Environmental Conditions in Karimunjawa to Support the Integrated Multi-Trophic Aquaculture (IMTA) Program

Anita Kusuma Wardhani[1], Muhammad Zikra[1], Bambang Semedi[2] and Agung Setyo Mukti[2]

[1]*Department of Ocean Engineering, Institut Teknologi Sepuluh Nopember (ITS), Surabaya, Indonesia*

[2]*Department of Marine Science, Faculty of Fisheries and Marine Science, Brawijaya University, Malang, Indonesia*

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Abstract: Karimunjawa National Park is a nature conservation area managed by the zoning system. Of the 9 zones that have been determined, one of them is the Maritime Cultivation Zone which is intended to support the interests of aquaculture. Aquaculture based on Integrated Multi-Trophic Aquaculture (IMTA) is a development system that supports cultivation by integrating a variety of different species. This study aims to analyze the suitability of Karimunjawa waters based on the measurement of environmental parameters such as temperature, DO, Ph and current salinity to support IMTA in Karimunjawa waters and observe the coral reef ecosystem as a supporter of assessing the condition of the aquatic environment. Based on the results of measurements of environmental parameters, the results obtained are still relatively good quality based on water quality standards. The average water temperature is 29.7 ° C, dissolved oxygen (DO) is 7 mg / l, pH is 8.1 and salinity is 32.7 ppt.

1 INTRODUCTION

Karimunjawa National Park is designated as a nature reserve area located in Jepara Regency, Central Java Province in Decree of the Minister of Forestry and Plantation No. 78/Kpts-II/1999 dated February 22, 1999, with an area of 111,625 hectares (BTNKJ, 2019). In Law No.5 of 1990 concerning Conservation of Natural Resources and their Ecosystems defines national parks as Nature Conservation Areas that have native ecosystems, managed with zoning systems that are utilized for research, science, education, supporting cultivation, tourism and recreation. Based on Decree of the Director General of PHKA No. SK 28/IV-SET/2012 concerning Zoning of Karimunjawa National Park, currently there are 9 (nine) zones within the Karimunjawa National Park area. The zoning of Karimunjawa National Park is fully presented in Figure 1. From 9 zones that have been determined, one of them is the Maritime Cultivation Zone, which is intended as a supporter of the interests of aquaculture such as seaweed cultivation, floating net cages with due regard to conservation aspects.

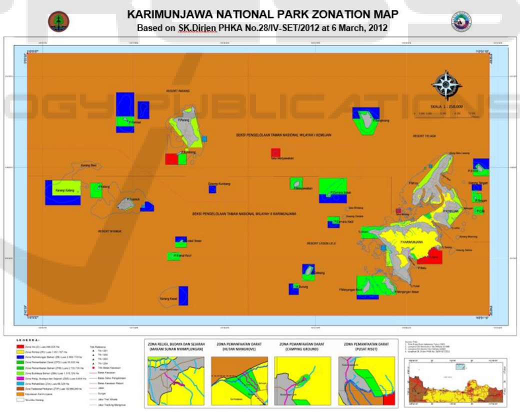

Figure 1: Zoning Map of Karimunjawa National Park.

Integrated aquaculture (integrated multi-trophic aquaculture / IMTA) is an innovation in the development of an aquaculture system that is applied to address the issue of the impact of aquaculture activities on the aquatic environment including sedimentation and enrichment of aquatic nutrients (Radiarta et al., 2014; 2015; Alexander et al., 2016). The IMTA system combines several different trophic-level species, between species that are fed (eg fish) and species that absorb inorganic material (eg seaweed) and species that absorb

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organic matter (suspension and deposit feeders such as shellfish) Troell et al., 2009; Barrington et al., 2009).

The implementation of the IMTA system not only produces high economic value biomass through product diversification but can also reduce waste entering the waters. In the IMTA system, waste generated from the main commodities that enter the waters will be converted and utilized by species absorbing organic and inorganic materials. The selection of commodities for the IMTA system is very flexible, can be adjusted to commodities that have developed in an area be it fish, seaweed, or shellfish. The selected commodity is adjusted to its function in the ecosystem and is a commodity with high economic value. By choosing the right cultivation species, this IMTA system will reduce the organic and inorganic content of nitrogen, carbon, and phosphate; making this system a candidate in nutrient trading credits (Chopin et al., 2010; Yuniarsih et al., 2014).

Analysis of the suitability of the condition of the waters of Karimunjawa National Park with the measurement of environmental parameters such as temperature, salinity, DO, and pH, as well as observation of marine aquatic ecosystems such as coral reefs, needs to be done as a first step before the implementation of aquaculture that supports the IMTA system. The IMTA system which is considere to be able to support the conservation aspects is expected to be able to provide more value to the environmental sustainability and fishery products found in the waters of the Karimunjawa National Park.

2 STUDY AREA

The research location is in the waters of the Karimunjawa National Park where the focus of the location is on Karimunjawa Island and Kemujan Island to take samples of water parameters and observe the aquatic environment ecosystem. Sampling is distributed at 7 station points (Figure 2), including Station 1. Harbour, Station 2. Fishing Port, Station 3.Ujung Gelam Beach, Station 4.Mangrove and river mouth, Station 5.Legon Lele/Core Zone, Station 6.Merican Kemujan Island/Utilization Zone of Seaweed Cultivation.

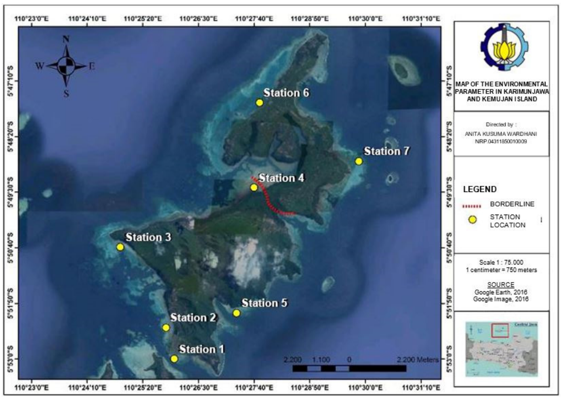

Figure 2: Map of Research Location.

3 METODHOLOGY

Parameter measurements are performed at 7 station points with 3 repetitions at each station point to get valid results. In this activity, fishing boats are used to go to 7 predetermined station points with the help of Global Positioning System (GPS) to obtain location accuracy (Figure 3).

Figure 3: Global Positioning System (GPS) as a Guide to 7 Station Points.

Figure 4: Water Quality Measurement using Refractometer for Salinity.

Figure 5: Water Quality Measurement using DO meter and pH meter.

Temperature measurement using a thermometer, salinity measurement using a refractometer (Figure 4), dissolved oxygen (DO) measurement using a DO meter and pH measurement using a pH meter (Figure 5).

The results of the measurement of environmental parameters are entered in the Surfer software to be processed into a map of the distribution of observed environmental parameters (Figure 7 - Figure 11).

Kriging interpolation is used in data processing to become a map of the distribution of environmental parameters.

Observation of the condition of coral reefs is also done as a consideration to assess quality based on quality standards. Observations were made using the GIS method and then carried out during a field check in the field with snorkelling (Figure 6).

Figure 6: Observation of the Condition of Coral Reefs.

4 RESULT AND DISCUSSION

4.1 Measurement of Water Parameters

Based on 7 predetermined station points, the results of measurements of water parameters include temperature, salinity, DO, Ph, and currents in Table 1 to Table 7.

Table 1: Measurement of Water Parameters at Station 1.

Parameter	Repetition			Average
	1	2	3	
DO (mg/l)	6,9	6,7	6,7	6,76
Temperature (°)	29	29	29	29
pH	8,2	8,2	8,2	8,2
Salinity (ppt)	32	32	33	32,2

Table 2: Measurement of Water Parameters at Station 2.

Parameter	Repetition			Average
	1	2	3	
DO(mg/l)	6,4	6,5	6,5	6,46
Temperature (°)	30	30	29	29,6
pH	8,2	8,2	8,2	8,2
Salinity (ppt)	35	31	31	32,3

Table 3: Measurement of Water Parameters at Station 3.

Parameter	Repetition			Average
	1	2	3	
DO(mg/l)	7,2	7,3	7,6	7,4
Temperature (°)	29	29	29	29
pH	8,2	8,2	8,2	8,2
Salinity (ppt)	32	33	32	32

Table 4: Measurement of Water Parameters at Station 4.

Parameter	Repetition			Average
	1	2	3	
DO(mg/l)	6,9	6,7	7,2	6,9
Temperature (°)	30	30	30	30
pH	8,1	8,2	8,1	8,1
Salinity (ppt)	33	33	33	33

Table 5: Measurement of Water Parameters at Station 5.

Parameter	Repetition			Average
	1	2	3	
DO(mg/l)	7,2	7,2	7,7	7,4
Temperature (°)	30	30	30	30
pH	8,2	8,2	8,2	8,2
Salinity (ppt)	33	33	33	33

Table 6: Measurement of Water Parameters at Station 6.

Parameter	Repetition			Average
	1	2	3	
DO(mg/l)	6,9	7,2	7,7	7,3
Temperature (°)	30	30	30	30
pH	8,2	8,2	8,2	8,2
Salinity (ppt)	33	33	33	33

Table 7: Measurement of Water Parameters at Station 7.

Parameter	Repetition			Average
	1	2	3	
DO(mg/l)	7,0	7,0	7,0	7,0
Temperature (°)	30	30	30	30
pH	8,2	8,2	8,2	8,2
Salinity (ppt)	33	33	33	33

The value of the measurement of the water parameters is then processed in the Surfer software to determine the distribution pattern. The results are shown in Figure 7 through Figure 10.

From the data that has been obtained, it shows that the results of the measurement of the environmental parameters of the waters are still relatively good after compared to the quality standards (Table 10).

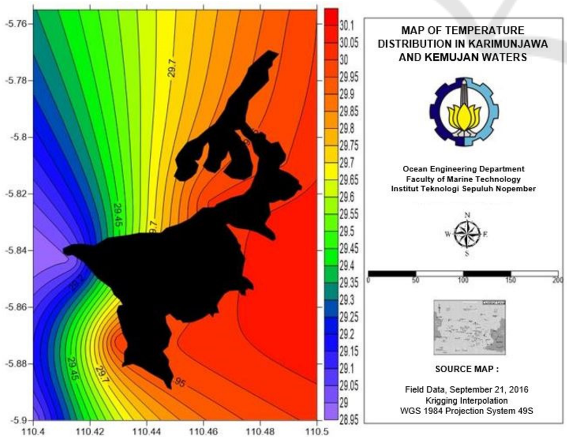

Figure 7: Water Temperatures Distribution on the Island of Karimunjawa and Kemujan.

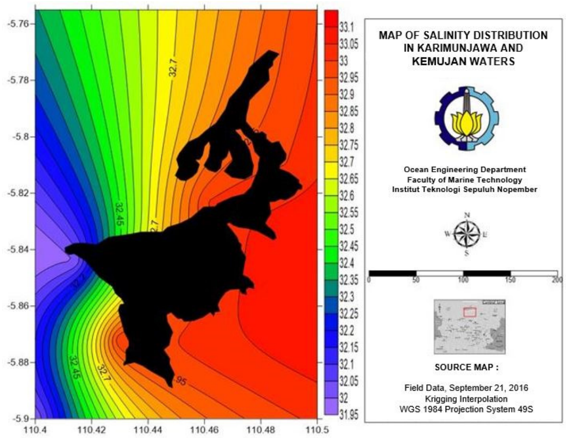

Figure 8: Salinity Distribution on the Island of Karimunjawa and Kemujan.

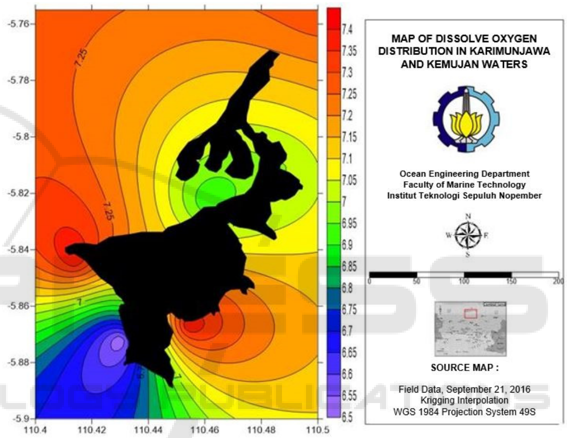

Figure 9: Dissolve Oxygen Distribution on the Island of Karimunjawa and Kemujan.

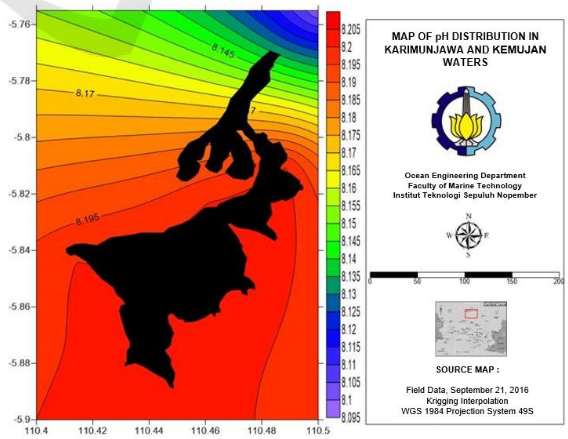

Figure 10: pH Distribution on the Island of Karimunjawa and Kemujan.

4.2 Sea Current Data Processing

Current data processing in the Surfer software shows the current velocity in the waters of the islands Karimunjawa and Kemujan ranging from 0.10 to 0.52 m / s (Table 8). Current data from OSCAR was taken in September, adjusting for the time when the ground check is roomy. In September there was the East to West transition season (September - November). Current patterns that occur in the waters around the Karimunjawa Islands are the effects of changes that are common in Indonesian waters (Ariyati et al, 2005). The map of the distribution of current speed can be seen in Figure 7.

Table 8: Current Speed on The Island of Karimunjawa and Kemujan.

Location	Result (m/s)
Station 1	0,248
Station 2	0,205
Station 3	0,113
Station 4	0,193
Station 5	0,268
Station 6	0,280
Station 7	0,514

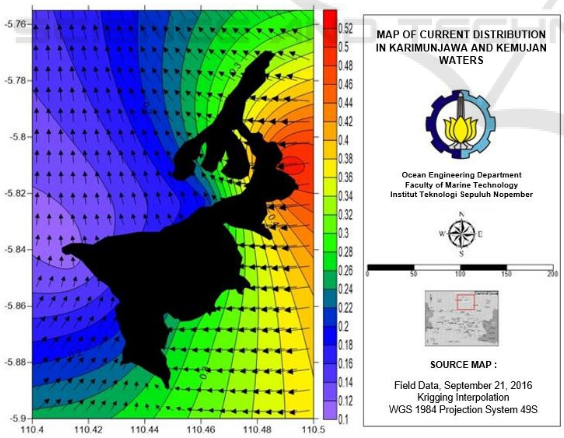

Figure 11: Current Speed Distribution on the Island of Karimunjawa and Kemujan.

4.3 Coral Reef Data Processing

As an additional parameter, the condition of the coral reef ecosystem in the waters of Karimunjawa Island and Kemujan Island was also observed. Initial observations were made using the GIS approach using Landsat 8. Satellite imagery data were taken

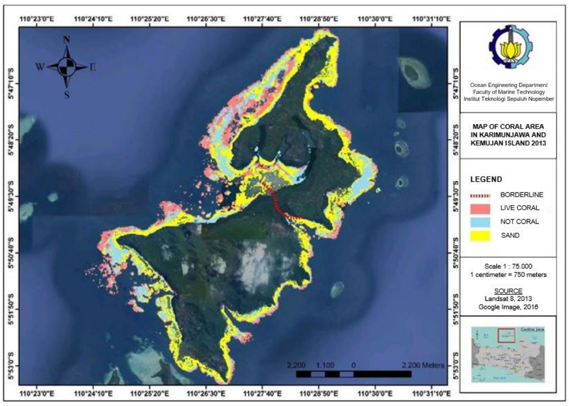

Figure 12: Map of Coral Area on the Island of Karimunjawa and Kemujan in 2013.

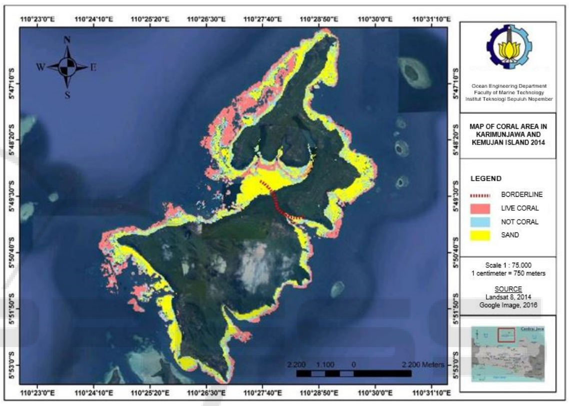

Figure 13: Map of Coral Area on the Island of Karimunjawa and Kemujan in 2014.

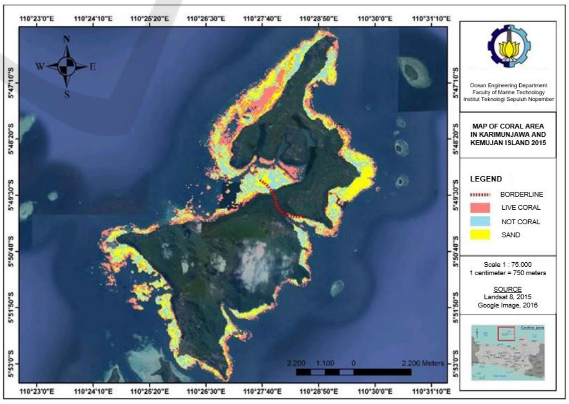

Figure 14: Map of Coral Area on the Island of Karimunjawa and Kemujan in 2015.

within 4 years, namely in 2013, 2014, 2015 and 2016 to see the changes and conditions. In this study, the 1981 Lyzenga algorithm was used to classify objects underwater. Detection of objects below sea level in Landsat data uses blue and red

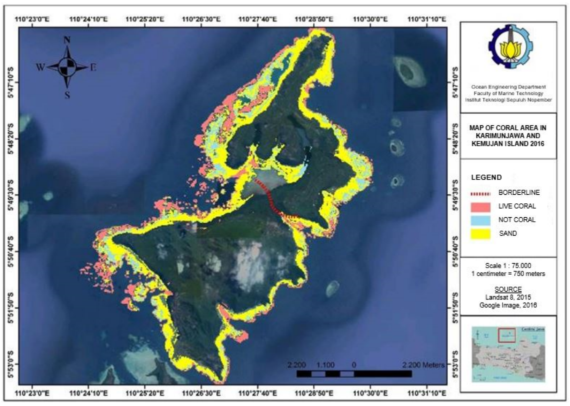

Figure 15: Map of Coral Area on the Island of Karimunjawa and Kemujan in 2016.

canal data. Kardono (1993) states that the blue and red canals are the best channels for penetration into the underwater column because in the blue and red channels there are wavelengths between 0.5 - 0.6 µm which are suitable for penetration into the water column. The following (Figure 12 to Figure 15) is a map of the extent of coral reefs from 2013 to 2016 on Karimunjawa Island and Kemunjan Island.

Based on the results of the processing of coral reefs from 2000, 2013, 2014, 2015 and 2016 on Karimunjawa Island and Kemujan Island can be seen from Table 9 below:

Table 9: The Extent of Live Coral, Not Coral and Sand.

Class/ Year	2013	2014	2015	2016
Live Coral (Km^2)	5,864	6,891	6,254	5,914
Not Coral (Km^2)	6,437	6,456	6,070	3,886
Sand (Km^2)	8,884	8,430	6,258	10,802

From the above data, the results of the percentage estimates of the area obtained from the processing of Landsat satellite image data in 2013, 2014, 2015 and 2016. Classified into 3 classes, namely live coral, not coral and sand. From 2013 to 2014 the extent of coral reefs increased by 8.7%, from 5.864 Km2 in 2013 to 6,891Km2 in 2014. From 2014 to 2015, the area of coral reefs decreased by 5.1% to 6,254 Km2 in 2015. Then in 2016, there was also a decrease in the area of coral reefs to 5.9141 Km2 by 2.7%. Following Figure 16 is a graph of the classification results and the extent of Landsat satellite imagery data for 2013, 2014, 2015 to 2016.

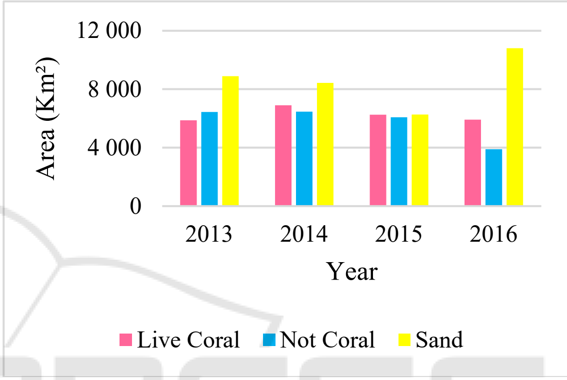

Figure 16: Results of Classification and Extents from Processing of Landsat Satellite Imagery.

Based on observations of the parameters of the quality of waters in Karimunjawa Island at seven points the location of sampling shows that the environmental conditions of the waters of Karimunjawa Island are in "Good" condition for aquaculture and marine biota, because no sample parameters were found with values that exceeded the quality standard as shown in Table 10.

Table 10: Comparison of Measurement Result of Water Parameter with Quality Standards.

	Parameter	St.1	St.2	St.3	St.4	St.5	St.6	St.7	Marine Biota Quality Standards	Coral Reef Quality Standards	Status
1	Temperature (°C)	29	30	29	30	30	30	30	±2 natural variation	28-30	Good
2	DO (mg/l)	6,7	6,46	7,4	6,9	7,4	7,3	7,0		>5	Good
3	PH	8,2	8,2	8,2	8,1	8,2	8,2	8,2	6,5 - 8,5	7-8,5	Good
4	Salinity (‰)	32	33	32	33	33	33	33	18 - 32/±10 natural variation	33-34	Good

5 CONCLUSIONS

Based on observations of the quality parameters of the waters of Karimunjawa Island at 7 points of the sampling station, it shows that the environmental conditions of the waters of Karimunjawa Island are in "Good" condition for the cultivation and ecosystem of coral reefs. Climate change and human activities are also thought to affect environmental conditions and changes in the size of coral reefs.

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