

# Vegetation Index and Mangrove Forest Utilization through Ecotourism Development in Dodola and Guraping of North Maluku Province

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## Abstract

*This study analyzes the vegetation index and mangrove forest utilization through ecotourism development in Guraping and Dodola Island of North Maluku Province. This research uses a remote sensing approach through Landsat 8 Operational Land Imagery (OLI) from 2013 and 2021, calculated based on the normalized difference vegetation index (NDVI) algorithms. This study indicates that ecotourism development can preserve the mangrove forest and generate economic and social benefits for the local community. Otherwise, the vegetation index in mangrove areas from 2013 to 2021 needs to be considered seriously as the primary data to optimize the management of tourism destinations. In the case of Dodola Island, the increased number of vegetation in 2017 experienced significant changes and threatened the sustainability of mangrove ecotourism. Thus, the mangrove monitoring needs to be optimized to anticipate the unsustainability of mangroves, which determines the sustainability of tourism in North Maluku Province. This study offers an idea to involve the local community in conserving the mangrove area through a controlled and sustainable rehabilitation program instead of economic activity purposes. The findings indicate that the existing condition of the Guraping mangrove forest in 2021 is classified as moderate compared with mangrove ecotourism in Dodola Island with sparse criteria based on the Decree of the Minister of State for the Environment in 2004. This research suggests adopting the community-based ecotourism mangrove development through collaborative advantages of all tourism stakeholders.*

*Keywords: ecotourism, mangrove, NDVI, remote sensing*

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## Introduction

Mangrove preservation through the ecotourism approach is one of the popular development concepts because it combines the concept of zoning for mangrove forest rehabilitation with tourism activities. It benefits the ecological aspect and benefits economically and socially. However, only a few studies consider fluctuations in the value of the mangrove vegetation index annually to determine the restoration or rehabilitation program for sustainability. Therefore, this study offers an insight using the geographic information system (GIS) approach through remote sensing techniques based on Landsat 8 Operational Land Imagery (OLI) satellite imagery data to identify changes in mangrove vegetation index through the normalized difference vegetation index (NDVI). Furthermore, managers of mangrove ecotourism destinations can recognize the lowest vegetation index annually and prioritize the rehabilitation, conservation, or restoration programs towards sustainability.

This research develops previous research by focusing on remote sensing for mangrove ecotourism studies. The study of mangrove forest management needs to be approached inclusively by considering the relevance of models to

interdisciplinary theoretical concepts. Singgalen et al. (2021) show that changes in the vegetation index value based on the NDVI calculation can be related to the criteria for damage to mangrove forests under the Decree of the Minister of State the Environment Number 201 of 2004. In addition, previous research showed the correlation between vegetation index and mangroves' existing condition in mangrove ecotourism destinations (Purwanto & Eviliyanto, 2022). Previous findings attempt to discuss the NDVI calculation result with the shape of the mangroves in the contextual region of Indonesia. However, the vegetation index calculation needs to be discussed in-depth with the socio-economic, socio-cultural, and socio-ecological dimensions. Thus, the findings will also describe community awareness through the ecological interest for mangrove preservation in various approaches, including ecotourism.

The health of mangrove forests is essential for mangrove ecotourism in Indonesia. Kawamuna et al. (2017) reported remote sensing approach becomes relevant to analyzing the distribution of mangrove communities in a wide range, thus facilitating the process of monitoring the health of mangrove forests. The surrounding community can optimize healthy mangroves to bring social and economic benefits. One

approach to the protection and maintenance of mangrove forests that are effectively developed in Indonesia is mangrove ecotourism, which can increase public awareness and participation in collaboration to maintain the ecological sustainability of mangroves. Wijaya and Huda (2018) stated that mangrove ecosystems need to be classified based on each mangrove type and family. Furthermore, the research location will be held in Guraping and Dodola mangrove ecotourism areas in North Maluku by considering the possibility of a study on changes in the index and mangrove ecotourism areas using remote sensing approach province, Indonesia.

The latest progress of mangrove ecotourism studies in Dodola Island, Morotai Island Regency, is exclusive in studying the ecology of coral reefs, seagrass communities, and mangroves compared to economic and socio-cultural studies (Nurafni & Nur, 2017; Koroy et al., 2018; Idrus & Kusman, 2021). Idrus and Kusman (2021) reported that the type and family of Mangrove dominate in Dodola Island is *Ceriops decandra*, with 177 trees and 755 seedlings in every zone. Otherwise, the rare type and families of mangroves in Dodola Island are *Rhizophora apiculata* and *Lumnitzera racemosa*. In addition, the development of tourism infrastructure in 2016–2017, such as the wood bridge in mangrove areas, intervenes the growth process of mangroves. In the context of Dodola Island tourist destinations, it is essential to map the mangrove forests based on zoning and changes in the vegetation index value in each zone from 2013 to 2021 to identify various indications of damage to mangrove areas caused by tourism infrastructure development. Thus, the findings recommend the contextual approach for mangrove ecotourism development on Dodola Island. The relevant process will increase the social, economic, and ecological benefits and enhance sustainable ecotourism.

The latest progress in mangrove ecotourism studies in Guraping, Oba Utara, Tidore Islands Regency, near Sofifi as the capital city of North Maluku Province, is limited on ecological dimension (Angkotasana & Daud, 2016; Nurafni & Nur, 2017). Mahmud (2018) shows that studies on mangroves in Guraping are still limited, even though the distribution of mangroves in Guraping has an area of 151.3 ha, which grows along with Tanjung Sora Gosale hills, as far as  $\pm 6.7$  km. Furthermore, as the responsible technical agency, the North Maluku Provincial Forestry Service has collaborated with the Guraping Village and the younger generation of the local community (*karang taruna*) to develop the Guraping mangrove forest area based on an ecotourism approach to gain economic and social benefits. Nurdiansah and Dharmawan (2018) shows that *Sonneratia alba* has an importance value index of 134.31%, while *R. apiculata* and *Avicennia lanata* have an importance value index of 79.50% and 48.00%. In the context of Guraping, it is necessary to analyze changes in the vegetation index of the mangrove area from 2013 to 2021 and then explore in-depth the collaborative approach between the government and the community in developing mangrove ecotourism for socio-economy and ecological sustainability.

Recent research on mangrove ecotourism on Dodola Island and Guraping, Oba Utara, Tidore Islands Regency is

the main reason for studying the vegetation index and mangrove forest utilization ecotourism development in North Maluku Province. The lack of studies on mangrove ecotourism with an interdisciplinary approach indicates a research gap in methodology, empirical findings, and theoretical contribution. The GIS approach, incredibly remote sensing in mangrove ecotourism areas, should also be discussed with the socio-cultural and socio-economic dimensions of the local community. This research will regularly analyze the changes in the vegetation index (2013–2021), efforts to optimize mangrove forest resources for sustainable livelihoods, and the community's contribution to maintaining ecological sustainability.

## Methods

This study uses a GIS approach, namely remote sensing techniques, to analyze changes in the vegetation index value of the mangrove area at the research location. Furthermore, the perspective of sustainable ecotourism is used to comprehensively analyze matters related to efforts to optimize mangrove forest resources for the ecological, economic, and socio-cultural sustainability of local communities. This research was held in the Guraping mangrove tourism destination of Tidore Islands Regency and Dodola Island of the Morotai Regency. Meanwhile, the flow of this research can be seen in Figure 1.

Figure 1 shows that the flow of this research is divided into three stages, namely the pre-processing stage, processing stage, and analyzing and reporting phase. In the pre-processing step, Landsat 8 OLI was downloaded from the United States geological survey (USGS) website. Furthermore, the raster data is processed using the QGIS 3.20 application using the semi-automatic classification plugins (SCP) to Apply DOS 1 atmospheric correction on each previously downloaded band. The corrected raster from 2013–2021 is set with the coordinate reference system World Geodetic System (WGS) 84 or Universal Transverse Mercator (UTM) zone 52N. Also, the polygon shapefile draws based on mangrove ecotourism areas on Dodola and Guraping Islands.

In the processing stage, each raster data is calculated using the NDVI algorithm and then cropped according to the previously shaded polygon shapefile data. Furthermore, the raster data computed using the NDVI algorithm is set to label precision, mode, and color ramp. After completing the calculations and masking the 2013–2021 raster data layer, proceed with the print layout of the mapping results of the 2013 and 2021 index value changes according to the map standard (title, scale bar, north arrow, and legend).

In the analysis and reporting stage, the results of raster data calculations based on changes in the vegetation index value of the mangrove area in Guraping and Dodola from 2013 to 2021 are visualized in graphic form. The maximum, average, and minimum values are discussed with the criteria for damage to mangrove forests based on the mangrove damage standard criteria by the Ministry of Environment and Forestry 2004. In addition, identifying criteria for damage to mangrove forests in Dodola and Guraping will be analyzed in-depth based on an inclusive, sustainable eco-tourism perspective, considering socio-cultural, socio-economic,

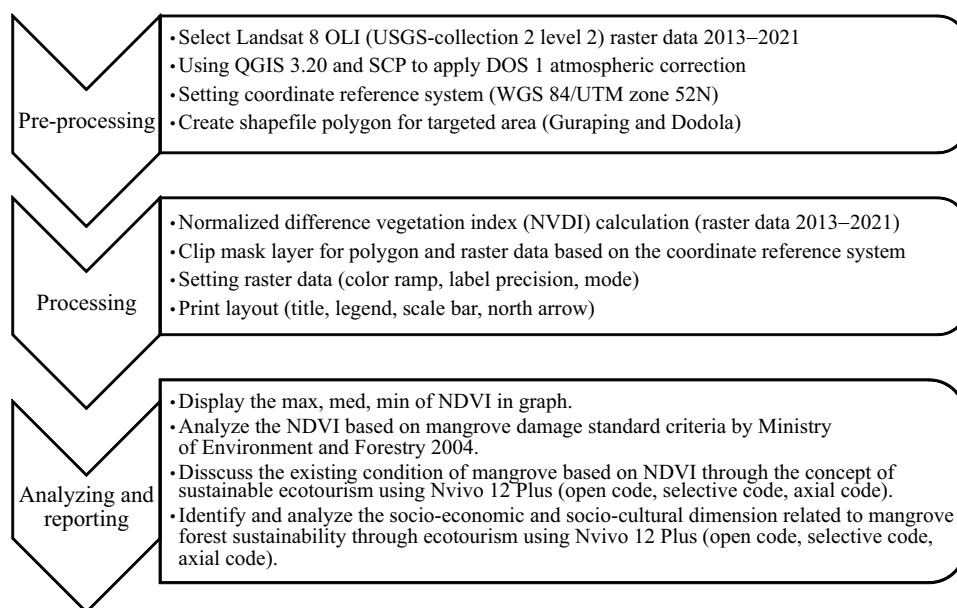


Figure 1 The research flow.

and socio-ecological conditions in-depth using Nvivo 12 Plus (open code, selective code, and axial code). Also, visualize and discuss the challenges and opportunities of developing ecotourism in Dodola and Guraping using a project map in Nvivo 12 Plus.

## Results and Discussion

The discussion in this study is divided into three main topics: first, the vegetation index of the mangrove area of Dodola Island in 2013–2021; second, the vegetation index of the mangrove area of Guraping Island in 2013–2021; index of vegetation and mangrove forest utilization through ecotourism development. Thus, a comprehensive description can be obtained of changes in the vegetation index and the development of mangrove ecotourism in North Maluku Province.

### Index vegetation of Dodola mangrove area 2013–2021

The development of mangrove ecotourism on Dodola Island has provided social and economic benefits for the surrounding community, one of which is the Kolorai Island community. The dominant source of livelihood for the people of Kolorai Island is fishing. Through the catch of fish that is sold to intermediaries or sold directly to the market, the people of Kolorai Island are able to maintain a sustainable livelihood. If explored in-depth, the family livelihood of the people on Kolorai Island can be traced based on the role of husband and wife in meeting the daily needs of clothing, food, and shelter. The activities of men that tend to be found are fishing activities, while the activities of women that can be found are related to processing catches. Meanwhile, children can be classified based on their roles and activities based on age and gender, where young children are still under the supervision of their mothers. In contrast, teenagers and young people can be creative according to their talents and abilities to support their parents' work or produce products independently according to creativity. The livelihoods of the people of Kolorai Island have changed along with the

development of tourism in the Morotai Island Regency, one of which is by optimizing the development of mangrove ecotourism on Dodola Island.

The people of Kolorai Island have experienced changes in their livelihoods since tourism activities. Through collaboration in various human resource capacity-building programs organized by local governments and universities, the people of Kolorai Island have begun to develop the village's potential into a tourist village that provides homestay facilities for tourists. Tourists visiting Dodola Island can stay on Kolorai Island and participate in the livelihood activities of the Kolorai Island community. Tourist visits from Dodola Island to Kolorai Island are still limited to special interest tourism activities, where tourists intend to spend time on small islands, get to know the socio-cultural dimensions of local communities, and the livelihoods of coastal and island communities. It shows that the development of mangrove ecotourism on Dodola Island has implications for improving the social and economic welfare of the surrounding community.

The policy of developing mangrove ecotourism on Dodola Island is a local-regional government program and the ministry of tourism and creative economy program. The development program of mangrove-ecotourism on Dodola Island is also embodied in the determination of the Morotai Island Regency as one of the national priority tourism destinations in Indonesia and a *kawasan ekonomi khusus* (KEK), which is set on July 1, 2018. The implications of this policy on infrastructure development budget support encourage the development of accessibility, accommodation, and amenities in Morotai Island Regency. In terms of accessibility, access to information, and the availability of sea transportation modes to support tourism activities from the port of Daruba to Dodola Island and other small islands have become more effective and efficient. In addition, the improvement of supporting facilities for mangrove ecotourism activities on Dodola Island is optimized through infrastructure development in the form of wooden bridges

surrounding the mangrove area, water sports amenities, and resorts.

Mapping mangrove zones is essential in the Dodola mangrove area of Dodola Island. In this research, the mangrove area of Dodola Island is divided into three critical areas, where each zone has mangrove characteristics with various vulnerabilities. Based on the results of mapping using the NDVI algorithm on Landsat 8 OLI data in the mangrove area of Dodola Island in 2013–2021, it can be seen that there is a significant change in the value of the vegetation index, as shown in Figure 2.

Figure 2 shows that the change in the value of the mangrove vegetation index on Dodola Island from 2013 to 2021 occurs significantly. Based on the results of the calculation of raster data using the NDVI algorithm, it shows that the average value of the vegetation index of the mangrove area of Dodola Island is 0.33, which decreases to 0.32 in 2021. In addition, the minimum value of the vegetation index in 2013 was 0.09, which means it declined

in 2021 to 0.02. Meanwhile, the maximum value of the vegetation index in 2013 was 0.41, which decreased to 0.40 in 2021. Changes in the index value need to be analyzed periodically based on each zone, as shown in Figure 3.

Figure 3 shows that the mangrove area in zone 1 of Dodola Island in 2013 had an average vegetation index value of 0.32, which decreased significantly in 2017 to 0.13. From 2018 to 2021, the average value of the vegetation index of zone 1 mangroves on Dodola Island was 0.32–0.34. This case indicates that the significant decrease in zone 1 of the mangrove area of Dodola Island needs to be taken seriously by identifying the factors that cause a reduction in the average value of the vegetation index and threats to the sustainability of mangroves in zone 1. Furthermore, the vegetation index value in zone 2 of the area of Dodola Island mangroves from 2013 to 2021 can be reported in Figure 4.

Figure 4 shows a significant change in the average value of the mangrove vegetation index in zone 2 in 2016 from 0.35 to 0.14 in 2017. Furthermore, the average value of the

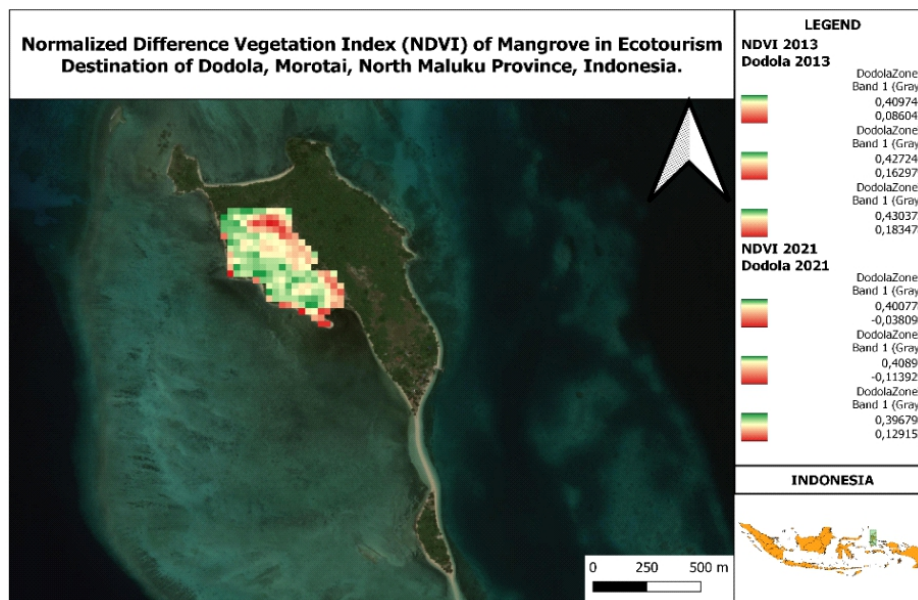


Figure 2 Calculation result of NDVI in mangrove area of Dodola 2013–2021.



Figure 3 NDVI value of zone 1 mangrove area of Dodola Island 2013–2021.

vegetation index in zone 2 of the mangrove area of Dodola Island increased significantly in 2018 to 0.32 and reached 0.34 in 2020. The decrease in the value of the mangrove vegetation index in zone 2 indicates the same thing as the condition of mangrove vegetation in zone 1. Likewise, the increase in the average value of the vegetation index in 2020 to 0.34 shows that the mangroves are in good condition for the recovery process. In addition, the vegetation index of mangroves in zone 3 can be reported in Figure 5.

Figure 5 shows the similarities in the case of a decrease in the average value of the mangrove vegetation index in zone 3 with zone 2 and zone 1. The average index value in zone 3 decreased from 0.33 in 2016 to 0.16 in 2017. Furthermore, the average value of the mangrove vegetation index zone 3 increased to 0.36 in 2018 and remained at 0.30–0.32 in 2019–2021. Nevertheless, the maximum vegetation index in zone 3 in 2021 has the lowest value in zone 1 (0.39) and zone 2 (0.40), which is 0.38. It shows that the condition of mangrove vegetation in zone 3 needs to be considered by the manager of ecotourism destinations in protecting and maintaining the sustainability of the mangrove area of Dodola Island.

Based on the calculation results of Landsat 8 OLI raster

data using the NDVI algorithm in QGIS 3.20, there is a change in the average value of the mangrove vegetation index as a reflection of changes in mangrove conditions from 2013 to 2021. The decline in the vegetation index in 2017 raises the assumption that the impact of tourism supports infrastructure development in the form of a wooden bridge along the 800m across the mangrove area of Dodola Island. Furthermore, the government policy to limit access mobility to Dodola Island during the Covid-19 pandemic in 2020 increases the average value of the mangrove vegetation index. Likewise, the decline in the average value of the vegetation index in the mangrove area of Dodola Island in 2021 is assumed to be due to the mobility of intensive domestic tourist travel. Based on the existing condition of the mangroves on Dodola Island, the criteria for damage to mangrove forests on Dodola Island based on zoning can be linked to the decree of the minister of state for the environment in 2004, as shown in Table 1.

Table 1 shows that in 2021, the average value of the mangrove vegetation index in zone 1 is classified as moderate criteria, while the average value of the mangrove vegetation index in zone 2 and zone 3 is classified as rare criteria according to the decree of the minister of state for the

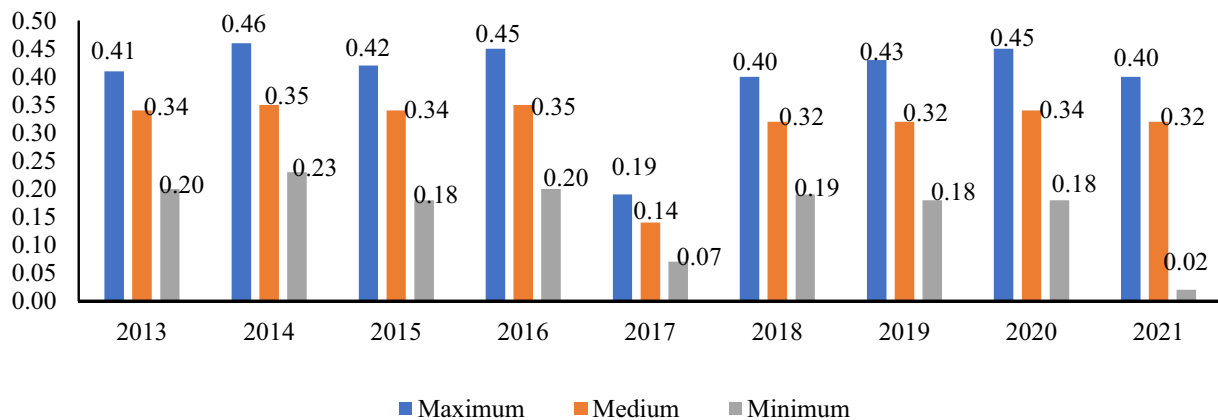


Figure 4 NDVI value of zone 2 mangrove area of Dodola Island 2013–2021.

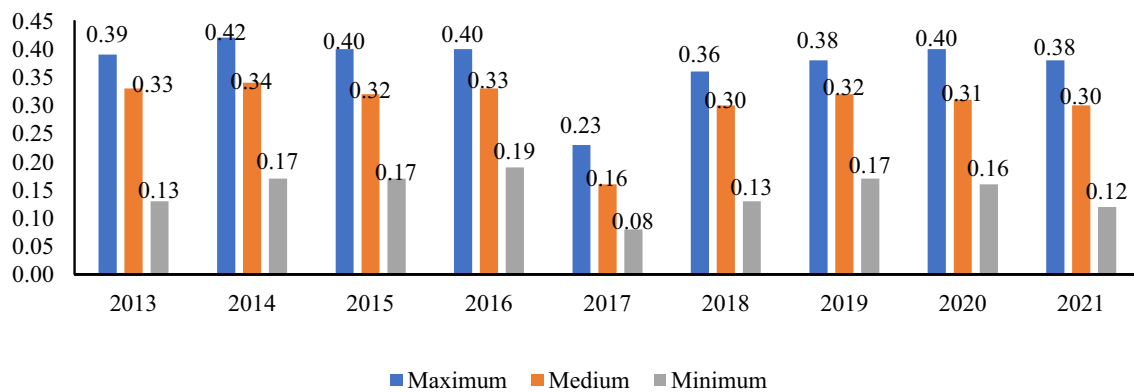


Figure 5 NDVI value of zone 3 mangrove area of Dodola Island 2013–2021.

environment in 2004. It shows the need for a rehabilitation program for mangrove areas in zone 3 and zone 2 to support ecotourism sustainability on Dodola Island. To optimize the management of mangrove ecotourism on Dodola Island, collaboration is needed between communities living around Dodola Island to actively participate in the rehabilitation and preservation of mangrove areas in each zone. Thus, the community-based or community-based mangrove ecotourism approach effectively maintains ecological sustainability while providing social and economic benefits for the surrounding community.

Based on the research results on the carrying capacity and condition of mangroves on Dodola Island, Idrus and Kusman (2021) showed that the environmental temperature value of the Dodola Island waters was in the range of 27.3–30.1°C. In addition, the pH values in zone 1, zone 2, and zone 3 of the mangrove area ranged from 4.88 to 5.07. Meanwhile, salinity in the mangrove area of Dodola Island in zone 1 is around 29–30‰, zone 2 is 31‰, and zone 3 is 15–24‰. Meanwhile, the dissolved oxygen concentration of DO on Dodola Island ranged from 6.3–6.7. If it is related to the Decree of the State Minister of the Environment Number 51 of 2004, the natural temperature is 28.3°C. The standard water pH for marine tourism is 6.5–8.5. Meanwhile, water salinity for tourist areas is 29–35‰ natural. Meanwhile, the oxygen concentration is too high (DO), more than 5 mg L<sup>-1</sup>. It shows that naturally, the condition of the mangrove forest on Dodola Island deserves to be developed as a tourist attraction.

### Index vegetation of Guraping mangrove area 2013–2021

Mangrove tourism destinations in Guraping have developed along with the support of the North Maluku provincial government policy to optimize mangrove forests' potential using community-based ecotourism. The mangrove area in Guraping, Oba Utara is part of the Tidore Islands Regency. It has implications for the socio-cultural behavior of the Guraping community, which is identical to cultural rituals. Communities living around the Guraping mangrove area have diverse livelihoods but are dominated by fishing activities to sea transportation service providers (speedboats) from Sofifi-Tidore and Sofifi-Ternate. The diversification of local people's livelihoods was also stimulated by the Guraping mangrove ecotourism development program, which allowed families to become entrepreneurs in tourist areas.

The participation of local communities in mangrove ecotourism activities begins with the collaboration between the Forestry Service of North Maluku Province and the youth organization, namely the youths in Guraping Village, in various infrastructure development activities, socialization of amenities development programs, attractions, and accommodations. The involvement of local communities in tourism development, especially the Guraping mangrove ecotourism, is still not optimal. Still, developing tourism infrastructure in Guraping can encourage economic growth and interest in domestic tourist visits. Tourism supporting infrastructure that tourists can use is a wooden bridge in the Guraping mangrove area and camping ground and recreation areas on Guraping Cape, as shown in Figure 6.

Table 1 Mangrove criteria based on average value of vegetation index in Dodola

Criteria	Cover (%)	Density	NDVI	Average value	Average value	Average value	
				vone 1 (2021)	vone 2 (2021)	vone 3 (2021)	
Health	Dense	≥ 75	≥ 1,500	0.43 ≤ 1.00	-	-	-
	Moderate	≥ 50 – < 75	≥ 1,000 – < 1,500	0.33 ≤ 0.42	0.33	-	-
Unhealth	Sparse	< 50	< 1,000	-1.00 ≤ 0.32	-	0.32	0.30



Sumber Gambar :  
 1. Generasi Pesona Indonesia Maluku Utara  
 2. www.celebes.co  
 3. www.timesindonesia.co.id

Figure 6 Mangrove-based ecotourism of Guraping, Sofifi.

Figure 6 illustrates the availability of tourism supporting infrastructure built by the local government and collaboration with local communities to optimize the destination management system. The existing condition of the mangrove area in Guraping has changed from 2013 to 2021, when there has been the conversion of mangrove areas for settlements, pond areas, port expansion, and other development projects. Along with demographic growth, the increasing demand for housing has forced people domiciled in Guraping to cut down mangrove trees to construct settlements. This condition is one of the factors causing changes in the vegetation index value in the mangrove area to

change from 2013 to 2021, as shown in Figure 7.

Figure 7 is the result of Landsat 8 OLI raster data for 2013–2021 in the three essential mangrove areas of Guraping, Oba Utara, and Tidore Islands Regency. In 2013, the maximum value of the mangrove vegetation index in each zone (zone 1, zone 2, and zone 3) was 0.420.49. Furthermore, in 2021, the maximum value of the mangrove vegetation index in each zone will experience a significant decrease in the field of 0.380.47. The fluctuation of the Guraping mangrove vegetation index value can be explicitly reviewed in each area from 2013 to 2021, as shown in Figure 8.

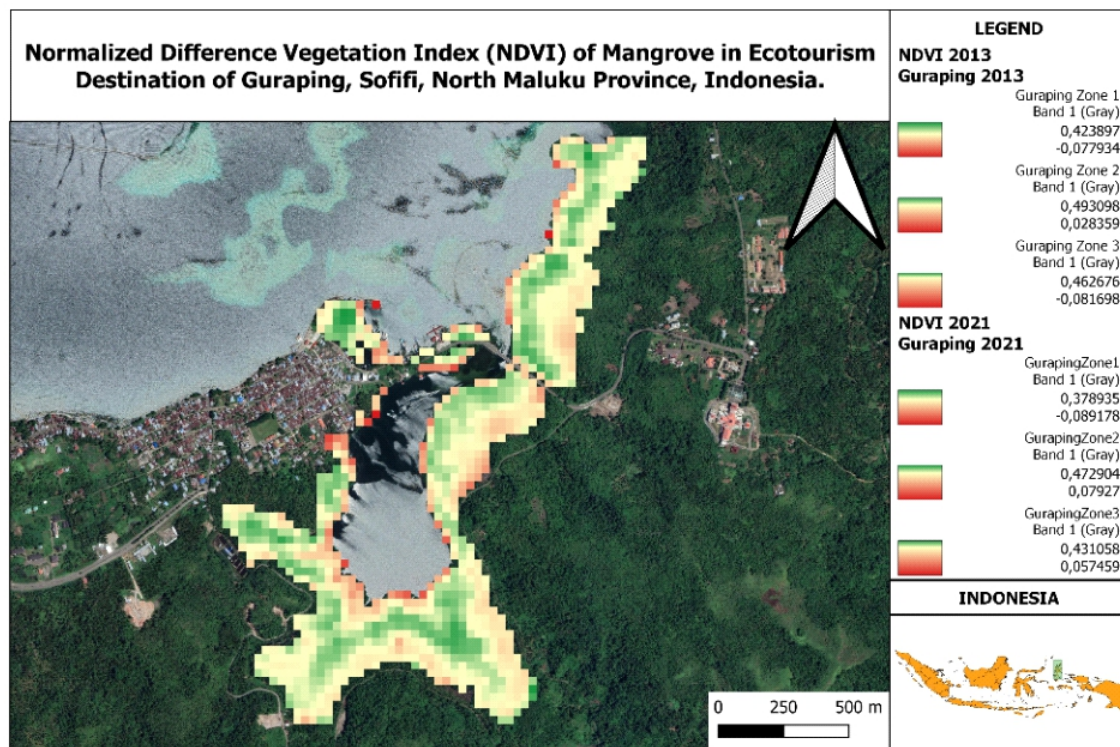


Figure 7 NDVI value of Guraping mangrove area 2013–2021.

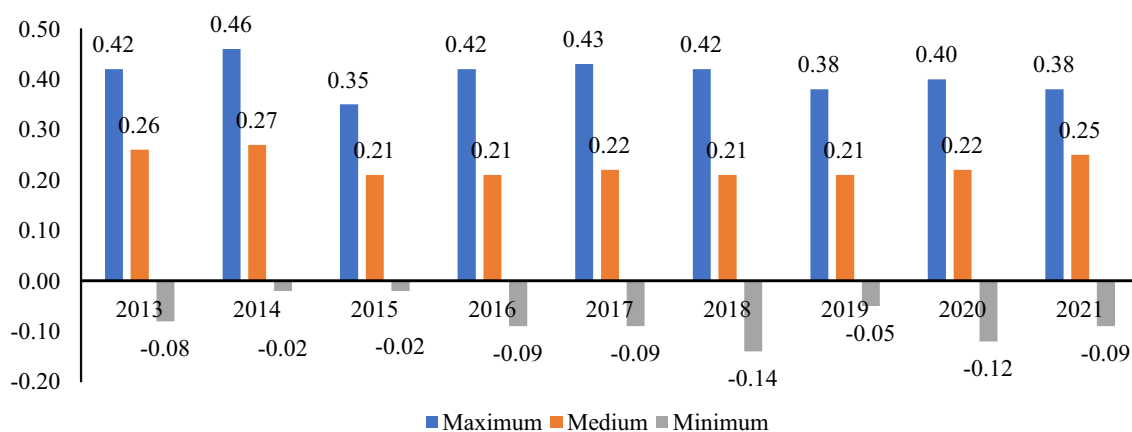


Figure 8 NDVI value of zone 1 mangrove area of Guraping 2013–2021.

Figure 8 shows that the maximum vegetation index value in the Guraping mangrove ecotourism area decreased significantly from 0.46 in 2014 to 0.35 in 2015. Furthermore, in 2016, the max value of the vegetation index of the zone 1 mangrove area again increased to 0.42. The decrease in the max value of the mangrove vegetation index in zone 1 again at 0.38 in 2019 and 2021. Overall, the average value of the Guraping mangrove vegetation index in zone 1 is 0.210.27, indicating that zone 1 mangrove areas need to be rehabilitated to maintain the mangrove ecosystem. In addition, in zone 2, the mangrove vegetation index value has a maximum and a higher average value, as shown in Figure 9.

Figure 9 shows that the maximum value of the Guraping zone 2 mangrove vegetation index in 2013–2021 is 0.44–0.52. Nevertheless, the average value of the Guraping zone 2 vegetation index decreased in 2015 to 0.34. The Guraping mangrove zone 2 area is located quite far from residential areas and close to community plantation areas. The vegetation index detected by Landsat 8 OLI has a higher average value than zone 1, which residential residents have dominated. In the context of Guraping Ecotourism, the mangrove area of zone 2 has the highest maximum value compared to zone 3, as shown in Figure 10.

Figure 10 shows the vegetation index value of the Guraping zone 3 mangrove area, which shows the average value of the mangrove vegetation index in the range of 0.310.41 from 2013 to 2021. However, the minimum value in 2013 was -0.08. Minimum values with numbers below 0 also occurred in 2015 (-0.01), 2016 (-0.12), 2018 (-0.03), and 2020 (-0.09). It means that the density of the Guraping zone 3 mangrove forest area has decreased. It shows that the cause is the felling of mangrove trees, land conversion, and the development of tourism infrastructure in the form of mangrove bridges. Based on the Decree of the Minister of State for the Environment in 2004, the existing condition of the Guraping mangrove forest in 2021 is classified as healthy and moderate, compared with mangrove ecotourism in Dodola Island Table 2.

Table 2 shows that in 2021, the average value of the mangrove vegetation index in Guraping is categorized as healthy-moderate. Changes in the mangrove vegetation index in zone 1 need attention from the forestry service and local youth (*karang taruna*) to maintain environmental sustainability even though the area around the mangrove is crowded with tourists. Things that need to be anticipated from tourism activities in mangrove areas are the behavior of

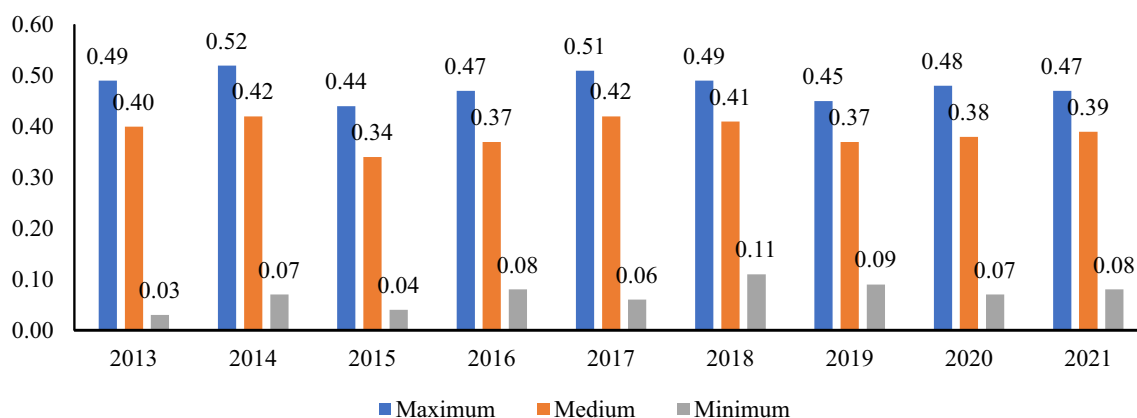


Figure 9 NDVI value of zone 2 mangrove area of Guraping 2013–2021.

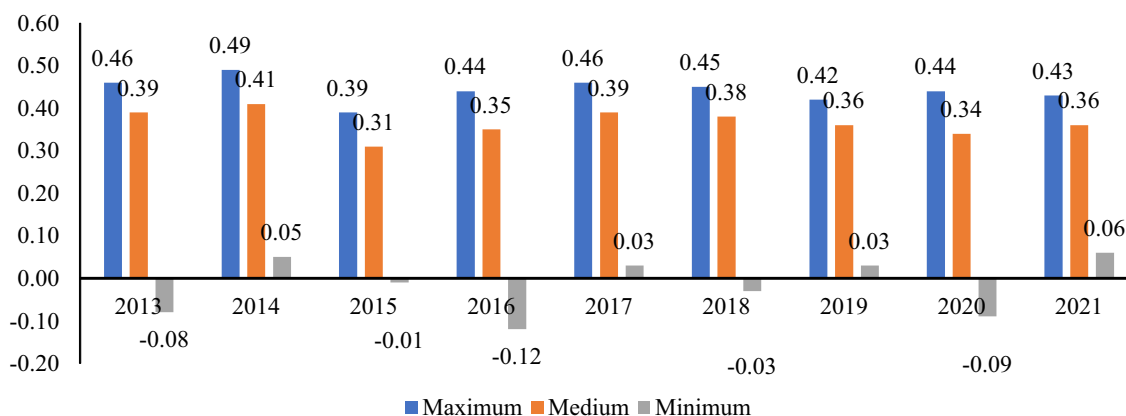


Figure 10 NDVI value of zone 3 mangrove area of Guraping 2013–2021.



Table 2 Mangrove criteria based on average value of vegetation index in Guraping

Criteria		Cover (%)	Density	NDVI	Average value zone 1 (2021)	Average value zone 2 (2021)	Average value zone 3 (2021)
Health	Dense	$\geq 75$	$\geq 1,500$	$0.43 \leq 1.00$	-	-	-
	Moderate	$\geq 50 - < 75$	$\geq 1,000 - < 1,500$	$0.33 \leq 0.42$	-	0.39	0.36
Unhealth	Sparse	$< 50$	$< 1,000$	$-1.00 \leq 0.32$	0.25	-	-

tourists who tend to damage the environment by throwing garbage in coastal regions to picking or breaking mangrove tree branches. These findings show that rehabilitation and preservation program for mangrove forests is needed in the form of a massive social movement as a form of awareness and concern for the environment and environmental conservation activities based on local wisdom in the form of traditional rituals of the local community. Thus, ecotourism becomes beneficial, and changes in the value of the vegetation index increase in healthy and dense mangrove conditions.

**Mangrove forest utilization through ecotourism development** Changes in the value of the mangrove vegetation index based on the results of the NDVI calculation provide an overview of the health condition or density of mangrove forests. Previous studies have shown that the mangrove vegetation index value needs to be monitored regularly to anticipate environmental degradation caused by mangrove forest damage. In its development, rehabilitation efforts for mangrove forest restoration are integrated with tourism development programs through the concept of community-based mangrove ecotourism.

This study found a scheme for utilizing the mangrove area in Guraping and Dodola as a tourist attraction through a community-based ecotourism approach. There are two keywords in the community-based ecotourism approach: community and ecotourism. These two concepts can be reviewed comprehensively based on Dodola and Guraping Islands context. The initiation of the development of mangrove areas on Dodola and Guraping Islands was encouraged by the local government through the forestry service and the tourism office. However, local communities show different responses according to traditions and norms and the level of acceptance of tourism activities.

In the context of the people living around Dodola Island and the Guraping mangrove area, some traditions and norms shape the habitus and relationships between humans and nature, humans and others, and humans and their creator. For people who live in Guraping, there is a tradition of *Tawaf Gam* which is a symbol of respect for nature and others. For the people around Dodola Island, there are cultural activities related to the reproduction of cultural materials as a symbolic meaning of the kinship bonds of local tribes. Both areas with traditions, norms, and artistic creations can be categorized as tourism resources. Meanwhile, the level of acceptance of tourism activities is essential, considering the understanding of the sacredness of local traditions and rituals and the possibility that it is restricted to tourists with an inappropriate way of dressing.

In the context of community culture in Guraping and Dodola Island, traditions and norms that contain the meaning of sacredness tend to be considered conservative, thus limiting the habits of tourists who are liberal in terms of dress. It affects the level of acceptance of the social community towards the characteristics of tourists who want to visit Guraping and Dodola so that they can respect the traditions and norms of the community by wearing clothes that follow the rules of the local community when they want to watch local traditional events. This condition shows that the tourism development approach relevant to the socio-cultural context of the Guraping and Dodola communities is an eco-tourism approach.

Through an ecotourism approach, environmental awareness education and cross-cultural understanding are a series of knowledge to be introduced to tourists visiting the mangrove areas in Guraping and Dodola. Ecological awareness and local socio-cultural education elements are essential to benefit mangrove ecology and preserve local culture. Tourists who visit mangrove tourism destinations in Guraping and Dodola can have a cross-cultural understanding and are aware of the environment. It also reduces environmental damage and social conflicts between local communities and tourists due to destructive behavior and the lack of knowledge of local socio-culture. Thus, tourist behavior plays an essential role in the concept of ecotourism.

Conceptually, the ecological and socio-cultural contexts in Guraping and Dodola Island show a close relationship, considering the lifestyle or livelihoods of coastal and island communities as fishermen whose daily activities cannot be separated from mangrove forests. Before the government's initiation to adopt the eco-tourism concept, local communities used mangrove trees for various household needs. Mangrove trees are sometimes cut down and converted into residential areas, and mangrove tree branches are also cut down to be used as firewood and for building poles for houses. In addition, some animals such as bats, monitor lizards, shellfish, crabs, and fish found in the mangrove area tend to be consumed as local food characteristics (Singgalen, 2022a). If done repeatedly without control, people's behavior like this will threaten the sustainability of mangrove ecology. Therefore, through the tourism and forestry services, the local government seeks to disseminate and educate about the benefits of mangrove trees that can generate economic value and encourage community social welfare through the development of community-based mangrove ecotourism.

The government built several infrastructures in wooden bridges and the Guraping and Dodola mangrove areas to



(2021) show that the people of Kolorai Island also have a cultural heritage that brings economic benefits, such as the ability to weave mats. Tourists interested in the woven products can buy them directly from the local community as a typical Kolorai souvenir.

In the context of the culture of the Guraping people, one of the rituals still preserved today is the *Tawaf Gam* ritual, which means cleaning the village. This ritual is believed to ward off evil things that want to hit the residents' settlements. The Ritual of *Tawaf Gam* is led by *Kapita* or *Bobato* and Nine other people called *Pasukan Sembilan*. The ceremony begins by walking from the medicine house named *Folasou*, surrounding the residential area, and stopping at several points to pay homage. Studies on the relationship between the Guraping people, nature, God, and others in the *Tawaf Gam* ritual have not been much. However, the norms and traditions of *Tawaf Gam* adopted by the Guraping community have become a stimulus for ecological awareness and force them to protect mangrove areas. Thus, the Guraping community maintains the mangrove ecotourism area to achieve sustainability.

In the context of the communities in Guraping and Kolorai, the approach used by local governments in achieving development goals is more dominant in the social and cultural dimensions. The synergy of development programs based on socio-cultural values can increase community participation in mutually beneficial collaboration. Afterward, a collaborative approach can optimize the socio-economic and socio-ecological dimensions. Singgalen (2020) shows that in the context of North Maluku Province, especially the people in Kao Village-North Halmahera Regency, local norms and traditions can control collective behavior in utilizing mangrove forest resources. It is manifested in community support to rehabilitate mangroves and support the essential ecosystem zone or *kawasan ekosistem esensial* (KEE) program. In addition, Singgalen et al. (2019) also show that the norms and traditions of the Limau community through the *Seri Kodoba* ritual have become collective norms that reflect community relations with others, community relations with nature, and community relations with God. Thus the socio-cultural approach needs to be prioritized in achieving the goals of sustainable tourism development.

## Conclusion

The results of this study indicate that based on the criteria for damage to mangrove forests on the Decree of the Minister of State for the Environment in 2004, the existing condition of the Guraping mangrove forest in 2021 is classified as healthy and moderate, compared with mangrove ecotourism in Dodola Island. Based on case studies on Dodola and Guraping Islands, it can be identified things that affect changes in the value of the vegetation index in the mangrove area from 2013 to 2021, namely the conversion of land for settlement expansion, cultivation, and the development of tourism supporting infrastructure. On the other hand, to maintain the sustainability of mangrove ecotourism, rehabilitation and restoration programs are needed to sustain healthy mangrove growth to show the density of mangrove forests with an NDVI value of 0.431.00. Meanwhile, the

synergy of the rehabilitation and restoration of mangrove forests can be adapted to the wisdom of local indigenous peoples, who culturally adhere to customary norms or values to maintain the sustainability of mangrove forests based on the concept of community-based mangrove ecotourism. Based on the idea of community-based mangrove ecotourism in Guraping and Dodola, the relevant sustainability concepts that need to be optimized are socio-economic benefits, socio-cultural preservation, and socio-ecology awareness.

## Recommendation

This study resulted in several practical recommendations to the local government responsible for developing the mangrove areas of Dodola and Guraping Islands through an ecotourism approach. First, community-based mangrove ecotourism is essential in increasing community participation in rehabilitation and restoration programs with low NDVI values for mangrove areas. It is needed to increase the sense of belonging in various collaborative programs. Second, the socio-cultural values of the surrounding community need to be integrated with the mangrove preservation program. Thus, the rehabilitation and restoration program in Dodola and Guraping can be optimal.

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