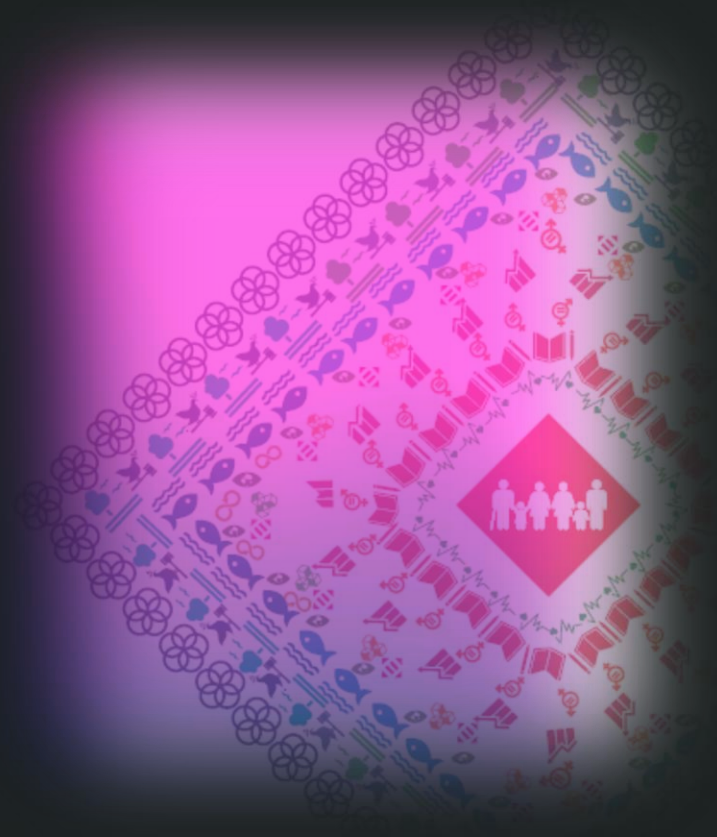
Remote sensing of sustainability

Shailesh Deshpande
Principal scientist, TRDDC, TCS Research

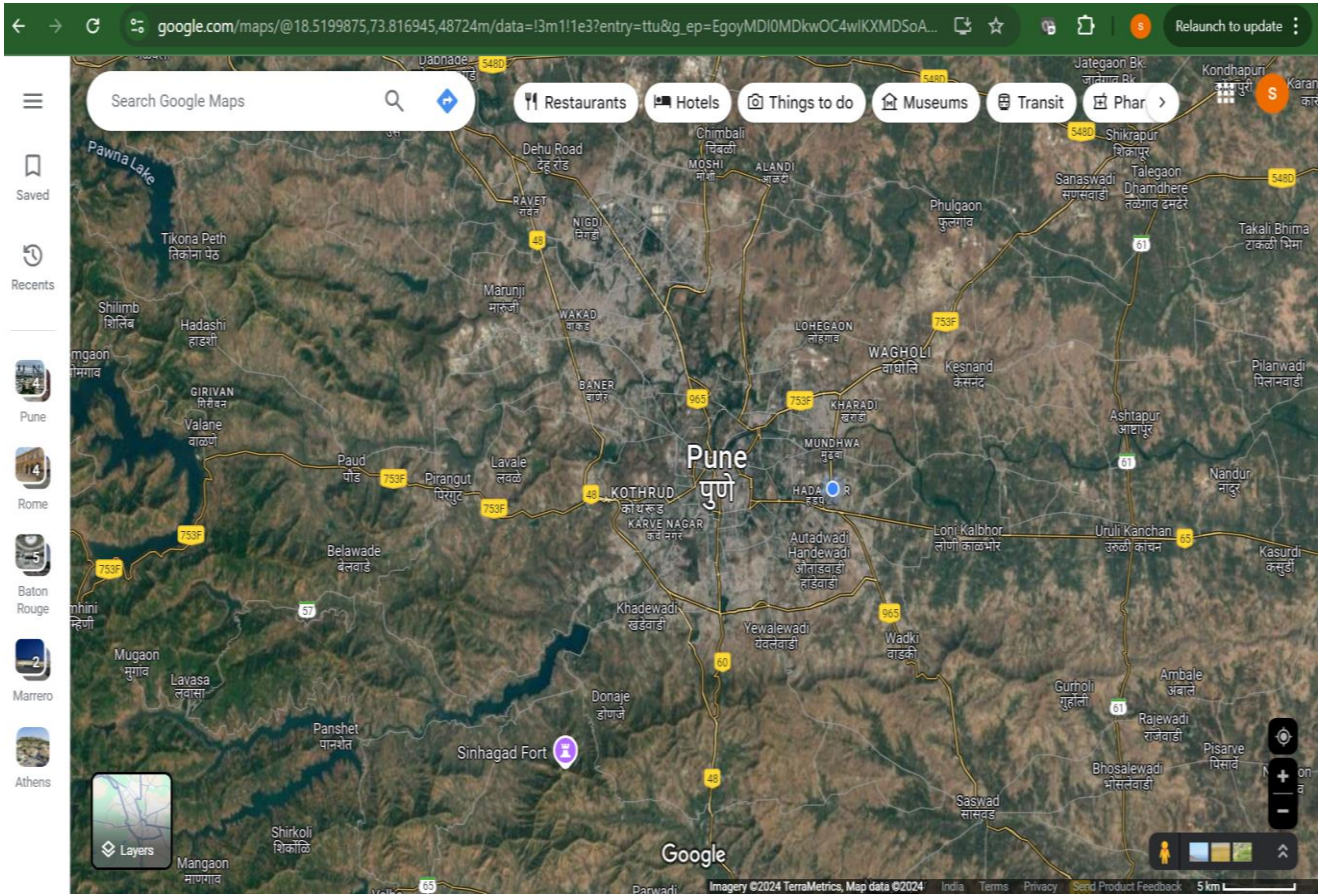
3 June 2025



Outline

- Remote sensing basics
  - Science and art
  - Some basic concepts
  - Special consideration
- Examples
  - Motivating example – Mula river changes, Pune
  - Monitoring of SDG indicators
- Exploration
  - Changes at IITGn campus in last 10 years

Google map?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Search Google Maps
Restaurants
Hotels
Things to do
Museums
Transit
Saved
Recents
Pune
Rome
Baton Rouge
Marrero
Athens
Pune
पुणे
Pawna Lake
Dehu Road
देहू रोड
Chimbali
चिंबळी
MOSHI
मोशी
ALANDI
आळंदी
Sanaswadi
सणसवाडी
Talegaon Dhamdhere
तळेगाव ढमढेरे
Shikrapur
शिक्रापुर
Kondhapuri
Phulgaon
फुलगाव
Takali Bhima
टाकळी भिमा
Tikona Peth
तिकोना पेठ
Shilimb
शिलिंब
Hadashi
हाडशी
Marunji
मारुंजी
WAKAD
वाकड
LOHEGAON
लोहगाव
WAGHOLI
वाघोली
Kesnand
केसनंद
Pilanwadi
पिलानवाडी
GIRIVAN
गिरीवन
Valane
वाळणे
BANER
बाणेर
KHARADI
खराडी
Ashtapur
आष्टापूर
MUNDHWA
मुंढवा
Paud
पौड
Pirangut
पिरंगुट
Lavale
लवळे
KOTHRUD
कोथरुड
KARVE NAGAR
कर्वे नगर
HADAPSAR
Nandur
नांदुर
Loni Kalbhor
लोणी काळभोर
Uruli Kanchan
उरुळी कांचन
Kasurdi
कसुर्डी
Autadwadi
Handewadi
ओतडवाडी
हांडेवाडी
Belawade
बेलवाडे
Khadewadi
खडेवाडी
Yewalewadi
येवलेवाडी
Wadki
वाडकी
Mugaon
मुगाव
Lavasa
लवासा
Donaje
डोणजे
Gurholi
गुरोली
Ambale
अंबाले
Rajewadi
राजेवाडी
Pisarve
पिसर्वे
Bhosalewadi
भोसलेवाडी
Panshet
पानशेत
Sinhagad Fort
Saswad
सासवड
Shirkoli
शिरकोळी
Mangaon
मांगगाव
Layers
Google
Imagery ©2024 TerraMetrics, Map data ©2024
India
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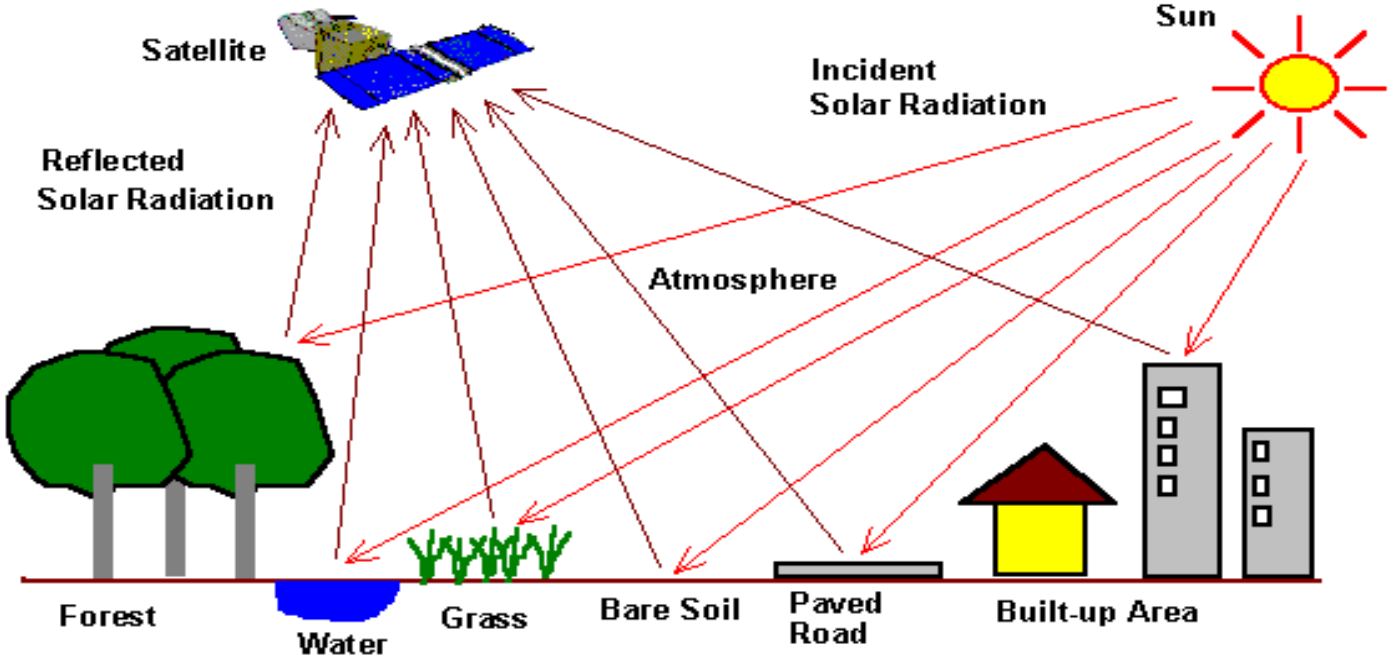
Send Product Feedback
5 km

Remote sensing



 |

A few significant applications

- Agriculture
  - Crop type detection,
  - Water stress, disease detection …
- Environment-Pollution detection, quantification and monitoring
  - Air pollution, Water pollution
  - Land-use cover,
  - Sea temperature and global warming, Chlorophyll measurement
- Disaster management
  - Prediction and monitoring
  - Damage area assessment

Some fancy words

- Active vs. passive
  - Energy is not produced by RS platform – energy is produced
  - Photograph - Radar

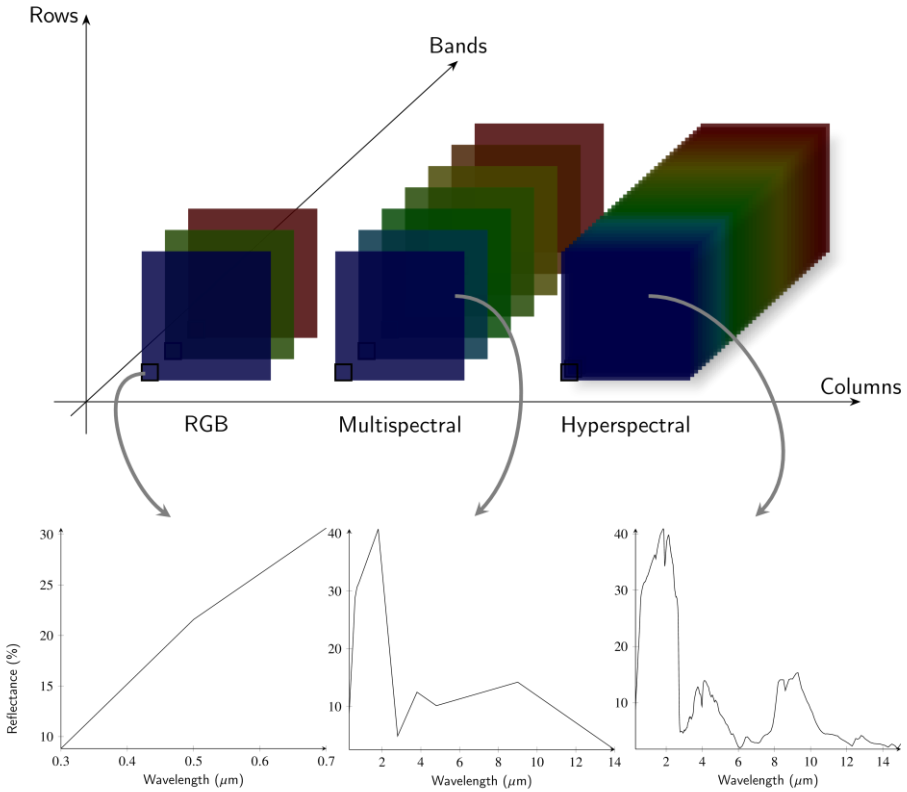
- Sun-synchronized – geo synchronized
  - Revolving around the earth at height (700-800 km app) – Stationary (35 km)
  - Remote sensing satellite – Weather satellites

Some fancy words cond.

- Resolution
  - Temporal resolution - revisit period (3-12 days),
  - Spatial resolution – 3 m - few kms,
  - Spectral resolution – narrow – broad (hyper spectral – panchromatic)

- DN, Radiance, Reflectance, Signature
  - Digital number indicating amount of reflected energy
  - Radiance – is actual energy measured in Watt/m^2
  - Spectral reflectance characteristics of a particular object to be recognized

RGB, Multispectral, hyperspectral



Pixel P

P
b1
b2
bn

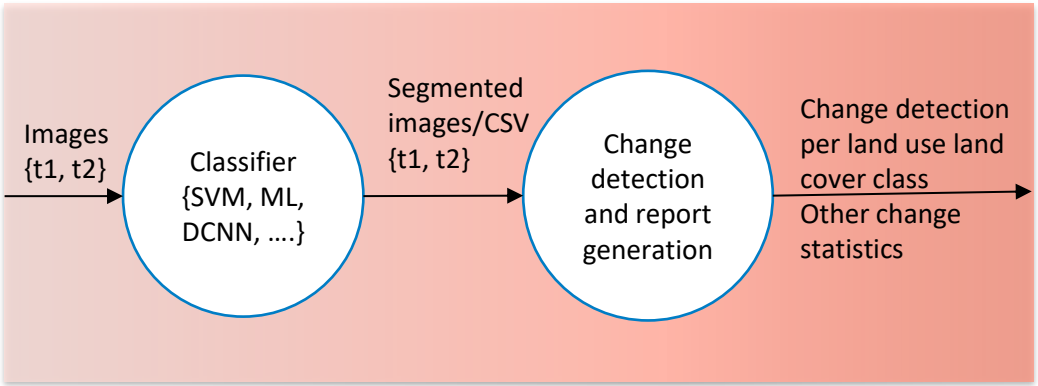
Spatial

Spectral

Remote sensing workflow example

Spectral

- RGB band values
- FCC
- Multispectral band values



Spatial

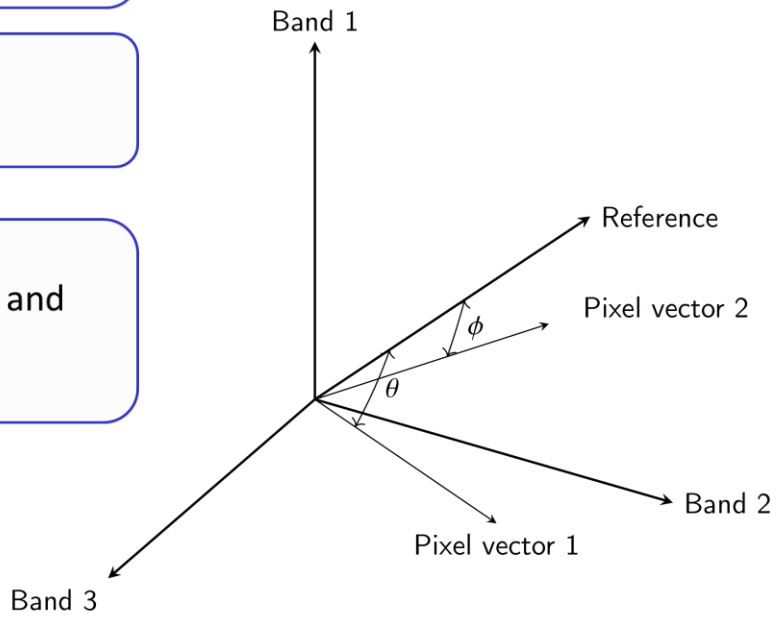
- Texture. Edges, contours
- Pixel to pixel association

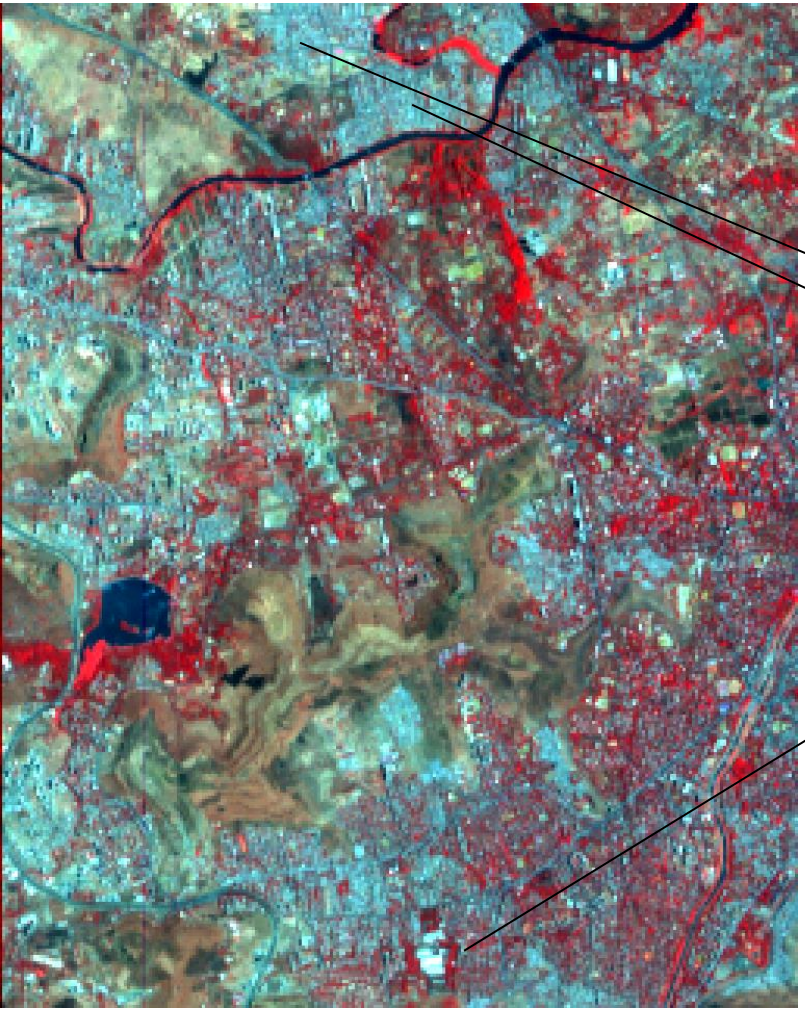
Processing steps for multispectral/hyperspectral image

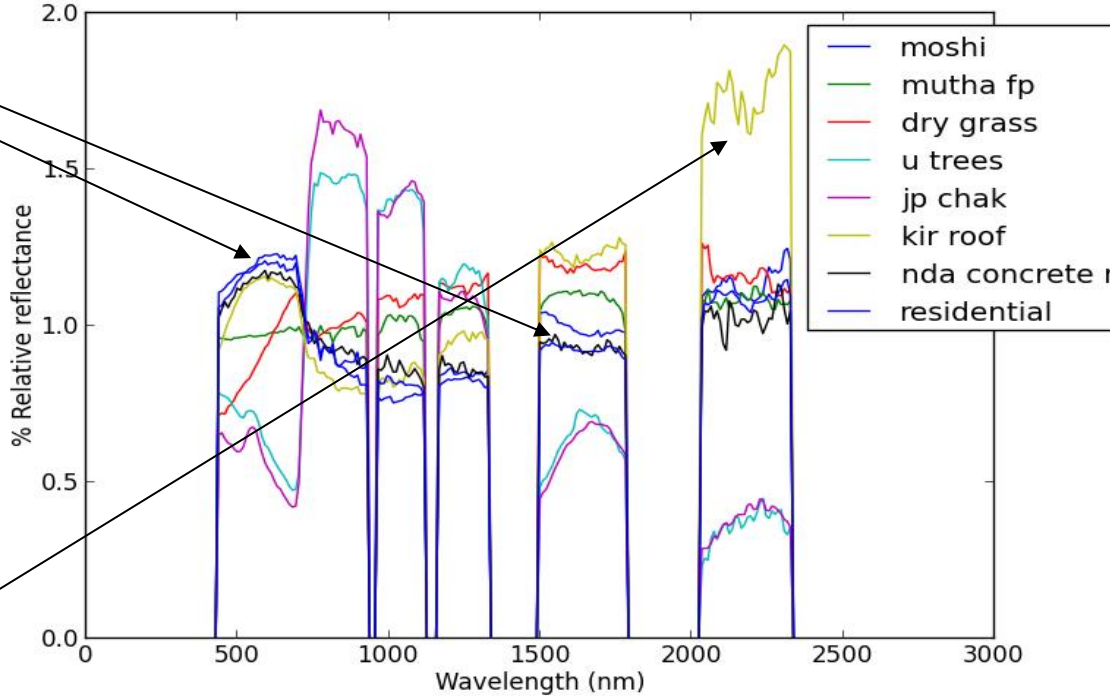
Normalize
- Remove illumination differences by normalizing each pixel to constant sum
- Remove haze using improved dark object technique

Calibrate
- Calculate average spectrum
- Divide each pixel by average spectrum

Classify
- Extract reference signatures
- Calculate similarity between reference spectra and spectrum of each pixel
- Choosing a class with maximum similarity

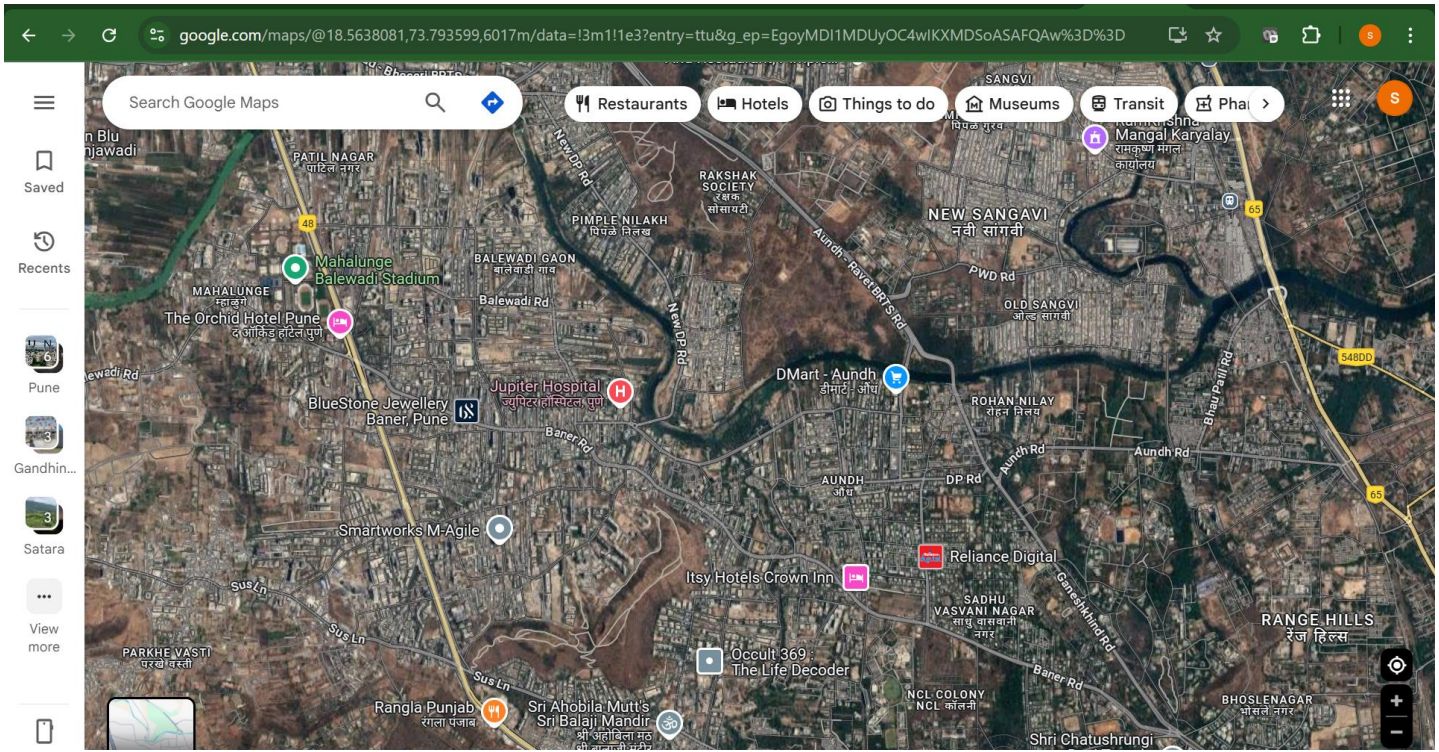





2.0
1.5
1.0
0.5
0.0
% Relative reflectance
0
500
1000
1500
2000
2500
3000
Wavelength (nm)
moshi
mutha fp
dry grass
u trees
jp chak
kir roof
nda concrete
residential

Motivating example

- Changes in the river channel because of beautification project



MultiSpec

File Edit View Project Processor Options Window Help

x0.333

Zoom out of image. Use shift key to zoom as fast as system can.

L6-LC09_L1TP_147047_2025

Lat-Long (Decimal)

L 18.565375 - 18.565106

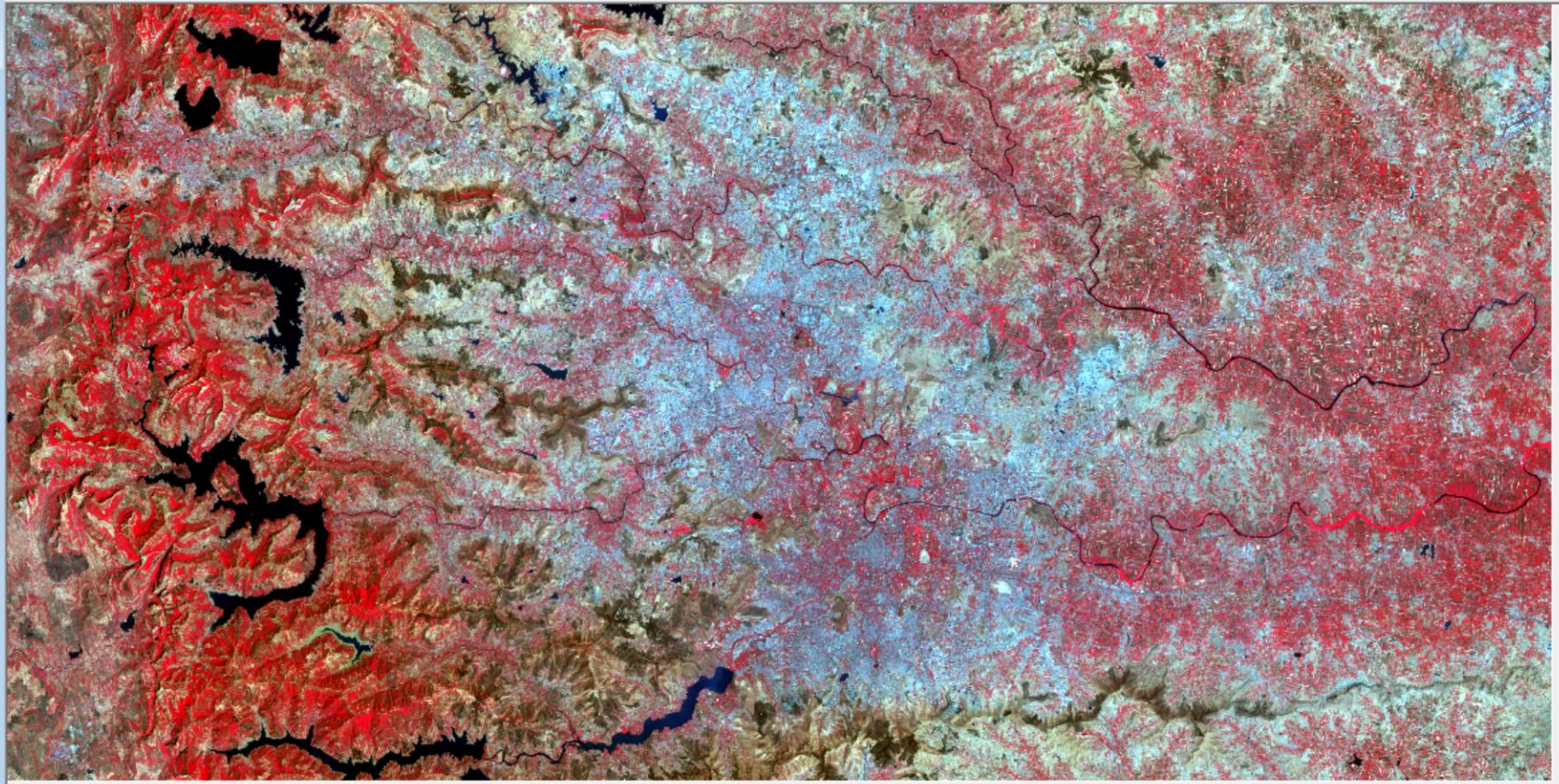
C 73.807927 - 73.808213

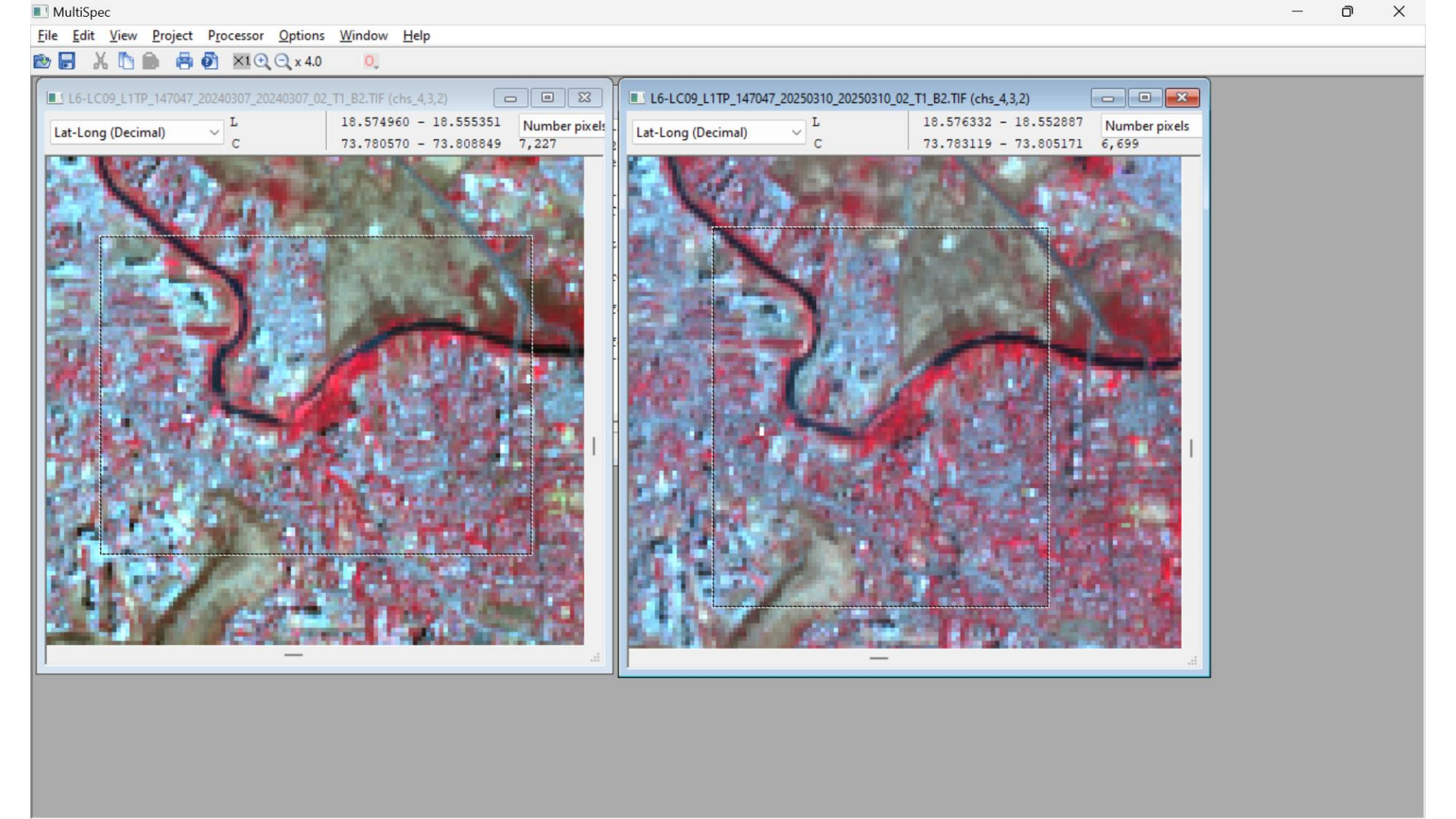
Number pixels

1

Scale

1:340,157




MultiSpec
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x 4.0
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Lat-Long (Decimal)
L
C
18.574960 - 18.555351
73.780570 - 73.808849
Number pixels
7,227
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Number pixels
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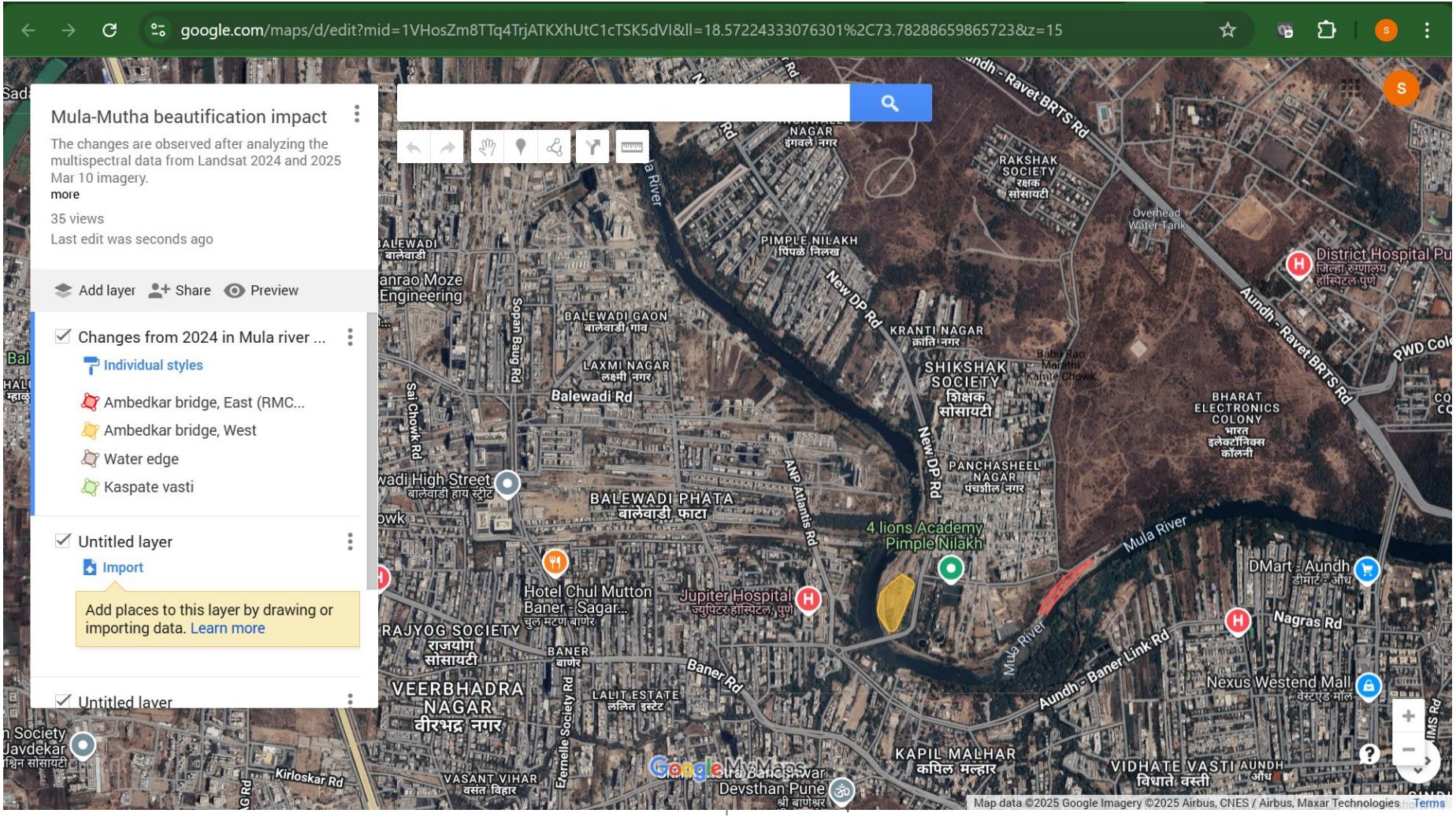
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Mula-Mutha beautification impact
The changes are observed after analyzing the multispectral data from Landsat 2024 and 2025 Mar 10 imagery.
more
35 views
Last edit was seconds ago
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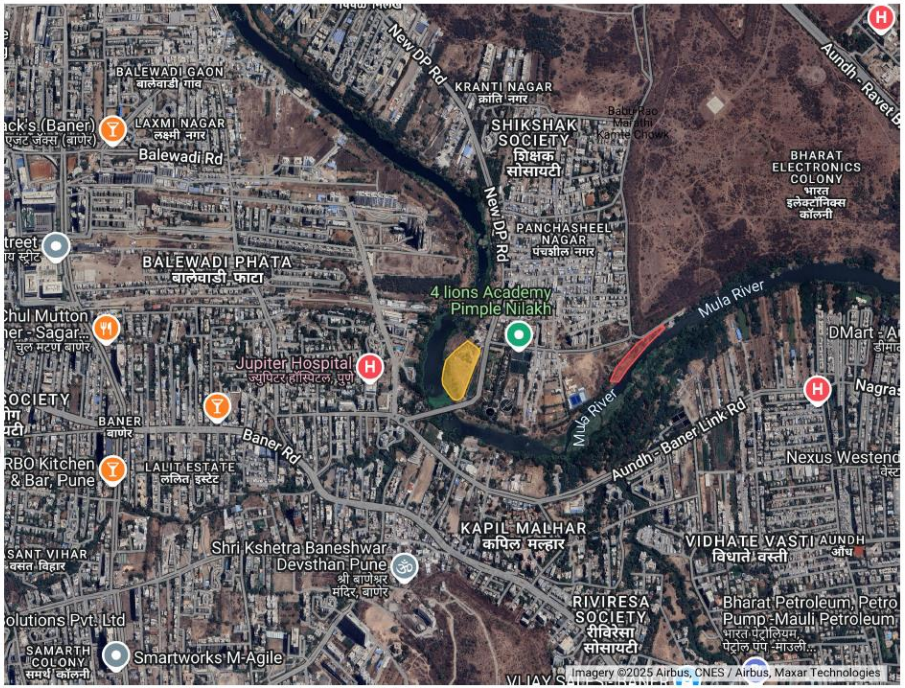
Preview
Changes from 2024 in Mula river ...
Individual styles
Ambedkar bridge, East (RMC...
Ambedkar bridge, West
Water edge
Kaspate vasti
Untitled layer
Import
Add places to this layer by drawing or importing data. Learn more
Untitled layer
Aundh - Ravet BRTS Rd
RAKSHAK SOCIETY रक्षक सोसायटी
Overhead Water Tank
PIMPLE NILAKH पिंपळे निलख
New DP Rd
KRANTI NAGAR क्रांति नगर
SHIKSHAK SOCIETY शिक्षक सोसायटी
BHARAT ELECTRONICS COLONY भारत इलेक्ट्रॉनिक्स कॉलनी
PANCHASHEEL NAGAR पंचशील नगर
BALEWADI GAON बालेवाडी गाव
LAXMI NAGAR लक्ष्मी नगर
Balewadi Rd
Sopan Bag Rd
Sai Chowk Rd
BALEWADI PHATA बालेवाडी फाटा
ANP Atlantis Rd
4 lions Academy Pimple Nilakh
Mula River
Hotel Chul Mutton Baner - Sagar...
Jupiter Hospital ज्युपिटर हॉस्पिटल, पुणे
RAJYOG SOCIETY राजयोग सोसायटी
BANER बाणेर
Baner Rd
Aundh - Baner Link Rd
Nagras Rd
DMart - Aundh
Nexus Westend Mall
VEERBHADRA NAGAR वीरभद्र नगर
LALIT ESTATE ललित इस्टेट
Eternelle Society Rd
KAPIL MALHAR कपिल मल्हार
VIDHATE VASTI AUNDH विधाते वस्ती
VASANT VIHAR वसंत विहार
Kirloskar Rd
Google Maps
Map data ©2025 Google Imagery ©2025 Airbus, CNES / Airbus, Maxar Technologies
Terms

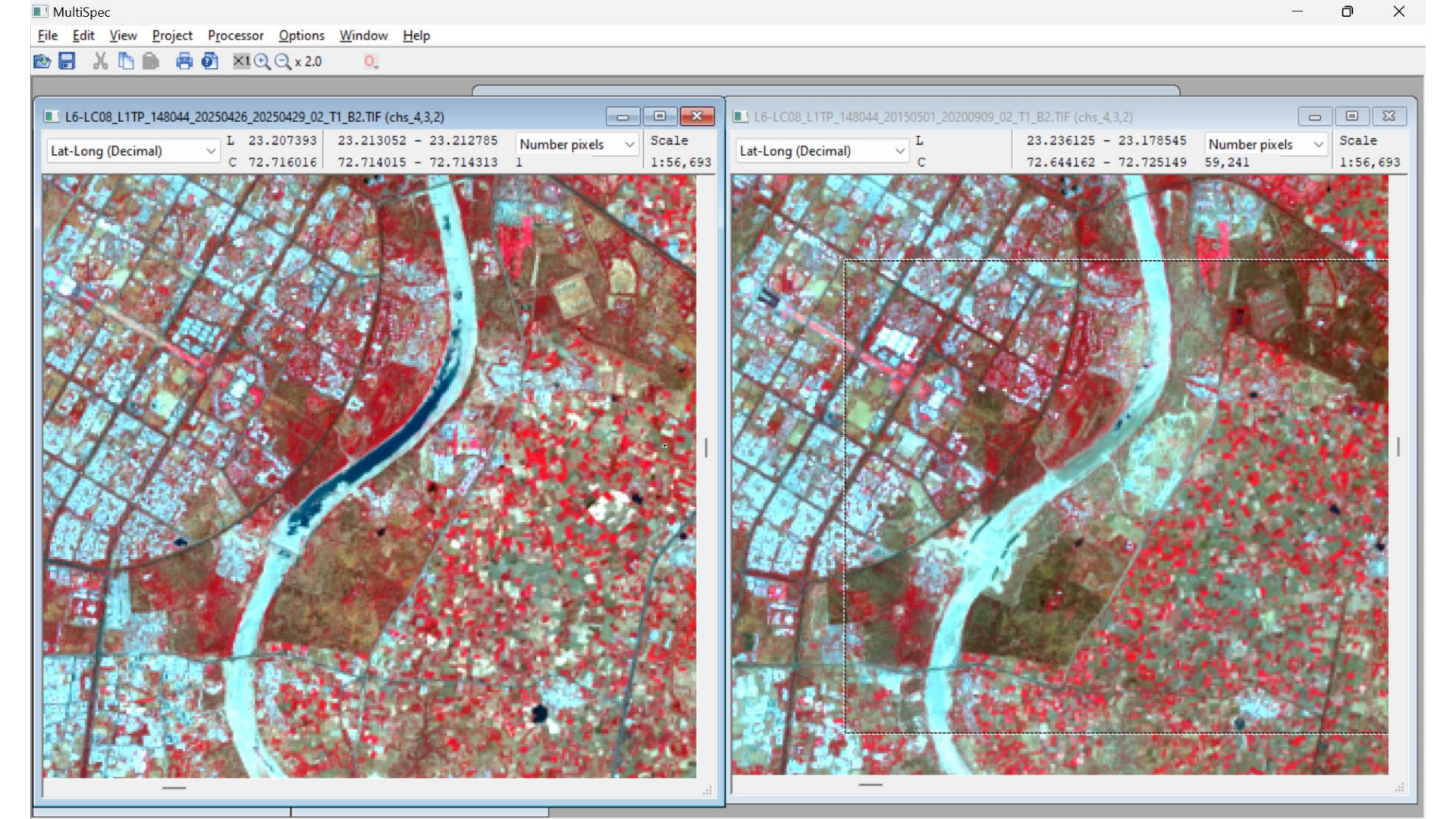
Mula-Mutha beautification impact

Changes from 2024 in Mula river channel

- Ambedkar bridge, East (RMC end)
- Ambedkar bridge, West
- Water edge
- Kaspate vasti

The changes are observed after analyzing the multispectral data from Landsat 2024 and 2025 Mar 10 imagery.
Prepared by Shailesh Deshpande and Nilesh Hiremath

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C 72.716016
23.213052 - 23.212785
72.714015 - 72.714313
Number pixels
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Scale
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L6-LC08_L1TP_148044_20150501_20200909_02_T1_B2.TIF (chs_4,3,2)
Lat-Long (Decimal)
L
C
23.236125 - 23.178545
72.644162 - 72.725149
Number pixels
59,241
Scale
1:56,693

SDG goals

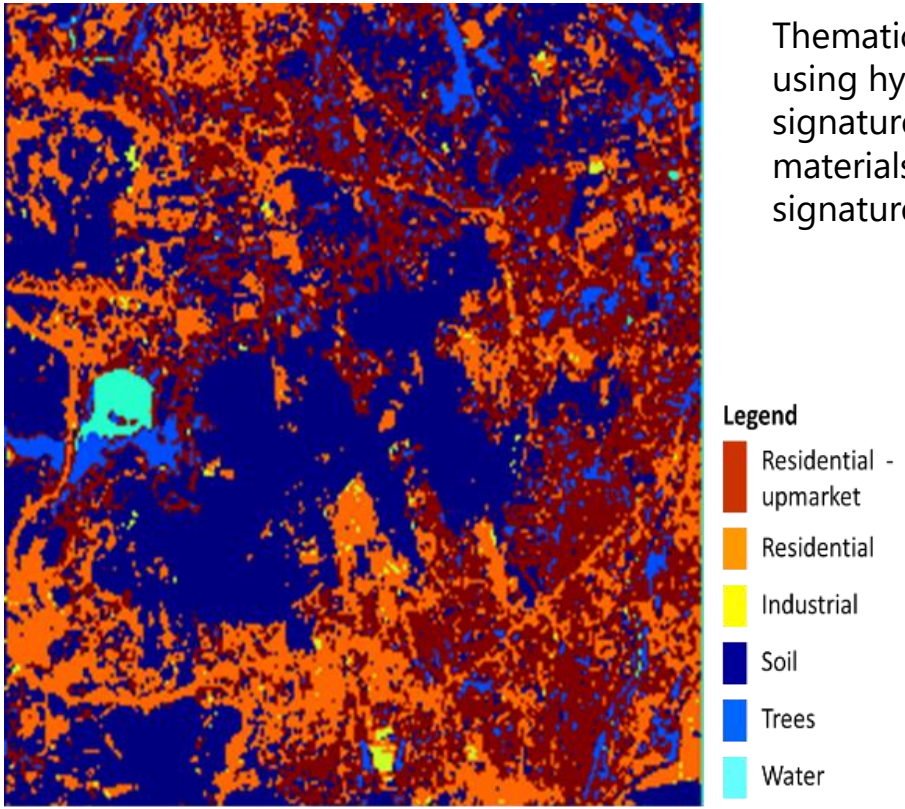

1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Indicator framework and its implication

- 1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters
  - 1.5.2 Direct economic loss attributed to disasters in relation to global gross domestic product (GDP)

- Audit perspective
- Intertwined goals
- It's a mammoth task
  - (data collection modeling and analysis)

Land use land cover analysis



Thematic classification using hyperspectral signatures of different materials and mixture signatures

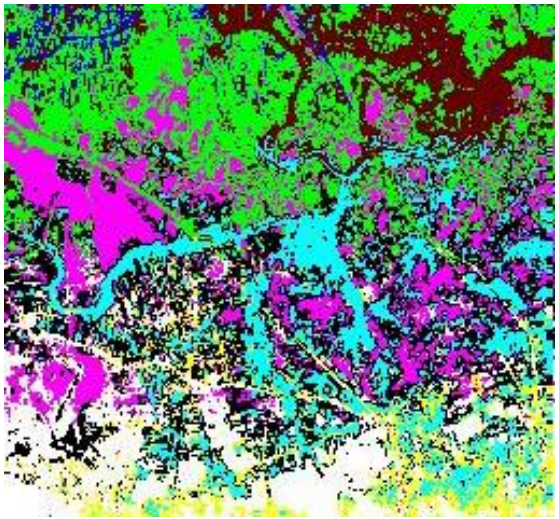
11 SUSTAINABLE CITIES AND COMMUNITIES

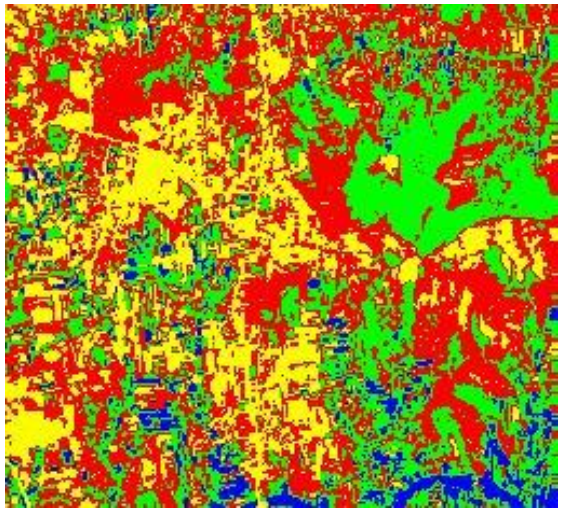
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

15 LIFE ON LAND

Economic zones in the city

Economic zone classification: Each theme is treated as a collection of urban materials, e. g. High eco. zone would have more trees and open areas, whereas slum would have little vegetation …





Low economy

Industrial

High economy

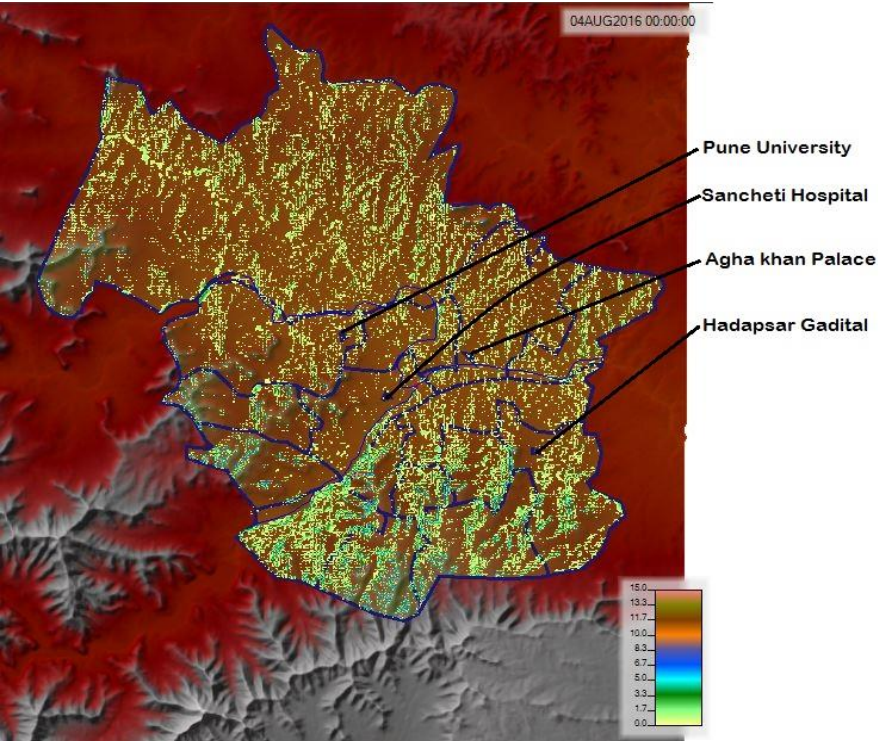
open areas

11 SUSTAINABLE CITIES AND COMMUNITIES

1 NO POVERTY

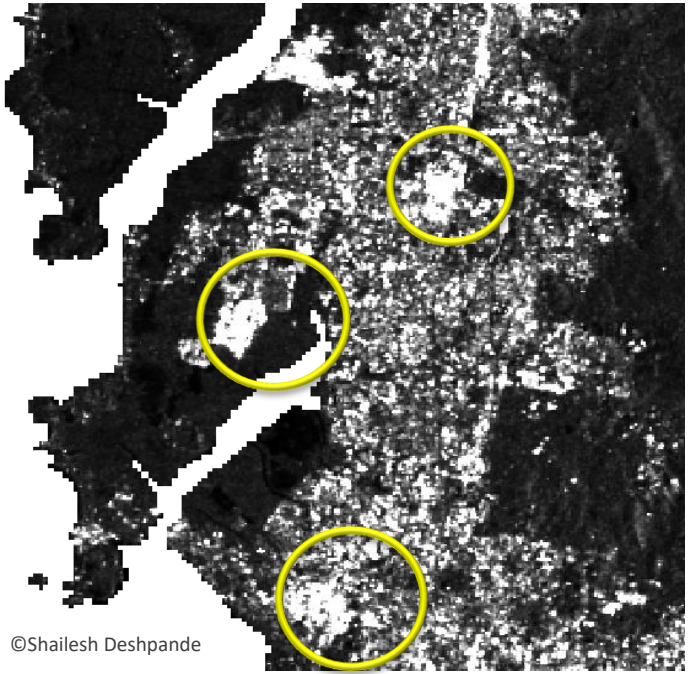
13 CLIMATE ACTION

Urban flood prediction and monitoring



Depth of water in Pune City at Different Locations for 3 August 2016

SAR image of Mumbai, Jul 2 2019;
bright white areas show flooded region

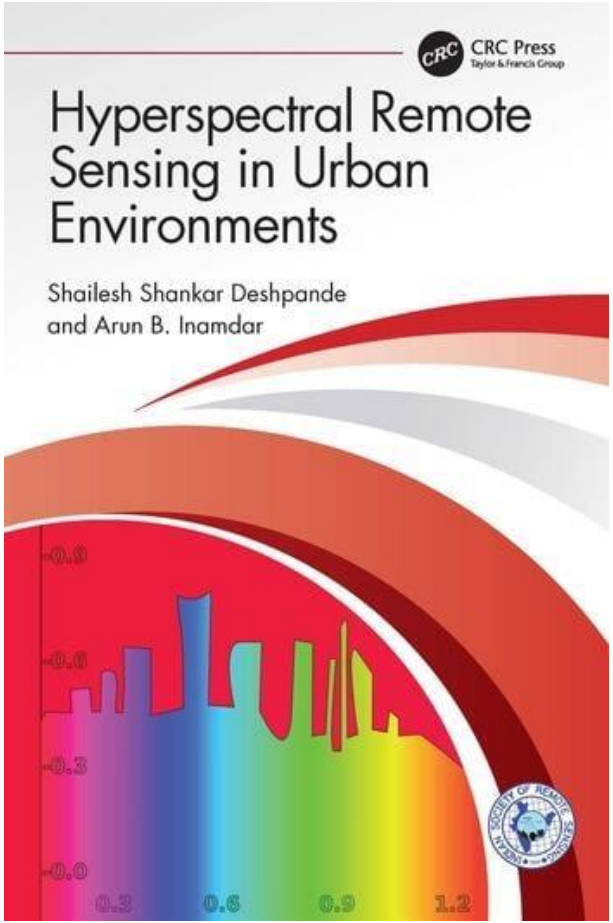


11 SUSTAINABLE CITIES AND COMMUNITIES

1 NO POVERTY

To Sum it up !

- Remote sensing is an invaluable tool for solving global problems



Sustainable is smart !
Smart is sustainable !

Source: Shailesh Deshpande, Arun Inamdar, Hyperspectral remote sensing of urban environment, Taylor and Francis

Key words –
Hyperspectral remote sensing,
Urban environment

https://www.routledge.com/Hyperspectral-Remote-Sensing-in-Urban-Environments/Deshpande-Inamdar/p/book/9781032359106

Email –
shaileshshankardeshpande@gmail.com

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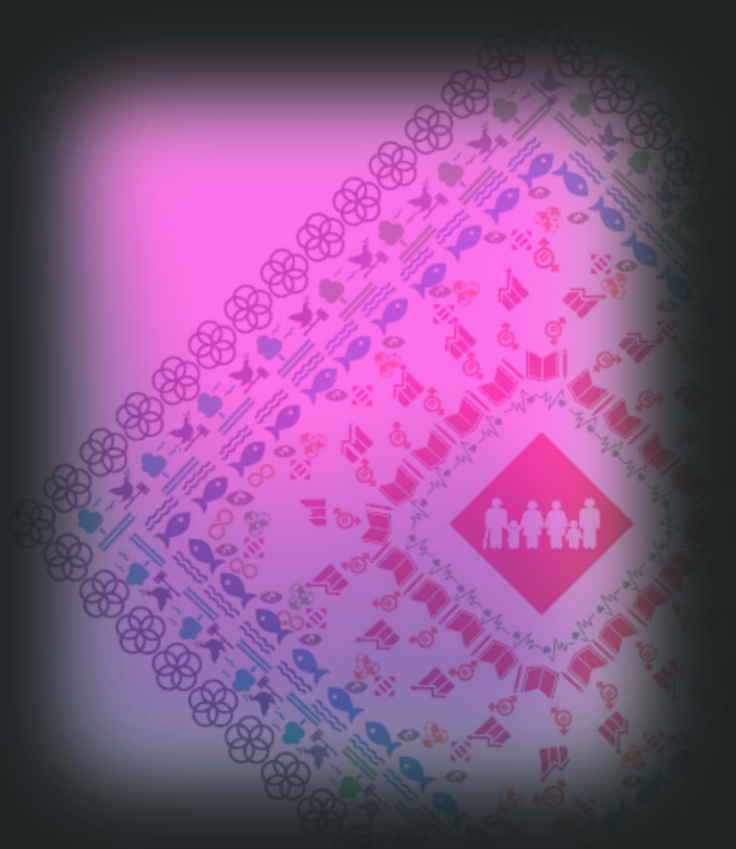
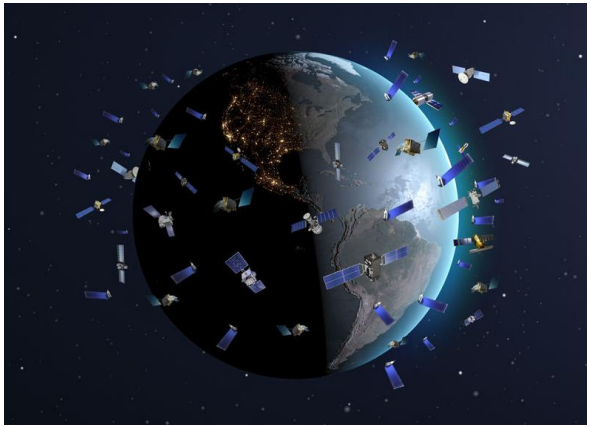
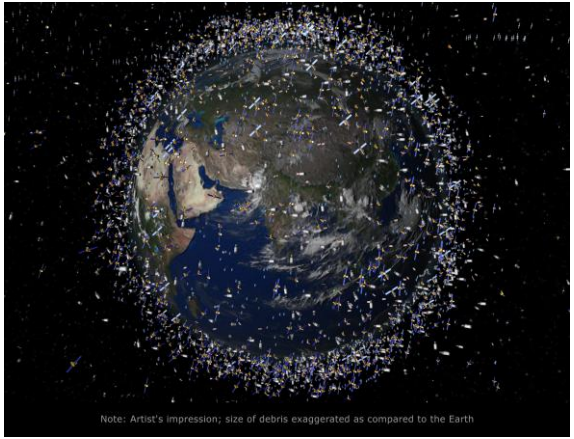
Thank You



RS then and now



https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.geospatialworld.net%2Fblogs%2Fhow-many-satellites-are-orbiting-the-earth-in-2021%2F&psig=AOvVaw0lzHMk-ZTw-JrRnzR9ikt7&ust=1701250386812000&source=images&cd=vfe&opi=89978449&ved=0CBIQjRxqFwoTCPD599qx5oIDFQAAAAAdAAAAABB2



Source - https://www.universetoday.com/96248/space-junk-ideas-for-cleaning-up-earth-orbit/

Number of satellites orbiting earth?

6542 (UNOOSA/UCS), 906 earth observation

Advantageous disadvantages

- Advantages
  - More accurate
  - Class label vs target material detection, chemical composition, quantification models
  - Unsupervised target detection is possible
- Disadvantages
  - Increase in size, dimensions
  - Atmospheric corrections are must
  - Spectral library resources are required
  - Mixed pixel problem

- Environmental
  - Pollution detection
- Defence
  - Hazardous chemicals
- Urban
  - Concrete age
- Industrial!
  - Drug manufacturing to plastic recycling

Key takeaways

- Spectral vs spatial
  - Focus is on spectral
- Atmospheric correction
  - Must apply atm. correction
- Spectral library is essential
  - ECOSTRESS (USA)
  - SPLIB (USA)
  - SPLIB tarang (India)
  - http://splibtarang.com/index.php

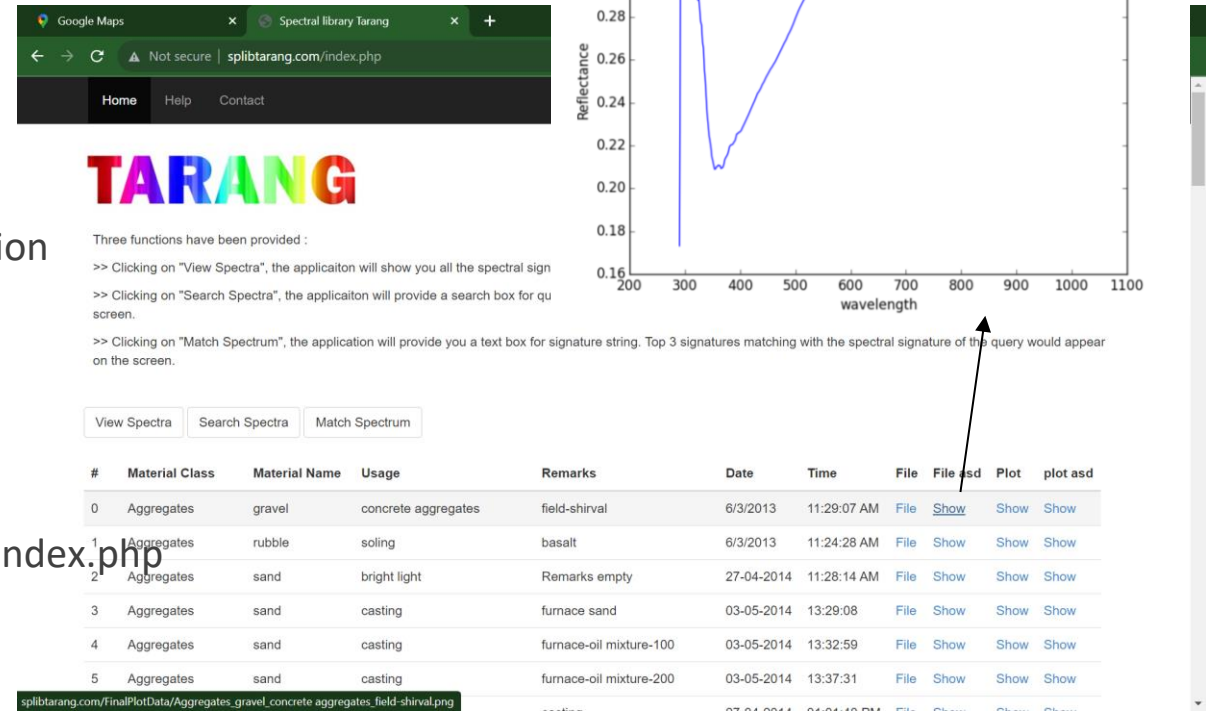
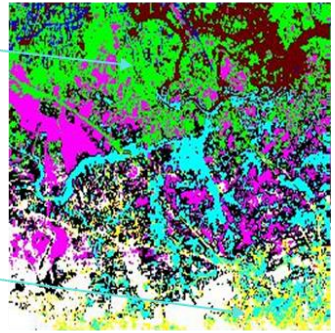
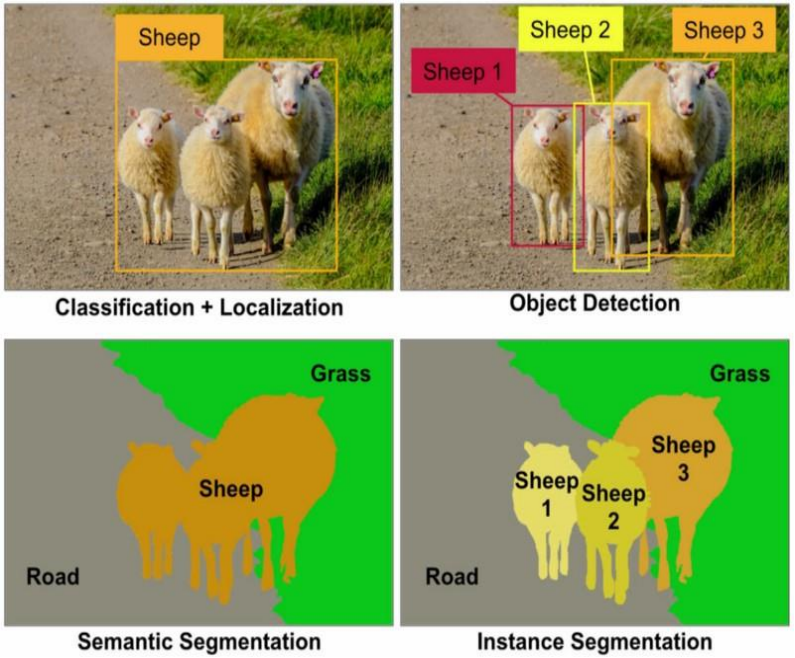


Image processing considerations

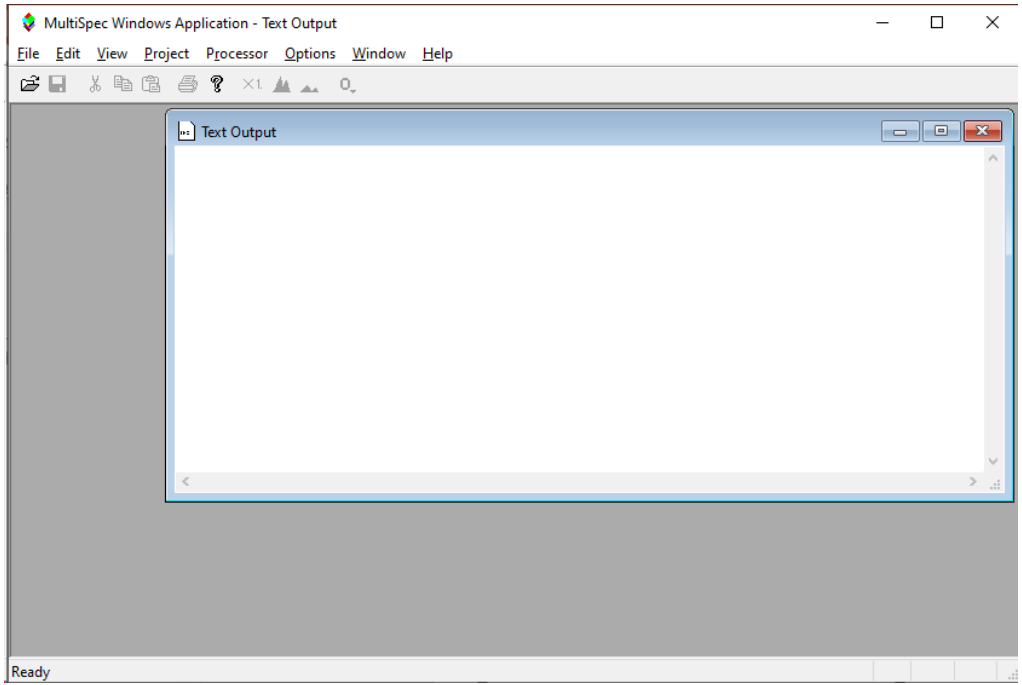
Economic zone classification: Residential vs Industrial, Upmarket vs mid-economy residential



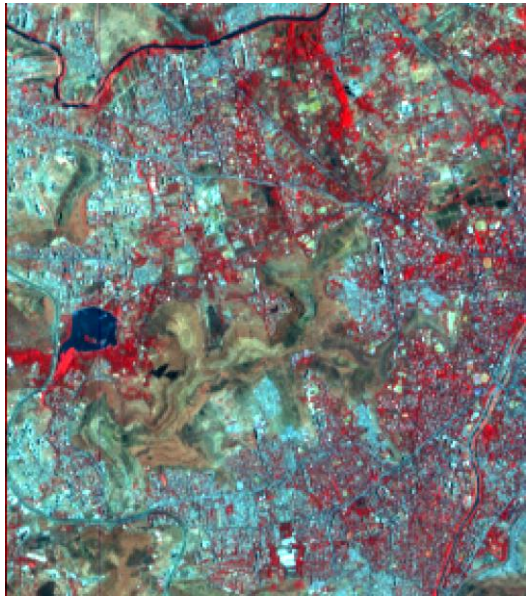


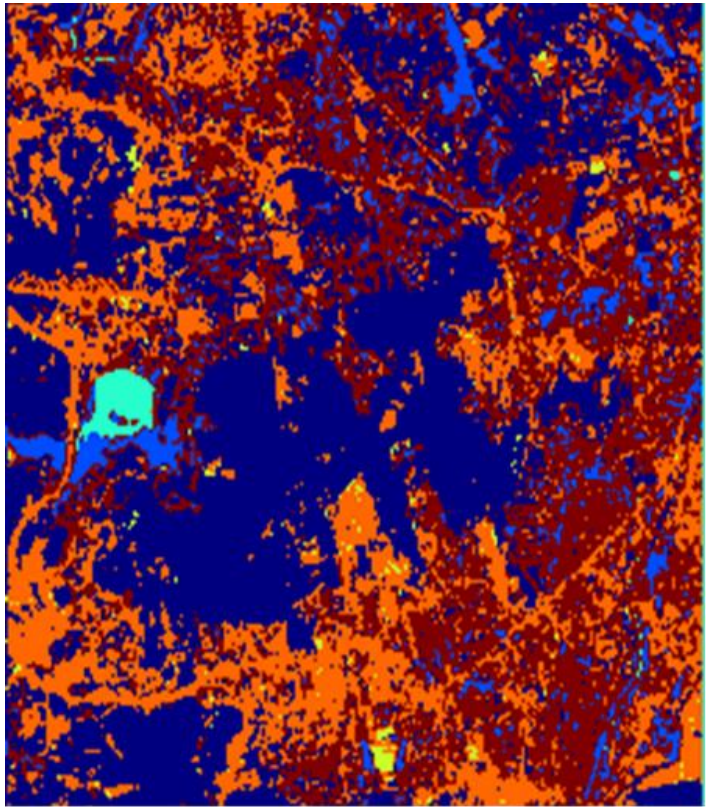
Explore Pune image with multispec

- Nice light package for exploring and working with MS and HS data



Results of target detection using SAM





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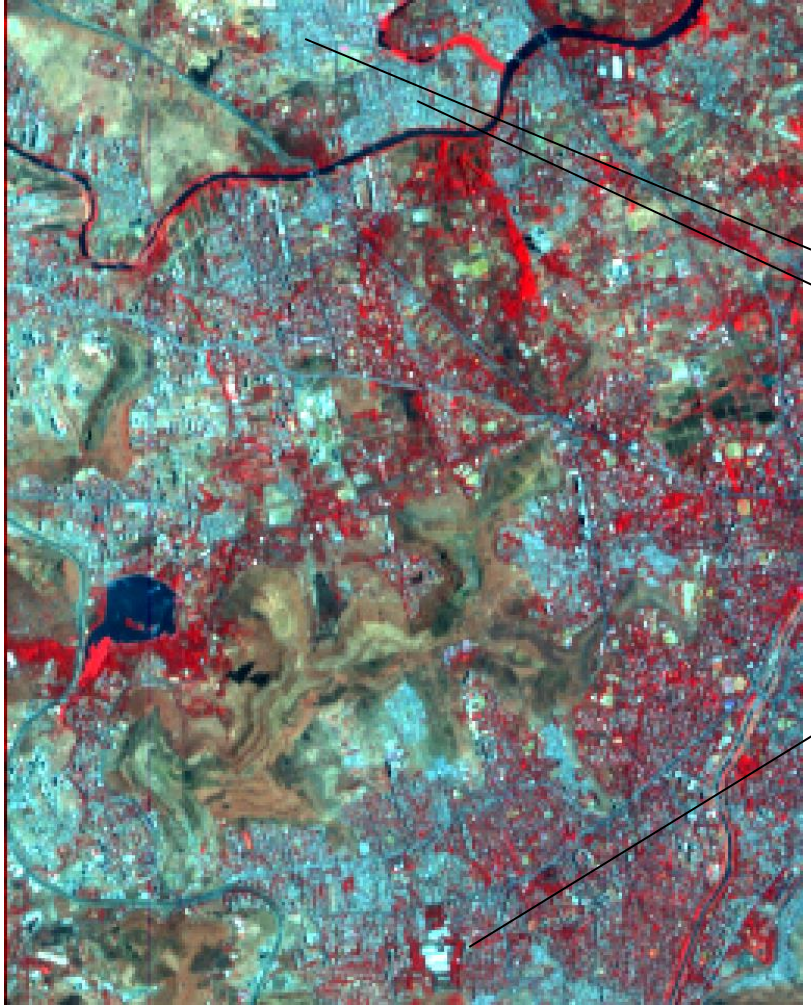
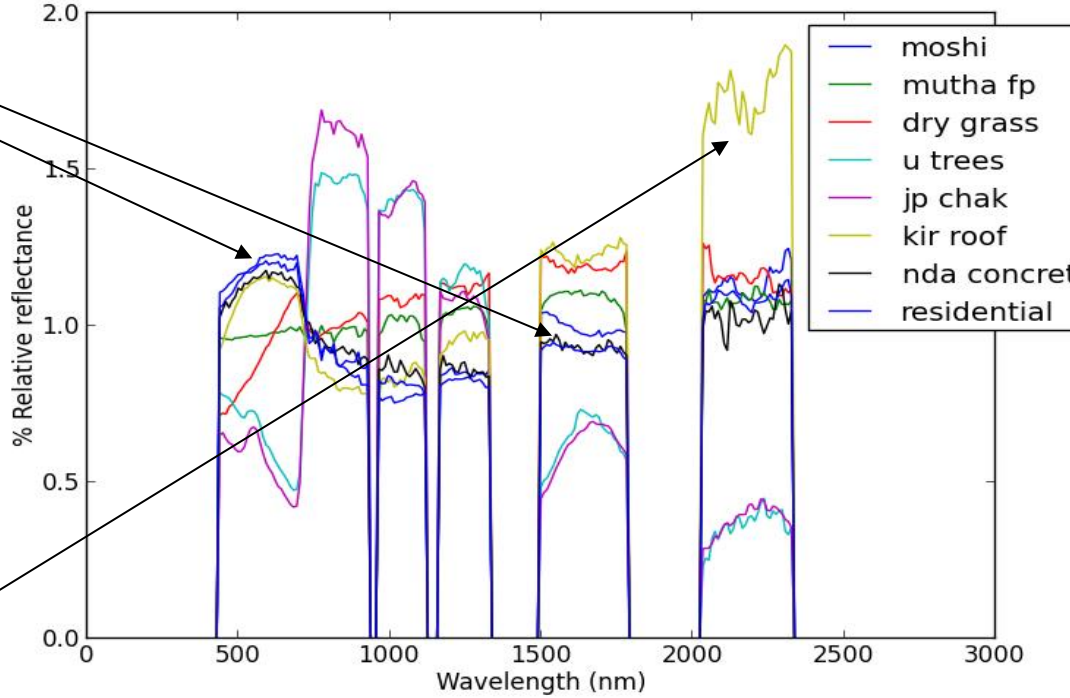
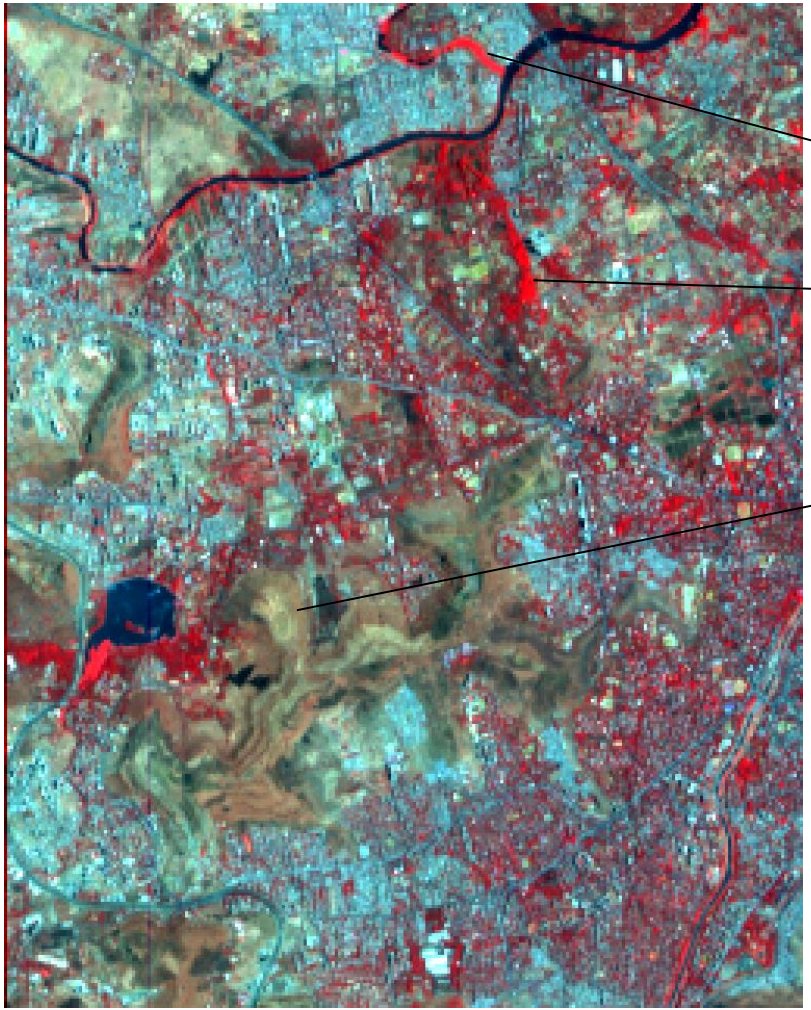
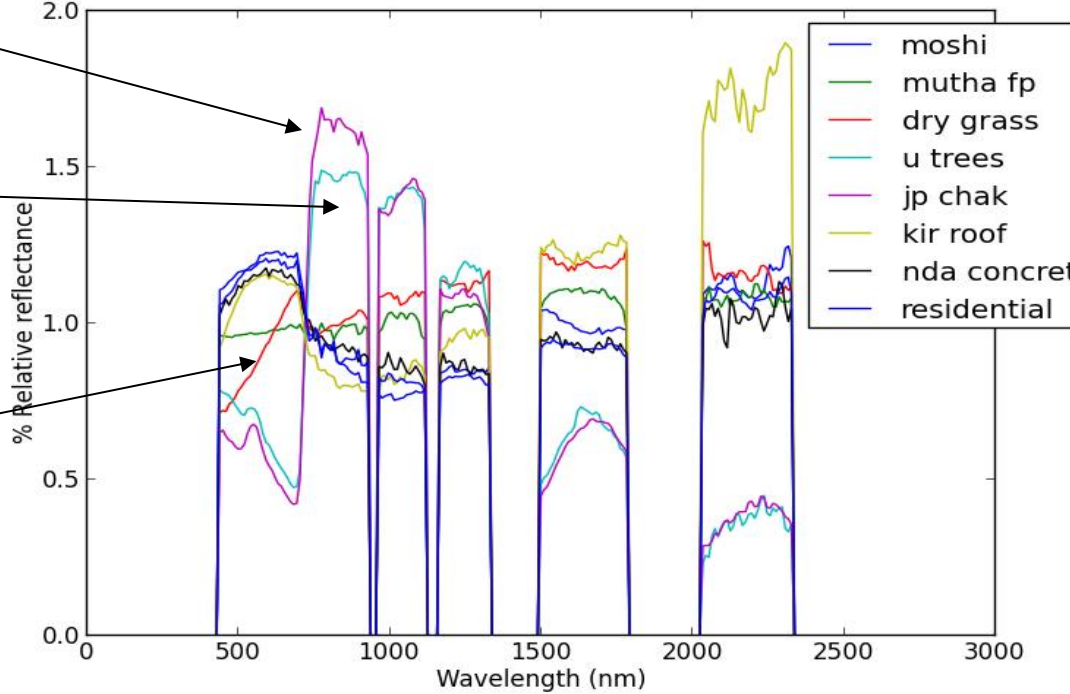
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

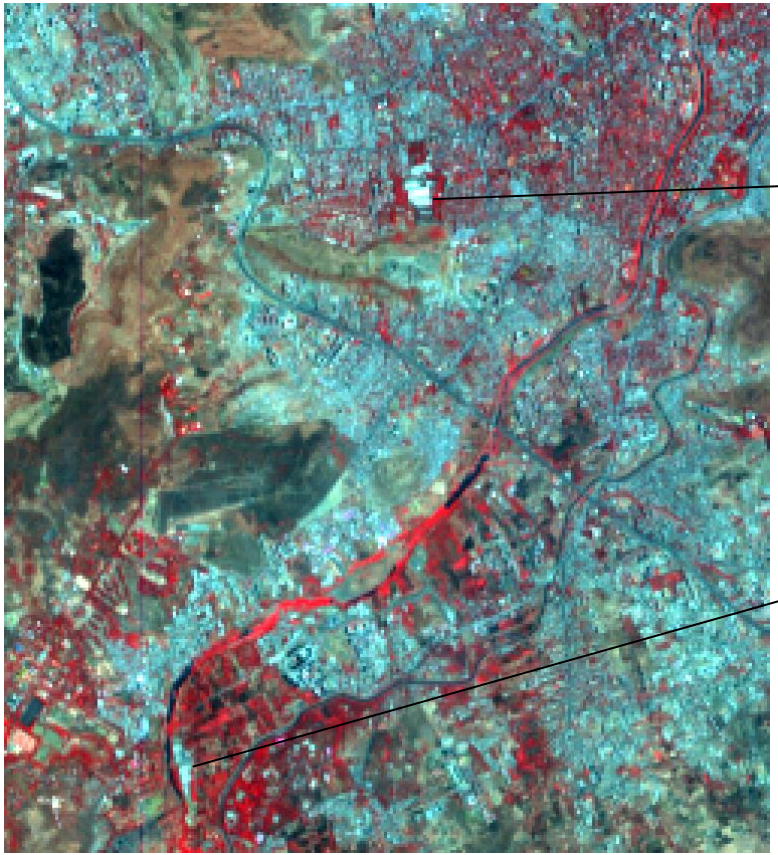
15 LIFE ON LAND

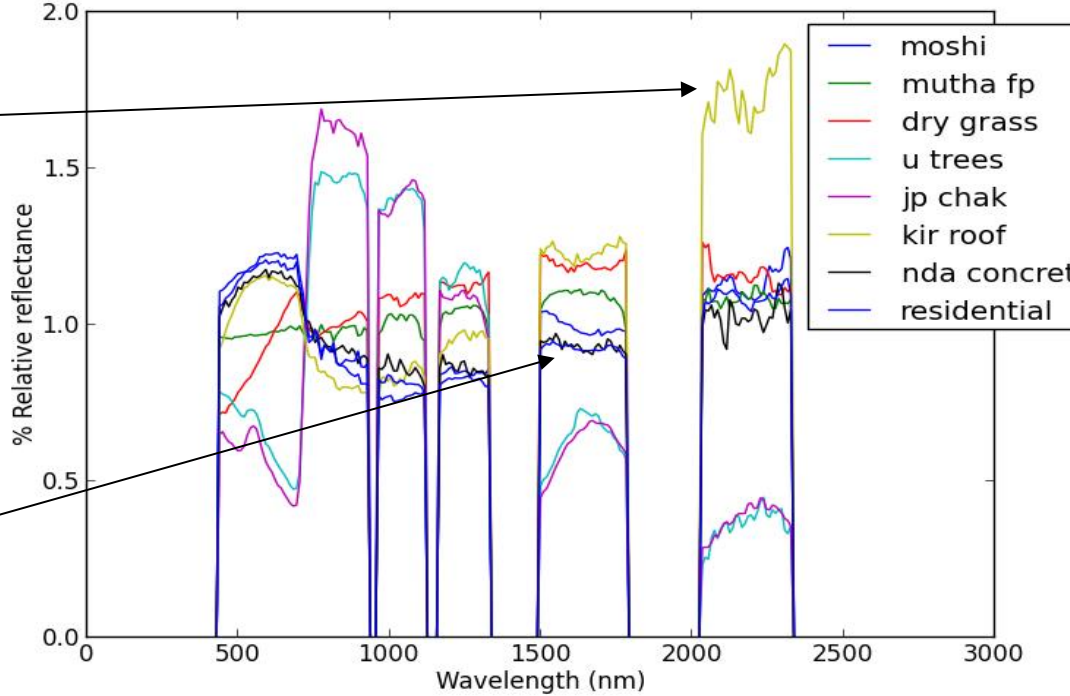



2.0
1.5
1.0
0.5
0.0
% Relective reflectance
0
500
1000
1500
2000
2500
3000
Wavelength (nm)
moshi
mutha fp
dry grass
u trees
jp chak
kir roof
nda concret
residential



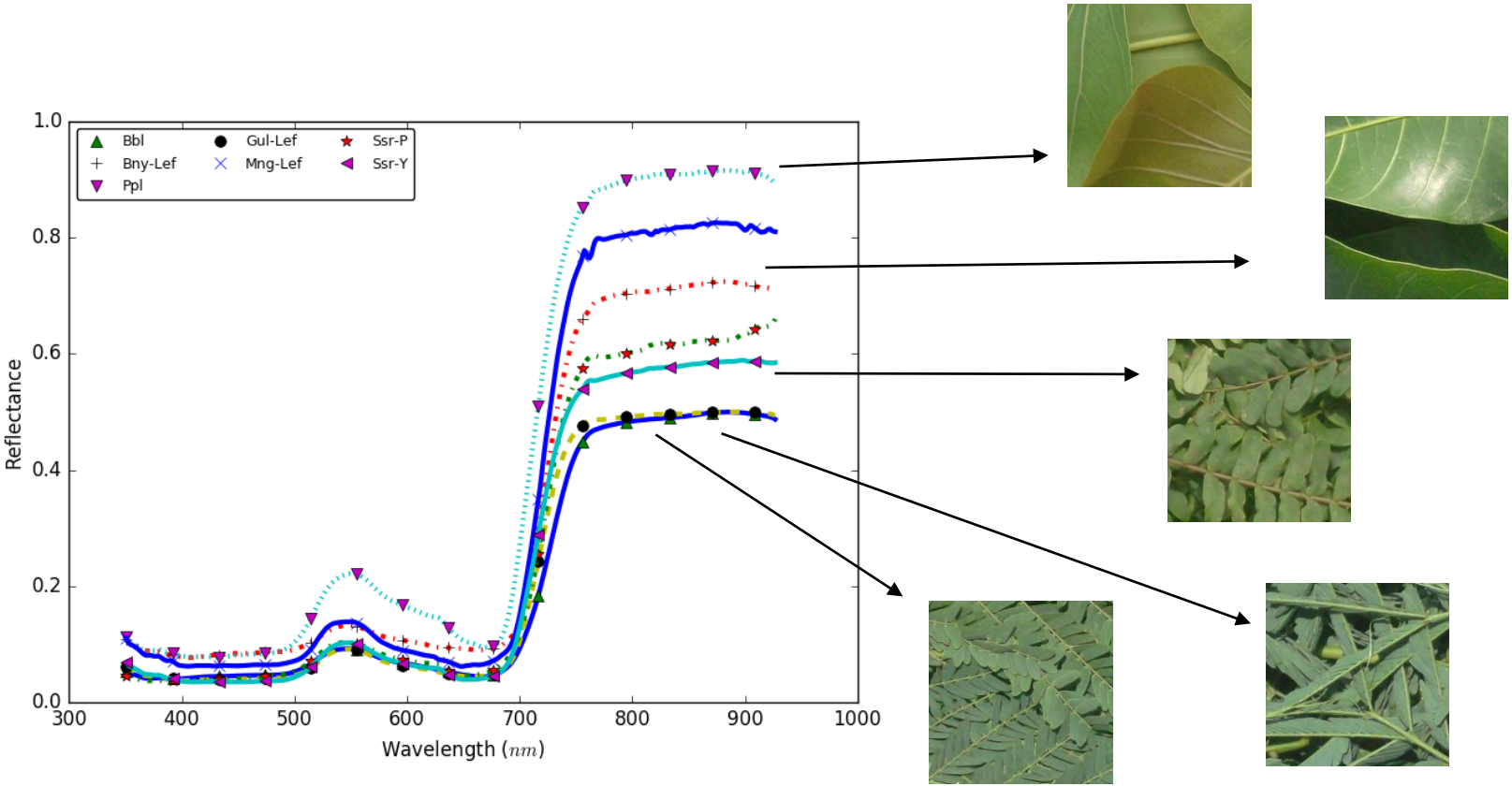

2.0
1.5
1.0
0.5
0.0
% Relative reflectance
0
500
1000
1500
2000
2500
3000
Wavelength (nm)
moshi
mutha fp
dry grass
u trees
jp chak
kir roof
nda concret
residential




2.0
1.5
1.0
0.5
0.0
% Relative reflectance
0
500
1000
1500
2000
2500
3000
Wavelength (nm)
moshi
mutha fp
dry grass
u trees
jp chak
kir roof
nda concret
residential

Field spectrometer

Example signatures contd.



Example signatures contd.