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Mapping and monitoring of mangrove density changes on tin mining area

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Abstract

This research discusses about mangrove density mapping and monitoring on tin mining area. The tin mining area refers to unconventional mining, which is a tin mining activity using simple mechanical instrument. Tin mining activity has been long existed in Bangka Belitung, conducted legally and illegally. Tin mining activity makes coastal supporting ecosystems such as mangrove cannot play their role normally. One of the regency in Bangka Belitung, which its coastal area is affected by unconventional mining, is South Bangka. The aim of this study is to monitor and measure the mangrove density changes. This research use Landsat data acquisition from year 1997, 2009 and 2014 through NDVI analysis. The result shows that tin mining activity in South Bangka coastal area causes reduction in mangrove density. The field studies indicated that 4 types of mangrove was found. The types of mangrove are *Avicennia marina*, *Sonneratia caseolaris*, *Rhizopora mucronata*, and *Xylocarpus granatum*. Mangrove management is needed in order to maintain the quality of coastal ecosystem. Moreover, the regulation and monitoring of the mining activity should be issued by the government to support environmental sustainability.

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Keywords: density; mangrove; mapping; tin mining

1. Introduction

Tin mining activity has been long existed in Bangka Belitung, conducted legally and illegally. At the beginning, the tin mining activity take place only in mainland, but now has been expanded to the coastal area. As the impact,

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coastal supporting ecosystems such as coral reefs, sea grasses, marine biotas, even mangrove forests cannot grow and function normally. Yáñez-Arancibia et al. [1] discovered that in a long time, mangrove destruction not only leads to decline in fisheries but also has negative impacts on adjacent sea grasses and coral reefs because of their interconnection.

Mangroves are one of the most important ecosystems of coastal and marine areas. They safeguard the ecology of the coastal areas and provide livelihood opportunities to the fishermen and pastoral families living in these areas. Mangroves also provide indirect benefits through its impact on up gradation of coastal and marine ecosystem. It is well known that coastal population succumbs to disasters of cyclones and Tsunamis, incurring heavy losses to their properties and live-stock. Mangrove plantation along the coast serves as a barrier to cyclones and Tsunamis and protects the people living in coastal areas. Mangroves are considered as one of the fragile ecosystem in coastal areas. Mangroves are unique plants capable of surviving under extreme saline environment. The mangrove ecosystem is highly productive and plays critical role in economic and social development. Mangroves act as a buffer zone between land and sea and protect land from erosion and play an invaluable role as nature's shield against cyclones, ecological disasters and a protector of shorelines. The most favorable mangrove habitats are those having a sheltered environment, muddy soils, good rainfall and temperatures ranging from 26 – 28°C. The endangered mangrove ecosystem has been accepted as a unique biological setup which needs protection and conservation. Mangroves harbor variety of life forms and economically, mangroves are a good source of timber, fuel and fodder and hence are the main source of income generation for shoreline communities like fishermen [2]. Mangrove ecosystem plays a crucial role in costal conservation and provides livelihood supports to humans. It is seriously affected by the various climatic and anthropogenic induced changes. The continuous monitoring is imperative to protect this fragile ecosystem [3].

South Bangka is one of regency in Bangka Belitung where its coastal area is affected by unconventional mining. Unconventional mining activity damages of the mangrove forest. Mining activity causes loss and reduces the mangrove area. This condition makes the mangrove lost its function, in ecological, physical, and economical benefit. Based on these situations, research mangrove density mapping is needed. Research is conducted using remote sensing technique and GIS. Ramasubramanian et al. [4] discovered that remote sensing is used as a tool for monitoring the changes, especially in mangrove forests, because the hilly or swampy terrain is inaccessible and vast. It provides relatively accurate information regarding the status of the vegetation in the forest and is cost effective and time saving. GIS and remote sensing tools are extensively used to understand the changes in mangrove areas and the recordings are used for planning and management.

Remote Sensing and GIS provide quantitative information on understanding the spatial distribution of mangrove forests [5]. Remote sensing technology has been applied in various ways to characterize mangrove ecosystems. Some of the documented applications include mapping the areal extent, detecting individual species, and providing estimates of structure and parameters such as leaf area, canopy height, and biomass [6]. Remotely sensed data is one of the best source of information that can show the location of all areas that have been deforested or degraded or still healthy. Moreover, Landsat Thematic Mapper data can be used to define the degree of degradation of the mangrove forest [7].

Remote sensing technique, due to its synoptic, multi-temporal, coverage and multi-spectral ability in whole range from visible to microwave wavelengths, can effectively act as a tool providing advance and reliable information on mangrove extent and status of its growth along the coastal areas. The reflectance pattern of the vegetation in visible & NIR spectral region gives information on condition of vegetation cover. The various satellite-derived indices such as Normalized Difference Vegetation Index (NDVI) and Ratio of NIR & Red wavelengths can also be effectively used to monitor the vegetation status and condition of the mangrove ecosystem. NDVI is based on the difference between maximum absorption of radiation in red due to chlorophyll and maximum reflection of radiation in NIR due to leaf cellular structure. The combination of red and Infrared (IR) bands along with vegetation indices help in distinguishing between mangroves, swamps and other vegetation in the wetland zones [2]. NDVI is an indispensable model to delineate the vegetation density of the mangrove forest which is useful to identify the health status of forest [8]. The NDVI is developed for estimating vegetation cover from the reflective bands over satellite data. Moreover the created NDVI images can be used to identify the pattern of changes that had occurred between two different dates [9].

The main purpose of this research is to identify the vegetation density in South Bangka mangrove forest using multi-temporal image data. Therefore this paper endeavored to the NDVI images in South Bangka mangrove forest using remote sensing, GIS and field survey. Satyanarayana et al. [10] informed that a combination of ground-survey and remote sensing data was very useful for the assessment of mangrove vegetation types.