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Spatial Lead Pollution in Aquatic Habitats and The Potential Risks in Makassar Coastal Area of South Sulawesi, Indonesia

Anwar Mallongi[1], Ruslan La Ane[1], Agus Bintara Birawida[1]

[1] Department of Environmental Health, Hasanuddin University, 90245, Makassar, Indonesia,
Corresponding author : anwarmallongi@unhas.ac.id, ruslan_fkm@yahoo.com, agusbirawida@gmail.com

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ABSTRACT

Background: *Lead can be a poison to the environment which may affects all body systems. Lead can also affect human health especially children, lead potentially lowering level of intelligence growth, loss, causing anemia, and disorder among children as lead is neurotoxin and accumulative. In addition lead can cause a decrease in the ability of the brain, whereas in adults may cause interference of high blood pressure and other tissue toxicity. Any increase in the levels of lead in the blood of 10 ug / dl led to a decrease in IQ of 2.5 points or 0.975 IQ. The research aims to produce a special model of health risk among elementary school children due to lead exposure in the coastal city of Makassar.*

Methods: *This study investigate the distribution of toxic lead in Makassar coastal area namely; sea water, sediments, shells and crab. Then investigate lead toxins around the school such as lead in soil, dust, paint, snacks and air. After create distribution maps lead risks we create analysis of environmental health risks for children.*

Results: *Result revealed that the analysis of spatial distribution of Lead in the sediment shows that the high distribution was in station 3 in Mariso districts then coastal Tallo area and the lowest was in Tamalate District. While the analysis of the spatial Pb distribution in mussels seen that the highest distribution Pb was in station 4 of districts Mariso then coastal waters Tallo area and the lowest was in Tamalate District 5.00 to 7.20 mg / g.*

Conclusion: *In conclusion, it revealed the concentration of Lead at all stations of those four districts have exceeded the level of allowed standard and may potentially lead to a hazard both to environment and human being who are living in the surround area.*

***Keywords**: Spatial models, school children, lead poisoning, coastal areas*

INTRODUCTION

The large amount of Lead disposed to the coastal water environment generate a hazard both to the environment and human being around the coastal. The accumulation of lead in the aquatic biota may become neurotoxin and accumulative which then potentially hazard for the higher consumers including human being as the highest consumer. The specific target of lead poisoning come to young children where lead can cause a decrease in the ability of the brain, whereas in adults it may cause interference of high blood pressure and other tissue toxicity.[1] Study shown that any increase in the levels of lead in the blood of 10 ug / dl led to a decrease in IQ of 2.5 points or 0.975 IQ scores.[2] Any exposure to air polluted by lead 1 ug / m3 likely to contribute 2.5 to 5.3 mg / dl in the blood of the person that is in place. Lead is taken into the body is normally 0.3 mg / 100cc per day, if the intake of lead 2.5 mg / day then it took 3-4 years to get the toxic effects. If the intake of lead 3.5 mg / day, it takes only a few years intoxication.

Demographic factors such as housing location, housing physic, a trip to the school and the type of vehicles to the school has a critical influence on blood lead levels. Research conducted by Khidri, et al [3] revealed street children and kindergarten children in Makassar (90%) of which contain concentrations of lead in their blood above the 10% threshold and the other had a lead concentration 10 mg / dl in their blood. The average content of lead in children's blood were examined was 23,96µg / dl. Research conducted in the city of Ambon by Mulyadi, et al on the transport driver city show that there were 47% of respondents had concentration of lead in their blood exceeds the normal limit of> 40 g / 100 ml and the concentration of hemoglobin below normal was <13 g / 100 ml. Results of research conducted by Ratna Sari Dewi [4] shows the difference in average air lead concentrations in densely populated areas of vehicles of 2.05 ug / m3 were slightly past the Environmental Quality Standards and the area is not densely vehicle average lead concentration is still below the air quality standard environment that is 0.10 ug / m3. The average difference in blood lead concentration on traders in overcrowded vehicles by 37.25 mg / 100 ml and the area is not congested vehicles by 33.43 mg / 100 ml. The average difference in blood hemoglobin concentration in a congested area merchants vehicles 11.32 g / 100 ml and the area is not densely vehicles by 13.71 mg / 100 ml.

The research from various countries indicate that Indonesia, especially the city of Makassar are not safe from the dangers of lead. Pb may cause symptoms of poisoning vary between children and adults, as well as the source and type of contamination, even low doses of lead toxicity also have permanent effects on children.[5,6] Therefore, comprehensive study of lead needs to be done. Using a spatial analysis of distribution in the environment, determines the health risks of coastal communities of Makassar and build a model of integration of environmental effect relationships of lead on human health. The approach is a solution to make the policy of prevention and prediction of decreased levels of lead, so as not to spread widely and cause health effects, especially a decrease in IQ that would lower the index of children's education is getting worse from year to year.

METHODS

This survey method applied two approaches; environmental risks and spatial model by using cross sectional design Study: it study the dynamics of the correlation between risk factors with effects at the same time and the execution of measurements conducted shortly "point time.[7]

The location of this research conducted coastal area of Makassar. The choice of location carried out in five districts namely coastal districts, Tamalate, Mariso, Ujung Tanah, Tallo and Biringkanaya. These districts represent nine coastal districts in the city of Makassar, which is indicated exposed to heavy metals lead.

Samples of seawater, sediment, shellfish, taken on the basis of the sampling sites have been determined using the Global Positioning System (GPS). We collected samples from eight stations with three repetitions. Seawater samples inserted into the sampling bottle made of plastic with 100 ml, Sediment put into a sterile plastic of 100 grams, and shells to be put into a sterile plastic with 10-15 tail. Furthermore examined levels of lead using AAS method in the laboratory.

Air samples taken at each station is done for 3 consecutive days morning, noon, and evening. Particles in the air captured by using high volume air samplers (High Volume Air Sample) and a filter or filter media. Pb contained in these suspended particles in the destruction by using acid solvents, and then measured by Atomic Absorption Spectrophotometer

Measurement of respirable dust using a Personal Dust Sampler (PDS) which contains paper filter that will catch dust that expose to children. This tool is equipped with a pump that will suck the dust out of the air into the filter by using a specific flow rate. Personal Dust Sampler (PDS) is a tool used to measure the concentration of dust among school children, principle of sucking the air with a certain speed (1.7 liters / minute) through a paper filter so that air through the pipeline will be filtered by a filter that has a certain weight. PDS types used in this study are the type SKC-224 models PCXR8. 46 made in Germany.

In this study used the land taken from five elementary schools divided into five three stations. Soil sampling at each elementary taken three different locations and at each location were taken three points then at any point in doing the repetitions. Soil samples were taken to a depth of 10 cm - 20 cm. Before taken the land cleared of litter, gravel / rock, grasses, and also roots. Equipment used to take soil samples comprising: a small shovel, navy (screwdriver), spoons, filters soil (sieve), measuring the depth of the soil (the crossbar), buckets of places to sift the soil, containers for storing soil samples were filtered and some plastic bags to store, samples collected immediately taken to the Laboratory for analysis. School snacks food Samples were taken at eight stations with three repetitions in each district adjacent to the air and soil sampling.

RESULTS AND DISCUSSION

Analysis of the data can be explained that in the city of Makassar there is considerable industrial watersheds and Tallo, especially the food industry and wood, bamboo, rattan. Total industry is closely related to the pollution load of the industry. Table 1 shows that the average lead (Pb) in the water, the sea has different variations, it appears that the average value is highest at the station at 0:19 8. districts Tallo mg / l, while the lowest in the sub-district station 1 Tamalate 0.12 mg / l.

Table 1. Distribution of Lead in Air, Sediment, anadara and soil in four districts

No	Variable	St 1 Tmlt	St 2 tmlt	St 3 mriso	St 4 mriso	St 5 UT	St 6 UT	St 7 TLo	St 8 Tlo
1	Air [mg / ml)	0.12	0.19	0.15	0.13	0.15	0.14	0.17	0.21
2	Sediment (mg / g)	6.03	6.68	8.00	7.97	7.45	7.13	7.77	7.67
3	Anadara (mg / g)	1.22	0.91	2.09	3.03	1.92	1.57	2.90	2.69
4	Soil (mg / g)	16.24	15.17	8.70	15.81	7.12	5.00	37.40	9.04

Based on the analysis of spatial distribution of metals in the sediment with pb with kriging interpolation method shows that the highest distribution pattern of Pb was in station 3 around Mariso districts then in Tallo coastal and lowest Pb concentration was in Tamalate District. While the analysis of the spatial distribution of metals in shells with pb method is seen that the distribution pattern of high Pb was station 4 Mariso districts around the then coastal waters Tallo and lowest districts was Tamalate District with 5:00 to 7:20 mg / g.

Table 2. Distribution of Pb in Air at Elementary School Neighborhood Coastal Makassar

Location (Districts)	n	Mean	Minimum – Maximum	Deviation standard
Tamalate	8	0,626	0,132 - 1,204	0,325
Mariso	8	0,493	0,141 - 1,622	0,474
Ujung Tanah	8	1,191	0,239 - 2,365	0,812
Tallo	8	1,634	0,863 - 2,111	0,469

Figure 1. Spatial distribution pattern Pb Air

Based on the analysis of spatial distribution of Pb metals in the air with kriging method is seen that the distribution pattern pb risen around the elementary school and then elementary school districts Tallo Tamalate coastal districts and the lowest in the sub-district that is in the fishing village Biringkanaya Untia can be seen from figure 1. *Spatial Distribution Pattern Pb school snacks*

Table 3 shows that the average lead at hawker has different variations, especially in the districts Tallo, Mariso, and Biringkanaya. The average value is highest in districts Tallo of 0.958 mg / kg, while the lowest in the districts Tamalate of 0,074 mg / kg.

Table 3. Distribution of Pb on school snack food in the Basic school

Location (Districts)	n	Mean	Minimum – Maximum	Deviation standard
Tamalate	8	0.570	0,08 - 0,99	0,294
Mariso	8	0.437	0,23 - 0,79	0,345
Ujung Tanah	8	0.658	0,97 - 1,30	0,309
Tallo	8	0.958	0,20 - 0,80	0.23

Based on the analysis of Pb spatial distribution of surface soil shown that high around the station 4 in the district Tallo followed by Tamalatea districts of the coastal and the lowest in Ujung Tanah district. Another study indicated Childhood exposure to lead remains a critical health control problem in the US. Integration of Geographic Information Systems (GIS) into childhood lead exposure studies significantly enhanced identifying lead hazards in the environment and determining at risk children. [8]

Review of the recent literature on GIS-based studies suggests that numerous environmental risk factors might be critical for lead exposure. New GIS-based studies are used in surveillance data management, risk analysis, lead exposure visualization, and community intervention strategies where geographically-targeted, specific intervention measures are taken. [9]. Among children in Chicago Public Schools (CPS), the severity of the effects of BLL on reading and math vary by racial subgroup (White vs. Hispanic vs. non-Hispanic Black). [9]

Presented data of lead content in the collected Air samples and school snack provide proof of the general pollution of lead at the Coastal of Makassar city. Obtained data were measured in relation to ambient air and frequently consumed school snack. Lead concentrations in far away from the source decreased with the increase of distance, whereas no significant correlation was found between lead levels in the muscle tissue and the length of both species.[10-14] Other results indicate contamination of these fish foods by lead with mean values varying from 8.0±0.8 to 12.5±1.6 mg kg^{-1}. The food processing technique accounted for up to seven times increase in fish lead levels.[1,12, 15]

Target Hazard Quotient (THQ)

The methodology for estimation of target hazard quotient (THQ) although does not provide a quantitative estimate on the probability of an exposed population experiencing a reverse health effect, but it offers an indication of the risk level due to pollutant exposure. This method was available in US EPA Region III Risk based concentration table 4.

Table 4. Target Hazard Question (THQ) for water column, sediment, shells and school snack from Makassar coastal area, Sulawesi Selatan, Indonesia 2017

Station	Location	Target Hazard Quotient (THQ)			
		Water column	*Shellfish (Anadara Trapezia sp.)*	*Crab*	*School snack*
St 1	Upstream, Tamalate (23 km) from Mks city	0.006	0.021	0.032	0.051
St 2	Upstream, Tamalate (18 km) from Mks city	0.005	0.023	0.033	0.053
St 3	Upstream, Mariso (15 km) from Mks city	0.006	0.020	0.025	0.047
St 4	Upstream, border in the West of Mks city	0.023	0.025	0.026	0.038
St 5	At the west Ujung Tanah, 10 km of mks city	0.035	0.018	0.029	0.038
St 6	Near shopping and entertainment center	0.033	0.038	0.039	0.041
St 7	Close to the river mouth in the North	0.020	0.041	0.037	0.036
St 8	Close to river mouth to the North	0.017	0.038	0.038	0.043

Table 4 shows, the value of THQ for water column, shell, crab and school snack consumption were ranged from 0.0017 to 0.035, 0.018 to 0.041, 0.025 to 0.038 and from 0.036 to 0.053 respectively. The highest THQ value observed in St.5 and St.6 where open market and community dwelling are located. In general, consumption of shell and crab is an important source of exposure to lead for humans. Communities are suggested to consume those contaminated aquatic habitat not regularly and in small amount.

CONCLUSION

The concentration of lead both in aquatic and terrestrial systems have been exceeded the allowable level for environmental standard and for lead in food standard. Although the magnitude of THQ values were still lower than 1, that means still safe for all those food to be consumed, it may produce hazard for long period of consumption due to the accumulation and biomagnifications process in the living aquatic habitats.

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