Community Structure of Coral Reef at Pasir Putih Beach in Situbondo East Java, Indonesia

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Abstract

Pasir Putih beach of Situbondo has coral reefs resources to support ecotourism program. The purpose of this study is to evaluate the structure of coral reef community in *Pasir Putih* beach. This study was taken place at four sites namely; *Batu Lawang*, *Teluk Pelita*, *Karang Mayit*, and *Karang pon-pon*. Method used was *Ex Post Facto* using belt transect sampling technique with size 1x1m and length 30m and 11 times repetition. The observed physic-chemistry parameters are temperature, salinity, conductivity, pH, turbidity, DO, nitrate, and orthophosphate. The results showed that the four sites almost have the same conditions. *Batu Lawang* location is dominated by *Porites mayeri* (Poritidae) which is vulnerable to severe conditions. The second location (*Teluk Pelita*) has a high index value of diversity. The third location (*Karang Mayit*) is dominated by Poritidae family. The fourth location (*Karang Pon-pon*) is dominated by the Acroporidae family which is a clear water indicator and has a fast growth rate. However, in the fourth location, the sedimentation is quite high compared to other sites. The value of abiotic factor in the *Pasir Putih* beaches of Situbondo has a relatively normal value, the pH of value from 7.55 to 7.56, temperature 29.99°C to 30.4°C, salinity 32.33 to 32.66 ‰, conductivity 37.8 to 40.2 $\mu\text{S}\cdot\text{cm}^{-1}$, DO 7.73 to 10 ppm, turbidity 0.57-1.56 NTU, nitrate from 0.32-0.1 $\text{mg}\cdot\text{L}^{-1}$ and orthophosphate 0.02 to 0.54 $\text{mg}\cdot\text{L}^{-1}$, the water in *Pasir Putih* Situbondo was still suitable for support the growth of coral reefs.

Keywords: Coral Reefs, Community Structures, *Pasir putih* Beach.

INTRODUCTION

Pasir Putih beach of Situbondo is marine tourism located in Sub-district of Bungatan, Situbondo Regency, East Java. This beach has easy accessibility because the road to the beach could use public transport or private vehicles, with easy access would invite many visitors who will come to the *Pasir Putih* beach of Situbondo.

There are some activities that visitors do when visiting *Pasir Putih*, for example traveled, swimming, boat tours, snorkeling, and diving. Some researchers argue that diving is one of the causes of the existing ecological damage in the marine waters [1]. Divers who use photography tools could cause more damage to the coral reefs [2].

Reviewing the diving and snorkeling activities in *Pasir Putih* beach of Situbondo, there is the existence of the availability of beautiful and exciting undersea natural scenery. For examples the condition of coral reefs, fish, and other marine animals. Previous research at the beach of Situbondo suggested that there were 11 species with the index value of diversity ranging from 1.17 – 2.33 [3]. The value was categorized as moderate.

Another research stated that the percentage of coral cover at the location of *Batu Lawang* 32.48%, *Teluk Pelita*, and *Karang Mayit* 23.30%, and *Karang Pon-pon* was 27.47% [4]. *Batu Lawang* and *Karang Pon-pon* are classified as moderate, whereas *Teluk Pelita* and *Karang Mayit* are classified as poor condition. Based on these facts, it is proven that coral reefs are fascinating to examine and it is urgently needed to monitor its ecological damage.

Coral reefs are marine ecosystems composed of a group of coral animals that form calcium carbonate or a kind of limestone. Coral reef ecosystems have biological, aesthetical and cultural benefits, but these ecosystems begin threatened, mainly in areas with large human populations. Excessive exploitation causes coral reefs vulnerable to climate change nowadays [5].

Coral reefs are attractive because they have unique shape, have very low mobility, as other animal habitats [6]. Coral reefs can also be an essential indicator to describe the quality of waters ecosystem in the site; whether it is good or not [7]. Therefore, this research is vital to find out the profile of coral reef community structure in relation to seawater quality at *Pasir Putih* beach of Situbondo with four location; *Batu Lawang*, *Teluk Pelita*, *Karang Mayit* and *Karang pon-pon*.

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RESEARCH METHODS

Study Site

This research was conducted on October-December 2017 at *Pasir Putih* beach of Situbondo (Fig. 1). The study conducted at four sites sampling location, the location I namely *Batu Lawang* ($7^{\circ}41'40''$ S, and $113^{\circ}49'21.70''$ E). This location has many human activities, for example, hotel construction dominates this area. Several mangrove plants could be found and shipping activity only for research. Location II is *Teluk Pelita* ($7^{\circ}41'22.89''$ S and $113^{\circ}49'42.85''$ E). This location has the most visitors. There are also hospitality, stalls selling typical souvenir of *Pasir Putih* beach. Location III is *Karang Mayit* ($7^{\circ}41'17.08''$ S and $113^{\circ}49'48.09''$ E). At this location, there is a dock and a conservation monitoring post. Fishing activities are most dominant in this area than in the first and second locations, and there are resident settlements after the monitoring post. Location IV is *Karang Pon-pon* ($7^{\circ}41'6.58''$ S and $113^{\circ}50'6.01''$ E). At this location, there are no activities, only the mangrove forest, and partially trees.

Figure 1. Map of Pasir putih Beach of Situbondo

Sampling Method

This research using *Ex post facto* method namely examining unmanipulated cause and effect [8]. Sampling technique in this research using belt transect. Belt transect is installed parallel to the coastline. It is aimed to know the difference of community structure or species distribution pattern between/inter-zones in the coral reef [9].

Data Collection

Waters quality parameters data retrieval (physic-chemistry) including temperature, salinity, conductivity, turbidity, nitrate, orthophosphate, pH and DO. The measurement analyzed in Ecology Laboratory at Faculty of Mathematics and Natural Sciences, University of Brawijaya.

Coral reef data retrieval used a belt transect method, using a 1x1 m plot size with a distance of 2m per plot, with the number of plots 11. In each

plot, we expanded the strings then divided into four sections for easy identification.

Coral reef data was taken using transect photographs. There was five times photo for each plot. The first photo namely the whole plot photo. The second photo is a photo of each box in the plot. One plot is divided into four section boxes. After retrieving the data using transect photographs, coral reefs were identified by the book of Indonesian Coral Reef [10].

Data Analysis

Coral reef data calculated and tabulated using Microsoft Excel to determine IVI (Importance Value Index) and Diversity Index (Shannon-Wiener Index). Analysis of seawater quality use One-way ANOVA ver 16 to determine the difference test between sampling sites. Biplot analysis was used to determine the correlation between parameter factors, then cluster analysis was used to determine the similarity in the four sampling locations using the PAST 3 program.

RESULT AND DISCUSSION

Community Structure of Coral Reefs

Coral reefs in the *Pasir Putih* beach of situbondo from the four sampling sites found as many as nine families namely Acroporidae, Agaciidae, Astrocoeniidae, Faviidae, Fungiidae, Pocilloporida, Poritidae, Caryophylliidae, and Siderastreidae with 39 number of species.

Figure 2. Importance Value Index of Coral Reef at *Pasir Putih* beach of Situbondo

The composition of coral reefs (Fig.2) at the first location namely *Batu Lawang* indicates the existence of *Acropora pallifera*. Wherein this Acroporidae (Fig. 3) family was stated usually exist in clear waters, it has a fast growth rate, susceptible to sedimentation and fishing activities [11]. At this location, there are a lot of human activities, i.e. building a hotel before this location. There is also mangrove forest nearby.

Figure 3. Acroporidae Family

Teluk Pelita has a diverse composition. No dominating species was found. This second location has nice water, although this area had the most visitors and other activities (hotels, stall, boat tours, and snorkeling). *Karang Mayit* location dominated by *Porites mayeri*. The Poritidae Family (Fig. 4) is usually able to survive in poor waters, turbid water conditions, and high sedimentation. Besides that, it can live in various habitats; sandy, muddy, or broken corals [12].

Figure 4. Poritidae Family

At the third location, there are fishing activities that are often seen, the dock and boat tours. The last location *Karang Pon-pon* location dominated by *Acropora* spp and *Leptoseris scabra*, which belong to the family of Acroporidae and Agariciidae, respectively. At this location, higher sedimentation occurred compared to the other three sites. At this location, almost 95% of the site is filled with forests, only a few were established buildings, and the buildings were already unused.

Various things can cause damage or decline of coral reefs in a region, one of which is the sedimentation [13]. Sedimentation is often associated with coral reef damage, lack of light penetration, the existence of small waves, and currents influences, which may cause sediments on coral reefs uncleaned and this causes the growth of coral reefs inhibited [14].

Based on Shannon-Wiener Index value (Fig. 5), the first location indicates medium diversity with the value of 2.98. The value of *Taxa Richness* 15 is

due to the dominant species namely *Acropora palifera*, wherein this species can survive in clear waters [11]. One of the factors that make the *Acroporidae* (Fig. 3) family grow in these waters is the existence of mangrove forests which partly contribute to the state of the aquatic ecosystem around [8].

Figure 5. Index Shannon-Wiener (H') Index Value and Taxa Richness (TR)

Batu Lawang shows the value of 4.11, which is classified with high diversity. Despite its high diversity, the value of *Taxa Richness* reaches 30. However, the species found in this location does not indicate species that can survive in clear waters, but the species that survive in a tolerant state such as the species of *Porites Mayeri* and *Porites compressa* belong to Poritidae (Fig. 4) family. It is susceptible to poor environmental conditions and able to survive on all substrate types. At this location, there are various human activities, for example, boat tours, snorkeling, docks, and swimming. These various human activities that carried out can lead to the decreased growth of good corals.

Karang Mayit shows the value of 3.20 included in the category of high diversity level with the value of *Taxa Richness* 17. Meanwhile, at the last location, *Karang Pon-Pon* has a value of 3.02. This location has the same *Taxa Richness* as *Karang Mayit*, with a value of 17. Seen that there is high sedimentation along the coastline at *Karang Pon-Pon*, this shows that corals can not grow well [10]. Sedimentation occurs due to several factors in unstable natural conditions, which also lead to sedimentation, for example, erosion, reduced light penetration, and the entry of freshwater into the oceans [15].

The Dominance Value Index (Fig. 6) from *Batu Lawang*, *Teluk Pelita*, *Karang Mayit*, and *Karang Pon-Pon* are 0.16, 0.07, 0.18, and 0.18, respectively. This value shows a low partial dominance value index because it is less than 0.4.

The highest Evenness Value Index is *Teluk Pelita* for 0.75. This is in accordance with the land use map wherein *Teluk Pelita* is the least experience of sedimentation than other locations. This affects the life of surround coral reefs, considering the condition of sedimentation decline that can accelerate the growth of coral reefs [15]. *Teluk Pelita* high evenness value index (Fig. 4) comparable to the highest human activity as well. Human activities do not affect the structure of coral reef community around it, this is inversely proportional to the research of Toyosima [2] which said that the higher human activity around the coast can decrease or damage the existing coral reef ecosystems. In research at *Pasir Putih* beach of Situbondo, this possibility of human activity does not affect the coral reefs due to several causes, for example, sedimentation is declining at *Teluk Pelita*, a place that was originally good for coral growth, and other natural factors.

Figure6. Dominance Value Index (Id) and Evenness Value Index(E)

Water Quality

Environmental factors are the most critical limiting factor for coral growth. Changes in the physic-chemistry factors of water will have an impact on changes in the composition and relative abundance of an organism living in an aquatic ecosystem [16], so that this condition must be kept for the balance of an ecosystem.

Abiotic factors at the *Pasir Putih* beach of Situbondo shown in Table 1. The temperature at the four locations has a range between 29.99°C-30.43°C. This value indicates that there is a

temperature range which is good for the growth of coral reefs, good coral growth between a temperature of 25°C-31°C [17]. Salinity value at these four research sites is in the range 32.66-32.33 ‰. This value indicates that in this salinity, the coral reefs are still able to live well, according to Suharsono [10], coral reef will grow well at the salinity range 27-40‰, but best in the normal salinity of the sea that is 36‰.

Conductivity is the ability of water to conduct electricity; the higher the conductivity value, the more ions contained in these waters [18]. The highest conductivity value is in the *Teluk Pelita*. The high value of conductivity can be due to the many activities of the people there, such as bathing so that the number of ions contained in the water increases [14].

The acidity (pH) in water measured by the number of hydrogen ions. The more hydrogen ions then the acidic the waters become, and vice versa [19]. The pH values at the four sampling sites ranged from 7.55 - 7.56. Under such conditions, including the normal pH for the organism to survive. If the pH is in very acidic or very alkaline conditions, it will affect the metabolism and causes respiration disorders [20].

Turbidity is a measure to the extent that light can penetrate water. If a waters experience high turbidity, it will prevent the penetration of sunlight into the seawater. If this happened, the rate of photosynthesis on coral reefs will decrease this may lead to a decrease in growth rates on the coral reefs [21]. Turbidity values in the four sites ranged from 0.57-1.56 NTU. There is no provision for good turbidity values for healthy coral reefs. In normal conditions, the value of turbidity is < 1 NTU, but in storm conditions coral reefs can tolerate aquatic turbidities > 100 NTU [22].

Dissolved Oxygen (DO) is the amount of dissolved oxygen in an aquatic ecosystem. A good DO value for coral growth ranged from 6.5mg.L⁻¹, the highest DO value at *Karang Mayit* reaching 10.6 mg.L⁻¹, *Karang Pon-Pon* value for 9.26mg.L⁻¹. The higher the value of the DO, then waters became much better because many organisms require oxygen and vice versa [23].

Table 1. Water Quality physics - chemistry

Location	Temp (°C)	Salinity (‰)	Conductivity (µS.cm ⁻¹)	Parameter				
				pH	Turbidity (NTU)	DO (Ppm.‰ ⁻¹)	Nitrate (mg.L ⁻¹)	Orthophosphate (mg.L ⁻¹)
Batu Lawang	29.9	32.26	37830	7.56	1.56	7.73	0.11	0.05
Teluk Pelita	30.76	32.33	40230	7.55	0.57	7.6	0.32	0.02
Karang Mayit	30.67	31.9	36900	7.57	0.62	10.6	0.18	0.54
Karang Ponpon	30.43	32.33	20710	7.56	1.04	9.26	0.1	0.03

The nitrate level on *Karang Pon-Pon* shows range value between 0.1-0.32 mg.L⁻¹. This value is categorized that the concentration of nitrate in the waters at *Pasir Putih* beach in Situbondo is still good, because nitrate content/level in normal sea waters ranges from 0.01-0.50 mg.L⁻¹ [24].

Orthophosphate levels on *Karang Pon-Pon* are in the range 0.03-0.56mgL⁻¹ indicates that the value is still on the standard limit, the value is good enough for the growth of an organism [25]. The higher the value of phosphate, the more nutrients, both derived from the decomposition of sediments and organic compounds derived from the dead bodies of flora fauna. Low phosphate levels can also be caused by intensive phytoplankton activity [26].

Biplot analysis (Fig.7) is used to determine the correlation between factors. *Batu Lawang* and *Karang Mayit* have a high value of orthophosphate, pH and DO (*dissolve oxygen*). That meaning high value is range normal to the growth of coral reefs, while Taxa Richness value is low. *Teluk Pelita* has a highvalue of diversity index, Uniformity Index, Nitrate, and Conductivity while the DO (*dissolve oxygen*) value and the Dominance Value Index is low.

Figure7. Biplot Analysis

Karang Pon-Pon has a high value of Dominance Index and DO (*dissolve oxygen*) while the value of Evenness index, diversity index, nitrate, and conductivity is low. From these four areas, *Karang ponpon* is close to the area of aquaculture, settlements, and waterways, thus it is suspected that there is sedimentation in this location [27]. Although the areas are close to mangrove areas, pond cultivation can damage mangrove ecosystems which later become spawning, then fish growth will affect local productivity. Some components that can influence the existence of these activities are DO

(*dissolve oxygen*), brightness, and the number of phytoplankton [28].

Continuous research is important so that the coral reefs condition can be better than before. It is necessary to conduct periodic monitoring, not only to check the damage but also record specific species of coral reefs that are easily affected by the sediment and not. We can also continue to make fishing zoning distribution, conservation with the aim of adjusting the area needs/utilization. It is also urgent to conduct rehabilitation to increase coral population, reduces algae that live freely, and finally increase public awareness to be responsible for managing coral reefs.

CONCLUSION

The condition of coral reefs on the *Pasir Putih* beach of Situbondo has almost similar conditions in all research locations, meaning that there is no trend from one of these locations. Each location has special characteristics to describe the causal conditions of coral reefs. The highest Dominant of Value Index is *Karang Pon Pon*. *Teluk Pelita* value of the Diversity Index is high, *Batu Lawang* and *Karang Mayit* has a high pH, DO and conductivity value.

The structure of the coral reef community has not been affected by human activity, as indicated by the broad diversity index on *Teluk Pelita*. Whereas this location has the most human activity, meanwhile *Karang Pon-Pon* almost no human activity shows a high dominance value. However, the species that dominate is *Acropora* sp which is a species in an excellent aquatic.

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