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Profiles of water quality at Menjangan Besar Island, Karimunjawa, Central Java Province, Indonesia

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Abstract. *Sulardiono B, A'in C, Muskananfola MR. 2018. Profiles of water quality at Menjangan Besar Island, Karimunjawa, Central Java Province, Indonesia. Biodiversitas 19: 2308-2315.* The development of anthropogenic and tourism activities causes the ecological impact on water quality. The profile of water quality and sediment are the representation of environmental condition of ecosystems, then they could be indicators of pollution, fertility, suitability, and environmental carrying capacity on marine life. This study aimed to characterize the environmental indicator based on the quality profile of Menjangan Besar waters, Karimunjawa, Central Java. Data collection using a purposive sampling method based on water and sediment characteristics in Menjangan Besar waters. The research location is divided into three stations, namely: station A: the waters of fish cage activity; station B: floating guesthouse activity; and station C: seaweed marine culture. Variable on water quality profile consists of N-NO_3 (mg/L) and PO_4-P (mg/L), chlorophyll-α (mg/m^3), and bacterial (CFU/mL), and other water quality support, while the variables on sediment quality profile consist of Phosphorus (mg/g) and PO_4-P (mg/g), organic (%), C-organic (%) and bacterial (CFU/g), and sediment grain size. The calculation data analysis method of water and sediment total bacteria profile used Total Plate Count (TPC) by following SNI 7545.1 (2009), while analysis for nitrification bacteria (*Nitrosomonas* and *Nitrobacter*) using Most Probable Number (MPN). Data analysis of sediment grains size used two methods, i.e. (i) dry mechanic method by using sieve shaker, and (ii) wet mechanic method by using a pipette. Data analysis of nitrate and phosphate using Brucine Sulfanilik method. Mapping of the spatial distribution of measurement data for water nutrient contents (NO_3-N and PO_4-P), bacteria, and Chlorophyll-α in the waters using ArcGIS software application tool. The results showed that nitrification bacteria content in the water column is lower than in the sediments layer. Total bacteria content in both the water column and sediment layer varies between stations. Total bacteria in station A is higher than the other stations. The water nutrient content (Nitrate and Phosphate) is still above the quality standard for Marine Biota (Kepmen LH No. 51/2004). The condition of the fertility of Menjangan Besar waters is oligotrophic tend to mesotrophic, in the sense that the waters quality is low to medium conditions, and not yet dangerous for marine biota.

Keywords: Bacteria, Karimunjawa, mesotrophic, Menjangan Besar, nutrients, oligotrophic

INTRODUCTION

Menjangan Besar Island is one part of the Karimunjawa Archipelago in the Java Sea and included in the District of Jepara, Central Java. The Menjangan Besar island is connected to the Karimunjawa Islands through a strait. This strait is a waters area dominated by coral reef ecosystem and its association. Based on the Decree of the Directorate General of Forest Protection and Nature Conservation No. SK.79/IV/Set-3/2005 dated 30 June 2005 concerning the Revision of the Zonation of Karimunjawa Islands National Park, it was determined that Menjangan Besar Island was included in the tourism and cultivation utilization zone, while in the western waters of Karimunjawa Island it was included in the rehabilitation zone.

The tourism activities in Menjangan Besar shows an increasing trend every year. Intensive land use of tourism activities in Menjangan Besar waters has the potential to pressure the environment and habitat destruction of the marine life, especially domestic waste. The distribution of suspended particles in the waters is influenced by the presence of currents, tides, and waves, which then settled in the bottom of the waters. Based on the environment characteristic at the Menjangan Besar waters cause the distribution of suspended particles settled at the seabed as organic material stored. In addition, Increasing organic material in Menjangan Besar waters also comes from increased activities in Karimunjawa mainland, such as the household, hotels, homestay, and tourism activities. According to Hadi et al. (2006), environmental conditions in the Karimunjawa coastal waters indicate the presence of environmental degradation caused by the contamination material polluted on the flow of groundwater leading to the sea waters. UNEP (1996) stated that coastal tourism activities have an impact on physical changes and habitat damage, such as the resulting toxic material and nitrification, the emergence of toxic materials and dissolved oxygen depletion, groundwater contamination, and sediment load changes.

Increased input of excessive organic material leads to the enrichment of inorganic nutrients in the waters. This nutrient enrichment is the cause of phytoplankton blooms. The effect of blooming phytoplankton is the dissolved oxygen depletion and death of fish and other aquatic animals. According to Livingston (2001), nutrient enrichment is indirectly associated with changes in the phytoplankton community composition through changes supported by predation, resource limiting factors, light requirements, and biological effects on sediments. The nutrients variable (nitrate and phosphate) can be used as a trophic indicator (Giovanardi and Tromellini 1992; Ignatiades et al. 1992; Stefanou et al. 2000). Nutrients (Nitrate and Phosphate) are essential materials for the growth of phytoplankton and algae in water, and within a certain range of levels are used to see the extent of aquatic discharges (Effendi 2003), namely oligotrophic (poor nutrient and low productivity), mesotrophic (medium nutrient and productivity), eutrophic (high nutrient and productivity), hyper-eutrophic (very high nutrient and productivity), and dystrophic (high organic matter contain). Bacteria as a microbiological parameter is an important indicator of aquatic land use demonstrated by the performance of micro-organisms in biological processes in sedimentary media (Pelczar et al. 2010). Thus, bacteria from water or sediments play an important role in the water environment as an indicator of environmental disturbance, the status of water fertility, and indicators of nutrient dynamics. The environmental disturbance caused by eutrophication impact. Thus, an excessive increase in organic waste leads to potential pollution of the aquatic environment.

The evaluation on the environment of the Menjangan Besar waters can be performed based on the assessment of the profile of nutrients (Nitrate and Phosphate), bacteria, Chlorophyll-α, and other water quality support, and sediment nutrient (phosphor and phosphate), bacteria, and sediment grains. Ulqodry et al. (2010) state that the dynamics of nitrate, phosphate and dissolved oxygen content are influenced by organic waste input from the land, thus affecting the pollution of the aquatic environment. The evaluation of nutrients (N_NO_3 and $P\text{-}PO_4$), bacteria and other supporting factors in the waters of Menjangan Besar is very important. This ecological impact resulted from the organic remains, either solid forms or liquid forms, as an indicator of waters pollution of Menjangan Besar Island. Ecosystem damage in coastal waters can be caused by increased nutrients, especially nitrate and phosphate in waters known as eutrophication Therefore, the evaluation of nutrients content, bacteria and water quality supporting factors in the waters and sedimentary medium of Menjangan Besar is very important.

A healthy aquatic environment for marine life, if the availability of nutrients in the water within the limits of the carrying capacity of the environment. However, if excessive nutrient value causes the phytoplankton blooming, and eutrophication process. The eutrophication process of waters destroy marine habitat. This statement is in accordance to Livingston (2001), that phytoplankton bioassay and nutrient load as a limiting factor for eutrophication. This information can be used as inputs for management of coastal regions and small islands, especially in Menjangan Besar region. The research aims to determine environmental indicators based on water quality profiles at Menjangan Besar waters, Karimunjawa, Central Java, Indonesia.

MATERIALS AND METHODS

The research was conducted in May 2017 in Menjangan Besar waters of Jepara District, Central Java, Indonesia, based on the characteristics of land use such as tourism and marine aquaculture activities in the research area. The research is located in three stations, namely station A is marine aquaculture activities, station B is floating guest house activities, and station C is seaweed aquaculture activities (Figure 1). The sample of water and sediment quality at each location were taken 4 and 2, respectively. Sample of bacteria on the water column and sediment observed overall were taken the average value of 3 replications on each station, with the consideration that the waters dynamic condition is relatively stable and not fluctuate significantly since the Menjangan Besar waters type is semi-enclosed. Coordinate positions on the respective locations can be seen in Table 1.

The materials used are water and sediment samples from Menjangan Besar waters. Methods of data collection using a purposive sampling based on water and sediment characteristics in Menjangan Besar waters. The parameters used are water quality and sediment profile. Variable on water quality profile consists of $N\text{-}NO_3$ (mg/L) and $PO_4\text{-}P$ (mg/L), chlorophyll-α (mg/m^3), and bacterial (CFU/mL), and other water quality support, while the variables on sediment quality profile includes Phosphorus (mg/g) and $PO_4\text{-}P$ (mg/g), organic (%), C-organic (%), bacterial (CFU/g), and sediment grain size. The instruments used for measuring water quality data are current meters, secchi disc with a scale of 0.1 cm for transparency data, refractometer for salinity data, and water quality checker to measure dissolved oxygen and temperature.

The calculation analysis of water and sediment total bacteria profile was performed using *Total Plate Count* (TPC) by following SNI 7545.1 (2009), whilst nitrification bacteria (*Nitrosomonas* and *Nitrobacter*) were analyzed using *Most Probable Number* (MPN). Two methods were adopted in grain size analysis, the dry mechanic method using sieve shaker (Buchanan 1971) and wet mechanic method using pipette and Brucine sulfanilic method. Was adopted for analyzing Nitrate and Phosphate (Radojevic and Bashkin 1999). The mapping of spatial distribution of water nutrients content ($NO_3\text{-}N$ and $PO_4\text{-}P$), bacteria and Chlorophyll-α in the waters was conducted using ArcGIS software application tools.

Table 1. Coordinate of sampling station in Menjangan Besar waters, Karimunjawa, Central Java, Indonesia

Station	Description Location	Longitude (E)	Latitude (S)
A	Around fish marine aquaculture (fish cage)	110^o 25’ 40,039”	05^o 52’ 56,332”
B	Around floating guest house	110^o 51’ 496”	05^o 53’ 13,036”
C	Around seaweed culture	110^o 25’ 58,885”	05^o 53’ 20,21”

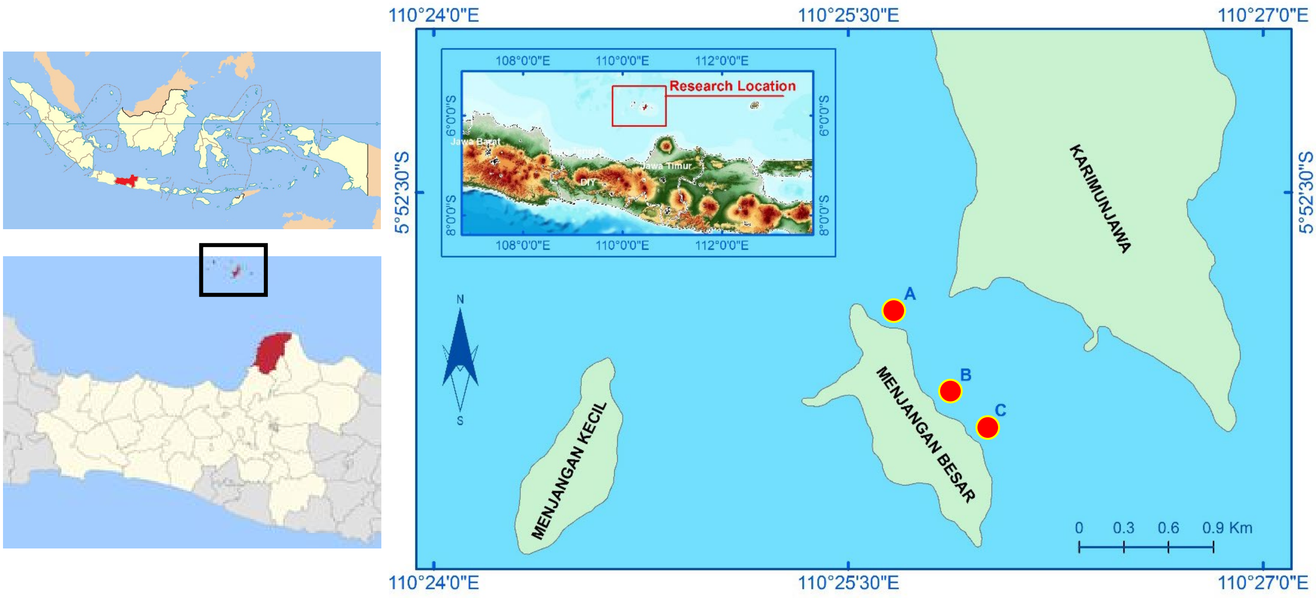


Figure 1. The location of the station observations in Menjangan Besar Waters, Karimunjawa, Central Java, Indonesia

The status of environmental conditions in the aquatic profile by comparing the results of the measurement of water quality criteria based on Lee et al. (1978), where values > 6.5 mg/L (uncontaminated), 4.5-6.5 mg/L (lightly contaminated), 2.0-4.4 mg/L (medium tainted), and < 2.0 mg/L (heavy pollution) and based on Regulation of Minister of Environment No. 51/2004 on the Sea Water Standard for marine tourism and marine biology. Interpretation of fertility indicators by comparing the results of water quality and sediment measurements based on criteria established by previous researchers.

RESULTS AND DISCUSSION

Water quality

The average content of NO_3-N (Nitrate) ranged 0.497 to 1.251 mg/L. while the average content of PO_4-P (Phosphate) ranged 0.094 to 0.107 mg/L. Two nutrient content indicators (Nitrate and Phosphate) at station B shows the highest concentration than other stations and the average content of chlorophyll-α content ranged 0.002 to 0.014 mg/m^3, where chlorophyll-α content average in the station A is highest than the other stations (Table 2).

The average value of current velocity measurements ranges 0.050 to 0.055 m/s, where the average value at station A has the highest than the other stations. The average value of transparency measurements ranged 2.15 to 2.58 m and the average value of the dissolved oxygen range 3.91-4.83 mg/L, If the value of dissolved oxygen was compared with criteria by Lee et al. (1978), where values > 6.5 mg/L (uncontaminated), 4.5-6.5 mg/L (lightly contaminated), 2.0-4.4 mg/L (medium contaminated), and < 2.0 mg/L (very heavy pollution), it can be said that the waters at all stations are not polluted in the middle of moderate pollution. The result of measurement of the average value of water temperature, pH, and salinity based on Regulation of Minister of Environment No. 51/2004 on the Sea Water Standard for marine tourism and marine biology, it shows that water conditions at all stations are still in the natural category.

Based on analysis using ArcGIS software application, there are different distribution patterns of nitrate and phosphate content in the three observation stations (Figures 2.A-B). Station B tends to have a higher concentration of NO_3-N and PO_4-P nutrients than the other two stations. However, the distribution of Chlorophyll-α, station A has a higher concentration than the other two stations (Figure 2.C). This difference of assumptions as the cause of differences in the pattern of nutrient distribution.

Sediment quality

The average of sediment nutrient of phosphor (P) ranges from 0.006 to 0.057 mg/g with the station A is highest than the other station, and the average phosphorous (PO_4-P) content ranges from 0.011-0.033 mg/g and station C is highest than the other station. Sediment texture analysis from all stations observed showed categorized sand (Table 3).

Tabel 2. Water quality parameters in the Menjangan Besar Island, Karimunjawa, Central Java, Indonesia

Variables		Station A (replication)					Station B (replication)					Station C (replication)				
		1	2	3	4	Aver.	1	2	3	4	Aver.	1	2	3	4	Aver.
Nitrate (NO_3-N)	mg/L	0.481	0.609	0.737	0.673	0.625	1.411	1.283	1.058	1.250	1.251	0.449	0.609	0.321	0.609	0.497
Phosphate (PO_4-P)	mg/L	0.106	0.098	0.083	0.087	0.094	0.125	0.128	0.098	0.075	0.107	0.083	0.098	0.125	0.109	0.104
Chlorophyll-α	mg/m^3	0.013	0.014	0.014	0.013	0.014	0.013	0.002	0.005	0.007	0.007	0.002	0.002	0.001	0.002	0.002
Water depth	m	6.50	5.70	6.60	5.90	6.18	5.00	4.40	5.30	4.20	4.73	4.50	4.60	4.30	4.70	4.53
Transparency	m	2.40	2.60	2.80	2.50	2.58	2.10	2.20	2.20	2.10	2.15	1.50	1.50	3.00	3.00	2.25
Current velocity	m/s	0.046	0.071	0.051	0.053	0.055	0.037	0.065	0.048	0.050	0.050	0.046	0.060	0.050	0.047	0.051
Dissolved oxygen	mg/L	4.80	4.90	4.85	4.75	4.83	3.70	3.90	3.85	4.20	3.91	4.40	4.60	4.50	4.20	4.42
pH		6.4	6.2	6.3	6.3	6.3	6.4	6.6	6.5	6.7	6.6	7.2	6.9	7.1	6.9	7.025
Temperature	ºC	30	30	31	30	30	31	31	31	32	31	32	31	31	31	31.25
Salinity	ppt	33	33	33	33	33	32	32	33	33	33	32	33	33	31	32.25

Table 3. Parameters of sediment quality and sediment texture in Menjangan Besar waters, Karimunjawa, Central Java, Indonesia

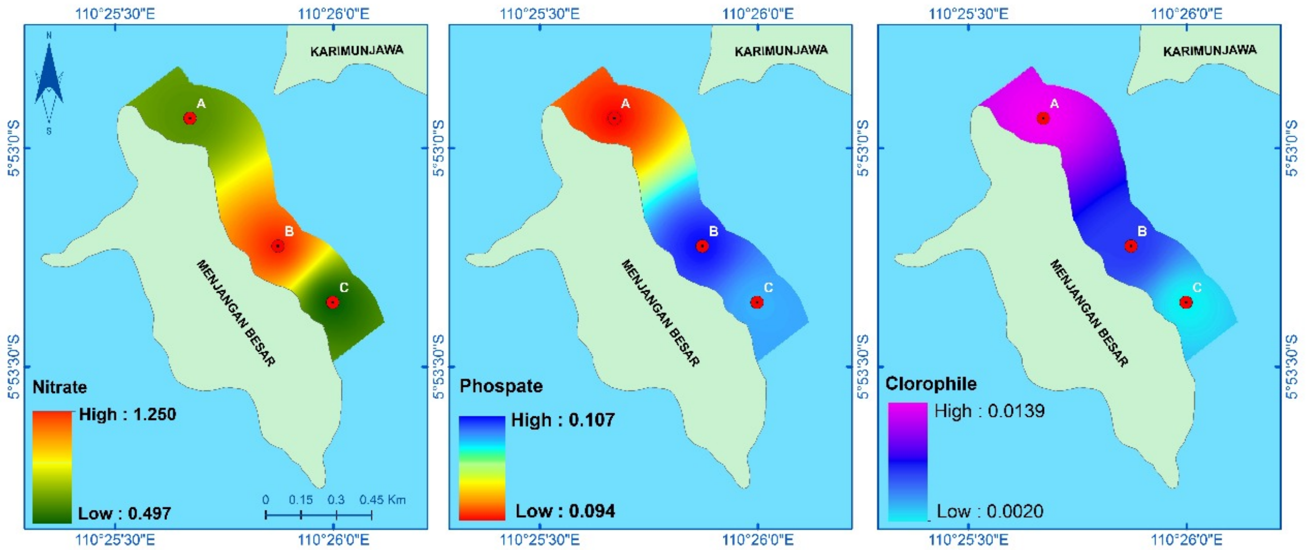
Variable	Unit	Station A (replication)			Station B (replication)			Station C (replication)		
		1	2	Average	1	2	Average	1	2	Average
Phosphor (P)	mg/g	0.110	0.004	0.057	0.008	0.003	0.006	0.007	0.014	0.011
Phosphat (PO_4-P)	mg/g	0.034	0.013	0.024	0.011	0.011	0.011	0.024	0.042	0.033
Organic Matters	%	3.340	3.850	3.595	3.320	3.180	3.250	2.130	3.070	2.600
C-Organic	%	0.030	0.030	0.030	0.030	0.030	0.030	0,.030	0.030	0.030
pH Sediment		61	6.1	6.10	6.3	6.2	6.25	6.1	5.9	6.00
Temperature of sediment	ºC	31.0	31.0	31.0	30.0	31.0	30.5	31.0	31.0	31.0
Salinity	ppt	40.0	40.0	40.0	39.0	38.0	38.5	39.0	39.0	39.0
Sediment category		Sand	Silt	Clay	Sand	Silt	Clay	Sand	Silt	Clay
Sediment fraction	%	93	5.71	1.31	94.02	3.8	2.18	92.1	3.76	4.13
Sediment texture		Sand			Sand			Sand		

Table 4. Interpretation of fertility and disturbance indicators based on water and sediment quality in Menjangan Besar waters, Karimunjawa, Central Java, Indonesia

Variable	Unit	Research results	Status	Description
Water quality				
Nitrate (NO_3-N)	mg/L	0.497-1.251	Oligotrophic-Mesotrophic	Vollenweider (1968)
Phosphate (PO_4-P)	mg/L	0.094-0.107	Eutrophic	Vollenweider (1968)
Chlorophyll-α	mg/m^3	0.002-0.014	Oligotrophic	Parslow et al. (2008)
Dissolved Oxygen	mg/L	3.91-4.83	Low-medium pollution	Lee et al. (1978)
Transparency	m	2.15-2.58	Mesotrophic	Henderson et al. (1987)
pH		6.3 -7.025	Mesotrophic	Henderson et al. (1987)
Sediment quality				
Phosphorus (P)	mg/g	0.006 -0.05	Low	Rosmarkam dan Yuwono (2002)
Phosphat (P-PO_4)	mg/g	0.011-0.330	low	Rosmarkam dan Yuwono (2002)
Organic Materials	%	2.6 -3.59	Low	Reynolds (1971)

Table 5. Bacterial content in the Menjangan Besar waters, Karimunjawa, Central Java, Indonesia

Station	Water Bacteria (CFU/ml)			Sediment Bacteria (CFU/g)		
	Total	*Nitrosomonas*	*Nitrobacter*	Total	*Nitrosomonas*	*Nitrobacter*
A	8.4 x 10^3	< 3.0	< 3.0	8.2 x 10^5	2,300	71
B	2.7 x 10^3	< 3.0	< 3.0	1.8 x 10^5	2,400	74
C	3.9 x 10^3	< 3.0	< 3.0	2.9 x 10^5	3,100	77
Average	5.0 x 10^3	< 3.0	< 3.0	4.3 x 10^5	2,600	74



A B C

Figure 2. Spatial distribution of nitrate,phosphate and chlorophyll-α in the Menjangan Besar waters, Karimunjawa, Central Java Province, Indonesia. A. Nitrate, B. Phosphate, C. Chlorophyll-α

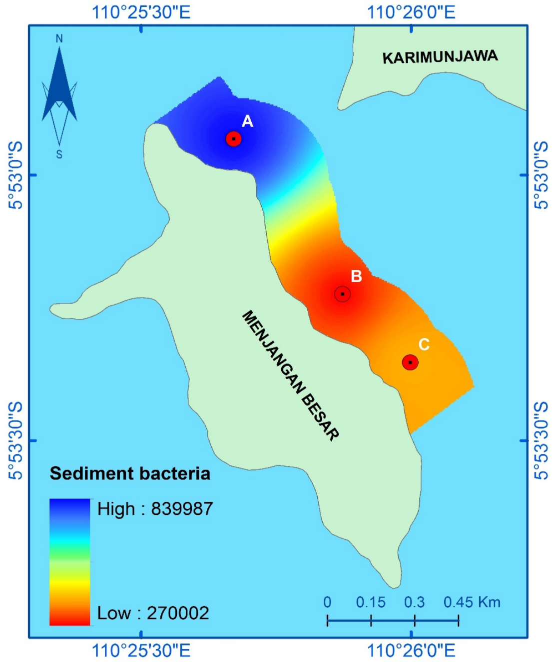


Figure 3. Spatial distribution of sediment bacteria in the Menjangan Besar waters, Karimunjawa, Central Java, Indonesia

The water quality analysis shows that status of nitrate nutrient is oligotrophic to mesotrophic, whereas chlorophyll-α status is oligotrophic, dissolved oxygen status is light to medium pollution, transparency and pH both in the mesotrophic status (Table 4). Sediment quality analysis shows that nutrients (phosphorus, phosphate, and organic material) in the study area was low. The low status of sediment quality in the study area is due to the dominance of the sediment fraction by the type of sandy texture, thus giving effect to the waters fertility condition.

Bacteria content

The average total bacteria and nitrifying bacteria content in the sediments is higher than in the water column (Table 5).

The total content of water bacteria in area study from 3 station ranges between 2.7 x 10^3 to 8.4 x 10^3 CFU/mL, with average content 5.0 x 10^3 CFU/mL and the nitrifying water bacteria of *Nitrosomonas* and *Nitrobacter* have content < 3.0 CFU/mL with average content < 3.0 CFU/mL. While total sediment bacteria content ranges 1.8 x 10^5 to 8.2 x 10^5 CFU/g, with the average content 4.3 x 10^5 CFU/g, and nitrifying sediment bacteria of *Nitrosomonas* and *Nitrobacter* ranges both 2,300 to 3,100 CFU/g and 71 to 77 CFU/g with the average content both 2,600 CFU/g and 74 CFU/g (Figure 3).

Discussion

Nitrate (NO_3-N) and Phosphate (PO_4-P) are the two nutrient variable used to describe the status of water fertility (Henderson et al. 1987), where the Nitrate and Phosphate are the two nutrients contributing to eutrophication in the aquatic ecosystem, and the leading factor that determines the level of aquatic fertility. Sediment and water column nutrients are an integral part of the nutrient cycle of the aquatic ecosystem. This nutrients cycle is the interaction between components formed through mass flow and energy and transformation. The ability of nitrogen in assimilating phytoplankton plays an important role in the dynamics of primary production (Ryther and Dunstan 1971; Eppley et al. 1979 *in* Henriksen and Kemp 1998). The availability of nitrate from biophysical-chemical processes in the aquatic environment is used for phytoplankton growth through photosynthesis, and with the support of water quality and bottom sediment will affect waters productivity. Nixon (1981) states that the nutrient cycle in coastal waters is an integral part of the biochemical process in the water column and sediments, where there is a strong correlation between the organic material produced in the sediment and the organic matter consumed by the benthic organism. Nutrients change dynamically depending on many factors, such as pH, dissolved oxygen, and bacteria. The nutrients changes dynamic depends on many factors, such as pH, dissolved oxygen, and bacteria. Furthermore, the condition is triggered by the denitrification phenomenon of nitrogen which causes no accumulation of nitrogen in the sediments. Sediments accumulate phosphorus from the remains of dead plants and animals will be decomposed by bacteria before it settles on the seabeds. Paytan and McLaughlin (2007) suggest that Phosphorus compounds bound to sediments can experience decomposition with the help of bacteria.

The results of Nitrate measurements in the water column showed that the fertility status in the Karimunjawa waters was classified as oligotrophic to mesotrophic with Phosphate values classified as eutrophic (Vollenweider 1968), while the results of measurements of Nitrate and Phosphate in sediments showed low fertility status (Rosmarkam dan Yuwono 2002). The condition of oligotrophic status in these waters is supported by the results of previous studies in Karimunjawa waters (Isnaeni et al. 2015), namely with a value of Nitrate content of 0.01 mg/L, which is classified as oligotrophic (Vollenweider 1968), where shown poor nitrate and low productivity. Similarly, based on the chlorophyll indicator shows oligotrophic status (Parslow et al. 2008). However, in terms of supporting water quality parameters, such as dissolved oxygen, transparency and pH tend to be natural, such as low to moderate dissolved oxygen (Lee et al. 1978), transparency and pH are mesotrophic (Hendarson et al. 1987).

Measurements of sediment quality of Phosphate, in particular, results differ from the quality of Phosphate in water. The Phosphor transformation value Reynolds (me/100 gram) according to Rosmarkam and Yuwono (2002) indicate lower category. The sandy texture of the sediments may be the contributing factor. Sand absorbs nutrients lower than silt and clay fractions; Sandy texture also contains lower organic materials as sandy soil allows high oxidation causing quick run-out of organic materials. This condition causes the level of organic material to be categorized low. Soil texture also determines the infiltration rate, permeability and the ability of soil to retain water. Sandy soil has lower water content, while according to Bailey et al. (1986), the increase of water supply due to temperature leads to the organic material increase, vice versa. It can be concluded that the waters fertility in Menjangan Besar is determined by not a single factor but some contributing factors, among others hydro-oceanographic factors.

The total sediment bacterial content is higher than the total water bacterial content (Table 5). This result is in line with the findings of Hanafiah, et al. (2009) that the population of bacteria is found mostly in the sediments. Some of the bacteria are from the family Corynebacteriaceae which reaches around 65% of the total bacteria population in the sediments. Second in rank is Bacillus which contributes 25% of the total bacteria population in the sediments. Another 10% is dominated by *Agrobacterium Azotobacter*, *Nitrosomonas, Nitrobacter, Rhizobium, Pseudomonas, Achromobacter, Clostridium,* and *Sprilum*. The results of the analysis of *Nitrosomonas* and *Nitrobacter* in the surface sediments were 2,300-3,100 CFU/g and 71-74 CFU/g respectively. If the results of this study were compared with the results of Setiabudi (2007) study on the similar type of bacteria in Kaping Bay, Bali, each of 400-39,000 CFU/g and 110-700 CFU/g, the results of this study would indicate a lower value. The relatively low content of both bacteria (*Nitrosomonas* and *Nitrobacter*) in the Menjangan Besar waters was thought to be due to the effects of anthropogenic activities in the Menjangan Besar waters that have not provided a dangerous condition for the environment. While nutrients (Nitrate and Phosphate) showed oligotrophic to mesotrophic category.

The nitrification potential at the sediment surface is affected by grazing and fecal pellet formation of the macrofauna (Henriksen and Kemp 1988). Nitrification Bacteria plays an important role in the oxidation process that changes ammonium to nitrate through a two-phase reaction (Kusumastuti et al. 2013). In the first process, oxidation of ammonium NH_4+ occurs from the reduced form producing “intermediate” compound which is oxidation to nitrite NO_2^-, then second, changes from nitrite to nitrate NO_3^-. The common significant bacteria in the nitrification process are bacteria within the genus *Nitrosomonas* and *Nitrobacter*. Results of the measurement of nitrification bacteria (*Nitrosomonas* and *Nitrobacter*) on the sampling sites indicate that the Nitrification bacteria content in the sediments is higher than that in the water column. This result is considered normal as the accumulation of organic particles settled in the river bed serves as a media for the bacteria to perform the ecological functions. Effendi (2003) supports this finding as it is stated that the growth of bacteria is normally influenced by the domination of bacteria involved in the nitrification, that is, the change from ammonium oxidation to Nitrite and Nitrate. Bacteria whose habitat attached to the sediments of other solids perform slower rate of nitrification bacterial growth compared to that of heterotroph bacteria. The growth rate of bacteria depends on the dissolved oxygen and organic materials. Based on the image data analysis (Figure 3), the bacteria content with high abundance is observed in the location around station A, which is in line with the results of phosphate sediments. Phosphorus sediment fixation is influenced by the bacteria activity, types of soil and the lithogenous source.

The anthropogenic tourism and marine aquaculture activities (fish cage) produced organic waste disposal materials in these waters. The organic waste disposal input has the potential to increase the eutrophication process. The existing condition of fish cage in the Menjangan Besar waters of about 3 units per unit is 20 plot, which is estimated at a size per plot of 25 m^2, so total area affected of more than 1500 m^2, with the intensive feeding pattern, by feeding 2 times daily during the maintenance period of 6 months and doses 5-10% of cultivated fish biomass < 100 g and 3-5% for cultivated fish biomass >100g (aquatic.co.id), it is suspected that wasted feed is relatively high, so it has the potential to reduce the waters quality. As well, the existing conditions of tourism supporting activities on the increasing tourists visiting have the potential to reduce the waters pollution. The existing conditions of tourism activities where each year increases. Statistical data of tourist visits in Jepara district which entered into Karimunjawa, recorded in 2017 as many as 77,056 visitors (Tourism Information Center Jepara 2017). If assumed per person the visitor generates domestic waste of 2 kg per person per day (SNI 3242 : 2008), so the contribution of the domestic waste load to the environment is 154,112 kg per person per day, and if length stay of visitor 3 days, then the amount of waste that is dumped into the environment is equal to 462,336 kg. The burden of waste discharged into the Menjangan Besar waters creates the potential for eutrophication. This eutrophication potential is supported by the presence of Nitrate input from the mainland of the city of Karimunjawa which enters into the Menjangan Besar. According to the results of research by Hadi, et al. (2006), there has been a process of degradation of the groundwater quality in the Karimunjawa city, where the ammonium value of groundwater tends to increase, which is then accompanied by an increase in the value of nitrate. Based on the geomorphological structure of the coast, nitrates stored in groundwater enter the waters of Menjangan Besar. It is further stated that the storage of nitrate in groundwater is thought to originate from the decomposition of organic nitrogen from domestic/organic waste. The presence of ammonium in water indicates the pollution that has just occurred.

In conclusion, the relatively high content of Nitrification bacteria in the sediments compared to that in the water gives effects to the change in ammonia oxidation in the dynamic formation of nitrite and nitrate compounds on the aquatic seabed. However, the low quality of water and sediment, in particular pH, current velocity, clarity, and dissolved oxygen, as well as organic matters, are considered to contribute to the decrease of aquatic ecosystem quality potentially. The results of nutrients measurements confirm this result both in the water column and the sediments which indicate that the water quality falls into the category of oligotrophic to mesotrophic, or low to medium. Supports from related authorities, therefore, are required to ensure the stability and sustainability of the ecosystem. However, the conditions found in the Menjangan Besar waters have not increased the dangerous indication, but this condition needs to be watched out.

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