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# The Relation of Nitrate and Phosphate to Phytoplankton Abundance in the Upstream Citarum River, West Java, Indonesia


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***Authors' contributions***

*This work was carried out in collaboration among all authors. Author KM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author HH and ZA managed the analyses of the study. Author HH managed the literature searches. All authors read and approved the final manuscript.*


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## ABSTRACT


Citarum River is the longest river in West Java Province, it is utilized for various anthropogenic activities that will affect the water quality, ecological state, and parameters of nitrates and phosphates in the waters of Citarum River. Nitrate and phosphate content can affect Phytoplankton abundance. Phytoplankton is a bioindicator to determine water quality. The purpose of this study is to determine the association of nitrates and phosphates with the abundance of phytoplankton and determine the quality of water in the Citarum River. The study began in August 2020 until September 2020. The research uses a survey method with a purposive sampling technique. Sampling was carried out at 5 stations with 5 times repetitions every 7 days. The water parameter analyzed are transparency, temperature, current, pH, DO, BOD, $PO_4^{2-}$,$NO_3^-$, Phytoplankton abundance, diversity index, and dominance index. Results showed that phytoplankton in the citarum river there were 24 genera divided into 4 phylum. Diversity index during the study reached between 0,91 – 0,99 and dominance index was in the range 0,01 – 0,2. Phytoplankton abundance



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ranges from 11 to 1292 ind/L. The highest genera phytoplankton composition at each station was found is Synedra as much as 1087 ind/ L. Nitrate content ranges from 0.13 - 0.33 mg/l and phosphate content range from 0.13 - 0.29 mg/l. The acquisition of R square value based on the simultaneous analysis of the relationship between nitrate and phosphate and the abundance of phytoplankton was 43,9% and 56,1% was influenced by other several factor namely temperature, water transparency, nutrient, and water flow.

*Keywords: Citarum river; nitrate; phosphate; phytoplankton.*

## 1. INTRODUCTION

Citarum River is the longest river in West Java Province, sourced from Mount Wayang, Kertasari District, Bandung Regency [1]. Utilization of Citarum River to support various activities and human lives as a source of water, transportation facilities, power plant, irrigation, industrial needs, tourism, and fishery development [2]. Citarum River now is one of the river with the worst pollution levels in the world [3].

The problems in the upstream Citarum River is that the river is polluted by domestic waste, agricultural waste, and industrial waste. The waste discharge into the river flow without prior treatment so the water river becomes polluted and affects the water quality [1]. The continuous influx of waste will have an impact on the ecology of the river. Disposal of agricultural and domestic waste can affect the chemical parameters of the waters namely nitrates and phosphates [4].

Nitrates and phosphates in the water are utilized by phytoplankton for growth and development [5]. Plankton is one of the Phytoplankton is the first organisms affected due to the input load received by the waters. Phytoplankton is aquatic organisms that can be used as bioindicators to determine the quality and fertility rate of the waters because phytoplankton have a high sensitivity to environmental changes and a short life cycle [6]. Therefore, it is necessary to research nitrate and phosphate content in the water to know the abundance of phytoplankton as an indicator of the quality of citarum river waters.

## 2. MATERIALS AND METHODS

### 2.1 Research Time and Place

The research was conducted in citarum watershed. The method used in the research is the survey method and the sampling technique is purposive sampling. The research activities were conducted in situ and ex-situ. Insitu research includes temperature measurement, pH, DO, water flow, and light transparency, whereas ex-situ research includes measurement of nitrate, phosphate, BOD, and plankton identification. The research was conducted in August-September 2020. Samples were taken from 5 stations with 5 samplings. Research location:

**Station 1:** Cisanti Spring, the foot of Mount Wayang – South Bandung covers the condition of the natural waters. The use of the surrounding land is the primary forest.

**Station 2:** Situ Cisanti, the outlet where the surrounding land use is the primary forest.

**Station 3:** Wangisagara, is a part of the river indicated by agricultural waste such as fertilizers, pesticides, livestock manure. The use of surrounding land is a residential area and agricultural land.

**Station 4:** Majalaya, the surrounding land use is a residential and industrial area.

**Station 5:** Sapan, covering the area after the meeting of 3 rivers namely Citarum River, Citarik river and Cikerus river. The use of surrounding land is a residential area, agriculture, and various industrial activities.

The location of the research station can be seen in Fig. 1.

### 2.2 Sampling and Measurement

A sampling of water and phytoplankton was carried out every seven days with five sampling times at five stations. Physical-chemical parameters of water analyzed in-situ and ex-situ. In- situ analysis consisted of five parameters include temperature, pH, DO, Water Transparency, and Current. Ex-situ analysis consisted four parameters BOD, Nitrate, and Phosphate. Physical-chemical parameters analyzed in-situ and ex-situ. Ex-situ analysis conducted at the Laboratory of Water Resource Management FPIK UNPAD.

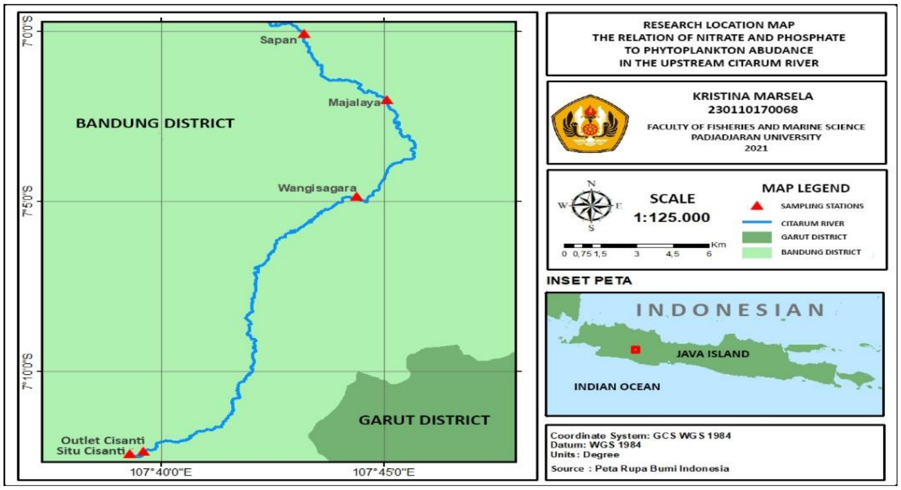


**Fig. 1. Map of research location**

## 2.3 Sample Analysis

Plankton data analysis was carried out using a comparative descriptive method at each station with the following observations.

### 2.3.1 Plankton abundance

Plankton abundance is calculated using the formula [7]:

$$N = n \times \frac{Vr}{Vo} \times \frac{1}{Vs}$$

Description:

N = Abundance of plankton (ind/L)
n =Number of plankton identified
Vr =Filtered plankton volume
Vo =Observed volume of plankton
Vs = Volume of filtered water (L)

### 2.3.2 Diversity Index

Diversity index formula according to Simpsons [8]:

$$H' = 1-\sum\left(\frac{ni}{N}\right)^2$$

Description:

H' = Diversity Index
ni = Number of individuals on the 1st type
N = Total number of individuals

### 2.3.3 Domination index

Calculating uniformity used simpson domination index as follows[9]:

$$D = \sum\left(\frac{ni}{N}\right)^2$$

Description:

D = Simpson Domination Index
ni = Number of individuals on the 1st type
N = Total number of individuals

### 2.3.4 Relation analysis

The relationship between nitrates and phosphates to phytoplankton abundance was analyzed using multiple linear regression with SPSS application version 26. The formula of multiple linear regression is as follows [9]:

$$Y= a+b1X1 \pm b2X2$$

Description:

Y = Abundance of Phytoplankton
a = Constant
b1, b2 = intercept
X1, X2 = independent variable (nitrate and phosphate)

## 3. RESULTS AND DISCUSSIONS

## 3.1 Parameters of Waters Quality

The physical and chemical parameters of the water during the study can be seen in Table 1. Citarum river temperatures measured during observation ranged from 20,8°C -29.4°C. Based on research conducted by [10] temperature measurements during the observation show that the temperature in the Upper Citarum River ranges from 19.7°C-27.9°C. This shows that the temperature in the Upstream Citarum River has not changed significantly. Citarum river temperature is optimal for phytoplankton growth. The optimum temperature range for phytoplankton growth in the water is 20°C - 30°C [11]. There is a difference in temperature in citarum river, the lowest temperature is at station 1 which is 23,3±1.9°C because around the sampling location there is vegetation covering the sampling location so that the sunlight is less than maximum, while the top temperature is at station 5 which is 26.4±1.6°C. Water temperature is influenced by sunlight intensity, geographical height and tree cover (canopy) factors from the surrounding vegetation [9]. The higher the intensity of solar radiation that hits the body of water, it will cause the higher the water temperature of the river [12].

The depth of each station is different so there are differences in light transparency. Measurements of light transparency in the waters of the citarum river during the study ranged from 9 to 155 cm. Based on the results of research conducted by [10], there are differences in light transparency, the transparency value ranges from 17.6 cm - 96.3 cm. The difference in the value of light transparency is due to the decrease in suspended solids in the observed waters. Station 5 has the lowest light transparency which is 29.1 ± 14.6 cm because influenced by the pollutant loads that enter the water so that it blocks the penetration of light into the water. Station 5 has a brownish cloudy watercolor due to indicated industrial and household waste disposal. Station 1 has the highest light transparency during the measurement is at Station I which is 151.5 ± 3.3 cm, the location of the water is still natural. Suspended solids concentration in water can affect the intensity of incoming sunlight [11]. Optimum light intensity for plankton is 30–50 cm [13]. Waters that have too high light transparency will decrease phytoplankton abundance, due to reduced food and plankton properties that move away from light [14]. The intensity of sunlight that is too high will cause the inhibition of photosynthesis or is called photoinhibition [15].

The current speed range during a measurement is between 0.02-0.38 m/s. The highest current speed is found in station 5 which is 0.33 ± 0.09 m/s and the lowest current speed is found in station 2 which is 0.03 ± 0.01 m/s. The average flow in the waters of the Upstream Citarum River is still categorized as very slow flow. There are five categories of currents, namely very slow currents (less than 0,10 m/s), slow (0,10-0,25 m/s), moderate (0,25-0,50 m/s), fast (0,50-1 m/s)and very fast (more than 1 m/s) [16]. High current speed in the water can cause plankton abundance to be small [17]. Plankton movement is very limited and is heavily influenced by currents [7].

Measurement of acidity degree (pH) in Citarum River ranges from 5.95-6.82. Based on the observations of [10], the pH in the upstream Citarum River ranged from 7.19 to 8.53 indicating an insignificant difference in pH values. Station 1 has the highest pH value which is 6.48±0.35, while the lowest pH is found in Station 5 and 4 which are 6.35 ±0.18 and 6.35±0.09. Factors that influence changes in pH values include biological activity, namely photosynthesis and respiration of organisms, temperature, and the presence of ions in the water [18]. PH value is based on government regulation no 82 of 2001 which is between 6,00 – 9,00, therefore the pH value is still below the quality standard limit. Aquatic organisms, especially plankton can live ideally in a smaller pH range slightly larger than a pH value of 7 [19].

Dissolved oxygen parameters can determine the quality of water because it plays a role in the oxidation process of organic and inorganic materials [20]. The measurement of dissolved oxygen value during observation in Upstream Citarum River ranged from 6.2-9.4 $mgO_2/L$. Based on the observation of [10] the value of dissolved oxygen ranged from 0,72–6,22 $mgO_2/L$ show a significant change in the value of DO. Dissolved oxygen content to five stations varied, Station 1 had the highest dissolved oxygen content of 7.52±0.8 $mgO_2/L$. The lowest dissolved oxygen value was found at Station 5 of 7.08±0.51 mg/l. Station 5 is indicated by household, industrial and agricultural waste. Station 5 has the highest BOD content among the other 4 stations, the high organic matter content in the waters will reduce the oxygen content. Human activities such as agriculture and waste disposal can lead to a decrease in dissolved oxygen concentration [21]. Dissolved oxygen in the waters is used by organisms for the process of respiration and breaks down organic substances into inorganic substances. Oxygen levels are lower along with the increased activity of microorganisms to decompose organic substances into inorganic substances using dissolved oxygen [22]. According to the criteria of government regulation no 82 of 2001 the range of value appropriate for fisheries which range from > 3 – 4 $mgO_2/L$. Furthermore, DO concentration in Upstream Citarum River still supported the growth of phytoplankton. Phytoplankton generally lived well because oxygen concentration at each station were more than 3 $mgO_2/L$ [23].

$BOD_5$ values in the waters indicate the level of pollution and can affect the dissolved oxygen concentration in the waters so that dissolved oxygen is reduced [20]. Measurement of $BOD_5$ value in Citarum River waters has a value between 0.3 mg / l to 6,5 mg / l. Based on the observation of [10] the $BOD_5$ value during observation in Upstream Citarum River ranged from 4,04–20,88 $mgBOD_5/L$, this indicates a significant decrease in the $BOD_5$ value in the upstream Citarum river. The highest BOD value is at Station 5 which is 4.7±1.8 $mgBOD_5$ /L while the lowest $BOD_5$ value is at Station 1 which is 1.4±0.8 mg / l. High $BOD_5$ values can be influenced by the disposal of organic materials derived from domestic waste and other waste into the river [24]. According to the criteria of government regulation, no 82 of 2001 for BOD is 3 $mgBOD_5/L$. The measurement result show that the BOD content of 3 river points namely stations 2, 4, and 5 Citarum Rivers exceeds the specified quality standard.

Measurement of nitrate content in citarum river waters ranges from 0.13 $mgNO_3$-/L to 0.33 $mgNO_3^-/l$. The highest nitrate content is at Station 5 which is 0.27±0.06 $mgNO_3^-/l$ while the lowest nitrate content is at Station 2 which is 0.20±0.05 $mgNO_3^-/l$. The nitrate content in the Citarum river is below the optimum rate for phytoplankton growth, which ranges from 0.13 - 0.33 $mgNO_3^-$ / L, while the optimum nitrate content for plankton growth is 0.9 - 3.5 $mgNO_3^-$ / L [25]. Nitrate content in the waters of citarum river shows oligotrophic waters, the concentration of nitrate in waters range between 0 to 1 mg / l is indicated oligotrophic water [26]. Nitrate in water is produced from the nitrogen oxidation process that is stable and easily soluble [11]. Based on Government Regulation No. 82 of 2001 concerning Water Quality Management and Pollution Control in connection with the classification and criteria for class II wastewater quality standards, the threshold value for nitrate in waters is 10 $mgNO_3^-$ / L, meaning that the results obtained are far below the specified threshold.

The content of phosphate watered based on observations in Citarum River has a range between 0.13-0.29 $mgPO_4^{2-}$ / L. The highest phosphate value is in Station 2 is 0.242±0.04 $mgPO_4^{2-}/L$ while the lowest phosphate value is at Station 4 is 0.21±0.05 $mgPO_4^{2-}$ / L. The content of phosphate in water is influenced by the disposal of industrial waste and domestic waste from the environment around the river [27]. The optimal phosphate content for phytoplankton growth ranges from more than 0.2 $mgPO_4^{2-}$ / L. [28]. According to the criteria of government regulation, no 82 of 2001 for Phosphate is 0,2 $mgPO_4^{2-}$ / L, so the measurement results show that the phosphate content in Upstream Citarum River is in accordance with the established quality standards.

### 3.2 Phytoplankton Abundance, Diversity Index, and Domination Index

Based on observation and identification of phytoplankton in Citarum River, phytoplankton. The identification of phytoplankton in citarum river is 24 genera divided into 4 Phylum namely Cyanophyta, Chlorophyta, Euglenophyta, and Chrysophyta as shown in Table1. The total abundance of phytoplankton at each station varies, which ranges from 11 to 1292 ind/L across the observation stations. This difference in abundance was possible because of the difference in the water quality between those station. The distribution of phytoplankton across the station is influenced by variation in physical and chemical factors in the waters such as temperature, current, pH, DO, and nutrient content [29].

Based on the table above, it can be seen that the highest abundance of phytoplankton at station 1 is the Crysophyta phylum, while the lowest abundance is Euglenophyta phylum. The highest total abundance was found in the 5th observation wich is equal to 15 ind/L.

Based on the table above, it can be seen that the highest abundance of phytoplankton at station 2 is the Crysophyta phylum, while the lowest abundance is Euglenophyta phylum. The highest total abundance was found in the 4th observation wich is equal to 76 ind/L.

Based on the table above, it can be seen that the highest abundance of phytoplankton at station 3 is the Crysophyta phylum, while the lowest abundance is Euglenophyta phylum. The highest total abundance was found in the 4th observation wich is equal to 1292 ind/L.

Based on the table above, it can be seen that the highest abundance of phytoplankton at station 4 is the Crysophyta phylum, while the lowest abundance is Euglenophyta phylum. The highest total abundance was found in the 5th observation wich is equal to 179 ind/L.

Based on the table above, it can be seen that the highest abundance of phytoplankton at station 5 is the Crysophyta phylum, while the lowest abundance is Euglenophyta phylum. The highest total abundance was found in the 4th observation which is equal to 379 ind/L. The five tables above show that the highest abundance of phytoplankton is at the 4th observation station 3, which is 1292 ind/L. While the lowest abundance is at station 1, the second observation. Genus with the highest abundance was Synedra at 1087 ind / L at the 4th observation at station 3. Station 3 is indicated by agricultural waste such as fertilizers, pesticides, livestock manure, and also household waste, while Station 1 is natural water with clear watercolor. High nutrient content can affect phytoplankton abundance [6]. The diversity of Bacillariophycea in waters can used as a bioindicator in monitoring water quality. If in water dominated by species from class Bacillariophyceae, then aquatic can indicated contamination [27]. Synedra is a phytoplankton class Bacillaryophyceae, Synedra can be used as an indication of declining water quality [30]. Synedra able to live with low DO conditions and found in waters in lightly polluted conditions [31]. The diversity index shows the relationship between the number of species and the number of individuals who make up a community [32].

Based on observational data Simpson diversity index during the study ranged from 0.94 to 0.98. Simpson's index value during observations showed that diversity to the five stations was high. Index values approaching 0 indicate low diversity and when the index value is close to 1.

Based on the observation data to the five stations there are no individuals who dominate in the waters. The domination index range from 0 to 1, the smaller the velue of the domination index then indicates that no species dominate, while the greater the value of the domination index then indicates the presence of certain species that dominate [9].

### 3.3 The Relationship of Nitrate and Phosphates to the Abundance of Phytoplankton

The abundance of phytoplankton in the waters affected by several environmental parameters. Nitrate and phosphate is the most relevan macronutrients are needed for phytoplankton growth [15]. The relationship of nitrate and phosphate to phytoplankton abundance in the Upstream Citarum River through multiple linier regression analysis shows positive regression with linier equations:

Y = - 4515,065–16907,441nitrat + 35902,517 fosfat

The correlation coefficient (r) obtained based on the analysis was 0,662. The value variable one with another variable has a strong correlation value, it is because 0,662 is found in the interval of correlation coefficient (r) between interpretations 0,60 – 0,799 show a strong influence [33]. Research on the relationship of nitrate and phosphate with phytoplankton abundance was also conducted by [32] in the waters of Bremi River. The coefficient correlation (r) 0,60 – 0,799 means that the variable have a strong correlation with each other. This indicates that nitrate, phosphate, and phytoplankton have a strong relationship in the waters of Bremi River.

According to the results of the calculation of the individual parameter test (t statistic test), the value of t hit nitrate < t table is -3,562 < 2,07387, so there is no effect of variable nitrate on phytoplankton abundance partially. Nitrate in water is produced from the nitrogen oxidation process which is stable and soluble [11]. Nitrates and phosphates in the waters are used by phytoplankton for photosynthesis [34]. The nitrate content in Upstream Citarum River is below the optimum rate for phytoplankton growth, which ranges frow 0,13 – 0,33 $mgNO_3^-$/L while the optimum nitrate content for plankton growth is 0,9 – 3,5 $mgNO_3^-$/L [25].

The t test for the phosphate parameters showed that the phosphate t hit > t table was 4.129 > 2,07387, so there was an effect of the phosphate variable on the abundance of phytoplankton. The phosphate content measured during observation in the Citarum River was 0,13 – 0,29 $mgPO_4^{3-}$/L. This shows the optimum number for phytoplankton growth ranges from more than 0,2 $mgPO_4^{3-}$/L [17].

Coefficient of determination ($R_2$) = 0,439. The results showed that the abundance of phytoplankton simultaneously influenced by nitrate and phosphate content of 43,9% and 56,1% was influenced by other factors. Factor supporting the phytoplankton growth are very complex and interacting between physical and chemical factors, such as dissolve oxygen, temperature, availability of nutrients such as nitrate and phosphate [25].

**Table 1. Water quality at the sampling station**

| Water Parametes | | Station | | | | |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | V |
| Temperature($^{o}$C) | Range | 20,8-25,2 | 22-28,1 | 23,5-29,4 | 21,6-27,7 | 23,6-27,6 |
| | Average | 23,3±1,9 | 25,8±2,4 | 25,9±2,2 | 26±2,6 | 26,4±1,6 |
| Water transparancy (cm) | Range | 152-155 | 42-59,2 | 11,7-61 | 9-43,5 | 15,2-49,5 |
| | Average | 151,5±3,3 | 55,6±7,4 | 48,2±20,2 | 29,1±12,5 | 29±14,6 |
| Current (m/s) | Range | 0,02-0,09 | 0,02-0,05 | 0,03-0,25 | 0,12-0,46 | 0,23-0,46 |
| | Average | 0,06±0,03 | 0,03±0,01 | 0,17±0,09 | 0,2±0,15 | 0,33±0,09 |
| pH | Range | 5,95-6,75 | 6,08-6,82 | 6,21-6,81 | 6,07-6,52 | 6,25-6,45 |
| | Average | 6,48±0,35 | 6,37±0,28 | 6,41±0,24 | 6,35±0,18 | 6,35±0,09 |
| DO | Range | 6,3-8,5 | 6,2-9,4 | 6,7-8 | 5,6-8,7 | 6,5-7,8 |
| | Average | 7,52±0,8 | 7,38±1,25 | 7,26±0,53 | 7,12±1,14 | 7,08±0,51 |
| BOD | Range | 0,3-2,3 | 2,3-4,9 | 0,3-2,6 | 2,9-4,2 | 2,0-6,5 |
| | Average | 1,4±0,8 | 3,4±0,9 | 1,8±1,0 | 3,6±0,5 | 4,7±1,8 |
| Nitrate | Range | 0,17-0,27 | 0,13-0,25 | 0,20-0,33 | 0,22-0,29 | 0,17-0,32 |
| | Average | 0,23±0,04 | 0,20±0,04 | 0,24±0,05 | 0,25±0,03 | 0,27±0,06 |
| Phosphate | Range | 0,21-0,28 | 0,19-0,28 | 0,16-0,28 | 0,12-0,25 | 0,20-0,26 |
| | Average | 0,24±0,03 | 0,24±0,04 | 0,24±0,04 | 0,2±0,05 | 0,24±0,02 |

**Table 2. Phytoplankton abundance at station 1**

| | Spesies | Abundance (ind/L) | | | | |
|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th |
| Cyanophyta | Oscillatoria | 1 | 1 | 1 | 2 | 1 |
| Chlorophyta | Crucigeniea | 0 | 0 | 2 | 0 | 0 |
| | Pediastrum | 1 | 2 | 2 | 0 | 1 |
| | Scenedesmus | 1 | 1 | 0 | 0 | 3 |
| | Closterium | 0 | 1 | 1 | 1 | 0 |
| | Penium | 0 | 0 | 0 | 1 | 1 |
| Chrysophyta | Surirella | 2 | 2 | 1 | 1 | 1 |
| | Synedra | 2 | 2 | 1 | 3 | 5 |
| | Navicula | 0 | 1 | 1 | 1 | 0 |
| | Melosira | 0 | 0 | 0 | 1 | 1 |
| | NItzschia | 3 | 0 | 5 | 2 | 0 |
| | Bacillaria | 1 | 1 | 1 | 2 | 1 |
| Euglenophyta | Euglena | 1 | 0 | 0 | 0 | 1 |
| Abundance | | 12 | 11 | 13 | 14 | 15 |

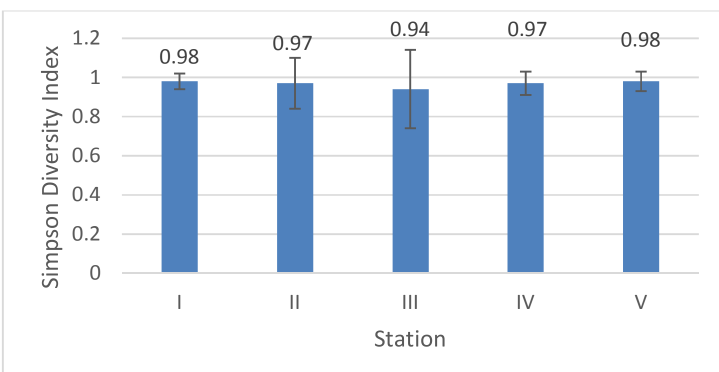


**Fig. 2. Simpson diversity index**

**Table 3. Phytoplankton abundance at station 2**

| Filum | Spesies | Abundance (ind/L) | | | | |
|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th |
| Cyanophyta | Oscillatoria | 1 | 4 | 1 | 5 | 0 |
| | Phormidium | 1 | 0 | 0 | 0 | 0 |
| Chrysophyta | Bacillaria | 4 | 8 | 0 | 16 | 0 |
| | Tabellaria | 1 | 0 | 1 | 4 | 1 |
| | Cyctotella | 2 | 2 | 2 | 1 | 4 |
| | Cymbella | 0 | 0 | 1 | 0 | 0 |
| | Surirella | 3 | 3 | 0 | 1 | 4 |
| | Ephitema | 0 | 0 | 1 | 0 | 0 |
| | Synedra | 4 | 5 | 3 | 16 | 3 |
| | Navicula | 7 | 1 | 19 | 7 | 5 |
| | Nitzschia | 10 | 10 | 32 | 5 | 2 |
| Chlorophyta | Pediastrum | 3 | 3 | 5 | 3 | 13 |
| | Scenedesmus | 1 | 1 | 2 | 16 | 13 |
| | Closterium | 1 | 2 | 0 | 1 | 0 |
| | Penium | 0 | 0 | 2 | 0 | 1 |
| Euglenophyta | Euglena | 0 | 0 | 0 | 0 | 1 |
| Abundance | | 38 | 39 | 68 | 76 | 48 |

**Table 4. Phytoplankton abundance at station 3**

| Filum | Spesies | Abundance (ind/L) | | | | |
|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th |
| Cyanophyta | Anabaena | 2 | 0 | 0 | 5 | 0 |
| | Spirulina | 0 | 0 | 0 | 0 | 0 |
| | Oscillatoria | 1 | 0 | 2 | 1 | 2 |
| | Phormidium | 1 | 1 | 7 | 2 | 4 |
| Chrysophyta | Bacillaria | 14 | 8 | 26 | 22 | 5 |
| | Cyctotella | 0 | 0 | 1 | 0 | 0 |
| | Tabelaria | 1 | 0 | 25 | 1 | 0 |
| | Leptocylindrus | 0 | 0 | 1 | 0 | 0 |
| | Cymbellia | 0 | 0 | 0 | 1 | 0 |
| | Surirella | 0 | 2 | 1 | 3 | 2 |
| | Synedra | 365 | 419 | 492 | 1087 | 820 |
| | Asterionella | 0 | 0 | 8 | 10 | 0 |
| | Navicula | 7 | 1 | 7 | 13 | 10 |
| | Melosira | 3 | 0 | 1 | 1 | 0 |
| | Nitzschia | 57 | 56 | 68 | 144 | 32 |
| Chlorophyta | Ulothrix | 0 | 0 | 0 | 0 | 0 |
| | Closterium | 2 | 0 | 1 | 1 | 3 |
| | Penium | 0 | 2 | 1 | 2 | 5 |
| Euglenophyta | Euglena | 0 | 0 | 0 | 0 | 1 |
| Abundance | | 453 | 489 | 640 | 1292 | 884 |

**Table 5. Phytoplankton abundance at station 4**

| Filum | Spesies | Abundance (ind/L) | | | | |
|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th |
| Cyanophyta | Oscillatoria | 7 | 6 | 2 | 17 | 1 |
| | Anabaena | 1 | 2 | 0 | 0 | 0 |
| | Spirulina | 0 | 1 | 0 | 4 | 4 |
| Chrysophyta | Bacillaria | 6 | 6 | 0 | 3 | 6 |
| | Cyctotella | 2 | 6 | 0 | 2 | 2 |
| | Leptocylindrus | 3 | 4 | 1 | 5 | 0 |
| | Cymbellia | 0 | 0 | 0 | 6 | 0 |
| | Surirella | 1 | 0 | 1 | 1 | 2 |
| | Synedra | 14 | 31 | 19 | 11 | 79 |
| | Navicula | 37 | 5 | 48 | 1 | 3 |
| | Nitzschia | 14 | 27 | 48 | 1 | 78 |
| Chlorophyta | Scenedesmus | 0 | 1 | 0 | 0 | 1 |
| | Ulothrix | 0 | 2 | 0 | 12 | 1 |
| | Closterium | 0 | 1 | 0 | 9 | 2 |
| | Penium | 0 | 1 | 1 | 0 | 0 |
| Euglenophyta | Euglena. | 1 | 2 | 1 | 9 | 0 |
| Abundance | | 86 | 90 | 122 | 81 | 179 |

**Table 6. Phytoplankton abundance at station 5**

| Filum | Spesies | Abundance (ind/L) | | | | |
|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th |
| Cyanophyta | Spirulina | 17 | 0 | 0 | 4 | 8 |
| | Oscillatoria | 26 | 45 | 65 | 216 | 99 |
| Chrysophyta | Bacillaria | 3 | 57 | 37 | 37 | 23 |
| | Cyctotella | 7 | 2 | 1 | 5 | 5 |
| | Leptocylindrus | 0 | 1 | 1 | 1 | 1 |
| | Surirella | 3 | 0 | 0 | 4 | 9 |
| | Synedra | 32 | 6 | 25 | 218 | 73 |
| | Navicula | 7 | 0 | 0 | 4 | 6 |
| | Melosira | 2 | 4 | 7 | 7 | 3 |
| | Nitschia | 37 | 18 | 23 | 16 | 10 |
| Chlorophyta | Pediastrum | 0 | 3 | 0 | 0 | 0 |
| | Ulothrix | 3 | 5 | 1 | 0 | 2 |
| | Closterium | 1 | 0 | 0 | 3 | 9 |
| | Penium | 0 | 0 | 0 | 0 | 3 |
| | Hyalotheca | 1 | 0 | 0 | 0 | 0 |
| Euglenophyta | Euglena | 0 | 8 | 0 | 8 | 7 |
| Abundance | | 139 | 149 | 160 | 379 | 206 |

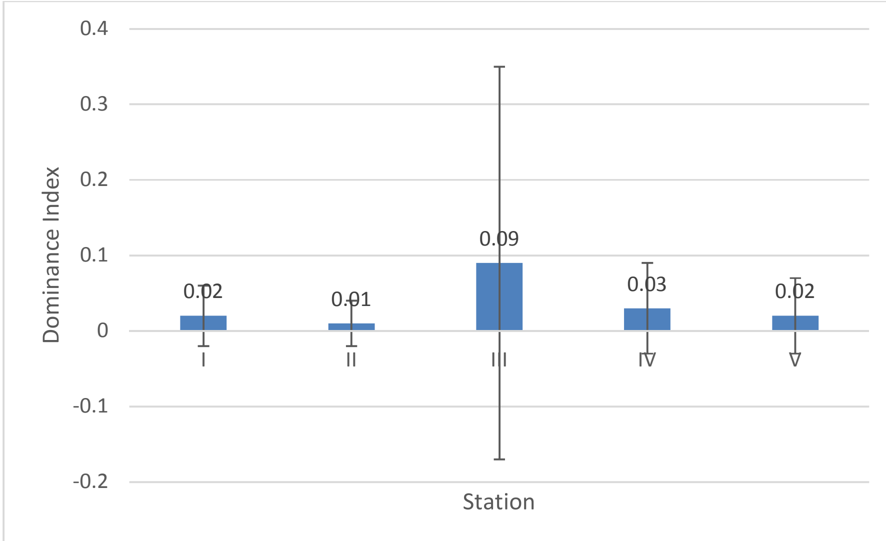


**Fig. 3. Dominance index**

## 4. CONCLUSION

Phytoplankton identified during the study were 24 genera from 4 phyllum. Diversity index and index of dominance during research respectively ranged from 0,94 to 0,98 and 0,01 to 0,09. Synedra has the highest abundance of 1087 ind/L. Synedra is one of the plankton class Cyanophyceae, the dominance of the Synedra it can be used as an indication of declining water quality.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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