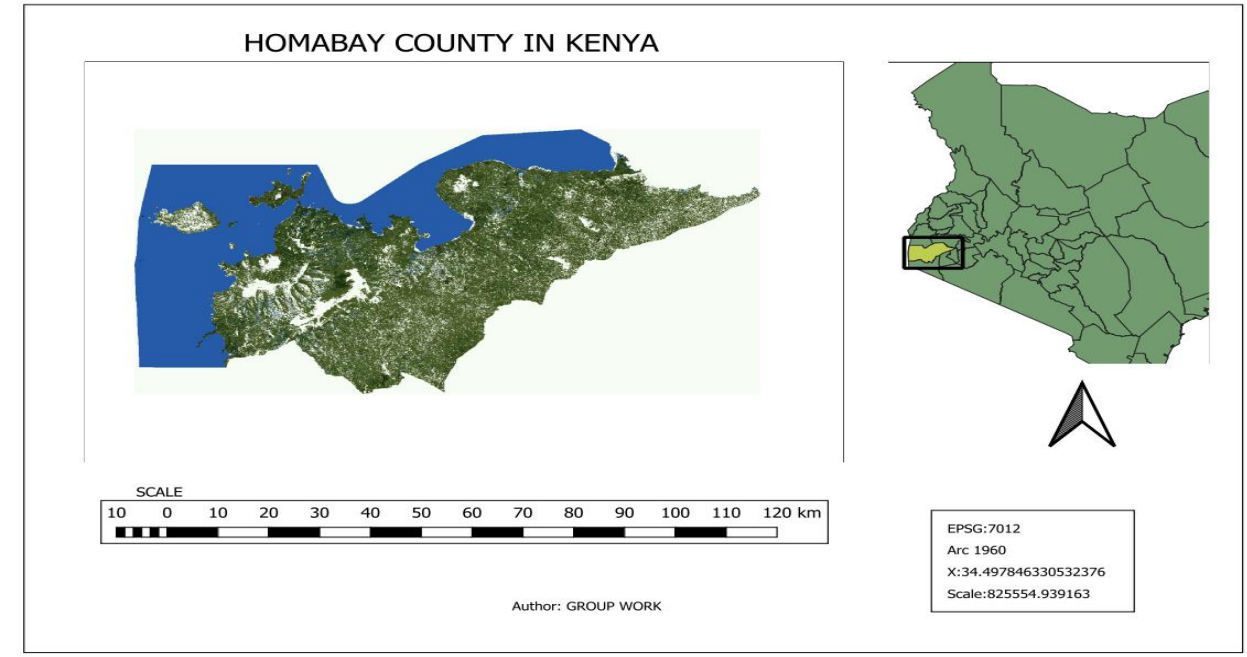
Forest Change Detection in Homa Bay County Using Landsat Imagery

Introduction

The rapid loss of forests poses significant environmental challenges, including loss of biodiversity, disruption of water cycles, and increased carbon emissions. Monitoring land cover changes, particularly forest cover, is crucial for sustainable management and conservation efforts. This project aims to utilize remote sensing data, specifically Landsat imagery, to classify land cover types and detect forest area changes over time.

Study Area



The Objective of the Project

The main objectives of this project include:

1. To classify land cover in Homa Bay County) utilizing Landsat imagery.
2. To quantify forest areas from 2010 to 2024 at five-year intervals [2010, 2015, 2020, 2024].
3. To detect and analyze spatial changes in forest cover from 2010 to 2024.

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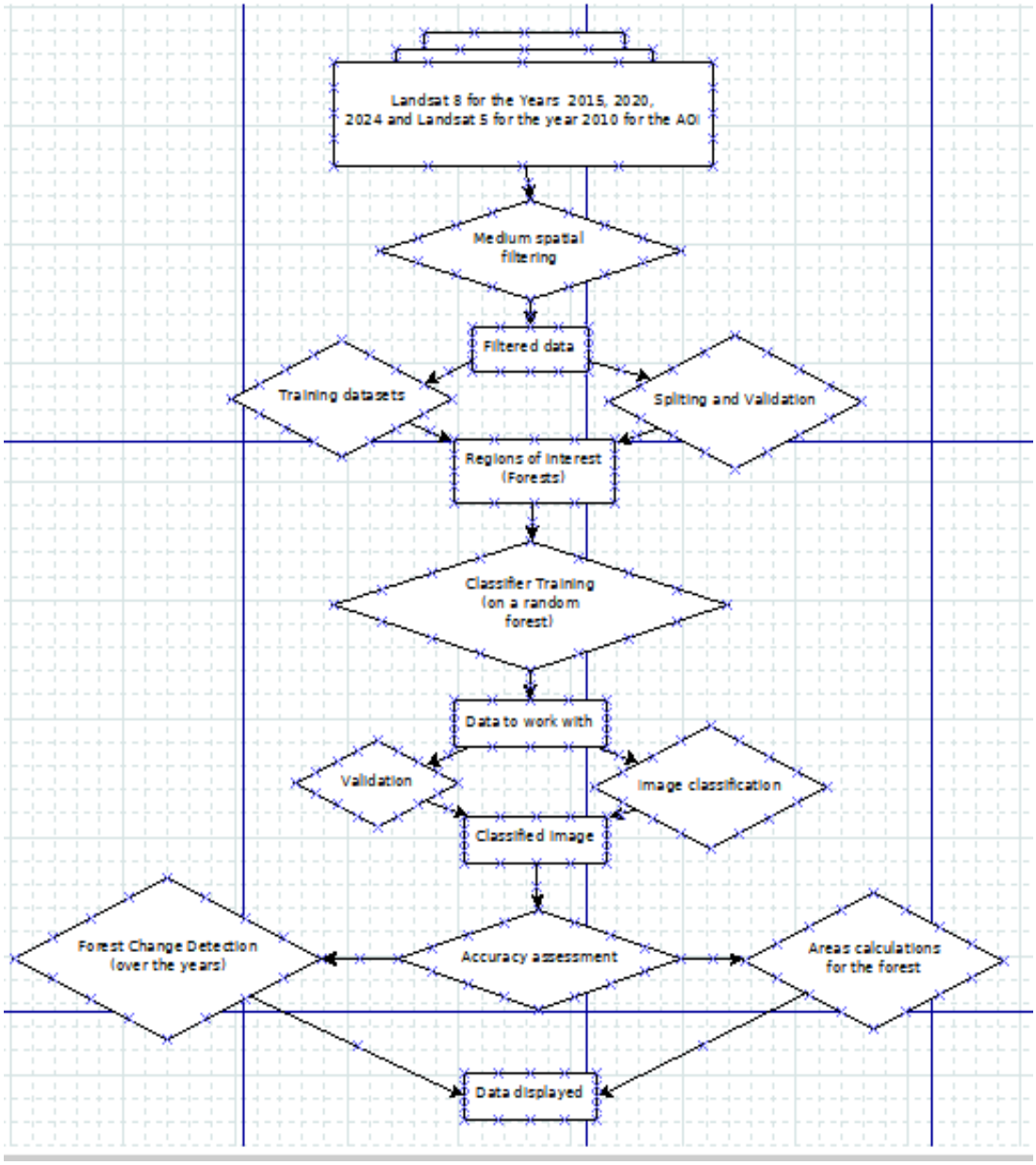
The Methodology



The study followed a systematic methodology that includes the following steps:

1. **Selection of AOI**: The area of interest was defined and centered on the map for focused analysis.

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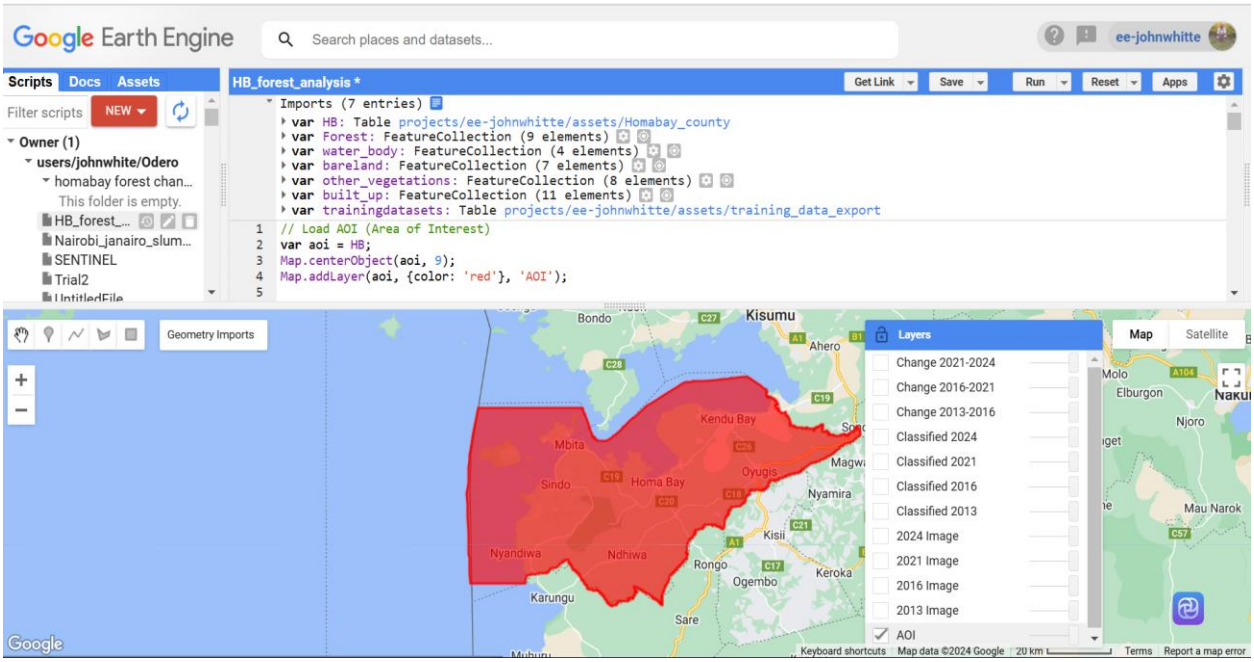
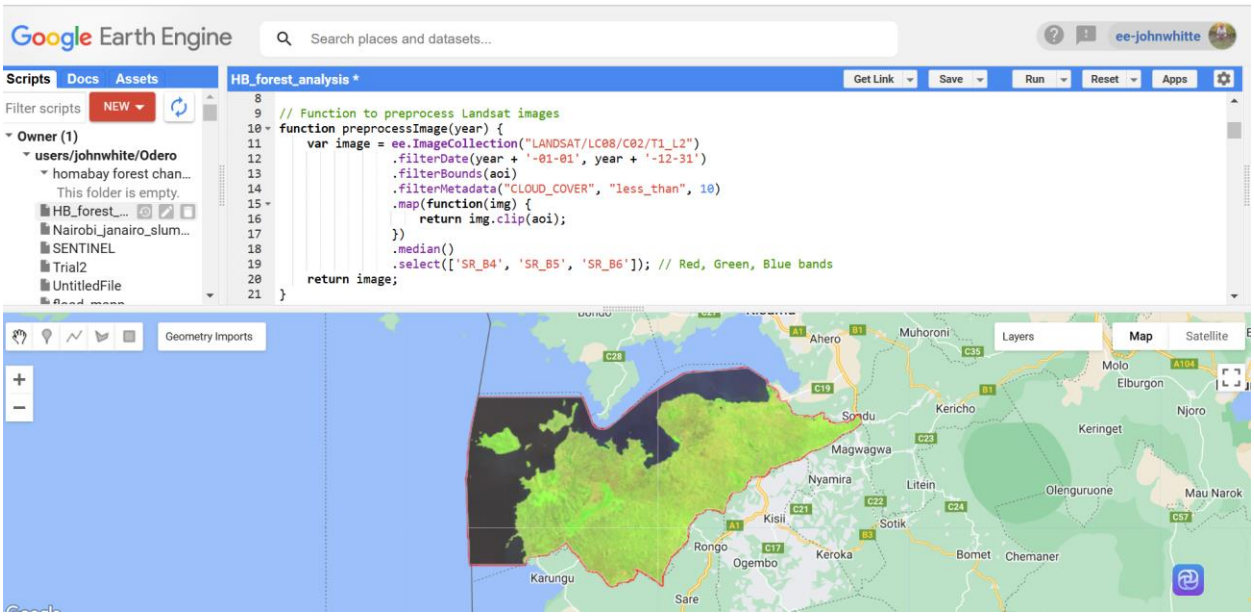


2. **Acquisition of Remote Sensing Data**: Landsat 5 imagery for the year 2010 and Landsat 8 for the remaining years; 2015, 2020, and 2024 were downloaded and filtered for cloud coverage and clipped to the AOI.



3. **Preprocessing**: Each image was processed by applying a median filter and selecting relevant bands (SR_B4 for Red, SR_B5 for Green, SR_B6 for Blue).

4. **Training Dataset Preparation**: Training data was sourced from a CSV file containing labeled land cover classes.

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```
// Load CSV training data
var trainingData = ee.FeatureCollection("projects/ee-johnwhitte/assets/training_data_export");

```

5. **Split Training and Validation**: The data was randomly split into training (70%) and validation (30%) subsets.

```
// Split training data into training and validation subsets
var withRandom = trainingData.randomColumn('random');
var trainingSet = withRandom.filter(ee.Filter.lt('random', 0.7)); // 70% for training
var validationSet = withRandom.filter(ee.Filter.gte('random', 0.7)); // 30% for validation

```

6. **Classifier Training**: A Random Forest classifier was trained using the training subset based on selected spectral bands.

```
// Train classifier using training subset
var trainedClassifier = ee.Classifier.smileRandomForest(10).train({
    features: trainingSet,
    classProperty: 'class',
    inputProperties: ['SR_B4', 'SR_B5', 'SR_B6']
});

```

7. **Validation**: The classifier was evaluated against the validation dataset, generating a confusion matrix to derive accuracy metrics.

```
// Classify validation dataset
var validated = validationSet.classify(trainedClassifier);

```

8. **Image Classification**: The trained classifier was utilized to classify the preprocessed images for each year.

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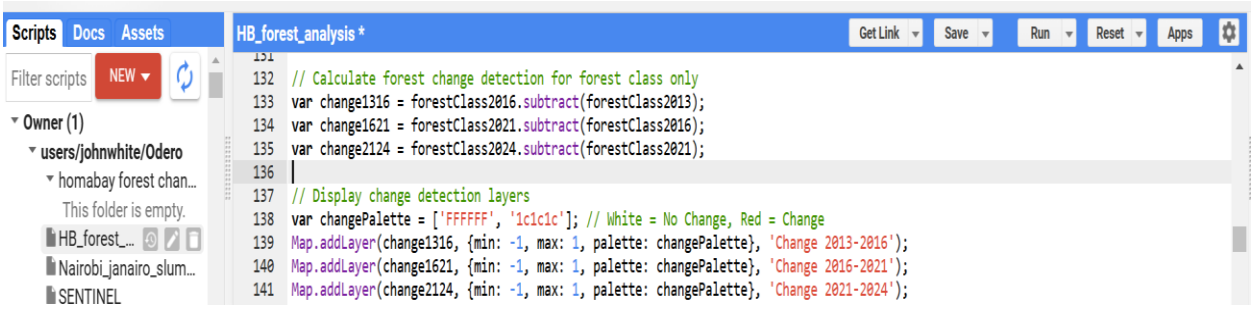
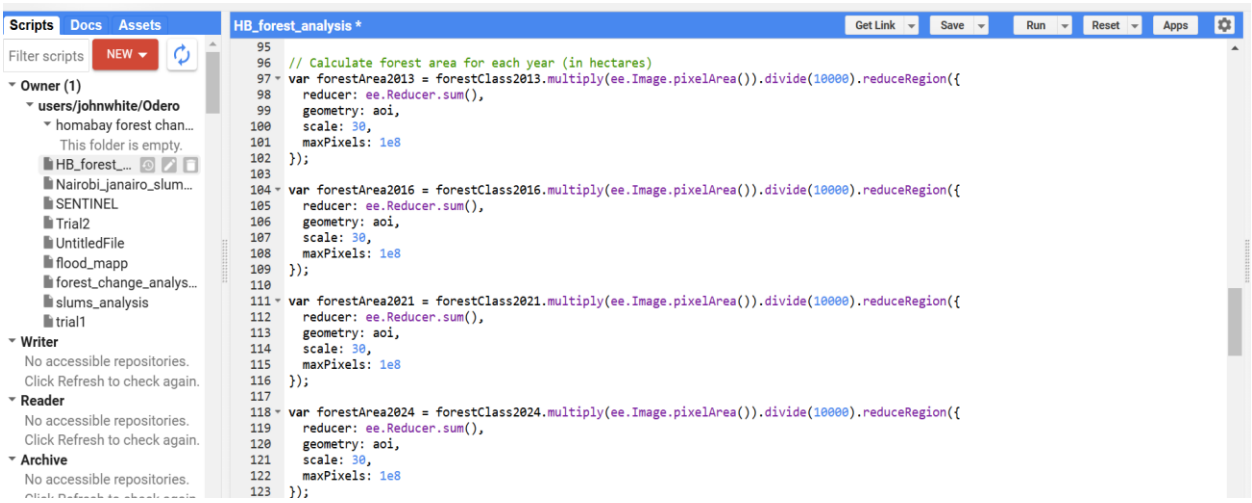
9. **Change Detection**: Forest change detection was performed by calculating differences in forest class between years.



10. **Area Calculation**: The areas of forest cover were calculated in hectares for each year.



Tools Used

The following tools were utilized in the project:

- Google Earth Engine (GEE): For accessing, processing, and analyzing satellite imagery, specifically Landsat 8 data. GEE facilitates cloud-based processing and enables efficient handling of large datasets.
- JavaScript API: The coding for data processing, classification, and visualization was done using JavaScript within the Google Earth Engine environment.
- Excel for further analysis of the results i.e. for plotting graphs

Results and Discussion

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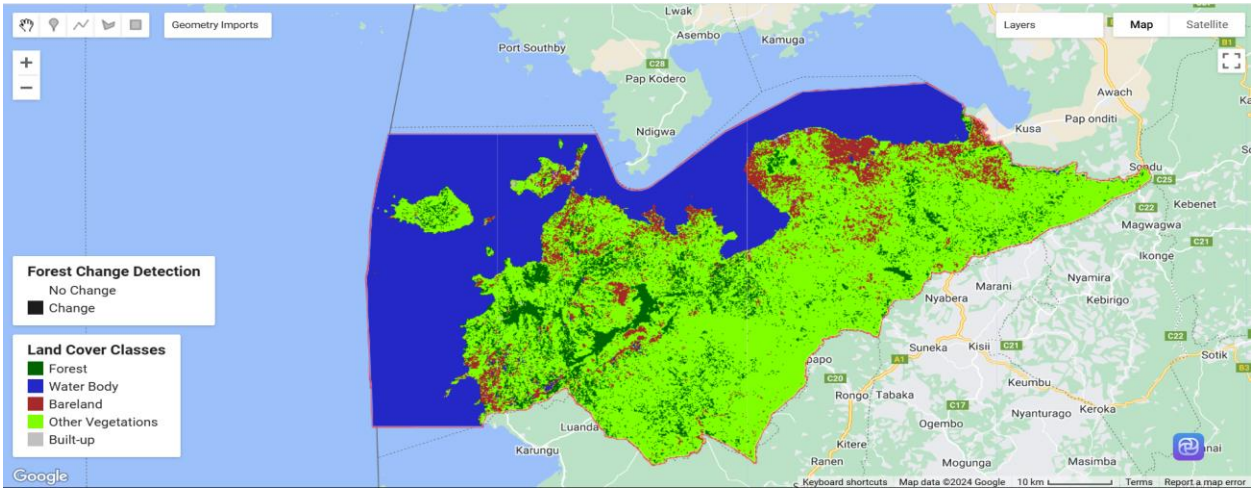
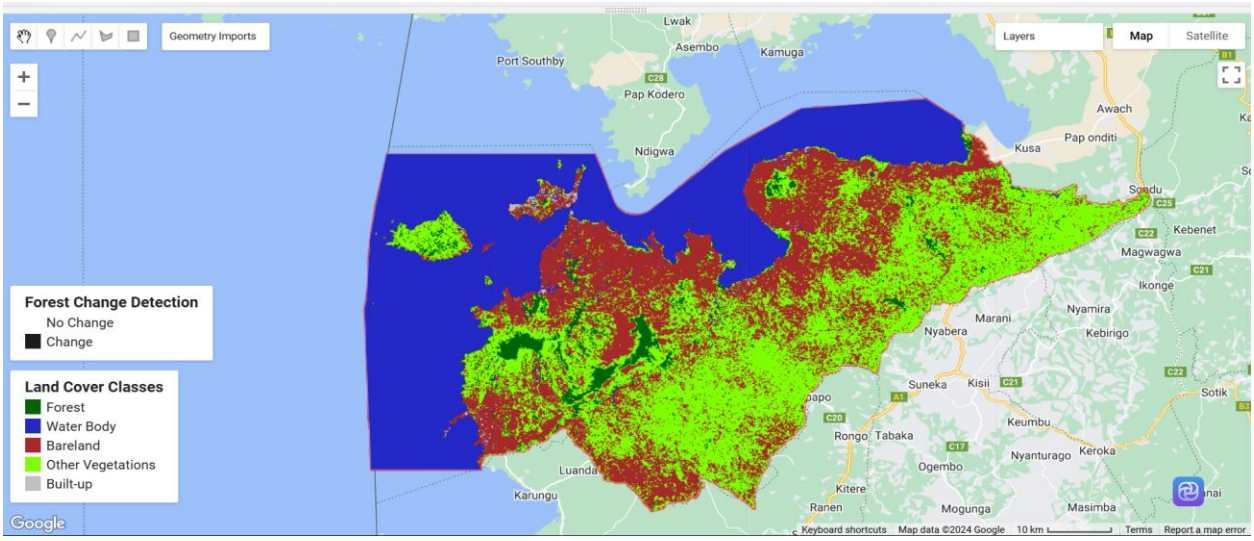
The classification output reveals diverse land cover types in Homa Bay County each year, with forests classified as a distinct category. The analysis yielded the following:

- **Classification**

2010



2015



2020

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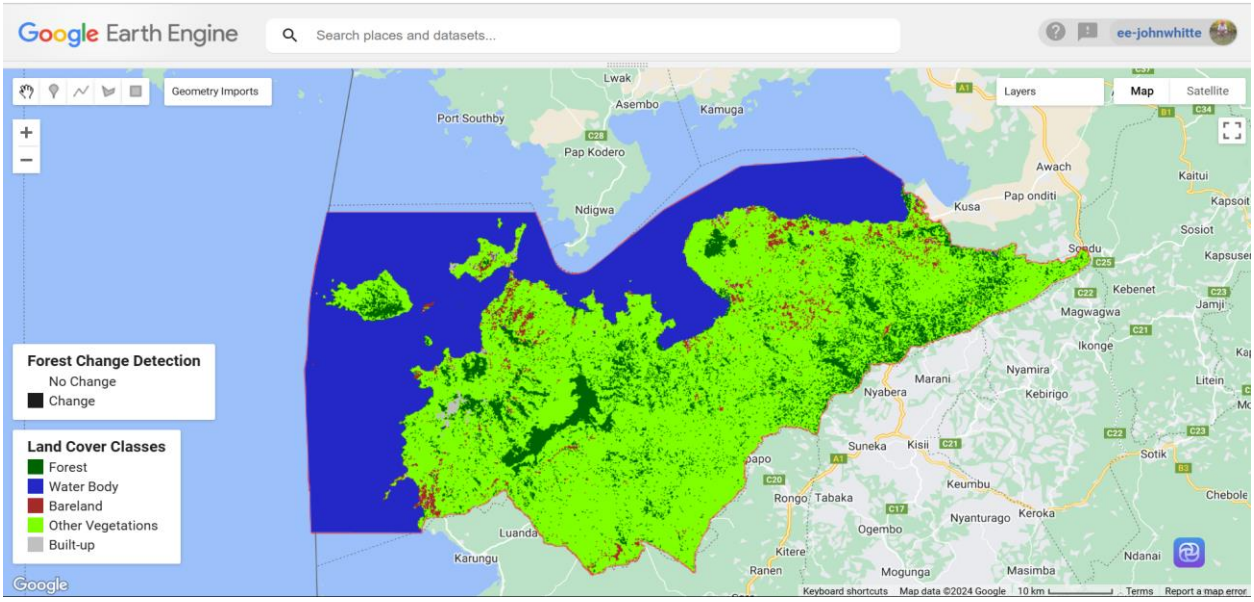
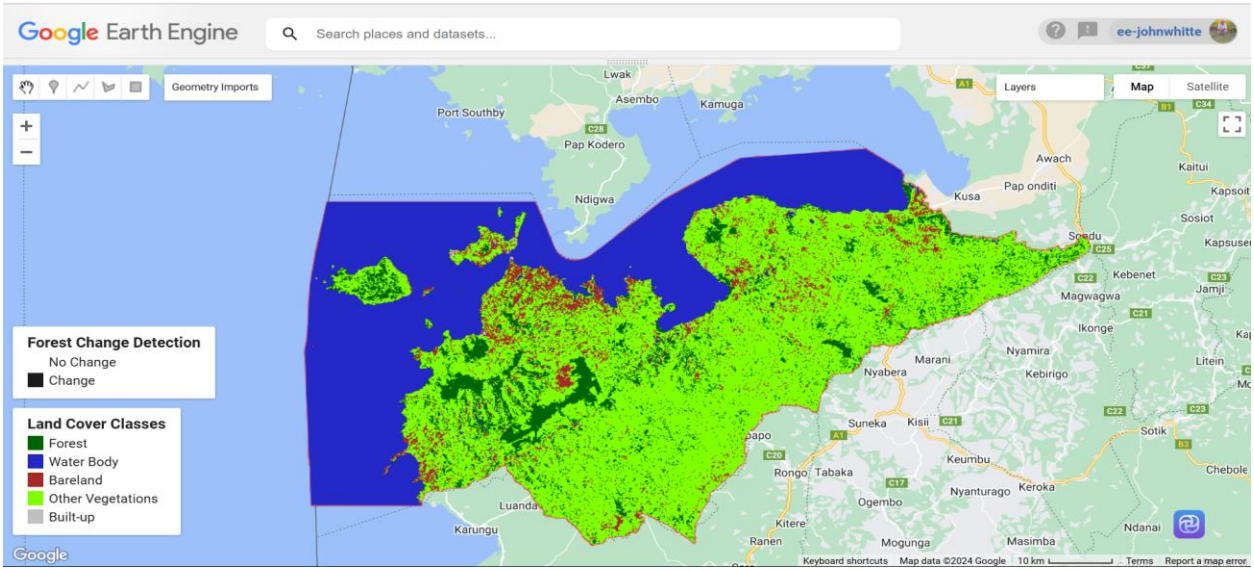


2024



- **Forest change detection**

Subsequent forest change detection analysis indicated:

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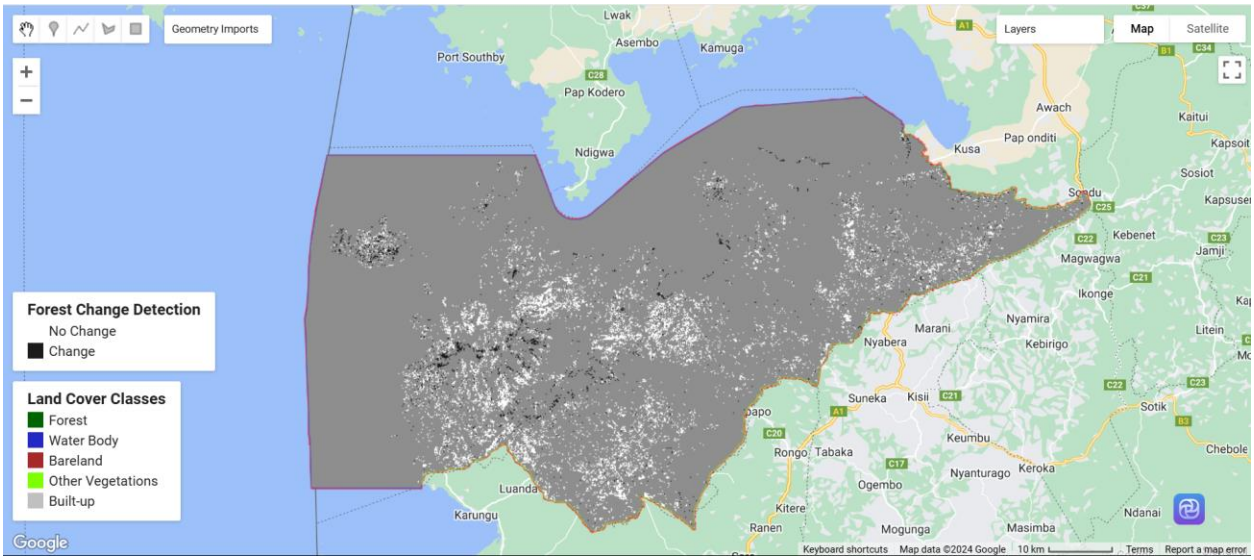
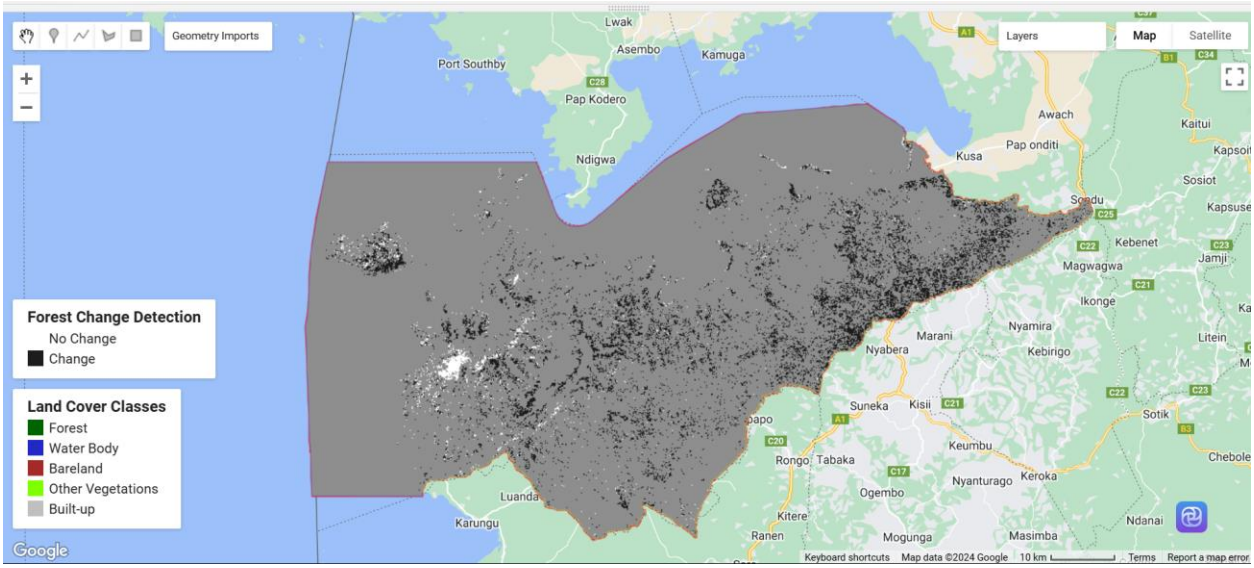
2010 - 2015



2015 - 2020



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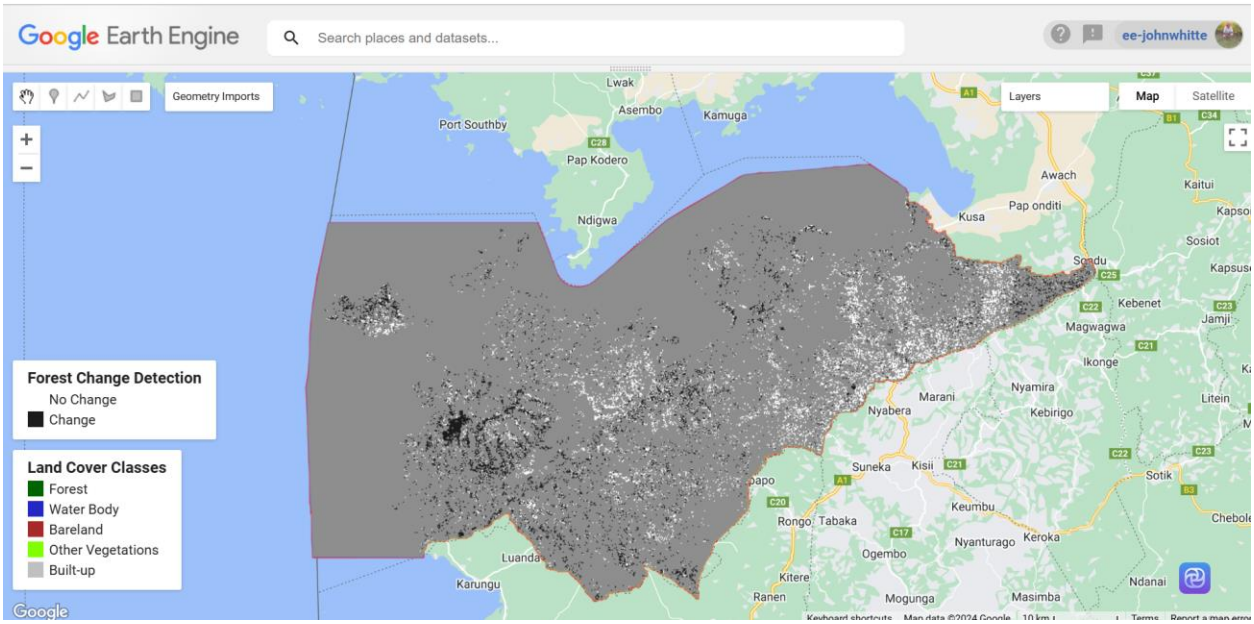
2020- 2024



Forest cover areas for the years

	2010	2015	2020	2024
Forest_Area(hecteres)	52095.63876	50964.51645	67393.87264	64933.79564

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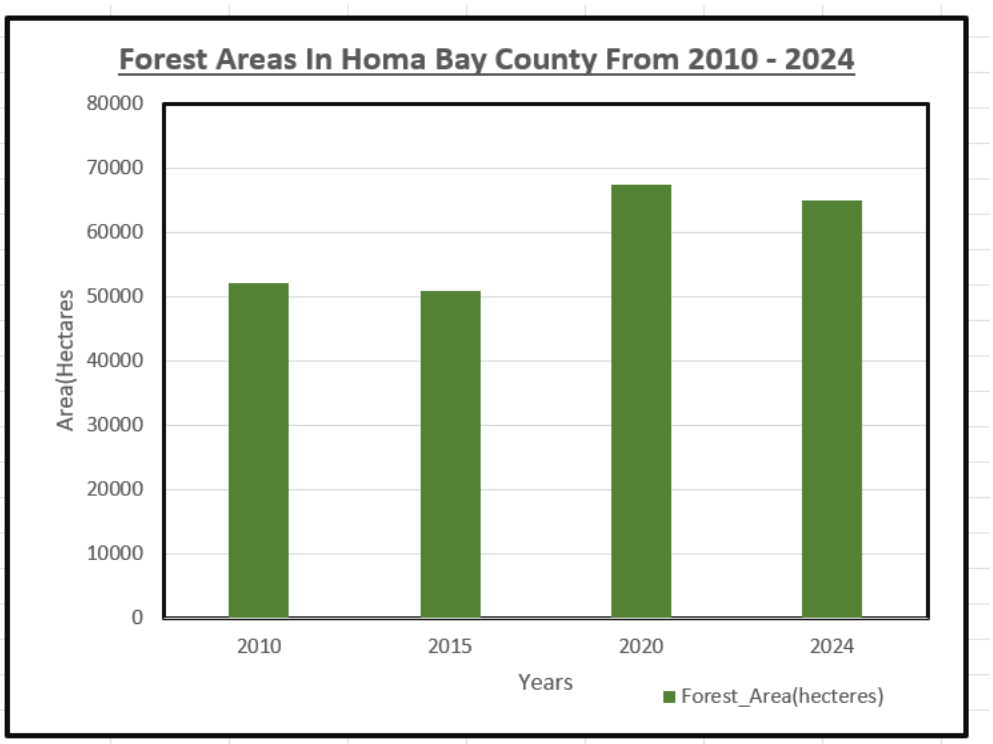
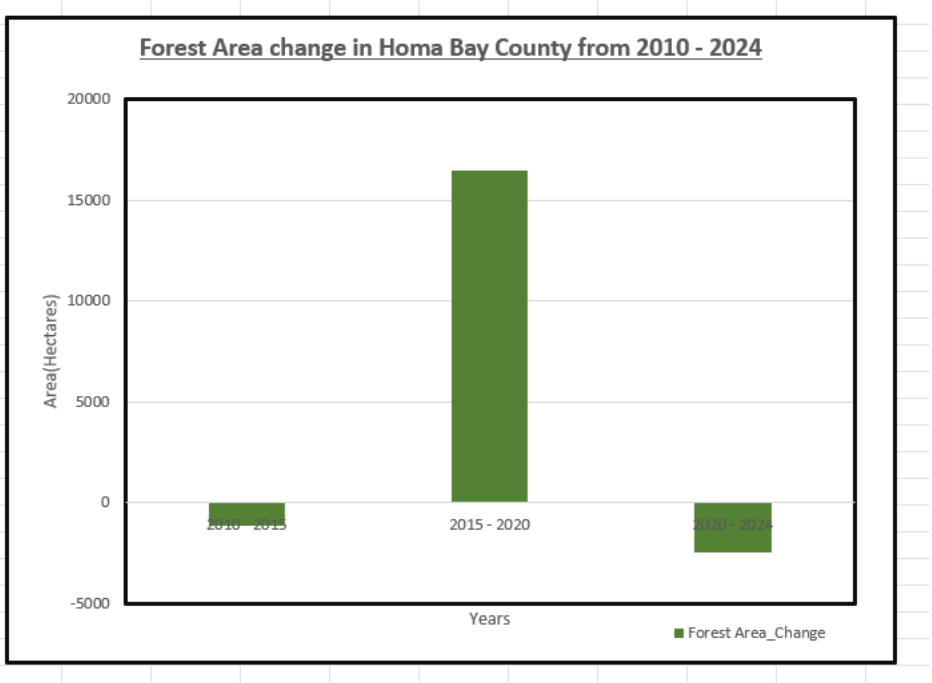


Forest area change

	2010 - 2015	2015 - 2020	2020 - 2024
Forest Area_Change	-1131.12231	16429.35619	-2460.077



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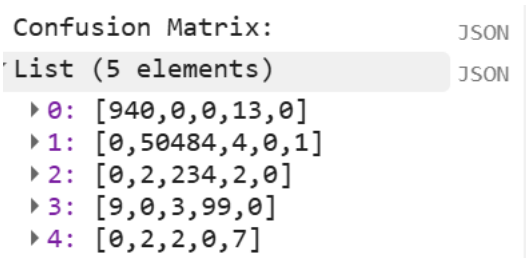
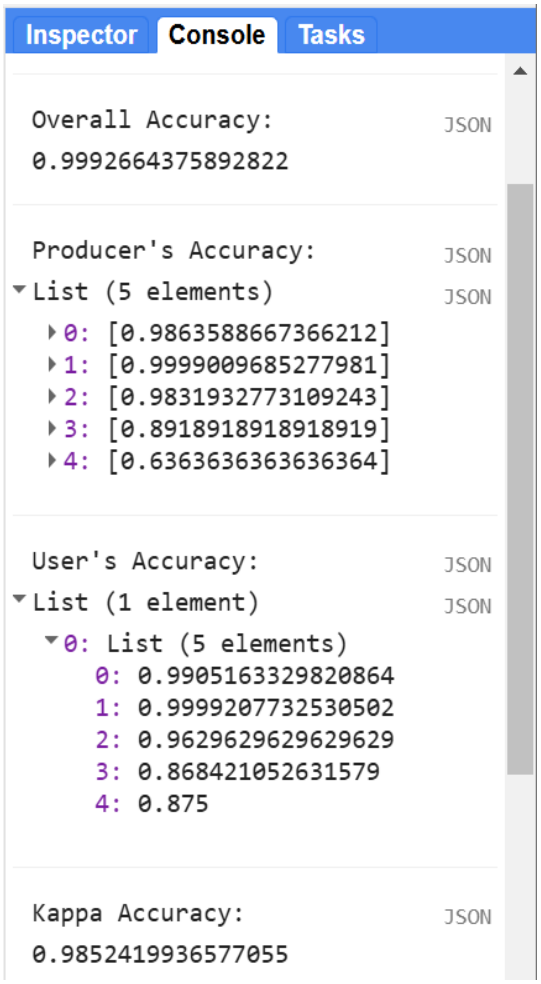
The confusion matrix calculated during validation showed accuracies as follows. However, notable discrepancies in specific land cover types highlight areas for potential improvement.



index	class_Name
0	Forest
1	water_body
2	bareland
3	other vegetation
4	built_up



Conclusion

This project effectively demonstrates the potential of remote sensing techniques and machine learning in monitoring land cover dynamics, specifically focusing on forest change detection.

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The results reveal a concerning trend of forest area reduction, accentuating the need for ongoing surveillance and management strategies.

Recommendation

Based on the findings and conclusions drawn from this study, it is recommended that:

1. Continuous monitoring using remote sensing should be implemented for timely intervention in forest management.
2. Enhanced collaboration with local authorities is encouraged to formulate conservation strategies.
3. Future studies should aim for a more granular analysis with additional years of data to establish trends over extended periods.
4. Exploration of other classification algorithms and hyperspectral data could potentially improve classification accuracy.

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