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Coral Bleaching Percentage in Krueng Raya Waters, Aceh Besar

Chitra Octavina[a*], Zahratul Hayati Asri[b], Syahrul Purnawan[c], Maria Ulfah[d]

[a,b,c]*Departemen of Marine Science, Faculty of Marine and Fisheries, Syiah Kuala University, Aceh Province, Indonesia 23111*

[a]*Email: chitraoctavina@unsyiah.ac.id*

Abstract

Coral bleaching happened in some district coincidentally that caused by rising of sea surface temperature level through climate change phenomenon. Krueng Raya Water, Aceh Besar district was one of district which affected by its impact. This research explained the percentage of bleaching index in Krueng Raya water on 3 research station which were Lhok Me, Ahmad Rhang Manyang and Inong Balee. On June 2016, the highest bleaching index occurred in Inong Balee station with 55.5% and the lowest bleaching index occured in Ahamd Rhang Manyang with 79.44%. On August 2016, the highest bleaching index occured in Lhok Me station with 94.93% and the lowest bleaching index occured on Ahmad Rhang Manyang station with 28.64%. The result of this resarch indicated that temperature was one of coral bleaching cause. Not only geographical location,but also the composition of coral communities can affect coral bleaching event.

Keywords: bleaching index; coral bleaching; coral reefs; climate change; temperature.

1. Introduction

Coral reefs are massive deposits of calcium carbonate that are symbiotic with small algae called zooxanthellae [10]. The symbiosis between zooxhanthellae and corals is a symbiotic mutualism. Algae photosynthesize with the help of sunlight to produce the oxygen which is needed by corals, while corals release carbon dioxide as a result of the respiration process required by zooxhanthellae. Almost 75-99% of the coral food supply is given by zooxhanthellae, so this algae is very important for the survival of coral reefs [12].Coral reefs are the main oxygen contributor in the sea so its existence is so vital for all biotic components that live in its environment.

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* Corresponding author.

In addition, coral reefs have other important roles such as (1) as nursery ground and feeding ground and (2) as fishing ground for fishermen. Not only ecological functions, these ecosystems also become a source of protein for humans.

Coral reefs are very vulnerable animals affected by the environment. This is the reason why coral reefs are one indicator of water quality. Significant changes in environmental conditions (such as temperature) may lead to coral bleaching conditions. Coral bleaching is an event of loss of zooxhanthellae in coral animals. Algae gives color to the corals of yellow and brown attached to each coral animal (coral polyps) and it is estimated there are about 1-5 million zooxanthellae cells in each 1 cm^2 of coral surface area [10].

Coral bleaching occurred in 1998 ranging from 74% white and 70% white and dead. In 2002, almost 72% turned white and> 5% recovered. Then in 2006, it was recorded that almost 98% was white and 39% died, whereas in 2010 80% of corals were declared white and 40% dead [9].

In early January of 2016, NOAA has sent an early warning of coral bleaching that will occur in early March 2016 as a result of a rise in ocean temperatures caused by El-Nino. After the NOAA warning came out, there has been a mass coral bleaching globally until Indonesia and 15 provinces in Indonesia recorded coral bleaching such as Aceh province, West Sumatera, Central Java, East Java, Bali, NTB, NTT, Maluku, West Kalimantan, East Kalimantan, South Sulawesi, Gorontalo, North Sulawesi and Raja Ampat [5]. Based on information obtained from NOAA also states that the Aceh region affected by the El-Nino effect is the exposure of the west coast of Aceh. However, some communities also reported that this incident also occurred in the east coast of Aceh. Therefore, the Inong Balee, Ahmad Rhang Manyang, and Lhok Me areas were selected as the area representing the east coast of Aceh with the coral cover quite well affected by the El-Nino.

This incident needs to be followed up because the major impact of this disaster is the loss of coral reef ecosystem which is a world underwater forest. Based on all the important roles and effects of these events, it is necessary to have information about these events and to proceed with special treatment to preserve the coral reef ecosystem for the survival of biomes. Therefore, the purpose of this study was to analyze the level of coral bleaching in the waters of Aceh Besar, as well as to know which coral genes are resistant and susceptible to temperature changes.

2. Materials and Methods

Coral bleaching research was conducted in Krueng Raya Watershed, Mesjid Raya Sub-district, Aceh Besar District. This research was conducted in June and August 2016.

The tools used in this research are skin diving equipment, underwater stationery (slate and pencil), thermometer, Coral Identification Book, Global Positioning System (GPS) and Underwater Camera.

Determination of the retrieval station is done by random sampling technique at 3 locations ie Inong Balee, Ahmad Rhang Manyang and Lhok Me. This study was conducted along the edge of the reef by observing the coral genus colonies at depths of 3-6 m. The corals were recorded by randomly swimming 10 strokes, then

recording all coral genus colonies with a radius of 2 m and this process was repeated as many as 30 repetitions [6].

Each colony is identified in its genus and grouped into six categories: (1) not white (normal), (2) pale, (3) 0-20% white, (4) 20-50% white, (5) 50-80% white, (6) 80-100% white. The grouping method or color level change was originally described by Gleason (1993), recently used by [6], and authorized by [3].

2.1. Data Analysis

The Coral Bleaching index or bleaching index is calculated from the percentage of observations in each of the six coral bleaching categories, referring to McClanahan (2004) which is denoted as follows:

$$\text{Bleaching Index (BI)} = \frac{(0c1+1c2+2c3+3c4+4c5+5c6+6c7)}{6}$$

Where: BI = Bleaching Index (%), C1 = Not white (normal), C2 = Pale, C3 = 0-20% White, C4 = 20-50% White, C5 = 50-80% White, C6 = 80- 100% White, C7 = death

3. Result and Discussion

3.1. Sea Surface Temperature

Sea surface temperature recorded daily by NOOA showed an increase in sea surface temperature around Krueng Raya waters in June and August 2016. The temperature rise was also measured in situ at a research station and found temperatures in these waters by 33 ° C in June and 32 ° C in August 2016. The temperature observation at the research station showed that the optimum temperature value for coral growth was 26-28 °C [2] was exceeded. Shifting the water temperature from the optimum temperature can be one of the top causes of coral bleaching [16].

3.2. Coral Bleaching Percentage

The observed percentage of coral bleaching in Krueng Raya at baseline was 24% and decreased by 4% in the second observation month. Observations on the percentage of white corals, i.e, in the range of 0-20%, 20-50%, 50-80%, and 80-100% range, all indicate a decrease in percentage in August compared to June 2016. A more significant decrease occurred in the range white reefs 80-100%, which in June 2016 showed a value of 38% and fell by 2% in August 2016.

The decrease in white coral percentage was 80-100% followed by increased coral mortality. The reef death in June 2016 was recorded at only 9% and increased rapidly to 53% in August 2016. [16] explains that corals that experience partial or complete bleaching may lead to coral mortality.

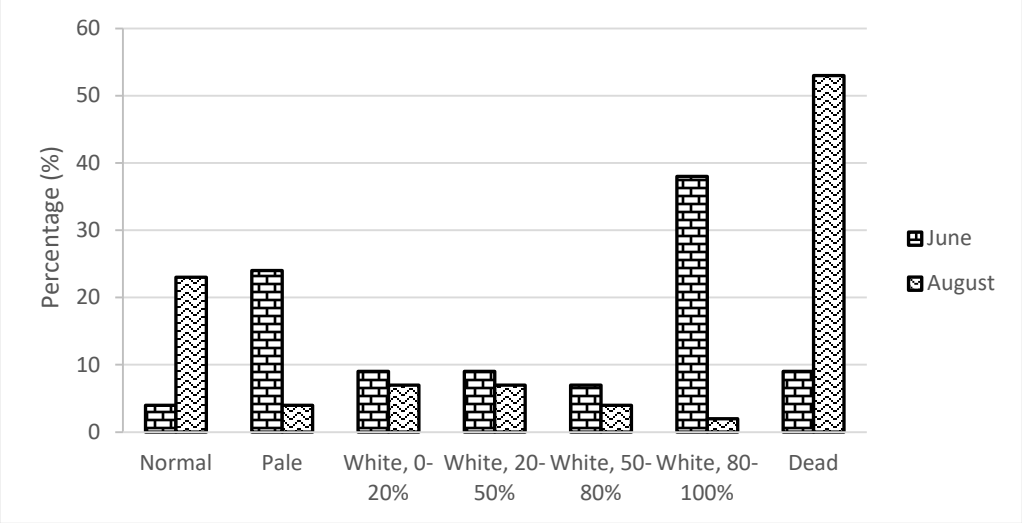


Figure 1: Percentage of coral bleaching in June and August 2016

Real conditions in the Krueng Raya area during the observation month from June to August 2016 showed that intense intensity of the sun followed by low rainfall in the Krueng Raya area caused the heat to be stored longer at sea level.

Therefore, the indication makes the Krueng Raya area to face the accumulated pressure on coral reefs at 3 research stations seen from the total coral bleaching of each category in June 2016 of 82%.

The same is true in Navassa Island, US where continuous temperature pressures rise up to> 30 ° C and intense sunlight illuminates these waters causing corals that live in shallow water to tend to whiten [8].

In the continuous and long-term pressure of causing death for coral animals [4].

3.3. Coral Bleaching Index (Bleaching Index)

The bleaching index found on each station in Krueng Raya has varied values seen in Figure 4.3. Overall, the coral bleaching index in June 2016 varied with a range of 41.32% to 79.44%.

The highest index of bleaching in June occurred in Inong Balee which was 79.44%.

The high level of coral bleaching in the Inong Balee region can be due to the contour structure in the region is slope and has the dominant coral structure structure in the shallow depth.

At shallow depths, enabling environmental stresses on coral reefs to be quite high in the area due to intense and direct sunlight exposure causing easier absorption of corals.

The lowest coral bleaching index in June 2016 is in the waters of Ahmad Rhang Manyang with a value of 41.32% compared to the other two stations.

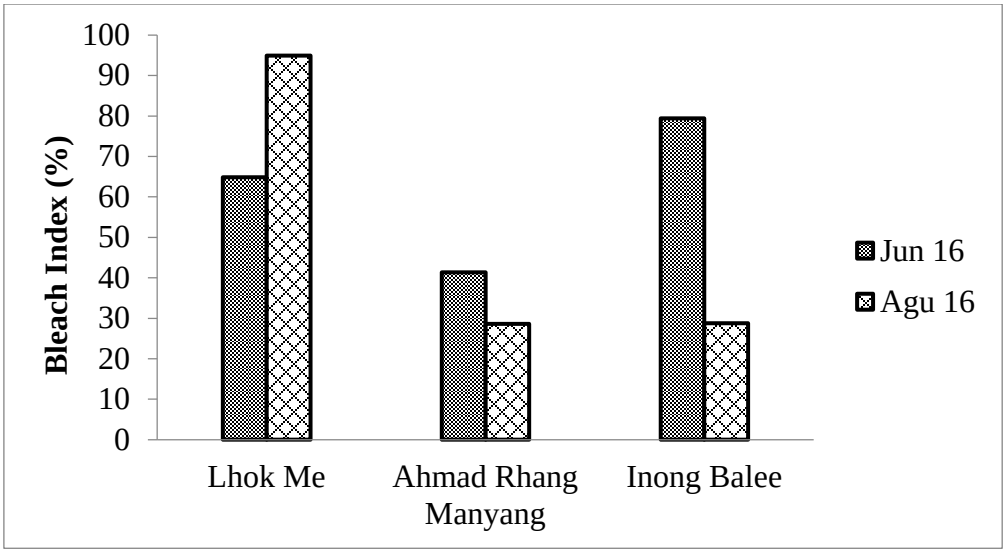


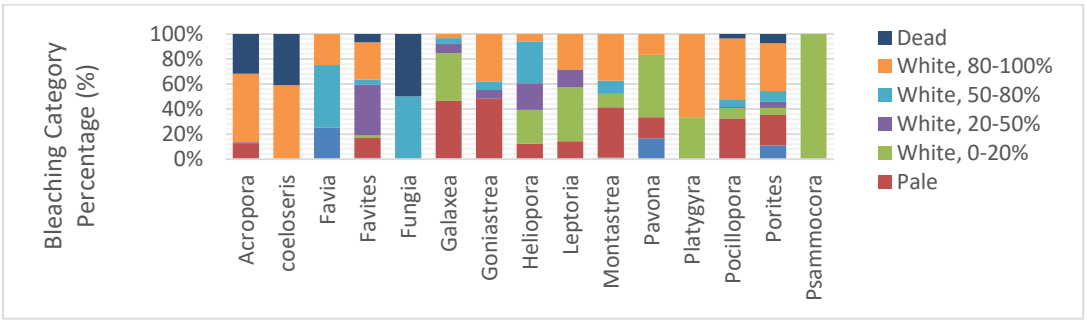
Figure 2: Whitening Index Charts in Krueng Raya

This variation in value is generally caused by several factors such as uneven distribution of temperature, current patterns that bring warm water to the region, salinity, topography of the waters, sunlight to sedimentation [15]. The coral bleaching index provides information on the level of coral bleaching in a region. The higher the coral bleaching index value, the higher the bleaching rate occurring in the region and vice versa. The lower the coral bleaching index value at a station, the lower the bleaching in the area.

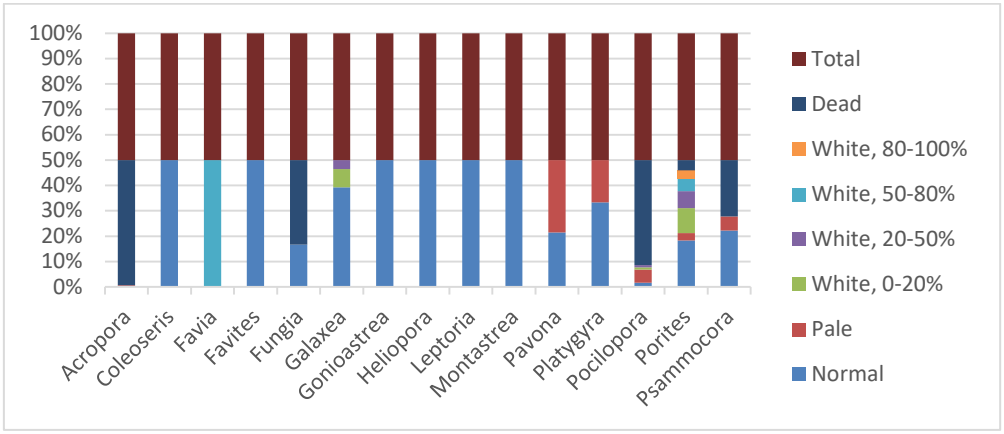
3.4. Coral Bleaching and Death Rates

Acropora experienced considerable bleaching compared to other coral colonies, whereas in the following months *Acropora* suffered a high mortality. Unlike the coral *Coleoseris, Favites, Goniastrea, Leptoria* and *Montastrea* that can return to normal after facing considerable pressure in June 2016. This is because the five lifeform corals are shaped massive (massive) which is very different from *Acropora* in the form of branching (branched). The coral community structure in a region also has a role to play in coral reef resilience and resilience. Based on [17], coral species have different responses to bleaching factors because different Zooxhanthellae can confront and adapt to different bleaching pressures. Therefore, the ecosystem order also has an influence on the resilience of a coral reef ecosystem. [6] suggest that in comparison with the intensity of illumination absorbed in waters, coral species composition can protect the fairness of bleaching phenomena in the Great Barrier Reef, Australia or vice versa. The coral reef ecosystem in Krueng Raya waters differs from station to station. Ahmad Rhang Manyang Beach and Inong Balee Castle Fortress has a coral reef structure that is almost the same coral reef structure which is dominated by massive rocks (massive). In contrast to the coral reef ecosystem in Lhok Me. Lhok Me has a coral reef structure in dominance by branching and branching (tabular) causing high-risk vulnerability. According to [14] the genus of a very sensitive and susceptible to the temperature change is *Acropora* and *Pocillopora* where *Acropora* is one of the genus of corals with branching and tabular forms. In August 2016, there was an increase and decline in Krueng Raya. The decline of coral bleaching index occurred in Ahmad Rhang Manyang area with 12.58% difference from index which was found that is 28,65%. Not only Ahmad Rhang Manyang, Inong Balee also decreased the bleaching index by 50.68%

from the index obtained with a value of 28.76%. The opposite happens in Lhok Me. Lhok Me experienced an increase in the bleaching index by 30.04%, so the bleaching index obtained was 94.93%. Based on the research results, the highest coral bleaching index was found in Lhok Me. This increase in value is due to the structure of coral communities in Lhok Me waters in the dominance of branching and branch crops (tabular) which are highly vulnerable to changes in environmental conditions so that corals in this region are unable to recover (recovery) from bleaching and culminate in dead. The lowest coral bleaching index is found in Ahmad Rhang Manyang. This is caused by the geographical location of Ahmad Rhang Manyang beach which is flanked by two hills and is blocked by a small island so that the current pattern that carries the temperature distribution is not parallel to the coastline. In addition, the reef structure in this region is dominated by massive corals that tend to be more resistant to changes in environmental conditions [1].



(a)



(b)

Figure 3: Percentage of coral bleaching and mortality categories based on genus levels June 2016 (a) and August 2016 (b)

In June 2016, the percentage of coral bleaching accounted for 87% and decreased by 23% in August 2016. While the percent of coral mortality in June 2016 was 9% and increased by 53% in August 2016. Similar research also [14] on Sabang Weh Island explaining the bleaching condition that is too long (> 10 weeks) can cause coral polyp death. This bleaching occurs due to unusual temperature changes due to weather changes affecting the aquatic environments of the region. The temperature rise occurring at the research station in June

2016 was higher than that of August 2016 which made corals difficult to recover due to the considerable rise in temperatures and intolerable coral reefs and mass coral mortality. In addition to the dramatic increase in coral mortality, the percentage of normal corals also increased from 4% in June 2016 and increased by 24% in August 2016. This figure concludes a 20% recovery process from June 2016. Although the percentage of bleaching is very small, but the reefs in this region are capable of recovery (recovered). According to [10] corals that have experienced a critical point at the optimum temperature of 36^{o}C then the coral can experience the potential for self-recovery. The coral events can survive even though the external environment is still high enough to be characterized by: (a) incomplete bleaching, in which the Zooxhanthella is still normal in living polyp tissue in both position and quantity; (b) Zooxhanthella repopulation occurs rapidly. Conversely, if bleaching occurs in total and can significantly cause death in coral biota.

4. Conclusion

Based on the results of research on coral bleaching in June and August 2016 it can be concluded that coral bleaching occurring in the waters of Krueng Raya Aceh Besar in June 2016 and August 2016 experienced 55.9% is bleaching. The most resistant coral genera to temperature changes are *Coleoseris, Favites, Goniastrea, Leptoria* and *Montastrea*, whereas the non-surviving genus is *Acropora*. This is because the genera *Coleoseris, Favites, Goniastrea, Leptoria* and *Montastrea* have massive life forms (chunks) while the genus *Acropora* has a branching (branching) life form.

5. Recommendation

Based on the results of this study, further research is needed in the term longer to see the overall recovery process in the region that. Coral tagging on bleached corals too needed to see changes in community structure to the genus level.

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