Destruction level on coral reef in the Ambon bay

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Abstract. Ambon Bay is a part of Amboin Island located at the Eastern Indonesia. The bay has
an area of 124.5 km², and consists of a shallow inner bay and a deeper outer bay. Ambon bay
has a complete tropical ecosystem of coral reef ecosystem, sea grass area and mangrove
ecosystem including natural resources which associated to those three ecosystems. Monitoring
result on coral ecosystem had been done for 33 years from 1986 – 2019 indicated the
percentage of coral cover age were declined. On 1986, percentage coverage of live coral was on
good category (coverage percentage of live coral >50%), but on the last 30 years shown
declaring. Percentage of live coral coverage is on very good category, and then turned to good
category, then to amber until worst. Few location at Ambon Inner Bay (IAB) Halong and Kate
Kate) even have no more coral reef now, live coral coverage is 0%. This is caused by
sedimentation of land clearing at the higher level and solid trash. It is suggested to restore the
coral reef ecosystem by transplantation technique and reduce the trash into the coral reef area.

1. Introduction
Ambon Island has a semi-enclosed (enclosed bay) with an area of 124.5 km² consisting of 2 parts,
namely the Inner Ambon Bay (IAB) and the Outer Ambon Bay (OAB). The two bays are separated by
a narrow and shallow sill with a depth of 8-15 m and a width of 0.5 km which is located between the
villages of Poka and Galala [1]. The width of IAB is 2.5 km² with average depth of 26 m. The OAB is
relatively open water and connected to the Banda Sea with increasing depths (600 m) at the mouth of
the bay. The existence of a threshold causes the exchange of water mass in IAB to last for about 17
hours [2, 3], so that if there is continuous and rapid contamination (household waste, sedimentation,
etc.) will be trapped in IAB.

Mangroves, seagrass and coral reefs in the Ambon Bay are experiencing symptoms of decline in
terms of area, cover and species for the past 35 years. The area of mangrove forests in Ambon Bay
continues to decrease along with the rapid rate of deforestation [4]. The percentage of live coral
coverage has decreased over the last 35 years due to the increasing sedimentation and solid waste in
Ambon Bay [5]. Due to the solid waste in Ambon Bay, the study of Indonesian Institute of Sciences
has reported the exponential increasing of solid waste especially plastic waste in Ambon Bay in 30 years [6, 7].

Spatial and ecologically, the coastal of Ambon Bay are related to the upper land used. The management of coastal and marine areas in Ambon Bay cannot be separated from environmental management carried out by these activities. Environmental impacts arising from development activities in the upper land, such as agriculture, plantations, forestry, industry, settlements, transportation activities, aquaculture in Ambon Bay will have a direct impact on the condition of coral reefs in Ambon Bay. In addition, the water quality parameters (chemistry and physics) include temperature, turbidity, chlorophyll, total suspended solids salinity (TSS) and acidity (pH), dissolved oxygen and salinity has impacts to the existence coral reefs in the Ambon Bay. This paper determined the rate of damage to coral reefs in Ambon Bay for the last 35 years and the factors causing the damage of coral reefs in the Ambon Bay.

2. Methodology

A descriptive correlational method was used to explain the level of coral damage in Ambon Bay with environmental factors as the main cause that influenced the damage to coral reefs [8]. Environmental factors and anthropogenic activities such as upper land used, sedimentation, and water quality parameters (environmental materials) related to marine biota are the main parameters that become aspects of this study. The method for obtaining information and data obtained for each parameter was obtained in situ and from literature studies.

2.1 Coral reef data collection

Coral reef data collection was observed with permanent transect using Line Intecept Transect (LIT) at 8 locations in Ambon Bay, where 6 observation locations were in the OAB and 2 observation locations in the IAB (the map and the coordinates of the monitoring points described in in Figure 1 and Table 1) [9]. This method is used to obtain data on the intersection of abiotic and biotic components at the bottom of reef waters. A plastic meter measuring 100 m is placed parallel to the shoreline in the coral reef area following the contours, then all biota that are directly below the transect line are recorded based on growth forms with accuracy to centimeters. The data obtained were analyzed using the “Life Form” program. This program calculates the percentage cover and the number of occurrences from each category and the length of each taxon found in line transects. In addition, for inventorying of coral species, a “Free Collection” was also carried out around the transect area and “Photographing” the coral species found. The types of stony corals that were not identified in-situ were sampled/photographed and then identified in the laboratory according [10 – 13]. To assess the condition of coral reefs, the analysis results obtained then classified into four categories [14], as follows:

• Category 1 (Highly damaged) percent cover of stony coral between 0 - 24.9%.
• Category 2 (damaged) percent of coral reef cover between 25 - 49.9%.
• Category 3 (Good) percent coral reef cover between 50 - 74.9%.
• Category 4 (Very good) percent coral cover between 75 - 100%.

The percentage cover of biota is calculated as follows:

\[
\text{The percentage cover of biota} = \left(\frac{\text{total length of a category of biota/ transect rope length}}{\text{transect rope length}}\right) \times 100\% \quad (1)
\]

2.2 Coral mortality index (IM)

A formula by [9] is used to calculate the coral mortality ratio as follows:

\[
\text{IM} = \frac{\% \text{ dead coral cover}}{\% \text{ closure (dead coral + live coral}}} \times 100\% 
\]
Figure 1. 8 sites of transect coral in the Ambon Bay

Table 1. Detail site location of monitoring coral reef in the Ambon Bay

| Location           | Latitude  | Longitude    |
|--------------------|-----------|--------------|
| Liliboy            | 3,761028 LS | 128,021333 BT |
| Hative besar       | 3,678444 LS | 128,137972 BT |
| Eri                | 3,747306 LS | 128,129278 BT |
| Batu capeu         | 3,660528 LS | 128,150194 BT |
| Poka               | 3,662583 LS | 128,197278 BT |
| Kota Jawa Rumahtiga| 3,662583 LS | 128,179722 BT |
| Halong             | 3,659278 LS | 128,208056 BT |
| Hunuth             | 3,633143 LS | 128,211874 BT |

2.3 Upper land used
Data and information related to the upper land used, obtained through secondary data according to previous studies [8, 15 – 16]. The data of land used in Ambon Island has analyzed by multi-temporal data Landsat satellite imagery with various sensors, such as MSS (Multi Spectral Scanner) on Landsat 1, 2, 3, 4 and 5. Sensor TM (Thematic Mapper) on Landsat 5, and ETM sensor (Enhanced Thematic Mapper) on Landsat-7. The satellite imagery data used are from 1972 (Landsat-1 MSS), 1985 (Landsat-5 MSS), 1993 (Landsat-5 TM), 1997 (Landsat-5 TM), 2001 (Landsat-7 ETM) 2006 (Landsat-7 ETM) and 2012 (Landsat L-7 LTM +).

2.4 Observation of Oceanographic physical and chemical parameters
Data and information related to oceanographic physical and chemical parameters measurements obtained from Ambon Bay monitoring conducted by the Research Center for Deep-Sea (National Research and Innovation Agency) since 2008 to 2021, including temperature, salinity, density, irradiance, dissolved oxygen (DO), chlorophyll, turbidity, and light transparency. These data was carried out by conductivity depth (CTD) profiler SBE-19V2, and current meter Alec Compact-EM. 9. Meanwhile, measurement of the quality of chemical parameters, seawater and nutrient conditions conducted by a Van Dorn tube at two depths (0 meters and 10 m). Water samples were analyzed for DO and pH in-situ using Hanna Instruments 98196 Multipara meter. The seawater sample which was placed in a sample bottle made of polyethylene was filtered using a Büchner funnel before being brought to the laboratory for analysis of phosphate, nitrite, nitrate, and silicate by spectrometric method using a Shimadzu 1700 UV-VIS spectrophotometer [17].
2.5 Analysis of Coral Reef Condition with upper land used and Oceanographic Physical-Chemical parameters.

In order to find out whether the impact of land clearing on Ambon Island which causes sedimentation and the influence of oceanographic physical-chemical parameters can affect the condition of Ambon Bay coral reefs, multiple linear regression analysis is used which is described by the following equation:

\[ Y = \alpha + 1 \times X_1 + 2 \times X_2 + n \times X_n + e \]

Where

- \( Y \) = dependent variable
- \( \alpha \) = constant
- 1, 2 = regression coefficient
- \( X_1, X_2 \) = independent variable

3. Result and Discussion

3.1 The impact of land clearing to the coral reef condition

Monitoring with permanent transects at eight locations in Ambon Bay showed that the condition of coral reefs has decreased in the percentage of live coral coverage over the last 35 years. This is in line with the results of the analysis of monitoring of land clearing using Landsat satellite imagery from 1972 - 2012 in the Ambon Island. In 40 years, through the analysis of the Ambon Island vegetation index, it is known that there has been an increase in open land from 31.2 ha to 714.2 ha, while dense vegetation has decreased from 12,389 ha to 10,119.9 ha (Table 2).

| Land Cover Classification | Color Code | Okt-72 | Mar-88 | Apr-90 | Nov-93 | Jan-98 | 01-Mar | 03-Feb | 06-Mar | 09-Feb | 12-Feb |
|---------------------------|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Open Field                |            | 31,2   | 51,3   | 124,6  | 135    | 714,2  | 24,6   | 119,6  | 130,3  | 184,1  | 305,2  |
| Low Vegetation            |            | 126,4  | 147    | 313,2  | 168    | 577,6  | 98,6   | 171,6  | 161,2  | 326,8  | 399,4  |
| Medium Vegetation         |            | 757,7  | 628,2  | 591,6  | 795    | 1892,9 | 489,8  | 597,4  | 719,5  | 1264,7 | 14960,7|
| Dense/very dense Vegetation|          | 12389,3| 12478,1| 12275,2| 12206,5| 10119,9| 12691,7| 12416  | 12293,6| 11550  | 11124,3|
| Sea and Land              |            | 213594 | 213594 | 213594 | 213594 | 213594 | 213594 | 213594 | 213594 | 213594 | 213594 |
| Total                     |            | 226899 | 226899 | 226899 | 226899 | 226899 | 226899 | 226899 | 226899 | 226920 | 226920 |
| Satellites and sensor     |            | L-1 MSS| L-3 MSS| L-5 TM | L-5 TM | L-7 ETM| L-5 TM | L-5 TM | L-5 TM | L-5 TM | L-7 ETM|

1972 very small open land, 1998 became land
1972 medium/highly vegetation very extensive; 1998 decrease
2000-2001 Ambon riots many people leave Ambon reduced human activity
2001 open land becomes small, 2012 becomes large again
2001 extensive dense vegetation return to dense, 2012 decrease
The land clearing in the catchment area and along the watershed has a direct effect on the amount of material that will be transported to the sea through the erosion process which will eventually empties into the sea. Accumulation of sediment in IAB between 1982 and 2008 (26 years) showed a positive value, where there was an increase in sea level height due to accumulation of sediment with an average accumulation value of 0.03 meters/year (3 cm/year) in IAB [9]. Meanwhile, the previous study in 1987 [18] showed that the sedimentation process spread evenly across the bottom of IAB waters was 5.95 mm/year, or about 0.6 cm/year. Compared to the latest study in 2008, it can be seen that the average sediment accumulation in IAB has increased by 2.4 cm/year or about 6 times higher than in 1987 [9, 18]. Another study reported the modelling movement of sediment at the highest and lowest tide conditions in the Ambon Bay [19]. The average depth in the initial modelling conditions is 0.1 m per day while at the highest tide is 0.015 m per day with the dominant direction towards IAB. At low tide the sediment transport becomes 0.06 m per day with the dominant direction towards OAB. Changes in the direction and magnitude of this displacement are influenced by the speed and current in the two conditions of different magnitudes. Land clearing causing sedimentation impact on the percentage of live coral cover that has been degraded for the last several time periods can be seen in Table 3.

Table 3 and Figure 2 showed the percentage coverage of hard coral that still survives with live coral conditions. From these data, only three locations that in the Good category, namely: Liloboy, Eri and the city of Java. The three locations are in OAB where the impact of sedimentation and solid waste has little effect on the Banda Sea and there is no influence of large rivers flowing in Ambon Bay.

| Site Parmanet Transec | 1987 | 2007 | 2009 | 2012 | 2015 | 2017 | 2019 |
|----------------------|------|------|------|------|------|------|------|
| Liliboi (OAB)        | 69.23| 41.77| 41.27| 48.33| 60.13| 61.8 | 45.2 |
| Hative besar (OAB)   | 43.3 | 22.4 | 32.5 | 15.63| 14.1 | 16.15| 14.74|
| Eri (OAB)            | 76.4 | 51.1 | 51.4 | 61.33| 78.7 | 81.84| 51.08|
| Batu Capeu (OAB)     | 22.75| 13.87| 17.6 | 13.83| 30.37| 33.21| 11.06|
| Kota Jawa (OAB)      | 63.3 | 53.07| 57.43| 58.97| 48.73| 51.57| 54.64|
| Poka (OAB)           | 56.2 | 62.63| 65.47| 59   | 11.1 | 12.18| 19.3 |
| Halong (IAB)         | 32.5 | 42.9 | 39.7 | 39.93| 9.5  | 10.21| 17.5 |
| Hunuth (IAB)         | 23.1 | 13.1 | 9.6  | 15.43| 8.1  | 10.44| 3.12 |
The results of benthic component monitoring for the last 32 years can be seen in the Table 5-8.

**Table 4.** Total species benthic and reef status of coral reef in Ambon Bay in 1987 and 2007

| Reef Permanent Transect | Total Species | 1987 %Component benthic transec result | reef status | Total Species | 2007 %Component benthic transec result | reef status |
|-------------------------|---------------|----------------------------------------|-------------|---------------|----------------------------------------|-------------|
|                         |               | HC/LF | D/C/DCA | Algae | OT | Abiotic | IM | HC/LF | D/C/DCA | Algae | OT | Abiotic | IM | HC/LF | D/C/DCA | Algae | OT | Abiotic | IM |
| Liliboi (OAB)           | 37            | 69,25 | 11,91 | 0 | 11,5 | 8,24 | 0,05 | 137 | 41,8 | 5,77 | 32,3 | 26,5 | 1,7 | 0,12 | Fair |
| Hative besar (OAB)      | 26            | 43,5  | 10 | 0 | 26,7 | 20 | 0,62 | 178 | 22,4 | 16 | 25,9 | 18,1 | 13,6 | 23,65 | Fair |
| Eri (OAB)               | 37            | 76,4  | 8,3 | 0 | 10,1 | 5,2 | 0,07 | 139 | 51,1 | 16 | 12,9 | 8,2 | 17,8 | 0,16 | Excellent |
| Batu Caperau (OAB)      | 14            | 22,75 | 19,35 | 0 | 25 | 33,1 | 0,62 | 141 | 13,9 | 11 | 10,7 | 35,7 | 20,46 | 0,44 | Fair |
| Kota Jawa (OAB)         | 29            | 63,3  | 11 | 0 | 15,2 | 18,05 | 0,69 | 151 | 53,1 | 18 | 10,7 | 3 | 15,66 | 0,25 | Good |
| Poja (OAB)              | 14            | 56,2  | 2 | 1,5 | 0,5 | 39,8 | 0,78 | 122 | 52,6 | 9 | 10,7 | 1,57 | 18,33 | 0,10 | Good |
| Halong (OAB)            | 25            | 32,5  | 14 | 15,6 | 3,1 | 38,8 | 0,97 | 96 | 42,9 | 26 | 24,4 | 0 | 12,7 | 0,32 | Fair |
| Hunuth (IAB)            | 17            | 23,1  | 3 | 5,1 | 6,8 | 70,3 | 0,98 | 19 | 13,1 | 3 | 6,1 | 6,5 | 77,3 | 0,19 | Poor |

**Table 5.** Total species benthic and reef status of coral reef in Ambon Bay in 2009 and 2012

| Reef Permanent Transect | Total Species | 2009 %Component benthic transec result | reef status | Total Species | 2012 %Component benthic transec result | reef status |
|-------------------------|---------------|----------------------------------------|-------------|---------------|----------------------------------------|-------------|
|                         |               | HC/LF | D/C/DCA | Algae | OT | Abiotic | IM | HC/LF | D/C/DCA | Algae | OT | Abiotic | IM | HC/LF | D/C/DCA | Algae | OT | Abiotic | IM |
| Liliboi (OAB)           | 37            | 137  | 2 | 34,3 | 17,1 | 5,3 | 0,05 | 129 | 48,3 | 0,77 | 32,4 | 13,9 | 4,37 | 0,02 | Fair |
| Hative besar (OAB)      | 26            | 178  | 3 | 21,2 | 22 | 21,4 | 0,88 | 122 | 15,6 | 3,25 | 6,4 | 12,4 | 62,13 | 0,17 | Fair |
| Eri (OAB)               | 37            | 139  | 2 | 91,48 | 4,49 | 28,6 | 0,84 | 129 | 61,3 | 0 | 18,43 | 6,63 | 13,6 | 0,80 | Good |
| Batu Caperau (OAB)      | 14            | 141  | 3 | 23 | 26,4 | 76 | 0,15 | 118 | 13,8 | 14 | 21,3 | 18,2 | 32,8 | 0,50 | Poor |
| Kota Jawa (OAB)         | 29            | 151  | 4 | 26,47 | 1,23 | 18,07 | 0,87 | 131 | 59 | 8,47 | 5,83 | 0,37 | 26,37 | 0,23 | Good |
| Poja (OAB)              | 14            | 96   | 1,1 | 12,8 | 0,3 | 20 | 0,82 | 115 | 59 | 8,97 | 0,81 | 0 | 31,2 | 0,23 | Good |
| Halong (OAB)            | 25            | 96   | 4 | 36,7 | 0,77 | 18,07 | 0,89 | 121 | 59,9 | 20,25 | 15,9 | 31,6 | 0,34 | Fair |
| Hunuth (IAB)            | 17            | 19   | 4,1 | 5,5 | 6,5 | 80,3 | 0,30 | 68 | 15,4 | 10,8 | 0 | 73,77 | 0,41 | Poor |

Figure 2. Percentage of hard coral coverage on reef site Transec in Ambon Bay 1987-2019
Table 6. Total species benthic and reef status of coral reef in Ambon Bay in 2015 and 2017

| Reef Permanent Transec | Total Species | 2015 %Component benthic transec result | IM | 2017 %Component benthic transec result | IM | Reef status |
|------------------------|--------------|----------------------------------------|----|----------------------------------------|----|-------------|
|                        |              | HC/LF | DC/DCA | Algae | OT | Abiotic | HC | DC/DCA | Algae | OT | Abiotic | 1987 | 2007 |
| Liliboi                | 129          | 68,13 | 14,33 | 12,1 | 16,5 | 3,14 | 0,32 | 149 | 61,8 | 15,23 | 2,23 | 12,5 | 3,27 | 0,20 | Good | Good |
| Hative besar           | 75           | 14,1 | 28,6 | 7,4 | 14,2 | 34,7 | 0,16 | 83 | 16,2 | 29,6 | 0 | 14,3 | 34,7 | 0,65 | Poor | Poor |
| Eri                    | 135          | 78,7 | 6,53 | 1,3 | 2,2 | 11,27 | 0,37 | 157 | 83,8 | 6,55 | 0 | 2,07 | 24,27 | 0,87 | Excellent | Excellent |
| Batu Capeu             | 113          | 39,27 | 19,87 | 11,6 | 16,1 | 22,96 | 0,21 | 113 | 35,2 | 19,87 | 6,6 | 16,5 | 23,07 | 0,37 | Fair | Fair |
| Kota Jawa              | 136          | 48,75 | 29,9 | 3,3 | 6 | 12,27 | 0,26 | 154 | 71,6 | 29,9 | 0 | 8 | 12,53 | 0,37 | Fair | Good |
| Poka                   | 48           | 11,1 | 53,13 | 2,25 | 4,45 | 29,07 | 0,19 | 54 | 12,2 | 54,5 | 0 | 2 | 22,2 | 0,82 | Fair | Poor |
| Halong                 | 63           | 9,5 | 42 | 14,9 | 2,6 | 31 | 0,13 | 69 | 10,2 | 43,35 | 0 | 0,6 | 31,6 | 0,81 | Poor | Poor |
| Hunuth                 | 24 | 8,1 | 36,3 | 1 | 1,3 | 53,3 | 0,25 | 26 | 10,4 | 36,35 | 0 | 0 | 53,25 | 0,78 | Poor | Poor |

Table 7. Total species benthic and reef status of coral reef in Ambon Bay in 2019

| Reef Permanent Transec | Total Species | 2019 %Component benthic transec result | IM | Reef status |
|------------------------|--------------|----------------------------------------|----|-------------|
|                        |              | HC/LF | DC/DCA | Algae | OT | Abiotic | IM | |
| Liliboi                | 149          | 45,2 | 23,06 | 3,56 | 21,8 | 6,38 | 0,34 | Fair |
| Hative besar           | 83           | 14,74 | 26,48 | 0,36 | 28,4 | 30,02 | 0,64 | Poor |
| Eri                    | 157          | 51,08 | 26,94 | 4,84 | 2,76 | 14,38 | 0,35 | Good |
| Batu Capeu             | 113          | 11,06 | 21,98 | 18,28 | 26,28 | 22,4 | 0,67 | Poor |
| Kota Jawa              | 154          | 54,64 | 21,38 | 4,31 | 5,18 | 14,49 | 0,28 | Good |
| Poka                   | 54           | 19,3 | 55,04 | 1,63 | 3,14 | 20,89 | 0,74 | Poor |
| Halong                 | 69           | 17,5 | 20,32 | 39,48 | 2,14 | 20,56 | 0,54 | Poor |
| Hunuth                 | 26           | 3,12 | 4 | 50,48 | 0 | 42,4 | 0,56 | Poor |

Note: HC/LF: Hard Coral/Live Coral; DC/DCA: Dead Coral/Dead coral covering algae; OT: Other fauna; IM: Index mortality

3.2 The impact of land clearing to the coral reef condition

The results of measuring chemical parameters for the Inner Ambon bay and Outer Ambon Bay locations for the east and west seasons are the results for 10 years (2008 – 2019) described in the Figure 3 – 6.

Figure 3. Chemical parameters during the East Monsoon in the IAB (2008 – 2019)
Figure 4. Chemical parameters during the West Monsoon in the IAB (2008 – 2019)

Figure 5. Chemical parameters during the East Monsoon in the OAB (2008 – 2019)

Figure 6. Chemical parameters during the West Monsoon in the OAB (2008 – 2019)
Based on the data above in accordance with the standard value for the seawater quality in coral reef ecosystem by Indonesian Government decree No.51 of 2004 [20], the average physical and chemical parameters are still within the environmental quality standards for marine biota. There are only two parameters namely; Turbity or turbidity and Dissolved Oxygen (DO) which is above the threshold and below the threshold of the guideline. Turbity in 2012 exceeded the required threshold in the IAB location, while the DO chemical parameter was below the required threshold in 2008 at the IAB and OAB locations in the east and west seasons.

3.3 Plastic waste coverage on coral reef in Ambon Bay

It is estimated by Ministry of Industrial of Republic Indonesia that 4.8 million tons per year of plastic waste in Indonesia is mismanaged. About 9% or 620,000 tons of them are entering the water body (river, lake and ocean). Plastic pollution caused a serious threat to coral reefs because plastics can cover the surface of reef and can role as an agent of disease to the reef. The plastics can carry the microbes with them through the aquatic environment and can end up settling in coral reef ecosystems. Once the plastic is entangled in the reefs, these plastics will stay for a long period and wreak havoc on them. Marine debris that gets entangled in coral reefs can damage reef physically. After damaging the coral they expose the coral reefs to microbes [21, 22]. Figure 7 and Figure 8 showed that the coral reef in the Ambon Bay was heavily contaminated with plastic.

![Figure 7. Plastic waste coverage on coral reef in the Batu Capeo (OAB) site](image1)

![Figure 8. Plastic waste coverage on coral reef in Rumah Tiga site](image2)
3.4 Analysis of Coral Reef Condition Relationship with Top Land Clearing and Physical - Chemical Parameters

In order to determine whether the impact of land clearing on Ambon Island which causes sedimentation and the influence of oceanographic physico-chemical parameters affect to the health of coral reefs, multiple linear regression analysis using MINITAB 7 software was used. The time period for the analysis is 7 years. The data used are separated for IAB and OAB which for the east season with high rainfall and the west season with low rainfall (Table 8 – 11).

Table 8. Multiple Linear Regression during East Monsoon in the IAB

| Year | % Coverage up land (X1) | Temperature (X2) | Salinity (X3) | Chl (X4) | Turbidity (X5) | pH (X6) | DO (X7) | % Coverage of Hard coral (Y1) | Index Mortality (Y2) |
|------|------------------------|-------------------|---------------|-----------|----------------|---------|---------|-------------------------------|---------------------|
| 1    | 31.2                   | 27,845            | 32,426        | 1,190     | 1,060          | 8,18    | 3,34    | 27,80                         | 0.18                |
| 2    | 51.3                   | 26,155            | 32,864        | 0,649     | 0,856          | 7,73    | 5,97    | 28,00                         | 0.96                |
| 3    | 124.6                  | 26,758            | 28,548        | 1,102     | 5,434          | 7,75    | 4,97    | 24,65                         | 0.02                |
| 4    | 714.2                  | 26,597            | 33,341        | 1,169     | 0,444          | 8,02    | 6,30    | 27,68                         | 0.38                |
| 5    | 24.6                   | 26,176            | 33,986        | 1,495     | 0,479          | 7,43    | 6,03    | 8,80                          | 0.82                |
| 6    | 130.3                  | 26,542            | 33,693        | 0,714     | 0,898          | 7,43    | 6,38    | 10,32                         | 0.80                |
| 7    | 305.2                  | 27,094            | 32,920        | 0,648     | 0,753          | 08.01   | 6,16    | 10,31                         | 0.55                |

Table 9. Multiple Linear Regression during West Monsoon in the IAB

| Year | % Coverage up land (X1) | Temperature (X2) | Salinity (X3) | Chl (X4) | Turbidity (X5) | pH (X6) | DO (X7) | % Coverage of Hard coral (Y1) | Index Mortality (Y2) |
|------|------------------------|-------------------|---------------|-----------|----------------|---------|---------|-------------------------------|---------------------|
| 1    | 31.2                   | 29,539            | 33,597        | 0,440     | 0,563          | 8,15    | 4,430   | 27,80                         | 0.18                |
| 2    | 51.3                   | 29,542            | 33,708        | 0,527     | 0,685          | 8,1     | 4,120   | 28,00                         | 0.96                |
| 3    | 124.6                  | 29,397            | 33,823        | 0,714     | 0,623          | 7,95    | 5,450   | 24,65                         | 0.02                |
| 4    | 714.2                  | 28,600            | 33,802        | 0,443     | 0,527          | 8,11    | 6,390   | 27,68                         | 0.38                |
| 5    | 24.6                   | 28,888            | 33,719        | 1,060     | 0,555          | 7,61    | 6,300   | 8,80                          | 0.82                |
| 6    | 130.3                  | 29,580            | 32,808        | 0,291     | 0,388          | 7,76    | 5,750   | 10,32                         | 0.80                |
| 7    | 305.2                  | 29,361            | 33,784        | 0,679     | 0,625          | 02.52   | 5,290   | 10,31                         | 0.55                |
Based on the results of linear regression analysis, % coverage up land on Ambon Island has a significant effect on the mortality index where the value (p < 0.05). This clearly showed that land clearing on has a huge impact on coral mortality rates in Ambon Bay Waters. This is due to land clearing without following the environmental impact analysis procedure. It suggested to restore the condition of coral reefs by planning land clearing in a planned manner by conducting a thorough environmental impact analysis study. Rehabilitation of coral reef ecosystems through coral transplantation and artificial coral reefs can be a solution to gradually restore coral reef conditions.

4. Conclusion
Spatial and ecologically, the coastal and marine areas of Ambon Bay are related to the upper land (land). This is caused by the coastal area is a meeting area between land and sea, so that the management of the coastal and marine areas of Ambon Bay cannot be separated from the environmental management carried out by the coastal and marine areas. It suggested to restore the condition of coral reefs by planning land clearing in a planned manner by conducting a thorough environmental impact analysis study. Rehabilitation of coral reef ecosystems through coral transplantation and artificial coral reefs can be a solution to gradually restore coral reef conditions.
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