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Identification of Mangrove Cover in Banten Bay using Google Earth Engine

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Abstract

The existence of mangroves is a factor in the natural preservation of an area. The goal of this research is to identify the mangrove forest cover in Teluk Banten using guided classification based on machine learning available in GEE.The method used in this research is to visually analyze the spectral value of Sentinel 2A. The composite images used in the analysis include Bands 8A114 and Bands 8A115. Determination of subset images (cropping) is carried out to accommodate the size of the image according to the size of the research location to determine its distribution, extent and changesMangrove classification can be done using various digital image classification approaches, including pixel-based classification, object-based classification, and supervised and unsupervised learning. The choice of classification scheme depends on the purpose of the study and the available data. The mangrove cover area that is seen in red shows that the results of using the CART model can determine the area that is included in the mangrove class.Mangrove identification using GEE machine learning can produce mangrove cover. The result of mangrove cover area depends on how much training area is given. Training areas are used by CART in determining which areas are categorized as mangrove cover.

Keywords: Mangrove, GEE, Machine Learning, CART

1. Introduction

Mangroves are transitional ecosystems from land to sea which have an important role in life, especially in coastal areas (Dinilhuda *et al*, 2018). Mangrove forests are habitats for many types of fish, shrimp and molluscs, as well as spawning grounds, rearing and foraging for various small marine animals(Dinilhuda *et al*, 2018). In addition, mangrove ecosystems also have other benefits such as growing islands and stabilizing beaches, producing oxygen needed by various living things, reducing the content of carbon dioxide gas (CO2) in the air and contaminants in coastal swamp waters, and providing environmental services in carbon storage that has a good impact on the environment and humans. Therefore, the existence of mangroves is a factor in the natural preservation of an area.

Coastal environmental degradation, especially mangrove forests, is a crucial reason for monitoring changes that occur in these areas. One of the methods that support monitoring is remote sensing (Dinilhuda *et al*, 2018). The main cause of mangrove forest degradation in the world is due to anthropogenic influences such as agricultural activities, plantations, fish and shrimp ponds, settlement development, and legal logging (Eddy *et al.*, 2019). Mangrove forests are one of the most productive marine ecosystems on Earth, providing a unique habitat for many species and important goods and services for humans (Nahlohy and Masniar, 2020).

Remote sensing helps in monitoring mangrove forests by providing up-to-date information on the current status of mangrove forests (Simarmata *et al.*, 2021) (Purwanto and Setiawan, 2015) (Maurya *et al.*, 2021). Remote sensing is an efficient method for mapping and monitoring mangroves due to their visible spectral and spatial signatures which are easily detectable on satellite images (Simarmata *et al.*, 2021) (Maurya *et al*, 2021). Remote sensing is also relatively cheap and easy to obtain, making it a cost-effective method for monitoring mangroves (Purwanto and Setiawan, 2015) (Maurya *et al*, 2021). Additionally, remote sensing has a wide coverage and can reach remote areas, making it possible to monitor the entire mangrove forest (Purwanto and Setiawan, 2015) (Maurya *et al.*, 2021). Remote sensing can also be used to develop new vegetation indices for mangrove ecosystems, which can find the probability of mangroves in a given area or can directly separate mangroves vegetation from other vegetation with multispectral and hyperspectral remote sensing (Maurya *et al.*, 2021).

According to Tamiminia *et al* (2020), Google Earth Engine (GEE) is a cloud-based platform that can be used for processing geo-big data on a global scale. GEE is a free platform that can process petabyte scales of remotely-sensed data, such as Landsat and MODIS, and can be used for various geo-big data applications (Tamiminia *et al.*, 2020). The use of machine learning in land cover mapping has been done frequently, but the critical steps and model selection are often overlooked . Shih *et al.*. (2019) noted that this is a common issue. Therefore, it is important to carefully select the appropriate model and follow the necessary steps to ensure accurate results. One of the initial steps in land cover classification is selecting a training area or region of interest (ROI) that represents the pattern of each class. The selection of the training area is based on the spectral pattern that each class has (Arif and Wahyuni, 2016) .

The research aims to use machine learning available in GEE to map the mangrove ecosystem in Kubu Raya Regency (Fariz *et al.*, 2021) Another study analyzes the health level of mangrove vegetation based on the Normalized Difference Vegetation Index (NDVI) value using a technique. A different research aims to determine the ability of radar and optical satellites to detect mangroves and classify them (Nagendra *et al.,* 2019). There are also studies that introduce new algorithms such as the Mangrove Vegetation Index (MVI) to differentiate mangroves from non-mangroves with precision, without requiring complex classification techniques (Haryanto *et al.,* 2023). The goal of this research is to identify the mangrove forest cover in Teluk Banten using guided classification based on machine learning available in GEE.

2. Method

This research was conducted in Banten Bays, Banten province with the coordinate limitations 106° 4' 49.4" - 106° 15' 49.41" E and 5° 53' 48.57" - 6° 2' 12.57" S. The satellite imageries used in this study were Sentinel 2A image acquisition dated 1 January 2021 – 31 December 2021.

The method used in this research is to visually analyze the spectral value of Sentinel 2A which has been corrected for cloud cover. The composite images used in the analysis include Bands 8A114 and Bands 8A115. Digital processing for each data set includes multispectral fusion selection, sharpening, and filtering. Determination of subset images (cropping) is carried out to accommodate the size of the image according to the size of the research location to determine its distribution, extent and changes.

The machine learning used in the research mentioned is based on logic, specifically the CART algorithm (Tamiminia *et al.*, 2020). CART stands for Classification and Regression Trees, which is a decision tree-based algorithm used for classification and regression analysis. The text appears to be an excerpt from a research paper discussing land cover classification. The land cover classes used in the study were limited to three categories: water bodies, mangrove land cover, and non-mangrove land cover. The non-mangrove land cover class includes vegetation. Other sources discuss land cover classification and its various classes, such as vegetated areas, forests, lakes, and settlements.

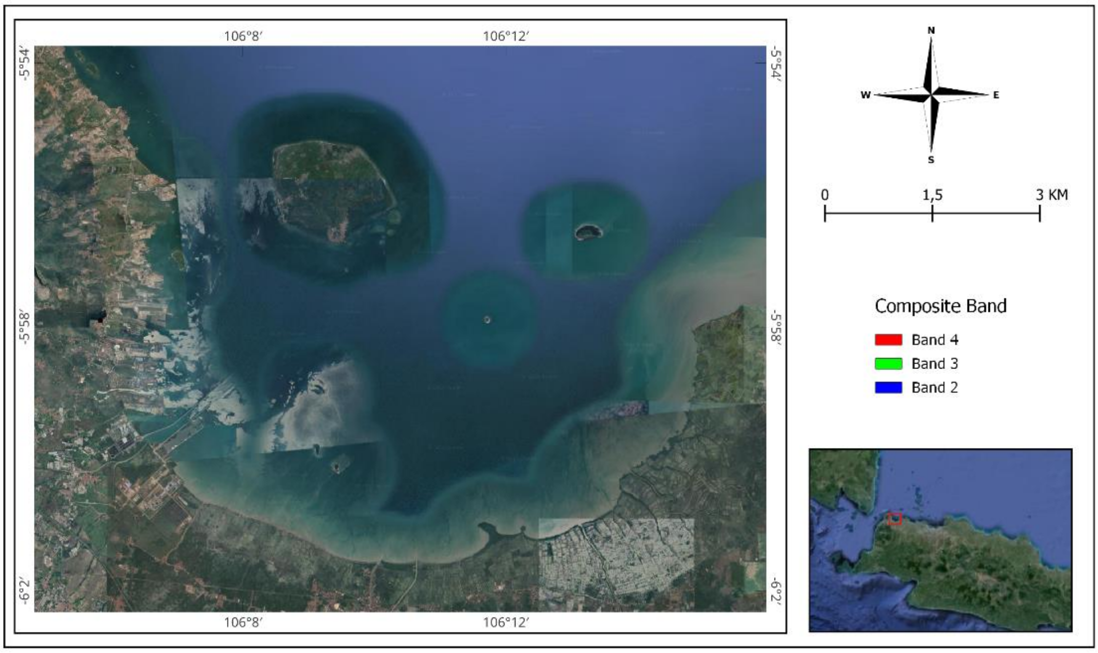

Fig 1. Map of the study area

3. Result and Discussion

3.1 Mangrove Identification

Remote sensing image analysis is an important but challenging task. Digital image classification provides a variety of approaches for image analysis that can be used in combination to extract useful information from remote sensing images (Xie *et al*, 2008) . Scene classification is a fundamental task in remote sensing image analysis, aiming to identify the land-cover categories of remotely sensed image patches. There are various digital image classification techniques in remote sensing, such as supervised, unsupervised, and object-based classification. To learn more about remote sensing image analysis and interpretation, there are courses and lectures available online.

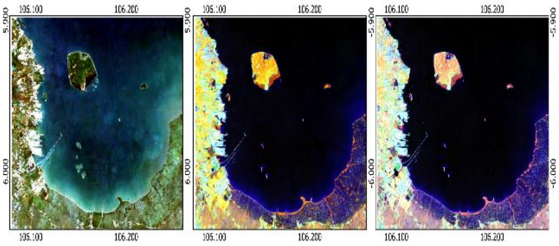

Fig 2. Image composite band 432, band 8A114 and band 8A115

Identification of the difference between the color of the image results for mangrove vegetation is used using the composite image results with the comparison of bands 8A114 and 8A115. The composite comparison of the two composites shows that the results of composite band 8A114 have a higher sharpness compared to composite band 8A115. However, the results obtained by the two composites still show the difference between mangroves and other vegetation.

The optical image results in the 8A near infrared band channel in mangroves will produce higher reflection values so that they can show clear differences between mangrove and non-mangrove class vegetation.

The provided search results suggest that near-infrared (NIR) wavelengths show an inverse response to red wavelengths, and that mangrove and non-mangrove vegetation reflect NIR wavelengths differently. The reflectance spectrum in the near-infrared and short-wave infrared exhibits five absorption bands, which are related to water absorption. NIR wavelengths are used to assess leaf water content, as they are sensitive to changes in water content.

the spectral reflectance of vegetation is higher in the near-infrared channel compared to built-up and open land. This suggests that vegetation reflects more NIR wavelengths than built-up and open land.

While the search results do not provide a direct answer to the question, they suggest that NIR wavelengths are sensitive to water content and that vegetation reflects more NIR wavelengths than built-up and open land. This could explain why the NIR values are higher for mangrove and non-mangrove vegetation compared to non-vegetation classes.

3.2 Mangrove classification

Mangrove classification can be done using various digital image classification approaches, including pixel-based classification, knowledge-based and object-based classification, and supervised and unsupervised learning.

One way to classify mangroves is by using machine learning algorithms, such as CART (Classification and Regression Trees) (Jiang *et al.,* 2021). The results of mangrove classification using CART can be seen in Figure 3. Mangroves can be identified as a separate class by framing the results of the training data (Maurya *et al.*, 2021). The accuracy of classification using deep learning depends on the quality and quantity of training data, as well as the choice of deep learning model and its parameters.

Remote sensing techniques, such as satellite imagery, have been used to identify large-area mangrove distributions based on remote sensing data (Zhao and Qin, 2021). The classification approaches to identifying large-area mangrove distributions can be categorized into three types: one-class classifications, multi-class classifications, and binary classifications. The choice of classification scheme depends on the purpose of the study and the available data. The mangrove cover area that is seen in red shows that the results of using the CART model can determine the area that is included in the mangrove class.

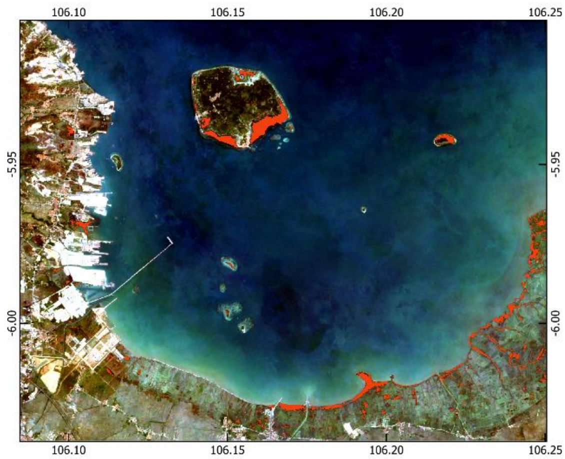

Fig 3. mangrove classification results based on machine learning CART (red is mangrove)

4. Conclusions

Mangrove identification using GEE machine learning can produce mangrove cover. The result of mangrove cover area depends on how much training area is given. Training areas are used by CART in determining which areas are categorized as mangrove cover.

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