Nutrient variability, pollution, and trophic status in Muara Gembong, Bekasi

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Abstract. In recent decades, the level of pollution in the waters has increased, causing a decrease in the quality of the aquatic environment. This research aims to obtain nutrient variability, pollution status, and water fertility through concentrations of ammonia, nitrite, nitrate, and phosphate in the water column and sediment. The research was carried out on 3rd April 2019 in Muara Gembong, Bekasi. Pore water samplings were taken from three locations. Moreover, samples were processed from the 5th to 15th of April 2019 at the Biogeochemistry Laboratory and the Laboratory of Biotechnology and Molecular Microbiology, Faculty of Fisheries and Marine Sciences, Padjadjaran University. Pollution index was assessed according to KepMen LH No. 115 of 2003 to determine the status of pollution. Carlson trophic state index (TSI) assessment was applied to determine the trophic status for nutrients profile analysis (ammonia, nitrite, nitrate and phosphate) according to PPRI No. 82 of 2001 about the management of water quality, and KepMen LH No. 51 of 2004 about seawater quality standards. The results showed that the profiles of all nutrients were found below the quality standards, had moderate mesotrophic and eutrophic trophic levels, while the pollution status remained in the moderate category.
Key Words: Citarum, Muara Gembong, pollution, trophic state index, waste.

Introduction. Coastal areas have high complexity and they are very susceptible to changes. Population growth is certainly accompanied by the increase in economic needs, unavoidably causing a much greater use of space and the need for more resources, while, on the other hand, resulting in the number of the same resources to decrease over time. These conditions lead to over-exploitation, which subsequently can have implications on the environmental damage. One of the environmental issues is the potential for high level of pollution in coastal waters as it is happening in the waters of Muara Gembong due to various spatial use activities. Pollution is an unwanted, often dangerous waste that invades the environment through human activity and is one of the existential challenges in this period (Landrigan et al 2018). In Muara Gembong, human activity becomes the main cause of the sharp decline in coastal health. Furthermore, pollution is defined as the process of introducing harmful or poisonous substances into the natural environment. Therefore, coastal and marine pollution is defined as the introduction of toxic substance such as plastics, oils, chemicals, agricultural waste, and industrial waste into the waters. Pollution affects the air, water, and soil, or food that endangers the health, resilience or activities of humans and other living organisms (Miller Jr. 2002). Pollution in marine coastal areas is also considered from point and non-point land-based sources, such as rivers, drainage ditches, submarine outfalls and coastal cities (Vikas & Dwarakish 2015). The source of pollution in the water of Muara Gembong comes from Citarum River, the longest and largest river in the province of West Java. The presence of this river has greatly affected the lives of the surrounding communities. Utilisation of the Citarum River varies greatly from upstream to downstream from fulfilling household needs, irrigation, agriculture, animal husbandry, to a vast number of industries. The impact of pollution does not only endanger the life of the biota and marine environment, but also human health, and in some cases, it even causes death. Aesthetically speaking, it also reduces and damages the aesthetic value of the coastal environment, and can be detrimental to the social economy. Water flowing through Citarum River has been contaminated by various wastes, such as toxic and hazardous chemical wastes from industry among others. The organic waste contained in the water and sediments of the Citarum River is slightly different and decomposes to increase the concentration of nitrogen and phosphorus, encouraging the growth of phytoplankton. At optimum concentration, nutrients N and P are beneficial for phytoplankton growth. However, when the concentration of these elements appears to be high, phytoplankton growth occurs (blooming) up to the level of eutrophication, and exactly this condition causes pollution. When it becomes severe, water quality will decrease, the water turns turbid with low dissolved oxygen, while toxic gases and toxic materials arise (Sugiura et al 2004). These conditions cause the water to be unsuitable for raw and recreational water sources as well as environmental carrying capacity for various functions to decline. The objective of this study was to obtain the nutrient variability, pollution status, and water fertility in Muara Gembong, Bekasi.

Material and Method

Description of the study sites. Administratively, the Regency of Bekasi is one of the regencies in West Java Province situated directly adjacent to DKI Jakarta. The Regency of Bekasi has 16 large rivers, with the Citarum River as one of them. The Citarum River stretches 269 km starting from Situ Cisanti in Kertasari, Bandung (upstream) to Muara Gembong, Bekasi (downstream). Muara Gembong is a sub-district within the Regency of Bekasi in West Java Province, Indonesia (Paryono et al 2017).

This study was conducted from April to August 2019 in Muara Gembong, one of the estuaries with many inhabitants with its settlement located not far from the river itself. Likewise, some fishers build houses along the river in Muara Gembong due to its close proximity to their sources of income. The area is not only used as a residence for the fishermen searching for fish in the sea, but also as an area for prospective ponds and agriculture. These residential settlements, mostly fishing settlements along the waters of Muara Gembong use the waters for their daily needs, and consequently, also causing wastes due to their domestic activities. Data was collected from 3 stations and each location can be seen in Figure 1.

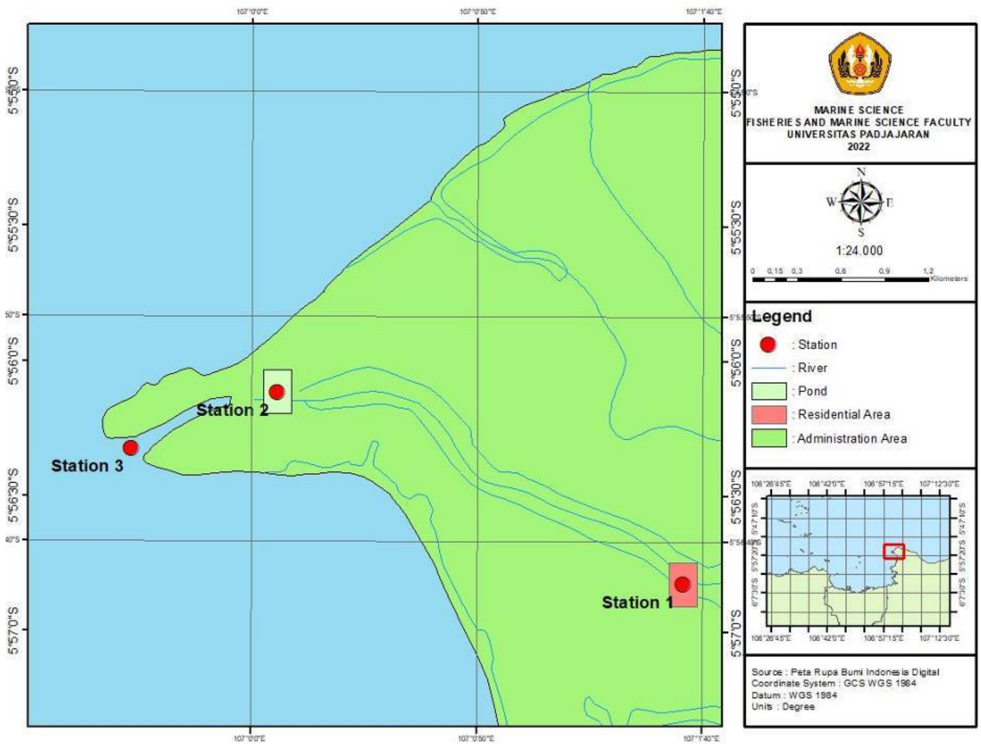

Figure 1. The location of Research at Muara Gembong, West Java, Indonesia.

Station 1 is located at 05°59'26.9" SL and 107°03'03.7" EL. This area is a residential area near the river flow. A lot of waste materials are found near the river. Station 2 is located at 5°56'12.25" SL and 107°0'10.16" EL. This area happens to be the fishpond area for the residents living around the estuary. In this area, fishers also use the water from the estuary for bathing and other domestic activities. Station 3 is located at 5°56'33.75" SL and 106°59'17.36" EL, an estuary area that is situated close to the sea. Mangrove trees are also encountered on the edge of station 3.

Collection of data. Water sampling was carried out using water samplers, which were inserted into the waters vertically, with 3 different depth points each: on the surface of the water, on the water column at a depth of 5 m and on the bottom of the water at a depth about 12 m. Sample processing to analyse ammonia, nitrite, nitrate, and phosphate were undertaken at the Biogeochemistry Laboratory, and Biogeotechnology and Molecular Microbiology laboratory in Building 3 of the Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran. Physico-chemical parameters of the water measured in this research include the transparency using secchi disk, temperature using ORP meter HI98190, salinity using refractometer ATAGO, acidity (pH) using ORP meter HI98190, and dissolved oxygen (DO) using Winkler method.

Data analysis

Nutrient concentration calculation. The calculation of ammonia, nitrite, nitrate, and phosphate concentrations were measured spectrophotometrically using the formula:

$$\text{Nutrient} = \frac{1000}{25} \times \frac{\text{Sample absorbance}}{\text{Standard absorbance}} \times 5 \text{ micrograms}$$

Pollution status analysis. Pollution index assessment refers to Minister of Environment's Decree No. 115/2003 with the determination of value below:

$$PIx = \frac{\sqrt{(\frac{Ci}{Lix})^2{}_M - (\frac{Ci}{Lix})^2{}_R}}{2}$$

where: PIx = pollution index;
Lix = concentration of water quality parameters stated in the allotment of water standards;
Ci = concentration of water quality parameters from the survey results;
(Ci/Lix) M = maximum Ci/Lix value;
(Ci/Lix) R = average Ci/Lix value.

Trophic state index (TSI). Calculation of the average trophic state index (TSI) according to Carlson (1997) is described using the formula as follows:

$$\text{TSI (SD)} = 60 - 14.41 \ln(\text{SD})$$
$$\text{TSI (CHL)} = 30.6 + 9.81 \ln(\text{CHL})$$
$$\text{TSI (TP)} = 4.15 + 14.42 \ln(\text{TP})$$

$$\text{TSI} = \frac{\text{TSI (SD)} + \text{TSI (CHL)} + \text{TSI (TP)}}{3}$$

where: SD = Secchi disk (m);
CHL = chlorophyll-*a* (μg L^{-1})
TP = total phosphate (μg L^{-1})

Results and Discussion

Ammonia concentration. Observation of ammonia levels taken from the three stations was carried out by the laboratory tests on water samplings in each layer and pore water in the waters of Muara Gembong.

Concentration of ammonia from the three observation stations horizontally shows that stations 1 and 2 have greater ammonia levels than the ones taken from station 3. As shown in Figure 2, the concentration value of ammonia at station 1; 0.224 mg L^{-1} at water surface, 0.178 mg L^{-1} in the water column, and 0.221 mg L^{-1} at the bottom of the waters, while the sampling taken from station 2 was measured at 0.202 mg L^{-1} at the surface of the water, 0.191 mg L^{-1} in the water column, and 0.214 mg L^{-1} at the bottom of the water. Station 3 on the other hand has a concentration value of 0.180 mg L^{-1} at surface waters, 0.212 mg L^{-1} at the water column, and 0.206 mg L^{-1} at the bottom of the water. Meanwhile, the concentration of ammonia measured vertically at each station has the highest concentration value at the bottom of the water, which is attributed to higher ammonia level in the vertical distribution with the increasing water depth. Proportionally in-line with the lower oxygen level, the condition of increasing ammonia levels is closely related to the entry of organic matter, which makes it easier to decompose (Hutagalung et al 1997). Previous study explains that ammonia in water is an indicator of possible bacterial, sewage and animal waste pollution (Kamal et al 2015).

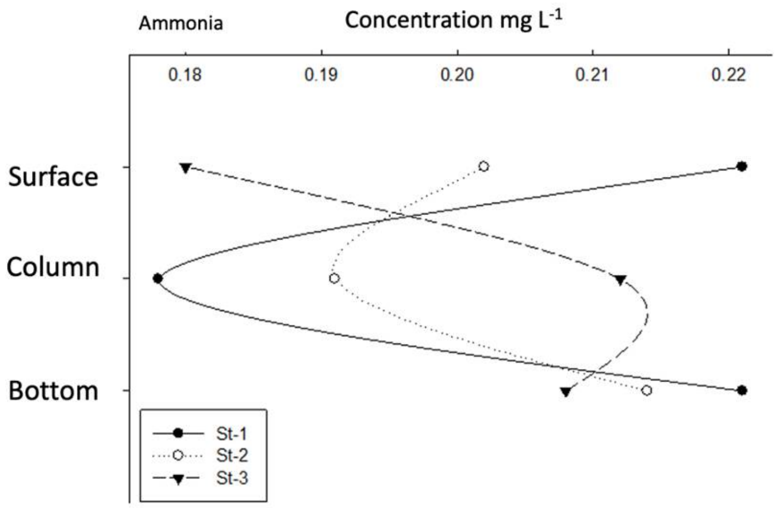

Figure 2. Ammonia concentration.

According to the quality standard emphasised in the Decree of the State Minister of Environment concerning Water Quality Status Guideline No. 115/2003, the quality standard for NH_3-N is 0.02 mg L^{-1}. The results of ammonia examination in the laboratory show that ammonia value of the three stations is still measured above the quality threshold at each layer. On the other hand, compared to the Minister of Environment's Decree No. 51/2004 concerning the seawater quality standards for marine organism, the value of ammonia concentration at three stations (below 0.3 mg L^{-1}) proved to be on par with the standard quality. The causes of high ammonia concentrations in waters are largely due to a large amount of urea content and ammonification process that come from decomposition of organic matter by microbes. Ammonia concentration in the water or aquatic ecosystem will increase if the acidity and temperature also increase (Ngibad 2019). Over and above, daily activities around the waters of Muara Gembong have significantly caused the current high ammonia values. Domestic and industrial waste water discharges resulting from the aforementioned activities flow into the waters of Muara Gembong, affecting the ammonia levels in the water. Kamal et al (2015) in their study said that ammonium can also oxidise to NO_3, leading to decreased levels of dissolved oxygen and the eutrophication of costal ecosystems.

Figure 3 shows the concentration of ammonia in pore water measured with varied values in three stations: station 1 at 1.561±0.05 mg L^{-1}, station 2 at 1.350±0.07 mg L^{-1}, and station 3 at 0.512±0.012 mg L^{-1}. The highest value of ammonia concentration was measured at station 1, while station 3 has the lowest value. Based on the Decree of Minister of Environment No. 51/2004, where the maximum ammonia concentration is set to 0.3 mg L^{-1}, all the values of ammonia in all stations have actually exceeded the quality standard limits. The research shows that ammonia is the nutrient with the highest concentration level found at both stations 1 and 2. Thus, at these two stations (1 and 2), the ammonification process is more likely to occur. A study conducted by Apriyanti et al (2013) explains that ammonification process is due to the high urea content and originating from the decomposition of organic matter by microbes. Moreover, station 1 happens to be located near residential areas, so the high concentration of ammonia may highly likely be caused by the residents' activities such as the result of excision (urine and faecal excrement), and other domestic activities. Meanwhile, the highest level of ammonia concentration was found at station 1 due to its close location to the ponds and areas for agriculture. Ammonia is derived from microbiological oxidation of organic substances from fish food waste (pellets) and agricultural waste that enters the waters of the River Citarum. Generally, ammonia is generated by plants and animals in the water through the decomposition of organisms, and also by the activity of microorganisms (Prosser & Embley 2002).

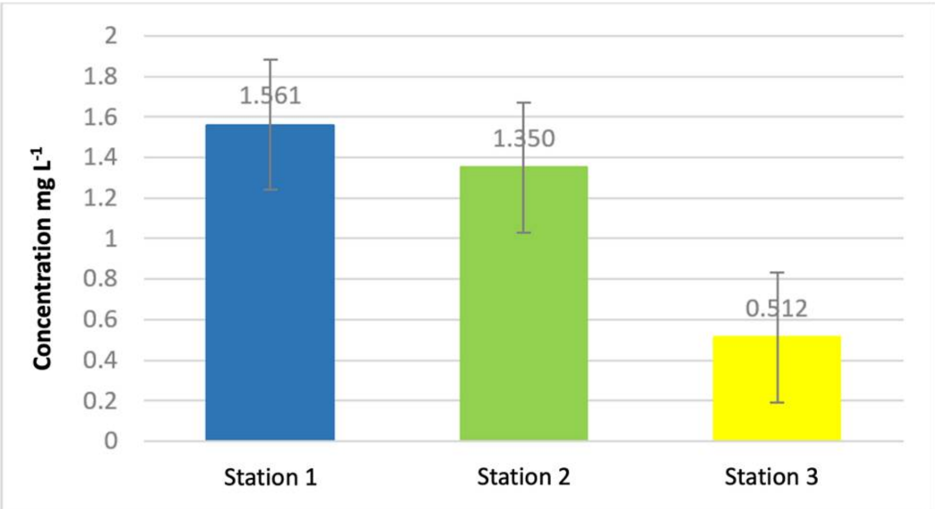

Figure 3. Ammonia concentration in pore water.

Nitrite concentration. Laboratory observations on nitrite content in Muara Gembong water at 3 different stations can be seen in Figure 4.

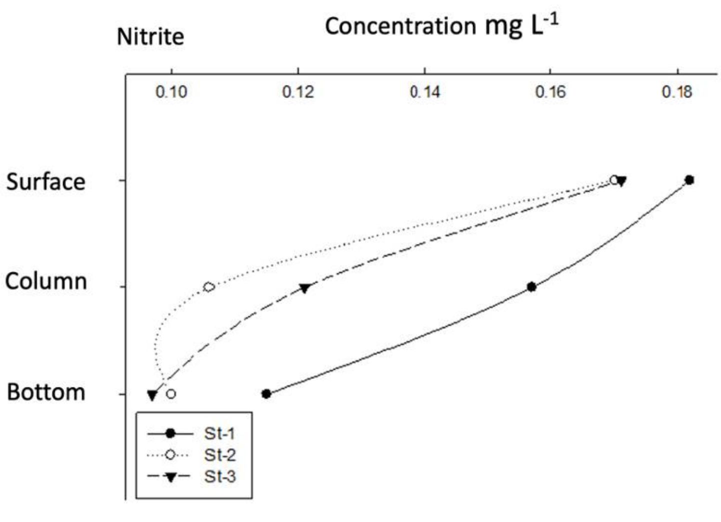

Figure 4. Nitrite concentration.

The results obtained from this study shows, from all the three stations' measurements on the water surface, water column, and bottom waters, station 1 has a higher nitrite concentration compared to stations 2 and 3, which is largely attributed to the location of station 1 being in a residential area near the river flow with a lot of waste materials near the river. The nitrite concentration value at station 1 was measured at 0.182 mg L^{-1} in the water surface, 0.157 mg L^{-1} in the water column, and 0.115 mg L^{-1} in the water bottom. Moreover, station 2 has a concentration value of 0.170 mg L^{-1} in the water surface, 0.106 mg L^{-1} in the water column, and 0.100 mg L^{-1} at the bottom of the water. Station 3 has a nitrite concentration value measured at 0.171 mg L^{-1} in the surface waters, 0.121 mg L^{-1} in the water column, and 0.097 mg L^{-1} at the bottom of the water. Nitrite is a transitional form between ammonia and nitrate taking place in anaerobic conditions (Effendi 2003). Human activities are extremely advancing the increase of nitrogen deposition, nitrogen surplus in livestock, and also crop production system (Xia et al 2018).

The concentration of nitrite decreases in each of the three stations due to the increasing organic contents. Following the previous study by McComb (2002), the content of organic matter can inhibit the process of nitrification in order for the concentration of nitrite to decrease in each of its layers. According to the quality standard stated in the Guidelines for Determination of Water Quality Status in Decree of the Minister of Environment No. 115/2003, our nitric concentrations obtained at the three stations exceeded the quality standard. This condition is mostly triggered by the activities of the residents, and one of them is disposing of household waste around the waters of Muara Gembong itself. As for the nitrite concentration in pore water, station 1 measured 0.141±0.04 mg L-1, while station 2 measured 0.189±0.07 mg L-1, and station 3 measured 0.187±0.014 mg L-1 (Figure 5).

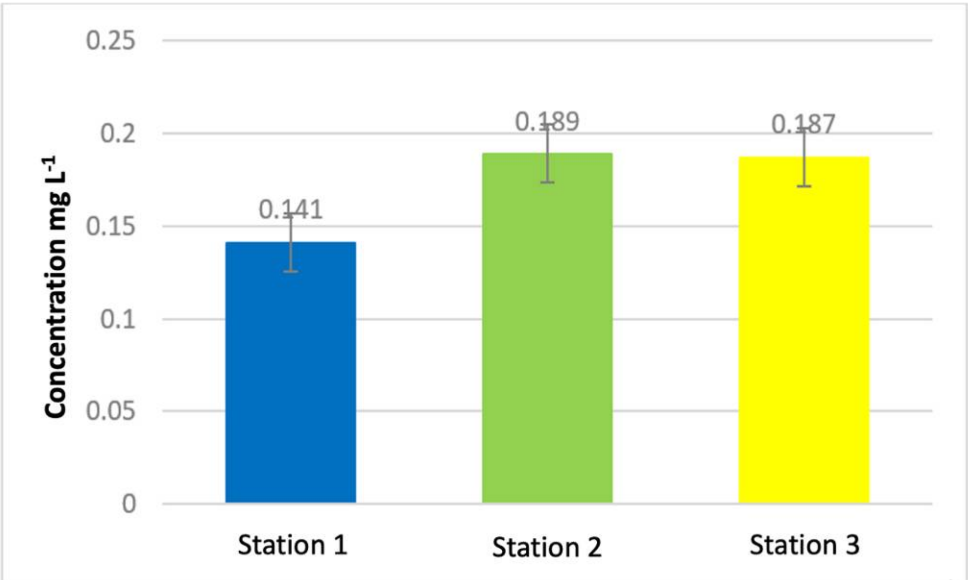

Figure 5. Nitrite concentration in pore water.

The Government Regulation of the Republic of Indonesia No. 82/2001 that the maximum level of nitric concentration is 0.06 mg L^{-1}. Therefore, the nitrite values measured at the three stations exceed the quality standard limits. Compared to nitrate concentration, the score of nitrite concentration appears to be smaller. This is consistent with the study conducted by Effendi (2003) where nitrites are generally found in very small amounts due to their unstable nature and the presence of oxygen. Moreover, nitrite is generally a form of transition between ammonia and nitrate that immediately changes to a more stable form. Nitric can easily be oxidised to nitrate, thus nitrate is the compound that are often found in either underground water or surface water.

Nitrate concentration. Nitrate concentrations in the water column at station 1 have higher concentrations than those found at stations 2 and 3. The bottom waters scored higher nitrate concentration levels at station 3 compared to the ones found at stations 1 and 2.

Based on Figure 6, the results of the concentration value at station 1 were measured at 0.335 mg L^{-1} in surface waters, 0.356 mg L^{-1} in the water column, and 0.219 mg L^{-1} in the bottom of the water. When it comes to station 2, it scored 0.307 mg L^{-1} in the water surface, 0.273 mg L^{-1} in the water column, and 0.144 mg L^{-1} in the bottom of the water, while station 3 was measured at 0.451 mg L^{-1} in surface waters, 0.312 mg L^{-1} in water column, and 0.431 mg L^{-1} in bottom of the water. The horizontal distribution of nitrate levels is getting higher towards the coast (Hutagalung *et al* 1997) and it showed that the highest nitrate levels are measured at station 3, nitrate compounds are produced from the process of perfect oxidation of nitrogen compounds in the waters.

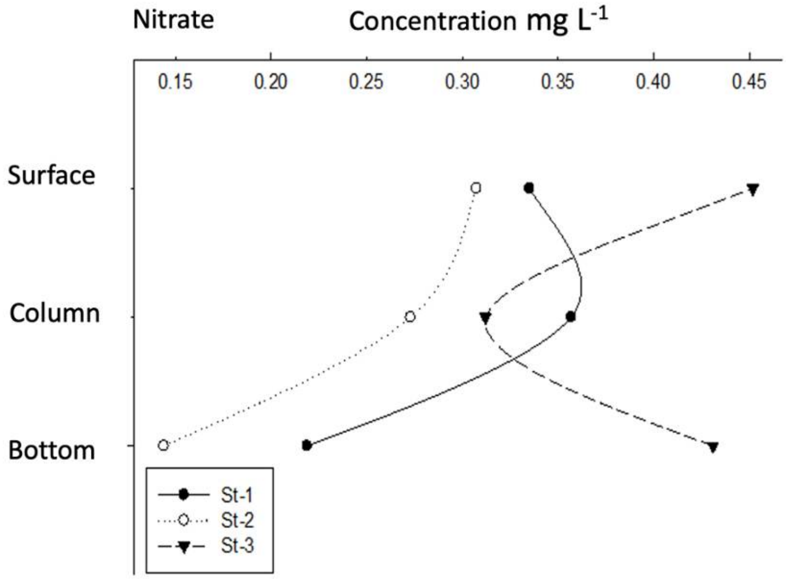

Figure 6. Nitrate concentration.

Results at each station show that a dense concentration of nitrate is found in the surface of water compared to the bottom of water due to the photosynthesis process that occurs more likely in the surface of the water rather than in the bottom of the water. Nitrate concentration of water decreased significantly with depth to water table and was correlated positively with the amount of nitrogen applied to the farms located in the vicinity of wells (4-10 m deep) (Singh & Sekhon 1976). It has also been assumed that nitrate contamination in the surface water cause eutrophication. Effendi (2003) mentioned that nitrates are produced from the complete oxidation process of nitrogen and ammonia compounds in water.

The main source of nitrate comes from soil erosion, runoff from land including fertiliser and waste (Chester 2000). Moreover, conforming to Effendi (2003), the concentration of nitrate-nitrogen in natural waters rarely exceeds 0.1 mg L^{-1}, yet the results obtained in Muara Gembong waters are measured more than 0.1 mg L^{-1} for natural waters due to a number of factors. The presence of low and high nitrate contents at certain concentrations is caused by numerous factors, including the current-carrying nitrates, and abundance of phytoplankton. Furthermore, Xia et al (2018) mentioned that human activity and climate change also had reflective and increasingly significant effects on the nitrogen concentration especially in rivers and streams. Nitrate concentration at station 1 was measured at 0.435±0.05 mg L^{-1}, while station 2 at 0669±0.037 mg L^{-1}, and station 3 at 0.807±0.013 mg L^{-1} (Figure 7).

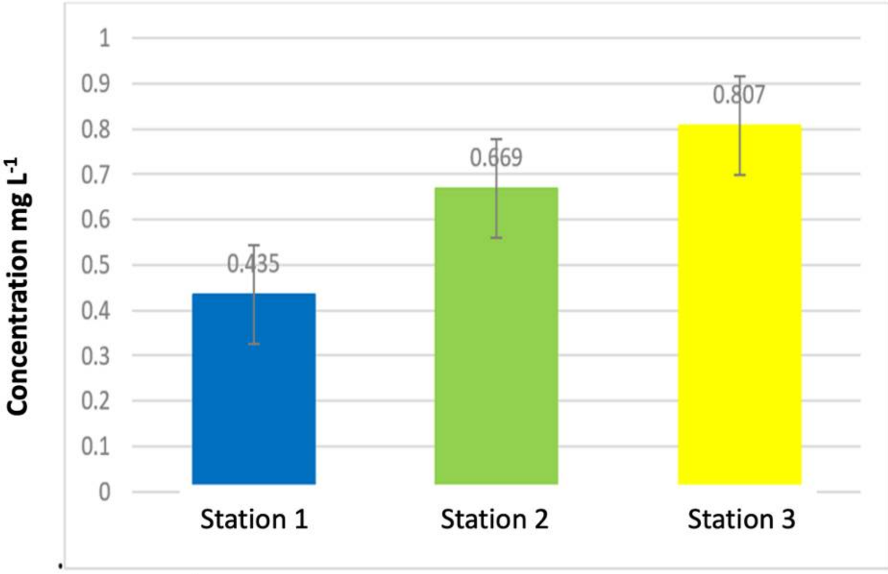

Figure 7. Nitrate concentration in pore water.

The Minister of Environment's Decree No. 51/2004 mentioned, that the maximum value of nitrate concentration is 0.008 mg L^{-1}, which means the nitrate values obtained in all stations exceed the quality standard. The results show that the highest nitrate concentration was found at station 3 (Figure 7). Nitrification process at station 3 is more likely to occur, due to the abundance of nitrifying bacteria by adequate oxygen concentration, while, still at station 3, the concentration of ammonia is found less dense than the concentration of nitrate. Compared to the measurement at the other two stations, the low ammonia content at station 3 is worth noting, and presumably due to the oxygen content and the conditions at the station itself, where the occurrence of nitrification or oxidation from the form of ammonia to nitrate is still supported. Yet, according to the Minister of Environment's Decree No.51/2004, the maximum nitrate concentration is no greater than 0.008 mg L^{-1}.

Generally, the nitrate content in sediments tends to appear low because nitrates are used by phytoplankton and other organisms in the first place due to the ability of nitrates to dissolve more quickly in water, making the amount of particles that settle in the sediment to be low. High nitrate concentrations are thought to be originated from domestic waste, agricultural fertiliser residues, and nitrite undergoing nitrification. The primary source of nitrate pollution in South-East Asian villages is derived from human and animal's waste (Smith et al 1999). The high nitrate content in waters may be caused by the high content of dissolved substances and the decomposition of sediments or organic compounds derived from dead flora and fauna (Pujiastuti et al 2013). The high nitrate content in the waters is also likely caused by the pollution coming from fertilisation, animal dung, humans, and industry. However, nitrates are not toxic to aquatic organisms. The horizontal distribution of nitrate levels will be higher towards the coast, and high levels are found in estuarine waters.

Phosphate concentration. Excessive phosphate in water bodies can cause nutrient enrichment. Concentration levels of phosphate are affected by the input of organic matter carried by the river (Rizal et al 2017). Phosphate concentration is showed in Figure 8. The results of the concentration value at station 1 were measured at 0.055 mg L^{-1} at surface waters, 0.157 mg L^{-1} at the water column, and 0.078 mg L^{-1} at the bottom of the water, while station 2 scored its concentration values 0.086 mg L^{-1} at surface waters, 0.083 mg L^{-1} at the water column, and 0.136 mg L^{-1} at the bottom of the water, and station 3 at 0.130 mg L^{-1} at surface waters, 0.141 mg L^{-1} at the water column, and 0.069 mg L^{-1} at the bottom of the water. Effendi (2003) mentioned that a water is classified as eutrophic if the concentration happens to be ranging between 0.035 and 0.1 mg L^{-1}. The difference in concentration measured at its depth from each station is attributed to several factors depending on the source of pollution. Domestic activities such as household activities that could be very complex have the potential to pollute coastal and marine ecosystems. Increased household activities in coastal areas cause greater volume and more types of nutrient waste produced from time to time such as ammonia, nitrate, nitrite, and phosphate. As a result, the burden on water bodies that have been used to dispose waste becomes too much that would eventually harm humans and the environment (Ihsan et al 2018).

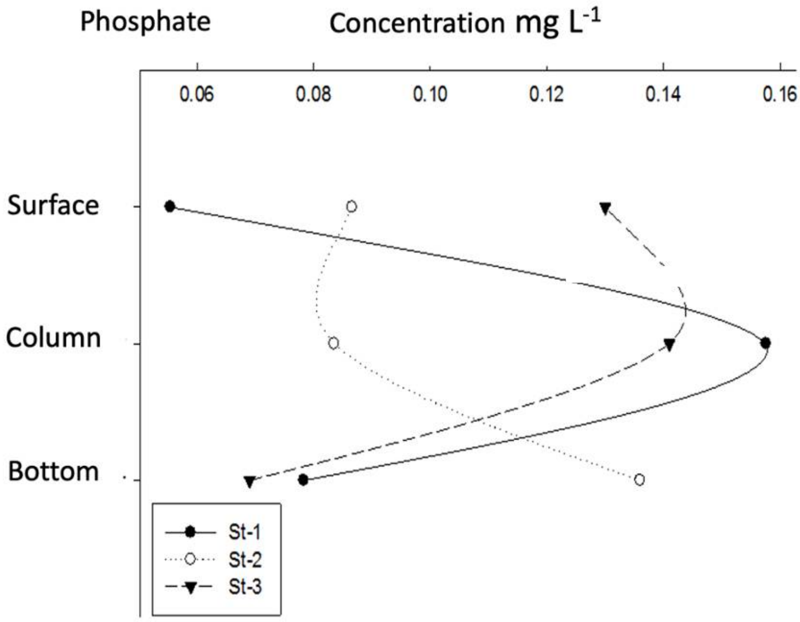

Figure 8. Phosphate concentration.

The water column and bottom waters have different phosphate concentration when observed from the surface of the waters. Based on Figure 8, stations 1 and 2 have higher phosphate levels at the bottom of the waters than station 3. This result is attributed to the decomposition of the phosphate compounds bound in the sediment, with the help of bacteria through the abiotic process to produce dissolved phosphate compounds. Followed by another study by Zhang et al (2014), sediment is a place for storing and releasing material into water pools in the estuary and coastal waters, due to the close proximity of the bottom of the waters to sediments in the waters.

From these three stations, phosphate concentrations in the surface waters are greater than in bottom waters at station 3 (Figure 8), and it is the high currents that cause resuspension process. Based on the previous study conducted by Warnken et al (2000), resuspension events are caused by winds and tides. Furthermore, the resuspension process can cause different sediments at the bottom of water to then emerge into the pool of water, and lead the chemical elements including phosphate to be surfaced into the water pool. The estuary is a source of nutrients in marine waters, and generally, the concentration of nutrients in estuaries are higher and lower when moving further from offshore (Muchtar 2001). Based on Minister of Environment's Decree No. 51/2004, the seawater quality standards for marine organism is set to 0.0015 mg L^{-1}, and from the study obtained at three stations, the value of phosphate therefore exceeds the quality standard. Source of phosphate comes from nonpoint source pollution such as runoff from pasture and croplands, atmospheric deposition, and stream bank erosion, with runoff from pasture and croplands being the largest. Other nonpoint source pollutions include urban runoff, non-agricultural runoff, and seepage from individual sewage treatment system (MPCA 2007).

Figure 9 explains about total phosphate concentration at station 1, station 2, and station 3. The values of total phosphate concentration at the three stations were measured at 0.217±0.05, 0.242±0.037, and 0.322±0.013 mg L^{-1} respectively.

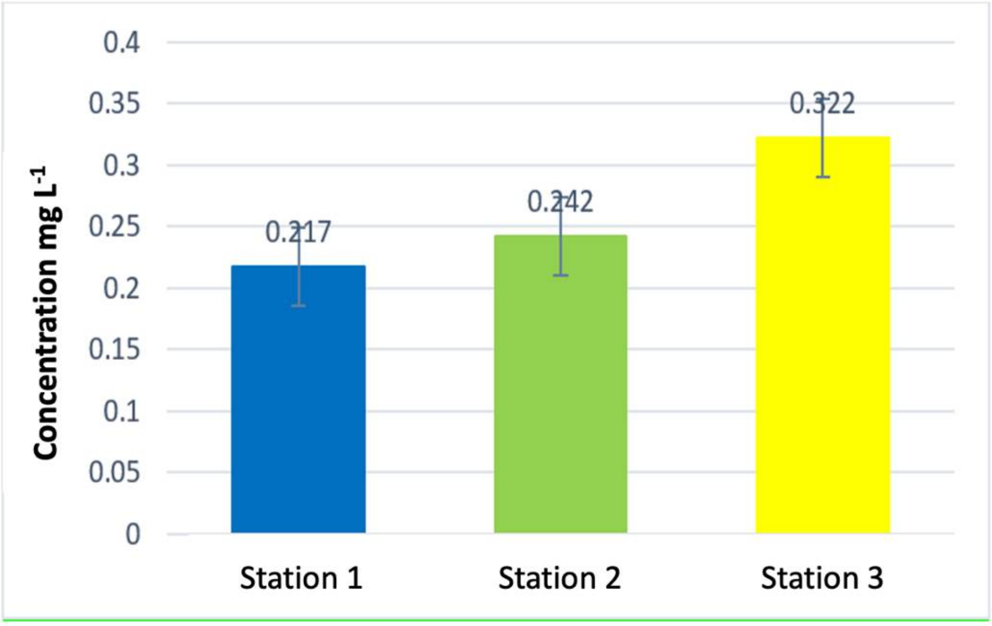

Figure 9. Total phospate concentration.

Government Regulation No. 82/2001 explained that the maximum total phosphate content for the waters to be classified life-supporting is 0.2 mg L^{-1}, thus the phosphate values at all stations exceed the maximum limit. Phosphate conditions exceeding the maximum limit are usually caused by nonpoint source pollution. Nonpoint source pollutions are sources of pollution that can be determined by neither specific sources, such as excess fertiliser, sedimentation, runoff results, or other sources.

Furthermore, the total phospate contents at station 3 appear as the highest concentration, which is due to the input of nutrient from the surrounding community activities. According to Effendi (2003), the anthropogenic source of phosphorus is domestic waste, mostly from detergents. Total phosphate conditions that exceed the maximum limit can also be caused by nonpoint sources. Nonpoint pollution sources are sources that cannot be determined by any specific sources, such as excess fertiliser, sedimentation, runoff results, or other sources. Meanwhile the surrounding land at station 2 is utilised for agricultural uses. This agricultural land can provide runoff from the use of fertiliser, which is phosphorus, to the river. Forty-five percent of the source of phosphate in rivers comes from agricultural activities (Cooper et al 2002). Moreover, the high and low phosphate concentrations are caused by the process of fish excretion in the form of feces and other forms of waste. That form can settle at the bottom of the water and accumulate in sediments (Yildiz et al 2017).

Pollution status. Based on the calculation of the pollution index (PI) in Table 1, the pollution status in the waters of Muara Gembong is classified into the medium polluted group. The PI values of pollution status at station 1 scored 6.76, station 2 scored 6.87, and station 3 scored 6.9.

Table 1

Pollution index

Station	*Pollution index*	*Information*
1	6.76	VI = 5.0 < VI, ≥ 10 Category = medium polluted
2	6.87	VI = 5.0 < VI, ≥ 10 Category = medium polluted
3	6.9	VI = 5.0 < VI, ≥ 10 Category = medium polluted

The stations used for this study are considered highly active for the local community. According to Xia et al (2018), rivers will receive input of materials and energy from the areas along the river, or from all human activities that are related to waste production, and which then flow through the river bodies. Industrial developments in residential areas along the river provide input of pollutants for the river waters as well, which will eventually flow into the estuary.

Although there are no signs of eutrophication in these waters, these conditions can be disquieting since ammonia, phosphate, nitrates, and nitrites are environmental parameters that contain nutrients. If all those parameters occur at high concentrations, eutrophication will happen, which is extremely harmful to aquatic ecosystems. Related study from Wibisono (2005) explains that the examination of nitrate and phosphate contents, or often referred to as nutrients, need to be conducted since these parameters are parameters of the fertility level of water, but if it passes the fertility level, a predetermined threshold will cause a decrease in the water quality.

Evaluation of trophic status through the application of the trophic state index method. Aquatic fertility is the process of adding nutrients to water bodies, or the ability of water to provide nutrients suitable for phytoplankton life. It is commonly observed that the most pronounced phytoplankton responses to enrichment occur when both nitrogen and phosphorus are added together. According to Schlüter et al (2000) the concentration of nutrients, especially nitrogen and phosphorus can affect chlorophyll-*a*. Chlorophyll-*a* is a green plant pigment essential for photosynthesis. Nitrogen and phosphorus, apart from being the limiting factors that play a role in determining the trophic status of aquatic life, are also prerequisite in the photosynthesis process. Figure 10 shows the graph of trophic status results.

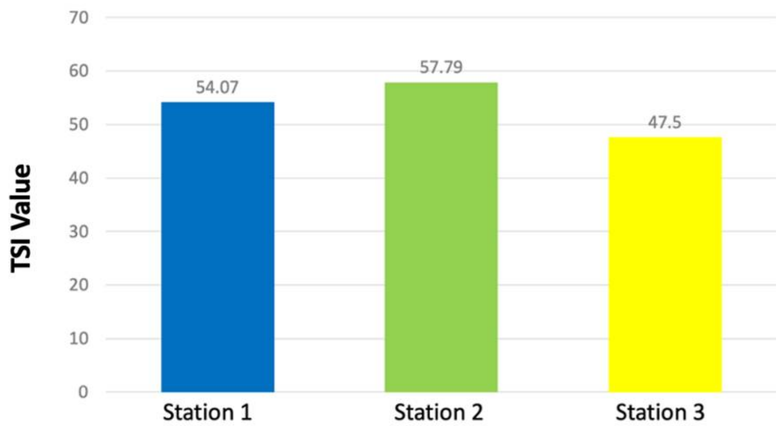

Figure 10. Trophic status results.

The study results show that station 1 had the TSI value of 54.07, station 2 - 57.79, and station 3 - 47.50 (Figure 10). Thus, referring to the TSI standard, the fertility level in the waters of Muara Gembong can be classified as mild eutrophic conditions with a range of numbers 50-60 at both stations 1 and 2, while station 3 has mesotrophic condition with a range of numbers 40-50.

Conclusions. This study found that the primary nutrient prevalent in both water and pore water is nitrate. This prevalence is attributed to the waste found in Muara Gembong waters that predominantly comes from domestic waste, whereas nitrate comes from leftover food, domestic waste, and from nitrites undergoing the process of nitrification. Pollution status of Estuary Gembong is obtained using the pollution index analysis scoring at the values ranging from 6.76 to 6.9 that can actually be classified as moderately polluted. Water fertility levels calculated using Carlson Trophic State Index (TSI) method obtained values ranging from 47.5 to 57.79, thus classified as mild mesotrophic and eutrophic conditions in Muara Gembong.

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Conflict of interest. The authors declare that there is no conflict of interest.

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