Building Height Estimation Based on Shadow Detection Using Open-Source Object-Based Image Analysis (OBIA)

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1. Introduction

This study presents a workflow for detecting shadows and estimating building heights using Object-Based Image Analysis (OBIA) techniques. The **nickyspatial** Python package was employed to perform image segmentation and classification. The input dataset consisted of a panchromatic image, which was classified into four distinct classes:

1. Shadow
2. Non-shadow
3. Buildings
4. Non-buildings

The methodology integrates image segmentation, sample-based classification, and geometric calculations derived from shadow lengths to estimate building heights.

2. Data and Methods

2.1 Segmentation

Image segmentation was conducted using the run_slic_segmentation function from the **nickyspatial** package. A panchromatic image (po_97258_pan_0010000.tif) was processed with the following parameters:

- **Scale parameter:** 30.0
- **Compactness:** 0.3

```
segmentation_layer = run_slic_segmentation(
    raster_path="po_97258_pan_0010000.tif",
    output_dir="results",
    scale=30.0,
    compactness=0.3
)
```

Segmentation Results: (Fig 01)

- Image dimensions: (1, 2001, 2001) [bands, height, width]
- Coordinate Reference System (CRS): EPSG:32611
- Number of segments: 4,448
- Output: results\slic_segments.png

The segmentation overlay was generated and stored for further classification.

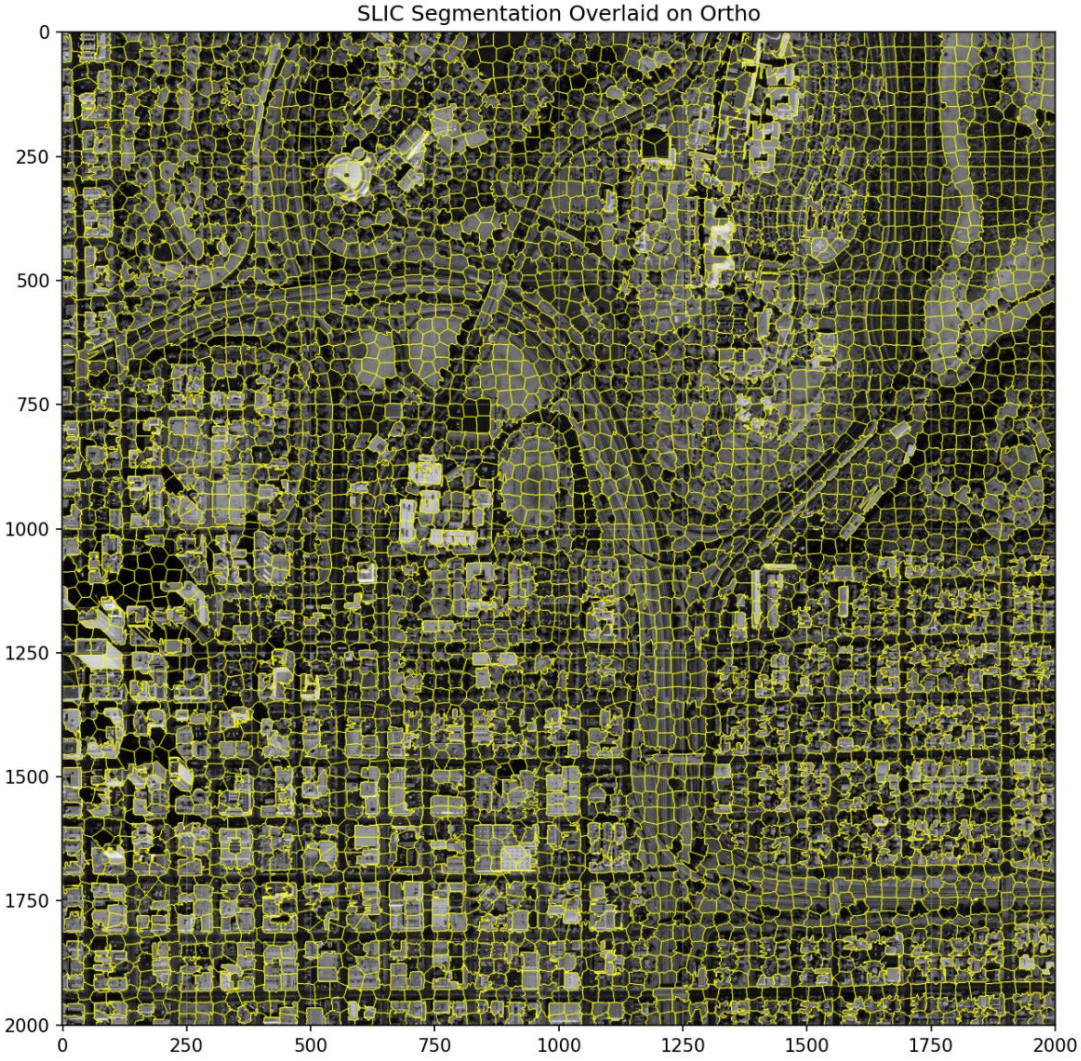

Fig 01. Segmentation Result

2.2 Training Sample Creation

Training samples were created using a graphical user interface (GUI) (Fig 02) developed by **Upendra Oli**, based on the nickyspatial/class_samples repository (nickyspatial/class_samples at master · kshitijrajsharma/nickyspatial). The segmented GeoJSON file was automatically loaded into the GUI for annotation.

Four classes were defined (fig 03):

1. Shadow
2. Non-shadow
3. Buildings
4. Non-buildings

Random segments were selected as training samples. Each segment ID was recorded and subsequently used in the classification notebook (fig 04/ 05/ 06).

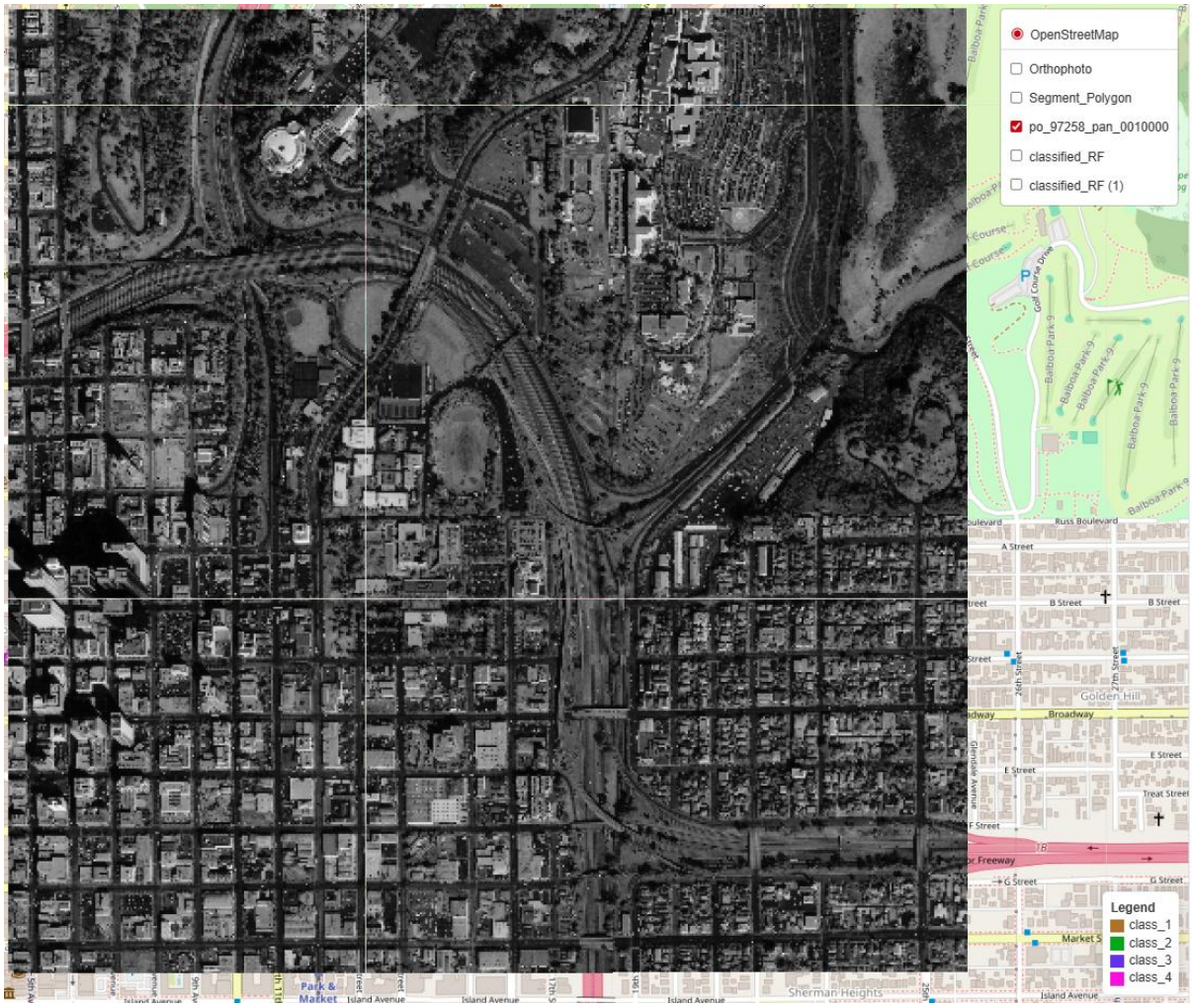

Fig 02. GUI for training samples

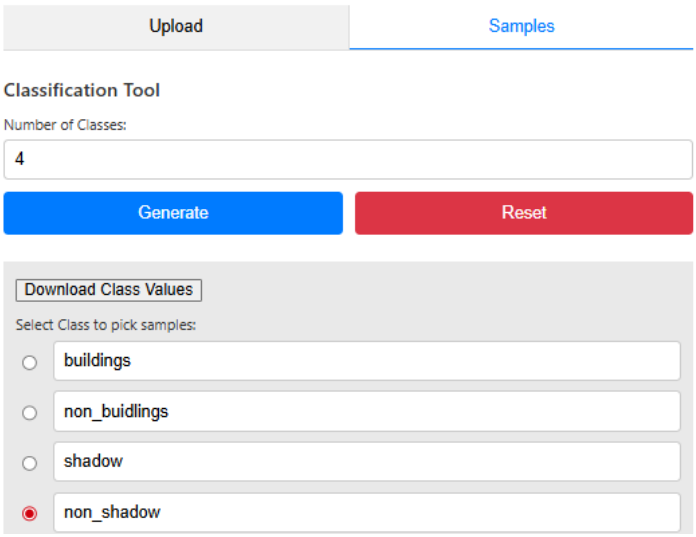

Fig 03. Classes

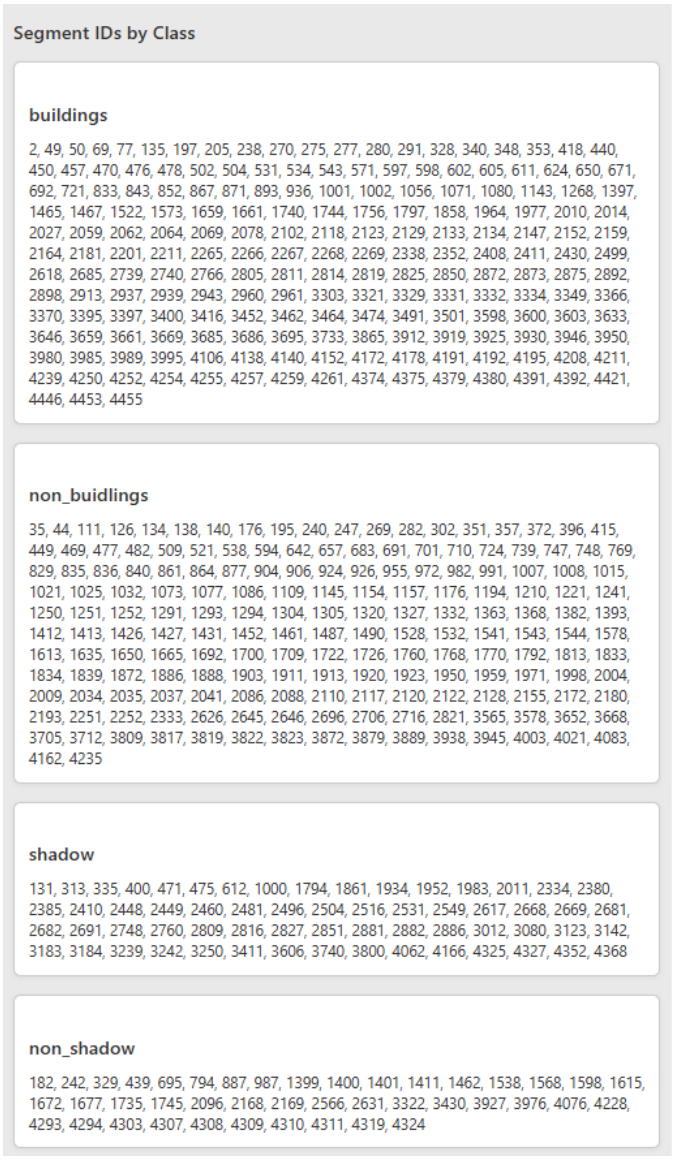

Fig 04. IDs for Training Samples.

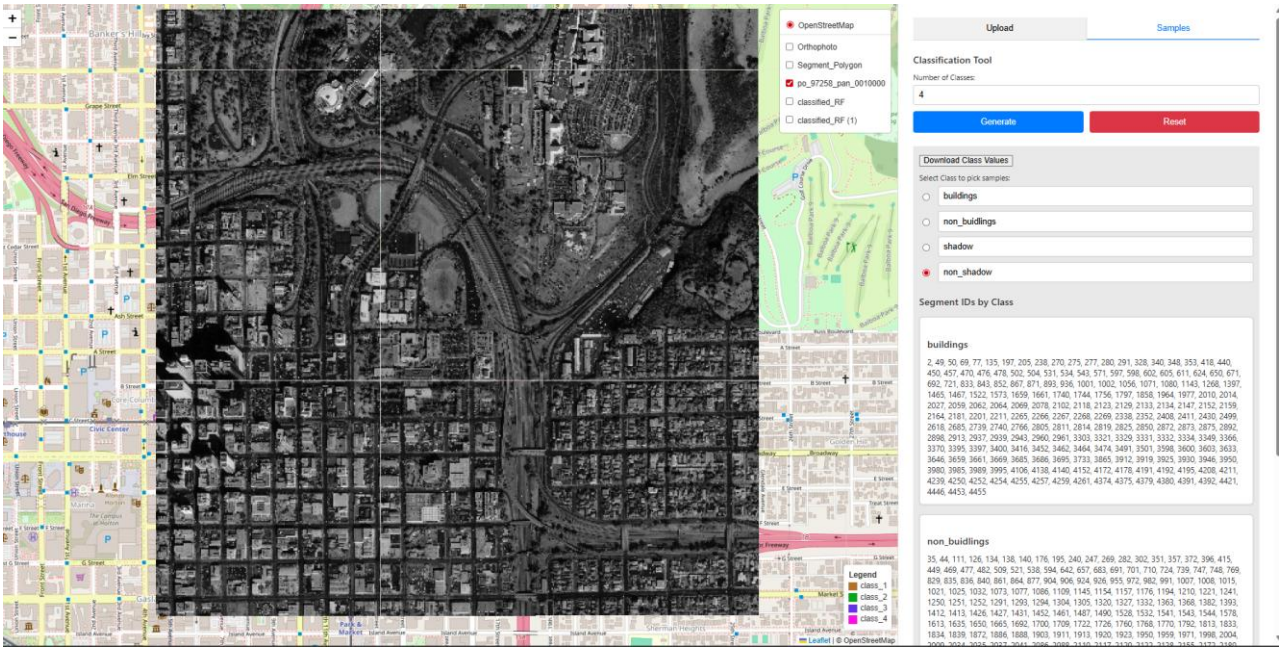

Fig 05. Overall view.

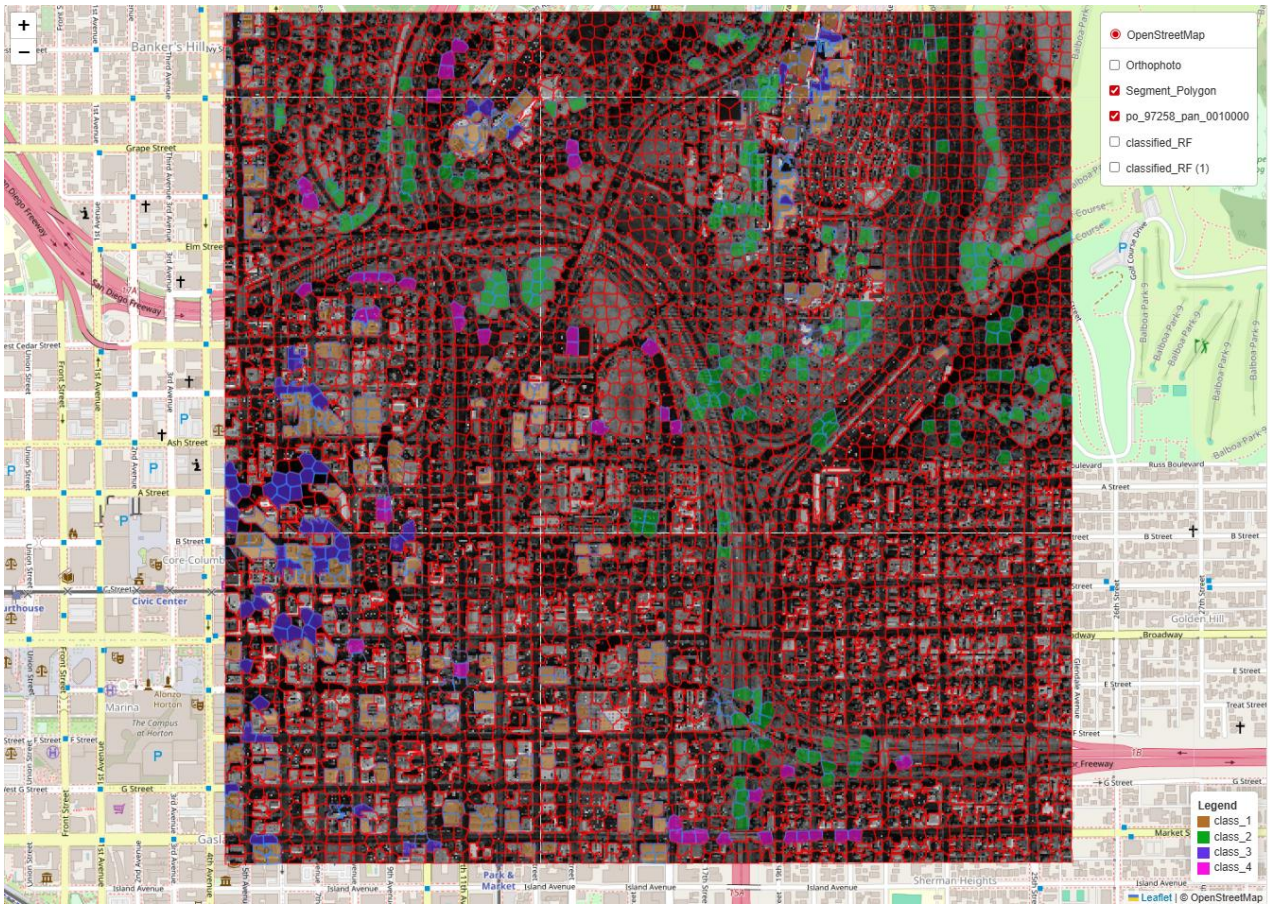

Fig 06. Samples Result in the GUI.

2.3 Classification

A supervised classification was performed using the collected training samples. The resulting classification achieved an **overall accuracy of 83.16%**.

Top-ranked features contributing to classification:

Feature	Value
band_1_median	23.534
band_1_mean	21.667
band_1_max	19.442
band_1_std	10.518
band_1_min	6.006

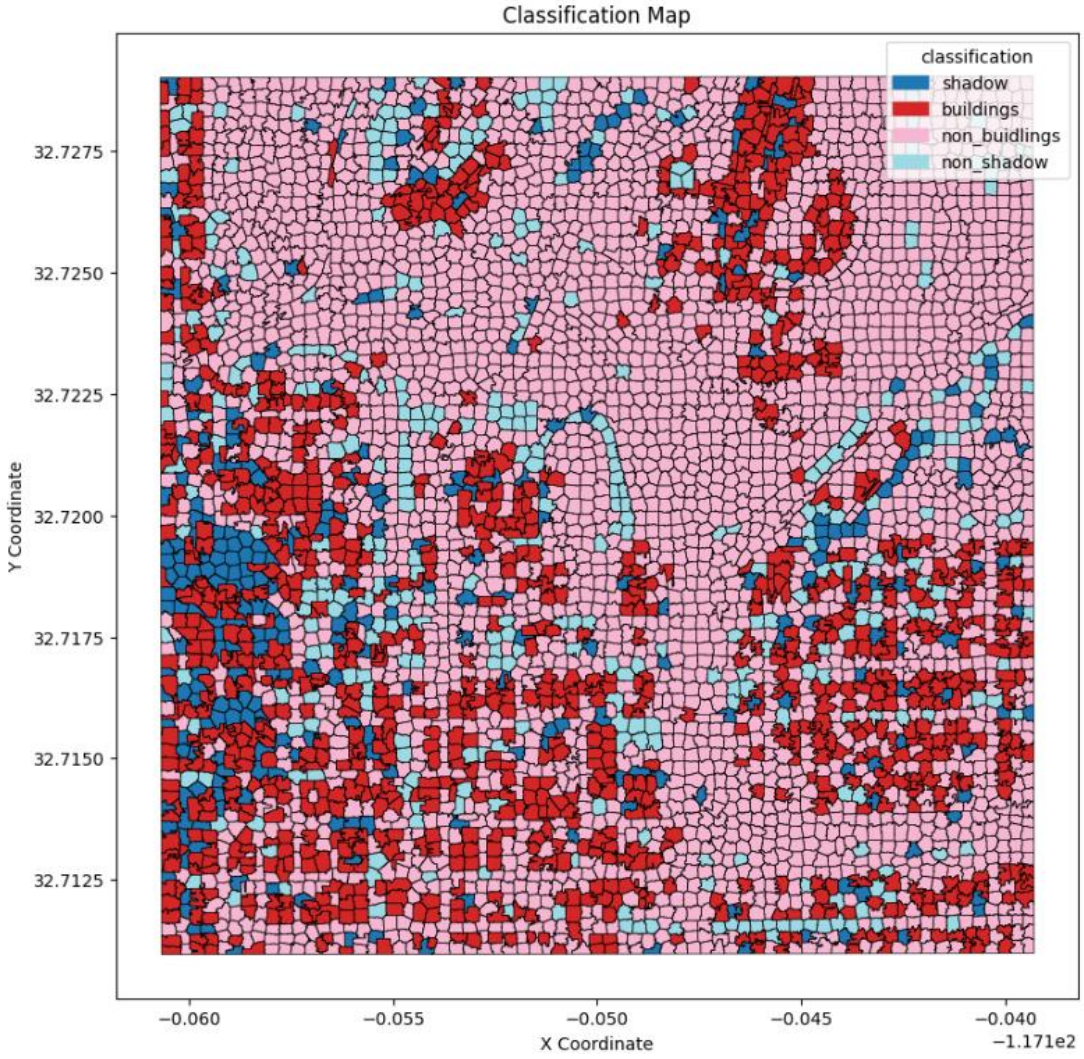

Fig 07. Classification Map

The classified image was visualized within the GUI, with a corresponding legend indicating each class (Fig 08 / 09).

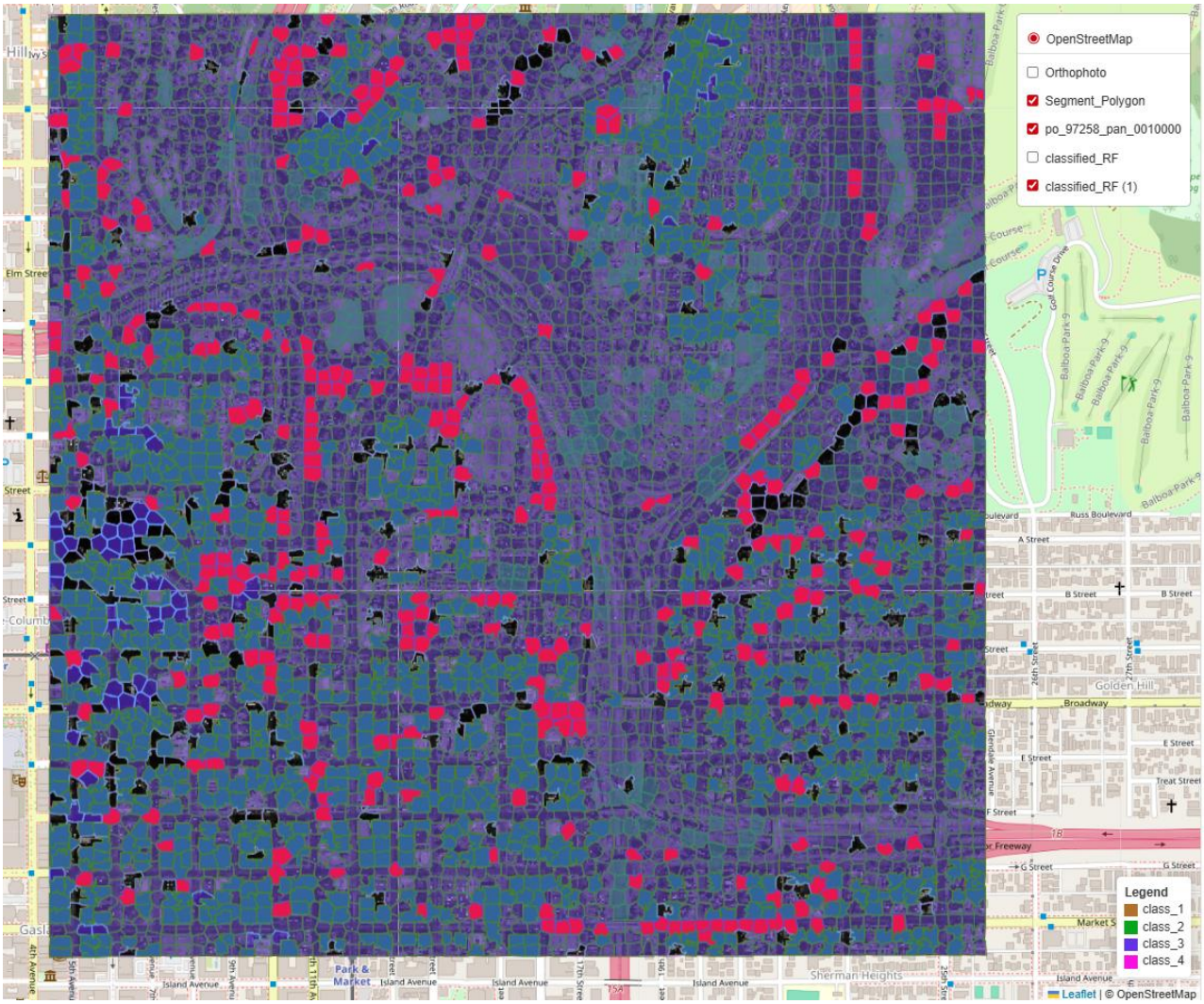

Fig 08 Visualizing classification geojson file on the GUI.

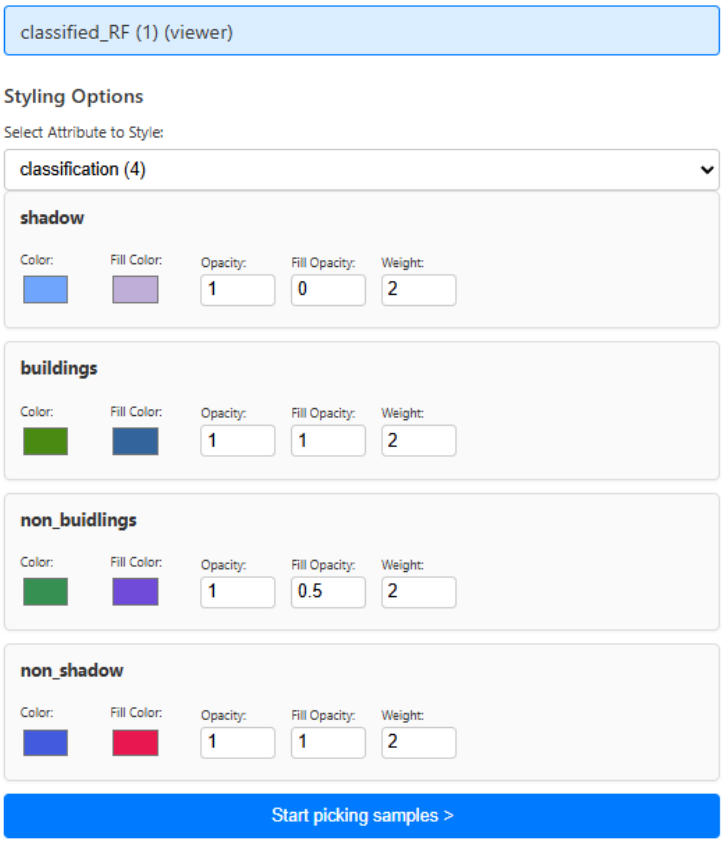

Fig 09. Legend of Classes on the GUI.

3. Building Height Estimation

Following the classification, the next step involves:

1. Calculating shadow lengths from the classified shadow polygons.
2. Using image metadata (sun azimuth and elevation) to automatically estimate building heights.
3. Developing a dedicated GUI tool for automated building height calculation.

4. Conclusion

The integration of OBIA segmentation, supervised classification, and shadow geometry provides an effective framework for building height estimation from panchromatic imagery. The approach demonstrates high classification accuracy and can be extended to incorporate automated geometric measurements for urban feature extraction.

Note:

The accompanying Jupyter Notebook containing the full implementation has been uploaded to my GitHub and everything including the GUI is explained Here: SaharAbdulallim/IP_Application-Development-Earth-Observation-: this is the final project for my class in EO , it's about estimating building highest based on shadow length using object based image analysis OBIA.