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CORRELATION BETWEEN CADMIUM CONCENTRATION AND TOTAL ORGANIC MATTER IN SEDIMENTS AT TALLO ESTUARY, MAKASSAR CITY, INDONESIA

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ABSTRACT

This study aims to determine the distribution and relationship between the concentration of cadmium metal (Cd) and total organic matter (TOM) in sediments in the Tallo estuary, Makassar City. The study collected sediment samples from 12 points, distance of 500m between points sampling. Furthermore, 12 sediment samples were analyzed for Cd and TOM concentrations in the laboratory. The results of measurements of Cd metal in sediments showed concentrations ranging from 0.001 - 0.037 mg/kg. The concentration of Cd metal found was still in the low category. While the concentration of TOM in sediment ranges from 6.7 -30.3%, indicating a low concentration. The distribution of Cd and TOM showed that the farther from the estuary, the lower the concentration. Based on the results of the regression test, the relationship between Cd and TOM concentrations was 80.1%. This shows that the accumulation of Cd metal in Tallo River sediments is strongly influenced by the concentration of organic matter.

Keyword: Cadmium; sediment; total organic matter; Tallo, estuary

INTRODUCTION

The coastal area of Makassar city is an area with a fairly high population. Coastal areas are rich in resources and have high economic value, such as ports, industrial areas, recreation and tourism. Various human activities that take place on land have an impact on waters, for example waste that is discharged through rivers will flow into the sea. The flow of the Tallo River is optimally utilized for water transportation, the tourism industry, water assets, and the cultivation of the fishery sector. Of course, this will be a particular concern in the position of the hydroponic sea zone and fishing areas around river mouths. Pollution that occurs is generally caused by various causes, dominated by the surrounding residential areas and the disposal of company waste that is around the river.(Jais et al., 2020). Some activities around the Tallo River can produce cadmium metal pollution such as the use of paint and batteries, where this metal can trigger several abnormal conditions in the human body such as damage to the heart, liver, lungs, kidneys, bones, mutagenesis, cancer which can lead to death. in humans (Sutrisno & Kuntyastuti, 2017).

The river estuary is the downstream part of the river which is directly related to the sea which has a function as a discharge or disposal of river water discharge coming from upstream. On the other hand, the river estuary is also used as a medium for the entry and exit of fishing boats (Hamdini & Kasman, 2017). The existence of fishing boats in the estuary produces liquid and solid waste from boat washing, engine cooling and garbage disposal which can affect oceanographic conditions around the estuary causing increased levels of organic and inorganic matter in the waters. Apart from organic matter, one of the pollution factors in the waters is metals. Metal compounds dissolved in water are adsorbed by particulates and precipitated in sediments. Metals contained in the water column will undergo a process of combining with other compounds, both organic and inorganic (Akbar et al., 2016).

Organic matter provides the basis of nutrition and energy for micro and microorganisms, has a major impact on the speciation of many metals by processes such as complexation and adsorption. Fine sediment particles have a good ability to bind metals in sediments and accumulate organic matter, because fine sediment particles have a large area. a large surface area with a more stable ionic density for binding metals than coarser sediment particles (Maslukah, 2013). In sediments currents are the initial movers of the movement of heavy metals in the waters, where Currents carry particles that float on water bodies and sediments at the bottom of the waters (Garvano et al., 2017). The distribution of sediments, pollutants, and biotic communities in a body of water will depend on its hydrodynamic conditions (Sukarno & Yusuf, 2013).

Cadmium metal (Cd) is a metal that is abundant in the aquatic environment with a very toxic effect even at low concentrations (Rumahlatu et al., 2012). Compared to other metals such as Pb and Cu, Cd metal is difficult to degrade so it is cumulative and very toxic to humans because it causes kidney function disorders and damages the aquatic environment. Pollution from Cd metal is caused by human activity, industrial waste, factory waste, and others. Exposure to Cd contamination can cause effects that can cause death if exposed in large quantities resulting in an imbalance in aquatic organisms (Setiawan, 2013). Setiawan's research (2013) states that the content of heavy metal Cd in the waters around the mouth of the Tallo River is 0.729 ppm. The results of this study are lower when compared to the results of a study conducted by Samawi, et al., (2020) which stated that the concentration of the heavy metal Cd in the water at the mouth of the Tallo River was 0.04 mg/l. . Based on the guidelines for environmental quality standards according to the Decree of the State Minister for the Environment Number: 51 of 2004 concerning seawater quality standards, the threshold for Cd in seawater for marine tourism is 0.002 ppm, for marine biota is 0.001 ppm and for port waters. is 0.01 ppm. Thus the waters at the mouth of the Tallo River have a Cd content above the normal threshold.

Based on the above description, looking at the condition of the waters at the mouth of the Tallo River which are increasingly indicating pollution caused by waste metal Cd, a study was conducted to determine the distribution of cadmium metal in sediments and its relationship to the concentration of total organic matter at the mouth of the Tallo River. The purpose of this research is to provide information about the distribution of Cd content and concentration of total organic matter in sediments at the mouth of the Tallo River. The literature review that the author uses is based on literature relating to Heavy Metals, Metal Cadmium (Cd), Sedimentation, Metal Content in Sediments. Then a review of the literature regarding the environmental parameters that the authors use relates to Total Organic Matter (TOM), Current Velocity, Temperature, Salinity, Degree of Acidity (pH), Eh.

MATERIALS AND METHODS

This research was conducted from June-December 2022. The sampling location was carried out in the waters of the Tallo River estuary, Makassar City, Indonesia. Sample analysis was carried out at the Chemical Oceanography Laboratory, Faculty of Marine Science and Fisheries, Hasanuddin University and Makassar Health Laboratory Centre.

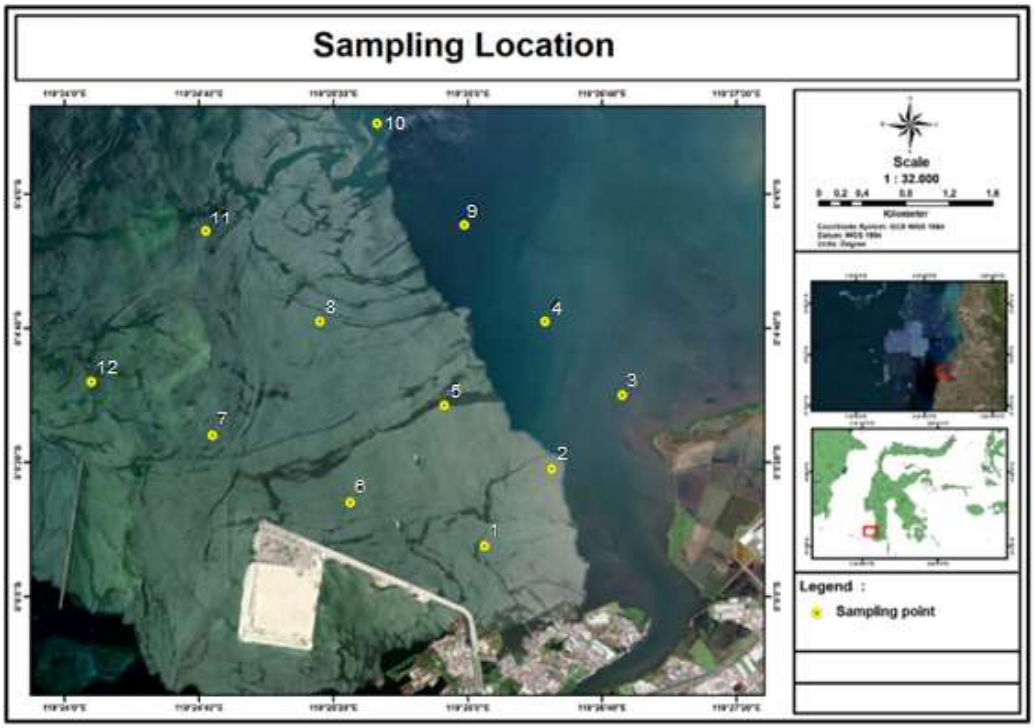

Figure 1. Sampling location in Tallo Estuary waters

This study uses several sampling and analysis tools, namely GPS to determine the position of the sampling point. Ekman dredge to take sediment samples, Inductively Coupled Plasma - Optical

Emission Spectrometer (ICP-OES) to determine Cd concentration in sediments, Digital thermometer to measure water temperature, Hand refractometer to measure salinity, pH meter to measure water pH, Eh meter to measure redox potential sediment, and the Current meter measures current velocity.

Sampling of marine sediments was carried out at 12 sampling points in areas affected by Cd sources around the Tallo River Estuary. At each point the sampling was carried out using the Eijkman Grab, sediment samples were taken in the middle of the Eijkman grab to avoid tool contamination. Then the sample is put into a sample bag and put in a cool box, then taken to the laboratory for analysis. Measurements of current velocity, temperature, salinity and degree of acidity (pH) and Eh were carried out directly at each point together with sediment sampling. Sample analysis of the total organic matter content (TOM) of the sediment was carried out using the Loss on Ignition (LOI) method based on the procedure of Allen et al., (1974). Furthermore, an analysis of the content of Cd metal in sediments was carried out using the wet destruction method (Loring and Rantala 1977) and measured using ICP-OES. The data obtained were analyzed in the form of distribution of Cd metal using maps and analysis of the relationship between Cd and Total Organic Matter (TOM) using simple linear regression.

RESULTS AND DISCUSSION

Result

Content and distribution of Cd metal in sediments

The results of analysis of the content of Cd metal in sediments are shown in the graph in Figure 2 which shows the results for the value of each sampling point. The highest concentration value was found at point 2 of 0.037 mg/kg and the lowest average value was 0.01 mg/kg at points 8, 11 and 12 at the mouth of the Tallo River.

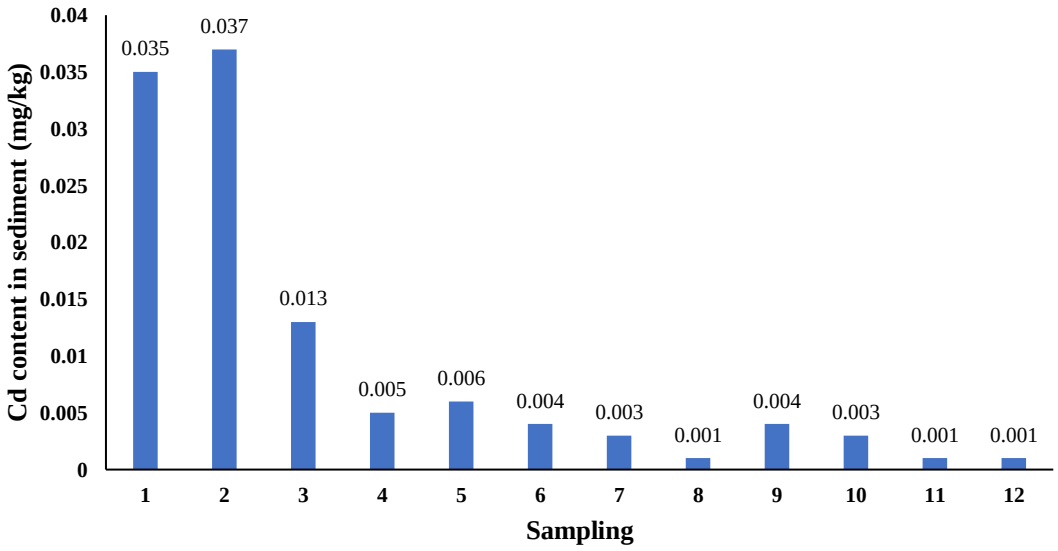

Figure 2. Cd metal content in sediment (mg/kg) at the Tallo Estuary

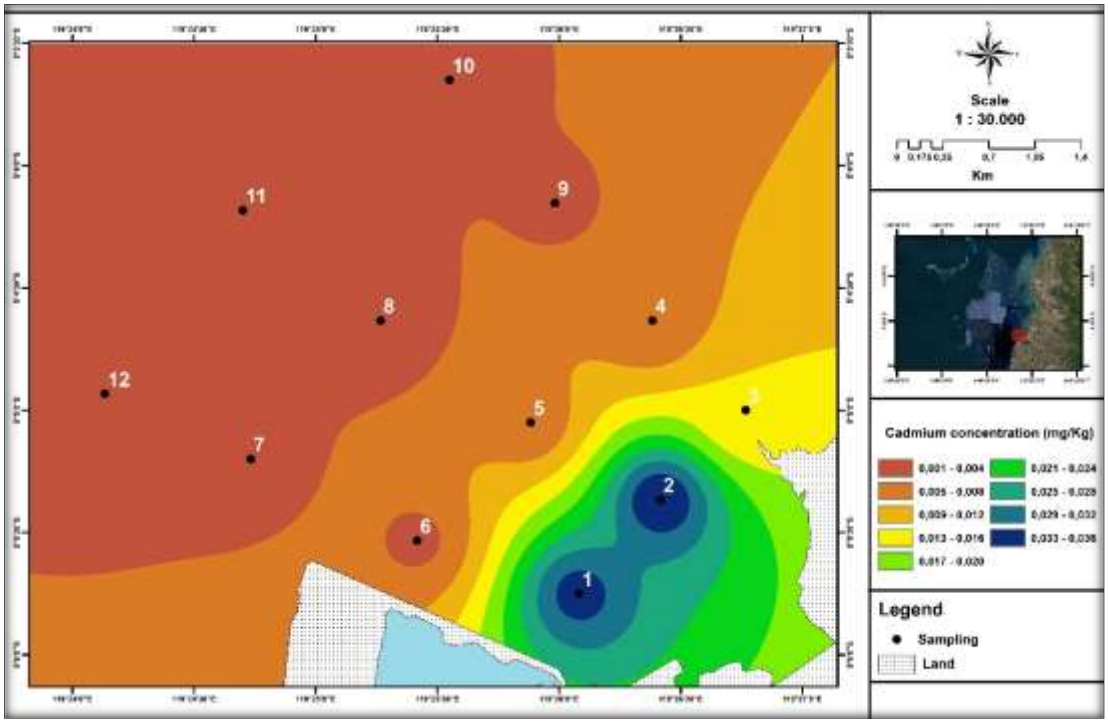

Figure 3. Distribution of Cd Metal in Sediments at the Tallo Estuary

Content and distribution of Total Organic Matter (TOM) in sediments

The results of the analysis of Total Organic Matter in sediments are shown in the graph in Figure 4 which shows the results for the value of each point. The highest concentration value is at point 2 of 30.15% and the lowest average value is 6.70% at point 12 at the mouth of the Tallo River.

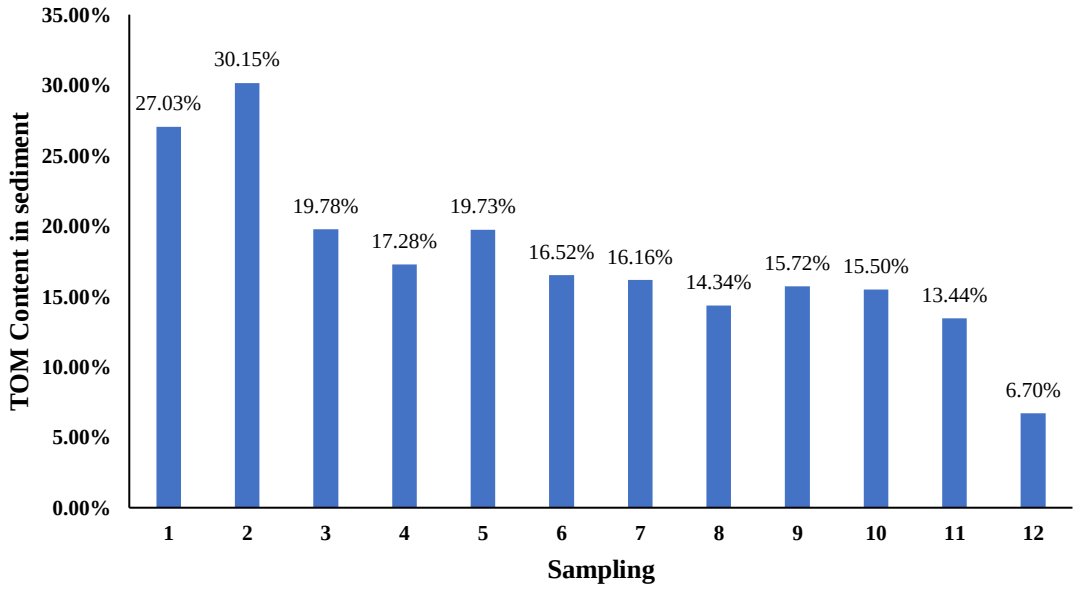

Figure 4. TOM content in sediments at the Tallo Estuary

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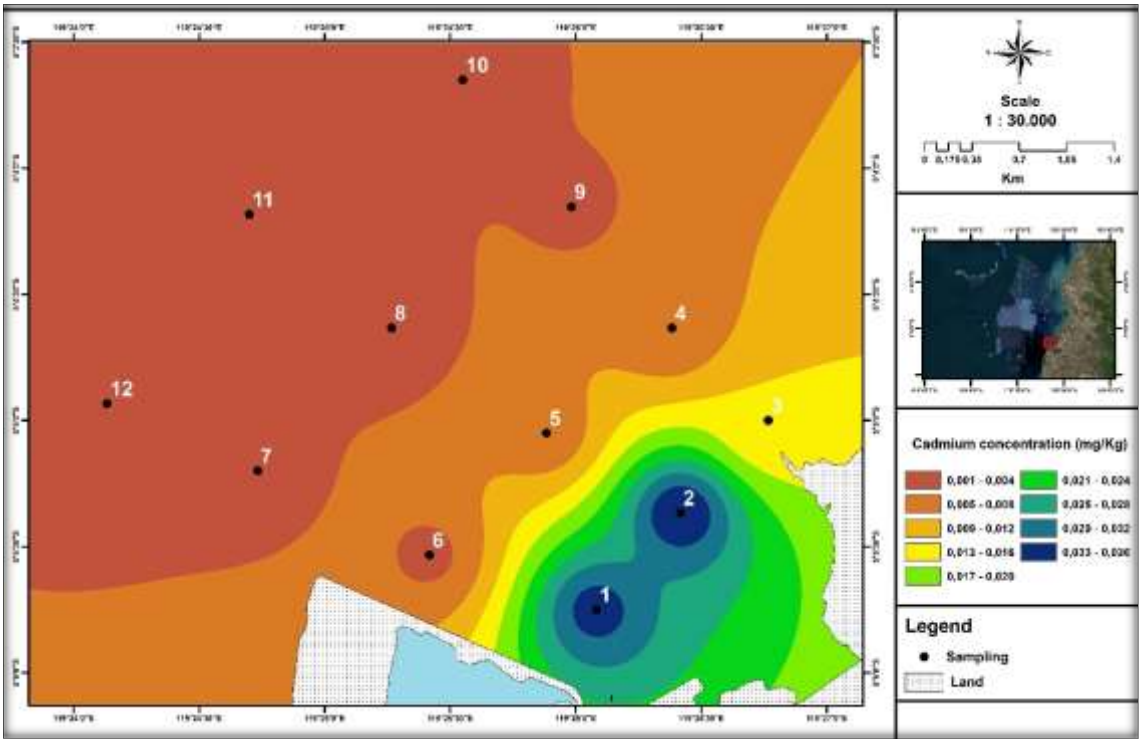

Figure 5. Distribution of TOM in sediment at the Tallo Estuary

Relationship between total organic matter and cadmium content in sediments

Data analysis was carried out to see the relationship between Cadmium (Cd) metal and total organic matter, a simple linear regression test show that cadmium metal (Cd) has a value (r) of 0.816 which means it is very strong against total organic matter. Where the higher the BOT content, the Cd content of the sediment increases

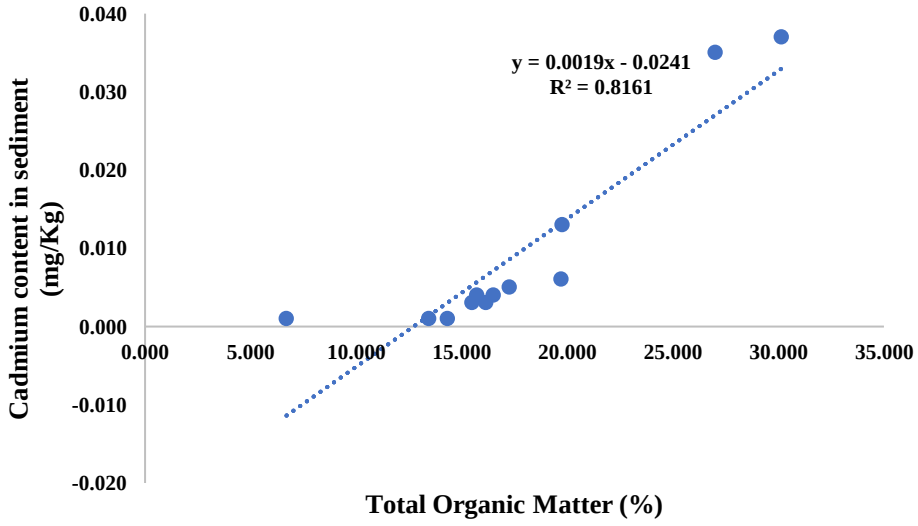

Figure 6. Relationship between Cd and Total organic matter

Oceanographic parameters

The results of oceanographic parameter measurements can be seen in Table 2. Temperature parameters range from 30-32ºC. Salinity ranges from 30-34 ppt. Current velocity shows a speed ranging from 0.024-0.117 m/s. The degree of acidity of the waters was obtained in the range of 6.54-7.68 and the redox potential (Eh) values of the sediments ranged from -202 to -138 mV.

Table 2. Oceanographic Parameters in Tallo Estuary

Sampling point	Temperature (°C)	Salinity (‰)	Current (m/s)	pH	Eh (mV)
1	31	34	0.052	6,54	-175
2	31	31	0.049	6,86	-202
3	32	32	0.117	6,80	-170
4	32	31	0.111	7,15	-181
5	31	32	0.072	7.03	-197
6	31	31	0.036	7,53	-188
7	31	33	0.049	6,91	-161
8	31	32	0.024	7,15	-146
9	31	33	0.037	7,34	-165
10	31	30	0.074	7,68	-156
11	31	30	0.069	7.06	-186
12	30	32	0.044	7,21	-138

Discussion

Based on the results of a simple linear regression test, Cd metal with total organic matter has a correlation (r) of 0.903, meaning that the accumulation of Cd metal in sediments is strongly influenced by organic matter content. Thus the total organic matter increases, the higher the concentration of Cd metal in the sediment. This is in accordance with Maslukah's research (2013) which states that organic matter is the most important geochemical component in controlling the binding of heavy metals from estuarine sediments. Meanwhile Najamuddin et al., (2020) argued that heavy metals in waters are easily bound to organic matter which causes dissolved heavy metals to turn into heavy metals in the form of particles and accumulates in the bottom of aquatic sediments.

In general, the heavy metal Cd is produced from human activities in the form of industrial activities such as fiber shipbuilding. Cd metal will enter the waters and gradually accumulate which then has a negative impact on aquatic biota. The results of measurements of Cd concentration in sediments at the mouth of the Tallo River ranged from 0.001 to 0.037 mg/kg. Based on the ANZECC and ARMCANZ (2000) quality standards, the heavy metal Cd in sediments is 1.5 mg/kg, this indicates that the content of Cd metal in the Tallo River estuary is still relatively low. However, Cd metal that accumulates in sediments can be very toxic which will be dangerous if it accumulates in the bodies of aquatic biota and contaminates aquatic ecosystems. According to Indirawati (2017), that cadmium metal (Cd) is one of the very dangerous heavy metals in marine waters which if it is in certain concentrations it will be very dangerous for aquatic organisms and even for human health. .

The high Cd metal in this study was in a position near the estuary reaching 0.035 mg/kg and 0.037 mg/kg, due to its position close to the shipyard where it is suspected that waste from the use of paint entered the river. While the low content of metal (Cd) in a position far from the estuary compared to others, this is thought to be due to fewer human activities in that location and its location far from land. Based on the results of research by Setiawan (2015) and Samawi et al (2020), Cd concentrations were found in sediments at the Tallo River estuary of 5.16 mg/kg and 0.22 mg/kg. Thus there has been a decrease in the content of Cd metal in sediments in the Estuary of the Tallo River, this is presumably due to the processing of waste carried out by the industry in the KIMA area before being discharged into the stream which empties into the Tallo River.

The presence of Cd metal in sediments is influenced by parameters such as temperature, salinity, and pH of the waters. Water temperature measurements at each sampling point did not show a large variation, namely with a temperature range of 30 – 32ºC. An increase in water temperature can cause the solubility of heavy metals, so that the metal content in the waters increases. In accordance with the statement of Rachmawatie et al., (2009) which explained that a decrease in water temperature will increase the adsorption of heavy metals into particulates that settle to the bottom of the waters.

The solubility of heavy metals is also caused by the influence of the pH of the waters. The pH value obtained from this measurement is in the range of 6.54 – 7.68, which means that the pH at the observation site is in accordance with government

regulation number 82 of 2001, for pH parameter values between 6 – 9. According to Parawita et al., (2009) Heavy metals can experience displacement due to deposition in sediments or the bottom of the waters. In low pH conditions (acidic) it will cause the solubility of heavy metals to increase because heavy metals in waters are present in the form of free ions, paired with organic ions and inorganic ions. In accordance with the statement of Budiastuti et al., (2015) that low pH levels will result in high solubility of metals in waters.

Another factor that also affects metal solubility is salinity. Heavy metals dissolved in water bodies naturally take the form of free ions, inorganic ion pairs, inorganic and organic complexes. Cd cations dissolved in seawater will interact with existing anions to form inorganic complexes thereby reducing the presence of Cd ions in free form. (Yudiati et al., 2012). At low salinity there will be an increase in free Cd cations, because relatively few complex ions are formed. According to the statement of Budiastuti et al., (2015) the lower the salinity, the higher the toxicity and accumulation of heavy metals. It can be seen in Figure 2 that the concentration of Cd metal was 0.037 mg/kg higher at sampling point 2 with low salinity conditions of 29 ppt.

Another process that causes the movement of metal particles is current velocity. The high concentration of Cd metal at point 2 is caused by the low current velocity resulting in metal accumulation. In addition, point 2 is an estuary water area so that the movement of water masses decreases and the current velocity decreases. Rustiah et al., (2019) in their research found that when the current speed is weak, Cd metal will settle to the bottom of the water sediments. This is in line with the results obtained at point 2 with a Cd metal content of 0.037 ppm where the current speed is 0.049 m/s. In addition, current speed also affects the concentration of total organic matter, according to Putri et al., (2014) Accumulation of organic matter on the seabed is caused by low current velocity, low currents will accelerate the process of accumulation of organic matter and other particles at the bottom of the waters. .

The total organic matter content at the study sites is shown in Table 3 with the highest values at side points 1 and 2 with values of 27.03% and 30.15%, while the lowest values are found at sampling point 12 of 6.70%. Increasing the total organic matter content has an effect on increasing the concentration of Cd metal, according to the statement of Najamuddin et al., (2020), organic matter can bind heavy metals in sediments to form complex bonds so that the concentration of organic matter is higher. organic matter content in the sediment, the more pollutant concentration will increase the heavy metals in the sediment. The process of accumulation of total organic matter in sediments is related to the redox potential. Based on the redox potential value of the sediment, it can be seen that a waters has experienced enrichment of organic matter (Paena et al., 2014). Regarding the accumulation of organic matter Pearson & Stanley (1979) determined a redox potential value of -150 mV as an indicator of the period of accumulation of organic matter in sediments over a long period of time. The Eh value in sediments affects the concentration of metals accumulated in sediments, a low redox potential value will increase the value of heavy metal concentrations (Najamuddin et al., 2020).

Thus, the accumulation of Cd metal in marine sediments is closely related to the presence of organic matter and is supported by other oceanographic parameters such as current velocity, salinity, and water temperature.

CONCLUSION

Based on the discussion, it is concluded that the concentration of Cd and organic matter in marine sediments near the estuary is higher than outside the estuary. The relationship between Cd concentration and sediment organic matter has a strong correlation, so that the high accumulation of Cd metal in Tallo estuary sediments is strongly influenced by the concentration of organic matter in the sediments. In addition, the parameters of current velocity, salinity and temperature also affect the binding of Cd metal in sediments.

REFERENCES

Akbar, A., Wulandari, S. Y., & Maslukah, L. 2016. Konsentrasi Bahan Organik Total (Bot) Dan Logam Berat Timbal (Pb) di Sedimen Perairan Pantai Tasikagung, Rembang. 5, 496–503.

Allen, S.E., H.M. Grimshaw., J.A. Parkinson and C. Quarmby. 1974. Analysis of Soil in Chemical Analysis of Ecological Materials. Oxford, Blackwell Scientific Publication, Oxford.

ANZECC and ARMCANZ. 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Australia.

Budiastuti, P., Raharjo, M., & Nikie, D. 2015. Analisis Pencemaran Logam Berat Timbal di Badan Sungai Babon Kecamatan Genuk Semarang. Riskesdas,(3), 103–111.

Garvano, M. F., Saputro, S., Hariadi. 2017. Sebaran Kandungan Logam Berat Timbal (Pb) Pada Sedimen Dasar di Sekitar Perairan Muara Sungai Waridin, Kabupaten Kendal. 6, 100–107.

Indirawati, S.M. 2017. Pencemaran Logam Berat Pb dan Cd dan Keluhan Kesehatan Pada Masyarakat di Kawasan Pesisir Belawan. Jurnal JUMANTIK (2): 54-60.

Jais, N. J., Ikhtiar, M., Gafur, A., Hasriwiani Habo Abbas, & Hidayat. 2020. Bioakumulasi Logam Berat Kadmium (Cd) dan Kromium (Cr) yang Terdapat dalam Air dan Ikan di Sungai Tallo Makassar. Window of Public Health Journal, November, 1 (3): 261–274.

Loring, D.H. and R.T. Rantala. 1977. Geochemical analysis of marine sediment and suspended particulate matter. Technical Report No.700. Fisheries and Marine Service. Environmental Canada.

Maslukah, L. 2013. Hubungan antara Konsentrasi Logam Berat Pb, Cd, Cu, Zn dengan Bahan Organik dan Ukuran Butir dalam Sedimendi Estuari Banjir Kanal Barat, Semarang. Buletin Oseanografi Marina Juli, 2, 55–62.

Najamuddin, N., Tahir, I., Paembonan, R. E., & Inayah, I. 2020. Pengaruh Karakteristik Sedimen terhadap Distribusi dan Akumulasi Logam Berat Pb dan Zn di Perairan Sungai, Estuaria, dan Pantai. Jurnal Kelautan Tropis, 23(1): 1-14.

Paena, M., Kamariah, Asaf, R. 2014. Distribusi Potensial Redoks Sedimen Di Perairan Teluk Gayau, Kabupaten Pesawaran, Provinsi Lampung. 425–431.

Parawita, D. I Insafitri, W. A. Nugraha. 2009. Analisis Konsentrasi Logam Berat Timbal (Pb) Di Muara Sungai Porong. Jurnal Kelautan (2)2: 117-124.

Putri, Z.L., S.Y. Wulandari, L. Maslukah. 2014. Studi Sebaran Kandungan Logam Berat Timbal (Pb) Dalam Air Dan Sedimen Dasar Di Perairan Muara Sungai Manyar Kabupaten Gresik, Jawa Timur. Journal of Oceanography, 3 (4): 589 – 595,

Rachmawatie. Hidayah,Z. Abida, I.W. 2009. Analisis Konsentrasi Merkuri (Hg) dan Kadmium (Cd) di Muara Sungai Porong Sebagai Area Buangan Limbah Lumpur Lapindo. Jurnal Kelautan: Vol 2(2): 125-134.

Rumahlatu, D., Corebima, A. D., Amin, M., Rachman, F. 2012. Kadmium dan Efeknya terhadap Ekspresi Protein Metallothionein pada Diadema setosum (Echinoidea; Echinodermata). Jurnal Penelitian Perikanan, 1(1): 26–35.

Samawi M. F., Werorilangi S., Isyrini R., Hendra, 2020 Bioavailability exchangeable phase of heavy metals in sediments and contamination in shellfish at estuaries on the west coast of South Sulawesi, Indonesia. AACL Bioflux 13(4):2365-2374.

Setiawan, H. 2013. Pencemaran Logam Berat Di Perairan Pesisir Kota Makassar Dan Upaya Penanggulangannya. Info Teknis EBONI, 11(1): 1–13.

Sukarno, M., Yusuf, M. 2013. Kondisi hidrodinamika dan pengaruhnya terhadap sebaran parameter fisika-kimia perairan laut dari muara sungai Porong, Sidoarjo. Buletin Oseanografi Marina. 2: 1-6.

Sutrisno, & Kuntyastuti, H. 2017. Pengelolaan Cemaran Kadmium Pada Lahan Pertanian Di Indonesia. Pengelolaan Cemaran Kadmium Pada Lahan Pertanian Di Indonesia, Buletin Palawija. 13(1): 83–91.

Yudiati, E., Sedjati, S., Enggar, I., & Metoda, M. 2012. Dampak Pemaparan Logam Berat Kadmium Pada Salinitas yang Berbeda Terhadap Mortalitas Dan Kerusakan Jaringan Insang Juvenile Udang Vaname (Litopeneus Vannamei). Ilmu Kelautan: Indonesian Journal of Marine Sciences, 14(4): 29–35.