Journal of Coastal and Ocean Sciences *e-issn: 2746-4512*
Volume 6 No. 3, September 2025: 150-156 *p-issn: 2745-4355*

Analysis of Mangrove Forest Health in the Coastal Area of Kutawaru Village, Cilacap Regency, Central Java

Rusiani Oktaria[1*], Efriyeldi[1], Zulkifli[1]
[1]Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau, Pekanbaru 28293 Indonesia
Corresponding Author: anioktaria18@gmail.com

Received: 7 July 2025; Accepted: 28 August 2025

ABSTRACT

Mangroves are forests that grow in coastal areas and play a crucial role in maintaining environmental balance, as the health of this ecosystem significantly impacts the stability of coastal areas and the survival of communities that depend on natural resources. This study aims to analyze the Mangrove Health Index *(*MHI) in the coastal area of Kutawaru Village, Cilacap Regency, Central Java. The transect method was used at three research stations representing mangrove forests. The observed parameters included type identification, canopy cover, stem diameter, and density of trees and saplings. A total of 14 mangrove species were identified, with *Rhizophora apiculata* as the dominant species, having the highest Importance Value Index (IVI) of 104.69%. The highest tree density is found at Station 3, with a value of 4,611.11 trees/Ha, and the average canopy cover is 80.8%, which is classified as very dense. The average MHI value of 73.74% shows that the condition of the mangrove ecosystem in this region is relatively good. The results of this study are expected to serve as a reference for the formulation of sustainable mangrove management and conservation policies.

Keywords: Mangrove health index, Canopy cover, Mangrove Ecosystem, Cilacap

1. INTRODUCTION

Mangroves are forest ecosystems that grow in coastal areas, playing a critical role in the coastal environment. Mangrove forests function as a wave barrier, protect coastlines from erosion, serve as a habitat for various marine life, and also play a role in absorbing carbon (Efriyeldi et al., 2020; Farista & Virgota, 2021; Aritonang et al., 2022). Along with the development of coastal areas and the increase in human activities, the health condition of mangrove forests is beginning to be threatened. One of the mangrove forest areas that is rapidly degrading is the Segara Anakan Lagoon area, Cilacap Regency, Central Java.

The eastern area of Segara Anakan, located in Kutawaru Village, Central Cilacap District, is an area vulnerable to degradation due to human activities, including industrial development, settlements, and port operations. The primary issue affecting mangrove forests in Kutawaru Village is the impact of urban and industrial activities in coastal areas. The destruction of mangrove forests in Kutawaru Village can have negative consequences, including increased coastal abrasion, loss of biodiversity, and reduced ecosystem functions that support the lives of the surrounding community. The existence of mangrove forests is crucial, particularly in mitigating the rate of sedimentation and protecting coastal areas in Kutawaru Village.

The health of mangrove forests in Kutawaru Village can be assessed by examining the density, species composition, and structure of the mangrove forest itself. Low mangrove density indicates degradation, which is often caused by human activities such as land conversion for development, industrial activities, and pollution from domestic and industrial waste. The health of mangrove forests can be categorized into three criteria good, medium, and poor based on the value of the Mangrove Health Index (MHI). The health of mangrove ecosystems is directly related to the balance of coastal ecosystems and the survival of communities that depend on these natural resources. Therefore, the health status of forests needs to be monitored periodically to predict future changes and is vital in the formulation of environmental policies and natural resource management. This research aims to assess the health of the mangrove forest in Kutawaru Village, providing recommendations for the sustainable management and preservation of the mangrove ecosystem.

2. RESEARCH METHOD

Time and Place

The research was conducted in February - May 2025 in the mangrove forest area of Kutawaru Village, Cilacap. The research locations were established at three different stations, selected based on the representation of mangrove conditions (Figure 1).

Figure 1. Research location

Method

The method used in the study is the survey method. The technique used in determining the research Station is purposive sampling. Purposive sampling is a sampling technique that selects stations based on the characteristics of the population included in the sample, ensuring that the sample used in this study accurately represents the condition of the mangrove ecosystem (Kuncahyo et al., 2020). Mangrove vegetation data collection was carried out by referring to Dharmawan & Pramudji (2017), namely by sampling plots. In measuring mangrove crown cover, hemispherical photography is used.

Procedures

Identify the type of mangrove, Stem Diameter, and Mangrove Density

Mangrove species identification is guided by Sukma et al. (2023); Noor et al. (2012). Type identification was carried out directly in the field at three research stations. Each Station has three transects, and each transect has three sampling plots. The individual types of mangroves found on each plot are calculated and recorded in numbers to be analyzed using a formula to obtain mangrove density values.

Stem diameter measurements were carried out at the height of the chest of adults, which is 1.3 m, in a plot of size 10x10 m^2 for the tree category and 5x5 m^2 for the sapling category. The tree category has a stem with a large diameter of 4 cm. Stems that have branched many times, with a diameter of less than 4 cm, are categorized as saplings. Stems that are less than 1 m tall and not branched are categorized as seedlings (English et al., 1997).

Canopy cover data was taken using the hemispherical photography method. Hemispherical photography is a photographic method used to see the mangrove canopy cover through photos with a camera (Purnama et al., 2020). Each 10 x 10 m^2 plot is divided into several photo shooting points, depending on the shade of the mangrove canopy (Figure 2).

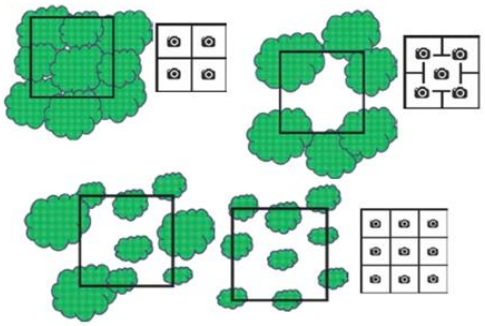

Figure 2. Taking photos of the canopy cover, depending on the thickness of the mangrove canopy

Data Analysis

Importance Value Index (INP)

The importance index of a type ranges from 0% to 300%, providing an overview of the influence or role of a kind of mangrove plant species in the mangrove community (Wasil & Muhsoni, 2023). The parameters analyzed to obtain INP are as follows, using a formula according to Bengen (2002):

$$K = \frac{\sum \text{individuals of a species}}{\text{sample plot area}}$$

$$KR = \frac{\text{Density of species}}{\text{The density of all species}} \times 100\%$$

$$F = \frac{\sum \text{plot occupied by a type}}{\text{total number of plots}}$$

$$FR = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100\%$$

$$D = \frac{\text{Total basal area of species}}{\text{sample area}}$$

$$DR = \frac{\text{Dominance of a species}}{\text{Dominance of all species}} \times 100\%$$

$$INP = FR + KR + DR$$

Description:

K = Density
KR = Relative Density
F = Frequency
FR = Relative Frequency
D = Dominance
DR = Relative Dominance

INP = Importance Value Index

Canopy Cover

The concept of this analysis involves separating the color of the sky pixels (white) from the color of the mangrove vegetation pixels (black). The value of 0 represents the pixels of the sky, while the value of 255 represents the pixels of mangrove canopy cover. The percentage of canopy cover is calculated using a formula as described by Kuncahyo et al. (2020).

$$\% \text{ Canopy Cover} = \frac{P255}{\Sigma P} \text{ x } 100\%$$

Description:

P255 = The number of pixels that are worth 255.

ΣP = the sum of all pixels

Based on KLH (2004) concerning the standard criteria for mangrove damage, the condition of mangrove forests is divided into three categories, as shown in Table 1:

Table 1. Mangrove damage criteria

Criteria	% Coverage	Tree Density (tree/ha)
Very dense	>75	>1500
Medium	50-70	1000 ≥ 1500
Damaged	<50	<1000

Mangrove Health Index (MHI)

The health value of mangroves was obtained from the percentage of mangrove canopy cover, average diameter (sapling + trees), and sapling density. The value of the mangrove health index is calculated using an equation according to Dharmawan & Pramudji (2017):

$$SC = 0.25 \text{ x } C - 13.06$$

$$SD = 0.45 \text{ x } D + 1.42$$

$$SNsp = 0.13 \text{ x } Nsp + 4.1$$

$$MHI\ (\%) = \frac{SC+SD+SNsp}{3} \text{ x } 10$$

Information:

MHI = Mangrove health index

SC = Canopy cover percentage score

SD = Average diameter score (sapling + tree)

SNsp = Sapling density score

The MHI value is divided into three categories according to Dharmawan & Pramudji (2017) in Table 2:

Table 2. Mangrove categories based on MHI value

Category	MHI value (%)
Poor	0 - 33.33
Moderate	33.34 - 66.66
Excellent	66.67 - 100

3. RESULT AND DISCUSSION

Types of Mangroves

Based on the results of identification at three research stations in Kutawaru Village, 14 species of mangroves from 7 families were found. Mangroves of the *Rhizophoraceae* family appear to be more dominant than other families (Table 3).

Table 3. Mangrove species found in Kutawaru Village

Vegetation components	Family	Species	Code	S1	S2	S3
Mayor	Avicenniaceae	*Avicennia alba*	*A.a*	✓	✓	✓
	Arecaceae	*Nypa fruticans*	*N.f*	✓	✓	✓
	Meliaceae	*Xylocarpus granatum*	*X.m*	✓	✓	-
		Xylocarpus moluccensis	*X.g*	-	✓	-
	Rhizophoraceae	*Bruguiera gymnorrhiza*	*B.g*	✓	✓	✓
		B. sexangula	*B.s*	✓	✓	-
		Ceriops decandra	*C.d*	-	✓	-
		C. tagal	*C.t*	✓	✓	-
		Rhizophora apiculata	*R.a*	✓	✓	✓
		R. mucronata	*R.m*	-	✓	✓
	Sonneratiaceae	*Sonneratia alba*	*S.a*	-	-	✓
		S.caseolaris	*S.c*	-	✓	✓
Minor	Myrsinaceae	*Aegiceras corniculatum*	*A.c*	✓	✓	✓
	Sterculiaceae	*Heritiera littoralis*	*H.l*	-	✓	-

Description: (S) = station; (✓) = found; (-) = not found

Based on Table 3, the most abundant mangrove species are found at Station 2, with 13

species, while Stations 1 and 3 have eight species each. In general, mangroves can grow in various locations, depending on the type of substrate, and each location typically has its own unique mangrove species. The mangrove species *R. apiculata* is found most abundantly at each station, which is due to the ideal environment for the species. Environmental characteristics influence the dominant species that inhabit each type of substrate. Bengen (2002) stated that *R. apiculata* mangroves generally grow on muddy substrates and live in areas with periodic seawater inundation. The mangrove species *H. littoralis* is only found at Station 2. Mangrove *H. littoralis* generally grows on the land edge of mangrove forests, cannot grow in places that are too open or have poor drainage, and is intolerant of environments with high salinity (Giesen et al., 2007). This is the limiting factor, so this type of mangrove is less able to compete with other species that dominate along the edges of mangrove vegetation.

Importance Value Index (INP)

Based on Table 4, the highest INP value in the tree category mangrove is found at Station 3, namely in the *R. apiculata,* with an INP value of 116.14%, while the lowest value is found at Station 2 in the *H. littoralis* with an INP value of 2.78%. The highest INP value in the pile category was found at Station 3, specifically in *R. mucronata,* with an INP value of 154.56%. In contrast, the lowest value was recorded at Station 2 in *X. moluccensis*, at 4.93%.

The high INP values in *R. apiculata* and *R. mucronata* in this study are closely related to the favorable environmental conditions, particularly the presence of muddy substrates, which are dominant in almost all research stations. Meanwhile, *H. littoralis* and *X. moluccensis* have the lowest INP values compared to the others because they are mangroves with the fewest species. The high or low INP value of a type is influenced by the number of stands found in the data collection plot; the greater the number of stands, the greater the INP value. Another factor that causes the difference in INP values is the type of substrate and the tides of seawater (Heri et al., 2020). Muddy substrate conditions and locations that tend to be submerged at high tide are unsuitable for this species of mangrove. *H. littoralis* prefers sandy or clayey substrates with good drainage, while *X. moluccensis* species generally live on sandy or rocky beaches, behind or slightly above the high tide line.

Mangroves *R. apiculata* and *R. mucronata* have the most significant influence on the mangrove ecosystem in Kutawaru Village. According to Agustini et al. (2016), types that obtain a high INP will be superior in utilizing resources or more adept at adapting to the local environment.

Table 4. INP value of mangrove species in the category of trees and saplings

Species	Tree INP (%)			Sapling INP (%)		
	S1	S2	S3	S1	S2	S3
Aegiceras corniculatum	0	7.04	17.45	20.59	10.12	40.2
Avicennia alba	106.61	48.88	62.42	33.85	0	8.99
Bruguiera gymnorrhiza	69.28	21.85	31.93	123.33	34.37	52.39
B. sexangula	4.75	3.06	0	0	0	0
Ceriops decandra	0	0	0	0	17.99	0
C. tagal	9.45	8.74	0	26.16	91.15	0
Hiritiera littoralis	0	2.78	0	0	0	0
Nypah fruticans	5.23	21.57	9.16	0	0	0
Rhizophora apiculata	104.69	97.63	116.14	88.01	69.1	30.24
R. mucronata	0	48.17	44.49	0	56.73	154.56
Sonneratia alba	0	0	14.77	0	0	13.55
S. caseolaris	0	26.84	4.05	0	0	0
Xylocarpus granatum	0	7.64	0	8.06	15.62	0
X. moluccensis	0	8.8	0	0	4.93	0
	300	300	300	300	300	300

Canopy Cover

The results of data processing yielded a percentage value of canopy cover in Kutawaru

Village, ranging from 80.22% to 81.52%. Overall, the condition of the mangrove canopy cover in Kutawaru Village is in good condition, meeting the very dense criteria as defined by KLH (2004) regarding the standard destruction of mangrove forests. The highest canopy cover value was found at Station 2, with an average value of 81.52%, followed by Station 3 with an average value of 80.67%, and finally Station 1 with an average value of 80.22%.

The difference in density affects the percentage level of mangrove canopy cover. Station 2 has a lower tree density value of 3700 Trees/ha compared to Station 3 with a tree density of 5077.78 Trees/ha. However, Station 2 has a higher canopy cover percentage of 81.52% compared to Station 3, which has a canopy cover percentage value of 80.67%. This is suspected because Station 2 has a stake density value of 8,000 trees/ha, which is higher than Station 3's value of 4,933.34 trees/ha. The density of the sapling has a significant impact on the percentage of canopy cover. As the results of a study conducted by Nurdiansah & Dharmawan (2021) on Middleburg-Miossu Island, West Papua, where zone 1 with a sapling density value of 0 tree/100m^2 which has a lower canopy cover percentage, namely with a percentage of 46.03% compared to other zones that have a pile density of 20-22 tree/100m^2 with a higher canopy cover percentage of 84.57-85.04%.

Mangrove vegetation in Kutawaru Village is dominated by *R. apiculata* and *R. mucronata* species, which is another factor that affects the value of canopy cover in the area because this type of mangrove is known to have a wide leaf morphology. Additionally, the compatibility between the substrate and mangrove species in a given area can be observed from the number of species in the vegetation stands. The greater the number of mangroves stands, the more suitable the substrate conditions are for the species' growth needs (Masruroh & Insafitri, 2020). The muddy substrate conditions in Kutawaru Village are ideal for the growth of *R. apiculata* and *R. mucronata*.

Table 5. Canopy cover value and mangrove density in Kutawaru Village

Station	Canopy Cover (%)	Density (tree/ha)	
		Tree	Sapling
1	80.22	2711.11	4311.11
2	81.52	3700	8000
3	80.67	5077.78	4933.34
Average	80.8	3829.62	5748.15

Mangrove Health Index (MHI)

The Mangrove Health Index (MHI) is a formula used to evaluate the health quality of the mangrove community in an area (Wasil & Muhsoni, 2023). In general, the MHI calculation is designed to assess the health of mangrove forests using three primary parameters of the mangrove stand structure: stem diameter, canopy cover, and density.

Overall, the health condition of mangroves in Kutawaru Village indicates that the mangrove ecosystem is in good condition, with an average value of 73.74%. Station 1 has a lower MHI score than other stations, with an MHI score of 66.62%, which is categorized as medium. This is due to the low value of the components that make up MHI, where the value of mangrove density and pile density at Station 1 is lower, with a mangrove tree density of 2711.11 trees/ha and a pile density of 4311.1 trees/ha at Station 1. Although Station 1 has a good canopy cover condition of 80.22%. However, the regeneration of piles is still relatively low, which affects the MHI score at Station 1, categorized as medium. As in a study conducted by Nurdiansah & Dharmawan (2021) on Middleburg-Miossu Island, West Papua, in Zone 1, with the lowest MHI score of 38.7%, which was influenced by the low percentage of canopy cover and the absence of regeneration at the sapling level.

Mangroves at stations 2 and 3 have higher MHI scores because the MHI constituent parameters are found with higher values. Station 2 has an MHI score of 83.63%, with a canopy cover percentage of 81.52% and a sapling density of 8,000 trees per hectare. Meanwhile, Station 3 has an MHI score of 70.79%, with a canopy cover percentage of 80.67% and a sapling density of 4,933.34 trees per ha.

Table 6. Mangrove health index (MHI) value in Kutawaru Village

Station	MHI (%)	Category
1	66.62	Moderate
2	83.63	Excellent
3	70.97	Excellent
Average	73.74	Excellent

Overall, the health status of mangrove forests in Kutawaru Village is in good condition. This is because of the rehabilitation efforts that have been carried out by various parties, such as the Sida Asih Mangrove Conservation Group, the ecotourism manager of SIMANJA (Jagapati Mangrove Conservation), and PT Pertamina Integrated Terminal Cilacap, which planted around 75,000 mangrove trees in an area of 4.45 hectares in Segara Anakan Kutawaru from 2020 to 2024. Additionally, conservation activities involve the community and students, such as the planting of 2,410 mangrove seedlings by students of SMA Negeri 1 Cilacap, in collaboration with the Cilacap Regency Environment Agency, in February 2023. Although the mangrove forest area in Kutawaru Village faces ecological pressure, the partnership between the government, the private sector, and the community has shown positive results in efforts to preserve and restore the coastal ecosystem.

4. CONCLUSION

The composition of the mangrove species found is 14 species. Kutawaru Village has a mangrove ecosystem dominated by *R. apiculata* and *R. muronata*. The density of mangrove vegetation in Kutawaru Village is in good condition, categorized as very dense, with a tree density between 2711.11 and 5077.78 trees per hectare and a sapling density ranging from 4311.11 to 8000 trees per hectare. The mangrove community as a whole showed good health conditions with an MHI score of 73.74%. The MHI scores at Station 1, Station 2, and Station 3 were 66.62%, 83.63%, and 70.97%, respectively.

REFERENCES

[KLH] Kementerian Lingkungan Hidup. (2004). Keputusan Menteri Lingkungan Hidup Republik Indonesia No. 201 tahun 2004 tentang Kriteria dan Pedoman Penentuan Kerusakan Mangrove.

Agustini, N.T., Ta'alidin, Z., & Purnama, D. (2016). Struktur Komunitas Mangrove di Desa Kahyapu Pulau Enggano. *Jurnal Enggano*, 1(1): 19–31.

Aritonang, L., Septyani, E., & Maria, L. (2022). Pemetaan Perubahan Luasan Mangrove Melalui Analisis Citra Satelit Landsat di Tangkolak Barat, Karawang, Jawa Barat. *Jurnal Geosains dan Remote Sensing*, 3(1): 30-35.

Bengen, D.G. (2002). *Pedoman Teknis Pengenalan dan Pengelolaan Ekosistem Mangrove*. Pusat Kajian Sumber Daya Pesisir dan Lautan *IPB, Bogor.*

Dharmawan, I.W.E., & Pramudji, P. (2017). *Panduan Pemantauan Komunitas Mangrove.* Pusat Penelitian Oseanografi LIPI. Jakarta.

Efriyeldi, E., Mulyadi, A., & Samiaji, J. (2020). Condition of Mangrove Ecosystems in Sungai Apit Siak District Based on Standard Damage Criteria and Quality Indicators of Mangrove Environment. *IOP Conference Series: Earth and Environmental Science*, 430(1): 012013).

English, S., Wilkinson, C., & Baker, V. (1997). *Survey Manual for Tropical Marine Resources*. Australian Institute of Marine Sciences, Townsville. 390 p.

Farista, B., & Virgota, A. (2021). Serapan Karbon Hutan Mangrove di Bagek Kembar Kecamatan Sekotong Kabupaten Lombok Barat. *Bioscientist*: *Jurnal Ilmiah Biologi*, 9(1): 170-178.

Giesen, W., Wulffraat, S., Zierenand, M., &Scholten, L. (2007). *Mangrove Guidebook for Southeast Asia.* FAO and Wetlands International. Bangkok.

Heri, P., Burhannudin, B., & Riyono, J.N. (2020). Keanekaragaman Jenis Vegetasi Mangrove di Desa Sungai Bakau Besar Laut Kecamatan Sungai Pinyuh Kabupaten Mempawah. *Hutan Lestari*, 8(2): 269–277.

Kuncahyo, I., Pribadi, R., & Pratikto, I. (2020). Komposisi dan Tutupan Kanopi Vegetasi Mangrove di Perairan Bakauheni, Kabupaten Lampung Selatan. *Journal of Marine Research*, 9(4): 444-452.

Masruroh, L., & Insafitri, I. (2020). Pengaruh Jenis Substrat terhadap Kerapatan Vegetasi *Avicennia*

marina di Kabupaten Gresik. *Juvenil*: *Jurnal Ilmiah Kelautan dan Perikanan,* 1(2):151-159.

Noor, Y.R., Khazali, M., & Suryadiputra, I.N.N. (2012). *Panduan Pengenalan Mangrove di Indonesia*. *Edisi 3.* PHKA/WI-IP. Bogor.

Nurdiansah, D., & Dharmawan, I.W.E. (2021). Struktur Komunitas Dana Kondisi Kesehatan Mangrove di Pulau Middleburg-Miossu, Papua Barat. *Jurnal Ilmu Lingkungan dan Teknologi Kelautan Tropis.* 13(1): 81-96.

Purnama, M., Pribadi, R., & Soenardjo, N. (2020). Analisa Tutupan Kanopi Mangrove dengan Metode Hemispherical Photography di Desa Betahwalang, Kabupaten Demak. *Journal of Marine Research*, 9(3): 317-325.

Sukma, R.N., Sa'adah, N., & Yuliardi, A.Y. (2023). Identifikasi Jenis-Jenis Mangrove di Pantai Ya'ang, Desa Labuhan, Kecamatan Brondong, Kabupaten Lamongan. *Jurnal Riset Kelautan Tropis, 5*(1): 9-20.

Wasil, M., & Muhsoni, F.F. (2023). Mangrove Health Index (MHI) di Wisata Mangrove Tajungan Kecamatan Kamal Kabupaten Bangkalan. *Juvenil: Jurnal Ilmiah Kelautan dan Perikanan*, 4(4): 366-375.