Identification of Coral Reefs in Mamburit Waters, Sumenep Regency

Sawiya[1*], Mohammad Mahmudi[2], Guntur[2]

Graduate Program of Fisheries and Marine Sciences, Faculty of Fisheries and Marine Sciences, University of Brawijaya, Malang, Indonesia
Faculty of Fisheries and Marine Sciences, University of Brawijaya, Malang, Indonesia

Abstract

This research was conducted in September to October 2013 in Mamburit Waters, Sumenep Regency. This study was aimed to assess the percentage of coral reefs and acknowkedge the type of the coral reefs. Coral reefs was observed with the *Line Intercept* (LIT) method laid parallel to the coastline in the depth of 3 m and 10 m in *windward* and *leeward* area. Total of 59.88% coral reefs lived in *leeward* area in 3 m depth includes in good category and the percentage of dead coral reefs and other fauna for 40.12%. In the 10 m depth, 69.19% live coral reefs include as medium category with percentage of dead coral reefs and other fauna for 30.81%. *Winward* location of 3 m depth has 68.38% live coral reefs in good category and percentage of dead coral reefs and other fauna for 31.62%. Whereas for 10 m depth, 40.86% of live coral reefs include as medium category with percentage of dead coral reefs and other fauna for 59.14 %.

Keywords: coral reefs, *leeward*, *windward*, Mamburit

INTRODUCTION

Kangean is an island in East Java Province with 2 districts: Kangayan and Arjasa that has coral reefs cover area of 2,900.5 ha and 3,536.2 ha consecutively. It is located in eastern of Madura Island and northern of Bali Island [1]. Coral reefs also function as habitat for biota feeding ground, spawning, nursery ground, reproduction area. Diverse sea organism of various tropic levels such as fish, crustacea, mollusc, echinodermata, polychaeta, and other biota living surround the coral reefs. Coral reefs provide some habitat for these living organisms [2], each component in this community has tight dependance of each other [3].

The Island of Mamburit has very good potencies to be developed into underwater tourism site. It is due to its diverse resources, especially from coastal resources, e.g. sea biota, coral reefs, fish, mollusc, etc. Most people in Mamburit Island are fishing for their occupation. From the general fisheries catches, percentage of living coral reefs needs to be concerned because it affects the public economy in fisheries. The less percentage of coral reefs, the less sea biota evolves [4].

Moreover, fishermen in Mamburit Island exploit coral reefs for building materials. Fishermen also fishing with small boats when low tide thus the coral reefs get massive damages. The accurate data of coral reefs in Mamburit Island is absence thus it needs direct review from authority so that fisheries become more environment-friendly. It also to prevent the exploitation of coral reefs for building materials, thus it is important to identify the coral reefs, to determine the percentage of living or dead coral reefs. This study is aim to assess the percentage and the type of the coral reefs. Result of this study is expected to provide information especially to the local government and researchers to be referenced.

MATERIALS AND METHODS

This research is conducted in September to October 2013 in waters area of Mamburit, Sumenep Regency (Figure 1). This study was initiated by the determination of study sites by using Line Intercept (LIT) method parallel to coast line. This research conducted in four stations (Table 1) and positioned by Global Positioning System (GPS). Each windward and leeward area divided into four observation plot. Coral reefs along the roll meter were identified and the growth was observed.

Table 1. Study Site Potition

Location	Direction	Depth (m)	Coordinates
I	winward	3	6°50'48.39" S 115°13'5.84" E
II	winward	10	6°50'30.13"S 115°13'19.54" E
III	leeward	3	6°50'29.24" S 115°12'56.97" E
IV	leeward	10	6°50'13.88" S 115°13'9.54" E

* Correspondence author:
Sawiya
Email : sasa.syahid@yahoo.com
Address : Faculty of Fisheries and Marine Sciences, University of Brawijaya, Jl. Veteran, Malang, 65145

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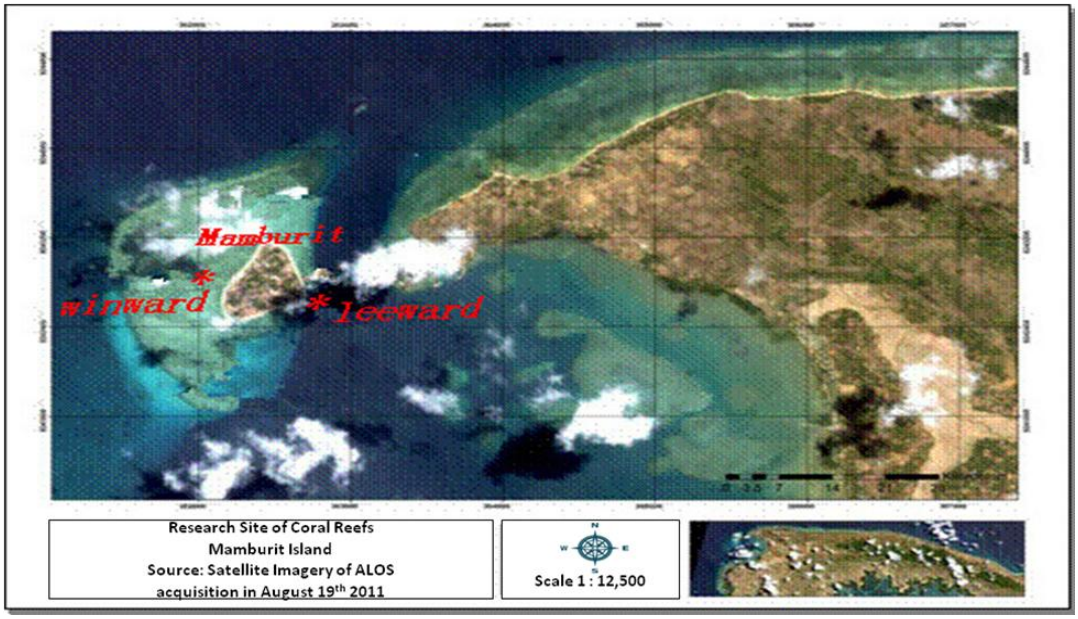

Figure 1. Observation Site of Coral Reefs in Mamburit Island (ALOS Imagery).

Measurement of Environment Parameter

Environment parameters were measured on each station consisted of depth, temperature, salinity, surface currents, water transparency, and DO. Methods of measurement refer to Sari and Usman [5].

Depth (Meter)

Depth measured in each station along with the observation on coral reefs coverage. The depth of waters' bottom (coral reef) was acknowledged by deep gauge on the hose regulator of diving equipment.

Temperature (°C)

Temperature measured in each determined station with thermometer. Thermometer dipped in the water and measured number recorded.

Salinity (‰)

Salinity was measured by refractometer in each station. Refractometer dipped in the water and the scale showed the salinity value.

Surface current (ms^{-1})

Current was measured with floating ball with string length of 5 m. Measurement conducted by releasing the floating ball along with stop watch and then the result recorded.

Water Transparency (meter)

Trancparency of water measured with secchi disc. Secchi disc entered into the water until the white part of the disc was not seen. The string length showed the transparency of the water.

DO (mgm^{-3})

The tool was calibrated on zero scale and then probe was dipped in the water for a while until the tool showed the numbers of DO.

Data Analysis

Percentage of coral reefs coverage includes the coverage of dead coral, live coral, and other lifeform. It counted with formula of English *et al.* [6]:

$$C = \frac{a}{A} x100\%$$

Description: C = percentage coverage of lifeform i
a = transect length of lifeform i
A = total length of transect

Data analysis to calculate the percentage of coral reefs coverage refers to formula of UNEP [7] and living coral reefs categorized based on Ofri [8] in Table 2.

$$\%\ Coverage\ = \frac{Total\ Length}{Transect\ Length} \times 100$$

Table 2. Category of living coral reefs coverage

Percentage (%)	Category
00.0 – 24.9	bad
25.0 – 49.9	medium
50.0 – 74.9	good
75.0 – 100.0	very good

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RESULT AND DISCUSSION

Parameter of Mamburit Waters

The highest salinity is in the 10 m depth of Leeward, followed by 10 m and 3 m depth of winward, and 3 m depth of Leeward. According to Eliza [9], coral organism is living in average salinity of 35‰. The highest salinity is 3635‰ in Leeward area, however the average salinity in Mamburit is 35‰; the salinity that appropriate for the growth of coral reefs. The increase of salinity leads to mortality for the coral reefs.

Temperature parameter in 10 m depth of Leeward area is 29°C, while 3 m depth of Leeward is 30°C. Otherwise, 10 m and 3 m depth of Windward is similar, i.e. 30°C. The high temperature was due to the measurement that conducted in the day light, and the weather condition at the time is hot. However, the temperature still supports the growth of coral reefs in Mamburit waters. Effendi [10] stated that temperature for coral reefs to grow is ranged between 22-29°C with maximum point of 36°C. The change on sea water's temperature caused Zooxanthellae off of their host, i.e. coral reefs.

pH in the depth of 10 m Leeward is 7.3, while in 3 m depth is 7.4. Otherwise in Windward, pH of 10 m and 3 m are same, i.e. 7.3. Acidity degree (pH) in sea waters is commonly average 7.5 - 8.4. Ministry of Environment determined the ideal pH for sea biota ranged 7-8.5, while Salm [11] suggested normal pH in waters area ranged 8.0-8.3.

DO in Leeward area of 10 m depth is 6.7 $mg.m^{-3}$, while in 3 m is higher, i.e. for 6.9 $mg.m^{-3}$. Otherwise, DO in windward of 10 m depth is 7.9 $mg.m^{-3}$, whereas in 3 m is 7.7 $mg.m^{-3}$. The DO in Mamburit area is sufficient for the growth of coral reefs.

Current speed in Mamburit waters of Leeward area is similar for 10 m and 3 m, i.e. 10.47 $m.s^{-1}$. Meanwhile, windward of 10 m depth has 14.31 $m.s^{-1}$ current speeds, whereas in 3 m depth, the current speed is 13.14 $m.s^{-1}$. Nontji [12] explained that the current speed on the water surface is 0.06 – 0.64 $m.s^{-1}$. Water current is needed to obtain food, e.g. zooplankton, and oxygen, as well as to clean the surface of coral reefs from sediment thus the growth of the coral reefs will not obstructed.

Waters transparency is supporting factor for coral reefs growth. Waters transparency in Mamburit ranged 3-10 m. The transparency was relatively high, showed that the water condition of Mamburit is relatively clean and clear.

Percentage of Coral Reefs in Mamburit

The growth form of coral reefs in windward area of Mamburit found a total of 11 types of coral reefs include: ACB, ACD, ACS, ACT, CF, CHL, CM, CME, CS, CMR, and CB (Table 3). We found 11 types of coral reefs in windward area, plot I at the 3 m depth with 64.82% living coral reefs which categorized as good. The coral reefs were dominated by particular type of CF for 27.02%, with dead coral reefs and other fauna for 35.18%.

A total of 7 types of coral reefs were found in Plot II, with 71.94% living coral reefs categorized as good. Dead coral reefs and other fauna were found as much as 28.06%. Coral reefs in this location were dominated by the type of ACD for 6.96%.

Otherwise, 8 types of coral reefs in the depth of 10 m, Plot III for 41.54% with dead coral and other fauna for 58.46%. It is categorized as medium. This location was dominated by the type of ACB for 25.12%. We found 6 types of coral reefs in Plot IV with 40.18% living coral categorized as medium, while the dead coral and other fauna for 59.82%.

Table 2 and 3 showed the percentage of each type of coral reefs. The higher light intensity supports the growth of coral reefs because the light will affect the abundance of Zooxanthellae [13]. This has to be related to the 3 m and 10 m depth; which the highest percentage of living coral reefs found in the depth of 3 m. It is caused by the light intensity that reached the bottom of the sea, whereas many shatter of coral reefs found in 10 m depth. The shatter was caused by the waves and human activities.

Coral reefs with good category commonly found in the depth of 50 m and 20 m. However, coral reefs that found in the depth of 3 m and 10 m has more species diversity and a better growth compared to the ones in the depth of 50 m and 20 m; affected by the light intensity which enter the waters depth [4,12]. Coral reefs in the depth of 3 m and 10 m of Windward indicate that the Mamburit waters are still clear.

The condition accelerates the growth of coral reefs because the photosynthesis process from solar light towards the coral reefs that penetrate the bottom of the sea. The average percentage of living coral reefs in 3 m depth Windward area is 68.38% (categorized as good), with dead coral and other fauna for 31.62%. Otherwise for 10 m depth, the percentage of living coral is 40.86% (medium category), with dead coral and other fauna for 59.14%.

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Table 3. Coral Reefs in Windward Area of Mamburit

Living coral reefs	3 m depth of windward				10 m of windward			
	Plot I		Plot II		Plot III		Plot IV	
	length (cm)	%	length (cm)	%	length (cm)	%	length (cm)	%
Acropora branching (ACB)	813	16.26	872	17.44	1256	25.12	995	19.9
Digitate(ACD)	348	6.96	1467	29.34	17	0.34	142	2.84
Sub massive(ACS)	358	7.16	353	7.06	46	0.92	75	1.5
Tabulate(ACT)	78	1.56	290	5.8	205	4.1		
Branching(CB)	33	0.66						
Foliose (CF)	1351	27.02			5	0.1	90	1.8
Heliopora (CHL)	26	0.52	75	1.5	80	1.6		
Massive (CM)	196	3.92	540	10.8	432	8.64	677	13.54
Millepora (CME)	30	0.6			36	0.72	30	0.6
Mushroom (CMR)	8	0.16						
Sub massive (CS)								4.14
Total percentage %		**64.82**		**71.94**		**41.54**		**40.18**
average		**6.48**		**11.99**		**5.19**		**6.69**
Dead coral reefs								
Hard coral (DC)	275	5.5	291	5.82	821	16.42	27	0.54
Dead coral with algae (DCA)	235	4.7	367	7.34	118	2.36	70	1.4
Others: anemon, gorgonian (OT)	12	0.24	587	11.74			207	4.14
Rubble (R)	941	18.82	30	0.6	1721	34.42	1875	37.5
Abiotik sand (S)	82	1.64			247	4.94	812	16.24
Soft coral(SC)	18	0.36			16	0.32		
Spongs (SP)	121	2.42	128	2.56				
Turf alga (TA)	75	1.5						
Total percentage %		**35.18**		**28.06**		**58.46**		**59.82**
Average		**4.49**		**33.06**		**11.69**		**11.96**

Table 3. Coral Reefs in Leeward Area of Mamburit

Living of Coral reefs	3 m depth of leeward				10 m depth of leeward			
	Plot I		Plot II		Plot III		Plot IV	
	length (cm)	%	length (cm)	%	length (cm)	%	length (cm)	%
Acropora branching (ACB)	970	19.4	1308	26.16	2147	42.94	1359	27.18
Digitate (ACD)	244	4.88	92	1.84	361	7.22	356	7.12
Sub massive(ACS)	475	9.5	217	4.34	102	2.04	400	8
Tabulate(ACT)	91	1.82	55	1.4	7	0.14	66	1.32
Branching(CB)	151	3.02	68	1.76				
Foliose (CF)	158	3.16			13	0.26	914	18.28
Heliopora (CHL)	37	0.74	30	0.6				
Massive (CM)	825	16.5	1039	24.06	604	12.08	553	11.06
Mushroom (CMR)	228	4.56						
Millepora (CME)					37	0.74		
Total percentage %		**63.58**		**56.18**		**65,42**		**72.96**
Average		**7.06**		**8.02**		**9.34**		**12.16**
Deat coral reef								
Hard coral (DC)	319	6.38	283	5.66	141	2.82	553	11.02
Dead coral with algae (DCA)	206	4.12	187	3.74	113	2.26	551	4.62
Others: anemon, gorgonian (OT)	5	0.1						
Rubble (R)	955	19.1	1029	20.58	114	2.28	332	6.64
Abiotik sand (S)	285	5.7	185	3.7	1342	26.84	238	4.76
Soft coral(SC)	15	0.3	135	2.7				
Spongs (SP)	6	0.12	348	6.96	19	0.38		
Turf alga (TA)	30	0.6						
Halimedae (H)			24	0.48				
Total percentage %		**36.42**		**43.82**		**38.58**		**27.04**
average		**4.55**		**6.26**		**6.91**		**6.76**

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Windward area was dominated by Coral Massive (CM) and Acropora Brancing (ACB). It implies that the greater light intensity, the greater growth of the coral reefs [13]. Light that enter the waters is needed by Zooxanthellae which live in the tissues of coral reefs, which affect the growth of coral reefs. Thus the light penetration that depends on the depth of the sea affects the growth of coral reefs [4].

Light intensity in the depth of 10 m is able to penetrate to the bottom of the sea, but the percentage of living coral reefs decreased compare to the coral that lives in the depth of 3 m. There are several issues found in the study site as follows. Shattered coral reefs in the depth of 10 m were caused by the waves, fishing (fish, sea cucumber, etc) which lived in the coral reefs. The fishing executed by diving and crack open the coral reefs thus it destructed and shattered.

Table 3 showed 11 types of coral reefs' growth form in Leeward area of Mamburit water, i.e. ACB, ACD, ACS, ACT, CF, CHL, CM, CME, CS, CMR, and CB. Specifically, in the 3 m depth of Leeward, we found 10 types of coral in Plot I. The living coral reef is 63.58%, categorized as good and dominated by ACM type. Percentage of dead coral is 19.4% and other fauna is 36.42%.

We found 7 types of coral reefs in Plot II, with 56.18% living coral (good category). The coral dominated by ACB coral type for 26.16%, whereas dead coral and other fauna found for 43.82%. Similarly in Plot III of 10 m depth, we found 7 types of coral reefs for 65.42%, which categorized as good. Coral reef of ACB is dominant with percentage of 42.94%, while the dead coral and other fauna for 34.58%.

In Plot IV, we found 6 types of coral reefs for 72.96%, dominated by ACB type (27.18%), with dead coral and other fauna for 27.04%. Average percentage of living coral in 3 m depth is 59.88% (medium category), while dead coral and other fauna for 40.12%. Living coral reefs in the depth of 10 m is higher, i.e. 69.19% includes in good category with dead coral and other fauna for 30.81%.

Coral reefs in Leeward area mostly found shattered because in low tide, fishermen walk on the coral for fishing. Thus many coral reefs were damaged. It is different with the Windward area that faces the upwind. Fishermen are rarely fishing here. Fishing activities mostly conducted in Leeward area, however the coral reefs percentage in both locations was not much different.

CONCLUSION

Percentage of living coral reefs in Leeward area of 3 m depth is 59.88% categorized as good, with dead coral reefs and other fauna for 40.12%. Whereas for 10 m depth, the living coral reefs is 69.19% includes in medium category with dead coral reefs and other fauna 30.81%. Winward area of 3 m depth has living coral reefs for 68.38% in good category with dead coral reefs and other fauna of 31.62. Whereas for 10 m depth, the living coral reefs is 40.86% include in medium category with dead coral reefs and other fauna of 59.14%. Type of coral reefs in Mamburit waters are ACD, ACB, CF, CM, ACT, CB, CHL, CME, CMR, and CS.

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