Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan (2024) 13(2): 322-327

DEPIK
Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan
Journal homepage: www.jurnal.usk.ac.id/depik

Assessing changes in the mangrove ecosystem land area of Tanakeke Island, Takalar Regency, using Landsat 8 imagery

Dwi Rosalina[1,*], Katarina Hesty Rombe[1], Yasser Arafat[1], Khairul Jamil[1], Hawati[1], Anisa Aulia Sabilah[1], Warni[1], Ani Leilani[2], Rezza Ruzuqi[3], Suci Puspita Sari[4], Eva Utami[4]

[1]*Marine Engineering, Maritime and Fisheries Polytechnic of Bone, South Sulawesi, Indonesia.*
[2]*Fisheries Business Expert, AUP, Jakarta, Indonesia.*
[3]*Fisheries Mechanization, Maritime and Fisheries Polytechnic of Sorong, Southwest Papua, Indonesia.*
[4]*Marine Science, University of Bangka Belitung, South Sumatra, Indonesia.*

ARTICLE INFO

Keywords:
Mangrove
Landsat 8
Rewataya village
Unsupervised

DOI: 10.13170/depik.13.2.33697

ABSTRACT

Rewataya Village is situated on Tanakeke Island, within the Takalar Regency. Despite its significance, previous studies have not addressed the mapping of changes in mangrove land area within this locale. The present research aimed to fill this gap by assessing alterations in mangrove land area from 2013 to 2023, alongside examining density and canopy cover conditions. The method employed for mapping changes in land area entailed utilizing the unsupervised method with maximum likelihood classification. Additionally, the assessment of mangrove conditions involved employing plot line transects to determine species density and hemispherical photography methods to evaluate canopy cover. Notably, two types of mangroves, namely *Rhizophora mucronata* and *Rhizophora apiculata*, are prevalent in this village. The mangrove species density in Rewataya Village, Tanakeke Island, is categorized as "good." In addition, the canopy cover in Rewataya Village falls within the classification of "very dense" according to mangrove damage criteria. However, there has been a notable reduction in the mangrove ecosystem area between 2013 and 2023, with a decrease of 42.28 hectares (from 367.13 hectares to 324.84 hectares).

Introduction

Mangroves—a type of tropical or subtropical plant capable of thriving in muddy substrates (Babo, 2020)—form ecosystems known as coastal areas, housing a collection of plants living in the interface between sea and land. In 2017, Indonesia's mangrove ecosystem encompassed a total area of 3,361,261 hectares (Rahadian *et al.*, 2019). These ecosystems serve crucial roles for both humans and associated biota. Mangrove forests function as spawning grounds for various fish species, safeguard coastal areas from erosion, provide natural sustenance, and support diverse biota (Afkar, 2022). The protective role of mangroves against erosion, high waves, and strong winds underscores their significance. Ensuring ecosystem sustainability is likely to yield numerous benefits, including enhanced biodiversity within these ecosystems (Rani *et al.*, 2022).

Mangrove ecosystems are identifiable through the application of remote sensing technology (Kustandiyo *et al.*, 2014). Remote sensing—a non-invasive scientific technique—enables the description of objects without direct physical contact. Employing remote sensing technology facilitates the mapping of mangrove forest areas, offering comprehensive distribution maps of these vital ecosystems within a given region (Shalihati, 2014). The increasing utilization of remote sensing stems from its myriad advantages, including the ability to accurately depict surface objects in their true shape and location (Nurmalasari & Santosa, 2016). Satellite imagery, particularly from the Landsat satellite, is commonly utilized for this purpose. Landsat imagery

* Corresponding author.
Email address: myrafirifky@gmail.com

p-ISSN 2089-7790; e-ISSN 2502-6194
Received 15 August 2023; Received in revised form 30 August 2023; Accepted 9 May 2024
Available online 29 August 2024

Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan
Volume 13, Number 2, Page 321-327

typically boasts a spatial resolution of 30 meters and utilizes L-band SAR classification (Kovacs *et al.*, 2013). This satellite's 16-day temporal resolution and free data retrieval process further enhance its utility. Landsat imagery finds extensive application in various survey and research endeavors, spanning disciplines such as geology, geomorphology, mining, forestry, and land area change analysis.

The utilization of images from 2013 and 2023 was prompted by significant land conversion, which has led to the erosion of a substantial portion of mangrove areas due to extensive logging for charcoal production and conversion of mangrove forests into ponds (Damar *et al.*, 2021). Thus, this study aimed to delineate changes in mangrove ecosystem area and canopy cover using the hemispherical photography method.

Hemispherical photography constitutes a photographic technique employed to assess mangrove canopy cover or terrestrial forest canopy cover through images captured with a camera (Purnama *et al.*, 2020). In this study, a handheld smartphone camera was employed, offering advantages such as real-time accessibility, adaptability to varying cloud cover conditions, and spanning multiple years. The utilization of cell phone cameras for hemispherical photography represents an indirect approach to gauging light transmission. The research was conducted on Tanakeke Island, situated within the Takalar Regency of South Sulawesi.

Tanakeke Island is encircled by mangrove forests, forming a verdant barrier that serves both ecological and economic purposes. Ecologically, these mangroves act as a natural shield, protecting the island from ocean waves and other environmental forces. Economically, they serve as a vital resource, fulfilling the daily needs of the local community. According to a study conducted by the South Sulawesi Marine Conservation Foundation (2015), as cited by Anhar *et al.* (2019), the estimated area of mangrove forest on Tanakeke Island in the early 1980s was approximately 1,770 hectares. However, this area has dwindled over time, with only 500–700 hectares remaining. Hence, the urgency of this research lies in providing a comprehensive overview of the mangrove ecosystem's current condition on Tanakeke Island.

Materials and Methods

Research location and time

This study was conducted from March 13, 2023, to May 10, 2023, at the office of CV Nypa Indonesia. Data collection took place in Rewataya Village, situated on Tanakeke Island, within the Takalar Regency of South Sulawesi, as illustrated in Figure 1.

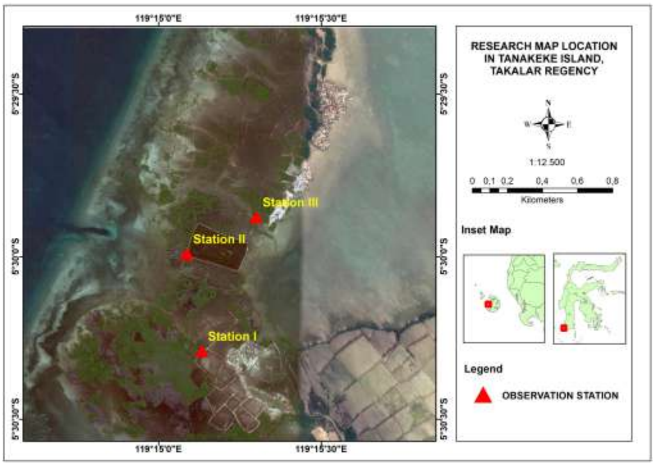

Figure 1. Research location

The selection of this location for data collection was based on its potential to serve as a tourist destination and its capacity to offer benefits to numerous communities.

Data analysis

Mangrove species density

Species density refers to the quantity of a particular species per unit area, calculated using the formula below (Agustini *et al.*, 2016; Indonesia's Minister of Environment Decree No. 201/2004).

$$D_i = \frac{n_i}{A}$$

Where:
D_i = Density of species i (individuals/m^2);
n_i = Number of individual specimens of species i;
A = Total sampling area (m^2).

Canopy cover

The employed method entailed distinguishing between pixel colors representing the sky (white) and those representing mangrove vegetation (black). Canopy cover analysis was conducted by calculating the percentage of mangrove vegetation cover pixels in binary image analysis (Chianucci & Cutini, 2012) using the following formula.

$$C = \frac{P255}{\sum P} \times 100\%$$

Where:
C = Canopy cover percentage (%)
$P255$ = Number of pixels with a value of 255
$\sum P$ = Total number of pixels

Standard criteria for mangrove damage

Indonesia's Minister of Environment Decree No. 201/2004 outlines three categories based on mangrove canopy cover, as presented in Table 1.

Table 1. Standard criteria for mangrove damage

Conditions	Criteria	Cover (%)	Density (trees/ha)
	Very dense	≥ 75	≥ 1500
Good	Medium	≥ 50 – < 75	≥ 1000 – < 1500
Damage	Rare	< 50	< 1000

Results

Mangrove species density

Based on observations of mangroves on Tanakeke Island, particularly in Rewataya Village, two types of mangroves were identified: *Rhizophora mucronata* and *Rhizophora apiculata*. *Rhizophora mucronata* was observed in three stations, whereas *Rhizophora apiculata* was exclusively found at station 2. The characteristics of station 1 differ from those of stations 2 and 3. Station 1 is situated directly adjacent to the sea and is distant from residential settlements, while station 2 serves as a route for fishing boats to the sea. Station 3, on the other hand, is close to residential areas and is utilized by surrounding residents as a docking area for boats.

Table 2. Mangrove species density

Mangrove species	Trees (individuals) / ha	Saplings (individuals) / ha	Condition
R. mucronata	3100	1400	Good
R. mucronata	1667	467	Good
R. apiculata	533	500	Rare
R. mucronata	900	4233	Good

The calculation of sapling rates is presented in Table 2. The table indicates that the highest density value is recorded for *Rhizophora mucronata*, with 4233 trees per hectare at station 3, followed by station 1, also with *Rhizophora mucronata*, at 1400 trees per hectare. *Rhizophora apiculata* registers a density of 500 trees per hectare at station 3.

Canopy cover

Observations revealed the presence of two mangrove species in the plot, namely *Rhizophora mucronata* and *Rhizophora apiculata*. Utilizing the hemispherical photography method, differing mangrove canopy cover values were obtained for the three stations. Station 1 exhibited a canopy cover of 81.10%, station 2 recorded 80.97%, and station 3 registered 79.83%. These results are depicted in Figure 2. According to Indonesia's Ministry of Environment Decree No. 201/2004 and referring to standard criteria for mangrove damage, the condition is classified as "very dense" when canopy cover exceeds 75%.

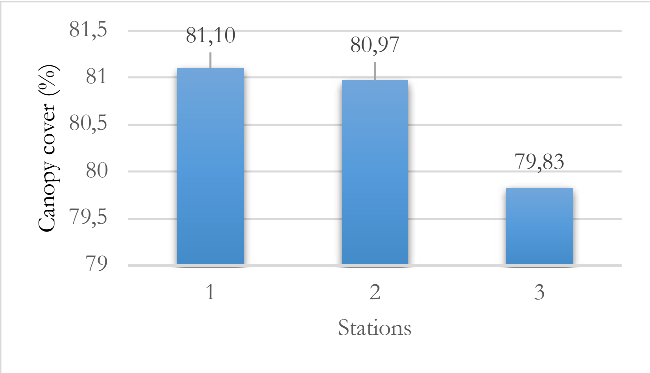

Figure 1. Results of canopy cover analysis

Changes in mangrove land area

The mangrove ecosystem of Tanakeke Island, specifically Rewataya Village, is currently undergoing a decline compared to its condition in 2013. This decline can be attributed to several factors, primarily anthropogenic activities such as land conversion for cultivation or residential purposes, as well as the expansion of the charcoal industry, leading to a reduction in mangrove land (Purwanti, 2020). Changes in land use manifest as fluctuations in the area of land utilization, as illustrated in Table 3.

Table 3. Changes in land area

Land Cover	Area in 2013 (ha)	Area in 2023 (ha)	Change (ha)	Note
Mangroves	367.13	324.84	– 42.28	Decrease
Settlement	12.62	15.78	+ 3.15	Increase
Pond	285.11	324.24	+ 39.12	Increase

Table 3 highlights the changes in the mangrove ecosystem from 2013 to 2023, revealing a decrease of 42.28 hectares (from 367.13 hectares to 324.84 hectares) in mangrove coverage. Conversely, ponds experienced a notable increase of 39.12 hectares (from 285.11 hectares to 324.24 hectares), while settlements expanded by 3.15 hectares (from 12.62 hectares to 15.78 hectares). Overlaying the classifications from 2013 and 2023 unveils the alterations in mangrove areas. The analysis utilizes a band combination of red, green, and blue bands, along with additional panchromatic bands for image sharpening. Figure 2 illustrates these changes, depicting both additions and reductions in mangrove land, as well as the survival of mangrove patches from 2013 to 2023.

Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan
Volume 13, Number 2, Page 321-327

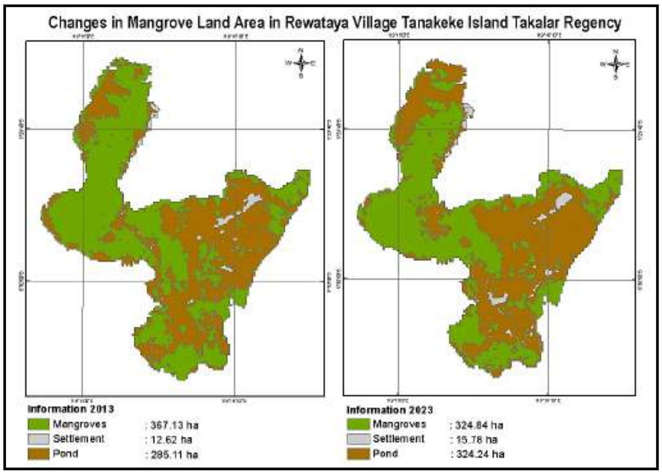

Figure 2. Changes in mangrove land area in 2013 (A) and 2023 (B)

Discussion

Takalar Regency—situated in South Sulawesi Province—occupies coordinates between 119°14'22"–119°20'29" E and 5°26'43"–5°32'24" S. Known for its expansive mangrove forests, Takalar Regency stretches along the western coast of the Makassar Strait to the southern shores of the Flores Sea, with Patallassang serving as its capital. With a coastline spanning approximately 74 kilometers, Takalar Regency boasts significant potential in the marine sector, particularly in mangrove forestry. Apart from that, Tanakeke Island, encompassing an area of 43.12 km^2, falls under the category of small islands (Setiawan, 2016) and is administratively part of the Tanakeke Islands District. Characterized by lowland topography with slopes ranging from 0 to 8% (Setiawan *et al*., 2017), the island comprises five villages: Maccini Baji, Mattiro Baji, Balangdatu, Tompotana, and Rewataya. For this research, Rewataya Village was selected as the study site. Administratively, Rewataya Village is situated at coordinates 5°29'24.000" S and 119°15'36.000" E and comprises three stations.

This study examined mangrove species density across different levels, specifically tree and sapling levels. Among all stations, the highest tree-level density was observed at station 1, dominated by 3100 saplings per hectare, followed by 1667 saplings per hectare at station 2 and 900 saplings per hectare at station 3. Analysis of substrate data collected at each station revealed the presence of muddy and sandy substrates, which are conducive environments for the growth of *Rhizophora mucronata* (Aswin *et al*., 2021). Fitra (2022) suggests that the high density of mangroves may be attributed to the sandy and muddy soil substrates, facilitating the adaptation and successful propagation of *Rhizophora mucronata* seeds at the observation sites. Tabba *et al*. (2015) emphasized the high adaptability of *Rhizophora apiculata*, attributing it to its robust root system that firmly anchors into the soil, featuring numerous branching structures with air pockets. However, *Rhizophora apiculata* exhibits reduced growth in substrates with low or hard silt content, preferring muddy, fine, and deep soils typically inundated during normal tides (Amin *et al*., 2015). Shofanduri *et al*. (2018) further noted that while *Rhizophora mucronata* shares habitat areas with *Rhizophora apiculata*, it demonstrates greater tolerance to harder substrates and sandy conditions. These findings are summarized in Table 2.

Kuncahyo *et al*. (2020) highlight that variations in mangrove density across different regions are influenced by aquatic environmental conditions, substrate types, and human activities surrounding mangrove vegetation. Following Indonesia's Minister of Environment Decree No. 201/2004, which establishes standard criteria and guidelines for assessing mangrove damage, the total species density values indicate that mangrove conditions at stations 1 and 3 are classified as "good." However, at station 2, where *Rhizophora apiculata* is rare, the mangrove condition is categorized as "rare," indicating a need for rehabilitation efforts by the community and relevant stakeholders. These findings are summarized in Table 2.

Based on the canopy cover results depicted in Figure 3, Rhizophora species—known for their broad leaf morphology with sizes ranging from 9 to 20 cm—tend to exhibit extensive canopy cover. However, the observed percentage of mangrove canopy cover is relatively low due to the sparse presence of individual mangroves at the study site, rendering them rare or less abundant. Consequently, gaps in the tree canopy emerge as individual mangroves are widely spaced apart. The tree canopy serves as a natural barrier, intercepting and dispersing sunlight and rain. Insufficient sunlight exposure can impede sapling growth, as taller trees foster optimal tree growth (Kuncahyo *et al*., 2020). Furthermore, Nurdiansah & Dharmawan (2018) emphasize that the percentage of mangrove canopy cover is influenced by tree density categories and the suitability of environmental characteristics.

Ecosystem degradation stems from the local perception that mangrove areas are public property open for unrestricted resource exploitation, leading to extensive damage (Setiawan, 2017). The reduction in mangrove coverage is attributed to the reliance of local communities on mangrove forests. Large-scale logging for charcoal production and land conversion for pond construction further exacerbate mangrove degradation (Setiawan, 2015). This assertion is supported by Hidayat *et al.* (2020), who detailed that the degradation in Tanakeke stemmed from pond construction, extensive logging for charcoal production, and various other land uses. As a result, detrimental consequences arise, including heightened flooding occurrences, embankment degradation, and coastal erosion exacerbated by rising sea levels (Setiawan & Larasati, 2016). Hermawan *et al.* (2018) further underscored that heightened awareness of mangrove ecosystems' importance has prompted individuals to abandon disused ponds in favor of mangrove replantation efforts, recognizing the crucial role of mangroves in environmental preservation.

Conclusions

Across all stations, two predominant mangrove species were identified, namely *Rhizophora mucronata* and *Rhizophora apiculata*, exhibiting the highest density at the tree level. The canopy cover, reaching 81.10%, falls within the "very dense" category. From 2013 to 2023, the mangrove ecosystem experienced a decrease of 42.28 hectares (from 367.13 hectares to 324.84 hectares) due to land conversion for pond construction, extensive logging for charcoal production, and other purposes. These findings underscore the critical importance of effective management and utilization of mangrove conservation areas, particularly in enhancing community livelihoods and promoting them as tourist destinations. Such considerations are crucial for the sustainable preservation of mangrove ecosystems.

Acknowledgments

The authors extend gratitude to the government of Takalar Regency for granting research permits on Tanakeke Island, particularly in Rewataya Village.

References

Afkar. 2022. Karakteristik Mangrove dan Pemanfaatannya oleh Masyarakat. Media Sains Indonesia, p75.

Agustini, N.T., Z. Ta'alidin, D. Purnama. 2016. Struktur komunitas mangrove di Desa Kahyapu Pulau Enggano. Jurnal Enggano, 1(1): 19-31.

Amin, D. N., H. Irawan, A. Zulfikar. 2015. Hubungan Jenis Substrat dengan Kerapatan Vegetasi *Rhizophora Sp.* di Hutan Mangrove Sungai Nyirih Kecamatan Tanjungpinang Kota Tanjungpinang. Repository Umrah, 1(1): 1-15.

Anhar, F.P., Hidayat, A., Ekayani, M. 2019. Analisis nilai manfaat dan kerugian dari pemanfaatan ekosistem mangrove di Pulau Tanakeke, Sulawesi Selatan. Jurnal Sosial Ekonomi Kelautan Dan Perikanan, 14(1): 1-12.

Aswin, A. Damar, G. Yulianto. 2021. Kondisi vegetasi dan perubahan tutupan lahan ekosistem mangrove Pulau Tanakeke Kabupaten Takalar Provinsi Sulawesi Selatan. Jurnal Ilmu dan Teknologi Kelautan Tropis, 13(2): 305-318.

Babo, P.P., C.F.A. Sondak, J.J.H. Paulus, J.N.W. Schaduw, P.A. Angmalisang, A.N. Wantasen. 2020. Mangrove community structure at Bone Baru Village, SubDistrict of North Banggai, District of Banggai Sea, Central Sulawesi. Jurnal Pesisir dan Laut Tropis, 8(2): 92-103.

Baderan, D. W. K. 2017. Keanekaragaman jenis tumbuhan mangrove di kawasan pesisir Tabulo Selatan, Kabupaten Bualemo, Provinsi Gorontalo. Prosiding Seminar Universitas Lambung Mangkurat, 1: 41–44.

Chianucci, F., A. Cutini. 2012. Fotografi hemispherical digital untuk memperkirakan sifat kanopi hutan: kontroversi dan peluang saat ini. IForest-biogeosciences and Forestry, 5(6): 290.

Damar, A., G. Yulianto. 2021. Kondisi vegetasi dan perubahan tutupan lahan ekosistem mangrove Pulau Tanakeke Kabupaten Takalar Provinsi Sulawesi Selatan. Jurnal Ilmu dan Teknologi Kelautan Tropis, 13(2): 305-318.

Danoedoro, P. 2012. Pengantar Penginderaan Jauh Digital. Penerbit Andi: Yogyakarta.

Dharmawan, I.W.E., Pramudji. (2017) Kajian Kondisi Kesehatan Ekosistem Mangrove di Kawasan Pesisir Kabupaten Lampung Selatan. COREMAP-CTI Pusat Penelitian Oseanografi LIPI. Jakarta.

Dharmawan, I.W.E., Pramudji. 2017. Panduan Pemantauan Komunitas Mangrove. Pusat Penelitian Oseanografi LIPI. Jakarta.

Fitra, R.A. 2022. Kondisi ekosistem mangrove di Kecamatan Wundulako Kabupaten Kolaka. Jurnal Ilmu Alam dan Lingkungan, 13(2): 17-24.

Hermawan, A., H. Setiawan. 2018. Kearifan Lokal Masyarakat Pulau Tanakeke dalam Mengelola Ekosistem Mangrove. Balai Litbang Lingkungan Hidup Dan Kehutanan Makassar, 15(1): 53–64.

Hernoza, F., B. Susilo, A. Erlansari. 2020. Pemetaan daerah rawan banjir menggunakan penginderaan jauh dengan metode normalized difference vegetation index, normalized difference water index dan simple additive weighting (Studi Kasus: Kota Bengkulu). Rekursif: Jurnal Informatika, 8(2): 144-152.

Hidayat, R., Amal, Suprapta. 2020. Analisis perubahan hutan mangrove dan faktor-faktor yang mempengaruhinya di Pulau Tanakeke Kabupaten Takalar. Journal of Environmental Science, 3(1): 88-99.

Jamil, K., K.H. Rombe. 2022. Mangrove vegetation, Tampara Village, South Kaledupa District, Wakatobi Regency, Southeast Sulawesi Province. Berkala Perikanan Terubuk, 50(1):1384-1393.

Kartikasari, AD., M.S. Bangun. 2015. Analisis persebaran ekosistem hutan mangrove menggunakan citra landsat-8 di Estuari Perancak Bali. GEOID, 11(1): 1-8.

Kementrian Lingkungan Hidup. 2004. Keputusan Menteri Negara Lingkungan Hidup Nomor: 201 Tahun 2004 Tentang Kriteria Baku dan Pedoman Kerusakan Hutan Mangrove. Jakarta.

Kovacs, J., X. Lu, F. Flores-Verdugo, C. Zhang, F. Flores de Santiago, X. Jiao. 2013. Applications of alos palsar for monitoring biophysical parameters of degraded black mangrove (Avicennia germinans) forest. J. Photogram. Rem. Sens, 82: 102–111.

Kucahyo, I., R. Pribadi, I. Pratikto. 2020. Komposisi dan tutupan kanopi vegetasi mangrove di perairan Bakauheni Kabupaten Lampung Selatan. Journal of Marine Research, 9(4): 444-445.

Kustandiyo, H., B.M. Sukojo, E. Parwati. 2014. Studi tingkat kerapatan mangrove menggunakan indeks vegetasi. Jurnal Geoid, 9(2): 101-107.

Lukiawan, R., E.H. Purwanto, M. Ayundyahrini. 2019. Standar koreksi geometrik citra satelit resolusi menengah dan manfaat bagi pengguna. Jurnal Standardisasi, 21(1): 45-54.

Maulani, A., N. Taufiq-SPJ, I. Pratikto. 2021. Perubahan lahan mangrove di Pesisir Muara Gembong, Bekasi, Jawa Barat. Journal of Marine Research, 10(1): 55-63.

Nurdiansyah, D., I.W.K. Dharmawan. 2018. Community Mangrove Alas Purwo National Park, Bayuwangi: National Parks Nature Center Purwo Bayuwangi, pp. 32.

Nurmalasari, I., S.H.M.B. Santosa. 2016. Pemanfaatan citra sentinel-2a untuk estimasi produksi pucuk teh di sebagian Kabupaten Karanganyar. 4(4): 1–11.

Purnama, M., Pribadi, R., Soenardjo, N. 2020. Mangrove canopy cover analysis using hemispherical photography method in Betahwalang

Village, Demak Regency. Journal of Marine Research, 9(3): 317-325.

Purwanti, R. 2020. Economic valuation of mangrove forest in Tanakeke Island, Takalar District, South Sulawesi Province. Buletin Eboni, 2(1): 25–34.

Rahadian, A., L.B. Prasetyo, Y. Setiawan, K. Wikantika. 2019. Tinjauan historis data dan informasi luas mangrove Indonesia. Jurnal Media Konservasi, 24(2): 163-178.

Rahayu, D. Candra. 2014. Koreksi radiometrik citra landsat-8 kanal multispektral menggunakan top of atmosphere (toa) untuk mendukung klasifikasi penutupan lahan. In Seminar Nasional Penginderaan Jauh: Deteksi Parameter Geobiofisik dan Diseminasi Penginderaan Jauh, pp. 762–767.

Rani, S. T., I.G. Yudha, R. Caesario, S.A.H. Mahardika. 2022. Status keberlanjutan pengelolaan ekosistem mangrove di Kabupaten Tangerang. AQUACOASTMARINE: Journal of Aquatic and Fisheries Sciences, 1(1): 7-15.

Riefani M.K., M. Arsyad. 2019. Bird species in mangrove ecotourism mangrove Pagatan Besar, Tanah Laut Regency, Indonesia. Prosiding Seminar Nasional Lingkungan Lahan Basah, 4(1): 192-196.

Rodiana L., F. Yulianda Sulistiono. 2019. Kesesuaian dan daya dukung ekowisata berbasis ekologi mangrove di Teluk Pangpang, Banyuwangi. Journal of Fisheries and Marine Research, 3(2): 194-205.

Setiawan, H., D.A. Larasati. 2016. Kontribusi ekosistem mangrove dalam mendukung pembangunan wilayah pesisir dan pulau kecil: Studi kasus di Pulau Tanakeke Kabupaten Takalar Sulawesi Selatan. In Prosiding Seminar Nasional Mengawal Pelaksanaan SDGs Surabaya, 153-162 pp.

Setiawan, H. 2015. Studi pengelolaan hutan mangrove sebagai bahan baku industri arang di Pulau Tanakeke Kabupaten Takalar Sulawesi Selatan. Seminar Nasional Sweindu BPTHHBK, 1-11. Mataram, 1 Oktober 2015.

Setiawan, H. 2016. Strategi Coping masyarakat pulau kecil dalam menghadapi dampak perubahan iklim. In Prosiding Seminar Nasional Geografi UMS. Surakarta: Muhammadiyah University Press, 288-298 pp.

Setiawan, H., R.I. Purwanti, R. Garsetiasih. 2017. Persepsi dan sikap masyarakat terhadap konservasi ekosistem mangrove di Pulau Tanakeke, Sulawesi Selatan. Jurnal Penelitian Sosial dan Ekonomi Kehutanan, 14(1): 57-70.

Shalihati, S. F. 2014. Pemanfaatan penginderaan jauh dan sistem informasi geografi dalam pembangunan sektor kelautan serta pengembangan sistem pertahanan negara maritim. Geo Edukasi, 3(2): 115-126.

Shofanduri, A., Lianah, R.A. Hariz. 2018. Perbandingan kualitas tanah di Pantai Alasdowo Kabupaten Pati dengan Pantai Mangunharjo Kota Semarang sebagai media pertumbuhan mangrove *Rhizophora sp*. J Biol Educ, 1(2): 151-165.

Sidik, F., W. Nuryani, R.Z. Abdul, J.H. Jejen, P.K. Hanggar, I. Fikrul. 2018. Panduan Mangrove Estuari Perancak. Bali (ID). Balai Riset Observasi Laut. 50p.

Simanjuntak, B.C., R. Juliani. 2016. Aplikasi citra landsat 8 oli untuk menganalisa kerapatan vegetasi mangrove di Pesisir Kabupaten Langkat. EINSTEIN (e-Journal), 4(1): 1-6.

Tabba, S., N.I. Wahyuni, H.S. Mokodompit. 2015. Komposisi dan struktur vegetasi mangrove tiwoho di Kawasan Taman Nasional Bunaken. Jurnal Wasian, 2(2): 95-103

Wirandha F.S., Marwan, Nizamuddin. 2015. Klasifikasi penggunaan lahan menggunakan citra satelit spot-6 di Kabupaten Aceh Barat Daya dan Aceh Besar. Seminar Nasional dan Expo Teknik Elektro.

How to cite this paper:
Rosalina, D., K.H. Rombe, Y. Arafat, K. Jamil, Hawati, A.A. Sabilah, Warni, A. Leilani, R. Ruzzuqi, S.P. Sari, E. Utami. 2024. Changes in Land Area of Mangrove Ecosystem Using Landsat 8 in Tanakeke Island, Takalar Regency. Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan, 13(2): 321-327.