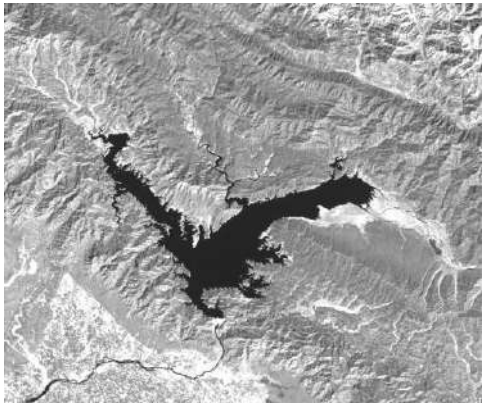
Band (.45 to .515μm)

Band (.525 to .605 μm)

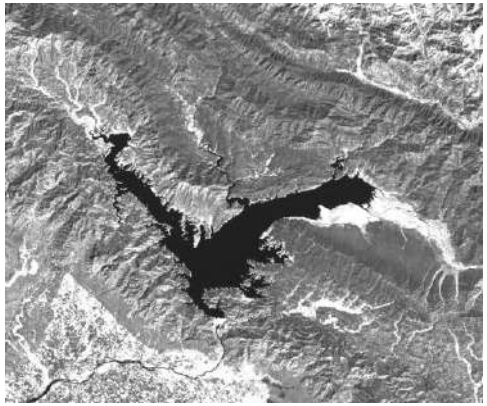
Band (.63 to .690 μm)



Band (.75 to .90 μm)

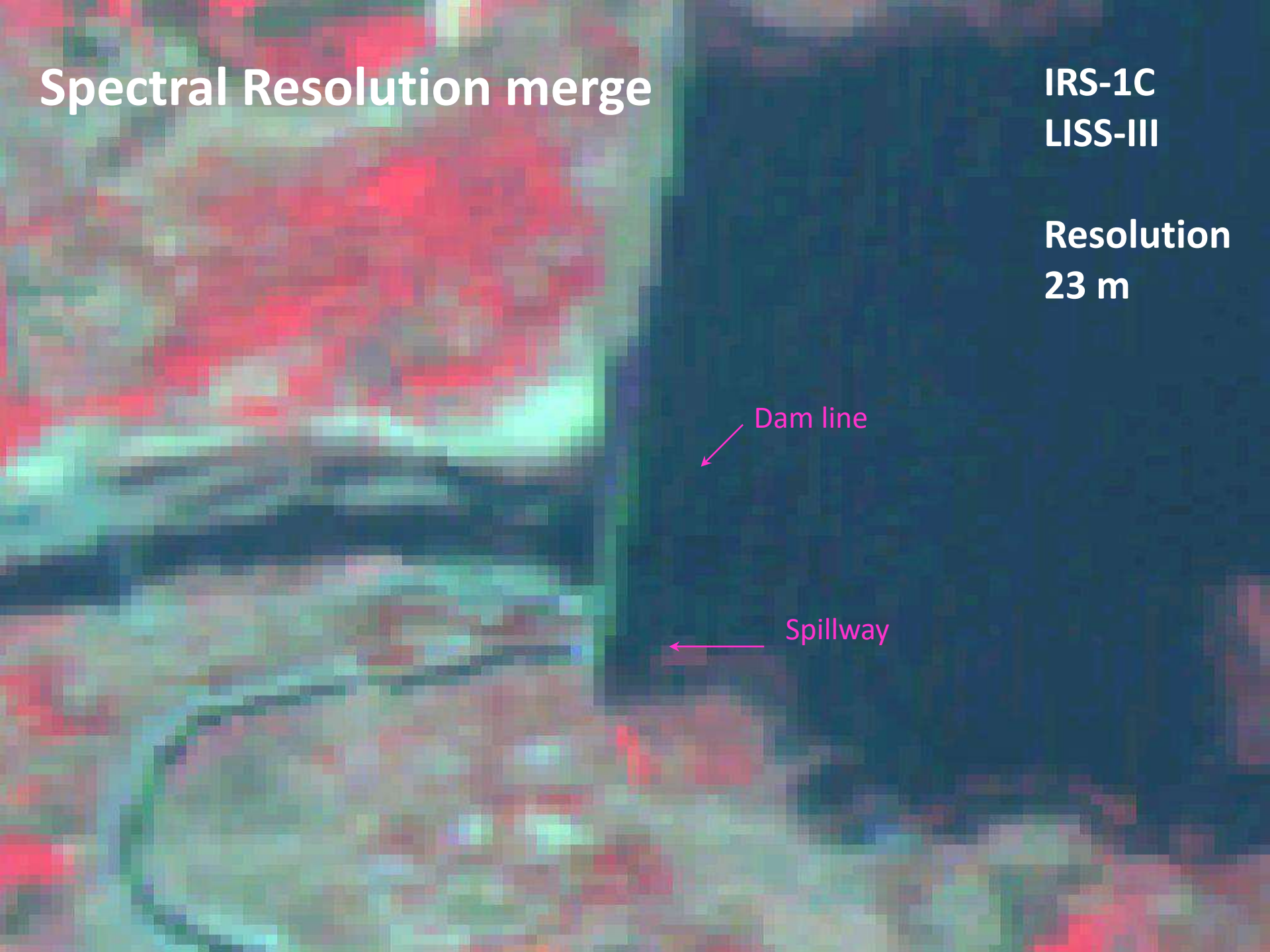


Band (1.55 to 1.75 μm)

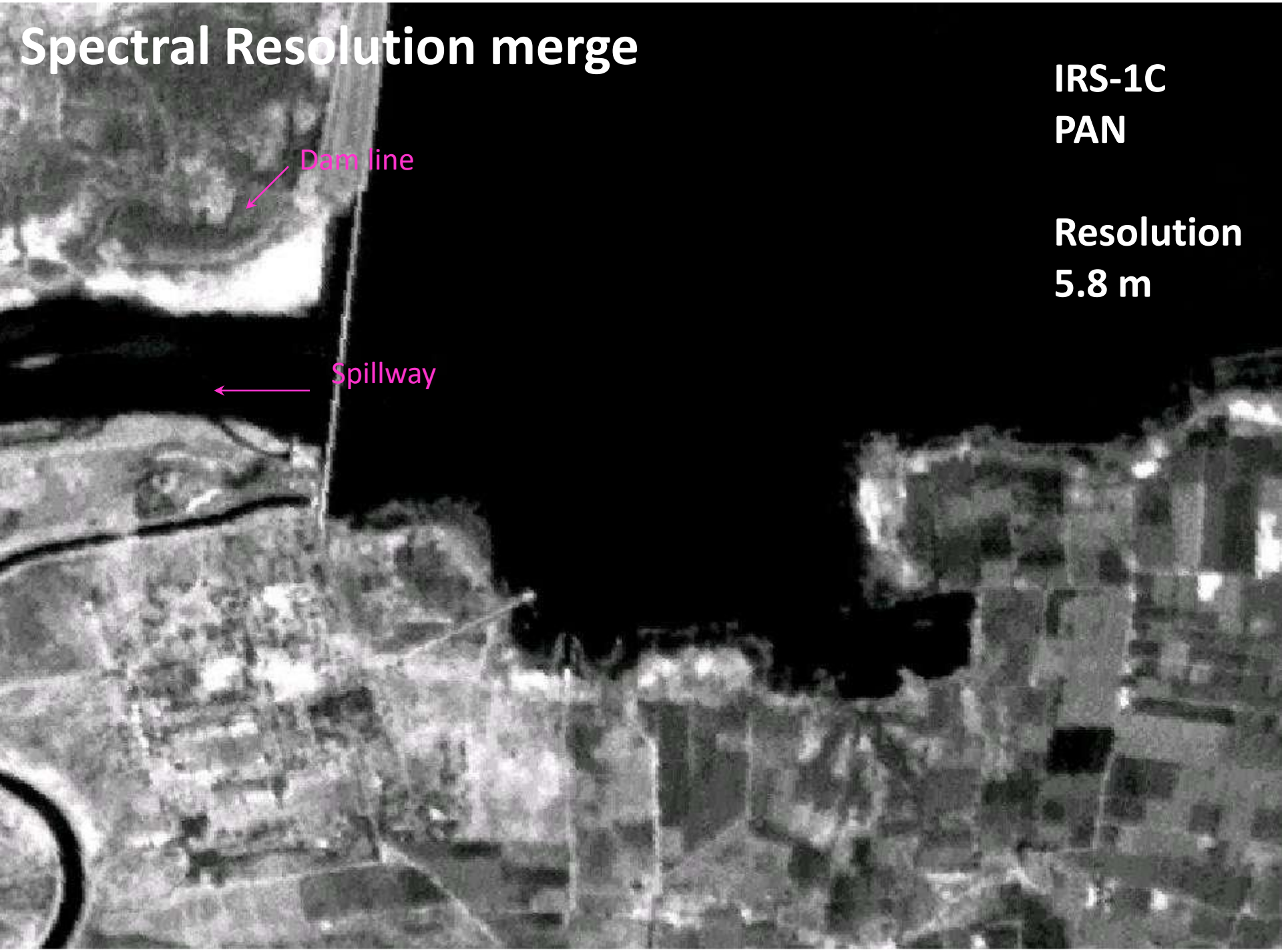


Band (2.09 to 2.35μm)

- **number of bands in the spectrum** in which the instrument can take measurements.
- Higher spectral resolution = better ability to exploit **differences in spectral signatures**


Spectral Resolution merge
IRS-1C
LISS-III
Resolution
23 m
Dam line
Spillway

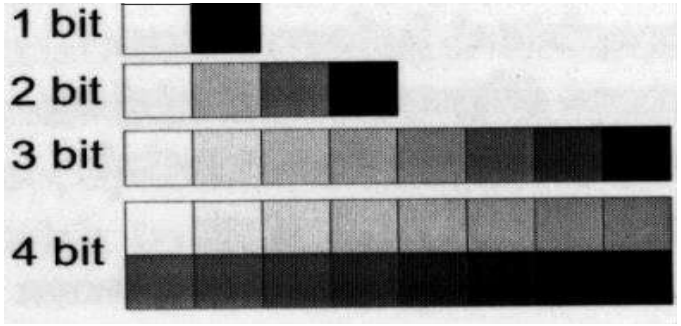
Spectral Resolution merge




Spectral Resolution merge
IRS-1C
LISS-III
Resolution
merge
Dam line
Spillway

Radiometric Resolution

2 (number of bits) = number of grey levels

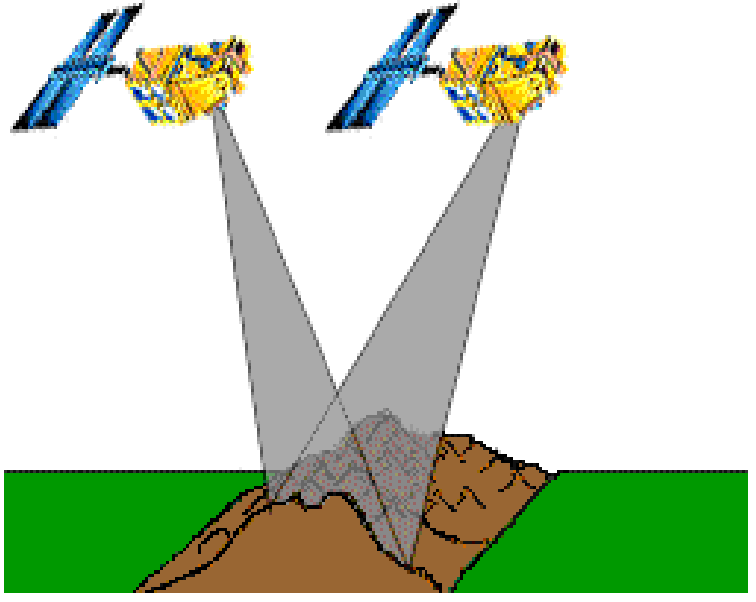


bits	Grey Levels	range (b-w)
1	2	0-1
2	4	0-3
3	8	0-7
4	16	0-15
5	32	0-31
6	64	0-63
7	128	0-127
8	256	0-255
9	512	0-511
10	1024	0-1203

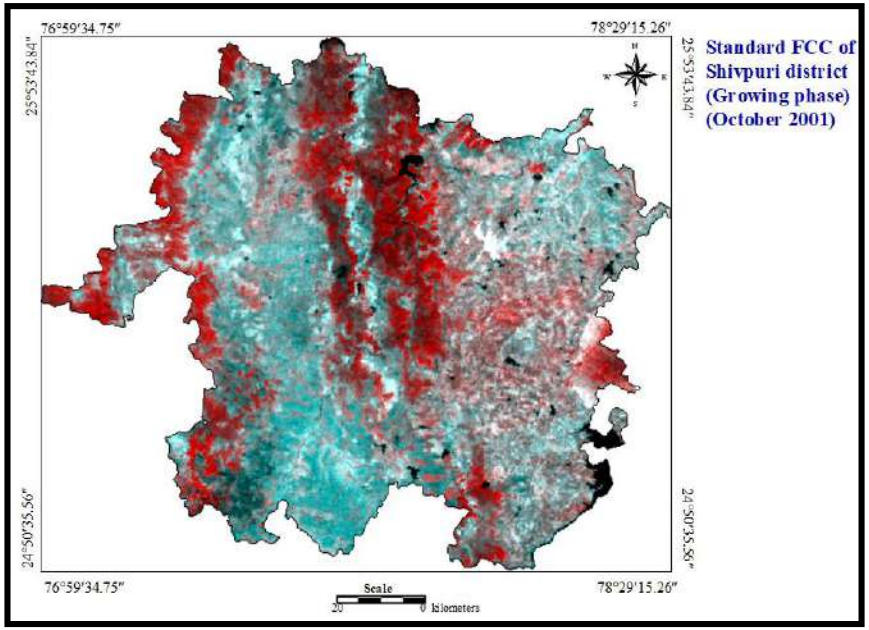
WorldView-3 images
11-bits per pixel Pan and MS; 14-bits per pixel SWIR

Temporal Resolution

- Represents the frequency with which a satellite can re-visit an area of interest and acquire a new image.
- Depends on the instrument's field of vision, and the satellite's orbit

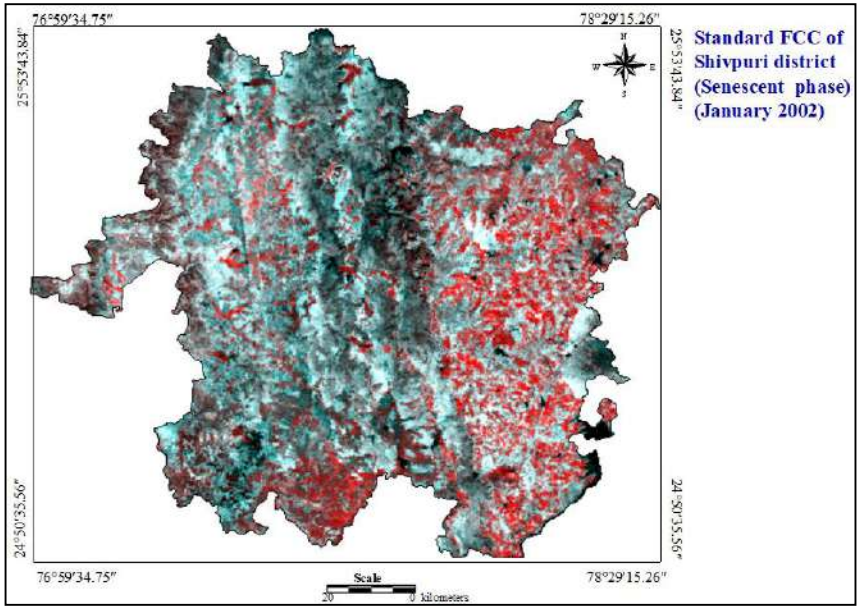


Vegetation Phenology (Shivpuri district, M.P.)



Growing Phase

October 2001

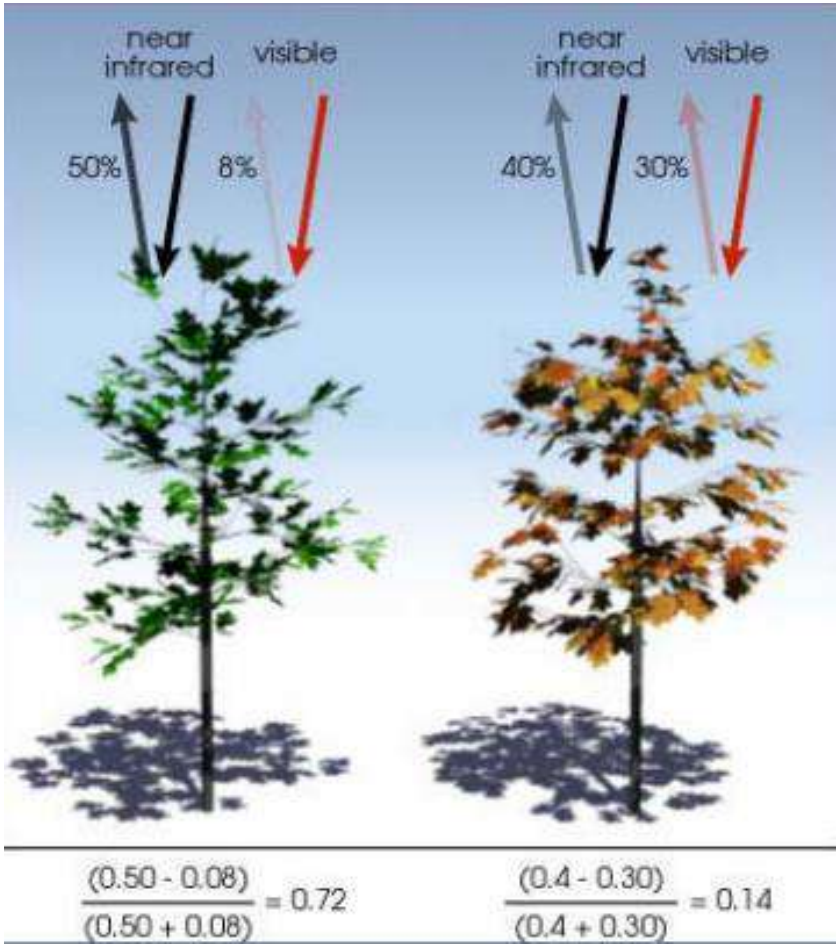


Senescent Phase

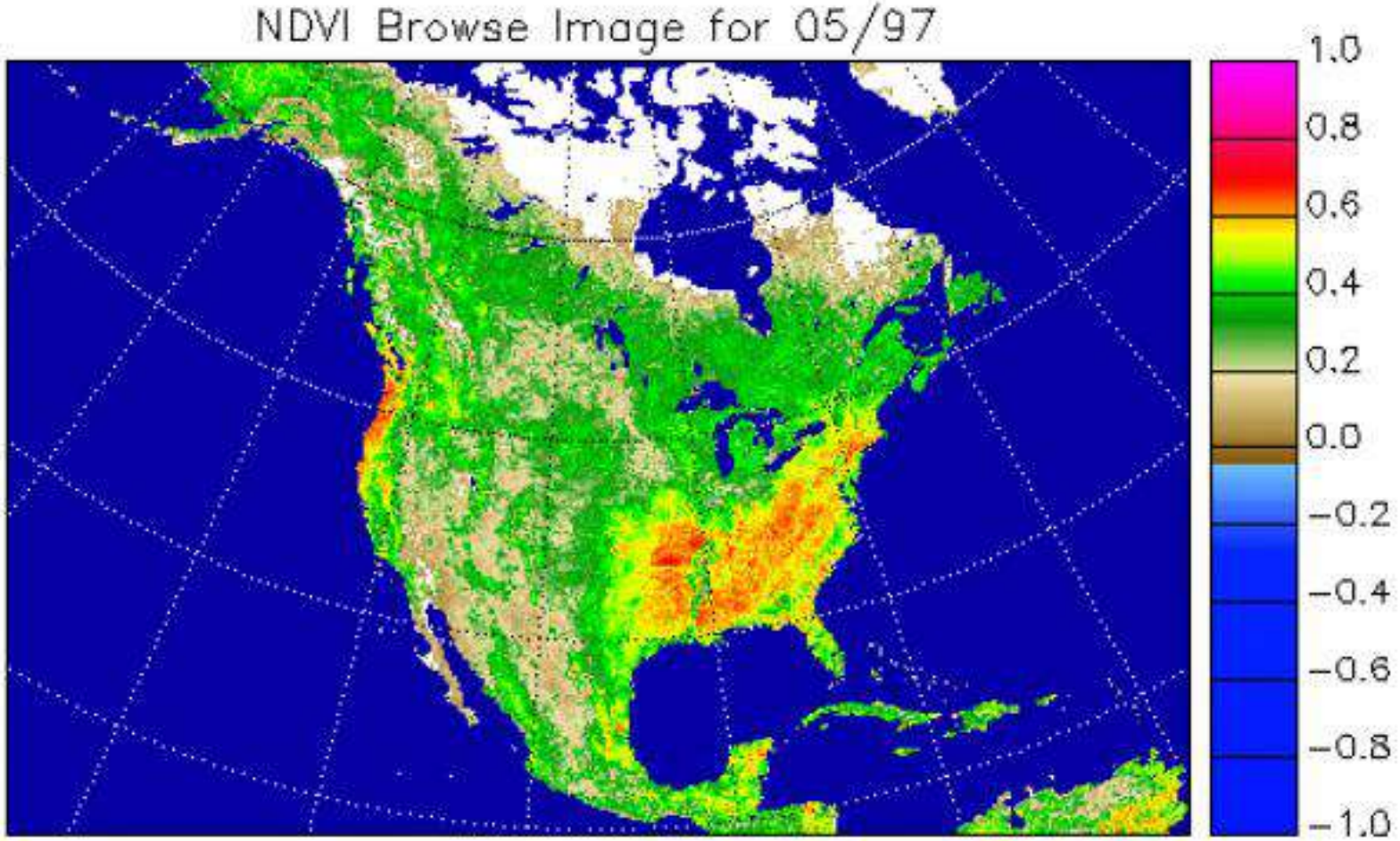
January 2002

Normalised Difference Vegetation Index (NDVI) - Image Enhancement

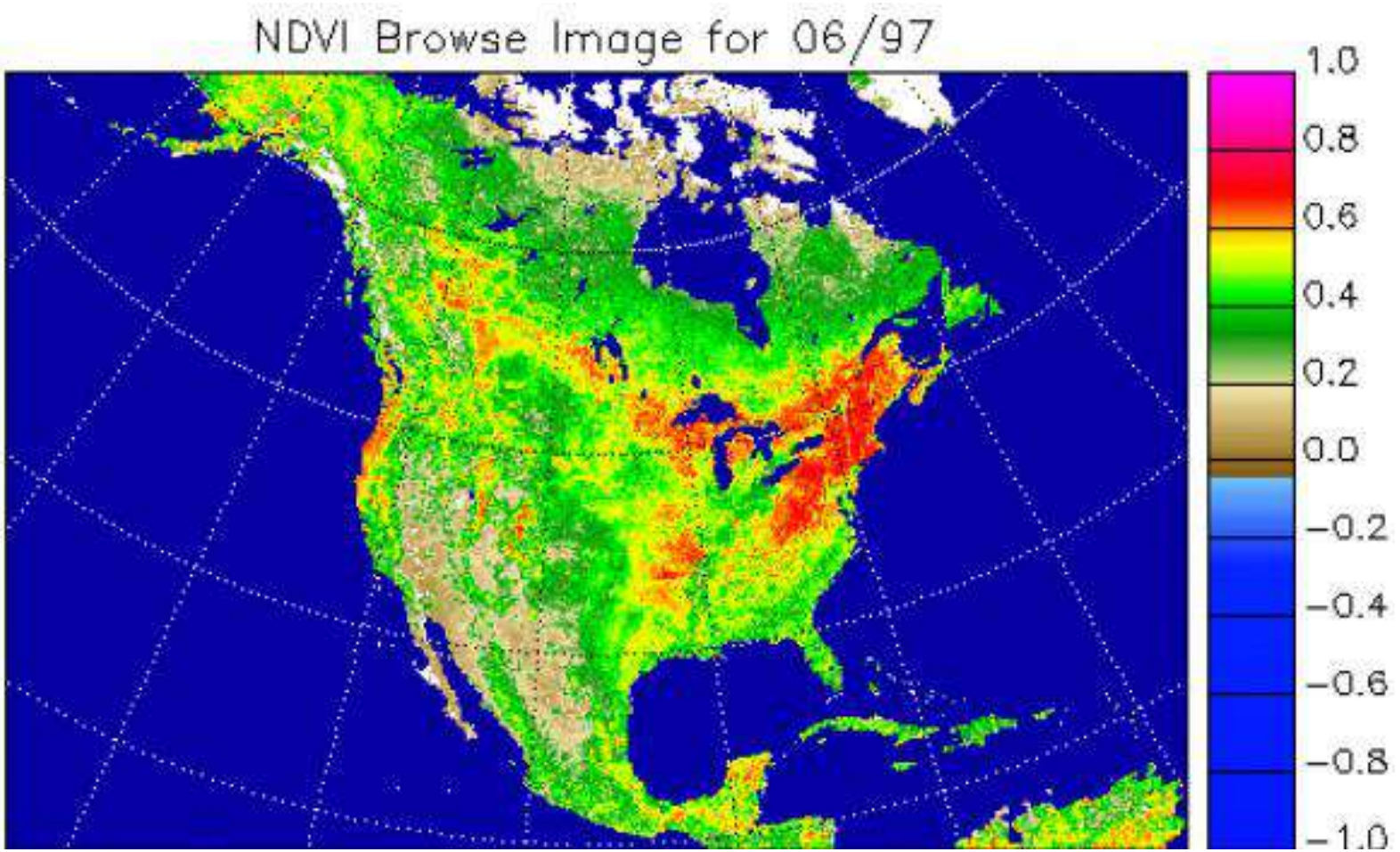
NDVI = (NIR – Red)/ (NIR+Red)



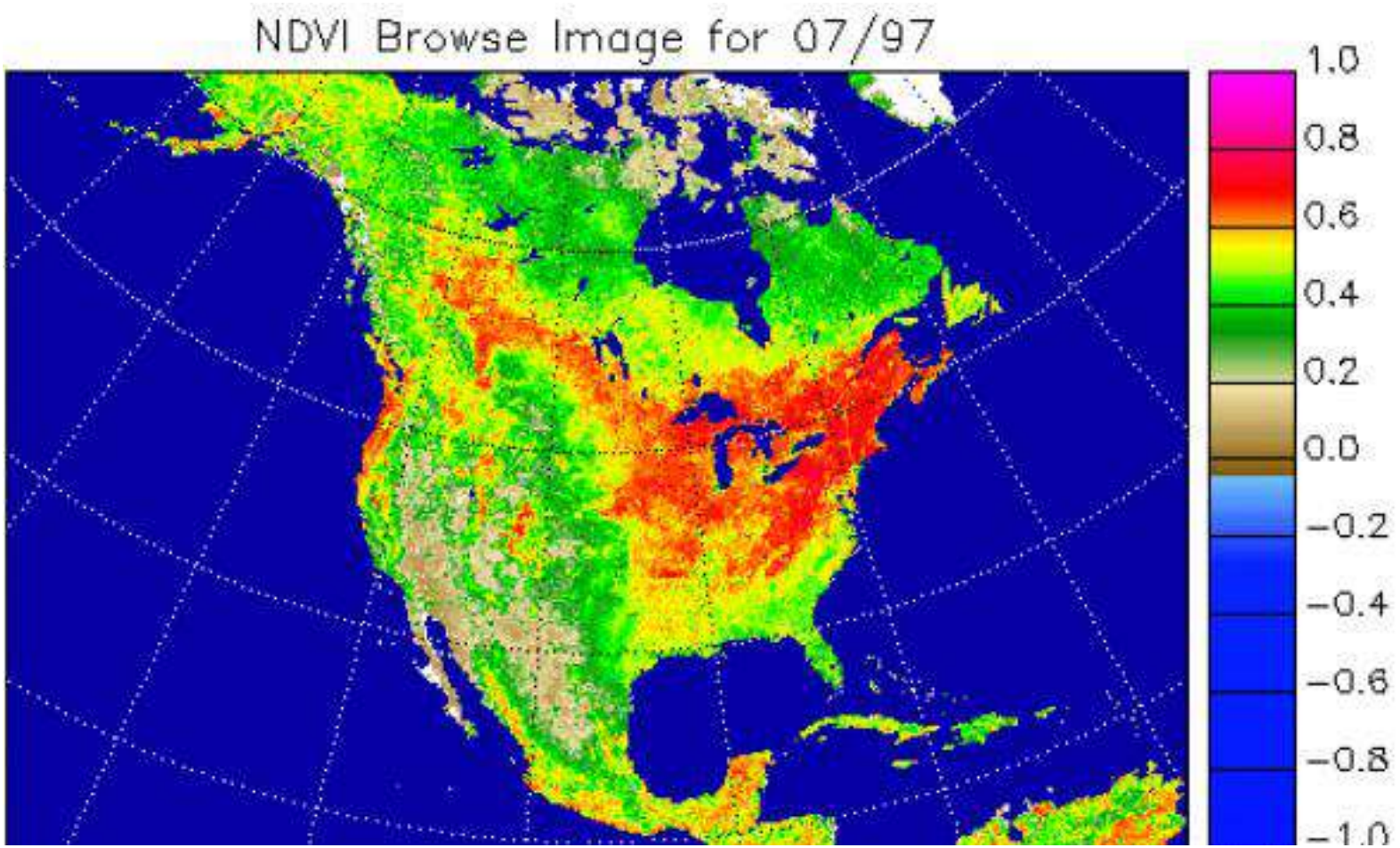
Reference: NOAA AVHRR (http://uregina.ca/piwowarj/Satellites/AVHRR_NDVI_Montage.GIF)



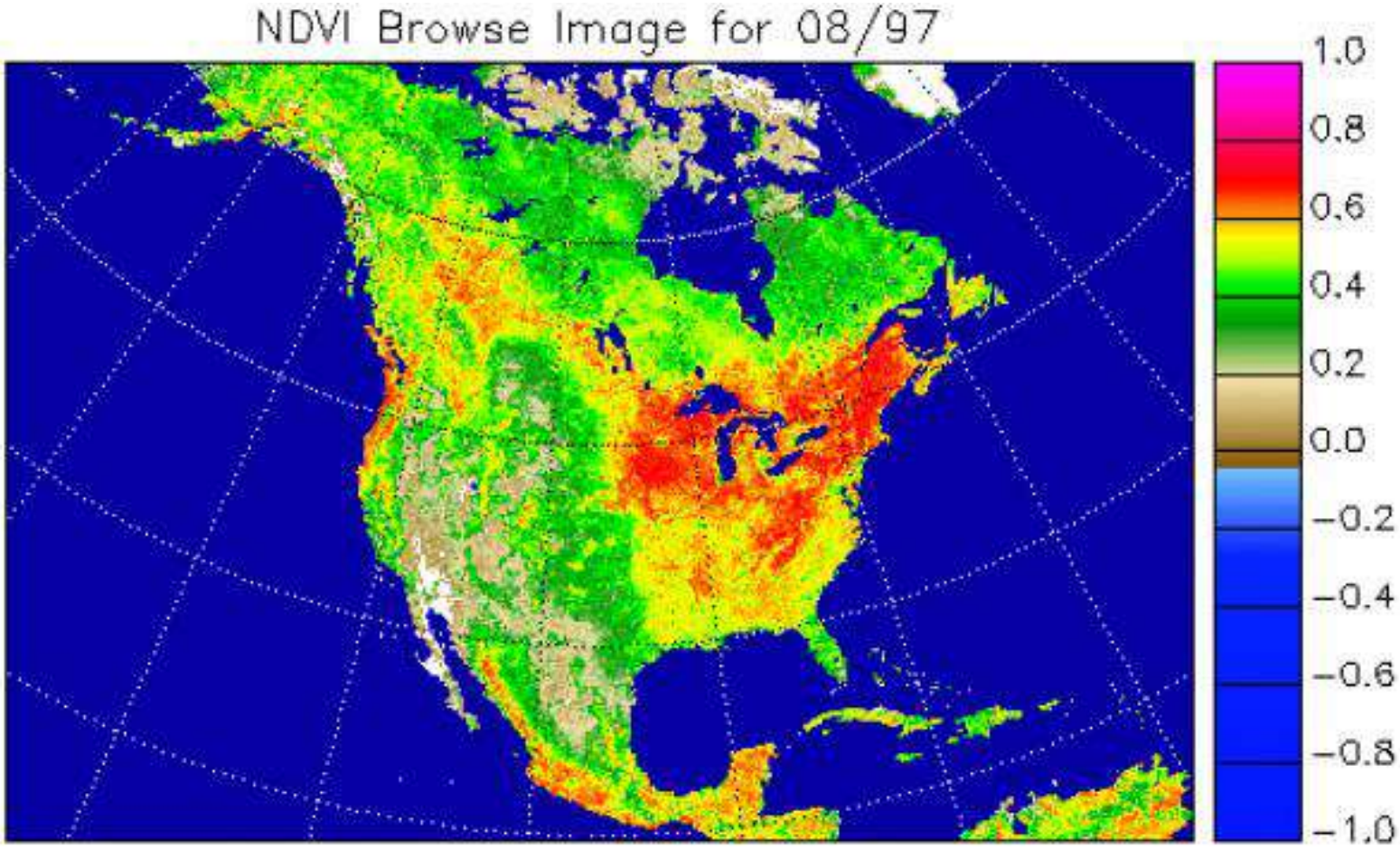
Reference: NOAA AVHRR (http://uregina.ca/piwowarj/Satellites/AVHRR_NDVI_Montage.GIF)



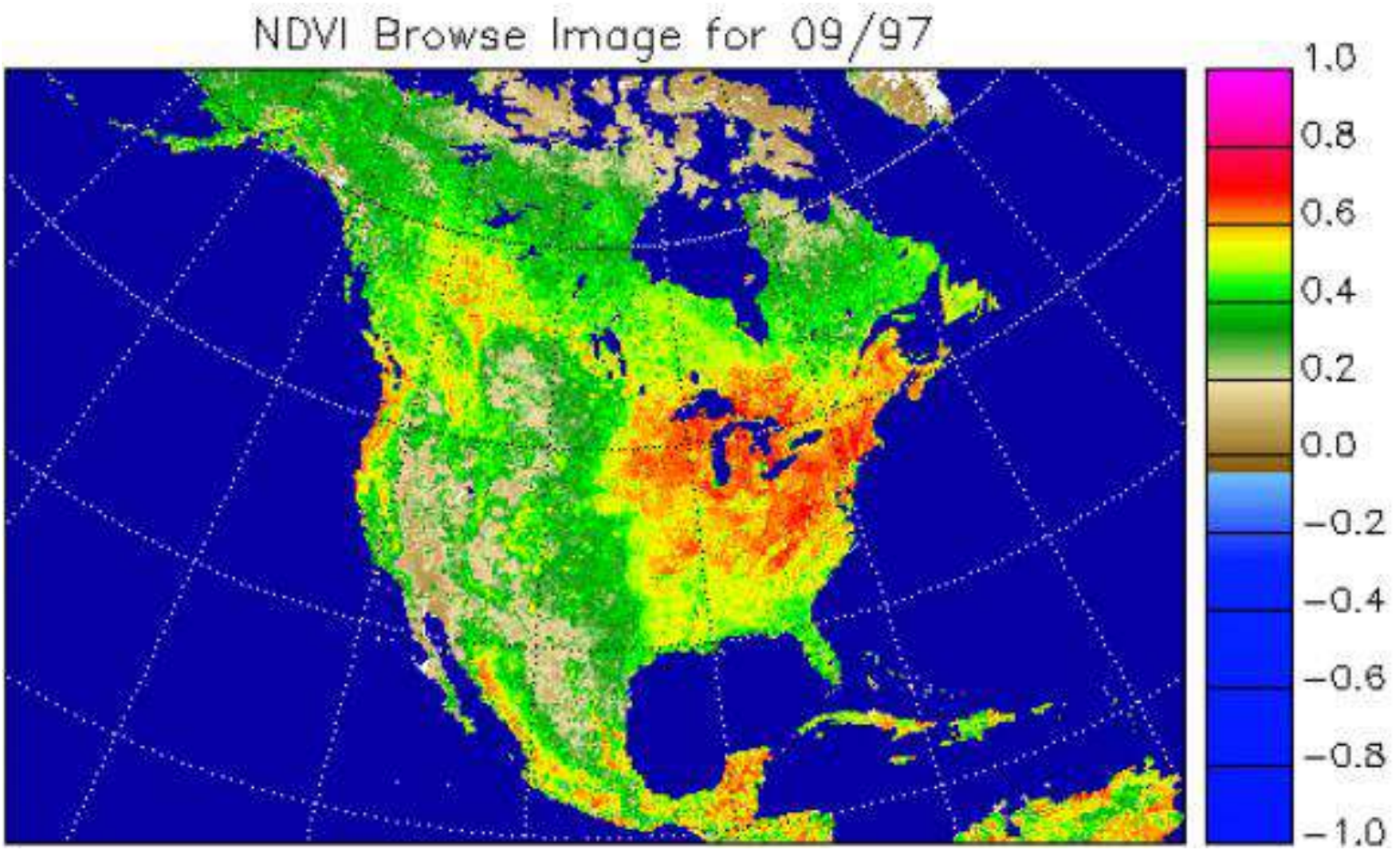
Reference: NOAA AVHRR (http://uregina.ca/piwowarj/Satellites/AVHRR_NDVI_Montage.GIF)



Reference: NOAA AVHRR (http://uregina.ca/piwowarj/Satellites/AVHRR_NDVI_Montage.GIF)



Reference: NOAA AVHRR (http://uregina.ca/piwowarj/Satellites/AVHRR_NDVI_Montage.GIF)



Reference: NOAA AVHRR (http://uregina.ca/piwowarj/Satellites/AVHRR_NDVI_Montage.GIF)

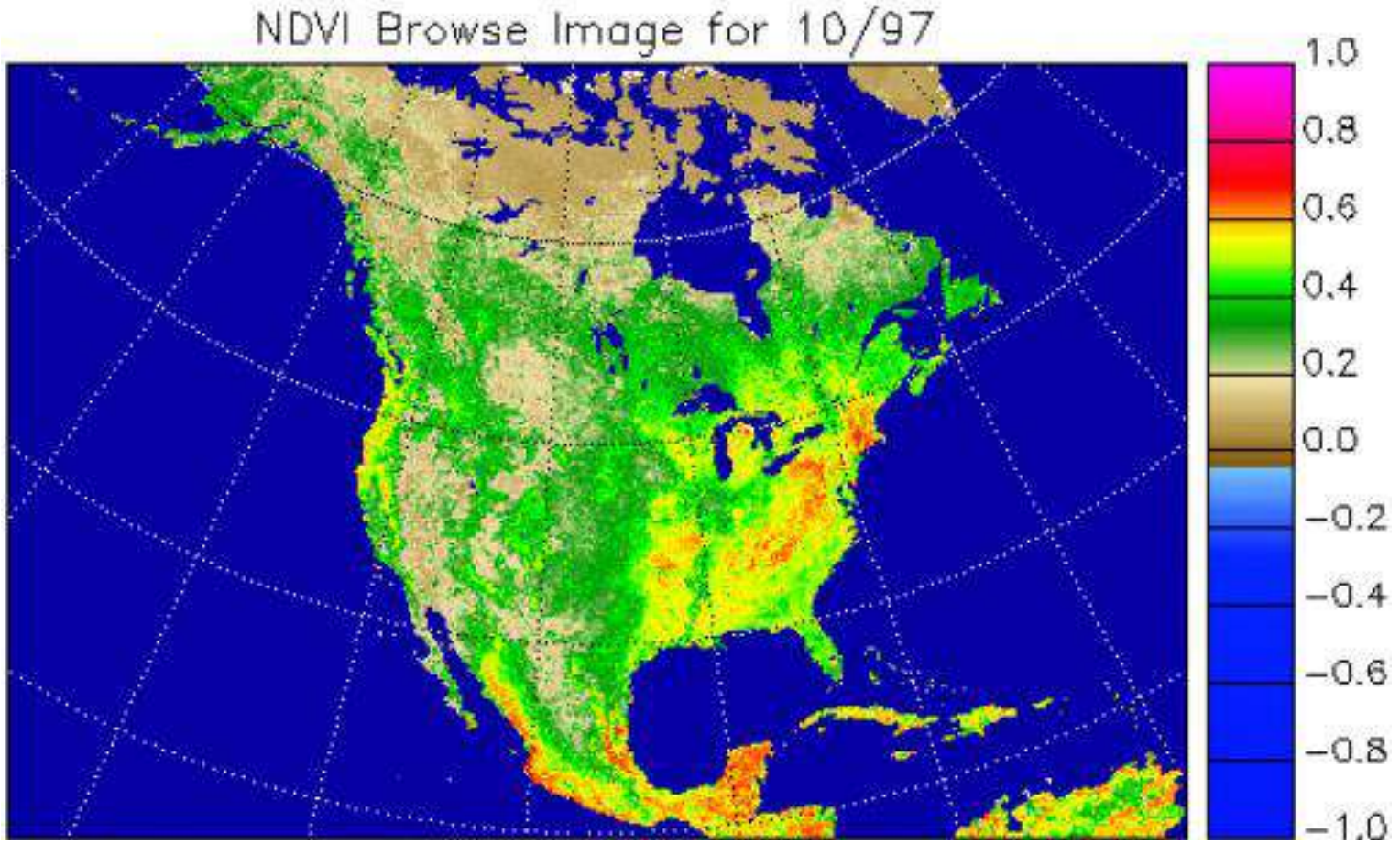
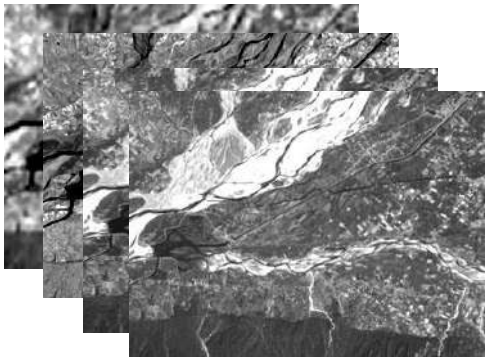


Image Classification



Allocation of a class to each spatial unit of analysis

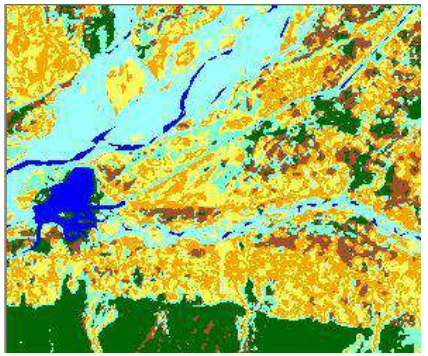


Image Classification – multiple date image processing

Garmser, Helmand (23Apr. 2006)

Garmser, Helmand (03 Jun 2006)

Pre-harvest and post-harvest images

Classified images

Final classification

Geospatial data sources

Free/low cost thematic data sets

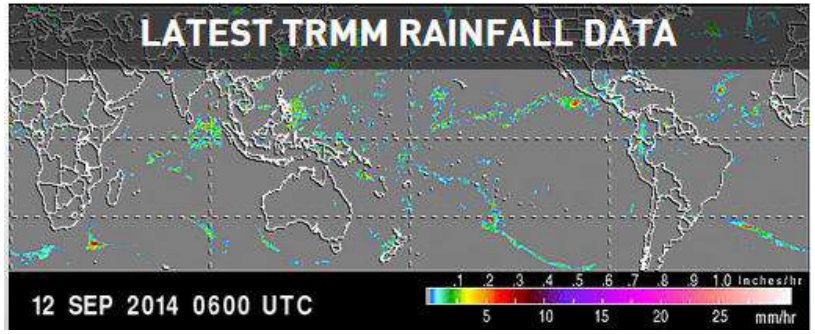
- DCW
- Openstreetmap
- ESRI
- Global Landuse

Free/low cost Image data sets

- Google earth
- Global DEM (ASTER and SRTM)
- Advanced Very High Resolution Radiometer (AVHRR)
- MODIS
- Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)
- Landsat MSS/TM data
- SPOT Vegetation

Advanced Earth observation

- **Worldview-3** from DigitalGlobe (Very High resolution images)
- **Sentinel satellites** (radar and multi-spectral imaging instruments for land, ocean and atmospheric monitoring)
- **TanDEM-X** (TerraSAR-X add-on for Digital Elevation Measurement)
- **ICEsat-1 & 2** (pioneered the use of laser altimeters in space – to measure ice sheet elevation change)
- **Landscan** (Global population data)
- **GPM** (new standard for precipitation measurements from space, based on success of TRMM)



Thanks