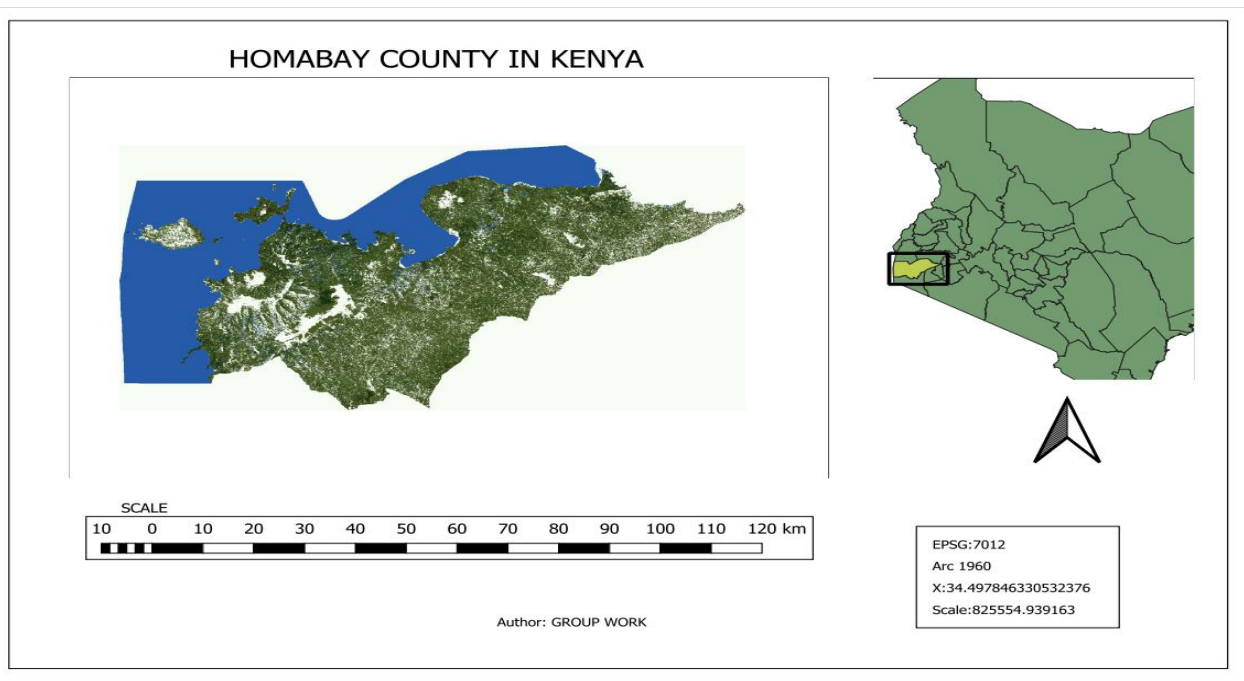


Forest Change Detection in Homa Bay County Using Landsat Imagery

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:

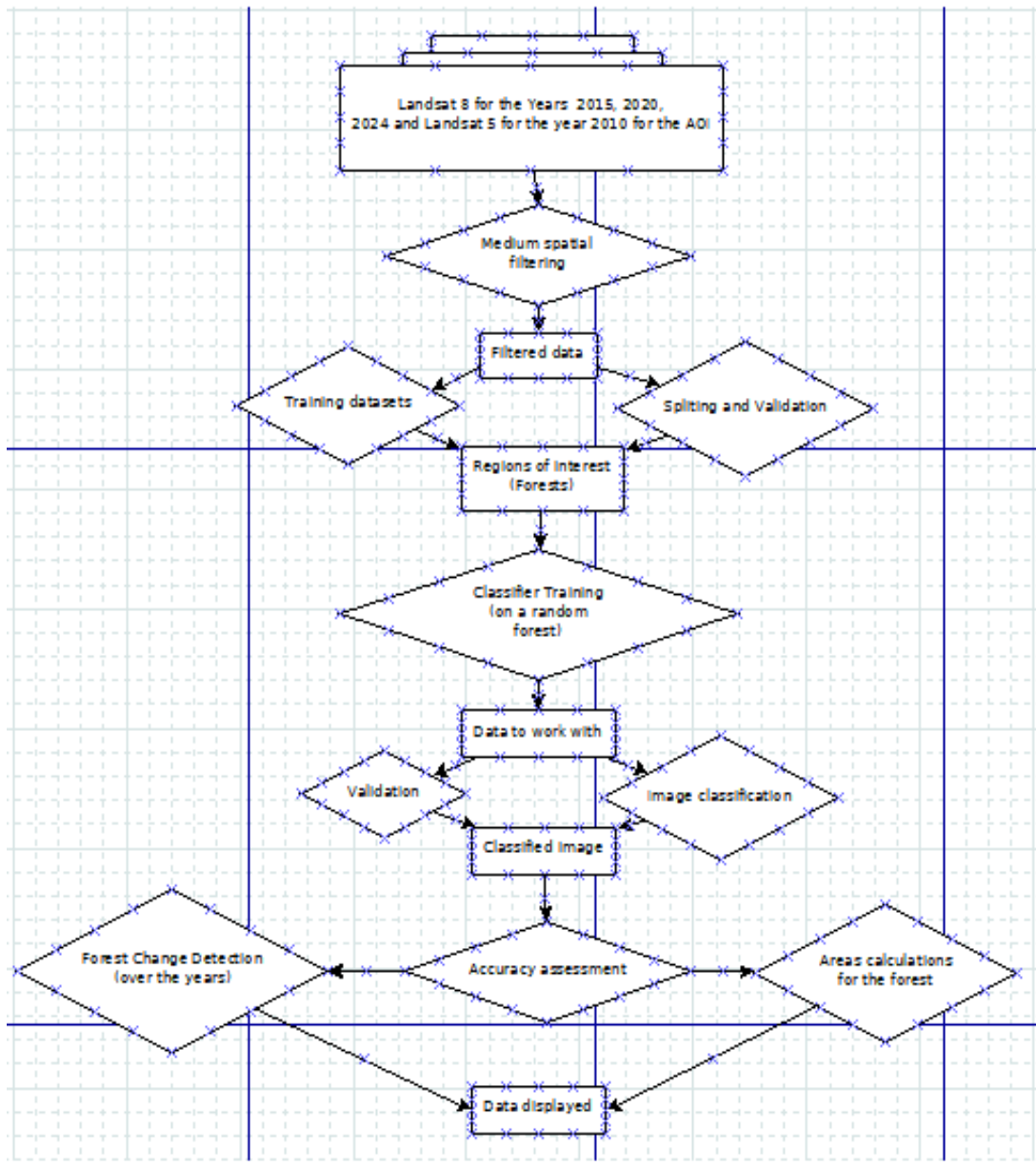
1. To classify land cover in Homa Bay County) utilizing Landsat imagery.
2. To quantify forest areas from 2010 to 2024 at five-year intervals [2010, 2015, 2020, 2024].
3. To detect and analyze spatial changes in forest cover from 2010 to 2024.

By John Odera

Contact: johnwuorodero@gmail.com

Phone: 0748427000

The Methodology



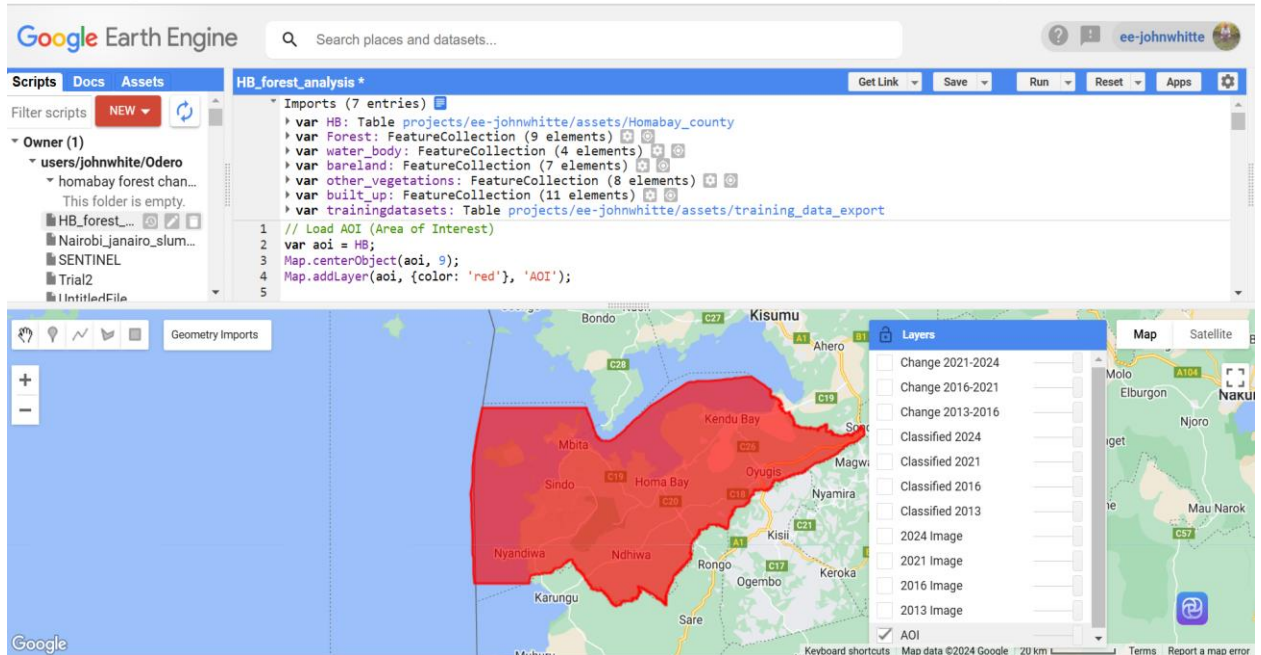
The study followed a systematic methodology that includes the following steps:

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

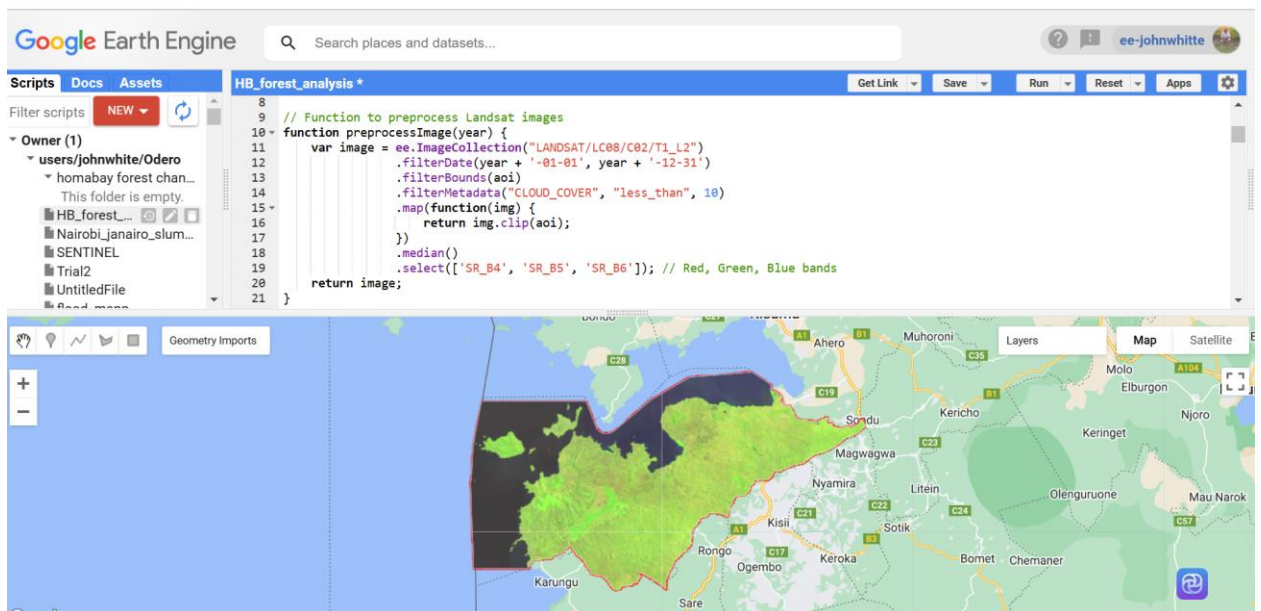
By John Odera

Contact: johnwuorodero@gmail.com

Phone: 0748427000



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.

```

33 // Load CSV training data
34 var trainingData = ee.FeatureCollection("projects/ee-johnwhite/assets/training_data_export");
35

```

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

```

36 // Split training data into training and validation subsets
37 var withRandom = trainingData.randomColumn('random');
38 var trainingSet = withRandom.filter(ee.Filter.lt('random', 0.7)); // 70% for training
39 var validationSet = withRandom.filter(ee.Filter.gte('random', 0.7)); // 30% for validation
40

```

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

```

41 // Train classifier using training subset
42 var trainedClassifier = ee.Classifier.smileRandomForest(10).train({
43   features: trainingSet,
44   classProperty: 'class',
45   inputProperties: ['SR_B4', 'SR_B5', 'SR_B6']
46 });
47

```

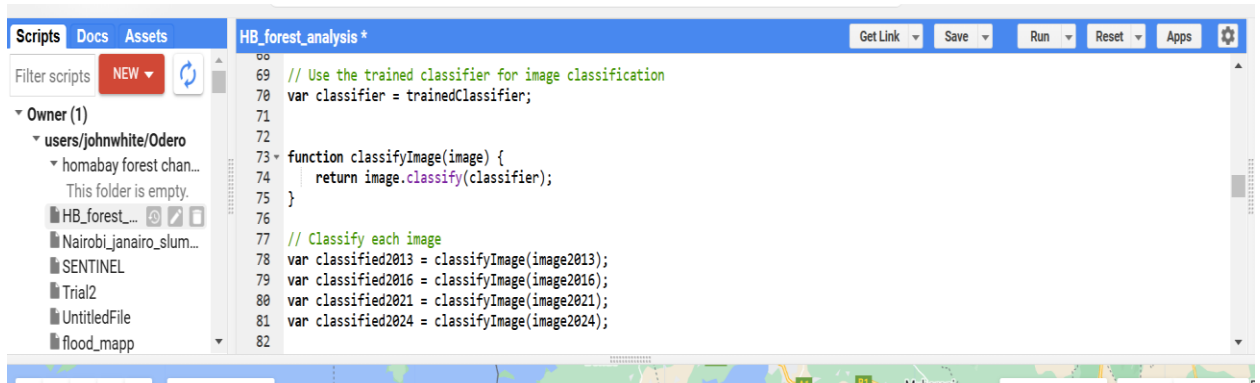
7. **Validation:** The classifier was evaluated against the validation dataset, generating a confusion matrix to derive accuracy metrics.

```

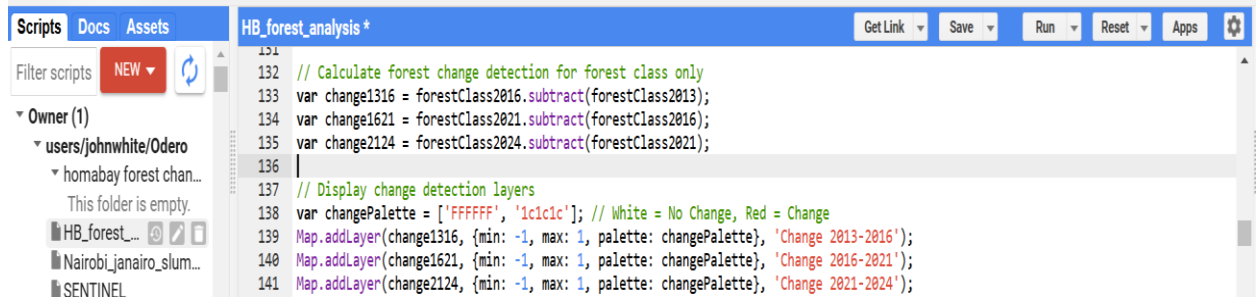
48 // Classify validation dataset
49 var validated = validationSet.classify(trainedClassifier);
50

```

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

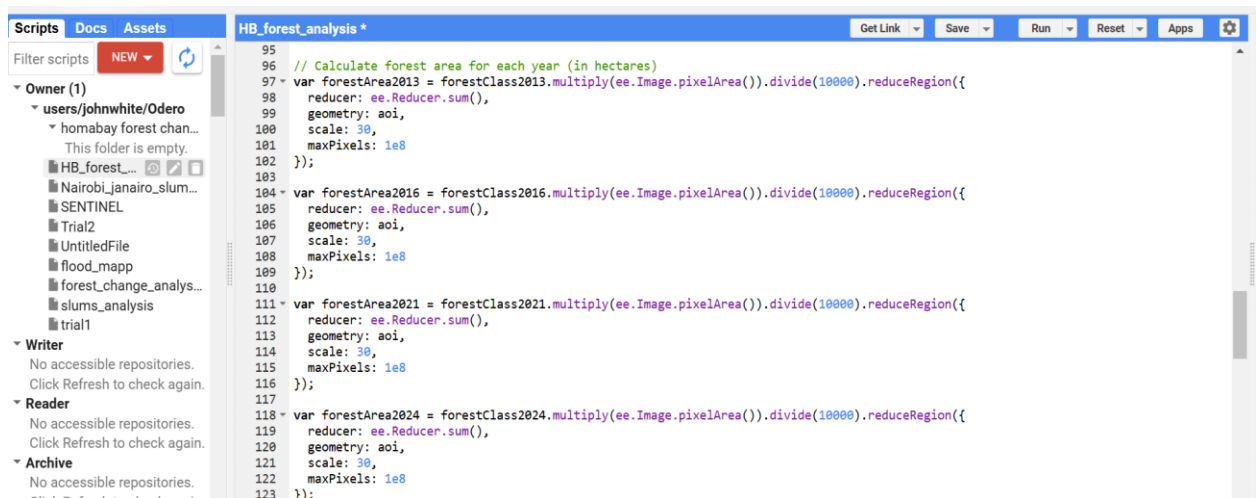


9. **Change Detection:** Forest change detection was performed by calculating differences in forest class between years.



```
131
132 // Calculate forest change detection for forest class only
133 var change1316 = forestClass2016.subtract(forestClass2013);
134 var change1621 = forestClass2021.subtract(forestClass2016);
135 var change2124 = forestClass2024.subtract(forestClass2021);
136
137 // Display change detection layers
138 var changePalette = ['FFFFFF', '1c1c1c']; // White = No Change, Red = Change
139 Map.addLayer(change1316, {min: -1, max: 1, palette: changePalette}, 'Change 2013-2016');
140 Map.addLayer(change1621, {min: -1, max: 1, palette: changePalette}, 'Change 2016-2021');
141 Map.addLayer(change2124, {min: -1, max: 1, palette: changePalette}, 'Change 2021-2024');
```

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



```
95
96 // Calculate forest area for each year (in hectares)
97 var forestArea2013 = forestClass2013.multiply(ee.Image.pixelArea()).divide(10000).reduceRegion({
98   reducer: ee.Reducer.sum(),
99   geometry: aoi,
100   scale: 30,
101   maxPixels: 1e8
102 });
103
104 var forestArea2016 = forestClass2016.multiply(ee.Image.pixelArea()).divide(10000).reduceRegion({
105   reducer: ee.Reducer.sum(),
106   geometry: aoi,
107   scale: 30,
108   maxPixels: 1e8
109 });
110
111 var forestArea2021 = forestClass2021.multiply(ee.Image.pixelArea()).divide(10000).reduceRegion({
112   reducer: ee.Reducer.sum(),
113   geometry: aoi,
114   scale: 30,
115   maxPixels: 1e8
116 });
117
118 var forestArea2024 = forestClass2024.multiply(ee.Image.pixelArea()).divide(10000).reduceRegion({
119   reducer: ee.Reducer.sum(),
120   geometry: aoi,
121   scale: 30,
122   maxPixels: 1e8
123 });
```

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

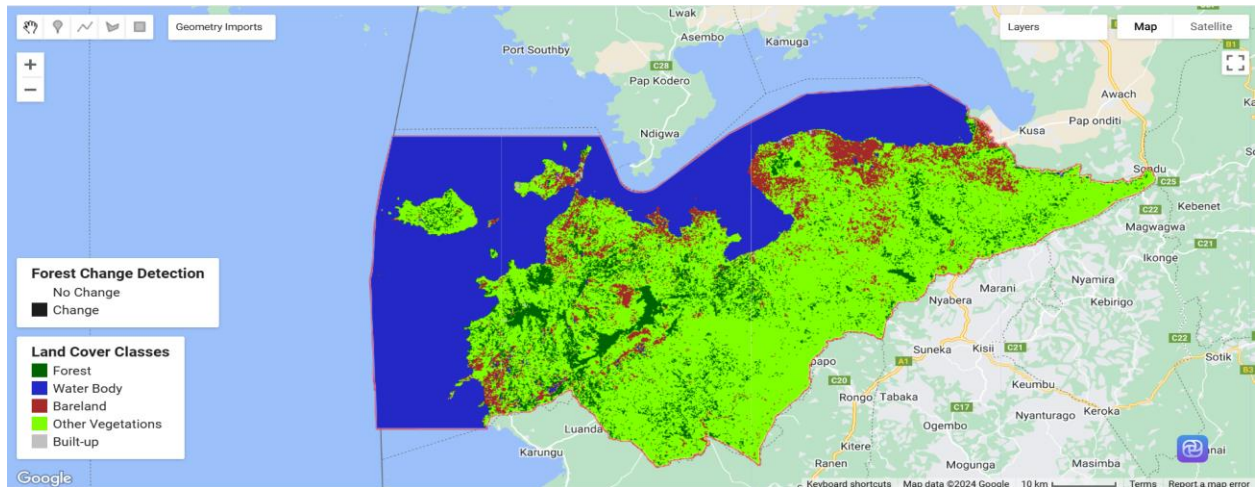
Results and Discussion

By John Odero
Contact: johnwuorodero@gmail.com
Phone: 0748427000

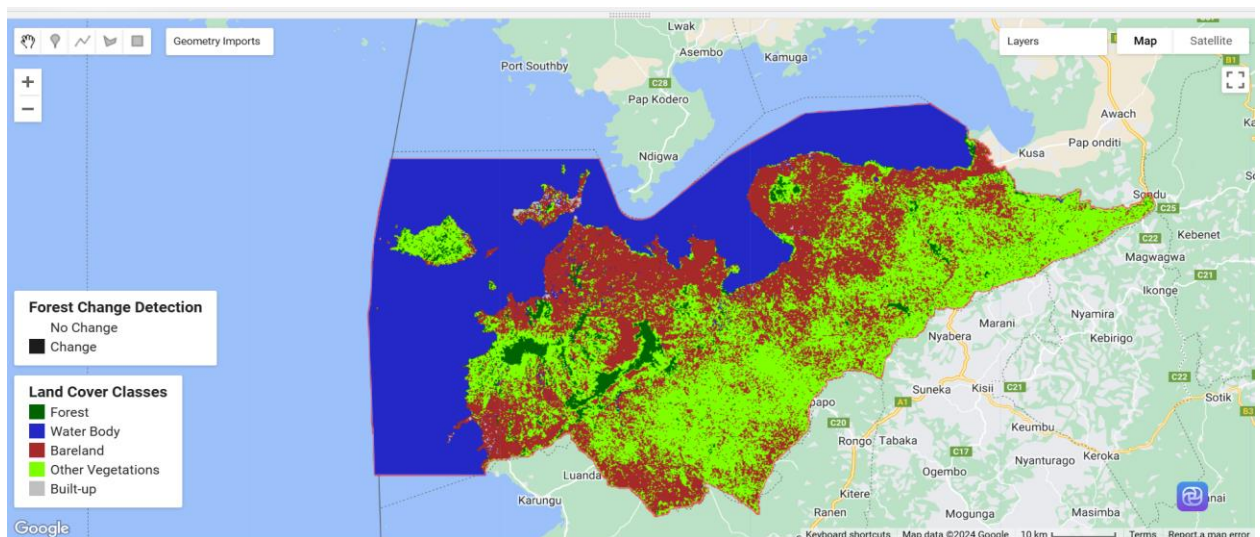
The classification output reveals diverse land cover types in Homa Bay County each year, with forests classified as a distinct category. The analysis yielded the following:

- **Classification**

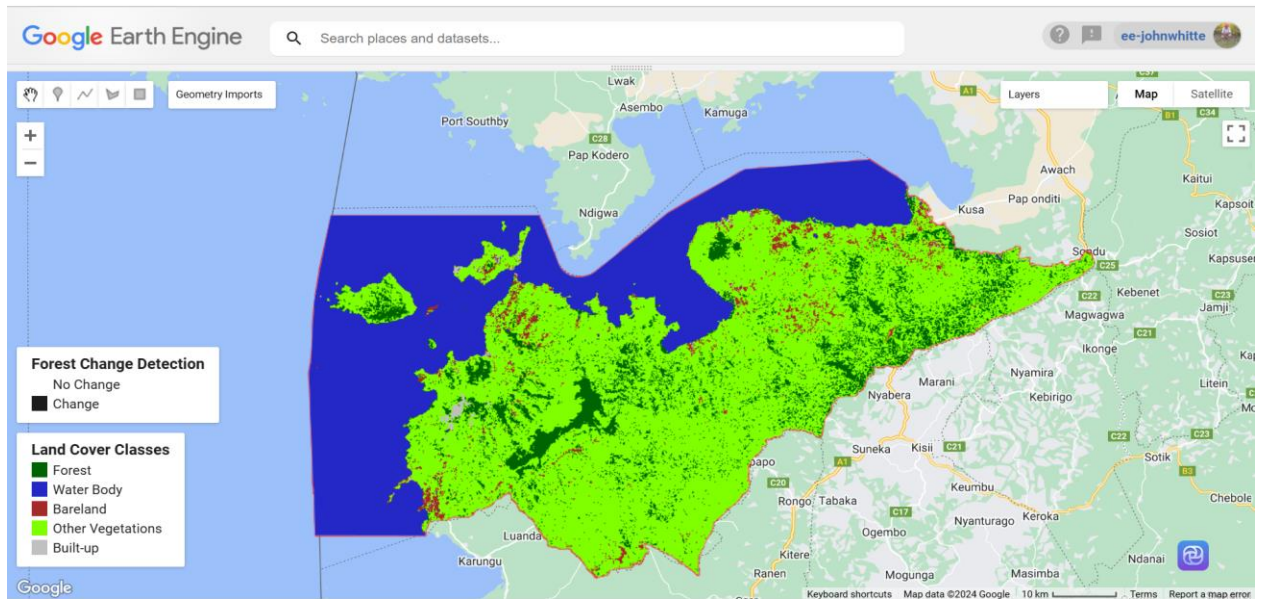
2010



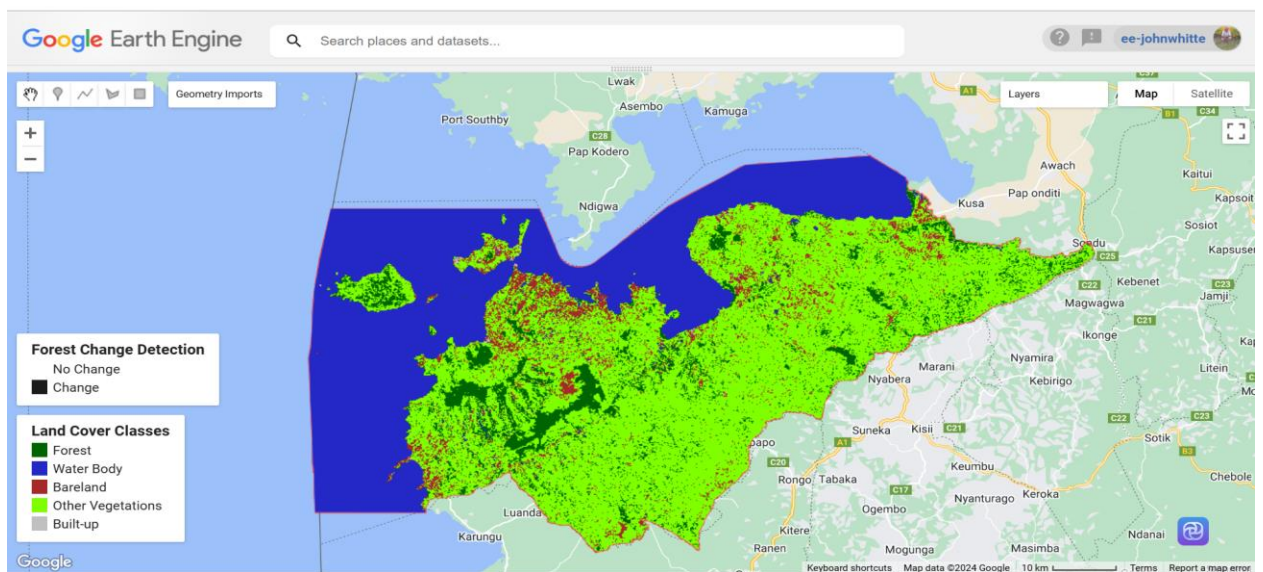
2015



2020



2024

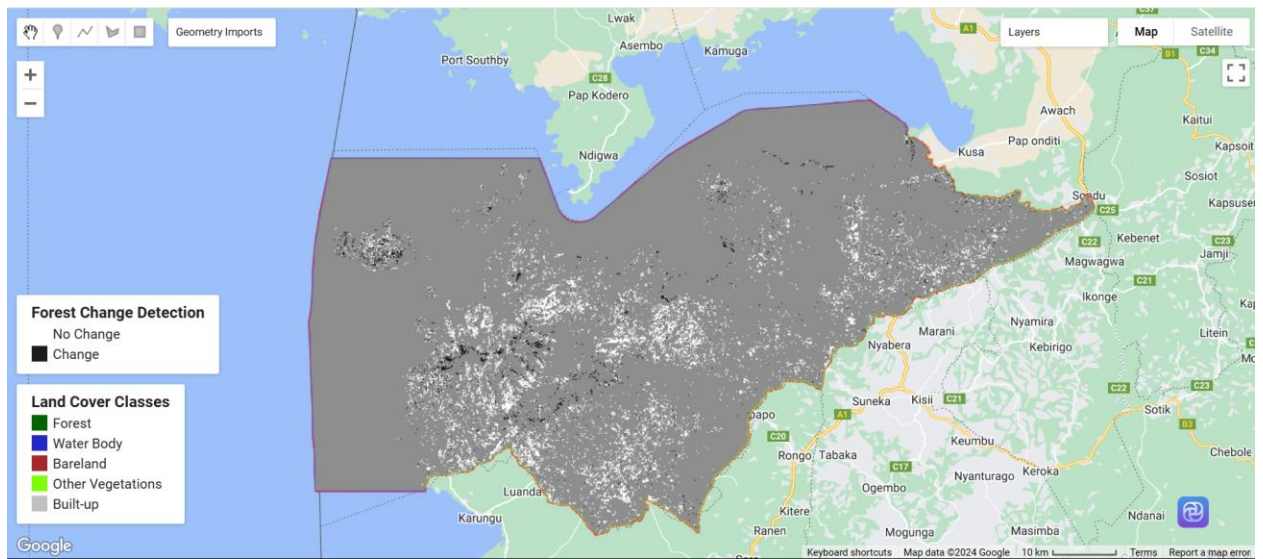


- **Forest change detection**

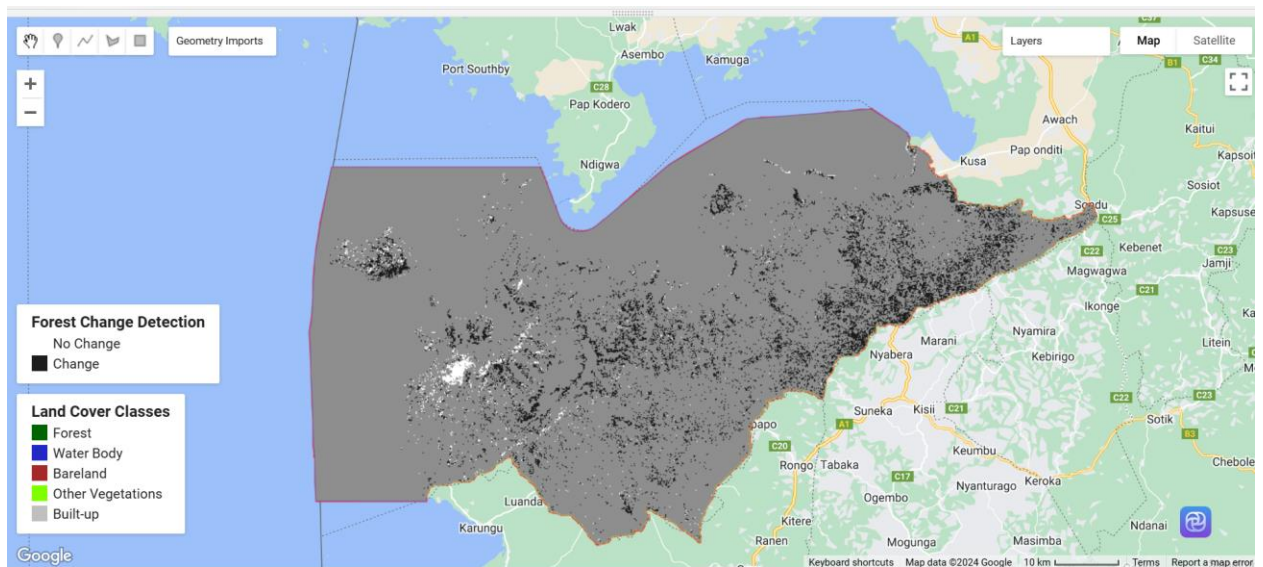
Subsequent forest change detection analysis indicated:

By John Odero
 Contact: johnwuorodero@gmail.com
 Phone: 0748427000

2010 - 2015



2015 - 2020

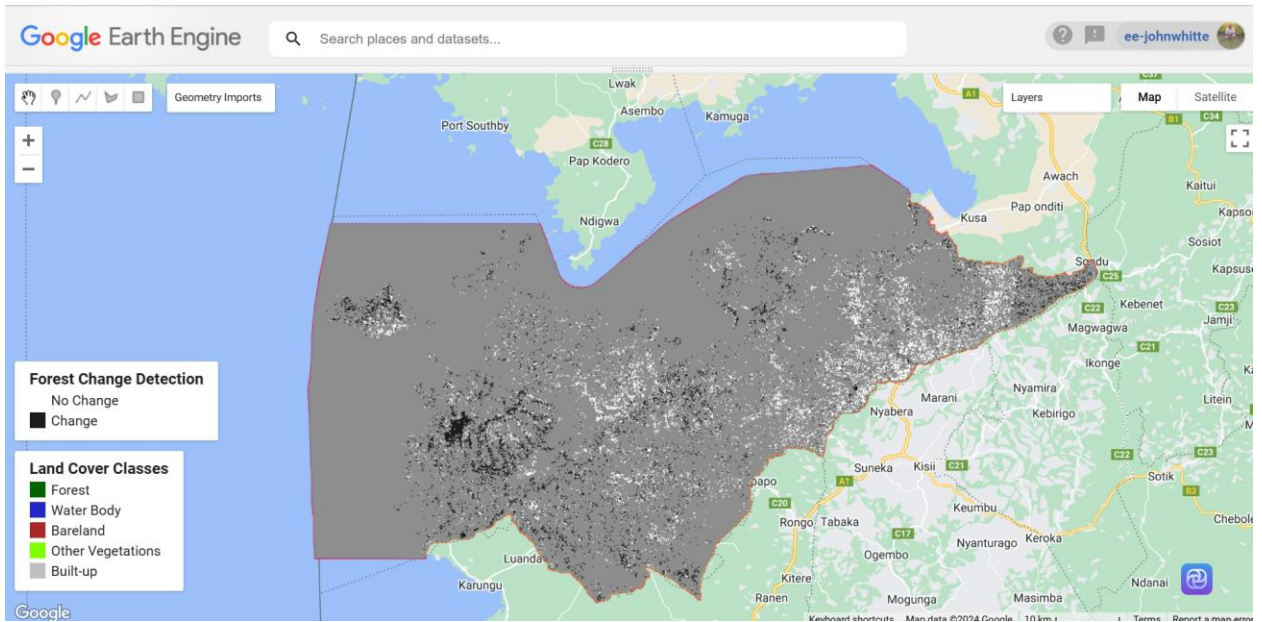


By John Odero

Contact: johnwuorodero@gmail.com

Phone: 0748427000

2020- 2024



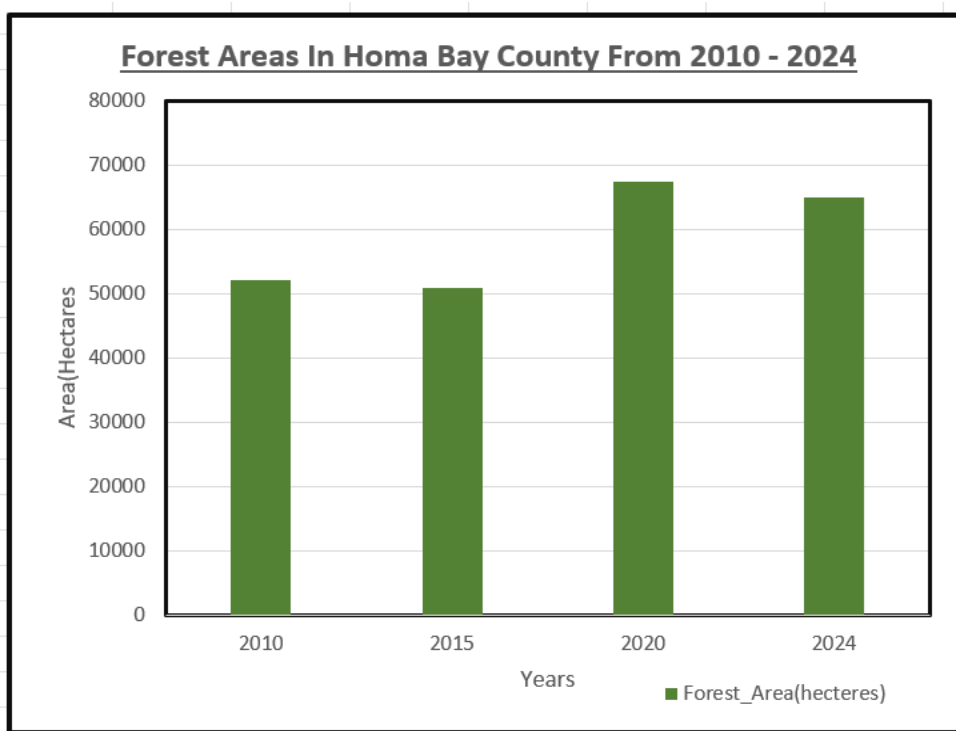
Forest cover areas for the years

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

By John Odera

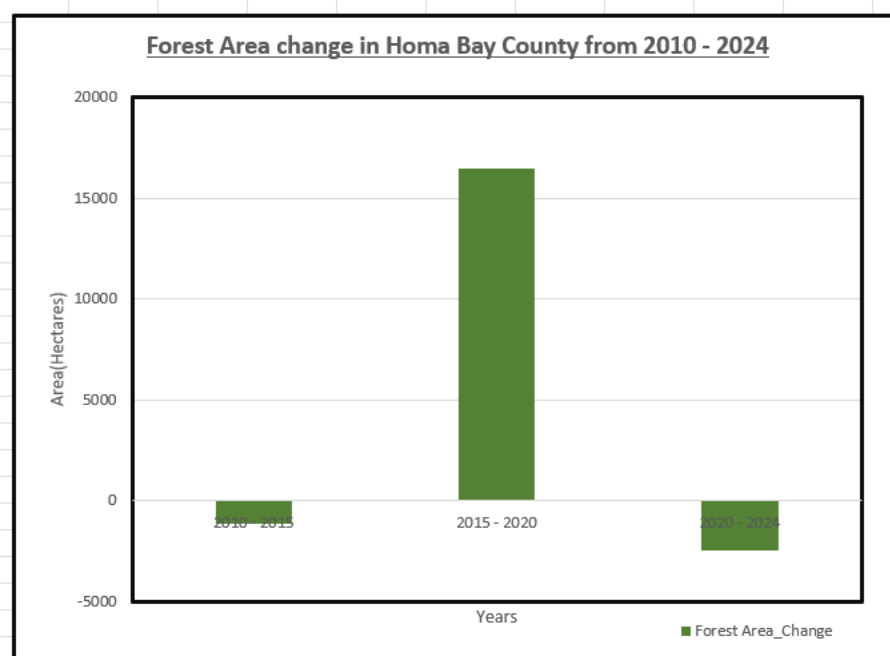
Contact: johnwuorodero@gmail.com

Phone: 0748427000



Forest area change

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



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

Confusion Matrix:	JSON													
List (5 elements)	JSON	<table><tr><th>index</th><th>class_Name</th></tr><tr><td>0</td><td>Forest</td></tr><tr><td>1</td><td>water_body</td></tr><tr><td>2</td><td>bareland</td></tr><tr><td>3</td><td>other vegetation</td></tr><tr><td>4</td><td>built_up</td></tr></table>	index	class_Name	0	Forest	1	water_body	2	bareland	3	other vegetation	4	built_up
index	class_Name													
0	Forest													
1	water_body													
2	bareland													
3	other vegetation													
4	built_up													
▶ 0: [940,0,0,13,0]														
▶ 1: [0,50484,4,0,1]														
▶ 2: [0,2,234,2,0]														
▶ 3: [9,0,3,99,0]														
▶ 4: [0,2,2,0,7]														

Inspector	Console	Tasks
Overall Accuracy:		
0.9992664375892822		
Producer's Accuracy:		
List (5 elements)		
▶ 0: [0.9863588667366212]		
▶ 1: [0.9999009685277981]		
▶ 2: [0.9831932773109243]		
▶ 3: [0.8918918918918919]		
▶ 4: [0.6363636363636364]		
User's Accuracy:		
List (1 element)		
▶ 0: List (5 elements)		
0: 0.9905163329820864		
1: 0.9999207732530502		
2: 0.9629629629629629		
3: 0.868421052631579		
4: 0.875		
Kappa Accuracy:		
0.9852419936577055		

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.

By John Odero
Contact: johnwuorodero@gmail.com
Phone: 0748427000

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.