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Distribution of Plumbum (Pb) and Cadmium (Cd) Concentrations on Particle Size and Sediment Depth Variation in Paotere Port Makassar, Indonesia

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ABSTRAK

Analisis kandungan logam berat Pb dan Cd pada berbagai ukuran partikel sedimen di perairan Pelabuhan Poatere Makassar telah dilakukan. Sampel sedimen diambil dengan menggunakan pipa polietilen dengan berbagai kedalaman. Sampel diayak menggunakan ayakan mekanik ukuran 1000, 250 dan 63 µm. metode analisis yang digunakan adalah *Atomic Absorption Spectroscopy* (AAS) yang sebelumnya didestruksi menggunakan *Microwave* dengan penambahan HNO_3 pekat. Sebaran ukuran partikel pada sedimen permukaan pada perairan Pelabuhan Paotere yaitu untuk ukuran partikel 250 – 1000, 63 – 250 dan 63 µm berturut-turut adalah 36,04%; 29,51% dan 10,07%. Kandungan logam berat Pb dan Cd meningkat seiring semakin kecilnya ukuran partikel sedimen. Konsentrasi logam berat Pb dan Cd pada ukuran partikel > 250 – 1000 masing-masing yaitu 42,63 dan 2,94 mg/kg, ukuran partikel > 63 – 250 yaitu 56,14 dan 2,95 mg/kg , ukuran partikel < 63 yaitu 142,31 dan 4,31 mg/kg. Kandungan logam berat Pb dan Cd menurun sejalan dengan bertambahnya kedalaman sedimen. Kandungan logam berat Pb dan Cd pada kedalaman 0 - 10 cm masing-masing 82,43 dan 4,33 mg/kg, kedalaman 10 – 20 cm yaitu 79,09 dan 3,05 mg/kg, dan kedalaman 20 – 30 cm yaitu 74,59 dan 2,82 mg/kg.

Kata kunci : AAS, kadmium (Cd), kedalaman, paotere, sedimen, timbal (Pb).

INTRODUCTION

Paotere ports have contributed greatly to support the life of makassar people. Such as the fish auction, transportation, and other service. That activity caused the water of the port serves as the final disposal of various pollutants. The existence of wide range pollution causing declining quality levels of water. One of pollutant that is currently very dangerous to marine life and humans is heavy metal, because it is toxic (Widowati, 2008). Heavy metals precipitate as sediment can be stay up to thousands years (Sarjono, 2009). But heavy metals that reserved by the sediments will be distributed on different particle size (Werorilangi, 2011).

Currently, the activities within the port are increasingly rising. The previous studies mentioned that sediment particle size gives the effect on heavy metal content. The fractions mud sediment is containing high heavy metals (Sahara, 2009). Various methods of analysis can be performed to determine the levels of heavy metals in sediments, but the most commonly used method is atomic absorption spectrophotometry (AAS) method. The analysis of the measurement result can be carried out by calibration curved method and standard addition. Based on the results of previous studies, curve calibration method is very effective to sediment sample and high concentrate sample. Based on these things, we conducted this study about Pb

and Cd content in the sediment around the waters of pare-pare port using atomic absorption spectrophotometers (AAS) instrument with calibration curve method.

MATERIALS AND METHODS

The materials that used in this study were marine sediment that was obtained from surrounding paotere port waters area, Pb (NO3) 2, Cd (NO3) 2.4H2O, HNO3 and aquabidest.

Sampling methods

Sampling was conducted at four different stations, namely:
Station I: Fishermen area and domestic waste canal.
Station II:Fish Auction, Tallo River Estuary, domestic and industrial sewage canal and Traditional Markets.
StationIII : The waters around of fish cages.
Station IV: Fisherman boats shipyard, and Pertamina tanker.

Each station samples were taken at 3 depths of sediment that is at a depth of 0-10, 10-20 and 20-30 cm from the sediment surface. Sediment samples were taken using polyethylene pipe. Samples obtained put in polyethylene containers. Then, samples of sediment stored in the ice box and immediately transported to the laboratory (Astuty, 2011). Samples were stored in a refrigerator (4 ° C) before sieving. Seawater also taken to assists the process of sieving. This is done, so that the condition is same as at the sampling station.
(Agustinawati, 2001).

Observed parameters

Samples that have been analyzed in the laboratory to determine the content of heavy metals Pb and Cd. Determination of heavy metals in sediments were analyzed using Atomic Absorption Spectro-photometer instrument (SSA) that were previously in the fractionation based on particle size and destruction use the microwave with the addition of HNO3. As supporting data, water quality parameters measured was done, at sampling sites which is water temperature, pH, salinity, dissolved oxygen (DO), and total dissolved solid.

RESULTS AND DISCUSSION

The result of the Pb and Cd content analysis by particle size and sediment depth around paotere port waters are as follows:

Sediment particle size fractination

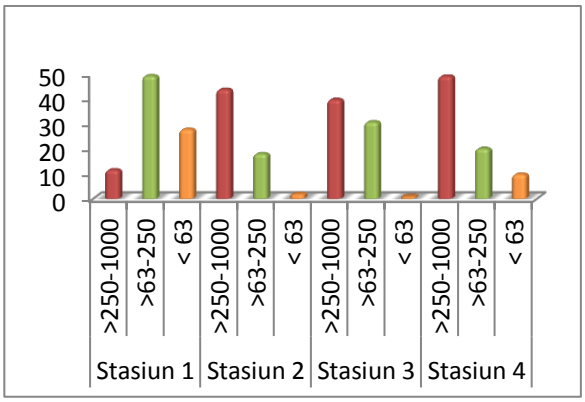

Figure 1.Fraction of the average particle size sediment (%) at various station in paotere port waters.

Significant differences in the characteristics of the sediment at station 1 (image 1), which is the highest percentage of sediment fraction is silt (> 63-250 lm) that is 49.25 %. and the lowest in the sand fraction (> 250-1000 lm) is 11.50%. in that it has a finer grain sediments than stations 2, 3 and 4 (image. 4) is caused by the distance between stations 1 is away from the shoreline, where the movement of sediment in the waters affected by the turbulence that occurs in the water itself, the tide downs as well as the breakwater structures (Romdania, 2010). while Stations 2, 3 and 4 the highest sediment fractions in the sand fraction (>

250-1000 lm) in a sequence that is 43.78%, 39.73%, 49.14% and the lowest in the clay fraction (<63 lm) in a sequence that is 1.86%, 0.91%, and 9.75%.

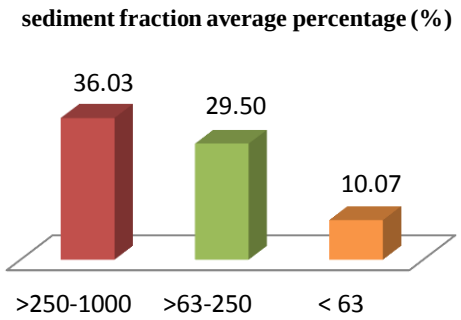

Figure 2. The average fraction sediment particle size at paotere port waters

Based on the study we have done, where the percentage of sediment fraction in all location are dominated by the sand fraction (>250-1000 µm). it is influenced by environmental condition and activities contained within the waters. Result of sediment particle size fractionation analysis in paotere port (image 2) is as follows: he sand fraction (> 250-1000 lm) is 36.03%, silt fraction (> 63-250 lm) is 29.50% and the lowest clay fraction (<63µm) is 10.07%.

Pb concentrations based on sediment particle size

Results of analysis of heavy metals Pb in sediment particle sizes vary widely. Based on the histogram that shown in Figure 3. Seen that a significant difference in the concentration of heavy metals Pb at Station II are much higher compared to the stations I, III, and IV. The differences are influenced by the condition of the marine environment itself, where the higher the activity, the level of pollution likely to be even greater.

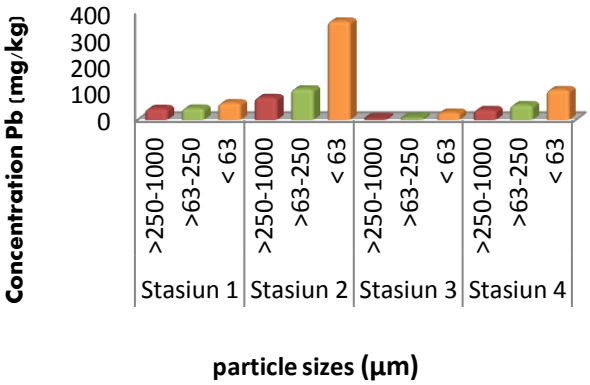

Figure 3. Heavy metal Cd concentration histogram based on sediment particle size

Highest Pb contents in the sediment samples contained in the second station at around 83.23 to 366.72 mg / kg, caused by the many sources of pollution around the site, such as fish-trading center, the canals as the final disposal of industrial wastes and domestic sewage originating from urban centers, traditional markets activity and shipping activities. Lowest Pb contents in the sediment samples contained on third station is approximately 7.39 to 27.43 mg / kg, this is caused by water conditions are far from the station of environmental III population. Heavy metals Pb at about the distribution of heavy metal station is carried by ship alternating current or tidal water flow.

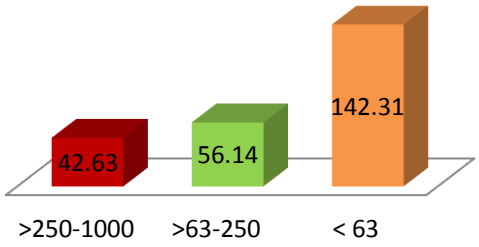

Figure 4. The average concentration heave metal pb histogram (mg/kg) based on particle size sediment.

In image 4. showed that the heavy metal content of Pb based on sediment particle size ranged from 42.63 to 142.31 mg / kg dry weight sediment. Pb concentrations increased the size of sediment particle size is decrease. In line with that proposed by Wahab (2005), that the interaction of heavy metals in sediments depends on the composition of the sediment. Higher concentrations of heavy metals commonly found in the sediment of mud, silt, sand from the stone, caused by sediment particle size, where sediments containing smaller particle size fractions of organic matter would accumulate larger, so did the heavy metals (Afriansyah, 2009) .

Based on sediment quality guidelines proposed by Febris and Werner (1994), the maximum concentration of Pb that can be tolerated by the organism is 33 mg / kg dry weight sediment. The analysis showed Pb concentrations by particle size sediment sampling locations throughout crossed a threshold, the maximum allowed (polluted) exception to the heavy metal concentrations of Pb at Station III.

Cd metal concentrations based on sediment particle size

The highest content of Cd in the sediment samples contained at station II is about 3.47 to 7.16 mg / kg, caused by the many sources of pollution around the site, such as the fish auction, the end of the canal as a dumping of industrial waste and domestic waste originating from urban centers, traditional markets activity and shipping activities.

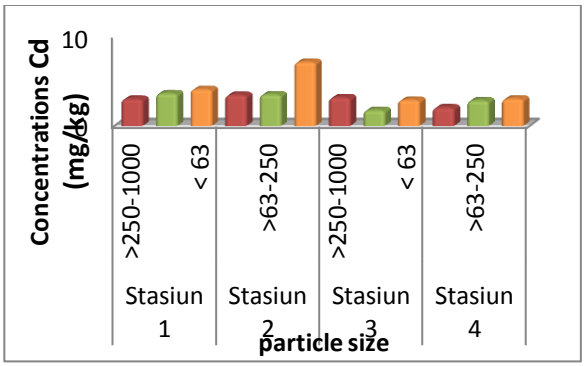

Figure 5. Heavy metal Cd concentration histogram based on sediment particle size

Lowest Cd content of the sediment samples contained on third station is approximately 1.77 to 3.13 mg / kg. This is caused by the activity around these waters away from the habitat of the population, but the concentration of heavy metals Cd is Cd accumulation of heavy metals carried by the alternating current fishing boats, passenger ships, and tankers by Pertamina.

Concentrations of heavy metals Cd (img.5) shows that the content of heavy metals Cd by sediment particle size ranged from 2.94 to 4.31 mg / kg dry weight sediment. Cd concentration increased by the decrease of sediment particle size. In line with that proposed by Wahab (2005), that the interaction of heavy metals in sediments depends on the composition of the sediment.

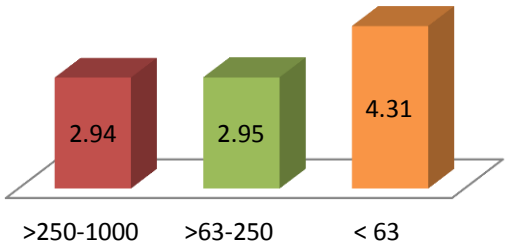

Figure 6. The average of heavy metal concentration histogram (mg/kg) based on sediment particle.

Higher concentrations of heavy metals commonly found in the sediment of mud, silt, sand from the stone, caused by sediment particle size, where sediments containing smaller particle size fractions of organic matter would accumulate larger, so did the heavy metals (Afriansyah, 2009) , but there is a difference in station III (img.5) increased Cd concentrations of heavy metals in the sand fraction (> 250-1000) due to the sediment particles having a smooth merger process (Aglomerates).

Based on sediment quality guidelines proposed by Febris and Werner (1994), the maximum concentration of Cd metal that can be tolerated by the organism is 1 mg / kg dry weight sediment. The analysis showed concentrations of Cd metal by particle size throughout the sediment sampling locations have exceeded the maximum allowed (polluted).

Heavy metal concentrations of Pb Based Sediment Depth

The heavy metal Pb concentration based on sediment depth is various at each sampling station. It is influenced by the amount of activity that can provide pollution to the marine environment. Highest Pb contents in the sediment samples contained at station II ranged between 166.98 to 196.00 mg / kg dry weight sediment, while the lowest Pb content in the sediment samples contained on third station ranged between 14.43 to 16.02 mg / kg dry weight sediment.

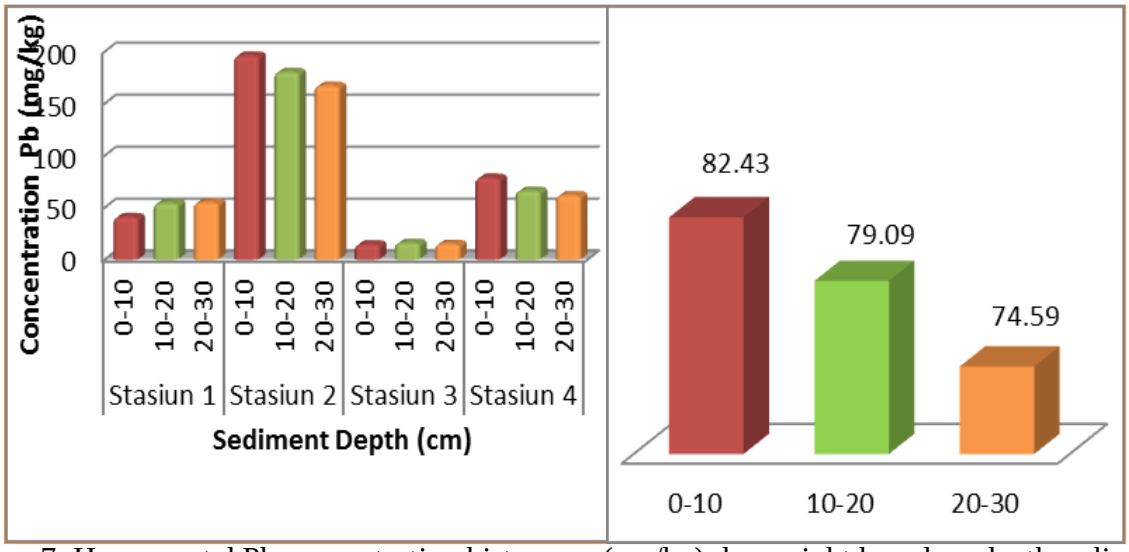

Figure 7. Heavy metal Pb concentration histogram (mg/kg) dry weight based on depth sediment

Highest Pb content of heavy metals in the sediment surface layer (0-10 cm) were expected as a result of increasing population activities that generate waste containing heavy metals Pb, such as housing, waste disposal site, the port for passenger ships, fish auctions, and unloading activities which are generally old irons.

Based on sediment quality guidelines proposed by Febris and Werner (1994), the maximum concentration of Pb that can be tolerated by the organism is 33 mg/kg dry weight sediment The analysis showed concentrations of Pb metal by particle size throughout the sediment sampling locations have exceeded the maximum allowed (polluted). exception to the heavy metal concentrations of Pb at Station III.

Heavy metal Cd concentration based on depth of sediment

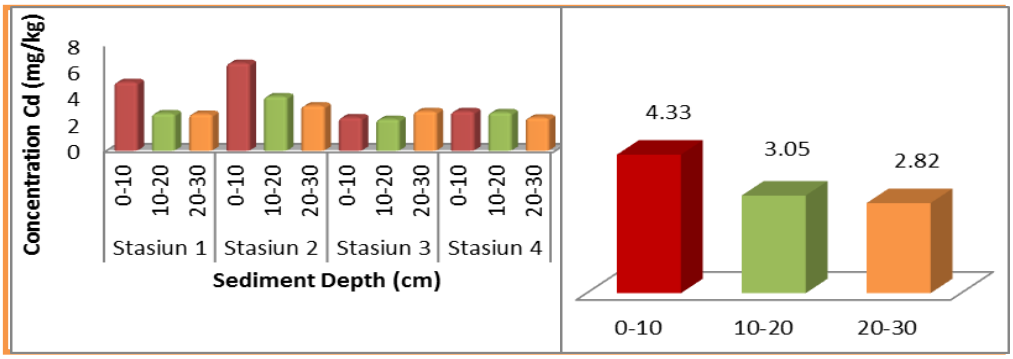

Figure 8. heavy metal Cd concentration histogram (mg/kg) dry weight based on sediment depth

Heavy metals Cd based on the depth of the sediment tend to be similar in Station I, III and IV, but the difference was significant at Station II (image .8). Highest Cd concentrations of heavy metals in Station II ranged between 3.41 to 6.64 mg / kg dry weight sediment, the lowest concentration at Station III is around 2.3899 - 2.9845 mg / kg dry weight sediment while at Station I ranged between 2.7879 - 5.2038 mg / kg dry weight sediment at station IV and between 2.4999 - 2.9845 mg / kg dry weight sediment.

The content of heavy metals Cd tended to decline with increasing depth of sediment layer. The high metal content of the surface thought to be caused by the increasing number of people who lives around the waters. The increasing activity of the citizen caused the waste that was produced goes in to the waters.

Based on sediment quality guidelines proposed by Febris and Werner (1994), the maximum concentration of Cd metal that can be tolerated by the organism is 1 mg / kg dry weight sediment. The analysis showed concentrations of Cd metal by particle size throughout the sediment sampling locations have exceeded the maximum allowed (polluted).

Environmental conditions Paotere harbor waters

In accordance with governor of South Sulawesi Regulation no.69 of 2010 on the quality standards and criteria for environmental damage, In accordance with Regulation No. governor of South Sulawesi. 69 of 2010 on the quality standards and criteria for environmental damage, the analysis of some physical and chemical aspects of the aquatic environment has exceeded the quality standard has been determined (Contaminated). It is inferred based on the chemical aspects such as salinity generally exceeds the predetermined threshold, in addition to the dissolved oxygen (DO) is also a strong indication of contamination (Dhahiyat et al, 2012)

DO levels in the waters ranged between 0.32 to 1.53 mg / L while the threshold has been determined that the low 6 mg / L. Surface temperature of waters around the harbor waters Paotere still within the range of natural temperature Indonesian waters ranged 28-31 oC (Wahab, 2005). The degree of acidity (pH) of seawater affect the deposition of heavy metals in the sediment, the higher the pH it will be easy to accumulate metals, pH value between 7-8 is still within the normal range of seawater pH is 5.6 to 8.3, while total dissolved solid (TDS) is 155.0 to 181.8 mg /kg.

Tabel 1. Data pengukuran langsung di lokasi pengambilan sampel.

Parameter	Satuan	Baku Mutu	Lokasi Pengambilan Sampel			
			Stasiun I	Stasiun II	Stasiun III	Stasiun IV
Suhu	°C	28-30	29	29	28	28
TDS	mg/L	1000	181,8	155,0	156,0	158,0
pH		7 - 8,5	8	7	7	8
Salinitas	ppt	33-34	31,3	26,3	27,1	27,1
DO	mg/L	>5	1,30	1,53	1,38	0,32

CONCLUSION

1. Based on the results of research conducted it can be concluded that: the distribution of sediment particle size on the surface of Paotere port waters consist of sand fraction (> 250 - 1000 µm) is 36,03 %, silt fraction (> 63 - 250 µm) is 29,50 % and the lowest is clay fraction (< 63 µm) is 10,07 %.
2. the content of heavy metal Pb and Cd increase as the decrease of sediment particle size. the concentration of heavy metals Pb and Cd on particle size > 250 – 1000, respectively is 42,63 and 2,94 mg/kg, the particle size > 63 – 250 is 56,14 and 2,95 mg/kg, the particle size < 63 is 142,31 and 4,31 mg/kg.
3. The content of heavy metals Pb and Cd decreases with sediment depth. The content of heavy metals Pb and Cd at a depth of 0 -10 cm, respectively 82.43 and 4.33 mg / kg, the depth of 10-20 cm is 79.09 and 3.05 mg / kg, and a depth of 20-30 cm is 74.59 and 2.82 mg / kg

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