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Original research article

Analysis of Changes in Mangrove Vegetation Area Using The Normalized Difference Vegetation Index Method in The Waters of Bungin Permai, South Konawe

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ABSTRACT

Changes around mangrove vegetation in Bungin Permai Waters, Tinanggea District, South Konawe Regency over the last 30 years (1992-2022). Aims to analyze changes in mangrove vegetation areas spatially and temporarily. The research method used remote sensing of Landsat 5 TM, 7 ETM +, and Landsat 8 OLI satellite image data and NDVI method to see changes in mangrove vegetation area, reduced mangrove vegetation area by 75% ranging from 767 Ha. Shows that, along with the reduction in mangrove vegetation area can cause an increase in TSS concentration, the potential for sea level rise to settlements, the absence of sedimentation rate retaining media to the high seas, to the loss of mangrove area animal habitat. The area of mangrove vegetation decreases by 75% or around 767 Ha over time.

Introduction

The estuary is the downstream part of the river associated with the sea. Problems in the estuary can be reviewed in the river mouth or estuary. The mouth of the river is the most downstream part of the river estuary that directly meets the sea. While the estuary is the part of the river that is influenced by tides (Donato *et al*., 2011; Triadmodjo, 1999).

Mangrove ecosystems are transitional ecosystems between land and sea and are known to have various very important roles, both ecological and economic. Ecologically, mangrove forests are a place for fish enlargement (nursery ground) which affects fisheries productivity and nutrient cycles, coastal

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protection from abrasion and tsunamis and binders dissolved sediments in the waters. Various types of fish can be found in the mangrove area (Hewindati *et al*., 2023). Apart from that, it is a habitat for shellfish and produces biomass (Bahtiar *et al*., 2023). Landsat image analysis is commonly used in determining conditions on the surface of the earth by looking at the reflectance and absorption characteristics of electromagnetic waves from objects on the surface of the earth. Remote sensing can be used for geological studies, land use/cover, agriculture, forestry, water resources, wetlands, ecology and environmental impacts (Sabins, 1999; Lillesand *et al*., 1990).

Landsat remote sensing data has spectral channels that can be utilized for a variety of applications related to vegetation, water and soil. Various combinations of spectral channels are used to be utilized according to the objectives to be achieved. Remote sensing acts as one of the initial methods used in mapping for various purposes, especially exploration, this is done because remote sensing can provide a comprehensive initial picture of geological, geomorphological, and other conditions that want to be known (Loekman and Khakhim, 2017; Lantzanakis *et al*., 2016).

Landsat is the oldest satellite on earth launched by the United States. The Landsat 5 TM carries an MSS sensor and a TM sensor. The spatial resolution of Landsat 5 TM includes 30 meters channels 1-5, and 7 and 60 meters channel 6), broadcast coverage of 185 and repeat recordings every 16 days. Landsat 7 satellite imagery is an earth satellite image that has ETM (Enchanced Thematic Mapper) and Scanner that can help for shooting aerial photos. Landsat 7 was launched in April 1999. The use of Landsat 7 satellite imagery is used for land cover mapping, geological mapping, and orbit sea surface temperature mapping. Landsat 8 OLI/TIRS imagery is an image launched by the Americas on XYZ, and has 11 kinds of channels (bands) with spatial resolutions ranging from 15 X 15 meters to 100 X 100 meters (Kristanto *et al*., 2017; Hermawan and Budiono 2008).

Mangrove forests can be identified using remote sensing technology, where the geography of mangrove forests in land and sea transition areas provides a distinctive recording effect when compared to other terrestrial vegetation objects. With this technology, spectral values in satellite images can be extracted into information on mangrove-type objects in the visible and near-infrared spectral ranges (Faizal *et al*., 2005; Suwargana, 2008).

The Normalize Difference Vegetation Index (NDVI) is an index of greenness or photosynthetic activity of vegetation and one of the most frequently used vegetation indices. NDVI is based on the observation that different surfaces reflect different types of light waves. Vegetation that actively performs photosynthesis will absorb most of the red waves of sunlight and reflect the near-infrared waves higher. Dead or stressed (less healthy) vegetation reflects more red waves and less on near-infrared waves (Asmadin *et al*., 2018).

Materials and Methods

Research Location

Data collection will be carried out in April 2023 which includes field data collection (insitu) located in Bungin Permai Waters, Tinanggea District, South Konawe Regency with coordinates 4°29'21.9"S 122°13'02.4"E.

Data Collection

Landsat satellite data used to map changes in mangrove vegetation area in Bungin Permai waters consist of Landsat 5 for 1992, Landsat 7 for 2002 and 2012, and Landsat 8 for 2022. Which consists of 4 data, namely:

1) Data acquired in 1992 during the dry and rainy seasons when it was still a mangrove vegetation area;
2) Data in 2002 on the dry and rainy seasons when it was still a mangrove forest area;
3) Data in 2012 on dry and rainy seasons when mangrove areas were used as pond areas;
4) Data in 2022 on drought and rain as the mangrove area turns into an embankment area.

Landsat satellite data was obtained from https://earthexplorer.usgs.gov, the website of the United States Geological Survey; USGS).

Monthly rainfall data in 1992-2022 was obtained from the Meteorology, Climatology and Geophysics Agency, BMKG. The available data is monthly data from the observation station closest to the research location, namely the Kendari Climatology Station.

Image data processing in this study was carried out using QGis, ENVI, Excel and ArcGIS software.

Data Analysis

Rainfall data from BMKG is used as an analysis consideration in identifying patterns of distribution of rainy and dry seasons.

Classification of mangrove vegetation using NDVI algorithm in equation (1) (Asmadin *et al.*, 2018) with the formula:

NDVI = (NIR-Red)/(NIR+Red)…………(1)

Information:
NIR : Reflectance of the near infrared band for a cell.
RED : Red band reflectance for a cell.

Results and Discussion

The image data processed is image data with different acquisitions, which is taken based on BMKG rainfall data. The downloaded image data represents the highest to lowest rainfall that occurred in a year, so that the highest and lowest rainfall in the year of image data collection. The rainfall data taken is monthly rainfall data during the dry season and rainy season and is taken temporally every 10 years (1992-2022), see Table 1.

Table 1. Landsat Image Acquisition Data

Acquisition data on Landsat satellite imagery 5, 7, and 8 in the rainy season	
a. 14 January 1992 (Landsat 5 TM)	c. 20 from 2012 (Landsat 7 ETM+)
b. 12 July 2002 (Landsat 7 ETM+)	d. August 19, 2022 (Landsat 8 OLI)
Acquisition data on Landsat satellite imagery 5, 7, and 8 in the dry season	
a. 26 September 1992 (Landsat 5 TM)	c. 30 Desember 2012 (Landsat 7 ETM+)
b. 1 November 2002 (Landsat 7 ETM+)	d. 31 Mei 2022 (Landsat 8 OLI)

Reduced density of mangrove trees in the mangrove vegetation area in the Puuwiau River Estuary. In figures 1 and 2 can be seen in detail using the NDVI method, it will be seen that the reduction in the area of mangrove vegetation consists of 2 aspects, namely in the period 1992-2022 there was actually an increase in the area of ponds and at the same time in that period there was also a reduction in the area of change The mangrove area has undergone major changes, a direct survey has been carried out to the research location that the reduction in mangrove vegetation area is due to by massive logging of mangrove areas to be used as pond areas.

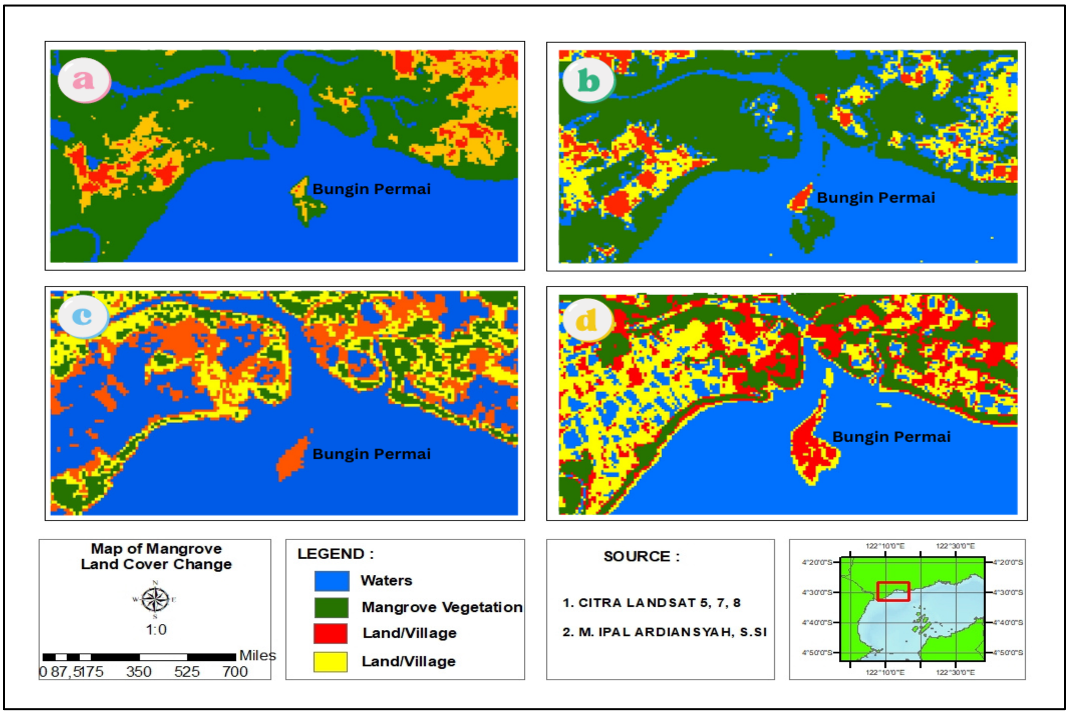

Figure 1. Map of Mangrove Land Cover Change in Bungin Permai Waters in 1992 (a), 2002 (b), 2012 (c), 2022 (d)

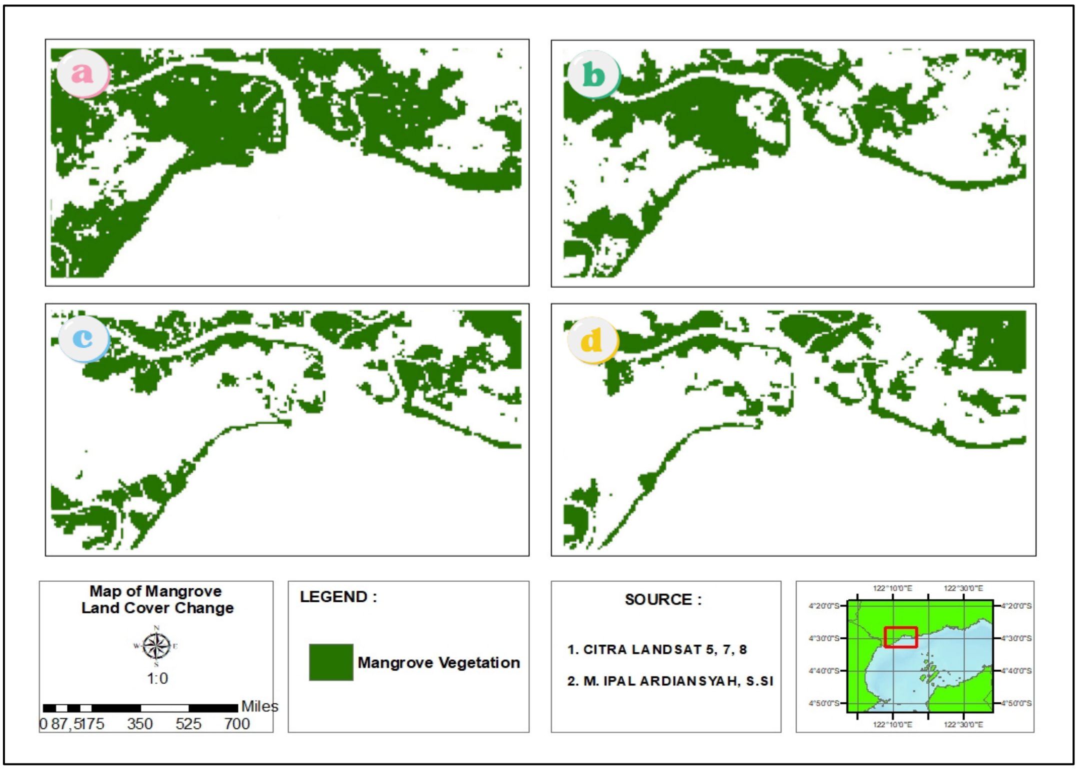

Figure 2. Map of Land Cover of Mangrove Area in Bungin Permai Waters in 1992 (a), 2002 (b), 2012 (c), 2022 (d)

In Figures 1 and 2, it can be seen that the change in mangrove vegetation area from 1992 to 2022 is decreasing. Within 10 years (1992-2002), the mangrove ecosystem in the Puuwiau River Estuary area decreased by around 158 Ha, for the next 10 years (2002-2012) it decreased by around 360 Ha, and for the next 10 years (2012-2022) it decreased by around 219 Ha. Changes in mangrove vegetation periodically can be seen in figure 3 in detail changes in mangrove area.

Table 2. TSS Concentration and Changes in Mangrove Vegetation Area 1992-2022 Using Landsat Image Data.

Year	TSS (mg/L)	Mangrove Speed (Ha)	Mangrove Expansion Change	
			Broad (Ha)	Percentage Change (%)
1992	3.70	1020	1020	100
2002	4.56	862	158	15
2012	3.53	482	538	52
2022	58.01	253	767	75

In Table 2 shows the percentage change in the mangrove area, the trend that occurs in the Puuwiau River Estuary area shows that the decrease in mangrove vegetation area will be followed by an increase in the concentration of TSS in the River Estuary. Rozali (2016) stated that the density of mangroves, especially the type of Rhizophora because the structure of the supporting roots can act as a sediment trap. This also applies to the Puuwiau River Estuary area which consists of Rhizophora, Avicennia, Sonneratia, and Bruguiera mangrove species.

The initial percentage of 100% that from year to year undergoes large-scale changes, it can be seen that the percentage is getting bigger, and the graph is decreasing which shows large and significant changes.

Conclusion

Over 30 years, there has been a change in the area of mangrove vegetation. The area of mangrove vegetation in 1992 in the Puuwiau River Estuary was around 1020 Ha, in 2002 the area of mangrove vegetation decreased to around 862 Ha, in 2012 the area of mangrove vegetation decreased to around 482 Ha, in 2022 the area of mangrove vegetation decreased to around 253 Ha. These changes in area influence the increasing concentration of TSS that occurs around the Puuwiau River Estuary.

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