Relationship of Sedimentation Rate to The Structure of Macrozoobenthos Community On Transitional in Ciletuh Bay, Sukabumi District, West Java

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Abstract. Ciletuh is a coastal area located in Sukabumi Regency, West Java, which is currently included in the Geopark region in West Java. Ciletuh is a name of a bay that faces directly to the Indian Ocean, hence the similarity of its ocean characteristic. At present Ciletuh Bay has undergone massive sedimentation due to the large amount of sediment entering the surrounding bay coming from Ciwaru and Cimarinjung River and the existence of many floating net cages around the Ciletuh Bay, all of which empties into Ciletuh Bay. High sedimentation rate will disrupt environmental conditions especially organism found in sediments such as benthos. This research was designed using descriptive analytic methods in the form of field observations to determine the research station, sediment sampling and supporting parameters carried out at the research station point. The study was conducted at 5 sampling stations based on different characteristics. The purpose of this research is to see the relationship between sedimentation rate and structure of the macrozoobentos community. Result presented that the species dominating the bay areas are Nassarius sp., Cerithium sp. Clypeamorus sp. Rhinodavis sp. Cerithiidae , Coralliophila sp., Turricula sp., Olivia caerulea., Thais sp., Phos roseatus, Hemifusus sp. Diplomariza sp. Neritadae, Donax sp., Pyramidella
sp., *Terebia* sp. Sedimentation rate calculated as 0.11 gr/cm²/day; 0.13 gr/cm²/day; 0.07 gr/cm²/day; and 0.3 gr/cm²/day. Based on sediment grain size, types of sediment founded on each station are (1) gravely mud, (2) sandy mud, (3) sandy mud with slight gravels, (4) mud with slight gravels, and; (5) sandy silt.

**Keywords:** Ciletuh Bay, Community Structure of Macrozoobenthos, Sedimentation Rate.

1. **Introduction**

Ciletuh Bay is an area that has a unique diversity of geological rocks that makes this region one of the geopark areas in the Sukabumi region, West Java (Hardiyono et al 2015). Other than its amusing geopark area to be studied, the waters in Ciletuh Bay is also an intriguing area to study its oceanography due to the condition of the waters which are influenced by the characteristics of the Indian Ocean and notable rivers that flows into its water body, created a mixture of fresh water and sea water (Roswanty and Purnomo, 2014). The waters in Ciletuh Bay are often used by the surrounding community for fishing activities such as shrimp, grouper fish and lobsters farming that affect Ciletuh Bay’s water quality and disrupt the life of macrozoobenthos that live in these waters. The level of sedimentation in Ciletuh Bay is considered high due to high human activities that bring negative impacts such as fishing activity when the water is receding to be hampered, the imbalance of life of aquatic organisms, the potential for accumulation of organic matter carried from rivers, and can cause overflow of water masses river so that the land area becomes flooded (Pamuji et al 2015).

The purpose of this study was to determine the value of the sedimentation rate and texture of the sedimentation and the relationship of the sedimentation rate to the structure of the macrozoobenthos community in the waters of Ciletuh Bay, Sukabumi Regency, West Java.

2. **Materials and methods**

This research was conducted in October 2018 in the waters of Ciletuh Bay using 5 sampling locations where the location of Station 1 is on Kunti Island; Station 2 of the Shrimp Pond; station 3 Mandra Island; station 4 Muara Sungai Ciwaru and station 5 Muara Sungai Cimarinjung and the processing of sediment samples was conducted at the Marine
Conservation Laboratory and macrozoobenthos analysis at the Ecology Laboratory of Padjajaran University. A picture of the location and the sampling point of the study can be seen in Figure 1.

Figure 1. Research Location

The research method used was a survey method with random sampling or purposive sampling at five stations including data on water quality (temperature, brightness, salinity, DO, pH and flow velocity), sediment samples for sedimentation rate analysis with sediment trap tools, macrozoobenthos samples by using ekman grab and filter. Retrieval of water quality temperature, DO, pH and salinity was repeated 3 times then for the collection of current data (in 1 minute) and brightness, the device was removed in the water column, calculated the length of the rope being drawn and repeated 3 times. Sediment sampling for the analysis of sedimentation rates is taken using a sediment trap embedded in the bottom of the water on each station, left for 10 days then the results of the sediment trapped inside were removed and put into the ziplock to be weighed in mass. In sampling of macrozoobenthos, sediment will be taken using an ekman grab tool then the sediment was inserted into the filter to divide macrozoobenthos from the sediment then stored the samples in ziplock and gave it a 4% formalin solution as preservative.

Sediment sample analysis is done by separating sediment grains based on grain size using a shieve shaker tool with texture classification using KUMMOD SEL software based on the Wentworth scale, calculations on sedimentation rates using the formula from APHA 1971:

\[
\text{Sedimentation rate} = \frac{10000}{\pi r^2} (A-B) \text{ (grams/m}^2\text{/week)}
\]
Notes:
A = weight of aluminum foil + sediment after heating (grams)
B = initial weight of aluminum foil (grams)
r = radius of sediment trap (cm)

Individual Abundance

\[ KI \text{ (ind/m}^3\text{)} = a \times n_i \]

Notes:
a : Conversion number
ni : Amount of individuals in species i

Diversity Index

\[ H' = - \sum p_i \ln p_i \]

Notes:
H’ = Species diversity index
S = The number that makes up the community
Pi = Ratio of the number of individuals in species i (ni) to the number of individuals in the community (N)

Uniformity Index

\[ e = H'/H_{max} \]

Notes:
e = Uniformity Index
H’ = Diversity Index
H_{max} = \ln S

Domination Index

\[ C = \sum (n_i/N)^2 \]

Notes:
C = Domination Index
N = Number of individuals in all species
ni = Amount of individuals in species i

Data analysis that obtained then analyzed using regression-correlation method.
3. Results and Discussion

3.1. Water Quality Parameters

Physical and chemical parameters of the waters will influence the presence of macrozooenthos both directly and indirectly. Some parameters such as temperature, salinity, pH, dissolved oxygen, water transparency, and depth will support the fertility of the waters. Water Quality Parameters is presented in Table 1.

| Station | latitude    | longitude    | Salinity | Temperature | pH  | DO  | Brightness | Depth |
|---------|-------------|--------------|----------|-------------|-----|-----|------------|-------|
| 1       | -7.186861°  | 106.431861°  | 35       | 29,5        | 7,97| 34  | 200        | 200   |
| 2       | -7.189389°  | 106.443500°  | 34       | 30          | 7,85| 7,2 | 35         | 80    |
| 3       | -7.182806°  | 106.448667°  | 34       | 28          | 7,74| 6,4 | 80         | 90    |
| 4       | -7.182845°  | 106.457651°  | 32       | 28          | 7,3 | 5,9 | 70         | 210   |
| 5       | -7.171157°  | 106.464503°  | 30       | 27          | 7,55| 5,9 | 50         | 180   |

Temperature values in the measurement range between 27-30°C. Based on the temperature value, the waters of the Ciletuh bay are included in the appropriate category to support the survival of macrozoobenthos. Ronsenberg (1987) in Nybakken (1992), states that temperature influences the movement, metabolism rate and macrozoobenthos mortality. In addition, temperatures that can endanger the life of macrozoobenthos range between 35-40°C (Welch, 1980).

Salinity value in Ciletuh Bay ranges from 30-35%/oo. Salinity affects the life of macrozoobenthos including the rate of growth and survival of aquatic biota (Yeanny, 2007). This salinity level is still in the normal limit of coastal water and mixed water.

pH value of waters is one of the important parameters in determining water quality (Prescott et al., 2004). The pH of Ciletuh Bay waters ranges from 7.3 to 7.97, the pH value is included in the category of not acidic or non-basic or can be said to be normal. Aquatic organisms have different abilities in tolerating aquatic pH. Mortality can be caused by a lower pH than it is caused by a high pH (Nuriyawan et al., 2016)
Concentration of dissolved oxygen ranged from 5.9-34 mg/L. The highest concentration was found at station 1, which reached 34 mg/L. This is due to the presence of sunlight that enters the body of the waters thus helping photosynthesis in supplying oxygen to the waters (Salmin, 2005). According to Araoye (2009), the diffusion of oxygen into water bodies naturally slows down except in conditions of strong turbulence, therefore some of the important sources of oxygen are through the process of photosynthesis by aquatic organisms and plants.

The results of the measurement of water transparency range between 35 - 200 cm. the turbidity level of a waters is influenced by suspended and colloidal materials contained in water, for example sediment particles, organic matter, plankton or microorganisms (Mason, 1981).

3.2. Grain Size

Results of the calculation of the percentage and type of sediment texture at each station in Ciletuh Bay can be seen in Table 2.

| Station | Sediment Fraction (%) | Sediment Type          |
|---------|------------------------|------------------------|
|         | Gravel | Sand | Silt |                      |
| 1       | 5.4    | 46.1 | 48.4 | Gravely Mud          |
| 2       | 0      | 35   | 65   | Sandy mud            |
| 3       | 0      | 11.3 | 88.7 | Sandy mud, slight gravels |
| 4       | 1.7    | 5    | 93.3 | Mud, slight gravels  |
| 5       | 0      | 14.3 | 85.7 | Sandy Silt           |

Based on the results of sediment analysis in Ciletuh Bay, Sukabumi Regency, West Java, gravel fraction values of 1.7 - 5.4% were obtained. The percentage of sand fraction ranges from 5 - 46.1%. And the percentage of silt ranges between 18.4 - 93.3%. Based on these data it can be seen that the percentage of silt is the largest sedimentary fraction compared to the gravel and sand sediment fraction, so that after analysis using the
KUMMOD (Soil Texture Segmentation) software (Mahbub, 2006) it can be seen that the type of sediment texture in Ciletuh Bay is silt.

Sediment with silt fraction dominates at each station, this can be caused by erosion activity in the highlands so that carrying soil particles carried by the river flow towards the estuary. Another factor that can be the cause of more clay fractions is due to the current speed at each station classified in the medium category so that the particles easily settle in the waters. If the current is weak, the particles that settle are dust and silt particles (Nybakken, 1992).

The amount of sediment mass that is transported through a unit of area in units of time is called the sediment rate. Based on the calculation of sediment rate, the data presented in Table 3 is obtained.

Table 3. Data from Sedimentation Rate Analysis Results

| Date of Sediment Trap installation | Date of Sediment Trap Retrieval | Station/Plot | Sedimentation Rate Accumulates (gr/cm² per day) |
|-----------------------------------|---------------------------------|--------------|-----------------------------------------------|
| 7/10/2018                         | 21/10/2018                     | Station 1    | 0,11                                          |
| 7/10/2018                         | 21/10/2018                     | Station 2    | 0,13                                          |
| 21/10/2018                        | 2/11/2018                      | Station 3    | 0,07                                          |
| 21/10/2019                        | 2/12/2018                      | Station 4    | 0                                              |
| 21/10/2018                        | 2/11/2018                      | Station 5    | 0,3                                           |

Results of sedimentation rates measurements during the study ranged from 0.3 to 0.11 gr/cm² per day. Based on these data the sedimentation rate is influenced by the speed of the current. According to Augustine et al., (2013) slower flow velocity will cause particles that are not washed up to settle and form the basic elements of water, while fast currents will wash away dissolved particles. In addition, the high rate of sediment in Ciletuh Bay is influenced by sediment deposition in the bottom waters and the mixing of fresh water and sea water so that it turns into a flooded area or shallow water. The highest sedimentation rate is at station 2 and the lowest is at station 5. Station 4 does not have the sedimentation rate because there are obstacles when installing and taking sediment traps,
this is because at station 4 it has a strong current so the sediment trap is not strong enough to be installed at the station.

Makrozoobenthos

Based on the calculation results of the macrozoobenthos community structure, the data obtained is presented in Table 4.

Table 4. Individual Abundance Calculation Results Data

| Seasonal Change | KI (ind/m³) | H' | e  | C  |
|-----------------|------------|----|----|----|
| Station 1       | 250        | 0,68 | 0,98 | 0,5 |
| Station 2       | 3750       | 1,69 | 0,7  | 0,289 |
| Station 3       | 625        | 1,32 | 0,95 | 0,28 |
| Station 4       | 250        | 0,68 | 0,98 | 0,5 |
| Station 5       | 375        | 1,09 | 0,99 | 0,33 |

From the results of the research that has been done, the value of individual abundance index (KI), diversity (H'), uniformity (e) and dominance (C) that obtained each have different results according to each station. In station 1, each one of the macrozoobentos was identified with the genus Nassarius sp. and Cerithium sp. In station 2 type of macrozoobenthos that were found are lepeamorus sp., Rhinodavis sp., Certhiidae sp., Coralliphila sp., Turricula sp., Cerithium sp., Olivia sp., Nassarius sp., Phos roseatus, and Hemifusus sp. At station 3 there were obtained macrozoobenthos with genus of Diplomariza sp., Nassarius sp., Neritidae sp., and donax sp. Station 4 obtains macrozoobenthos with the types of Nassarius sp., and Cerithium sp. At the last station, station 5, macrozoobenthos with the types of Pyramidella sp., Nassarius sp. and Terebia sp. were obtained.

Relationship of Sedimentation Rate to the Structure of Macrozoobenthos Community

The results of the linear regression calculation between the sedimentation rate of abundance, diversity, uniformity, and the dominance of macrozoobenthos in Ciletuh Bay Sukabumi Regency are presented in Figure 2.
Correlation rate of sedimentation to the abundance index of macrozoobenthos individuals is 0.1147, the correlation value of sedimentation rate to macrozoobenthos diversity is 0.0048, the correlation value of sedimentation rate with macrozoobenthos uniformity is 0.1466, the correlation value of sedimentation rate to macrozoobenthos dominance is 0.0336 then the graph shows the relationship between the sediment rate and the index of abundance, diversity, uniformity and dominance of macrozoobenthos. The higher the rate of sedimentation, the higher the abundance, diversity, uniformity and dominance of macrozoobenthos. This is because sediments that are carried by currents and settle at the bottom of the cation generally carry low nutrient content and are needed by macrozoobenthos for life.

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Conclusion

1. The highest sedimentation rate is found at station 2 with sediment rate of 0.13 gr/cm³/day with sandy mud sediment fraction and the lowest is at station 5 with sediment rate of 0.3 gr/cm³/day with sandy silt fraction.

2. The highest abundance and diversity were 3750 ind/m³ and 1.69 found in station 2 with the dominant macrozoobenthos type being *Nassarius sp.* with a low level of uniformity.

3. *Nassarius sp.* Is the type of macrozoobenthos that is most often found at each station.

4. A very strong correlation was obtained between the sedimentation rate and the uniformity and abundance index of macrozoobenthos.

Citation and References

[1] Araoye, P.A. 2009. The Seasonal Variation of pH and Dissolved Oxygen (DO2) Concentration in Asa Lake Ilorin, Nigeria. International Journal of Physical Science 4(5): 271-274.

[2] Hardiyono, A., Syarfi, I., Rosana, M. F., Yuningsih, E. Y., Herry, & Andriany, S. S. (2015). Geotourism Potential in the Ciletuh Bay Area, Sukabumi, West Java. Bulletin of Scientific Contribution, 13(2):119-127.

[3] Mason, C.F. 1981. Biology of Freshwater Pollution. Longman. New York. 250p.

[4] Nybakken, J.W. 1992. Marine Biology An Ecological Approach. Translated by Eidman and Bengen. PT. Gramedia Jakarta

[5] Pamuji, A., Muskananfola, M. R., & A’in, C. (2015). Effect of Sedimentation on Macrozoobenthos Abundance at Betahwalang River Estuary, Demak Regency.. Indonesian Journal of Fisheries Sciences and Technology (IJFST), 10(2): 129-135.

[6] Roswanty, M. R., & Purnomo, P. W. (2014). Sedimentation Level in Wudung River Estuary, Wedung District, Demak. Maquares, 3(2):129-137.

[7] Salmin. 2005. Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) as Indicators to determine Aquatic Quality. Oseana Journal. Volume 30 (3): 21-26
[8] Welch, E.B. 198.. Ecological Effect of Waste Water. Cambride University Press. Cambride. 337p

[9] Yeanny, M.S. 2007. Macrozoobenthos Diversity in Belawan River Estuary. Department of Biology. Faculty of Mathematics and Natural Sciences, North Sumatra University. Meda. 2(2): 37-4