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PROFILE OF NUTRIENT AND WATER FERTILITY LEVEL AT NUSAWIRU PANGANDARAN WEST JAVA

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ABSTRACT

Nutrient is one of the most essential elements in the growth and development of marine ecosystem. The aim for this research is to measure the fertility level of Nusawiru Water in Pangandaran West Java. The method used is survey and laboratory analysis using descriptive comparative method. The method used to estimate the level of fertility in this study is the TSI method. The result indicated that the chemical nutrient profile at Nusawiru consists of Ammonia (NH_3), Nitrate (NO^{3-}), Nitrite (NO^{2-}), O-Phosphate (PO_4). The total amount of Phosphate and chlorophyl shows that the water in the observation station of waste pond, estuary, delta, and open water are in Ultraoligotrophic status. The limiting factor in the waters of Nusawiru Pangandaran is phosphate, because the ratio of N and P at all observation stations are >12.

Keywords: Nutrients, Water Quality Parameters, Fertility Level,

INTRODUCTION

Coastal areas are areas that have distinctive ecological characteristics, which are different from mainland ecological areas in general. Coastal areas are transition places between land and sea, which are marked by significant ecological changes. Coastal areas, especially in estuary areas, are also very fertile areas or areas with high levels of biological productivity as well as diverse and strategic environmental services. However, on the other hand, coastal areas and river estuaries are also the most vulnerable areas to the threat of natural disasters and the impacts of climate changes, along with the disturbances related to human activities. These disturbances often have negative impacts on the environments, including in the form of ecosystem damage or the decrease in the quality of the coastal environments.

Nusawiru waters are coastal waters that have an estuary ecosystem to support people's lives. This ecosystem has a very important role in supporting people's lives in the Nusawiru Coastal Area. Besides, this ecosystem also has an ecological function in maintaining the environmental balance of the coastal areas. These waters have a large potential of marine biological resources.

Estuary ecosystems are partially enclosed waters that are directly contacting with the sea, so that the seawater with high salinity can mix with the fresh water (Pickard, 1967). Therefore, the estuary ecosystem has an economic and an ecological function. Economically, it can be used as places of settlements and places for the development of fisheries and marine activities (Bengen, 2004). On the other hand, ecologically, the estuary ecosystems are the sources of nutrients and organic contents that transported through tidal circulation, providing habitat for a number of animal species that depends on the estuaries, as the shelter and the feeding ground as well as the place for reproduction and/or a nursery ground, especially for a number of fish and shrimp species as the sources of nutrients.

In line with those functions of the coastal ecosystems, the Nusawiru Coastal Area currently has a big potential of marine biological resources and is also used for residential activities, aquacultures, capture fisheries, agricultures, and trades. All activities in the Nusawiru Coastal Area grow in line with the growth of the population which affects the coastal ecosystem, resulting in the decrease of the quality of the coastal ecosystem conditions. The decline in ecosystem quality in the Nusawiru Coastal Area affects its environmental quality. This can be seen from the environmental condition in the Nusawiru Coastal Area. The current environmental condition in the Nusawiru Coastal Area is the occurrence of poor environmental sanitation. In the Nusawiru waters, there is a conversion of mangrove land into a shrimp pond which has now begun to operate. Thus, the nutrient contents transported will be vary in compositions depending on the conditions of the waters and the path it passes through.

Human activities that change the nutrient contents and the entry of sunlight into aquatic ecosystems affect the trophic status of the waters. Trophic status explains how nutrients, water clarity and other factors stimulate the growth of algal biomass (chlorophyll a) and contribute in improving water fertility conditions (Duka & Cullaj, 2009). The trophic status index of the waters can be used as the main characteristic for determining the potential of these waters (Moreau & De Silva, 1991; Gomes et al., 2002).

In order to utilize the potential of natural resources and to prevent the decline of the water quality in Pangandaran Coastal Area, especially in the Nusawiru Waters, it is necessary to study the level of fertility of these waters. The parameters that can be used to assess the level of its waters' fertility are the nutrients contents and chlorophyll - a.

Changes in water quality that occur in waters area can be monitored through water quality measurements based on the quality standards using physical, chemical and biological parameters. The trophic status of waters is one of the indicators to determine the fertility level of the waters. One of the methods in determining the trophic level of waters using those 3 variables is the Carlson's Trophic State Index (TSI) method. The TSI method has 7 levels of aquatic trophic categories from ultraoligotrophic to hypereutrophic (Carlson's 1977).

Based on this explanation, to determine the trophic status of the Nusawiru Waters Pangandaran, a study was conducted with the title "Nutrient Profile and Trophic Levels in the Waters of Nusawiru, Pangandaran, West Java". This study further can be used as the basis for sustainable and environmental-based management, in consideration to the roles and functions of these waters as life supporting for its surrounding area.

MATERIALS AND METHODS

Research Location

This research was conducted from June – August 2021 in the Nusawiru Waters Pangandaran. This included activities to determine research stations, taking field samples, and sample processing. Water sample processing was carried out at the Ecology Laboratory of Universitas Padjadjaran. The map of the research location and the coordinates of the observation station is presented in Figure 1.

Figure 1. Research Location .

Station 1 is in the shrimp pond waste area with coordinates 108°30'11" east longitude 7°43'20" south longitude, station 2 is in the river mouth area with coordinates 108°30'5" east longitude 7°43'5" south longitude, station 3 is in the delta area with coordinates 108°29'38" east longitude 7°43'31" latitude, and station 4 is in open waters area with coordinates 108°25'30" east longitude 7°43'40" LS.

The materials used in this study were water samples, lugol, sodium hydroxide (NaOH), ascorbic acid ($C_6H_8O_6$), ammonium molyb (NH_4-molibat), antimonyl tartrate ($C_8H_{10}K_2O_{15}Sb_2$), $K_2S_2O_8$, $SnCl_2$, KH_2PO_4, concentrated sulfuric acid (H_2SO_4), $CuSO_4$, aquades, n-naphthylene, Sulfanilamide ($C_6H_8N_2O_2S$), N-(1-naphthyl)-ethylenediamine dihydrochloride, KNO_3, Nessler (HgI_4K_2), Acetone (CH_3COCH_3) 90% and the secondary materials used in this research were the direction and current speed taken from the website *www.marine.copernicus.com*. The direction and speed of the current will be analyzed spatially and temporally.

Sampling Method

Method used in this research was survey method. This method was carried out by circling the estuary of the Nusawiru Waters using a boat and determining four research points randomly as the representations of all research stations. Physic-chemical parameters of the waters (temperature, salinity, brightness, pH, and dissolved oxygen) were carried out using in-situ parameter (direct measurements), while the other parameters were carried out in the laboratory. The analytical method used in this research was descriptive analysis method.

Research Procedure

The procedure used in this research was in-situ and ex-situ parameters. In-situ parameters consists of temperature, salinity, brightness, pH, depth, dissolved oxygen. While, the ex-situ parameters include chlorophyll, ammonia, nitrite, nitrate, phosphate, and total nitrogen treated in the laboratory. The determination of the observation stations was conducted by using purposive sampling method, i.e., samples were taken from certain stations to represent the overall state of the waters (Ayuningsih, 2014). The Ammonia test used the SMEWW 4500 NH_3F method, the nitrate test used the SMEWW 4500 NO_3E method, the nitrate test used the SMEWW 4500 NO_2B method, the o-Phosphate test used the SMEWW 4500-PD method, and for the total phosphate test was used the SMEWW 4500-PBD method. As for the chlorophyll-a test, the SNI 4157:1996 method was used.

Data Analysis

Qualitative data analysis was carried out descriptively. Data analysis to determine the trophic status was carried out by comparing primary data on water quality with the criteria for determining the trophic status of waters and water quality standards. Descriptive analysis of the N:P ratio data was carried out by comparing the primary data of the N:P ratio with the quality standard of the N:P ratio. The N:P ratio was used to determine the content of N and P and their proportions in Nusawiru waters.

The method used to estimate the level of fertility in this study is the TSI method. The use of this method is based on the results of the calculation of the N:P ratio. If the results of the N:P ratio analysis indicates that P is the limiting factor, then the TSI method is quite relevant (Carlson, 1977) to measure the fertility status of Nusawiru waters.

The level of water fertility was measured through the calculation of the Tropic State Index (TSI) which is presented as Carlson's (1977) below:

TSI - TP = 14,42 x Ln [TP] + 4,15 µg/l

TSI - Chl-a = 30,6 + 9,81 x Ln [Chl-a] µg/l

TSI - SD = 60 - 14,41 x Ln [Secchi] meter

$$TSI = \frac{(TSI-TP)+(TSI-Chla)+(TSI-SD)}{3}$$

where:
TSI = Carlson Index Status Trophic
TSI-SD = Trophic Status Index for Secchi Disk Depth
TSI-TP = Trophic Status Index for Total Phosphorus
TSI-Chl = Trophic Status Index for Chlorophyll- a

Testing the similarity of water quality characteristics among the stations using the Canberra index. Parameters used to determine the similarity of the characteristics of water quality between stations include temperature, brightness, pH, dissolved oxygen (DO), nitrate-nitrogen, nitrite-nitrogen, ammonia, total P, and orthophosphate. The results will be displayed in the form of a dendrograms that describes the similarity of water quality characteristics between stations which are grouped based on their similarities. The following is the equation used in the Canberra index (Lance and Williams 1967 in Krebs 1989):

$$TSI = \left\{1-\frac{1}{n}\Sigma\left|\frac{Yi_1 - Yi_2}{Yi_1 + Yi_2}\right|\right\} x\ 100\%$$

Sc = Canberra index
Yi_1 = parameter i station 1
Yi_2 = parameter i station 2
n = number of parameters

RESULT AND DISCUSSION

Ammonia

The average ammonia concentration in waste ponds was 0.052 mg/L at the water's surface and 0.064 mg/L at the water's bottom. Ammonia levels at the estuary station were 0.042 mg/L at the water's top and 0.037 mg/L at the water's bottom. The ammonia concentration at the delta station was 0.046 mg/L at the water's surface and 0.039 mg/L at the water's bottom. Ammonia concentrations at offshore sites ranged from 0.032 mg/L at the top to 0.034 mg/L at the bottom. According to KepMNLH No. 51 of 2004, the waters of the Nusawiru Waters Pangandaran had ammonia levels that were less than the 0.3 mg/L sea water quality requirement for marine biota. Figure 2 shows the results of the ammonia (NH_3) content observations at each observation station

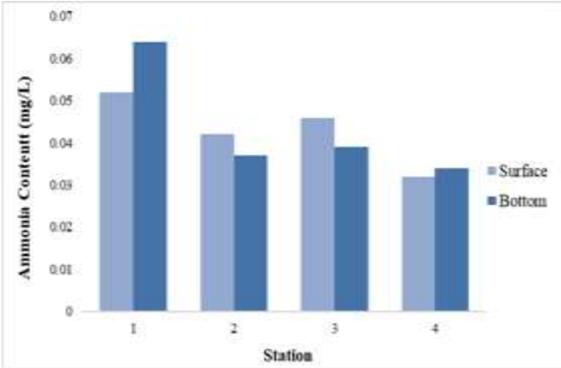

Figure 2. Ammonia content at the sample site

The high number of ammonias at the disposal pond station was assumed due to the station's proximity to settlement areas and the fact that it also receives ammonia from other water areas. Meanwhile, due to their location, open waters had the lowest ammonia content. According to Astrini et al. (2014), the high ammonia content in waters is due to the high organic matter that can come from agricultural activities, domestic waste, and industrial waste around the waters. According to Sasongko (2006), household waste has a nitrogen content ranging from 20 to 85 mg/l, with ammonia nitrogen accounting for roughly 60% of the total and organic nitrogen accounting for the remainder.

Nitrate

The surface concentration of nitrite in waste ponds is 0.231 mg/L, while the bottom concentration is 0.17 mg/L. The nitrate content of the estuary station is 0.184 mg/L at the surface and 0.164 mg/L at the bottom. The delta station has a nitrate content of 0.151 mg/L at the water's surface and 0.12 mg/L at the water's bottom. Nitrate concentrations in offshore stations range from 0.167 mg/L at the surface to 0.133 mg/L at the bottom. Based on the nitrate concentration, the waters are classified as oligotrophic, with nitrate levels ranging from 0 to 1 mg/L. (Effendi, 2003). Figure 3 depicts the results of observations of Nitrate (NO_3-N) content at each observation station.

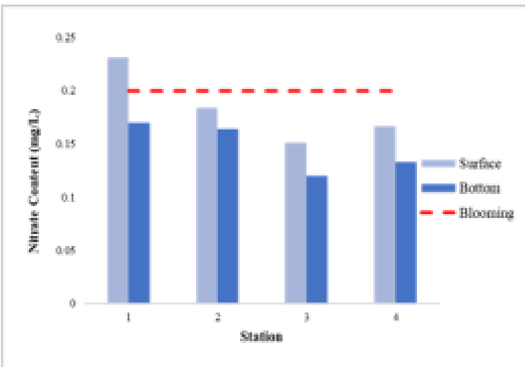

Figure 3. Nitrate content at the sample site.

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The average content of nitrate in waste ponds on the surface waters was 0.231 mg/L and at the bottom of the waters was 0.17 mg/L. The estuary station had a nitrate content of 0.184 mg/L at the surface of the water and 0.164 mg/L at the bottom of the water. The delta station had a nitrate content of 0.151 mg/L at the surface of the water and 0.12 mg/L at the bottom of the water. Offshore stations contained nitrate with a value of 0.167 mg/L at the surface and 0.133 at the bottom. Based on the nitrate concentration obtained, the waters were classified as oligotrophic waters with nitrate levels between 0 ± 1 mg/L (Effendi, 2003).

Nitrite

The average content of nitrite in waste ponds at surface waters was varied from 0.005 mg/L to 0.006 mg/L. The estuary station had nitrite content of 0.002 mg/L to 0.004 mg/L. The delta station had a nitrite content of 0.005 mg/L to 0.004 mg/L. Offshore stations contained nitrite with a value of 0.003 mg/L to 0.003 mg/L. Based on the Canadian Council of Ministers of the Environment (2008), states that natural waters generally contain nitrite of 0.001 mg/L and should not exceed 0.06 mg/L. The results of observations of the Nitrtite (NO_2-N) content at each observation station can be seen in Figure 4.

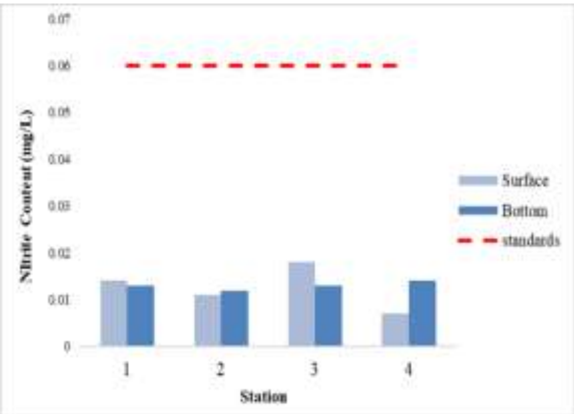


Figure 4. Nitrite content at the sample site

The nitrite content at all observation stations was less than 0.06 mg/L, which met the quality standards. The amount of dissolved oxygen in the water influences the concentration of nitrite. The measured nitrite concentration is much lower when compared to the nitrate concentration. This is because nitrifying microbes are aerobic microbes, specifically mycobacteria, which can only grow in waters with sufficient oxygen. This is in line with Effendi's (2003) assertion that nitrite is typically present in very small concentrations in natural waters due to its unstable nature as a result of the presence of oxygen. As a result, dissolved oxygen must be present for nitrifying bacteria to survive. The fact that nitrite is poisonous when it interacts with haemoglobin in the blood and prevents the blood from carrying oxygen makes it one of the important factors in determining the quality of water.

O-Phosphate

The average content of o-phosphate in waste ponds varied from 0.006 mg/L to 0.007 mg/L. The estuary station had an o-phosphate content of 0.009 mg/L at the surface of the water and 0.007 mg/L at the bottom of the water. The delta station had an o-phosphate content of 0.01 mg/L at the surface of the water and 0.005 mg/L at the bottom of the water. Offshore stations contained o-phosphate with a value of 0.004 mg/L at the surface and 0.003 mg/L at the bottom. Quality standards for seawater phosphate content for marine biota as stipulated in the Decree of the State Minister of the Environment No. 51 of 2004, which is 0.015 mg/L. The results of the observations showed that the waters did not exceed the phosphate quality standard. The results of observations of the o-phosphate content at each observation station can be seen in this figure (Figure 5)

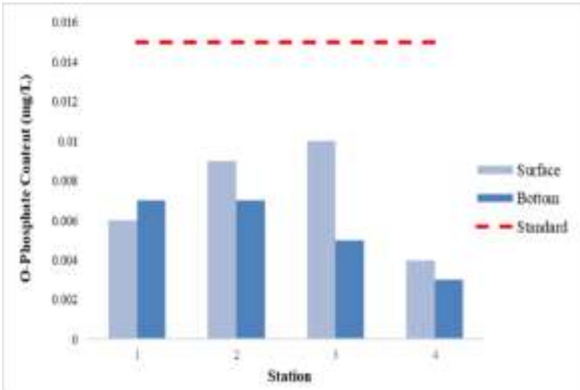


Figure 5. O-Phosphate content at the sample site

Ratio of N and P

The proportion of N values is obtained from the sum of ammonia, nitrate and nitrite, while the proportion of P values is obtained from the total phosphate content. The results of the calculation of the ratio of N and P at each station at the Nusawiru Waters Pangandaran can be seen in table 5 below.

Table 1. Ratio of N and P in the waters of Nusawiru Pangandaran

Station	Location	N : P
1	Water Pond	40.615
2	Estuary	27.063
3	Delta	24.333
4	Offshore	53.143

Sulastri et al. (2007) stated that in general, if the ratio of total N and total P < 12 indicates that nitrogen is a limiting factor for phytoplankton growth, the ratio of total N and total P > 12 indicates that phosphorus is a limiting factor for phytoplankton growth. Thus, in the waters of Nusawiru Pangandaran the limiting factor for phytoplankton in these waters is the content of P or phosphorus.

Limiting Factors of Fertility Status Total P

The average value of total P in waste ponds at surface waters was 0.014 mg/L and at bottom waters was 0.013 mg/L. The estuary station had an average total P value of 0.011 mg/L at the surface of the water and 0.012 mg/L at the bottom of the water. The delta station had an average total P value of 0.018 mg/L at the surface of the water and 0.013 mg/L at the bottom of the water. Offshore stations had an average total P value of 0.007 mg/L at the surface and 0.014 mg/L at the bottom.

Based on the trophic status classification, the total P value proposed by Vollenweider et al. (1998), all waters were included in the mesotrophic trophic status because they were in the range of 0.011-0.03, except for high seas stations on the surface which were classified as oligotrophic because their values are in the range of 0.003 – 0.01

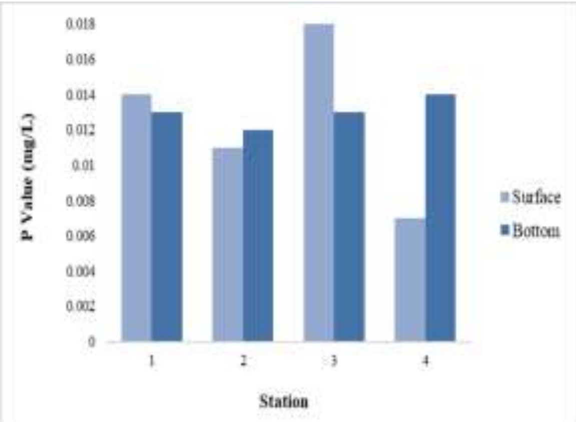


Figure 6. Phosphat

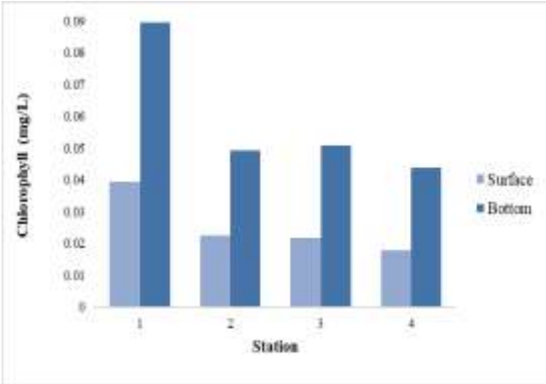
Nitrate – Nitrogen

Based on Wetzel's 2001 trophic status classification of nutrient nitrate measurements, all waters in Nusawiru Pangandaran can be classified as mesotrophic because they had nitrate values ranging from 0.1 to 0.2 mg/L, except for pond discharge stations on the surface whichwere included in the eutrophic status because they contained nitrate in excess of 0.2 mg/L.

Chlorophyll-a

The results of observations of the chlorophyll-a contents at each observation station can be seen in Figure 7 below.

The results of observations of the chlorophyll-a contents at each observation station can be seen in Figure 7 below. The average content of chlorophyll-a in waste ponds on the surface of the waters was 0.0394 mg/L and at the bottom of the waters was 0.0896 mg/L. The estuary station contained chlorophyll-a of 0.0226 mg/L to 0.0493 mg/L. The delta station contained chlorophyll-a of 0.0219 mg/L to 0.0509 mg/L. Offshore stations contained chlorophyll-a of 0.0180 mg/L to 0.0439 mg/L at the bottom.



Picture 7. Chlorophyll-a

The results of the observations showed quite varied results. The value of chlorophyll-a content at shrimp pond stations on the surface and bottom of the water were higher than other stations. The location of the waste pond station which can be seen in Figure 7 shows that the location of the pond is quite far from the open sea waters. These results were in line with theresults of research by Damar (2003) in the waters of the Jakarta Bay which found that the chlorophyll-a content of coastal waters was higher than that of sea waters. This is due to the contribution of nutrients received by plankton in areas closer to the mainland and utilized by phytoplankton to grow and develop (Wenno et al. 2012).

Sanusi (2004) states that the fertility level of a coastal waters can be assessed from chemical and biological characteristics. The biological factor that affects the fertility level of a waters is chlorophyll-a. Chlorophyll-a is a pigment that capable to do photosynthesis and is found in all phytoplankton organisms.

As a biota, the growth of phytoplankton requires macro nutrients in the form of N and P as well as micro nutrients in the form of Fe as the constituent elements of their cells (Yazwar 2008). The value of PO4 content in this study was more focused on delta stations, while other stations were lower. However, the chlorophyll-a content at the delta station was relatively the same as the estuary and open water stations and was lower than the pond station. Sarmiento et al. (2010) stated that an area of High Nurient Low Chlorophyll (HNLC) can be affected by Fe levels in these waters. It is suspected that the low content of chlorophyll-a at delta stations, estuaries and open waters is due to the lack of nutrients in the form of Fe in the waters which were not measured in this study.

Trophic level

The following is a table of trophic levels in the research that has been carried out:

Table 2. Trophic Level in Observation Station

Station	Location	TSI-TP	TSI-Chl-a	CTSI	Trophic level
1	Water Pond	20.568	3.7099	12.139	Ultraoligotrophic
2	Estuary	20.561	-2.0244	9.268	Ultraoligotrophic
3	Delta	20.575	-1.9024	9.336	Ultraoligotrophic
4	Offshore	20.558	-3.4935	8.532	Ultraoligotrophic

Based on the calculation of the level of eutrophication using the TSI method, all observation stations were in the Ultraoligotrophic status because the value obtained was <30. Waters with ultraoligotrophic status indicates that these waters have very low concentrations of nitrate, iron, phosphate, and carbon sources (Horikoshi 2016). In general, nutrients become less available along the indicated ultraoligotrophic-oligotrophic environment, because on the surface, organic compounds decomposed from plant and animal remains are rapidly consumed by microbes, resulting in nutrient deficiency in deeper soil layers (Morita and Richard 1997). Ultraoligotrophic are organisms that can live in environments that have very low nutrient levels, ultraoligotrophic characterized by fairly clear water conditions, high dissolved oxygen concentrations throughout the year and reaching the hypolimnion zone (Robert Carlson's 1977).

This is because the measured chlorophyll-a content is an expression of phytoplankton (primary producers). Primary productivity is determined by the content of chlorophyll-a. If a microalgae bloom occurs in a water, of course the chlorophyll content will be high. However, what happened in Nusawiru waters, microalgae were unable to compete with higher plants so that the population was low and aquatic plants dominated, namely mangrove plants. That is why the content of chlorophyll a in Nusawiru waters did not express trophic status.

CONCLUSION

Nutrient chemical profiles in the waters of Nusawiru Pangandaran, West Java, which consist of Ammonia ($NH3$), Nitrate ($NO3^-$), Nitrite ($NO2$), o-Phosphate ($PO4$), Total Phosphate and chlorophyll indicated that the waters in the waste pond observation station, estuary, deltas and open waters were in Ultraoligotrophic status. The limiting factor in the waters of Nusawiru Pangandaran is phosphate, because the ratio of N and P at all observation stations was >12.

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