Global Scientific JOURNALS

GSJ: Volume 8, Issue 1, January 2020, Online: ISSN 2320-9186

www.globalscientificjournal.com

THE EFFECT OF SEDIMENT DEPOSITION RATE ON COMMUNITY STRUCTURE OF MACROZOOBENTHOS IN SITU GUNUNG PUTRI, INDONESIA

Mochammad Faisal Rapsanjani[1], Isni Nurruhwati[2], Aiman Ibrahim[3], Zahidah Hasan[2]

[1]*Student at Faculty of Fisheries and Marine Scicence, Padjadjaran University, Bandung – Sumedang KM 21 Jatinangor 45363, Indonesia*
E-mail address: rapsanjanif@gmail.com
[2]*Lecturer at Faculty of Fisheries and Marine Science, Padjadjaran University, Bandung – Sumedang KM 21 Jatinangor 45363, Indonesia*
E-mail address: isni@unpad.ac.id
[3]*Researcher at Research Center for Limnology, Indonesian Institute of Sciences, Jakarta – Bogor KM 46 Cibinong 16911, Indonesia*

KeyWords
Sediment Deposition Rate, Abundance, Diversity, Macrozoobenthos, Situ Gunung Putri

ABSTRACT

Situ Gunung Putri is a small lake located in Bogor Regency, West Java. The purpose of this research is to determine the sediment deposition rate that occurs in Situ Gunung Putri and its effect on community structure of macrozoobenthos. The research method was using survey method and samples determined by using purposive sampling method. This research was conducted from March to June 2019 in five observation stations once two week and three times for each stations. The measurement of sediment deposition rate was conducted using sediments traps, while macrozoobenthos sampling is conducted by using Eckman Grab. The result shows that the sediment deposition rate in Situ Gunung Putri ranged from 76.95 to 1264 grams/m^2/day. Abundance of macrozoobenthos ranged from 89 to 1321 individuals/m^2. Shanon-Wiener Diversity Index ranged from 0.62 to 1.78. The analysis of linear regression show that sediment deposition rate in Situ Gunung Putri has a positive effect on abundance of macrozoobenthos with a value of 36.5%. Sediment deposition rate does not affect on diversity of macrozoobenthos.

INTRODUCTION

Situ is a Sundanese for small lake that is formed naturally or artificially, the source of water comes from springs, rainwater or surface runoff (Hasan et al. 2019). Situ Gunung Putri is located in Gunung Putri Subdistrict, Bogor Regency, West Java Province. Situ Gunung Putri has an area of 120,645 m^2 with a circumference of 1,603 m. It is located right on the side of the Jagorawi toll road and between industrial zones (BPS Bogor District 2000). Situ Gunung Putri is one of the natural lake which is used for fisheries activities, especially fishing using rods. Activities around Situ Gunung Putri include domestic, industrial, and agricultural activities. The variety of activities or land uses around the situ have the potential to produce material that can enter situ through the inlet or border of situ until deposited at the bottom of the waters.

Sedimentation is the deposition of rock or sediment material that has been transported by water or wind power. When erosion occurs, water carries rocks flowing into the river or the lake. When the transport strength is reduced or exhausted, rocks are deposited in the waters (Apriyanti 2016). Situ that have a relatively small size can be threatened by its sustainability due to high sedimentation rates. Changes and situ damages due to sedimentation will have an impact on reducing water capacity there, thereby increasing the potential for flooding. In addition, the process of sedimentation in situ can reduce the productivity of waters which in turn has an impact on changes in the condition of aquatic biota including macrozoobenthos (Puspita et al. 2005).

Macrozoobenthos are animals living in group in the bottom of the waters. Macrozoobenthos are one of the most important groups in aquatic ecosystems due to their role as key organisms in the food web. Macrozoobenthos has slow movement and is affected by the state of water quality and substrates. If the substrate changes, then the structure of the macrozoobenthos community will also change. Macrozoobenthos are one of the important groups in aquatic ecosystems that function as eaters of floating particles, eaters of detritus, carnivores or as plankton eaters (Setyobudiandi 1997).

Sedimentation greatly affected faunal communities not only physically, but also through changing sediment composition, organic matter, and nutrient input (Chou et al 2004). The research by Pamuji et al (2015) show that increasing in sedimentation rate may affect to increase of macrozoobenthos abundance. The purpose of this research is to determine the sediment deposition rate that occurs in Situ Gunung Putri and its effect on community structure of macrozoobenthos.

METHODS

This research was carried out for approximately four months in March-June 2019. The method used in this research is a survey method. Sampling was done by purposive sampling method at five selected stations once two week and three times for each stations. Sampling stations are shown in Figure 1 and Table 1. Each station observed water quality parameters at the bottom waters. The parameters observed using Water Quality Checker (WQC) included temperature, Dissolved Oxygen (DO), pH, and turbidity. The depth of the waters was measured using a Water Depth Sounder, while transparency uses a Secchi Disk. Water sampling at depth was done using a Kemmerer Water Sampler tool. The water sample is then put into a 250 ml HDPE sample bottle which will be used to Chemical Oxygen Demand (COD) measurement. Sampling of macrozoobenthos and sediments using the Eckman Grab (15 x 15 cm^2) , while for sediment accumulation using a sediment trap consist Polyvinyl Chloride (PVC) cylinder with 3 inch diameter and 30 cm high.

Measurement of accumulated sediment mass, sediment texture analysis, and identification of macrozoobenthos were respectively carried out at the Sedimentology Laboratory and Benthic Macroinvertebrates Laboratory, Research Center for Limnology, Indonesian Institute of Sciences. COD measurement was carried out in the Aquatic Productivity and Environment Laboratory, Bogor Agricultural University.

Figure 1. Map of Situ Gunung Putri showing the Sampling Stations

Table 1. Coordinates and Characteristics of Sampling Stations in Situ Gunung Putri

Stations	Coordinates	Characteristics
1	6°27'55.1088'' LS 106°53'21.4188'' BT	situ inlet of the dynamo industry and the vehicle spare parts industry.
2	6°27'45.3132'' LS 106°53'15.8784'' BT	situ inlet from residential areas.
3	6°27'49.0428'' LS 106°53'23.0316'' BT	situ midlet and there are aquatic plants as lotus and water hyacinth that covered 2/3 of situ.
4	6°27'45.6444'' LS 106°53'16.368'' BT	extensive farming area of elephant grass which tends to convert into swamp and is used by residents as animal feed.
5	6°27'46.7964'' LS 106°53'26.9124'' BT	situ outlet

Sediment Deposition Rate

Sediment deposition rate is the amount of sediment mass deposited through one unit area in each unit of time (Pamuji et al. 2015). Sediment deposition rate can be calculated using the following formula:

$$Sediment\ Deposition\ Rate\ = m/(L.t)(grams/m^2/day)$$

Where :

m = Sediment mass after heating 105°C (grams)
L = Cross-sectional area of sediment trap (m^2)
t = Installation time of sediment trap (day)

Sediment Texture

Sediment texture is determined by the percentage of three fractions namely sand, silt, and clay. The percentage of the three factions is carried out by the following formula (Hakim et al. 1986):

$$\%\ sand = 100 - \frac{(R1 - B1) + 0{,}36(T1 - 20)\ x\ (100 + M)}{W}$$

$$\%\ clay = \frac{(R2 - B2) + 0{,}36(T2 - 20)\ x\ (100 + M)}{W}$$

$$\%\ \boldsymbol{silt} = \mathbf{100} - \%\ \boldsymbol{sand} - \%\ \boldsymbol{clay}$$

Where :

R1 = first reading of the hydrometer of a soil sample
R2 = second reading of the hydrometer of a soil sample
B1 = first reading of the hydrometer standard
B2 = second reading of the hydrometer standard
T1 = first reading of temperature
T2 = second reading of temperature
0,36 = hydrometer correction factor
20 = calibration temperature of the hydrometer
W = the dry weight of the soil sample used analysis
M = % air dry soil example

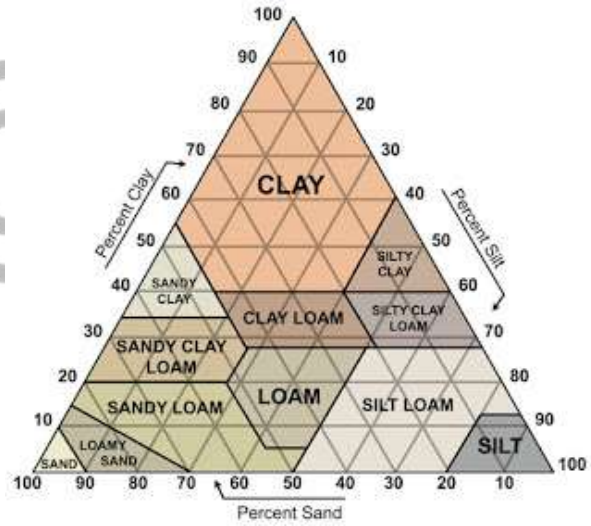

Figure 2. Sedimentary texture triangle
(Source : Buckman dan Brandy 1982)

Abundance of Macrozoobenthos

Abundance of macrozoobenthos can be calculated using formula as follows (Dhahiyat 2011):

$$D_i = \frac{n_i}{A}$$

Where :

D_i = Abundance of macrozoobenthos (individuals/m^2)
ni = Individual numbers of i^{th} species
A = Sampling area (*eckman grab*) multiplied by the number of replications (m^2)

Diversity of Macrozoobenthos

Diversity of macrozoobenthos can be calculated using the Shannon-Wiener formula as follows (Dhahiyat 2011):

$$H' = -\sum pi \, Ln \, pi$$

Where :

H' = Shannon Wiener Diversity Index
pi = ni/N
ni = Individual numbers of i^{th} species
N = Total number of individuals

Statistical Analysis

Relation analysis is used to see the relation between sedimen deposition rate with abundance and diversity of macrozoobenthos. This relation was analyzed using simple linear regression with SPSS application version 20.

RESULT AND DISCUSSION

Sediment Texture

The results of sediment texture analysis in Situ Gunung Putri from March to April 2019 showed that the sediment texture in all research stations was silt loam, except station 2 which had silt sediment texture (Table 2).

Table 2. Sediment Texture of Situ Gunung Putri Period March - April 2019

Station	Sediment fraction			Sediment texture
	% sand	**% clay**	**% silt**	
1	45,94	7,37	46,69	silt loam
2	8,29	7,96	83,75	silt
3	15,76	7,80	76,44	silt loam
4	30,53	7,83	61,64	silt loam
5	26,98	7,78	65,24	silt loam

According to Choirudin et al. (2014) changes that occur in the aquatic environment are caused by physical, chemical, and biological processes around the waters. The most influential one is the physical process that is the process of stirring and sedimentation controlled by currents in the waters. Although the current there is not as high as in the river area, but it will affect the process of sediment deposition rate and affect the size and texture of sediment deposited in Situ Gunung Putri.

Sediment fraction in Situ Gunung Putri which has the highest percentage value is in the form of silt measuring 50 - 2µm, followed by sand measuring 2mm - 50µm and clay measuring <2µm (Soil Survey Staff 1998). Differences in the characteristics and distribution of bottom waters, including the difference in size in the parent material. In addition sediment particle size can describe: 1) different types, 2) particle resistance to weathering and erosion 3) transportation and sedimentation processes (Friedman and Sander 1978 *in* Rifardi 2008). The grain size of sediment particles is one of the factors that control the process of sediment deposition in waters, the smaller the grain size the longer the particles are in a pool of water and the further they are deposited from the source, and vice versa (Rifardi 2008).

Sediment Depotition Rate

The results of the measurement of sediment deposition rate at Situ Gunung Putri in March-April 2019 showed a value between 76.95-1264 grams/m^2/ day. The lowest sediment deposition rate at station 5 with a value of 76.95 grams/m^2/ day. This is because station 5 is in an outlet area that has faster water movement than other stations so sediments not easily deposited and accumulated at these station. In addition, at station 5 there is already equipped with a cement wall so can reduce soil particle from edge of situ which enters the water column. The highest sediment deposition rate is found at station 1 with a value of 1264 grams/m^2/day. This is due to the movement of water at that station is relatively quieter compared to other stations. Although there is an inlet from industry, there is no swift flow of water. The depth of this station is very low compared to the depth at other stations. Edge of the situ is used by the community for fishing activities can be eroded by rain water so that it enters the water column and is deposited at the bottom waters (Figure 3).

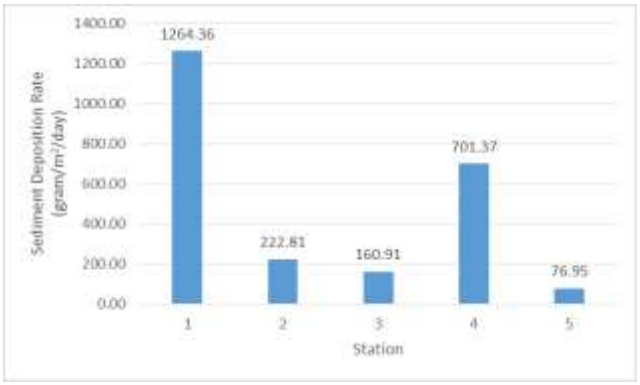

Figure 3. Sediment Deposition Rate in Situ Gunung Putri Period March - April 2019

According to Mananoma (2013), an increase in the rate of deposition is due to the flow of water that enters the water column either from the inlet or runoff from the ground when it rains. The greater the flow of incoming water flow, the more sediment is transported and will affect the sediment deposition rate. Sediment deposition rate are influenced by physical laws, especially the role of fluid in sediment transport, that is fluid transfers energy to particles and how the methode of sediment transport, suspension, and traction. To move the particles that are retained, the fluid must transfer energy in sufficient quantities to force the particles apart and the moving of these particles can be in the form of traction, saltation, rolling, and sliding (Rifardi 2008).

Abundance of Macrozoobenthos

Macrozoobenthos identified in the Situ Gunung Putri during the research amounted to 22 species from 3 class, namely Gastropoda, Oligochaeta, and Insecta. Abundance of macrozoobenthos during the research in Situ Gunung Putri ranged from 89 to 1321 individuals/m^2. The abundance of macrozoobenthos per station during the research is shown in Figure 4. The highest abundance value was obtained by Station 1 with a value of 1321 individuals /m^2, while the lowest abundance with a value of 89 individuals /m^2 was obtained by station 3. Gastropoda is the most common type of macrozoobenthos found in the Situ Gunung Putri, which is as many as 14 species which are dominated by the *Melanoides tuberculata* (39–937 individuals /m^2).

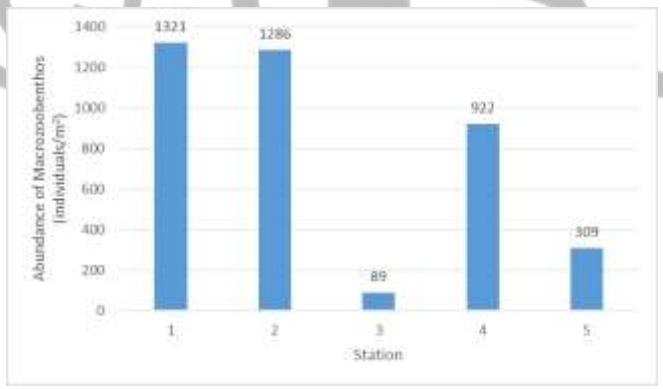

Figure 4. Abundance of Macrozoobenthos in Situ Gunung Putri Period March - April 2019

According to Tanjung (1994) in Rahayu (2015), the abundance of macrozoobenthos is influenced by the topography of the habitat in which they are located, the availability of food and oxygen, the type of sediment, the level of adaptation, competition and predatorism. Meanwhile, according to Fisesa (2015) An increase in human activities such as input of household and agricultural waste that produce sources of organic pollution continuously into the waters will affect the abundance of macrozoobenthos.

Diversity of Macrozoobenthos

The results of the research in Situ Gunung Putri show the value of Shannon-Wiener Diversity Index (H') has variations at each station. The highest diversity index at station 1 was 1.78 and the lowest at station 4 was 0.62. The value of diversity index (H') in detail

can be seen in Figure 5. Based on the classification according to Wilhm and Dorris (1986), station 1, 3, and 5 were classified into moderate diversity (1<H'<3), while station 2 and 4 were classified into low diversity (H'<1).

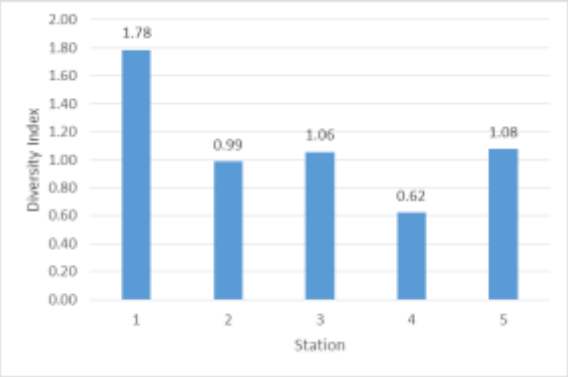

Figure 5. Diversity Index of Macrozoobenthos in Situ Gunung Putri Period March - April 2019

Diversity of macrozoobenthos in an area is influenced by contaminated substrate factors, abundance of food sources, competition between species, disturbance and conditions of the surrounding environment so that species that have high tolerance will increase while those that have low tolerance will decrease (Rahmawaty 2011). According to Rahayu (2015), the high value of the diversity index shows the good condition of the aquatic environment and supports the life of the biota in it. It can also be seen from the high levels of dissolved oxygen which are thought to be sufficiently available for consumption of biota in it.

Effect of Sediment Deposition Rate on Community Structure of Macrozoobenthos

Effect of Sediment Deposition Rate on Abundance of Macrozoobenthos

The results of simple linear regression analysis related to the effect of sediment deposition rate on abundance of macrozoobenthos showed a significance value of 0.017 (Table 3). The basis for decision making in regression analysis is to look at the significance value (Sig.). if the significance value (Sig.) is smaller than the probability of 0.05, sediment deposition rate has effect on abundance of macrozoobenthos. Conversely, if the significance value (Sig.) is greater than the probability of 0.05, the sediment deposition rate does not affect the abundance of macrozoobenthos. The significance value (Sig.) of 0.017 (<0.05) show that the sediment deposition rate affects the abundance of macrozoobenthos.

Table 3. Coefficient Value for The Effect of Sediment Deposition Rate on Abundance of Macrozoobenthos Period March - April 2019

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	469.031	167.985		2.792	.015
	Sediment Deposition Rate	.638	.233	.604	2.735	.017

a. Dependent Variable: Abundance of Macrozoobenthos

In general, the simple linear regression equation is Y = a + bX. The value of a in the formula shows a constant number of unstandardized coefficients. The a value of the simple linear regression results shown in Figure 6 shows the value of 469.031 which means that if there is no sediment deposition rate, then the constant value of the abundance of macrozoobenthos is 469.031. The b value is a number of regression coefficients with a value of 0.638 (Table 3). This figure shows that for every 1% increase in sediment deposition rate, the abundance of macrozoobenthos will increase by 0.638. The positive value of the regression coefficient shows that the sediment deposition rate has a positive effect on the abundance of macrozoobenthos so the resulting linear regression equation is Y = 469.031 + 0.638 X.

Table 4. R Square Value for The Effect of Sediment Deposition Rate on Abundance of Macrozoobenthos Period March - April 2019

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.604[a]	.365	.316	482.67699

a. Predictors: (Constant), Sediment Deposition Rate

Based on Table 4, it is known that R Square is 0.365. This value indicates that the influence of sediment deposition rate on the abundance of macrozoobenthos is 36.5% with the remaining value of 63.5% influenced by other variables. Referring to the discussion above, it can be concluded that the sediment deposition rate has a positive effect on the abundance of macrozoobenthos with a total effect of 36.5%. This positive effect means that the increasing sediment deposition rate may affect the increase in abundance of macrozoobenthos.

Effect of Sediment Deposition Rate on Diversity of Macrozoobenthos

The results of simple linear regression analysis related to the effect of sediment deposition rate on macrozoobenthos diversity showed a significance value of 0.540 (Table 5). The significance value (Sig.) is 0.540 (> 0.05) indicates that the sediment deposition rate does not affect the diversity of macrozoobenthos. The a value of the simple linear regression results shown in Table 5 shows the value of 0.453 which means that if there is no sediment deposition rate, the constant value of the macrozoobenthos diversity is 0.453. The value of b is a number of regression coefficients with a value of 0.000 so that the regression equation is Y = 0.453 + 0.000 X. The equation shows that each addition of 1% of the rate of deposition rate does not affect the diversity of macrozoobenthos.

Table 5. Coefficient Value of The Effect of Sediment Deposition Rate on Diversity of Macrozoobenthos Period March - April 2019

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.453	.136		3.337	.044
	Sediment Deposition Rate	.000	.000	.370	.690	.540

a. Dependent Variable: Diversity of Macrozoobenthos

CONCLUSION

Based on this research, it can be concluded that sediment deposition rate in Situ Gunung Putri shows values ranged from 76.95 to 1264 grams/m^2/day. Sediment texture in all research stations was silt loam, except station 2 which had silt sediment texture. Sediment deposition rate in Situ Gunung Putri has a positive effect on the abundance of macrozoobenthos with a value of 36.5%, but it does not affect the diversity of macrozoobenthos.

Acknowledgments

The author wishes to thank to Dr.Ir. Fauzan Ali, M.Sc. as the head of the Research Center for Limnology, Indonesian Institute of Sciences who has given permission to use laboratory facilities and thanks to Mr. Enjay and Mr. Idrus as the boat owner and at the same time as the guide for taking me to the research location.

References

[1] Apriyanti Y, "Studi Karakteristik Sedimen dan Laju Sedimentasi Sungai Daeng – Kabupaten Bangka Barat", *Fropil*, vol. 4, no. 2, pp. 165-174, 2016 (In Indonesian)
[2] Buckman H. O. and Brandy N. C, *Ilmu Tanah,* Raja Grafindo Persada: Jakarta, 1982 (In Indonesian)
[3] Choirudin I. R., Supardjo M. N., Muskananfola M. R., "Studi Hubungan Kandungan Bahan Organik Sedimen Dengan Kelimpahan Makrozoobentos di Muara Sungai Wedung Kabupaten Demak", *Diponegoro Journal of Maquares Management of Aquatic Resources,* vol. 3, no. 3, pp. 168-176, 2014 (In Indonesian)
[4] Chou, L.M., J. Y. Yu & T. L. Loh, "Impacts of sedimentation on soft-bottom benthic communities in thesouthern islands of Singapore", *Hydrobiologia,* vol. 515, pp. 91–106, 2004
[5] Dhahiyat Y., *Ekologi Perairan*. Unpad Press. pp. 214, 2011 (In Indonesian)
[6] Hakim, N. M. Y. Nyakpa, A. M. Lubis, S. Ghani, Nugroho, M. R. Soul, M. A. Diha, G. B. Hong, N. H. Balley, *Dasar-Dasar Ilmu Tanah*, University of Lampung: Lampung, 1986 (In Indonesian)
[7] Hasan, Z., T. Ilham, Y. Andriani, H.Herawati, and F. Sulawesty, "Water Quality Distribution in Situ Gunung Putri Bogor Regency, Indonesia". *Asian Journal of Fisheries and Aquatic Research*, vol. 4, no. 3, pp. 18, 2019

[8] Mananoma T., Tanudjaja L., Binilang A., "Analisis Sedimentasi di Muara Sungai Saluwangko di Desa Tounelet Kecamatan Kakas Kabupaten Minahasa", *Jurnal Sipil Statik,* vol. 1, no. 6, pp. 452-458, 2013 (In Indonesian)
[9] Pamuji A., Muskananfola M. R., A'in C., "Pengaruh Sedimentasi Terhadap Kelimpahan Makrozoobentos di Muara Sungai Betahlawang Kabupaten Demak", *Jurnal Saintek Perikanan,* vol. 10, no. 2, pp. 129-135, 2015 (In Indonesian)
[10] Puspita L., E. Ratnawati, I N. N. Suryadiputra, A. A. Meutia, *Lahan Basah Buatan di Indonesia*, Wetlands International-Indonesia Program: Bogor, pp. 261, 2005 (In Indonesian)
[11] Rahayu S., Mahatma R., Khairijon, "Kelimpahan dan Keanekaragaman Makrozoobentos di Beberapa Anak Sungai Batang Lubuh Kecamatan Rambah Kabupaten Rokan Hulu", *JOM FMIPA,* vol. 2, no. 1, 2015 (In Indonesian)
[12] Rahmawaty, "Indeks Keanekaragaman Makrzoobentos Sebagai Bioindikator Tingkat Pencemaran di Muara Sungai Jeneberang", *Bionature,* vol. 12, no. 2, pp. 103-109, 2011 (In Indonesian)
[13] Rifardi, *Tekstur Sedimen Sampling dan Analisis,* Unri Press: Pekanbaru Riau, pp. 101, 2008 (In Indonesian)
[14] Soil Survey Staff, *Kunci Taksonomi Tanah. Edisi Kedua Bahasa Indonesia,* Pusat Penelitian Tanah dan Agroklimat, Badan Penelitian dan Pengembangan Pertanian, 1998 (In Indonesian)
[15] Wilhm, J.L. and T. C. Dorris, "Biological Parameters for Water Quality Criteria", *BioScience,* vol. 18, no. 6, pp. 477 – 481, 1968
[16] Zahidah, *Produktivitas Perairan,* Unpad Press: Padjajaran University, pp. 114, 2017 (In Indonesian)