Study on water quality physical-chemical parameters aquaculture areas in Menjangan Besar Island, Kepulauan Karimunjawa, Jepara, Indonesia

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Abstract. Good water quality is extremely important to support life of organisms. The purpose of this research is to know the condition of physical and chemical factors in aquatic biota in aquatic ecosystems against sea Menjangan Besar Island. The samples were taken in two sampling times, i.e. August and November 2018. Research locations i.e floating net cage of monoculture and reference areas. Sampling was done in situ and exitu (Laboratory test). Data of abiotic parameters included the composition of DO, pH, salinity, temperature, water current, organic matter content (carbon and nitrogen), phosphate, nitrate, and ammonia. The results were compared with water quality standards based on KEPMEN-LH No. 51 of 2004 for marine biotas. The result showed that the parameters in according to the quality standards KEPMEN-LH No. 51 of 2004 are temperature, pH, salinity, DO, and ammonia while those that have exceeded the quality standards are phosphate and nitrate. The increase in parameters that have exceeded the maximum quality standard derived from natural resources, aquaculture activities, and domestic waste from community activities is quite high.

1. Introduction
The marine waters have a variety of very high biological resource potentials, including fish resources, mollusks, crustaceans, and echinoderms. Some species that have economic value include shellfish, snails (mollusks), sea cucumbers, sea urchins (echinoderms), shrimp, crabs (crustaceans), and fish. Fish resources include resources that can be renewed so that with wise management, benefits can continue to be enjoyed [1,2].

Menjangan Besar Island is one of the islands located in Kepulauan Karimunjawa, Jepara Regency, Central Java, Indonesia. The area covers 61 ha, with coastal lines reach 5,026 m. Menjangan Besar Island is included as the Karimunjawa National Park area for fish farming and tourism utilization zones [3]. It has beautiful natural scenery, easy accessibility, and economic development activities in...
the aquaculture sector [4]. The island is currently used as one of the aquaculture activities, mostly traditional fish farming. Such activity may potentially disturb surrounding water ecosystem.

This condition shows that aquaculture has the opportunity to support food security programs, especially in terms of meeting the needs of animal protein. One of the Menjangan Besar Island aquaculture systems is the floating net cage of the monoculture system in Cantang grouper fish. Monoculture cultivation business system is a cultivation system using one species that is done once or several times a year depending on the type of species [4].

Water characteristics both in terms of physical and chemical are influenced by external and internal factors. External influences come from the high seas that surround them including currents, tides, waves, temperatures, and salinity [5]. The condition of these waters is generally influenced by inputs sourced from aquaculture and community activities. Aquaculture activities and communities around the waters of Menjangan Besar Island are factors that influence the presence of nutrients in the waters which in turn have an impact on the quality of water for the benefit of the biota in these waters. Optimal utilization of water resources is needed so that environmental management can be done properly and correctly, especially regarding the functions and benefits of ecosystems in these waters. For this reason, it is necessary to observe the condition of water parameters. This is an attempt to detect whether the waters have experienced pollution or not. Another thing is to find out the interactions between the constituent components of the aquatic ecosystem including physical and chemical factors of the waters.

2. Method

The sampling sites were located at Menjangan Besar Island, Kepulauan Karimunjawa, Central Java, Indonesia at the coordinates between 110°25'40"-110°25'50"E and 5°53'10"-5°53'0"S. Two sampling locations were assessed with three sampling points and three replicates for each location, i.e. floating net cage of monoculture and reference area. The measurement of the physics-chemical water parameters was done three times for each location. The parameters measured in this study were pH, temperature (°C), dissolved oxygen (DO), water current, salinity, organic contents (carbon and nitrogen organics), phosphate, nitrate, and ammonia. Data of abiotic parameters were presented in tables and histogram. The samples were taken in two sampling times, i.e. August and November 2018.

![Figure 1](image_url). Map of sampling sites at Menjangan Besar Island, Karimunjawa, Central Java, Indonesia as a study site.
3. Result and discussion

3.1. Physical-chemical water factor

Physical-chemical water factors measured at the monoculture and reference area were dissolved oxygen, salinity, temperature, pH, and water current. The physical and chemical data obtained were pH (8), DO (5.8-6.6 mg/l), salinity (30-31‰), temperature (30-31°C), and water current (3.5-10 cm.s⁻¹). It can be concluded that factors values of physical-chemical water were recorded within normal range over the study period, as shown in Table 1.

| No | Parameters          | Quality standards | Location                          |
|----|---------------------|-------------------|-----------------------------------|
|    |                     |                   | Monoculture | Reference Area |
| 1  | Temperature (°C)    | 28-32             | 30         | 31             |
| 2  | Water Current (cm.s⁻¹) | -            | 3.5       | 10             |
| 3  | pH                  | 7-8.5             | 8         | 8              |
| 4  | Salinity (‰)       | s/d 34           | 31        | 30             |
| 5  | DO (mg/l)           | > 5               | 5.8       | 6.6            |

Source: KEPMEN-LH No. 51 of 2004 about water quality standards for marine biota

The results of temperature measurements in the field (in situ), obtained an average range of 30-31°C. In general, surface water temperatures range from 28-31°C [6]. Based on seawater quality standards for marine biota, the seawater temperature is still within normal limits and in accordance with the needs for the metabolism of marine biota and coastal marine ecosystems [7].

Based on the measurement results of the current water in the waters of Menjangan Island ranges from 3.5 cm.s⁻¹–10 cm.s⁻¹. The water current in aquaculture for optimum growth of biota ranges from 5-15 cm.s⁻¹ [8]. Based on the measurement results of aquaculture waters are still less than ideal aquaculture. Currents play an important role in the circulation of water, carriers of dissolved and suspended matter, oxygen solubility and can reduce biofouling organisms. Cage construction conditions must be adjusted to the current speed and bottom waters conditions. Greater current velocity can affect the position of the net and the anchoring system. The strong current can cause the raft position to shift. The current velocity that is too small can reduce the exchange of water in and out of the net and this condition affects the availability of oxygen in the maintenance net and the ease of disease, especially parasites attacking fish that are kept [9].

The salinity measurement results in the waters of Menjangan Besar Island is 30-31‰. The salinity value is not much different from the salinity value of Indonesian waters, where the average surface of Indonesian waters ranges from 33-34 ‰ [1]. Based on seawater quality standards for marine biota, most of the salinity values at the observation station are still in accordance with the quality standards of seawater for marine biota [7]. Salinity at the monoculture location and reference area has the same salinity value. The level of salinity of seawater at the location of the cultivation area can be influenced by the presence of deposition of organic material produced by the cultivation biota at that location.

The results of pH measurements at monoculture and reference area was 8. Based on observations, it shows that the pH value is still within the range according to the quality standard of the KEPMEN-LH No. 51 of 2004. The pH of seawater is relatively more stable and is usually in the range of 7.5 and 8.4, except near the coast [10]. The ideal pH value for waters is 7-8.5 [7]. Water conditions that are very basic or very acidic will endanger the survival of the organism because it will disrupt the process of metabolism and respiration.

The results of DO measurements at the observation site varied considerably in the range of 5.8–6.6 mg/l. In the data collection location, DO values obtained indicate that the waters are in very good condition, and still meet seawater quality standards for marine biota life with DO values > 5 mg/l [7]. According to Ref [11], the ideal oxygen content in water is between 3-7 mg/l. DO concentrations in the waters of Menjangan Besar Island are still classified as suitable for marine biota [12].
3.2. **Organic content (carbon and nitrogen)**

Based on the analysis, the average carbon content ranged from 1.26-1.32% and the nitrogen content ranged from 0.78-0.88% (Figure 2).

![Graph showing organic content value for Carbon and Nitrogen](image)

**Figure 2.** Proportion of organic content of Carbon and Nitrogen at the Menjangan Besar Island.

The higher concentration of carbon is caused by the accumulation of waste or residual organic matter, as well as the enrichment of nutrients in the process of decomposition of waste in the waters [13]. Organic matter on the substrate is needed as a food source for biota, which will then affect the number of biota populations in these waters.

Nitrogen contained in water is in several forms of compounds, namely ammonia (NH₃), nitrite (NO₂⁻), nitrate (NO₃⁻), free nitrogen gas (N₂) and in the form of organic compounds such as proteins or amino acids. The contamination of aquaculture water by nitrogen compounds is generally caused by nitrogen compounds derived from the remnants of fertilization, impurities and other substances contained in water sources. The main source of nitrogen compounds in aquaculture is the metabolism of aquatic animals [14].

3.3. **Nitrate, phosphat, and ammonia**

![Graph showing nitrate, phosphat, and ammonia values](image)

**Figure 3.** Nitrate, Phosphat and Ammonia at the Menjangan Besar Island.

Nitrate (NO₃⁻) is the main form of nitrogen in natural waters. Nitrate is one of the important nutrient compounds in the synthesis of animal and plant proteins [15]. High nitrate concentrations in waters can stimulate the growth and development of aquatic organisms if supported by the availability...
of nutrients. Nitrification which is the oxidation process of ammonia to nitrite and nitrate is an important process in the nitrogen cycle and takes place under aerobic conditions. The oxidation of ammonia to nitrite is carried out by nitrosomonas bacteria, while the oxidation of nitrite to nitrate is carried out by nitrobacter [16]. The analysis showed that the concentration of nitrate at the measurement location ranged from 0.2674 to 0.3525 mg/l. The nitrate content in the waters of Menjangan Besar Island has largely exceeded the quality standard, where the standard quality standard for nitrate concentration for marine biota is 0.008 mg/l [7]. This condition is very dangerous to marine biota, because according to Ref [16] that nitrogen concentrations of more than 0.2 mg/l can cause eutrophication (enrichment) of waters and further stimulate the growth of algae and aquatic plants rapidly (blooming). The high concentration of nitrate in the waters of Menjangan Besar Island can be caused by high organic material input from land activities which can be in the form of land erosion, the input of household waste, agricultural waste in the form of fertilizing residues and others carried into the sea waters.

Based on the analysis results, the concentration of phosphate content at the measurement location ranges from 0.006 to 0.0133 mg/l. This value indicates that the phosphate content in the waters of Menjangan Besar Island has exceeded the seawater quality standard for marine biota as stipulated is 0.015 mg/l [7]. These conditions can be dangerous for marine biota that lives in the waters of Menjangan Besar Island and can cause eutrophication. These conditions can be dangerous for marine biota that lives in the waters of Menjangan Besar Island and can cause eutrophication. According to Ref [17] that the maximum recommended phosphate level for rivers and waters that have been reported is 0.1 mg/l.

The results of the analysis showed that the concentration of ammonia in the waters of Menjangan Besar Island from the results of the analysis ranged from 0.0353-0.0509 mg/l. Based on ammonia quality standards in marine biota according to the KEMEN-LH No. 51 of 2004, the concentration of ammonia in the waters of Menjangan Besar Island does not exceed the standard quality standard of ammonia in the recommended sea waters of 0.3 mg/l for marine biota [7]. As it is known that ammonia is one of the parameters of organic pollution in waters, if the concentration of ammonia in the waters is too high, it can be suspected of pollution [18]. According to Ref [16], that the source of ammonia in waters is the result of the breakdown of organic nitrogen (protein and urea) and inorganic nitrogen contained in water, also comes from the decomposition of organic matter (plants and aquatic biota that have died) carried out by microbes and fungi. Increased ammonia levels in the sea are closely related to the entry of biodegradable organic matter (whether containing nitrogen or not).

4. Conclusion
The results showed that the parameters in according to the quality standards KEMEN-LH No. 51 of 2004 for marine biotas are temperature, pH, salinity, DO, and ammonia while those that have exceeded the quality standards are phosphate and nitrate. The increase in parameters that have exceeded the maximum quality standard derived from natural resources, aquaculture activities, and domestic waste from community activities is quite high.

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