Community Structure Of Coral Reefs In Saebus Island, Sumenep District, East Java

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Abstract. Increasing degradation coral reefs ecosystem has created many concerns. Reduction of this damage can only be done with good and proper management of coral reef ecosystem based on existing condition. The condition of coral reef ecosystem can be determined by assessing its community structure. This study investigates community structure of coral reef ecosystems around Saebus Island, Sumenep District, East Java, by using satellite imagery analysis and field observations. Satellite imagery analysis by Lyzenga methods was used to determine the observation stations and substrate distribution. Field observations were done by using Line Intercept Transect method at 4 stations, at the depth of 3 and 10 meters. The results showed that the percentage of coral reef coverage at the depth of 3 and 10 meters were 64.36% and 59.29%, respectively, and included in fine coverage category. This study found in total 25 genera from 13 families of corals at all stations. The most common species found were *Acropora*, *Porites*, and *Pocillopora*, while the least common species were *Favites* and *Montastrea*. Average value of Diversity, Uniformity and Dominancy indices were 2.94, 0.8 and 0.18 which include as medium, high, and low category, respectively. These results suggest that coral reef ecosystems around Saebus Island is in a good condition.

1 Introduction

Saebus Island is one of the islands that located in Kangean Islands, East Java, Indonesia. Administratively, this island is located at Sapeken Sub-district, Sumenep District of East Java Province. Coastal areas of this archipelago have high potential of natural resources, one of the largest marine resources is coral reef ecosystem [1]. According to [2], Sumenep District waters has areas of coral reefs covering 47,760.9 Ha, is the largest coral reefs area in East Java Province.

Coral reefs are known as tropical marine ecosystems with high productivity, which has important role not only on biodiversity including genetic but also on fisheries productivity [3,4]. As one of habitat, food source, spawning and growth spots for fish communities [5], coral reefs become very important in Kangean Archipelago region where the majority of coastal communities have livelihoods in the fisheries sector [6].

However, on the past few years, coral reef ecosystems on the region experienced drastic degradation due to destructive fishing activities using explosives and potassium [6]. Destructive fishing has been reported in Indonesia marine areas [7,8], and has caused reducing biodiversity and increasing extinction of marine organisms [9,10]. Generally, almost 45% of coral reefs in Indonesia are under high threat due to human exploitation activities as well as threat of temperature change and coral bleaching [11].

In order to reduce the rate of coral reef degradation, better management has to be implemented based on existing condition both threats and coral ecosystem. Therefore, ecological research on coral reef ecosystem is needed to base line condition of coral reef in the region [12]. This research aims to determine the structure of coral reef community in Saebus Island waters that includes measurement of cover percentage, diversity, uniformity, and dominance of coral reef communities.

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2 Methods

The research is conducted on September to November 2016 at Saebus Island, Sapeken Sub-district, Sumenep District, East Java. The research stations determined by purposive sampling method, based on Satellite imaging by Lyzenga methods. The observations were conducted at 4 stations, based on fairly good living coral coverage area from satellite imaging, also represent 4 different cardinal points. See Figure 1.

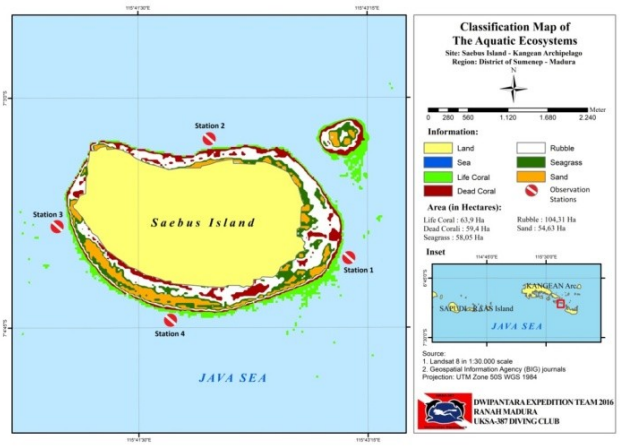

Figure 1. Map of research location

2.1. Field observation

Coral reef condition analyzed using Line Intercept Transect (LIT) observation [13] at 4 different stations at the depth of 3 and 10 m. coral reef data were recorded by measuring the diameter and record coral genus found along the transect.

2.2. Coral percent cover

Percentage of coral reefs community cover was obtained using [14] formula. Coral reefs conditions were categorized based on coral cover percentage with reference to Environmental Ministry Decree No.4/2001 (Table 1) [15] about fixed criteria of coral reefs damage.

Table 1. Category of coral reefs condition based on percent of live coral cover [15]

Category		Percentage
Bad	Poor	0 – 24.9
	Fair	25 – 49.9
Good	Good	50 – 74.9
	Excellent	75 – 100

2.3 Diversity, uniformly and dominancy index

Diversity index is measurement of community abundance, observed from the number of species/genus in one area, calculated with Shannon-Wiener Formula on [16].

Uniformity index represents the number of individual among species in one community, calculated with formula of [17]. The more balanced distribution of individual among species, the balance of the ecosystem will be increased.

Low Uniformity and diversity index represents dominancy of one species towards other species, and vice versa. Dominancy index calculated with Equation of [18].

3 Results

3.1 Coral reef conditions

From satellite imaging by Lyzenga algorithm displayed that Saebus Island has 227.61 Ha of coral reef area, with coverage of 63.9 ha of living coral, 59.4 ha of dead coral and 104.31 of abiotic substrate (Figure 1). Coral reefs on Saebus Island are categorized as Fringing reef type. Almost all of stations have similar characteristic. On the depth of 1 to 3 m form coastline to slope forms flat coral reef overlay, while on the depth of more than 3 m is reef slope. But, 4th station have quite different characteristic, on the depth of 1-10 m have low sloping degree and tends to form reef flat overlay from coast line to open ocean.

Table 2. Percent coral cover(%), coral reef condition, and number of genus in Saebus Island

Stations	Depth (m)	Coral cover (%)	Conditions	Number of genus
St.1	3	57.46	Good	8
	10	77.46	Excellent	10
St.2	3	62.62	Good	14
	10	61.85	Good	12
St.3	3	74.58	Good	10
	10	44.83	Fair	14
St.4	3	62.89	Good	15
	10	52.48	Good	14

Based on coral reef coverage percentage classification (Table 2), coral reef at Saebus Island categorized on “Fair” to “Excelent”. On 1st Station (10 m of depth), Coral reef condition categorized

on "Excellent" condition with coverage percentage is 77.46%. While on the 3rd station (10m of depth), coral reef condition categorized on "Fair" condition with 44.83% of area covered by coral. While the rest categorized on good condition with 52.48% - 74.56% area covered. Generally coral reef condition is good, there's no station categorized as "Poor" condition.

3.2 Diversity of corals

Based on genera diversity, station 4 (3 m) has the highest number of corals genus i.e. 15 genera were found. Then in a row 2nd station (3 m), 4th station (10 m) and 3rd station (10 m) with 14 genera found. While 1st station (3m) have least genera found with only 8 genera (Tabel 2).

Generally there are 25 genera of coral found on Saebus Island. Those 25 genera belongs to 13 famili, such as Acroporidae (5 genera), Astrocoeniidae (1 genus), Faviidae (5 genera), Fungiidae (1 genus), Helioporidae (1 genus), Merulinidae (1 genus), Milleporidae (1 genus), Mussidae (2 genera), Oculinidae (1 genus), Pectiniidae (1 genus), Pocilloporidae (3 genera), Poritidae (2 genera), and Siderastreidae (1 genus).

The most common coral found belongs to Acropora with high percentage at every station, ranging from 20.75% to 42.43%. Followed by Porites and Pocillopora with coverage percentage of 0.63%-10.75% found on every observation station. While the least found coral is Favites and Montastrea with less than 1% of coverage, and found only in 1 station. All of the data presented on Table 3.

Table 3. Kind of genus list and hard coral coverage (%) in Saebus Island

Family	Genus	Station 1		Station 2		Station 3		Station 4	
		3	10	3	10	3	10	3	10
Acroporidae	Acropora	29.40	42.43	27.59	26.13	39.11	20.75	28.90	23.53
	Anacropora	-	0.95	3.88	12.63	-	0.25	-	-
	Astreopora	-	-	-	-	-	0.69	0.25	0.25
	Montipora	8.40	-	-	-	-	-	2.00	1.19
	Palaclavarina	-	7.89	4.40	-	-	-	-	-
Astrocoeniidae	Palauastrea	-	3.47	-	-	-	-	-	-
Faviidae	Cypastrea	-	-	4.13	1.25	-	-	1.13	0.88
	Favia	6.60	1.58	-	1.00	6.73	-	-	-
	Favites	-	-	-	0.63	-	-	-	-
	Goniastrea	-	-	0.63	2.94	9.09	0.20	0.50	0.50
	Montastrea	-	-	0.50	-	-	-	-	-
Fungiidae	Fungia	-	0.63	0.13	3.63	1.50	0.13	-	-
helioporidae	Heliopora	-	-	-	0.50	-	0.13	2.25	0.38
Merulinidae	Hydnopora	-	12.78	-	-	-	-	0.50	0.38
Milleporidae	Millepora	-	-	5.25	4.25	4.50	9.68	-	-
Mussidae	Lobophyllia	0.10	-	1.88	-	-	0.13	0.75	0.63
	Symphyllia	-	-	-	-	-	1.25	0.25	-
Oculinidae	Galaxea	-	-	0.50	-	-	-	0.50	0.50
Pectiniidae	Oxypora	-	-	1.50	2.13	-	-	0.50	0.50
Pocilloporidae	Pocillopora	3.10	4.10	1.75	0.63	2.08	0.56	10.75	9.50
	Seriathopora	3.10	-	-	-	2.25	0.13	2.75	1.13
	Stylophora	-	-	-	-	1.13	-	-	-
Poritidae	Goniopora	3.00	2.21	0.38	-	-	3.05	5.05	7.30
	Porites	3.76	1.42	10.10	6.13	3.13	7.50	6.81	5.81
Siderastreidae	Psammocora	-	-	-	-	5.06	0.38	-	-

3.3 Diversity, uniformly and dominancy of coral reefs community

As Known in Table 4, coral reef diversity rates on Saebus Island Categorized as fair to high category with indices ranging from 2.52 to 3.24. Refers on [16], the diversity value of 1 > H' > 3 is categorized as fair diversity and fair community, while H'> 3 is a high diversity and high community category. 1st and 3rd stations have fair diversity levels with indices of 2.81,

2.65 and 2.52. While other stations have a high level of diversity. Uniformity index at all of the station categorized as high with index ranging from 0.66 to 0.99. Refers on [17], uniformity index ranging 0.6 < E< 1 categorized as high uniformity and stable community. While dominancy index represents low dominancy rate from all of the station, ranging from 0.14 to 0.24. According to [18], dominancy index ranging from more than 0 to less than 0.5 categorized as low dominancy can be concluded that there's no dominant coral on the area.

Table 4. Diversity, Uniformly and Dominancy indices

Stasiun	H'		E		C	
	3m	10m	3m	10m	3m	10m
St.1	2.81	2.65	0.74	0.70	0.19	0.24
St.2	3.03	3.08	0.80	0.81	0.18	0.16
St.3	3.05	2.52	0.99	0.66	0.19	0.23
St.4	3.24	3.16	0.85	0.83	0.15	0.14

4 Discussions

4.1 Coral diversity and composition

Overall, 25 corals genera were found at the survey sites which consist of 13 families. The most common genera found are Acropora, Porites and Pocillopora. While the least genera found are Favites dan Montastrea genera. [4] Reported that, Saebus Island has a coral reef that is still beautiful with the potential of coral reefs on the type of Acropora and Porites. The statement is similar to the results of this research which shows that the genus Acropora is the dominant coral species in each observation station with percent cover reach 20.75% - 42.43%, followed by Porites with percentage of 1.42% - 10.10%, then genus Pocillopora with percentage 0.63% - 10.75%. Dominancy of Acropora was also reported in other islands such as Gangga island [19].

Generally, Acropora branching corals are more likely to dominate at a location with supporting water conditions because they have higher growth rates than other species [12]. Acropora branching is able to grow very rapidly with a growth rate of 5-20 cm per year, inversely proportional to the Porites massive lifeform whose radial growth rate is only 1-2 cm per year [12]. The existence of resistant species against environmental stresses such as massive Porites lifeform is directly proportional to the level of diversity in an area, the higher its existence the higher the diversity in the area. Otherwise if a community is dominated by susceptible species such as Acropora and Pocillopora then the species diversity will be lower [3].

The results showed that the level of diversity in the research area with an average value of 2.94 index included in the category of fair diversity and fair community condition. This situation is thought to be due to variations in the presence of resistant species and susceptible coral species [3]. However, the dominance level in the area belongs to the low category with the index of 0.14 - 0.24, indicating that there is not actually a genus that dominates excessively in the area. This is supported by a high level of uniformity with an index of 0.66 to 0.99. The higher uniformity index will indicate the higher uniformity of the population in the community, meaning that the spread of individuals of each species around Saebus island waters is fairly quite and the condition of the community in the location tends to be stable [17,20].

4.2. Coral reefs condition

Sapeken Sub-district has the largest coral reef area compared to 21 other Sub-districts in Sumenep district with an area of 21,790.70 Ha [2]. The result of satellite image analysis shows that Saebus Island has coral reef area of 227.61 Ha which approximately 0.01% of coral reefs area in Sapeken Sub-district waters. The results of this study also show that coral reefs in Saebus Island can be categorized into "fair", "good", to "excellent" with live coral cover percentage of 44.83% - 77.46%. This condition is better if it is compared with other islands around Kangean Island, such as Mamburit Island with corals live cover between 35% - 75% [6], and also Kangean Island with coral reefs area that classified as "poor" condition with coral live cover about 9.40% - 18.36% [21].

The condition of coral reefs on Saebus Island has potential in the fisheries and tourism sectors. Acording to [22], fisheries and coastal resources in Sapeken waters are the greatest and realistic potential for sustainable empowerment with more than 30 fish families identified in this area. But based on this study, at several observation stations were found unnatural coral reefs damage, indicated by the impact of explosives or potassium. It was characterized by a rubble area that forms a crater among other coral reefs communities in that area. Based on the observation result, the percentage of rubble substrate covered 0.25% - 25.50%. High percentage of rubble can indicate that was damaged by human activities that affect the environment [21]. Damaged coral reefs in Kangean Archipelago are impacted of illegal fishing activities and overfishing use explosives and potassiums that often occur in the region [6,4]. Many fishermen are aware of their fishing activities that can damage the environment. However, with the perspective that protection / conservation policies will reduce the chance of catching fishes, then subsequent damage to aquatic resources is no longer cared [23].

By looking at the potential of coastal resources and coral reef damage issues in this area, there needs to be a protective action against the aquatic environment especially coral reefs by the authorities, as well as rehabilitation action on the damaged water environment [24]. However, very little information can be accessed to determine the condition of coral reefs in this region. Therefore, further research is needed to support relevant parties to develop appropriate and beneficial policies for the environment and civil

society. This research has provided general information about the condition of coral reefs community on Saebus Island, so it is expected to be a useful reference for other research that will be conducted around the area.

5 Conclusions

The conditions of coral reefs ecosystem at Saebus Island was categorized as "good" with average coral cover respectively 64.36 and 59.29 at depths of 3 and 10 meters. There were 25 genera of corals belongs to 13 families from all stations. The most common genera found were *Acropora*, *Porites*, and *Pocillopora*, while the least common genera were *Favites* and *Montastrea*. The Diversity levels of corals was included medium category with average Index of 2.94. Uniformity levels are included in high category with the average index of 0.80, while the dominance levels are included in the low category with the average index of 0.18.

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