Utilization of multitemporal imagery for analysis of changes in mangrove cover by Using Cloud Computing Method in the East Coast Region of Lampung Province

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Abstract. The East Coast of Lampung Province has extraordinary potential, unique potential such as visual appeal. In addition, the coast also has the potential as a residential area, fishery cultivation, ponds, agriculture, ports, tourism and so on. However, behind its potential, the East Coast region of Lampung Province, especially the coastal area, is prone to destructive activities around the sea, the cause of the damage can be influenced by natural factors which include wave and tidal action. and human activities such as converting mangrove land to ponds. The purpose of this study was to analyze changes in mangrove area cover using multitemporal imagery from 1991 to 2019. The research data used were Landsat imagery and Sentinel imagery. Identification of mangrove areas can be done through interpretation of remote sensing technology. Changes in mangrove land cover can be detected using multitemporal imagery. It is early to see how widespread the changes have been in a certain time frame. The use of remote sensing technology is one method that is widely used to map and determine the condition of an area using the classification method. Classification is designed to derive thematic information by classifying phenomena based on criteria. Satellite image processing is carried out using the image classification method with cloud computing-based software, namely Google Earth Engine (GEE). The sampling points for classification are evenly distributed in the mangrove area. Apart from mangrove objects, samples were also taken from water objects, urban areas, vegetation, ponds and coastlines. This aims to distinguish mangrove objects from other objects. Based on the results of image processing, the accuracy test obtained on the land cover map is above 85% because the image resolution used is a medium resolution image. The results of the field survey indicated that there was a change in mangrove cover to become ponds which resulted in a reduction in the area of mangrove cover.

Keywords: Mangrove, Change Detection, Landsat, Sentinel, GEE

1. Introduction
Indonesia's potential and diverse coastal areas have been exploited by the Indonesian people as one of the main sources of food, especially animal protein, for centuries. Meanwhile, the wealth of hydrocarbons and other minerals found in coastal areas. Such as mangroves, coral reefs and seagrass beds have also been used to support national economic development. Mangrove forests have economic, ecological and social functions. The economic functions that exist in mangrove forests are producing...
household needs, producing industrial needs, and producing seeds. Its ecological function is to protect
the coastline, prevent seawater intrusion, as a habitat for various bird species, and others [1].
The economic value of global mangrove forests is USD 1.6 billion/year [2]. Mangroves provide various
benefits in the form of fisheries, fiber, animal feed, food, fuel, medicines, tannins, wood, climate control / support, coastal protection, erosion control, safeguarding water quality, as a nutrient cycle, soil stabilization, coral reef support, as well as seagrass beds and provide cultural services for education, heritage, recreation, research to tourism [3].

In the last three decades, Indonesia has lost 40% of its mangroves [4]. This means that Indonesia has the fastest rate of mangrove destruction in the world [5]. Indonesia's mangrove deforestation accounts for 6% of total annual forest loss, even though it only covers less than 2% of the country's total forest area. This amount is equivalent to 0.05 million hectares (Mha) of the total 0.84 Mha of annual deforestation in Indonesia [6].

Mangrove forests in Lampung are along 896 km of the total length of the coast along 1,105 km [7].

Based on the Lampung Provincial Forestry Service, more than 50 percent of the mangrove forests in Lampung Province were damaged. The destruction of mangrove forests in Lampung Province as well as on the East Coast of Lampung is increasingly worrying because more and more mangrove forests have been turned into ponds. Changing the function of mangroves to pond land will worsen the ecosystem and the preservation of living marine biota. Damage to mangrove forests can increase the vulnerability of coastal communities to the risk of storms and high waves. Damage to mangroves will also result in reduced marine life around the forest itself. Based on Law Number 27 of 2007 concerning Management of Coastal Areas and Small Islands, one of which states that the opening of cultivation locations in coastal areas must first obtain permission from the local government.
The mangrove forests in Lampung are 896 km along the total length of the coast along 1,105 km. The existence of mangrove forests that cover about 81% of the Lampung coast can provide various benefits, including being a stabilizer of coastal conditions, preventing abrasion and intrusion of sea water, as a source of diversity of aquatic and non-aquatic biota, as a source of material that can be consumed by the community and others. so on [8]. Land damage in the coastal area of East Lampung Regency has made various parties take various countermeasures, both local and national. These efforts are carried out by provincial and district governments, local communities, non-governmental organizations (NGOs), universities, and others. Efforts to overcome the damage to coastal lands consist of rehabilitation activities for critical lands such as planting mangroves [8].

Information regarding changes in mangrove cover, especially on the coast of East Lampung Regency, needs to be studied, so this research aims to (1) identify changes in mangrove cover on the coast of East Lampung Regency in 1991, 1994, 1999, 2008, 2011, 2015, and 2019. (2) analyze the factors that influence the change in mangrove cover in East Lampung Regency.

2. Research Methods

This research was conducted using the Machine Learning method with the Random Forest algorithm on the Google Earth Engine (GEE). Random Forest (RF) is a method used for classification by building many classification trees where the random data is equally distributed and from each tree the value that appears the most in its class is selected. The generalization error of RF for tree classification depends on the accuracy of each tree in RF and the correlation between them RF can improve accuracy because there is random selection in generating sub-nodes for each node (vertices above) and the classification results from each tree are accumulated, then the classification results are selected that appear the most. The number of trees to be formed greatly affects the accuracy of the classification results. The data that has been collected is then classified by Landcover by conducting training samples in Landsat 5 and Landsat 8 imagery.

The process of remote sensing data extraction includes extraction of mangrove cover with parameters of mangrove density and density, as well as taking information on mangrove cover parameters. Analysis
of spatial heterogeneity in mangrove areas using satellite image technology based on spatial indicators such as coverage density and mangrove density. Identification is done by examining the morphological and spatial location variables.

The classification carried out in the study includes supervised classification using the maximum likelihood method. The application of these two classification methods simultaneously is to accommodate variations in mangrove biofisk information (such as differences in species, differences in percentage of catchment, differences in carbon content, etc.). Supervised classification using the maximum likelihood method is carried out to obtain a mangrove density map at the time of making the mapping unit. The classification results are in the form of area classes which are divided into high density, medium density and low density. Determination of density class is done visually using interpretation key which is then used as ROI in supervised classification. The ROI value is then used as a reference in classifying the image through statistical calculations in the form of mean values and standard deviation as well as variances and covariances.

3. Results and Discussion

This research obtained mangrove density maps, namely 1991, 1994, 1999, 2008, 2011, 2015, and 2019. Land cover can provide information that is very important to know whether it is changes in area of land cover and so on. Changes in land cover can be identified by the presence of a land cover map. In this study, Landsat image processing was carried out on the Google Earth Engine as well as classification, land cover area calculation and layout until a land cover map was obtained. The resulting land cover map is on the east coast of Lampung province in the period 1991, 1994, 1999, 2008, 2011, 2015, and 2019. The resulting land cover map has land cover classifications in the form of ponds, mangroves, vegetation, urban, and beach, and water. In 1991 the pond had an area of 7268.1 Ha, mangroves had an area of 3176.4 Ha, green vegetation had an area of 55944.9, urban had an area of 34575.9 Ha, the coastline had an area of 1146.3 Ha. The following is a map of mangrove density in East Lampung Regency:

![Figure 1. Land Cover 1991](image-url)
In 1994 there was a change in land cover area, the area of ponds increased to 7791.5 Ha, mangrove area decreased to 2189.3 Ha, green vegetation area decreased to 55571.8 Ha, urban area increased to 38409.3 Ha, coastline area decreased to 711.3 Ha.

![Figure 2. Land Cover 1994](image)

In 1999, changes in land cover area continued to occur with the area of ponds increasing to 8980.2 Ha, mangroves whose area increased to 6502 Ha, green vegetation, which also increased to 71134.4 Ha, urban area became 13154.8 Ha, and the coastline area decreased to 479.9 Ha.

![Figure 3. Land Cover 1999](image)
In 2008 the area of ponds increased again to 9634.9 Ha, the mangrove area increased to 6910.7 Ha, the area of green vegetation decreased to 65840.6 Ha, the urban area became 16298.2 Ha, and the coastline area decreased to 3105.6 Ha.

![Figure 4. Land Cover 2008](image)

In 2011 the area of the pond became 7826.6 Ha, mangrove 7476 Ha, green vegetation 53217 Ha, urban 32509.9 Ha, coastline 257.7 Ha.

![Figure 5. Land Cover 2011](image)
In 2015, the area of land cover continued to change with an area of ponds to be 9586.3 Ha, mangrove 9224.8 Ha, green vegetation 54038.6 Ha, urban 24892.5 Ha, coastline 1549.6 Ha. 

Figure 6. Land Cover 2015

In 2019, the land cover changed again with the pond area increasing to 9936.290519 Ha, mangrove 5080.699784 Ha, green vegetation 71745.88641 Ha, urban 14606.86766 Ha, coastline 944.6327003 Ha.

Figure 7. Land Cover 2019
The changes in land cover in the East coast of Lampung Province can be caused by human activity factors and natural factors that occur. The activity of clearing mangrove land into ponds, vegetation land that is used as residential areas, coastal abrasion that erodes the coastline. However, because the mangrove ecosystem is very important for the environment and its impact on natural disasters, currently there are many activities to conserve mangrove forests and green vegetation by replanting which can then affect the occurrence of extensive changes in land cover.

4. Conclusion
Mangrove forests in East Lampung Regency are always changing. In 1991 the mangrove area was 3176.4 Ha, in 1994 it decreased to 2189.3 Ha, in 1999 it was 6501.9 Ha, in 2008 it was 6910.7 Ha, and increased in 2011 to 7476.1 Ha, in 2015 it was 9224.9 Ha, and in 2019 the mangroves had an area covering an area of 5080.7 Ha. Changes in mangrove cover in the eastern coastal area of Lampung Province can occur due to several factors, both human and natural factors. The activity of clearing mangrove land into ponds, vegetation land that is used as a residential area, coastal abrasion that erodes the coastline. However, because the mangrove ecosystem is very important for the environment and its impact on natural disasters, currently there are many mangrove forest preservation activities by planting and rehabilitating mangrove forest areas.

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