The study of N:P ratio for estimating nutrient limitation at shallow lakes waters in Depok City West Java, Indonesia

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Submission date: 12-Apr-2023 11:40AM (UTC+0700)
Submission ID: 2062264369
File name: File_2.pdf (582.97K)
Word count: 2444
Character count: 12366

IOP Conference Series: Earth and Environmental Science

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Abstract. This study aims to analyze the concentration of Nitrate and Phosphate, also the N:P ratio in waters of shallow lakes in Depok City, West Java Province, Indonesia using secondary data collected in 2017 and 2019. In an environment, nitrogen and phosphate sources are fertilizers and wastewater discharged from livestock facilities and sewage from residential areas, which discharge into lakes. The results analysis of nitrate concentration ranged from 0.06– 3.02mg/L and phosphate concentration from 0.004-0.18mg/L. The N:P ratio calculation is known that 8.00-68.00, the value shows that there has been an excessive addition of phosphate elements into the shallow lake waters. Therefore, it appears that the N element is a limiting element that affects the biological conditions of ecosystems such as phytoplankton communities, species composition which is likely to occur dominance of certain types. This situation is quite reasonable, considering that around the lakes are residential areas that discharge domestic wastewater that uses detergents into the lakes. Anthropogenic nitrogen and phosphorus supply to natural ecosystems in shallow lakes in Depok City that the average N:P ratio in 2017 is 40.65 and 2019 is 35.99.

1. Introduction

Lake as water ecosystems is an important resource for aquatic wildlife and human needs [1, 2]. The water quality is governed by complex anthropogenic activities and natural processes [3, 4]. The nutrients that are generally the focus of attention in the aquatic environment are phosphorus and nitrogen, limiting water quality elements. Both of these elements have an important role in the blooming of phytoplankton or algae, commonly used as indicators of water quality and the level of fertility in waters [5].

The alterations of water quality have wide-ranging ecological and societal implications that. In general, lake ecosystems face threats that arise from various stresses related to excessive nutrient (nitrogen: N and phosphorus: P) from nutrient runoff [6]. Moreover, the cycles of the key nutrient elements nitrogen (N) and phosphorus (P) have been massively altered by anthropogenic activities. Thus, it is essential to understand how photosynthetic production across diverse ecosystems is not limited by N and P [7, 8, 9].

Freshwater ecosystems, including lakes, streams, and wetlands, are a large global sink for reactive nitrogen, but factors that determine the efficacy of freshwater nitrogen removal rates are poorly known. Using a global lake data set will be showed that the availability of phosphorus, a limiting nutrient, affects both annual nitrogen removal rate and efficiency [10]. Currently, there is a lot of

degradation of lake waters in Indonesia both in quality and quantity and the condition of the lakes in Depok, especially in shallow lakes.

In general, the function of shallow lakes in Depok City as a source of water, water management, flood control, micro-climate control, silt depositor and habitat for various types of flora and fauna and a place of recreation. These lakes must be conserved. The problems that are quite important due to changes in land use in the city of Depok include the increasing damage to the shallow lake ecosystem. Therefore, lake pollution from the surrounding environment needs to be controlled to preserve the lake's function. The research aims to 1) Analyzed the Concentration of Nitrate and Phosphate, 2) Determine the N:P Ratio (Redfield) in shallow lakes waters in Depok City.

2. Methodology

In Depok City, many lakes in categories as shallow lakes (the depth < 10 meters). This study analyzed the water quality by the secondary data obtained from monitoring data on the quality of the shallow lakes waters in Depok City, West Java Province, conducted by the Agency of Environment and Sanitation. The data used are the results of water quality monitoring conducted once a year in 2017 and 2019, which were selected for 7 shallow lakes located in the Eastern Part of Depok City from as many as 20 shallow lakes spread around the Depok City area of 200.29 km^2. The location of the shallow lake distribution shown in figure 1 and table 1.

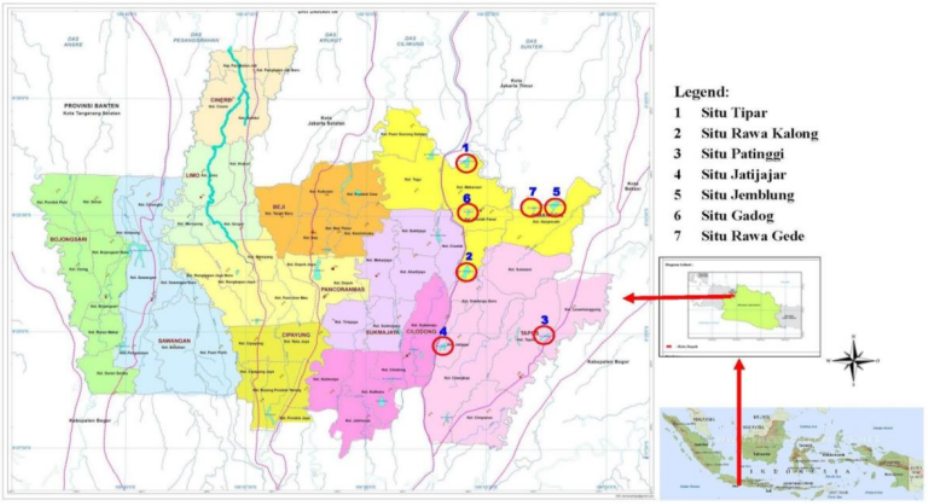

Figure 1. Sampling location in a shallow lake in the eastern part of Depok City.

Table 1. Sampling location in a shallow lake in the eastern part of Depok City.

Sampling Point	Shallow Lake	Coordinate	
		South	East
1	Situ Tipar, Cimanggis Subdistrict	06° 21' 12.32"	106° 52' 05.71"
2	Situ Rawa Kalong, Cimanggis Subdistrict	06° 23' 33.98"	106° 52' 03.65"
3	Situ Patinggi, Cimanggis Subdistrict	06° 25' 00.30"	106° 53' 46.00"
4	Situ Jatijajar, Cimanggis Subdistrict	06° 25' 15.02"	106° 51' 39.18"
5	Situ Jemblung, Cimanggis Subdistrict	06° 22' 11.30"	106° 54'

Sampling Point	Shallow Lake	Coordinate	
		South	East
6	Situ Gadong, Kec. Cimanggis Subdistrict	06° 22' 21.90"	106° 00.30" 52'
7	Situ Rawa Gede, Beji Subdistrict	06° 23' 26.43"	106° 06.40" 48' 09.96"

The secondary data that used, then compared to the Water Quality Standards by the Government Regulation Republic of Indonesia No. 82 of 2001 concerning Management of Water Quality and Water Pollution Control Class 2 for water recreation facilities, fisheries, irrigation, and cultivation.

3. Result and discussion

3.1 Nitrate concentration

The results of data analysis in table 2 show that the value of nitrate concentrations ranges from 0.06–3.02 mg/L. The values still comply with the water quality standard (10 mg/L) found in all shallow lakes waters. The nitrate in the waters lake comes from the nitrification process that occurs in the lake, from the air that enters the lake and from precipitation, which produces NH_4^+ and dissolved organic nitrogen, which eventually forms nitrates in the water. In addition, organic waste can also be a source of nitrates that enter the lake [12].

In some waters, generally nitrates are found as micronutrient compounds controlling primary productivity in the euphotic layer. If the nitrate concentration exceeds 5.0 mg/l, this represents the occurrence of anthropogenic pollution originating from human activities and animal waste. In comparison, the nitrate concentration exceeds 0.2 mg/l; this condition can cause water eutrophication, which stimulated algae and aquatic plants [13,14]. The results of data analysis obtained the following nitrate concentration data in Shallow Lake Waters of Depok City.

Table 2. Nitrate concentration in shallow lake waters of Depok City (once a year).

Year	Unit	Shallow Lakes							Average
		Situ Tipar	Situ Rawa Kalong	Situ Patinggi	Situ Jatijajar	Situ Jemblung	Situ Gadog	Situ Rawa Besar	
2017	mg/L	2.52	2.12	2.72	3.02	2.47	2.76	2.75	2.62
2019	mg/L	2.01	1.21	0.54	0.32	2.42	0.37	0.06	0.99

*Water Quality Standard = 10 mg/L

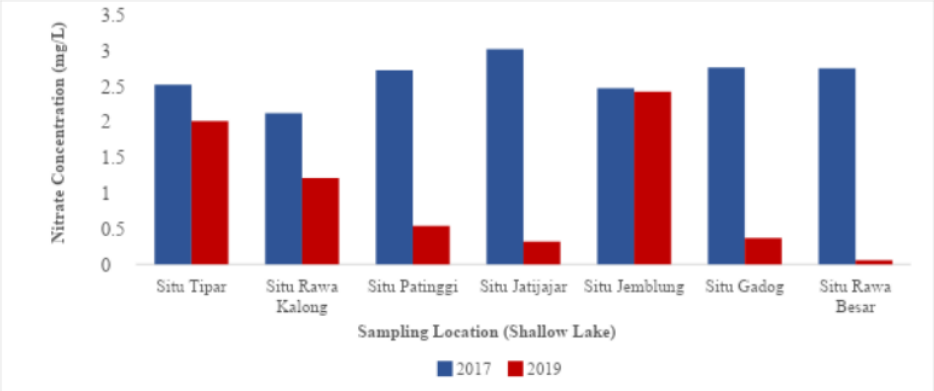

Figure 2. Nitrate concentration in shallow lake waters of Depok City.

3.2 Phosphate concentration

Phosphate is a very important nutrient compound. In waters, the source of phosphate compounds usually comes from nature, such as weathering of plants, animal waste, and soil erosion. Furthermore, phosphate concentration can be increased due to the wastewater from households that use detergents, home industries, and fertilizers in agricultural /plantation activities, which contains a lot of phosphates [15,16].

The results of data analysis in Table 3 show that the value of phosphate concentrations ranged from 0.004-0.18mg/L the values still comply with the water quality standard (0.2 mg/L),) as well.

Table 3. Phosphate concentration in shallow lake waters of Depok City (once a year).

Year	Unit	Shallow Lakes							Average
		Situ Tipar	Situ Rawa Kalong	Situ Patinggi	Situ Jatijajar	Situ Jemblung	Situ Gadog	Situ Rawa Besar	
2017	mg/L	0.069	0.10	0.04	0.18	0.04	0.064	0.074	0.08
2019	mg/L	0.07	0.14	0.008	0.04	0.04	0.006	0.004	0.04

Water Quality Standard = 0.2 mg/L

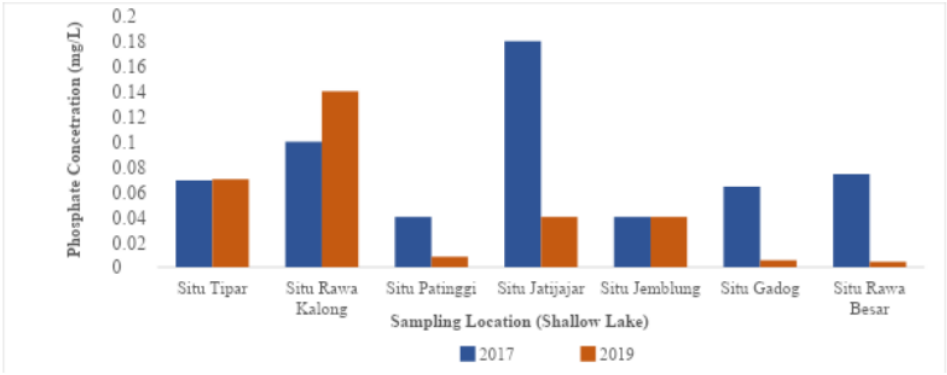

Figure 3. Phosphate concentration in shallow lake waters of Depok City.

3.3 N:P ratio

Nitrogen (N) and Phosphorus (P) are important elements in the process of cell metabolism and their presence always a benchmark to determine whether these elements are limiting factors or not. The value of the N/P Ratio measures the ratio of the uptake rate of these elements by microorganisms such as Phytoplankton. This value is called the "Redfield Ratio", which explains that the availability of elemental nitrogen in the form of nitrate (NO_3) must be 16 times more than elemental phosphorus (PO_4).

If the value of the N:P ratio is below 16, then the N element becomes the limiting element, whereas if N:P is highest than 16, then the P element is the limiting element from the existence of phytoplankton. This condition will impact the biological ecosystem circumnutates such as species composition, the biomass of phytoplankton in which certain species tend to dominate, and the food web's dynamics [17,18].

Table 4. N:P ratio in shallow lake waters of Depok City.

Year	Shallow Lakes							Average
	Situ Tipar	Situ Rawa Kalong	Situ Patinggi	Situ Jatijajar	Situ Jemblung	Situ Gadog	Situ Rawa Besar	
2017	36.52	21.20	68.00	16.78	61.75	43.13	37.16	40.65
2019	28.71	8.64	65.06	8.00	60.50	67.27	13.72	35.99

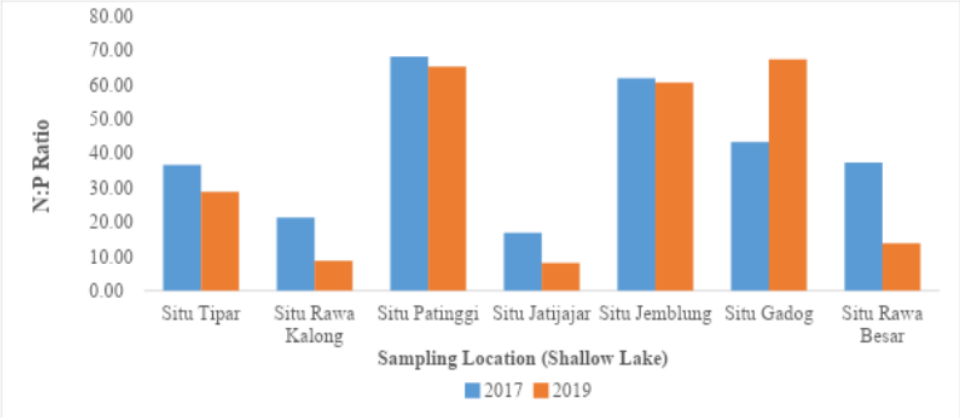

Figure 4. N:P ratio in shallow lake water of Depok City.

Overall, show in table 4, the N:P Ratio in shallow lake waters in Depok City mostly highest than 16, which means the P element is the limiting element from the existence of phytoplankton. This condition should be a concern because if management is not implemented, it will be to nutrient enrichment, eutrophication can occur [19,20].

4. Conclusion

The sources of nitrate and phosphate pollutants in shallow lake waters in Depok City include domestic activities around the study site, namely, household wastewater containing detergents, waste from livestock, fertilizers in plantations and fish cages in the waters. The results of data analysis, which are secondary data, show that the concentrations of nitrate and phosphate comply with the water quality standards describing that the shallow lakes waters are still in the excellent category. The N:P ratio is

higher than 16. P element is a limiting element from the presence of phytoplankton communities and aquatic plants, and this will impact biological conditions in waters.

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