Mangrove Extent Mapping Using Machine Learning and a Fusion of Optical and Radar Images

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1. Goal and Motivation

Main Objective: to assess the performance of different satellite imageries for mangrove mapping and monitoring

Motivation: Cloud cover effects make it difficult to evaluate the mangrove ecosystem in tropical locations using solely optical satellite data. Therefore, it is essential to conduct a more precise evaluation using data from several sources and appropriate model in order to manage the mangrove ecosystem as effectively as feasible

2. Study Location

This study area is located at Anlo Beach Wetland complex which is situated along the coastline of Ghana in Shama District, Western Region as shown in Figure (1). The area covers about 50.42km^2, lying approximately within latitudes 5°1'30"N and 5°3'5"N, and longitudes 1°34'30"W and 1°37'30"W as shown in Fig 1

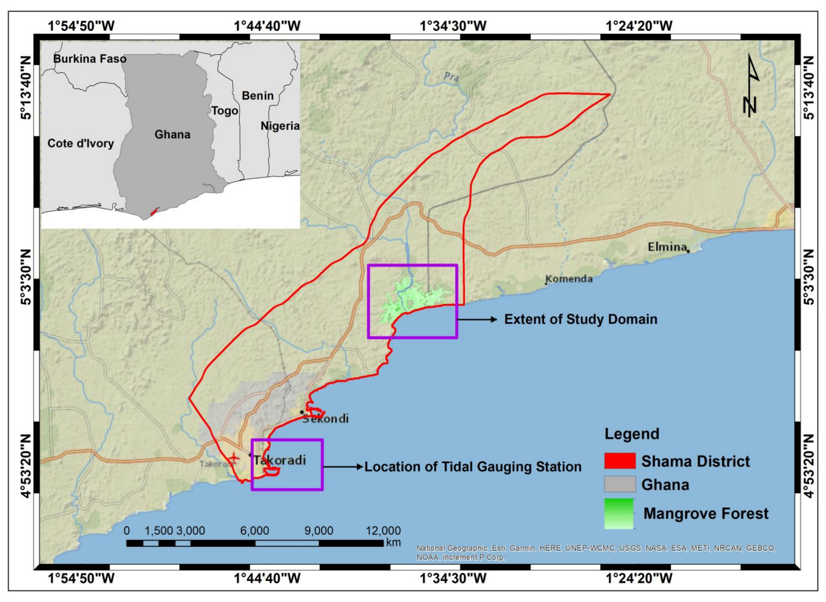

Figure 1. Map of study location

3. Approach

Google Earth Engine (GEE) cloud-based platform and random forest classification algorithm were used. Mangrove extent maps were generated by classifying both optical and radar images separately and in combination. The maps were created for the year 2019, to examine the performance of different satellite data.

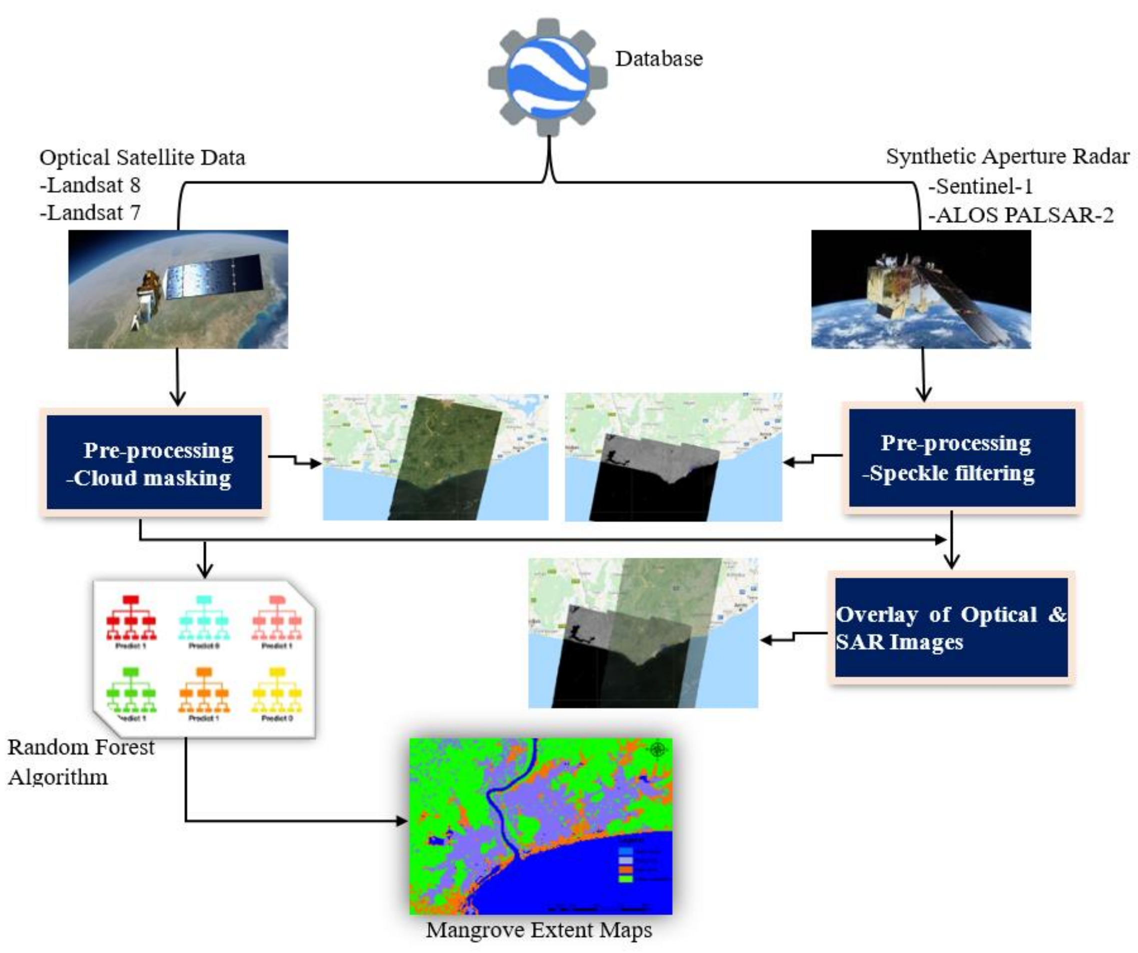

Figure 2. Flowchart of data extraction and random forest model

4. Result

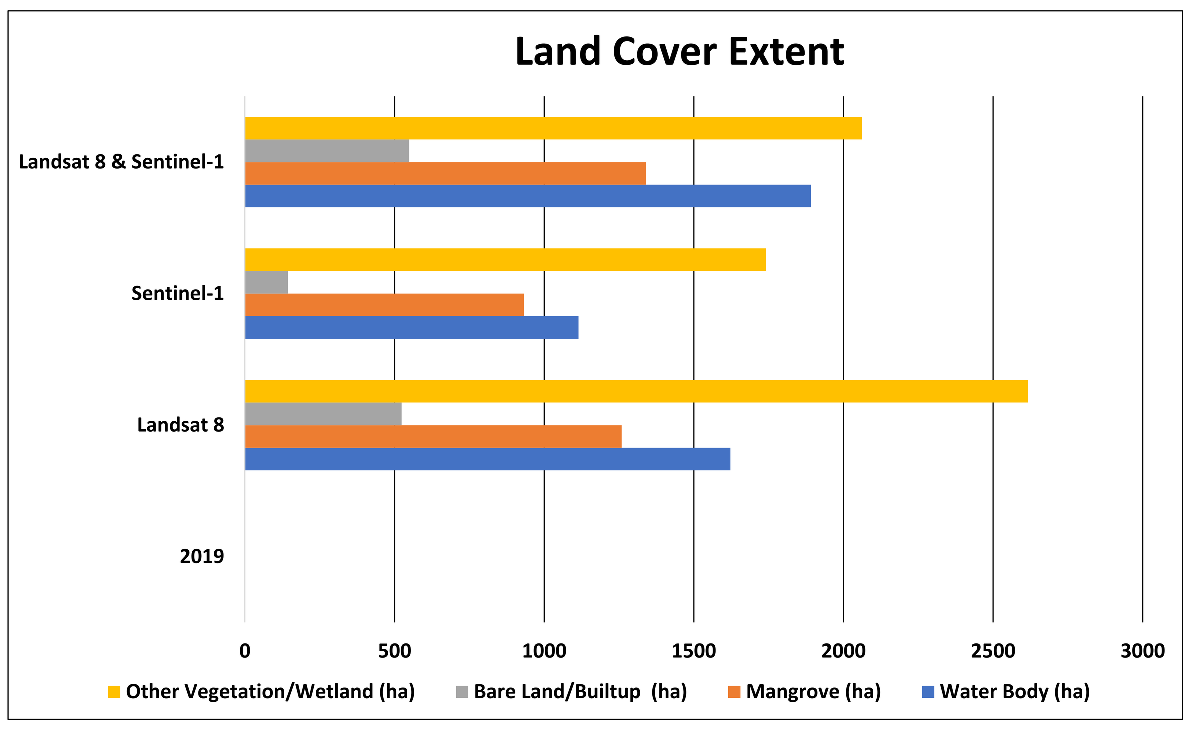

Figure 3. LULC extent for different classification scenario.

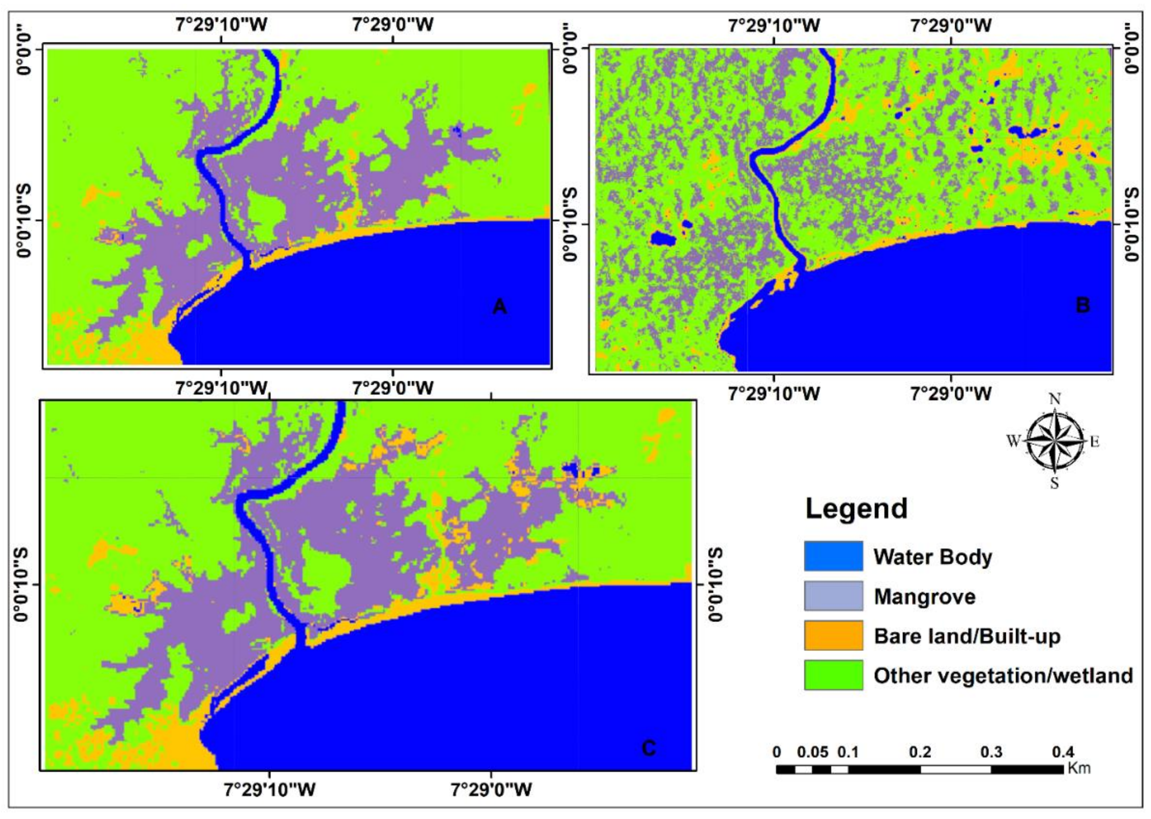

Figure 4. (a) classification scenario using optical image only (Landsat 8); (B) Classification scenario using sentinel-1 image only; (C) Classifi cation scenario using both optical and Sentinel-1.

5. Key Findings

- The result of Landsat 8 data only (2019) showed Mangrove extent of 1259 ha, water body extent of '1622 ha', Bare land extent of 524 ha and other vegetation extent of 2617 ha (Figure 3)
- overall classification accuracy for Landsat 8 was 99.1% with Kappa Coefficient of 0.797
- The result of Sentinel-1 data showed Mangrove extent of 933 ha, water body extent of '1115 ha', Bare land extent of 144 ha and other vegetation extent of 1741 ha
- The overall classification accuracy for Sentinel-1 classification was 84.6% with Kappa Coefficient of 0.687
- The combined classification of Sentinel-1 and Landsat 8 showed Mangrove extent of 1340 ha, water body extent of '1891 ha', Bare land extent of 549 ha and other vegetation extent of 2062 ha
- The overall classification accuracy for both Sentinel-1 and Landsat 8 when combined together was 98.9% with Kappa Coefficient of 0.828

8. Discussion

It was revealed that the Sentinel-1 image alone tend to underestimate the mangrove vegetation canopy (Figure 4).

- On the other hand, Landsat 8 alone tend to overestimate the vegetation cover. The third classification scenario that combines optical and radar data yielded the best classification results as the classes were relatively well distributed, capturing both clustered mangroves and mangrove patches near the water body (Figure 4).
- This findings agree with the work of Ghorbanian et al. (2021).
- This study confirms that combining synthetic aperture radar data with optical satellite data improves the accuracy of mangrove mapping, as recommended by several authors (Attarchi and Gloaguen, 2014; Ayman et al., 2017).

7. Conclusion

we developed a method in this research for combining optical and radar data in a spatial framework using the Google Earth Engine platform and a random forest algorithm. In this study, it was shown that cloud computing methods and machine learning algorithms, such Google Earth Engine, have the ability to accurately quantify mangrove stands as well as a variety of other land uses, particularly in cloud-prone regions. This would enable more precise estimate of mangrove changes at local and regional levels.

References

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