

Knowledge Based Pre - Classification

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Outline

1. Introduction / Concept
2. Literature Review / Summary of Case Studies
3. Practical
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What is Knowledge Based Classification ?

Classification based on the ground facts or conditions for which one has gained familiarity after experiencing the situation.

What is Pre - Classification ?

Anything prior to image (supervised/unsupervised) classification, the one in which individual pixels or objects are not examined based on their spectral response for different bands.

Concept

In general, Incorporation of any non spectral information into process of classification is referred to as Knowledge Based Classification (Denryi etal. 1996)

Knowledge-based classification procedure integrates remote sensing imagery with ancillary geospatial information from GIS.

With Rule based approach, Knowledge based classification tends to provide fully automated approach of classification.
In this way human knowledge is incorporated into machine.

Literature Review

- Knowledge-based classification have increasingly become important approaches for multisource data classification.

Integration of remote sensing, geographical information systems (GIS), and expert system emerges as a new research frontier.

To reduce uncertainties more research is needed to be done for improvement of accuracy [1].

- A GIS can be used to store the ancillary data for Knowledge Based classification [2].
- For Acute leukemia classification, such a Knowledge based system has shown an accuracy of 99.67%

Ancillary Data

- Elevation
- Population
- Land Use / Cover
- Demographics (Households, Employment)
- Environmental

Adds to the accuracy for the classification of simple spectral (pixel/object) based classification

Summary of Case Studies

Object Based Image Analysis: Buildings Extraction

Ruleset:

Elevation > 10ft

Advantage:

Removal of Salt and pepper
noise

Problem:

Trees



Digital Surface Model

a) Digital
Surface
Model



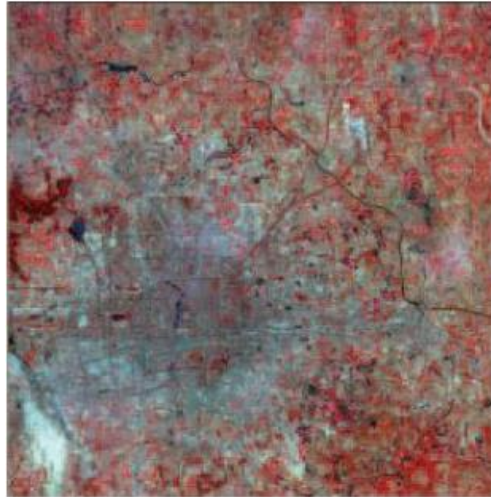
b) Ortho-
imagery



Object Based Image Analysis: Roads Delineation

Roads have large length and smaller width. Therefore, it will have large length to width ratio as compared to other object

Buildings have relatively similar length and width



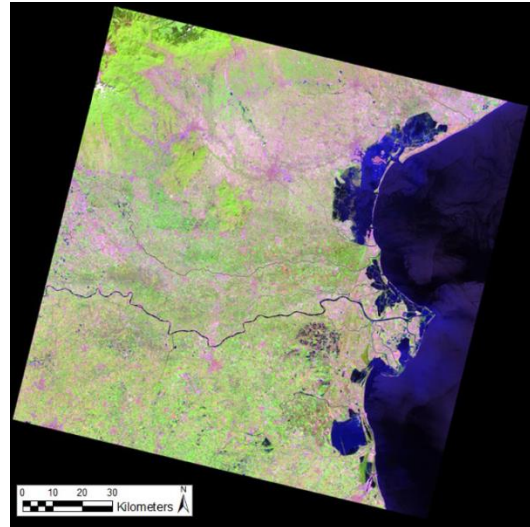
Geometry	Extent
Area	52426 Pxl
Length/Width	2.098
Number of pixels	52426
Volume	52426 Pxl

Satellite Image Automatic Mapper (SIAM) and Atmospheric Topographic Correction Thematic Mapper (ATCOR-SPECL)

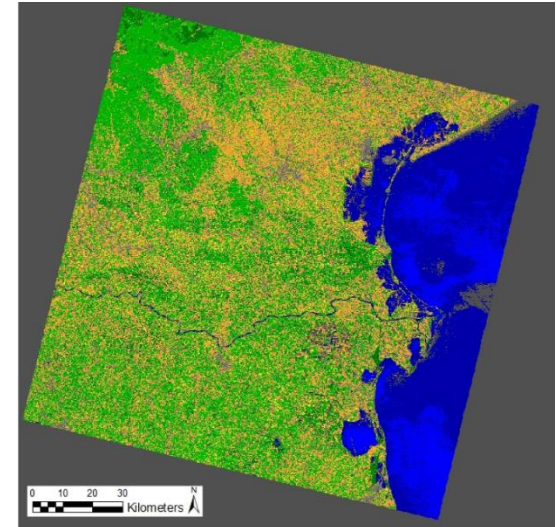
Using, SIAM SPOT 5 has been classified into 15 categories.

The SIAM pre-classification maps at the intermediate and fine semantic granularities are superior to those of the ATCOR™-SPECL single-granule maps.

(II) Thematic Quality Indicators TQIs of both the ATCOR-SPECL and the SIAM™ tend to exceed community-agreed reference standards of accuracy in 2013.



(a)



(b)

https://www.researchgate.net/publication/260593056_Quality_Assessment_of_Pre-Classification_Maps_Generated_from_SpaceborneAirborne_Multi-Spectral_Images_by_the_Satellite_Image_Automatic Mapper_TM_and_AtmosphericTopographic_Correction_TM-Spectral_Class

Comparison with Machine Learning Algorithms

Knowledge based classification was compared with Machine Learning algorithms where its results were comparable to Decision Tree (DT) Model Output.

Model	Precision	Recall	F1
KNN	0.72	0.68	0.69
DT	0.78	0.77	0.77
RF	0.84	0.81	0.82
Knowledge-based	0.76	0.73	0.74

Source: Trimble <https://ecognition.blog/machine-learning-vs-knowledge-based-classification-for-landslide-mapping/>

Advantages

Transferability, reusability and flexibility

Expert Knowledge Trained System

Disadvantages

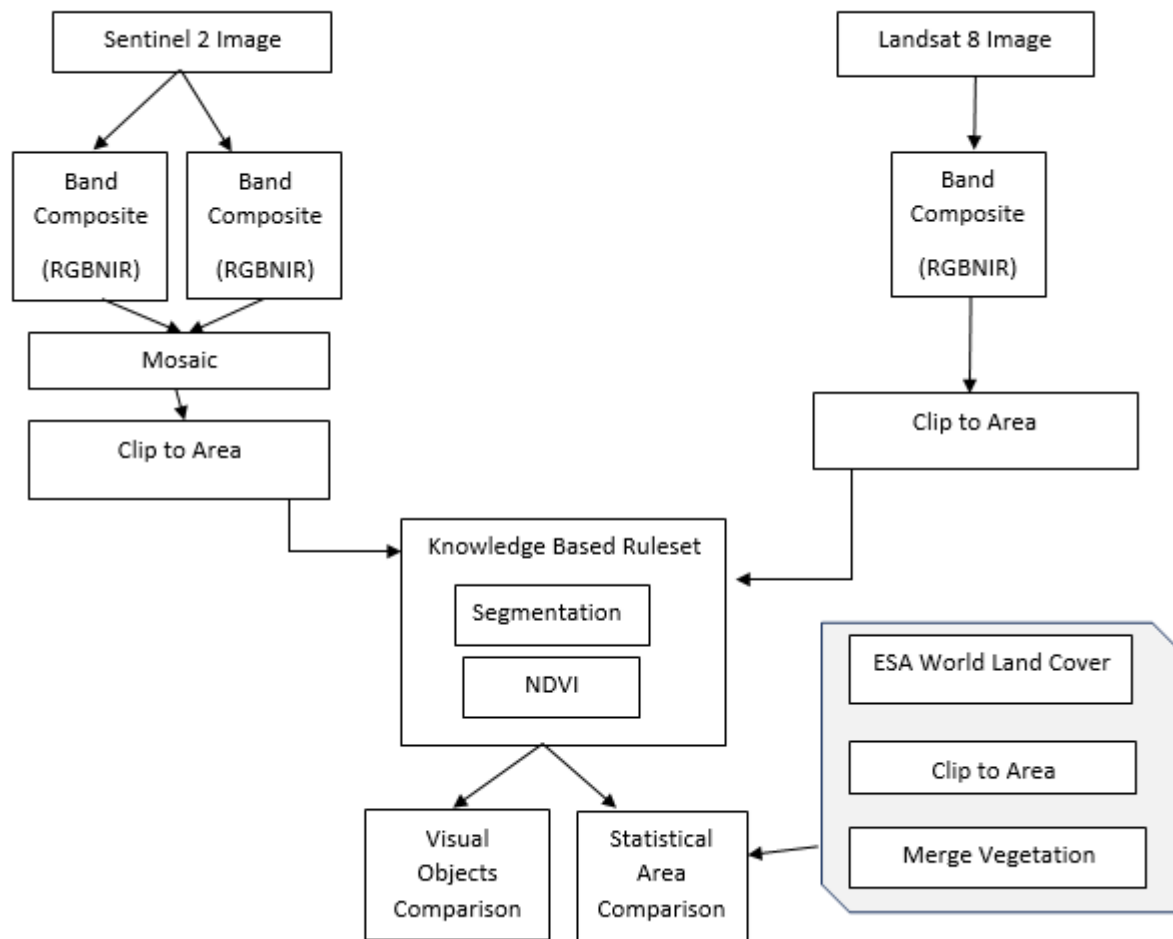
Object Changes with time (Object fate analysis) causes lower accuracy

Objects shrinking or expanding in size

Research Question

- Does knowledge based classification leads to same results for different satellite imagery of the same time?

Methodology

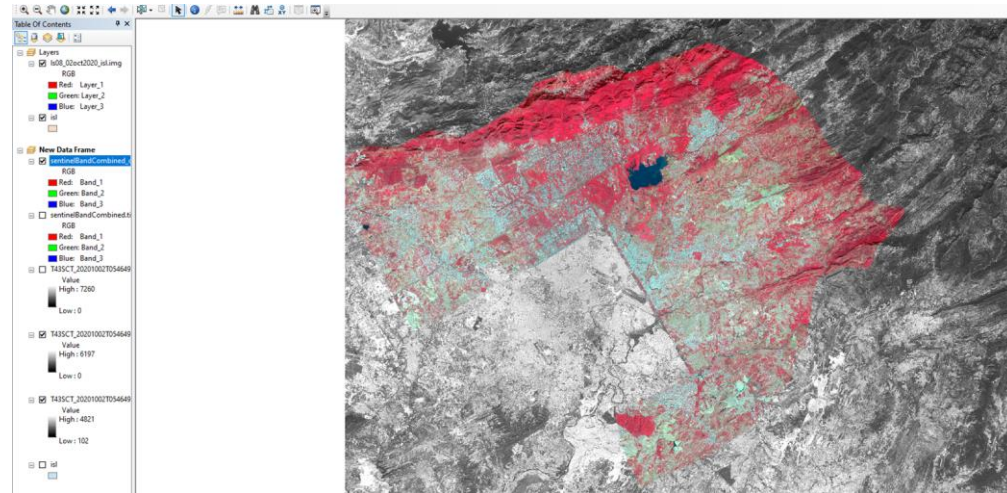
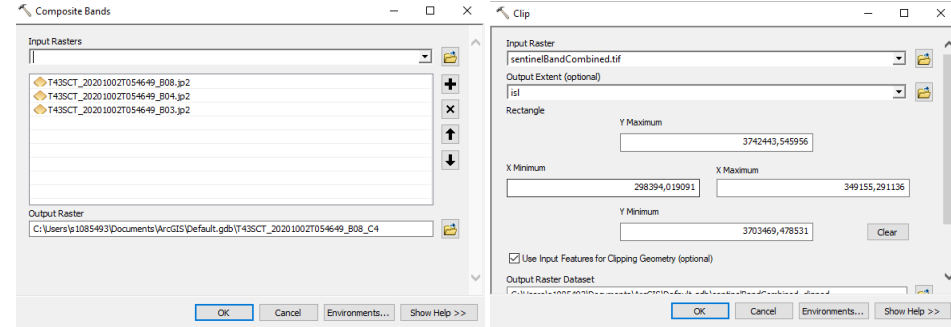


Software's Used

- Ecognition
- ArcGIS
- Excel

Practical

1. Composite Bands (NIR,RED,GREEN)
2. Clip
3. Visualization





Sentinel 2 Imagery
(2-10-2020)



Landsat 8 Imagery
(3-10-2020)

Ruleset Definition

In Ecognition Developer 10.1

- Assign class
- Check Condition for NDVI

NDVI is calculated in accordance with the formula:

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

NIR – reflection in the near-infrared spectrum

RED – reflection in the red range of the spectrum

Edit Customized Feature

Arithmetic

Feature name: NDVI

☒ Do not use units

Calculation Unit: No Unit

$$([Mean Layer 1] - [Mean Layer 2]) / ([Mean Layer 1] + [Mean Layer 2])$$

Edit Process

Name: do

Algorithm: assign class

Domain: image object level

Parameter	Value
Level	New Level
Class filter	none
Condition	NDVI > 0.2
Map	From Parent
Region	From Parent
Max. number of objects	all

Algorithm Description: Assign all objects in the image object domain to the class specified by the Use class parameter.

Parameter	Value
Use class	Vegetation

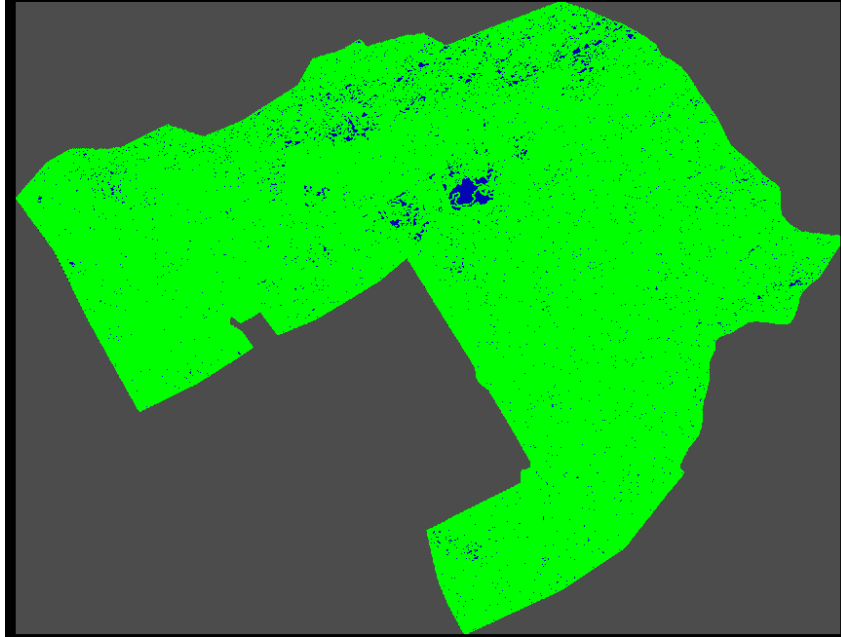
Loops & Cycles

☒ Loop while something changes only

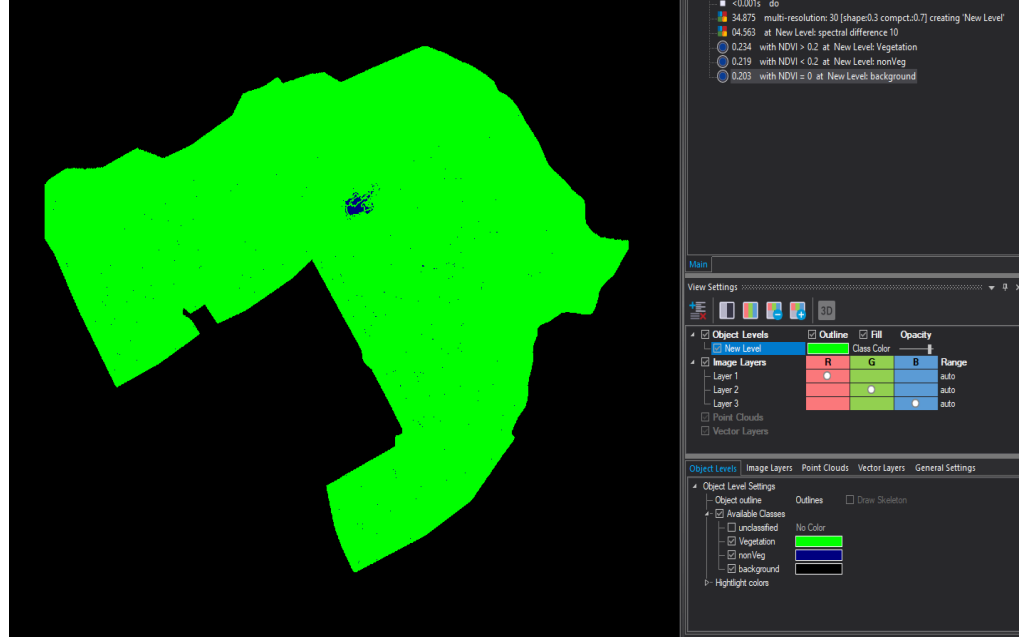
Number of cycles: 1

Execute Ok Cancel Help

Comparison of Sentinel and Landsat Objects

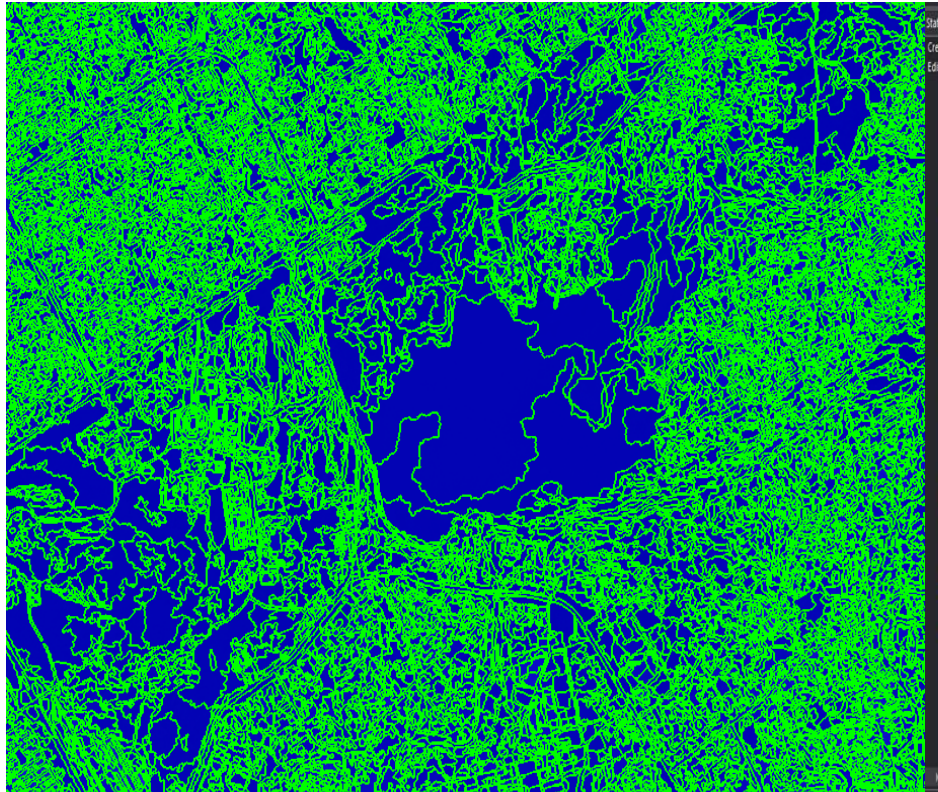


a) Sentinel

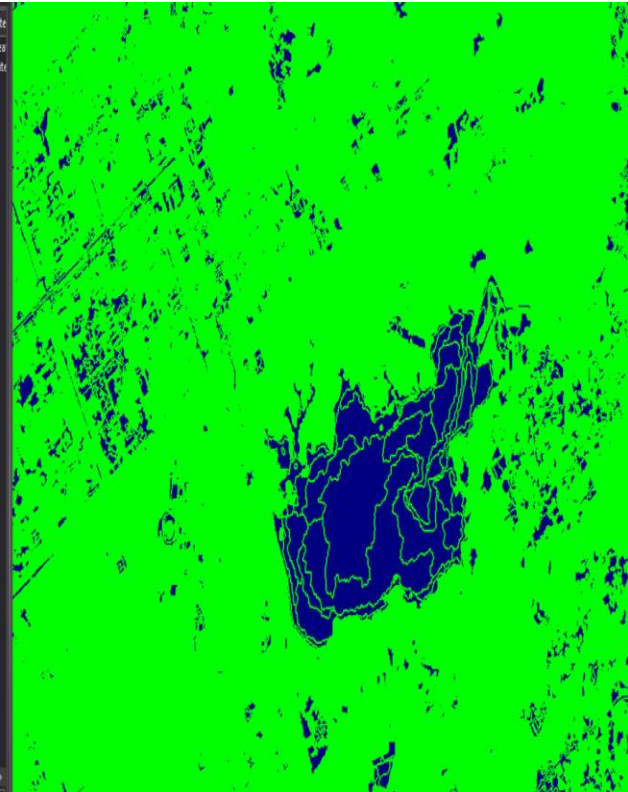


b) Landsat

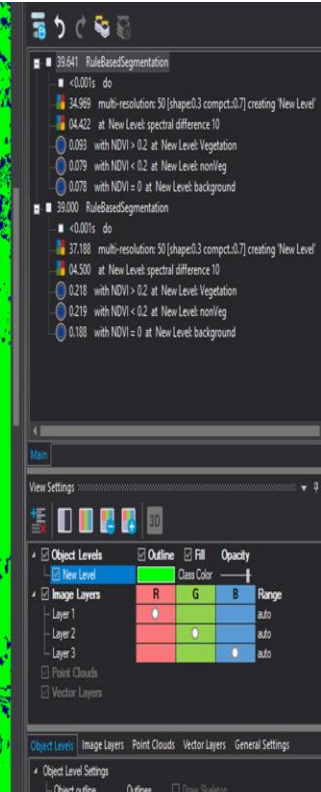
Comparison of Sentinel and Landsat Objects



a) Sentinel



b) Landsat



Google Earth Engine - ESA Land Cover Data (10m)

← → ↺ 📁 code.earthengine.google.com

Google Earth Engine 🔍 Search places and datasets...

Scripts **Docs** **Assets**

NEW ↺ **ADD A PROJECT**

CLOUD ASSETS
You haven't selected any Cloud Projects yet. Click "Add A Project" to access or upload assets.

LEGACY ASSETS
▼ **users/saadahmedjamal**
IslamabadUpdatedBoundary

New Script * **Get Link** **Save** **Run** **Reset** **Apps** ⚙️

```
var region1: Table = users/saadahmedjamal/IslamabadUpdatedBoundary

1 var dataset = ee.ImageCollection("ESA/WorldCover/v100").first();
2 var visualization = {bands: ['Map'],};
3 var dataset_clip = dataset.clip(region1);
4 Map.centerObject(dataset);
5 Map.addLayer(dataset_clip, visualization, "Landcover");
6 var projection = dataset.projection().getInfo();
7 Export.image.toDrive({
8   image: dataset_clip,
9   description: 'ESAWorldCover_imageToDriveExample_transform',
10  crs: projection.crs,
11  crsTransform: projection.transform,
12  region: region1});
```

Inspector **Console** **Tasks**

Manage tasks.

Search or cancel multiple tasks in the [Task Manager](#)

ESAWorldCover_imageToDriveExample_transform ✓ 4m

imageToDriveExample_transform ✓ <1m

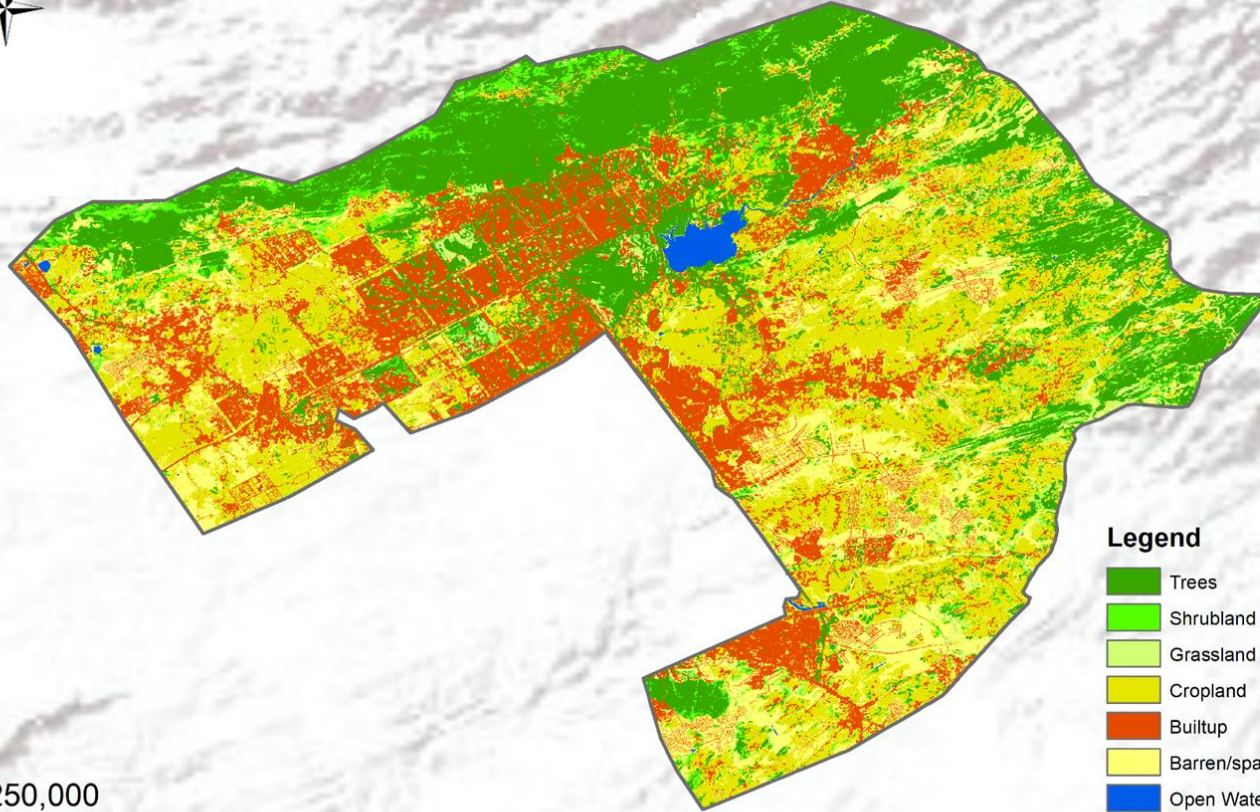
ID: 47BZGE2HYG5J2KUJN3VUT2AQ

Phase: Completed

Layers **Map** **Satellite**

Wah Cantt, Pind Bhadar Khan, Qutbal, Rawalpindi, Kahuta, Jahantal, Nawan, Sehnsa, Kotli, Dandli, Hari Dhara, Mandhole, Kuikhala, Panaka, Dawaradi, Bihallian, Village Karore, Taxila, Bhatiot, Gagan, Burj, Ratwal, Fateh Jang, Kot Fateh Khan, N80, M-14, M-2, N5, N6, N7, N8, N9, N10, N11, N12, N13, N14, N15, N16, N17, N18, N19, N20, N21, N22, N23, N24, N25, N26, N27, N28, N29, N30, N31, N32, N33, N34, N35, N36, N37, N38, N39, N40, N41, N42, N43, N44, N45, N46, N47, N48, N49, N50, N51, N52, N53, N54, N55, N56, N57, N58, N59, N60, N61, N62, N63, N64, N65, N66, N67, N68, N69, N70, N71, N72, N73, N74, N75, N76, N77, N78, N79, N80, N81, N82, N83, N84, N85, N86, N87, N88, N89, N90, N91, N92, N93, N94, N95, N96, N97, N98, N99, N100, N101, N102, N103, N104, N105, N106, N107, N108, N109, N110, N111, N112, N113, N114, N115, N116, N117, N118, N119, N120, N121, N122, N123, N124, N125, N126, N127, N128, N129, N130, N131, N132, N133, N134, N135, N136, N137, N138, N139, N140, N141, N142, N143, N144, 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N2122, N2123, N2124, N2125, N2126, N2127, N2128, N2129, N2130, N2131, N2132, N213

Islamabad Land Cover Map 2020



Legend

- Trees
- Shrubland
- Grassland
- Cropland
- Builtup
- Barren/sparse vegetation
- Open Water
- Herbaceous Wetland

1:250,000

Dataset: ESA WorldCover 10m v100

Sources: Esri, USGS, NOAA, Sources: Esri, Garmin, USGS, NPS

Comparison

Type	Acquisition Date	Pixel Count	Resolution	Area (km2)
Sentinel 2	02-Oct-20	6935137	10	693.51 (76%)
Landsat 8	03-Oct-20	626512	30	563.86 (62%)
ESA LandCover	2020-2021	4442156	10	444.21 (49%)

Conclusion

Knowledge based pre-classification applied on different satellites results in different results.

Knowledge based Classification approach is better than simple (per pixel/object) classification approach.

Data Availability

https://github.com/SaadAhmedJamal/SentinelAndLandsat_ComparisonImagery

References

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Questions?

Annex-I: Rulesets in QGIS (GAFSEG)

Deck Builder

Merge Cards

Check Conditions

PreProcessing: Bilateral

bands [1, 2, 3]

intensity 2

saveToDisk ☐

Segment: AlphaTree

bandWeightingStrategy maxDiff

bands [1, 2, 3, 4, 5]

dHistAttributeBand

omega 27

Operator: Merge

checkCondition num < 10

checkExclusivity ☐

iterations 10

mergeAlgorithm closest b1 mean

Deckbuilder

Deck Name: Deck_PU200_interim12.json

Deck Validity: Valid

Load Save

PreProcessing: Bilateral

bands [1, 2, 3]

intensity 2

saveToDisk ☐

Segment: AlphaTree

bandWeightingStrategy maxDiff

bands [1, 2, 3, 4, 5]

dHistAttributeBand

omega 27

Operator: Merge

checkCondition num < 10

checkExclusivity ☐

iterations 10

mergeAlgorithm closest b1 mean

- ☒ Operator: Merge Water1
- ☒ Operator: Merge Sealed1
- ☒ Operator: Merge Sealed2
- ☒ Operator: Merge Sealed3
- ☒ Operator: Merge baresols1
- ☒ Operator: Merge baresols2
- ☒ Operator: Merge SparselyVegetated
- ☒ Operator: Merge SparselyVegetated2
- ☒ Operator: Merge broadLeavedDeciduous1
- ☒ Operator: Merge broadLeavedDeciduous2
- ☒ Operator: Merge broadLeavedDeciduous3
- ☒ Operator: Merge broadLeavedDeciduous4
- ☒ Operator: Merge broadLeavedDeciduous5
- ☒ Operator: Merge broadLeavedDeciduous6
- ☒ Operator: Merge broadLeavedDeciduous7
- ☒ Operator: Merge WoodyBroadLeavedDeciduous8

checkCondition 12 & b12 mean < 2 & b14 mean < 1

checkExclusivity ☒

iterations 5

mergeAlgorithm closest b1 mean

Operator: Merge WoodyNeedleLeaved1

Go to Settings to activate Windows.

Comment:

knowledge-based by and large refers to the usage of explicit rules, mostly physical-model based, which definitely includes spectral properties as well (cf. thresholds of indices)