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DISTRIBUTION OF BOTTOM SEDIMENT BEFORE AND AFTER RECLAMATION AT CENTER POINT OF INDONESIA (CPI) MAKASSAR CITY

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ABSTRACT

Characteristics and distribution of bottom sediment is one of the important parameters in determining the management plan and land use in coastal areas. The purpose of this study was to determine the condition of the distribution of bottom sediments and to compare the changes that occurred in the distribution of bottom sediment before and after the reclamation of the Center Point of Indonesia (CPI) in Makassar City. Sediment sampling was carried out using a grab sampler at four stations, namely stastions on the island adjacent to the reclamation area and two other stations in the water around the reclamation area. The results showed that the bottom sediment in the waters around the reclamation area consisted of coarse sand and medium sand with an organic matter content of 14.92% in the sediment. On the islands adjacent to the reclamation area, the bottom sediments are move varied, consisting of coarse sand, medium sand and fine sand with lower organic matter content of 4.92% to 5.38%.

Keywords: Reclamation, Bed Sediment, Sand, Organic Content, Oceanographic Parameters.

INTRODUCTION

Reclamation is an area development effort by converting wetlands by stockpiling them so that later the land may be used for development activities. According to Presidential Decree No. 122 of 2012 concerning Reclamation in Coastal Areas and Small Islands (Article 1: Reclamation is an activity of utilizing land resources by means of confinement, land drying or drainage). The main objective of reclamation is to utilize a wetland into an area which used for various purposes as well as being a solution to increasing population growth and increasing land use in an urban area, as applied in Makassar City.

Currently Makassar City has carried out reclamation activities for the development of the Center Point of Indonesia (CPI) area. The planned land use area for the CPI area is 157 Ha with a distribution for the government of 50 Ha (32.00%) while for the private sector it is 107 Ha (68.00%), which will build as many as 12 facilities for public spaces (Alatas, 2017). Reclamation activities in urban coastal areas aside from providing the benefits of space availability for development will also cause negative sides (if not done wisely and with careful consideration) in the form of habitat and ecosystem changes such as environmental quality degradation, changes in current patterns, erosion and sedimentation which will damage ecosystems. beach. (Diposaptono, 2011) explains that all coastal buildings that protrude into the sea will disrupt the balance of longshore sediment transport (longshore currents) so as to reduce or stop the supply of sediment. One of the underwater conditions that is important to know in development planning is seabed sediment.

In a previous study conducted by Lanuru (2013) entitled "Modeling the distribution of suspended sediments in the CPI (Center Point of Indonesia) development area as an initial effort to mitigate damage to seagrass bed ecosystems" it can be seen the size of sediment particles, sediment types, and organic content. bottom sediment. This research was conducted in 2013, where the reclamation / stockpiling conditions in the city's coastal area had not been completely buried, and there had not even been development as it is today. The reclamation activities that have been going on for the last few years will definitely make changes to the ecosystem and sedimentation. Therefore there is a need for further studies on changes in bottom sediments after and before the Center Point of Indonesia (CPI) reclamation. This study aims to determine the distribution of bottom sediments due to reclamation in the waters of the Center Point of Indonesia (CPI) and to identify the distribution of bottom sediments before and after reclamation in the waters of the Center Point of Indonesia (CPI) development.

MATERIALS AND METHODS

The research was carried out in August 2021. The determination of stations was divided into 4 points (Figure 1) in the waters of Makassar City based on areas that might be affected by the Center Point of Indonesia (CPI) reclamation. Analysis of grain size and total organic matter of sediments was carried out at the Laboratory of Physical Oceanography and Coastal Geomorphology, Department of Marine Science, Faculty of Marine Sciences and Fisheries, Hasanuddin University.

Figure 1. Research location

Sampling Methods

Bottom sediment samples were taken using the Sediment grab sampler (Ekman Grab) as much as 500 gr collected from 12 points then stored in sample bags and brought to the laboratory for analysis of grain size and total organic matter content of the sediment.

The parameters measured in this research were current velocity, water depth and tides. Current velocity and depth were repeated three times at each sampling point. Measurement of current velocity was measured using a drift float then measuring the direction and time of travel of the drift float, the depth of the water was measured using a measuring line by sinking the rope until it reached the bottom of the water, then measuring the rope using a tape measure and observing tides for 39 hours with one hour intervals using the Doodson method.

Sample Analysis

Sediment Grain Size

Analysis for determining the grain size of the sediment was carried out using the dry sieving method. This method was used to determine the grain size of the sediment and the dominance of the sediment at each station (Lestaru et. al. 2018). Approximately 100 grams of dry sediment that has been weighed using an analytical balance as the initial weight was sifted for 10 minutes using a Sieve shaker. In the Sieve shaker there were Sieve nets arranged in layers with sizes (meshsize) of 2 mm, 1 mm, 0.5 mm, 0.25 mm, 0.125 mm and 0.063 mm. Any sediment fraction that remains on each sieve is weighed and classified according to the Wentworth scale. The results of the grain size analysis were continued with the help of the Gradistat program to determine the median and type of sediment.

Total Organic Matter (TOM)

Measurement of the organic matter content of the sediment was carried out using the Loss On Ignition (LOI) method. The LOI method aims to determine the content of organic matter by removing the organic matter contained in sediments through the combustion process (Desiani, 2013). The working procedure used in the analysis of the organic matter content of the sediment follows the work procedure (Lestaru, et. al. (2018) as much as 5 grams of sediment that has gone through the drying process as the initial weight (Wa) is put into a porcelain cup. The sample is then placed in the combustion using a tool Furnace at 650°C for 3.5 hours. This combustion process was aimed to obtain the value of organic matter contained in the sediment samples which will be lost during the combustion process. After reaching 3.5 hours the sample was removed then put into the desiccator, the desiccator functions as container to cool the sample. After going through the cooling process the sample was then weighed again the sample weight of the cup that has been in the furnace as the final weight (Wt).

Data Analysis

Data will be analyzed descriptively with the help of tables and graphs. The analysis used in this study was the Gradistat to determine the median 50 of the grain size of the sediment and the One Way Anova analysis to examine differences in sediment between stations.

Sediment Grain Size and Organic Matter Content

To determine the type of sediment based on grain size, the Wentworth scale was used (Table 1) (Hutabarat & Evans, 1985):

Table 1. Wentworth scale for classifying particles

Description	Size (mm)
Very Coarse Sand	1 – 2
Coarse Sand	0.5 – 1
Medium Sand	0.025 – 0.5
Fine Sand	0.125 – 0.25
Very Fine Sand	0.0625 – 0.125

Classification of the organic matter content is shown in Table 2 (Reynold, 1971)

Table 2. Criteria for the content of organic matter in sediments

Organic Content (%)	Criteria
>35	Very High
17 - 35	High
7 - 17	Medium
3.5 - 7	Low
<3.5	Very Low

RESULTS AND DISCUSSION

General Description of the Location

Makassar City is geographically located at 119°24'17'38" East Longitude and 5°8'6'19" South Latitude, and administratively has an area of approximately 175.77Km^2 consisting of 15 sub-districts and 153 villages (BAPPEDA, 2018). Makassar City is directly adjacent to the Makassar Strait, with a coastline of 32 km and has a cluster of coral islands of 12 islands popularly known as the Spermonde Archipelago. Based on the geographical location of Makassar City, this city deserves to be used as a *minapolitan* area (concept of marine and fishery development), through the Decree of the Minister of Maritime Affairs and Fisheries No. 32/MEN/ 2010 (Ruslin, 2017).

Currently Makassar City has developed reclamation activities, i.e., the construction of the Center Point of Indonesia (CPI). This reclamation activity was initiated by the Makassar City Government in order to make Makassar City as a strategic global business area (Aspan, 2017). Through the directives of the South Sulawesi Provincial Government regarding Governor's Decree No. 644/2013 which contains the granting of a beach reclamation permit in the Losari Beach area as part of the CPI and this project is inseparable from the 2009 Indonesian President's plan for the City of Makassar as a national strategic area with a planned project to build a state house in the Tanjung Bunga. In the waters of the CPI reclamation area, there is one of the canals that empties into the area, namely the Jongaya Canal. The Jongayya Canal has a length of 7.83 km which empties into the sea west of Makassar City (Dahlan, 2019). This canal functions as urban drainage and also as the main basis for flood control (Fisu, 2016).

Lae lae is a small island that is included in the Spermonde Archipelago in South Sulawesi. This island is 1.25 km from the City of Makassar. Lae lae Island is a high-density island where 0.22 km2 of the area is inhabited by 1.563 residents. On the island of Lae lae, there is a breakwater to protect the port of Makassar. The waters of Lae-lae Island is crowded with coral reefs and macro algae. The condition of the coral reefs on Lae-lae Island is arguably not good because of many community activities, both local residents and tourists. The abundance of macroalgae is dominated by *Sargassum* spp, *Turbinaria*, *Halimeda*, and *Caulerpa* (Zainuddin, 2012)

Similar to Lae-lae Island, Gusung Lae-lae Island also has a breakwater that functioned to protect the port of Makassar. Lae-lae Ca'di Island is located in Lae-lae has an area of ± 30,000 m2, this island is categorized as a small island. This area is located 1.6 km west of Makassar City. Geographically, Lae-lae Ca'di Island is located in the North Northeast – South Southwest 119º23'47.97” East Longitude and 5º 7' 19.86” South Latitude – 119º 23' 33.17” East Longitude and 5º 7' 42.25” South Latitude. (Harisuhud, 2013).

Oceanographic Parameter

Current Velocity and Depth

The results of measurement of oceanographic parameters at the observation locations is shown in Table 3. The results obtained from the current velocity measurement ranged from 0.036 – 0.132 m/s. Whereas, for the results of the depth measurements found values from 2.06 to 13.1m.

Table 3. Oceanographic parameter measurement results

Station	Sub Station	Physical Oceanographic Parameters	
		Current velocity (m/sec)	Depth (m)
CPI	1.1	0.036	1.63
	1.2	0.138	4.27
	1.3	0.035	12.65
Average		0.070	6.18
Lae-lae	2.1	0.041	3.90
	2.2	0.026	1.28
	2.3	0.041	1
Average		0.036	2.06
Gusung Lae-lae	3.1	0.060	0.59
	3.2	0.027	12.60
	3.3	0.310	2.43
Average		0.132	5.21
Outer Water	4.1	0.060	1.65
	4.2	0.132	17.97
	4.3	0.138	19.60
Average		0.110	13.1

Current velocity affects the size of sediment grains. Strong currents will deposit coarse sediment grains and weak currents will precipitate fine sediment grains (Ramli, 2017). Current speed measurements at the research location showed that the lowest current speed was 0.036 m/s at station 2 (Lae-lae) and the highest was 0.132 m/s at station 3 (Gusung lae-lae). According to Mason (1991) states that waters that have currents > 1 m/s are categorized as waters with very fast currents, water with current velocity > 0.5 – 1 m/s are categorized as fast currents, current velocity of 0.25 – 0, 5 m/s is categorized as slow current and current velocity <0.1 m/s is categorized as very slow current. Based on current velocity data at each station, the research location as a whole is included in very slow current flow category. The results of the current pattern model (current velocity and direction) at CPI after reclamation were carried out during semi-diurnal tide conditions. The results of the current pattern model are shown in Figure 2 at high tide and low tide conditions (Figure 3).

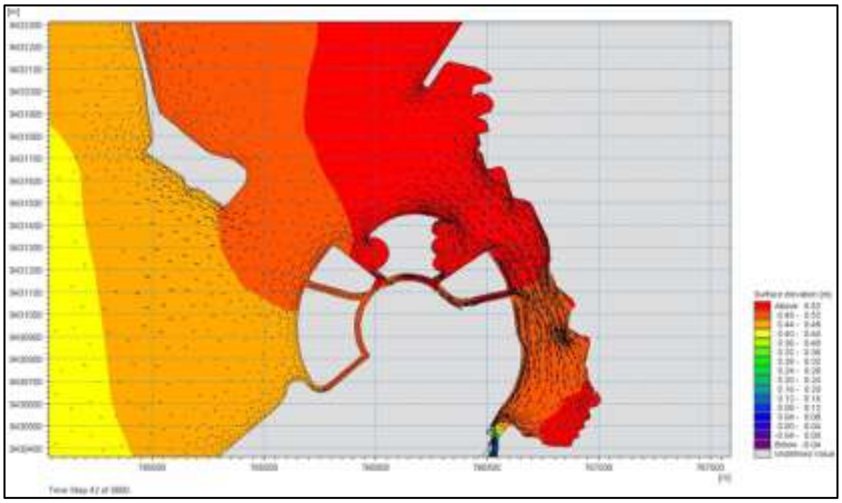

Figure 2. Hydrodynamic model of tidal current velocity and direction during high tide after CPI reclamation 2021 (Sahriadi, 2021).

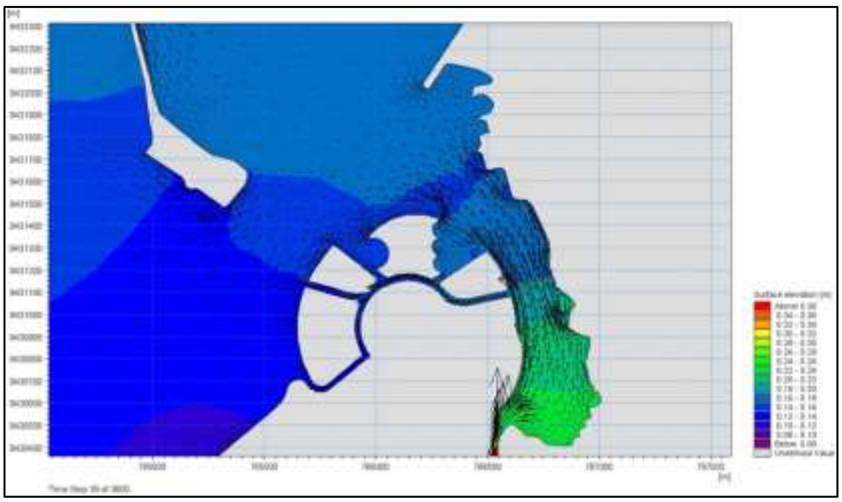

Figure 3. Hydrodynamic model of tidal current velocity and direction during low tide after CPI reclamation 2021 (Sahriadi, 2021).

The results of the current velocity model show that at high tide (Figure 2) it shows that the current comes from the north and then turns southeast to enter the bay with a speed of 0.44 – 0.52 m/s. At low tide (Figure 3) at station

1 (CPI) the current moves away from the coast or out of CPI towards the sea from the east with a speed (0.22 – 0.24 m/s) then heads northwest then turns towards southwest towards the open sea.

The results of the current velocity modeling using the RMA-2 model from the SMS program show that the current velocity in the Losari Beach area is very small both at high tide and at low tide. At low tide (Figure 5) the current speed in the lagoon area/Losari Bay averages 0.005 m/s while at high tide (Figure 4) the speed is around 0.009 m/s.

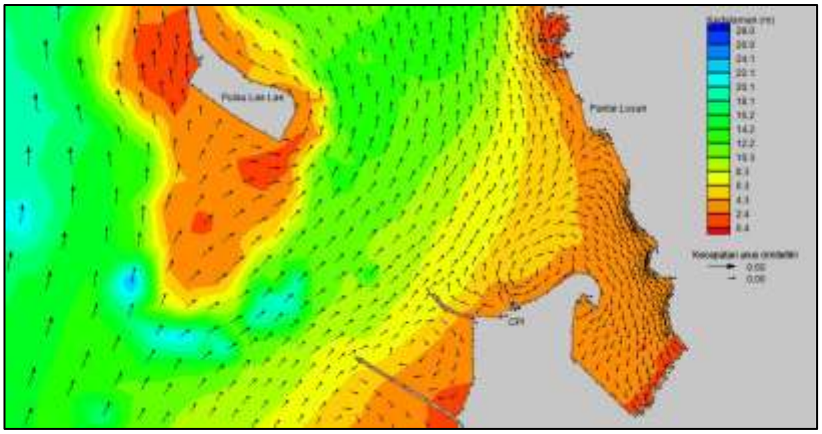

Figure 4. Hydrodynamic model of tidal current velocity and direction during high tide before CPI reclamation 2013 (Lanuru,2013).

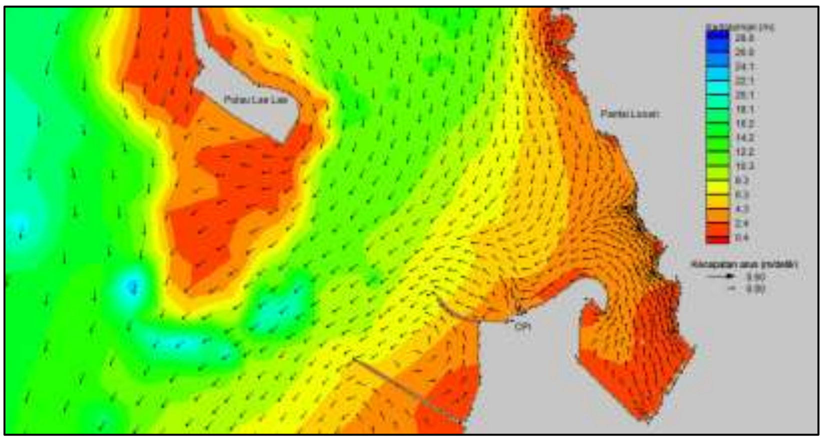

Figure 5. Hydrodynamic model of tidal current velocity and direction during low tide before CPI reclamation 2013 (Lanuru,2013)

Tides

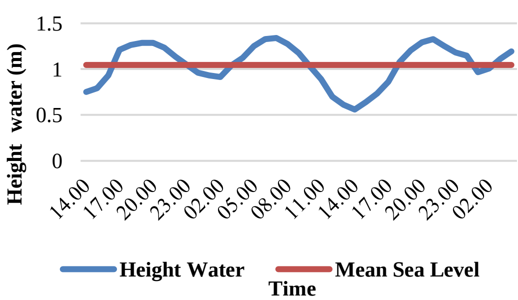

Figure 6. Tidal measurement

Based on tidal observations carried out for 39 hours using the Doodson method, it was found that the type of tide at the study site was a double daily tide (semi diurnal tide). According to Muhiddin (2020) Half daily tides (semi diurnal tides) are tides that occur twice as long as two highs and two lows in one full day (24 hours). The highest tide occurred at 07:00 am with a water level of 1.34 m and the lowest ebb occurred at 2 pm with a water level of 0.56 m. Thus, the value shows that the tidal range obtained is 0.78 m. Based on Doodson's analysis, the average water level (Mean Sea Level) is 1.04 m.

Bottom Sediment Distribution

Distribution of Grain Size

The results of grain size analysis after reclamation showed that the bottom sediment at the study site at station 1 (CPI) was dominated by medium sand and fine sand with grain size diameters ranging from 0.228 - 0.301 mm (Figure 7). This is influenced by the magnitude of the influence from the mainland in terms of stockpiling during reclamation activities which is thought to cause the type of sediment at this location to be dominated by medium sand, the input material from the reclamation development area falls into the waters through rain flow. This is similar to Anggari (2015) who found that the bottom of Tanjung Unggat waters contains coarse grain sizes, because at that location there is land reclamation which carries coarser particles through rain flow (run off) into the waters. Rifardi (2008) also explained that in general coarse-sized particles will be deposited at a location not far from the source.

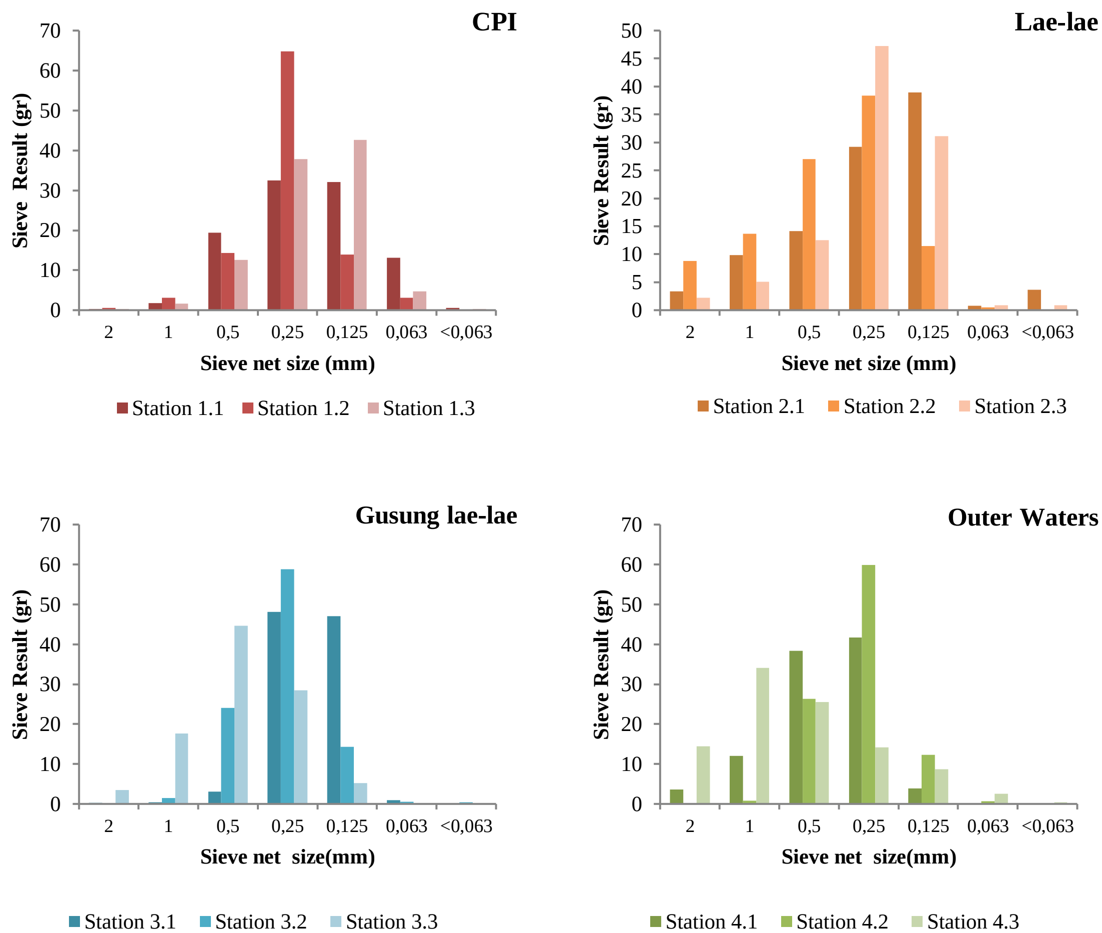

Figure 7. Distribution sediment grain size

At station 2 (Lae-lae), it is dominated by medium sand mixed with coral reef fragments and organism shells with grain size diameters ranging from 0.285 - 0.475 mm. The type of sediment at this station is influenced by the current speed. Based on current velocity observations at the time of the study, the current speed at this station is categorized as a very slow current, namely 0.036 m/s. Poerbandono and Djunarsjah (2005) state that large sediments tend to be resistant to current movement. The same thing was explained by Ramli (2017) that strong currents will deposit coarse sediment grains and weak currents will precipitate fine grained sediment grains.

The type of sediment at station 3 (Gusung lae-lae) is more varied compared to station 1 (CPI) and station 2 (Lae-lae), where fine sand, medium sand and coarse sand are found with grain size diameters ranging from 0.226 - 0.562mm. This is influenced by the sampling location which has a wide range of distances. At sub-station 3.1 which is on the east side of Gusung lae-lae island, the sediment is composed of fine sand, this is because the sampling location has a breakwater which affects the current speed. Anisa (2017) said that breakwater has an influence on changing the speed and direction of the current. Lanuru (2013) explains that waters that are protected or closed from the waves are relatively calm, calm waters allow fine sand and silt to settle. Sampling at substation 3.2 is on the south side of Gusung lae-lae island, the sediment type is composed of medium sand which is thought to be a mixture of the other two substations. At sub-station 3.3 the sediment is composed of coarse sand with a grain size diameter of 0.562 mm. The sampling location at substation 3.3 is on the west side of Gusung lae-lae island which is directly facing the sea or open water so that it affects the type of sediment. According to Nugroho and Basit (2014) explained that the closer to the mainland the finer the grain size of the sediment, while the grain size facing the open sea is coarser. At station 4 the outer waters, the sediment is basically composed of medium sand and coarse sand with grain size diameters ranging from 0.355 to 0.643 mm. The location of the station directly facing the sea or open water and adjacent to Lae-lae Island is thought to affect the type of sediment.

Comparison of Bottom Sediment Before and After Reclamation of Center Point of Indonesia

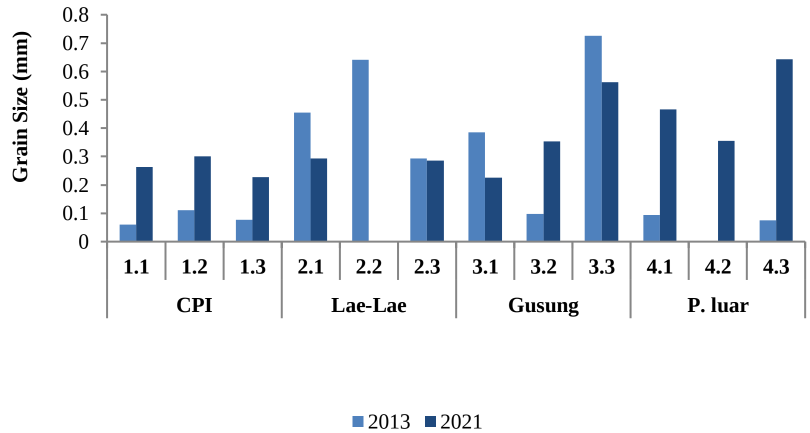

Figure 8. Ratio of sediment grain size distribution before (2013) and after CPI reclamation (2021)

The results of sediment data processing using Gradistat show that the study location is dominated by Medium Sand sediment types with a median ranging from 0.226 – 0.643 mm (Figure 8). The results of the gradistat are followed by One Way Anova analysis to see and test differences between stations. The results of the One Way Anova test showed that the grain size of the sediment (median) did not differ significantly between stations (P=0.258 or P>0.05)

Comparison of the distribution of bottom sediments before and after reclamation based on grain size shows that changes have occurred at several stations. At station 1 (CPI) and station 4 (outer waters) there was a change in grain size and type of sediment, while at station 2 (Lae-lae) and station 3 (Gusung lae-lae) the changes were relatively small. However, based on the pattern of distribution of bottom sediments at each station there is a difference at station 3 (Gusung-lae-lae) where at substation 3.2 there is a change in the size and type of sediment. This is presumably because substation 3.2 has a breakwater. Harisuhud (2013) said that the morphology of the Lae-lae and Gusung lae-lae islands had been engineered by building a barrier wall for wave-retaining purposes so that it could affect current speed.

At station 1 (CPI) there was a change in grain size and type of sediment, from very fine sand to medium sand. The changes that occur are most likely influenced by changes in current speed before and after reclamation, which was before reclamation the current speed in the lagoon/Losari Bay area at low tide averaged 0.005 m/s (Figure 5) and at high tide the speed was around 0.009 m/s (Figure 4). Whereas after reclamation, the current velocity is 0.20 – 0.30 m/s at low tide (Figure 3) and 0.44 - 0.48 m/s at high tide (Figure 2). The change in current speed occurs due to a narrowing that occurs on the east side of the CPI reclamation area resulting in an increase in current speed. Saraswati (2018) said that there was a change in current speed in the reclamation area due to changes in land area. Marpaung (2016) also explained that a smaller area causes a successive increase in current velocity. This affects the grain size and type of sediment at station 1 (CPI). Wisha, et. al. (2017) stated that sand sediments that have large grain sizes tend to be resistant to current movement so they are not transported following the speed and direction of the current.

At station 4 (outer waters) based on the grain size and type of sediment there is a change. The research conducted in 2013 was dominated by very fine sand, while in this study it was composed of medium sand and coarse sand. Based on the current pattern presented in Figure 2 and Figure 3, it is explained that the pattern of current movement during low tide conditions moves away from the coast or out of the CPI towards the sea from the east then heads northwest then turns southwest towards the open sea. Based on this, the type of sediment at station 4 (outer waters) is influenced by Lae-Lae Island and CPI reclamation.

Organic Matter Content

The organic content of the sediments in the study locations varied from 3.74 to 16.53% (Figure 9).

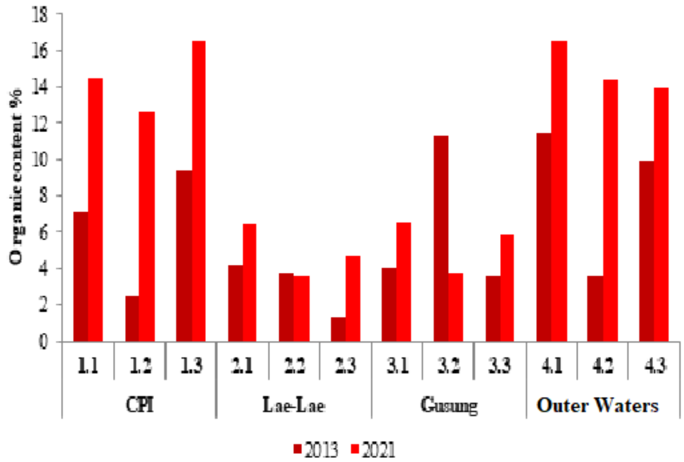

Figure 9. Organic content before (2013) and after CPI reclamation (2021)

The organic content of the sediments in the study locations varied from 3.74 to 16.53% (Figure 9). At station 1 (CPI) 14.54% and station 4 (outside waters) 14.92% had the highest organic content compared to station 2 (Lae-lae) 4.92% and station 3 (Gusung lae-lae) 5.38 %. Based on the criteria for organic matter content in sediments, Reynold (1971) categorized the organic matter content >35% as very high, 17-35% high, 7-17% medium, 3.5-7% low and <3.5% very low. . Based on this, at station 1 (CPI) and station 4 (outer waters) the organic matter content is categorized as medium and station 2 (Lae-lae) and station 3 (Gusung lae-lae) are categorized as low.

In research conducted in 2013 (before reclamation), the organic matter content of the sediments at the study sites varied from 0.81% to 14.50%. The comparison of organic matter content presented in Figure 5 shows an increase in organic matter content at station 1 (CPI) and station 4 (outer waters). The increase in organic matter at station 1 (CPI) is caused by human activities which continue to increase every year such as hotel waste disposal around the CPI reclamation area. The Losari Beach area has 11 hotels and 1 home stay and various places to eat, both street vendors, food stalls, cafes and restaurants as well as public facilities such as hospitals (Suriadi, 2015). Mushthofa et. al. (2014) explained that the high content of organic matter entering the waters comes from increased activities on land such as accumulation in rice fields and ponds, cultivation, industry and household activities that enter the waters. Apart from the fact that the location of the station is close to land, reclamation activities also have an impact on increasing organic matter content, both during dredging and stockpiling. Taking sand material taken from other places that contain a lot of organic matter and stockpiling it in the CPI reclamation area can increase its organic matter content because sediment can bind organic matter. In accordance with the statement, Arisa et. al. (2014) which stated that sediment particles can bind organic matter in both small and larger sediments. On the other hand, the sampling location at station 1 (CPI) has one of the canals that empties into the area, namely the Jongaya canal. Dahlan (2019) explains that Makassar City has three canals with a total length of 15.11 km, one of which is the Jongayya Canal 7.83 km which empties into the sea west of Makassar City. The Jongaya Canal which functions as urban drainage certainly carries organic matter content from the result of household waste disposal so that it can increase the organic matter content at station 1 (CPI).

At station 4 (Outer Waters) the increase in organic matter content is thought to have received input from the reclamation of CPI and Lae-lae Island which was carried away by current movements. Based on the current pattern (current speed and direction) during low tide conditions presented in Figure 3, it shows that the current speed is getting weaker from the coast towards the sea. Daulat et. al. (2014) explained that the lack of influence from currents can also affect the high concentration of organic matter where organic matter will settle faster because the currents are unable to carry it further out to sea. Duarte (2005) emphasized that the total organic matter in a waters is influenced by several factors, including; patterns of water currents, water bathymetry, aquatic substrates, anthropogenic influences originating from human activities and aquatic environment vegetation.

CONCLUSION

CPI Reclamation has an impact on current velocity and distribution of bottom sediments. At station 1 (CPI) the sediment is composed of medium sand and fine sand with a sediment organic matter content of 14.54%, at station 2 (Lae-lae) the sediment is composed of medium sand with a sediment organic matter content of 4.92%, at station 3 (Gusung lae-lae) the sediment is more varied than the other stations, the sediment is composed of fine sand, medium sand and coarse sand with an organic matter content of 5.38% and at station 4 (outer waters) the sediment is composed of medium sand and fine sand. crude with an organic matter content of 14.92%. The Center Point of Indonesia (CPI) reclamation development has had an impact on grain size, sediment type and organic matter content at station 1 (CPI) and station 4 (outer waters).

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