Original Research Article

Determination of Trophic Status Based on Chlorophyll-a in Cikidang River Pangandaran, West Java –Indonesia

ABSTRACT

Trophic status is an indicator of water fertility.In general, there are 3 classifications of trophic status, namely oligotrophic, mesotrophic and eutrophic (Zulfia and Aisyah 2013). According to Linus et al. (2016) Chlorophyll-a phytoplankton is often used as an indicator of water quality and water fertility status. This research is to determine the trophic status of the waters based on the concentration of chlorophyll-a in the Cikidang Pangandaran river for the development of fisheries management. The research was conducted from November 2021 - January 2022. The method used was a survey method with a purposive sampling technique.The results showed that the concentration of chlorophyll-a ranged from 3.10-7.77 mg/m^3. So it can be said that the trophic status of the Cikidang River is mesotrophic or moderate fertility. Parameters of supporting water quality are temperatures ranging from 26.75-29.57^{0}C, Light Transparency ranging from 16.12-135.75 cm, pH ranging from 7.38-7.48, Carbon dioxide ranging from 19.8-47.3 mg/L, BOD ranging from 10.41-16.36 mg/L, DO range from 4.38-5.06 mg/L, Nitrates ranged from 0.25-0.37 mg/L and Phosphate ranged from 0.009-0.02975. The water quality in the Cikidang River generally meets the requirements of class II and III quality standards according to Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management, so it is still supportive for the survival of fish resources.

Keywords: Chlorophyll-a, Trophic Status, River, Pangandaran, Oligotrophic, Mesotrophic, Eutrophic

1. INTRODUCTION

Cikidang River is one of the rivers in Pangandaran Regency, which empties directly into Pangandaran Beach. The Cikidang River is used as a source of agricultural irrigation, domestic waste disposal, fishing boat transportation routes, and capture fisheries activities. Along the flow of the Cikidang River passing through residential areas, of course, many human activities produce waste and are dumped directly into the river. The upstream area of the Cikidang River already has agricultural activities, where agricultural activities use chemical fertilizers so that runoff water from rice fields can enter the river body. These activities can lead to changes in the trophic status of the waters. According to Tammi et al. (2015) that the increase in anthropogenic activity allows the area to experience an increase in trophic status.

Trophic status is an indicator of water fertility. Natural water processes as well as human activities (such as settlement, agriculture, and fish farming) can cause changes in trophic status (Zulfia and Aisyah 2013). According to Zulfia and Aisyah (2013) the classification of the trophic status of the waters can be divided into 3, namely: Oligotrophic, which are waters with low fertility levels, clear waters, and do not support relatively large fish populations. Mesotrophic, water with moderate or medium fertility levels with moderate nutrient conditions. Eutrophic, water with a high level of fertility and support the survival of organisms in it.

Determination of the trophic status of waters can be obtained by calculating the concentration of chlorophyll-a dissolved in these waters. According to Linus et al. (2016) Chlorophyll-a, phytoplankton is often used as an indicator of water quality and water fertility status. Chlorophyll-a phytoplankton is an active pigment in plant cells that has an important role in the process of photosynthesis in waters (Adani et al. 2013). Chlorophyll-a is a phytoplankton pigment that is the main factor to produce primary production in the food chain in waters (Isnaeni et al. 2015). According to Baktiar et al. (2016) several physical and chemical parameters that can control and influence the distribution of chlorophyll-a in waters, namely light intensity, nutrients, especially nitrate and phosphate.Research by Rahman et al. (2015) The content of chlorophyll-a in the Tutupan River for each observation station shows the concentration of chlorophyll-a obtained in the category of low fertility.

So far, information regarding the trophic status based on the concentration of chlorophyll-a in the waters of the Cikidang River is still unknown. Therefore,This study aimedto determine the trophic status of the waters based on the concentration of chlorophyll-a in the Cikidang Pangandaran river for the development of fisheries management.

2. MATERIAL AND METHODS

2.1 Description Of The Sampling Sites

This research was carried out from November 2021 - January 2022. The method used was a survey method with a purposive sampling technique. Determination of the sampling location based on the order of the river and consideration of the organic input load so that it can describe the research location as a whole. The station covers 1 upstream area, 2 mid-river areas, and 1 downstream or Cikidang River estuary. The observation station can be seen in Figure 1.

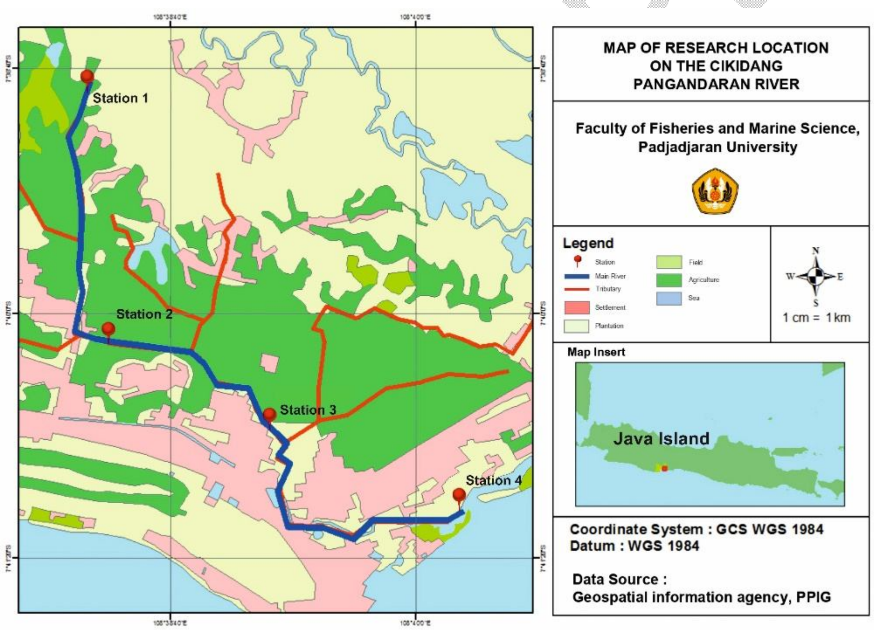

Figure 1. Location of the Research Station on the Cikidang River, Pangandaran

Station 1 : It is a water source in rice fields, and there are already agricultural activities with coordinates 7038'50.2" S, 108038'07.8" E.

Station 2 : located in Wonoharjo Village, is a watershed area that already has household and agricultural activities. Has a yellowish cloudy watercolor with coordinates 7040'09.0 S, 108038'19.2" E

Station 3 : In this area, you can see several drainage pipes coming from people's houses that flow directly into the river. The color of the water is turbid yellowish with coordinates 7040'36.4" S, 108039'11.7" E.

Station 4 : In this area there is fishing boat activity, it is suspected that the area contributes organic material input due to the tidal area. It is an estuary area with coordinates of 7041'04.4" S, 108040'14.8" E.

2.2Sampling And Water Quality Measurement

Water sampling was carried out 4 times in repetition at each station with a frequency of 14 days. Sampling of water and chlorophyll-a on the water surface to a depth of ± 50 cm (Hadiningrum 2018) was carried out in the morning before the photosynthesis process (Hamiedah et al. 2020). 1000 ml of water samples were taken and the chlorophyll-a sample was put into a 1500 ml bottle (Febbrianna et al. 2017) then stored in a cool box for analysis in the laboratory.

2.3Chlorophyll-A Concentration Measurement

Measurement of the concentration of chlorophyll-a in water samples from each station was carried out using the spectrophotometric method (Zahidah 2017) with a spectrophotometer at 665 nm, 645 nm, and 630 nm which is the maximum absorption of chlorophyll-a in acetone solvent. Calculation of the value of chlorophyll-a concentration according to (Wetzel and Likens 1991 in Zahidah 2017) is as follows:

$$\textbf{Chlorophyll-a} = Ca\,(v/(VL))$$

Ca is obtained from the equation: 11.6 D665 – 1.31 D645 – 0.14 D630

Description:
v = Volume of acetone used (mL)
V = Volume of filtered water to be extracted (L)
L = Cuvet length (cm)
D665 = Optimal density at a wavelength of 665 nm.
D645 = Optimal density at a wavelength of 645 nm.
D30 = Optimal density at a wavelength of 630 nm.

3. RESULTS AND DISCUSSION

3.1 Water Quality Parameters

The measurement of the physical and chemical parameters of the Cikidang River during the research, which can be presented in Table 1.

Table 1. Physical and Chemical Parameters Of The Cikidang River

No	Parameters	unit	The Results	PP Quality Standard No. 22 Year 2021	
				Class I	Class II
1.	Temperature	^{0}C	26,75 - 29,57	Deviation 3	Deviation 3
2.	Transparency	cm	16,12 - 135,75	-	-
3.	pH	-	7,38 - 7,48	6 - 9	6 - 9
5.	Carbon dioxide	mg/L	19,8 - 47,3	-	-
3.	BOD	mg/L	10,41 - 16,36	3	6
4.	DO	mg/L	4,38 - 5,06	4	3
7.	Nitrate	mg/L	0,25 - 0,37	10	20
8.	Phosphate	mg/L	0,009 - 0,02975	0,2	1,0

3.1.1 Temperature

The results of the measurement water temperature of the Cikidang River ranged from 26.75 to 29.57^{0}C (Figure 2). The highest temperature is at station 4 at 29.57^{0}C, and the lowest temperature is at station 1 at 26.75^{0}C. According to Mardhia and Abdullah (2018), the optimum temperature for water growth is 25-30^{0}C.

The result of temperature measurement is due to the time difference in the measurement, which is 06:30-11:00 WIB. At station 1, measurements were made in the morning so that the transparency of light entering the waters was lower. While measurements at station 4 were carried out during the day where the intensity of sunlight was high, so the water temperature was higher. According to Dharmawibawa et al. (2014) the high and low temperature in the waters is influenced by the intensity of light that illuminates the waters and the difference in altitude. The intensity of light affects changes in temperature in the waters, the higher the intensity of light, the temperature of the waters increases (Zahidah 2017).

Based on Government Regulation no. 22 the Year 2021 class II and III are 30C deviations from normal temperature, then the temperature parameter of the Cikidang river is still within the water quality standard criteria according to its designation.

3.1.2 Transparency

Thetransparency of the Cikidang River ranges from 16.12-135.57 cm (Figure 2). Station 2 has the lowest value because at the location there is the input of domestic and agricultural waste so the conditions of the waters are cloudy which prevents the entry of sunlight into the waters. According to Rahman et al. (2016) the high and low values of transparency are influenced by the presence of domestic waste which can inhibit the entry of sunlight into the water column. According to the Minister of Environment Regulation No. 28 of 2009 the Cikidang river is included in the status of hypertrophic waters because it has a transparency of <2.5 m.

3.1.3 Acidity (pH)

pH value at the time of observation in the Cikidang Pangandaran River ranged from 7.38 to 7.48 (Figure 2). The highest pH at station 2 is due to the activity of agricultural waste and domestic waste that directly enters the river body. According to Aquila et al. (2021) the input of water that carries organic matter from industrial waste, agricultural waste and also domestic waste causes a large concentration of pH in the waters.

According to Effendi (2003) aquatic organisms are sensitive to changes in pH and prefer a pH ranging from 7-8.5. pH of the Cikidang River based on Government Regulation no. 22 of 2021 is good for supporting fishery activities because it is still within the threshold of class II and III water quality standards, which is around 6-9.

3.1.4 Carbon Dioxide

Cikidang Pangandaran River's carbon dioxide ranged from 19.8 to 47.3 mg/L (Figure 2). According to Idrus (2018), a good concentration of carbon dioxide (CO_2) for the life of aquatic organisms is less than 15 mg/L, more than that will be dangerous because it can inhibit the binding of oxygen in the waters.

The concentration of carbon dioxide in the Cikidang River water is in a fairly high category and is dangerous for aquatic organisms. Because the concentration of carbon dioxide that can be tolerated by aquatic organisms is 5-10 mg/L (Idrus 2018).The high concentration of carbon dioxide in the water can be toxic to fish because it interferes with breathing. According to Utomo et al. (2017) the high concentration of carbon dioxide is caused by the decomposition of polluting materials in the waters.

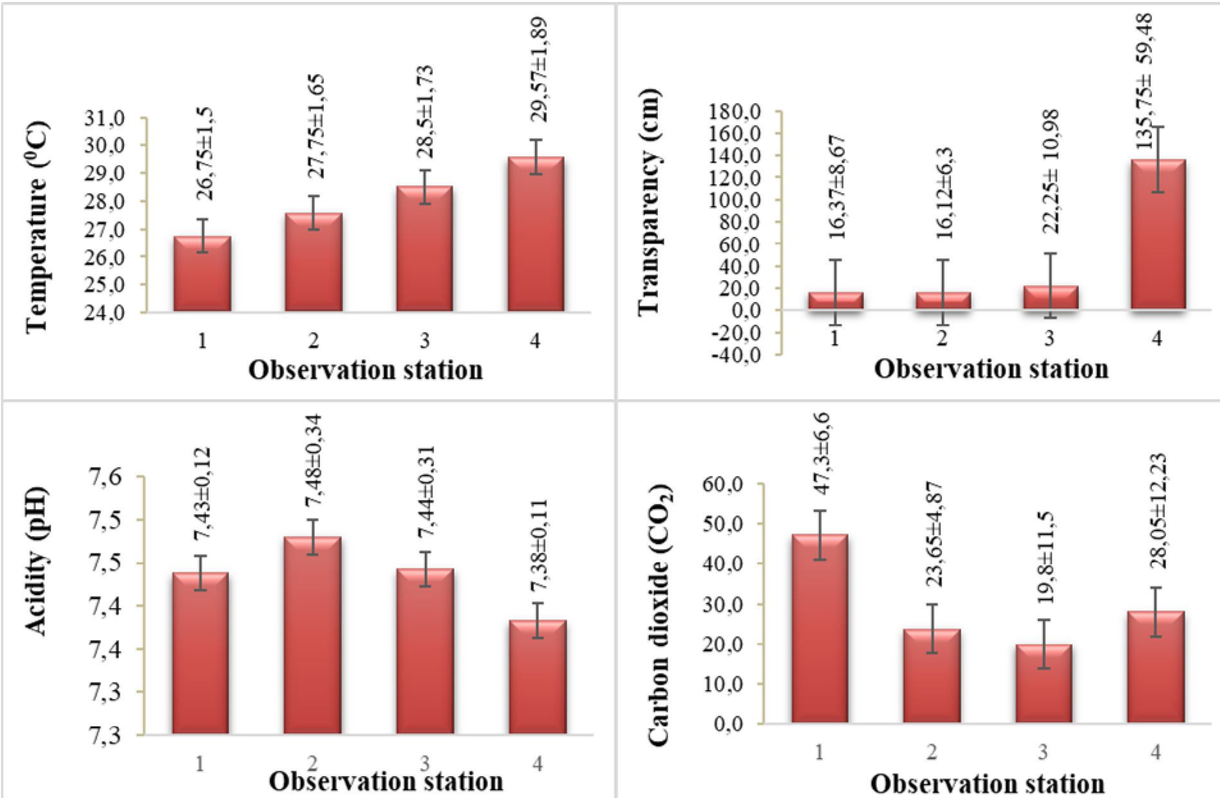

Figure 2. Graph of Temperature, Transparency, pH and CO2

3.1.5 *Biological Oxygen Demand* (BOD)

BOD on average ranges from 10.41-16.36 mg/L (Figure 3). The high concentration of BOD at station 2 is due to the activity of domestic and agricultural waste. According to Hamiedah et al. (2020) human activities such as agricultural activities have the potential to add organic matter that enters the waters so that it can increase the high concentration of BOD. The greater the concentration of BOD means that the waters are polluted (Mahyudin et al. 2015).

According to Effendi (2003), waters that have BOD levels of more than 10 mg/L can be said to be polluted. Based on Government Regulation No. 22 of 2021, the range of BOD results during research has exceeded the threshold for class II and III quality standards, which are more than 3 mg/L and 6 mg/L.

3.1.6 Dissolved Oxygen

Dissolved oxygen in the Cikidang River was not very different, ranging from 4.38-5.06 mg/L (Figure 3). The low oxygen concentration at station 4 is due to the high temperature at station 4. According to Pardede et al. (2013) the concentration of dissolved oxygen with temperature is inversely proportional, if the water temperature is low, the oxygen solubility of the water will increase. Based on Government Regulation No. 22 of 2021, the range of dissolved oxygen in the Cikidang River is under class II and III quality standards, namely at least 3 mg/L and 4 mg/L for fishery activities.

3.1.7 Nitrate

nitrate in the Cikidang Pangandaran River ranged from 0.25-0.37 mg/L (Figure 3). The highest nitrate is found at station 1, this is due to the presence of waste in the form of fertilizer waste at station 1. According to Effendi (2003) waste from agricultural activities (fertilization), industrial activities, and explosives can affect the concentration. nitrate in water. Based on the research results, the Cikidang River is still far below the water quality standard for classes II and III according to Government Regulation No. 22 of 2021 which stipulates nitrate concentrations of 10 mg/L and 20 mg/L.

3.1.8 Phosphate

Phosphate in the waters of the Cikidang River ranged from 0.009 to 0.02975 mg/L (Figure 3). The highest phosphate concentration was obtained from station 4 at 0.02975 mg/L. Station 4 is the estuary for all organic waste carried by the river flow so it has a higher phosphate concentration. According to Arbianti et al. (2017) one of the functions of the estuary ecosystem is to trap nutrients (nitrate phosphate) originating from the surrounding waters.

According to Rumanti et al. (2014) the optimal phosphate concentration for phytoplankton growth ranges from 0.27-5.51 mg/L, whereas if the phosphate concentration is less than 0.02 mg/L it will be a limiting factor. Based on PP No.22 of 2021, the average range of phosphate values in the Cikidang River is still far below the class II and III thresholds of 0.2 and 1.0 mg/L.

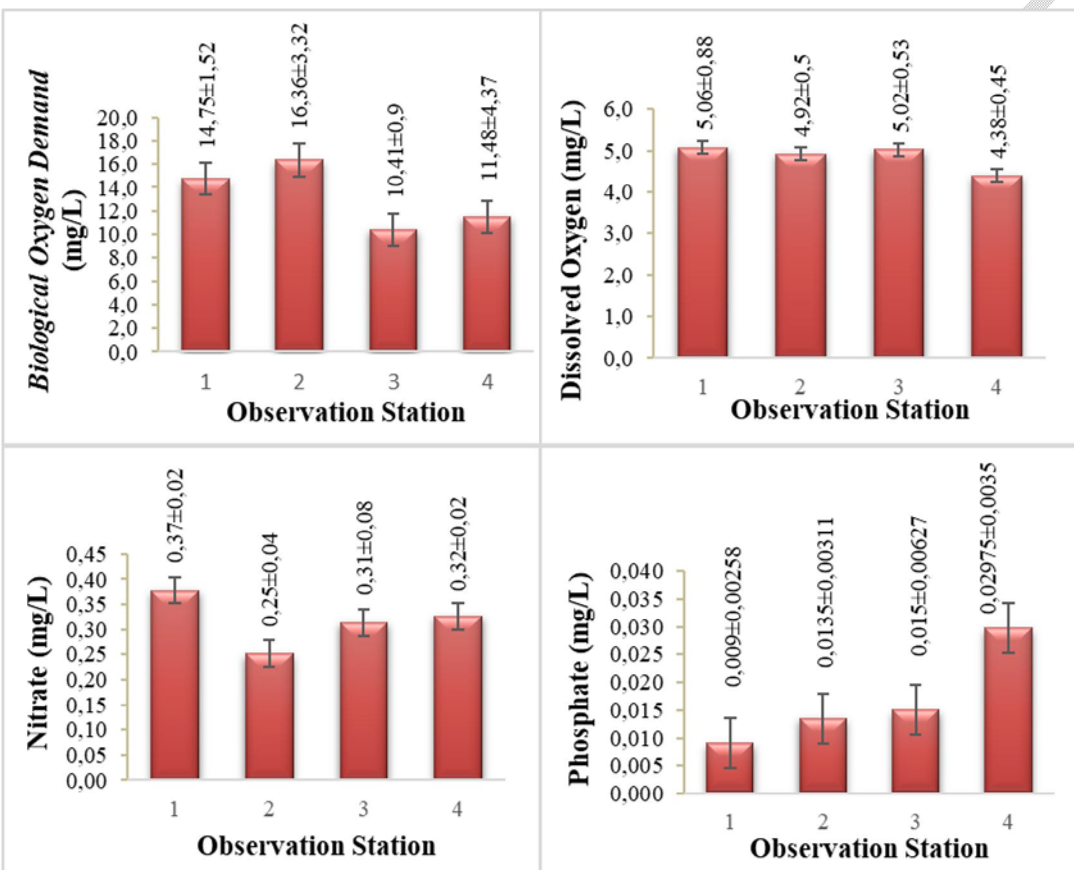

Figure 3. Graph of BOD, DO, Nitrate and Phosphate

3.2 Chlorophyll-a

Chlorophyll-α is an important pigment needed by phytoplankton in carrying out the photosynthesis process, besides that, phytoplankton are primary producers (primary productivity) because they are able to convert inorganic materials into organic materials through the process of photosynthesis (Herlianti and Soedarsono 2016). Measurement of chlorophyll-a in Cikidang River obtained values ranging3,10-7,77mg/m^3. The average chlorophyll-a at each station can be seen in Table 2. The highest average chlorophyll-a was 7.77 mg/m^3 at station 2 and the lowest was 3.10 mg/m^3 at station 4.

Table 2. Chlorophyll-a

Station	Chlorophyll-a (mg/m^3)
1	5,37±4,85
2	7,77±7,11
3	3,53±2,22
4	3,10±2,63

Based on Table 2, the value of chlorophyll-a concentration varies at each station. The highest average concentration of chlorophyll-a is at station 2, the high concentration of chlorophyll-a at this station is because it gets a lot of organic waste input from household activities and agricultural activities so it contributes a lot of nutrients. This is in line with the opinion of Hidayah et al. (2016) that waste from household activities and small industrial activities that produce organic waste is a source of nutrients. Nutrients are needed in the formation of chlorophyll-a concentrations in waters (Zahidah 2017).

The lowest average value of chlorophyll-a is found at station 4 at 3,10 mg/m^3, this is because station 4 is an estuary area that receives less organic matter input from the mainland. This is to the research of Sihombing et al. (2013), the closer to the open sea, the less nutrient input from land, causing lower chlorophyll-a concentrations. The research of Mariana et al. (2016) explained that the low concentration of chlorophyll-a in river mouths was due to the lack of nutrient input from the mainland. In addition, at station 4, many fishing boats pass by which makes organic matter carried away by the current from the fishing boat's trajectory. According to Puspitasari et al. (2021) that some organic and inorganic materials found in river mouths are deposited, dissolved, and even carried away by currents to the sea.

Based on the Minister of Environment Regulation No. 28 of 2009 the concentration of chlorophyll-a in the Cikidang River can be said to have mesotrophic status or moderate fertilitybecause it is < 5,0 mg/m^3. According to Wetzel (2001) that waters that have a concentration of chlorophyll-a 3-11 mg/m^3 can be said to have moderate or mesotrophic fertility levels.

4. CONCLUSION

4.1 Conclusion

The concentration of chlorophyll-a in the Cikidang River has an average of 3.10-7.77 mg/m3, based on this value, the Cikidang River enters mesotrophic waters or has moderate fertility.Water quality in the Cikidang River generally meets the requirements of class II and III quality standards according to Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management, so that it still supports the sustainability of fish resources

4.2 Recommendations

1. It is necessary to supervise and monitor all activities in the Cikidang River on a regular basis, so as not to provide pollution that has an impact on primary productivity so that it affects fish production in the Cikidang Pangandaran River.

2. To be able to do management, it is necessary to do further research. One of them is the research was conducted at another time, due to this research being conducted in the rainy season, it is necessary to do research in the dry season.

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