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Evaluation of Mercury Concentration in Water and Sediment at Artisanal Buladu Gold Mine in Gorontalo Province, Indonesia

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Abstract:
The research is aimed to investigate the spread of mercury concentration in the water and the sediment as the result of Artisanal Buladu gold mine activity in North Gorontalo Regency, Indonesia. Randomly sample taking was conducted in Pasolo/Hulawa River, Sulawesi Sea, and tailing waste with three times sampling repetition. The total samples of water and sediment were 94 samples. The analysis of mercury sample in the water and in the sediment was done in Integrated Research and Test Laboratory by using mercury analyzer and with AAS without any flame. The quality standard that becomes the reference for river water is Government Law 82 year 20110 Class I in which requirement is not more than 0.001 mg/l. The sea water uses Environment Ministry Decree No 51 Year 2004 with 0.001 mg/l. The quality standard of waste water uses Environment Ministry Decree No 202/2004 with the standard not more than 0.005 mg/l. The quality standard used in the sediment uses European safety standard with not more than 2 ppm.
The result of the analysis shows that mercury concentration in the sampling of river water I, II, and III were between 0.0006 – 0.00035 mg/l, 0.00063 –2.4284 mg/l and smaller than 0.06 ug/l. Sea water Sampling I, II and III were around 0.00025 – 0.00188 mg/l, 0.00063 – 1.1122 mg/l and 0.00034 – 0.00141 mg/l. In the Tailing, the result was around 0.00046 – 0.00339 mg/l, between 0.0033 – 0.9423 mg/l and 0.00053 – 0.07003 mg/l. Based on the result, it can be seen that mercury concentration in the water was above the quality standard. The mercury concentration in the sediment in sampling I, II and III in the river was around 10.8731 – 55.0680, 0.08995 – 136.70 and 0.55255 – 244.16 mg/kg. The sea sediment was around 8.7870 – 25.4630, 0.24190– 1.87 0.27745– 1.00 mg/kg. The concentration in the tailing was around 10.0643 – 36.4008, 3.31 – 135.55 and 104.36 – 236.22 mg/kg. Based on this result, mercury concentration in the sediment has been above the quality standard that has been required. It means that the mining activity needs a maximum management to overcome high level of mercury pollution.

Keywords: *mercury concentration, water, sediment, gold mine*

1. Introduction
The data from Forestry, Mining and Energy Institution North Gorontalo Province Year 2011 shows that North Gorontalo has non metal potential like gold within 47.534 Ha area that extends in Sulamata District 8.500 Ha, Atinggola 5.000 Ha, Galena 6.200 Ha located in Kwandang and Sumalata Regency, rocks 8.72 Ha (Anonymous, 2011)]. Exploration activity and gold exploitation in Buladu area by Dutch Government was started since 18th Century. Historical evidence that can be found in the area are 3 Dutch tombs in Buladu Beach died in 1899, mining holes with railways and carts, gold grain processing machine in the form of giant pot, and solid tailing found around mining location. Around 1970s, the exploitation activity was reopened by the residents. At that time, the society used traditional gold mining by washing sand and rock sediment along Buladu River (Balihristi, 2008).
The result of the research done by Mahmud, et. al. (2014) showed that the number of drums found in Sumalata Village are 152 drums, Padengo Village with 52 drums, West Ilangata with 133 drums, and Ilangata Village with 128 drums. The total numbers of the drums are 204 drums, and they are wasted and flown to the rivers that end in Sulawesi Sea. There are 261 drums polluting soil water around

Ilangata area. The total numbers of drums in North Gorontalo are 465 drums. Based on the research result, it causes a fear that the phenomena will endanger the society who dwells the area and the area around North Gorontalo Province. The number is higher if it is compared to the drums existed in Tulabolo District with 188 drums (Mahmud, 2012).

From many mining locations existed in Gorontalo Province, the researcher choses Buladu mining area located in Sumalata District North Gorontalo Province. The location of gold mining is in Hulawa Village that becomes the extended area of Buladu Village. In the location of gold mining, there is Pasolo River or Hulawa River, as a name called by the society, flowing in that area. The liquid waste from the gold mining flows to uncovered collecting ponds, and finally it is absorbed to the soil and flowing to the river. Close distance between the waste of Buladu mining area and the river will pollute water as it flows in the river. The water of Pasolo River is accumulated in Sulawesi Sea. The sea as waste acceptor from Pasolo or Hulawa River endangers and finally pollutes aquatic animals living in the sea.

The result of the initial research done by Mahmud, et. al. (2014) shows that water quality in the estuary of Sulawesi Sea was also 0.008 mg/l. However, the Ministry Decision of Environment Minister No. 51 Year 2004 about quality standard of sea water quality to the living creature in the sea in the term of mercury is 0.001 mg/l. Mercury concentration with 0.008 mg/l has been above the required quality standard. It surely endangers people who consume aquatic animals living in Sulawesi Sea. Public gold mining of Buladu village is done traditionally using mercury in processing gold grain and throwing the waste to waste collecting ponds close to the river as well as community residents. If the water waste pollutes the river, it will also pollute the sea around it. The worst impact is that pollution will become the toxin of the sea animals living in the sea and the people who consume them. The objective of the research is to evaluate the spread of mercury concentration in the water and in the sediment in order to find the most appropriate model concept in environmental management in Buladu traditional mining North Gorontalo Regency Gorontalo Province.

2. Material and Method

The research was conducted in Buladu traditional gold mining in Sumalata District. Sample taking in the water and the sediment was done in Pasolo/ Hulawa River, Sulawesi Sea and tailing waste. Sample taking in the river was conducted in 7 spots, in the sea 3 spots, and in the tailing waste 5 spots, and all of the samples taking processes were done three times. In addition, sample taking was done randomly. The numbers of water samples were 47 samples, and the samples from the sediment were 47 samples. Total numbers of samples were 94 samples. The analysis of mercury sample in the water and in the sediment used mercury analyzer in Integrated Research and Test Laboratory of Gajah Mada University, Indonesia and AAS without any flame in Quality Control and Test of Fisheries Result Office Gorontalo Province. Quality standard that becomes the reference for river water in Government Law 82 Year 2001 Class I about the control of water pollution in the surface water required is not more than 0.001 mg/l. The sea water uses Environment Ministry Decision no 51 year 2004 About Quality Standard of Sea Water for Sea Animals and Creature with required concentration not more than 0.001 mg/l. Quality standard of waste water uses Decision of Environment Ministry no 202/2004 in which mercury concentration not more 0.005 mg/l. Quality standard used to examine mercury concentration in the sediment uses European Safety Standard with safety value 2 ppm. The location of the reserach is shown in Figure 1.

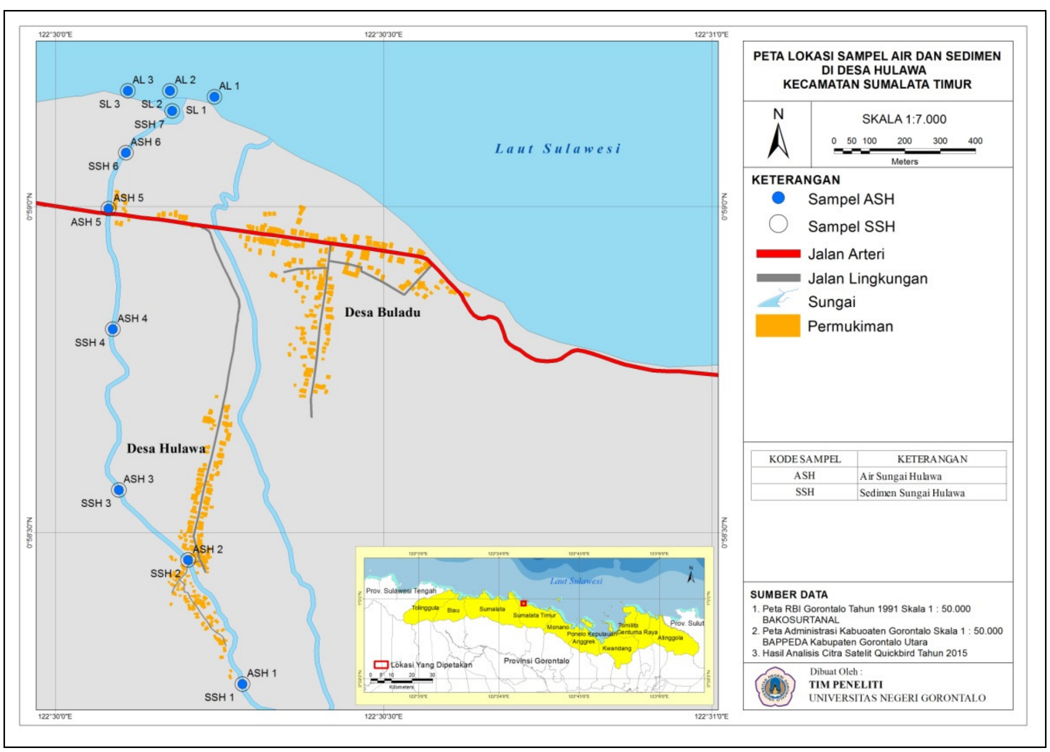


Figure 1: Sample Taking Location

3. Result and Discussion

3.1. Mercury Concentration in the Water

Mercury (Hg) is a microscopic material on the earth surface i.e. only around 0.08 mg/kg (Moore, 1991 in Efendi, 2003). In natural water, mercury is only found in a very little amount. An-organic mercury can transform into dimetil mercury with the help of microbe activities. In a low level of an-organic mercury, it will form dimetil mercury, while in a high level of an-organic mercury, it will form monometil mercury in natural water, the level of monometil and dimetil mercury is influenced by the existence of microbe, organic carbon, an-organic mercury level, pH and temperature (Efendi, 2003).

3.1.1. Sampling I

The analysis result of mercury concentration in the water in Pasolo River, Sulawesi Sea and Tailing Waste in Sampling I is presented in Figure 2.

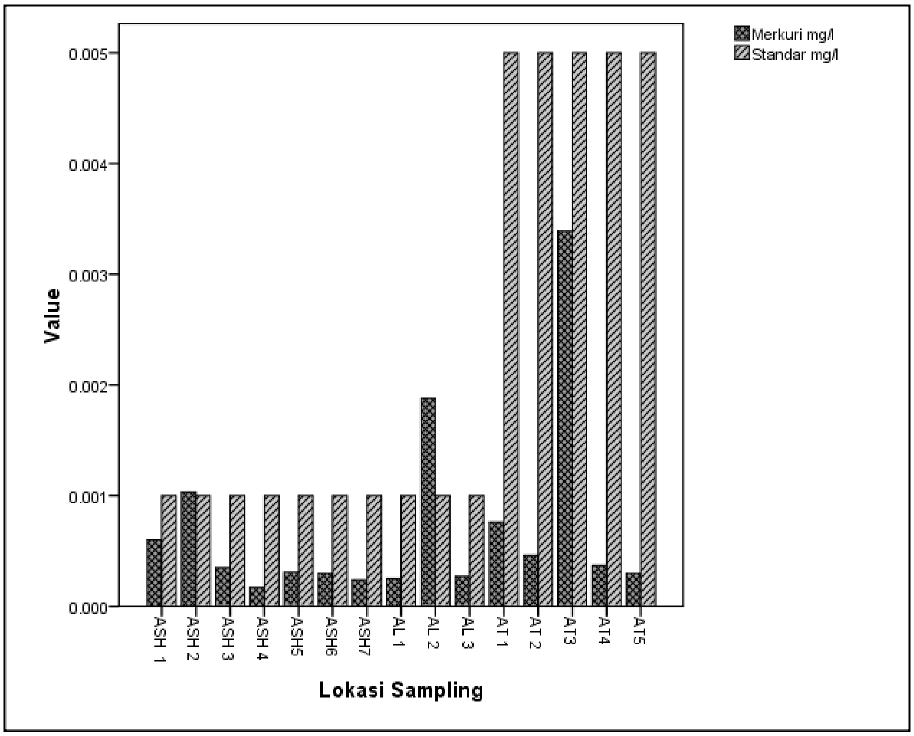


Figure 2: The Graph of Analysis Result of Mercury Concentration in the Water in Pasolo, Sulawesi Sea, and Tailing Waste in Sampling I

The analysis result of mercury concentration in Sampling I is around 0.0006 – 0.00035 mg/l. This result is still under the level of quality standard of Government Law no 82 Year 2001 Class I in which maximum limit required is not more than 0.001 mg/liter. Point location of ASH1 was taken on the mining headwater Buladu/Sumalata. In this location, mercury concentration measured was 0.0006 mg/l, and it was under the required quality standard. The existence of mercury concentration in this location was because of the existence of the other traditional gold mining in Pasolo River i.e. Padengo traditional mining. The location of ASH2 had mercury concentration with 0.00103, and it was above the quality standard required. It happens since the distance location between active drums and the river was only 10 m. Mercury concentration in Sampling I water has a tendency that the more flowing to the downstream, the smaller the concentration is.

Similar matter also happens in the research done by Mahmud (2012) showing that mercury concentration in bottom sediment in Tulabolo gold mining in several water debit had a tendency that the more to the downstream, the lower the concentration of mercury. Closer distance will have higher mercury concentration compared to further distance because the water along the river stream washes the material flowing from the headstream to the downstream.

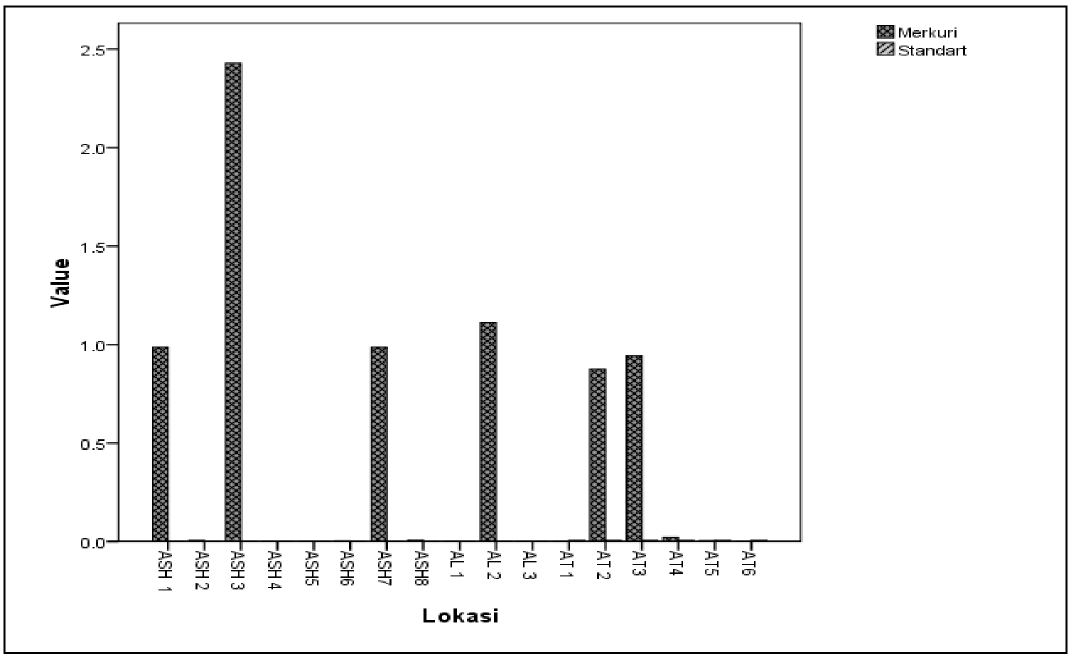
The analysis result of mercury concentration in the sea water was around 0.00025 – 0.00188 mg/l. Based on this result mercury concentration in the sea water tends to be close to the limit of quality standard of sea water following the Decision of Environment Ministry No. 51 Year 2004 about quality standard of sea water to the life of living animals and vegetation with the required maximum limit not more than 0.001 mg/l. In the sea water, mercury concentration AL1 was on the left part of Pasolo River estuary, and AL2 sample was taken from Sulawesi Sea exactly on the estuary, and AL3 was in the sea exactly on the right part of Posolo River. Mercury concentration in the sea water in AL2 location has the highest mercury concentration with 0.00188 mg/l. The value of this concentration has been above the quality standard of sea water following the Decision of Environment Ministry No. 51 Year 2004 stating that the rate is not more than 0.001 mg/l. This rate is high enough becuse the location of sample taking was done in Sulawesi

Sea, and it is a line with Pasolo River estuary. This result is higher compared to mercury concentration around Manado Bay in which result could not be detected in 4 areas of Manado Bay, Selayar, dkk (2015).

The analysis result of mercury concentration in the water of tailing waste in Sampling I was around 0.00046 – 0.00339 mg/l. Based on this result, it can be concluded that mercury concentration in the water of tailing waste tended to be close to the limit of quality standard following the Decision of Environment Ministry No. 202/2004 in which mercury concentration maximum should be 0.005 mg/l. The sampling location of the highest rate was in the point AT3 with 0.00339 mg/liter. Mercury concentration in the tailing was under the quality standard required because when the process of sample taking the drums were not being operated. Operational time in the reserach site was not certain; it depends on the stock of the rock that can be mined by the miners. Generally, high rate of mercury concentration in the tailing line happens because of incomplete amalgamation process. In the gold amalgamation process done by the society with traditional way, mercury can be released to the environemnt in the stage of wasihng and drying.

3.1.2. Sampling II

The analysis result of mercury concentration in the water of Pasolo River and Sulawesi Sea and tailing waste in the Sampling II is presented in the Figure 3.



. Figure 3: The Graph of Analysis Result of Mercury Concentration in the Water in Pasolo River and Sulawesi Sea and Tailing Waste in Sampling II

The analysis result of mercury concentration in Sampling II was around 0.00063 –2.4284 mg/l. This result has been above the quality standard based on Government Law No 82 Year 2001 Class I in which maximum limit required is not more than 0.001 mg/liter. High rate of mercury concentration in Sampling II because sample taking was done when the drums in the mining location were active. The highest mercury concentration in ASH7 was 2.4284 mg/l in the location of Pasolo River estuary.

The analysis result of mercury concentration in the sea water in Sampling II was around 0.00063 – 1.1122 mg/l. Based on this result, the mercury concentration in the sea water tended to be in the limit of sea water quality standard following the Decision of Environment Minister No. 51 Year 2004 About the Standard Quality of Sea Water for the Life of Sea Animals and Vegetation in which maximum limit required is not more than 0.001 mg/l. The highest concentration was 1.1122 mg/l, and it was on the sea in line with Pasolo River. The lowest was in AL3 location with 0.00063 mg/l. The reserach result done by Selayar, dkk (2015) in the location around Manado Port, Manado Trade Centre Area, RSUP Area and Malalayang Beach showing that mercury concentration cannot be detected. It shows that the condition of Sulawesi Sea especially the estuary of Pasolo River has been polluted by mercury.

The analysis result of mercury concentration in the water of tailing waste in Sampling II was around 0.0033 – 0.9423 mg/l. based on this result, the concentration of mercury in the water of tailing waste tended to be above the quality standard following the Decision of Environment Minister No 202/2004, in which maximum mercury concentration is 0.005 mg/l. The highest concentration in the gold mining of Buladu in AT3 location was 0.9423 mg/l, and the lowest was 0.00109 mg/l. Mercury concentration in Buladu gold mining had been very high compared to mercury concentration in community gold mining location in Cisungsang Village, Lebak Regency, Banten Province. Its reserach result shows that teh highest concentration was 0.265, and the lowest was 0.083 ppm (Pamungkas, dkk, 2015). It implies that this phenomena needs serius control by the local governemnt. Withiatna (2005) states that high mercury concentration in the tailing is generaly caused by incomplete amalgamation process. From the test done in Cineam area, the result shows that the process yielded mercury in one amalgamation round with 9 %. Based on several reseraches, the data obtained shows that the washed mercury after the amalgamation could reach 5% - 10% (Withiatna, 2005).

3.1.3. Sampling III

The analysis result of mercury concentration in the water of Pasolo River and Sulawesi Sea and in the tailing in Sampling III is represented in Table 1.

Sample Points	Analysis Result (mg/l)	Quality Standard (mg/l)
ASH 1	<0.00006	0.001
ASH 2	<0.00006	0.001
ASH 3	<0.00006	0.001
ASH 4	<0.00006	0.001
ASH5	<0.00006	0.001
ASH6	<0.00006	0.001
ASH7	<0.00006	0.001
AL 1	0.00078	0.001
AL 2	0.00034	0.001
AL 3	0.00141	0.001
AT 1	0.00163	0.005
AT 2	0.00224	0.005
AT3	0.00053	0.005
AT4	0.07003	0.005
AT5	0.00036	0.005

Table 1: Analysis Result of Mercury Concentration in the Water in Pasolo River and Sulawesi Sea and Tailing Waste Sampling III

The analysis result of mercury concentration in Sampling III was <0.00006 mg/l. This result was under the limit of quality standard following Government Law No 82 Year 2001 Class I in which maximum level that is allowed should be not more than 0.001 mg/liter. Low mercury concentration in sampling III happened because when conducting the process of sample taking, the condition of the drums was not active. Operation process of the drums was done only once a week, on Sunday. However, the condition can change depending on the stock of the rock founded in the area.

Mercury concentration in the water was lower compared to mercury concentration in the sediment. It is caused by several factors that influence the phenomena such as pH, oxygen, temperature and total suspended solid (Lacerda *et al*, 1991). Mercury concentration in the water is generaly always under the limit of the quality standard without seeing the change of distance from the tailing location. It is caused by physical and chemical condition in the water in which mercury concentration has an easily soluble character (Lindqvis et al, 1984 and Nriagu, 1979 in Lacerda et al, 1991).

The analysis result of mercury concentration in the sea water in sampling III was around 0.00034 – 0.00141 mg/l. Based on this result, it can be inferred that mercury concentration in the sea water tended to be above the quality standard of sea water following the Decision of Environment Ministry No. 51 Year 2004 about Sea Water Quality Standard for Sea Animals and Vegetation in which maximum limit required is not more than 0.001 mg/l. The highest concentration was in AL3 location with 0.00141 mg/l. The lowest one was 0.00078 mg/l. This concentration is similar to the concentration of the research result conducted by Paundanan, et al (2015) in which mercury concentration of the sea water was around 0.0008- 0.0042 mg/l. This result was higher compared to the research done by Environment Management Office DKI Jakarta, mentioning that mercury concentration in the water of Ciliwung River was not able to be detected (Ibad, 2015).

The analysis result of mercury concentration in the water of tailing waste in Sampling III was around 0.00053 – 0.07003 mg/l. based on this result, it can be said that mercury concentration in the water of tailing waste tended to be above the quality standard following the Decision of Environment Ministry No 202/2004, in which maximum mercury concentration should be 0.005 mg/l. The highest mercury concentration in AT4 location was 0.07003 mg/l. This location became the only active drum when the process of sample taking was conducted.

3.2. Mercury Concentration in the Sediment

3.2.1. Sampling I

The analysis result of mercury concentration in the sediment of Pasolo River, Sulawesi Sea and Tailing Waste in Sampling I is presented in Figure 4.

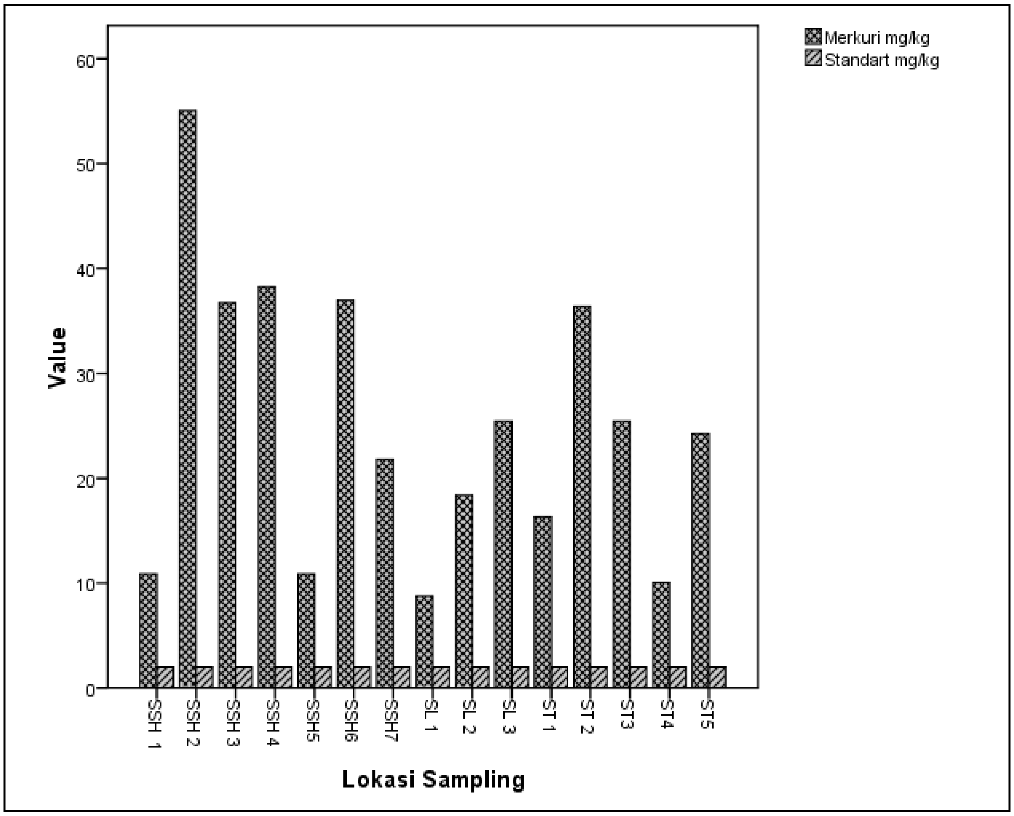


Figure 4: The Graph of Analysis Result of Mercury Concentration in the Sediment in Pasolo River, Sulawesi Sea and Tailing Waste Sampling I

The analysis result of mercury concentration in the river sediment in sampling I was around 10.8731 – 55.0680 mg/kg. This result has been above the quality standard stated by European safety standard with the amount not more than 2 mg/kg. The highest concentration was in SSH 2 location with 55.0680 mg/kg. The lowest concentration was in SSH5 location with 10.8731 mg/kg. The lowest concentration was still above the limit of quality standard required.

The analysis result of mercury concentration in the sea sediment was around 8.7870 – 25.4630 mg/kg. Based on this result, it can be seen that mercury concentration in the sea sediment had been above the limit of the quality standard stated by European safety standard that the maximum mercury concentration should not be above 2 mg/kg. The highest concentration was in SL3 location with 25.4630 mg/kg, and the lowest was 8.7870 mg/kg. Although becoming the lowest concentration, the condition was still above the limit of required quality standard that should be 2 mg/kg.

The analysis result of mercury concentration in the sediment of tailing waste in Sampling I was around 10.0643 – 36.4008 mg/kg. Based on this result, it can be inferred that mercury concentration in the sediment of tailing waste had been above the limit of quality standard stated by European Safety Standard in which maximum concentration should not be more than 2 mg/kg. The highest mercury concentration was in ST 2 location with 36.4008 mg/kg, and the lowest was in ST4 location with 10.0643 mg/kg. Although the amount of concentration became the lowest, the level was still above the required quality standard. Mercury concentration in the sediment Buladu traditional gold mining needed a serious attention. It happened because the concentration had been very high compared to the mercury concentration in Cisungsang gold mining, Lebak Banten Regency, in which highest concentration was 0.40700 ppm, and the lowest one was 0.30400 ppm.

3.2.2. Sampling II

The analysis result of mercury concentration in the sediment in Pasolo River, Sulawesi Sea and Tailing Waste in Sampling II is presented in Figure 5.

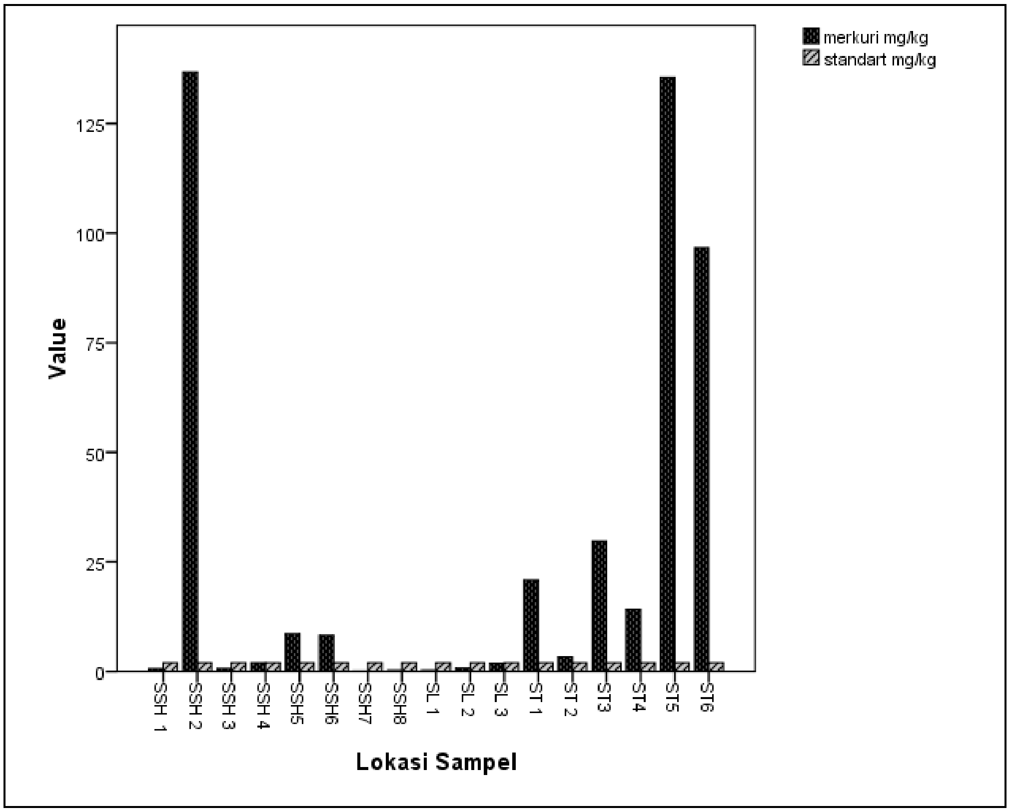


Figure 5: The Graph of Analysis Result of Mercury Concentration in the Sediment of Pasolo River, Sulawesi Sea and Tailing Waste Sampling II

The analysis result of mercury concentration in the sediment in sampling II was around 0.08995 – 136.70 mg/kg. The result was still above the limit of quality standard stated by European safety standard with no more than 2 mg/kg. The highest mercury concentration was in SSH5 location with 136.70 mg/kg, and the lowest was 0.08995 mg/kg. In SSH2 location there was tailing waste that was too close to the river, so there was very high pollution in that location.

Bottom sediment is defined as a particular part moving on the base of the river by rolling, moving, or jumping. The amount of the load is influenced by river stream condition. If there is enough supply to maintain the loading in the river stream capacity (Soemarto, 1999). The shape, size, and weight of soil particle will determine the capacity of sediment load. The capability of soil to be eroded not only depending on the size of the particles but also depending the character of organic material and an-organic material bound together with that particle. If soil particle is eroded from community mining area, the sediment formed will bring soil particles containing mercury as the result of amalgamation process to the river stream.

The analysis result done by Ikhsan (2007) shows that the smaller the diameter of sediment grain, the more bed load that can be loaded. The bigger debit of the river stream, the more bed load that can be loaded. The other factor that has influence toward mercury concentration in the bottom sediment within several distances is the river stream velocity. River stream with low velocity will cause mud formation and sediment in the river. In low debit, mercury concentration in the bottom sediment becomes very high especially the location which is close to the gold mining location. It happens because the debit as well as the velocity of the river stream is low, so the mercury waste loaded together with water stream to the river will become sediment in the bottom of the river.

The analysis result of mercury concentration in the sea water was around 0.24190– 1.87 mg/kg. Based on this result, it can be seen that mercury concentration in the sea sediment in sampling II tended to be close to the limit of the quality standard stated by European safety standard in which maximum standard was not more than 2 mg/kg. The highest mercury concentration was in SL3 location with 1.87 mg/kg, and the lowest one was 0.2419 mg/kg. This concentration was higher than the research done by Paundanan, et al (2015) in which mercury concentration in the sea sediment was around 0.017- 0.287 mg/l. High mercury concentration in the sea happens because Buladu traditional gold mining threw its mercury waste to open processing ponds and flew to the river and ended to the sea.

The analysis result of mercury concentration in the sediment of tailing waste in Sampling II was around 3.31 – 135.55 mg/kg. Based on this result, it can be concluded that mercury concentration in the sediment of tailing waste had been above the limit of quality standard following the criteria from European Safety Standard in which maximum limit does not reach 2 mg/kg. The highest concentration in ST4 location was 135.55 mg/kg. The highest condition is very extreme because the location became active location. The lowest concentration was 3.31 mg/kg. Very extreme concentration happened in the active drums location.

The bond of mercury in the sediment of surface water stream represents the characters of the contaminants passed including: (i) deposit and the flowing of mercury that becomes the mobilization as the result of burning and evaporating process from amalgam (ii) the input of mercury particulate will be broken down from the process of washing mineral contaminant in the tailing process (iii) mercury waste from breaking down the surface absorption (Appleton et al, 2001).

3.2.3. Sampling III

The analysis result of mercury concentration in the sediment in Pasolo River, Sulawesi Sea and Tailing waste in Sampling III is presented in Figure 6.

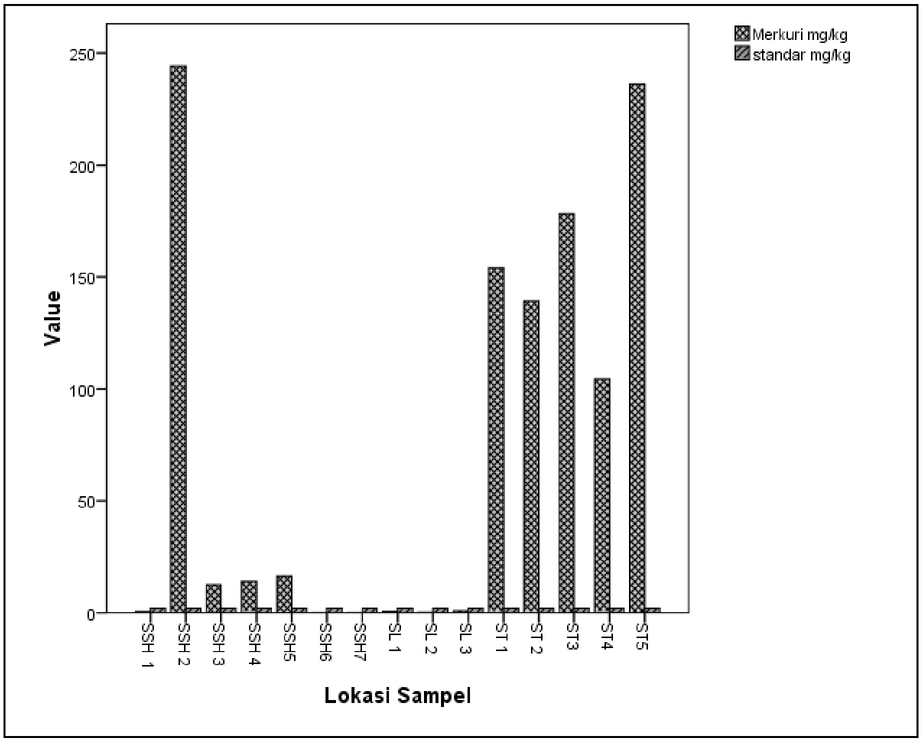


Figure 6: The Graph of Analysis Result of Mercury Concentration in the Sediment in the River, Sea and Tailing Waste of Sampling III

The analysis result of mercury concentration in the sediment in sampling III was around 0.55255 – 244.16 mg/kg. This result was still above the limit of quality standard stated by European safety standard mentioning that the concentration should not be more than 2 mg/kg. The highest mercury concentration was 244.16 mg/kg, and the lowest was 0.12340 mg/kg. Extreme concentration was 244.16 mg/kg happening in the location of waste disposal that was always active. SSH2 location was close to the liquid waste ponds of the tailing, so it had high level of sediment. The concentration had been very high compared to the research done by Kyereme, et.al, (.2015) in which measured concentration in the sediment due to traditional gold mining in Asutifi area, Ghana in the dry season with 1,163 mg/kg and in the rainy season with 0.030 mg/kg.

The analysis result of mercury concentration in the sea water was around 0.27745– 1.00 mg/kg. Based on this result, it can be stated that mercury concentration in the sea sediment in sampling III tended to be close to the limit of quality standard of European safety standard in which maximum value should not be more than 2 mg/kg. The highest concentration in SL3 location with 1 mg/kg, and the lowest was 0.27745 mg/kg.

The analysis result of mercury concentration in the sediment of tailing waste in Sampling III was around 104.36 – 236.22 mg/kg. Based on this result, it can be concluded that mercury concentration in the sediment of tailing waste had been above the quality standard following the standard of European Safety Standard, in which maximum limit should not be more than 2 mg/kg. The highest concentration was 236. 2 mg/kg, and the lowest concentration was 104.36 mg/kg. Although it shows the lowest concentration, the value was still above the limit of required quality standard.

Particle size has significant roles in heavy metal distribution in the sediment. The content of organic material correlates with particle size of the sediment. In the sediment with smooth percentage, the content of organic material is higher than in the sediment with rough texture. It has correlation with calm environmental condition, so it is possible that the precipitation of smooth sediment in the form of mud followed by the accumulation of higher content of organic material. Heavy metal coming from human activities and natural process can be distributed in the sediment particle which has different size. Sieka et al, (2000) has learnt the correlation between the size of sediment particle and the concentration of heavy metal. The distribution of heavy metal in several sizes of particle is influenced by the formation of sediment both from natural and non-natural process (Erlangga, 2007). In addition, the distribution of the metal is also influenced by the condition of sediment formation phase especially the phase that is able to absorb or to react with any particular metals (Sahara, 2009).

Naturally, the size of sediment grain is influenced by two factors, namely anthropogenic and the inserting of metal with natural process (Birch *et al*, 2001). The result of the research generally shows that the content of the highest heavy metal can be accumulated in the smaller sediment particle while the content of the lowest heavy metal can be accumulated in the particle which has bigger size (Siaka et al, 2000).

4. Conclusion

The result of the analysis shows that in sampling I, mercury concentration in the river water was around 0.0006 – 0.00035 mg/l; in the sea water, the concentration was around 0.00025 – 0.00188 mg/l; and in the water of tailing waste it was around 0.00046 – 0.00339 mg/l. The result of the analysis shows that in sampling II, mercury concentration in the river water was around 0.00063 –2.4284 mg/l; in the sea water it was around 0.00063 – 1.1122 mg/l and in the water of tailing waste, the concentration was between 0.0033 – 0.9423 mg/l. The result of the analysis shows that in sampling III, mercury concentration in teh river water was lower than 0.06 ug/; in the sea water it was around 0.00034 – 0.00141 mg/l; and in the water of tailing waste it was around 0.00053 – 0.07003 mg/l.

The result of analysis shows that in sampling I, mercury concentration in the river sediment was around 10.8731 – 55.0680 mg/kg; in sea sediment it was between 8.7870 – 25.4630 mg/kg; and in the sediment of tailing waste the concentration was between 10.0643 – 36.4008 mg/kg. The analysis result shows that in sampling II, mercury concentration in the river sediment was around 0.08995 – 136.70 mg/kg; in the sea sediment it was around 0.24190– 1.87 mg/kg; and in the sediment of tailing waste the concentration was around 3.31 – 135.55 mg/kg. The analysis result shows that in sampling III, mercury concentration in river sediment was around 0.55255 – 244.16 mg/kg; in the sea water it was around 0.27745– 1.00 mg/kg; and in the water of tailing waste the concentration was around 104.36 – 236.22 mg/kg. Buladu traditional gold mining needs an appropriate management model to overcome the pollution in the area.

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