

Investigation of Heavy Metals on Water Quality and Sediment: A Case Study Bireuen, Aceh Utara and Lhokseumawe City

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Abstract

Environmental pollution around the world in the last 10 years has continued to increase with increasing industrial growth. Environmental pollution has reduced the availability of clean water. Clean water is the main thing for all living things on this earth. Therefore, environmental pollution that occurs in the clean water crisis must be handled as soon as possible and reduced by various effective policies. The main focus of this research is to analyze heavy metal pollution on the surface of the water, clean water, and sediments caused by industrial activities. This research is a field study by taking samples directly at the location and then analyzing them in the laboratory. The results of the analysis showed that the highest heavy metal Fe on the water surface was found in Bireuen Regency by 0.28% compared to Lhokseumawe City with 0.0029% and Aceh Utara 0.0029%. Meanwhile, the highest heavy metals contained in clean water were recorded in Bireuen and Lhokseumawe City at 0.007% and 0.0064%, respectively. The results of the heavy metal analysis in the highest sediment were found in North Aceh at 42.93% compared to 8.02% and 18.12% for Bireuen and Lhokseumawe. Overall, the analysis carried out in this study shows that the surface water, clean water, and sediments have been contaminated by heavy metals. Meanwhile, the quality standard for surface water is 0.3 mg/l, net ai is 1.0 mg/l, and sediment is 20bj.

Keywords: Heavy metals, surface water, clean water, sediments

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1. INTRODUCTION

Water is a necessity for all living things that exist on this earth. Without water, all living things in the entire world will experience death. However, some regions or countries in the last few years often experience a lack of water both for the needs of humans and other living things (El *et al.*, 2012; Rossi *et al.*, 2013). The clean water crisis can affect population growth in nearly a quarter of the world (Holden *et al.*, 2019; Resources, 2020). In some areas in Indonesia, there has also been

frequently clean water crisis, especially areas that have often experienced drought (CNN, 2020). This water crisis can be influenced by several factors including development, industrial activities, waste, and other human activities (Tioritz, 2010). The industrial growth that continues to increase in recent years has had an impact on environmental pollution, especially on clean water.

Investigations regarding clean water pollution throughout the world have been carried out by several researchers.

Investigations of water pollution in urban river basins have been studied (Zeng *et al.*, 2020). The method proposed in their research is a multi-response surface based on integrated hydrodynamic water quality simulation. Where the simulation results are carried out that the reduction rate for pointed sources is 77.9%, the reduction rate for non-point sources is 40%. Research to control air pollution in China, the Beijing-Tianjin-Hebei region has been evaluated by Yi Ling et al (Yi *et al.*, 2020). Where the results of their investigation reported that environmental performance for controlling air pollution in Beijing has an upward trend over the 2010-2016 period, and it is estimated that the trend could continue for the next five years. A policy with the application of two appropriate biases from stakeholders shows that it is very appropriate to reduce water pollution as reported by (Fu *et al.*, 2020). Evaluation of Spatio-temporal changes in surface water pollution in the middle Nile Delta uses the algae pollution index (Palmer Index) as reported by (Salem *et al.*, 2017). Samples used in their analysis were taken from 18 stations during winter and summer. The results are reported that the overall sample tested shows a different and increasing trend. However, minute trends that occur in both seasons and places also show a difference. Water resources and environmental sustainability in China have been contaminated as reported by (Shi *et al.*, 2019). Their investigation aimed to identify nitrogen pollution and its source in the Weihe River, northwest of China, as well as the concentration of various forms of nitrogen. The analysis shows that forests and grasslands harm nitrogen concentration in surface water, with a total reduction effect reaching 55.8%. Meanwhile, some research on water pollution has also been discussed by several researchers (Cahyaningsih & Harsoyo, 2010; B. Chen et al., 2019; Herlambang, 2018; Liu et al., 2019; Lu, Wu, Zhang, & Zhang, 2020; Puspitasari, 2009; Warlina, 2004). The results of the study reported that in large part due to industrial activity. Besides, clean water pollution is also caused by municipal and industrial waste. From a portion of the research, it is proposed that pollution can be carried out with the intervention of the government as a policymaker.

Furthermore, the analysis of sediments in various countries in the world has been

carried out. Sediment investigations have been carried out in various places with various cases. Investigations regarding sediment deformation and strain evaluation with newly designed and built experimental equipment carried out by (Wang *et al.*, 2020). Their experimental results then compared for dissociation with methane hydrate and various hydrate saturations, porosity, and particle size of the sediment itself. Sediment geochemistry analyzed by evaluating the contribution of the Susquehanna River and shoreline erosion has been studied (Russ *et al.*, 2020). Analysis of these sediments is carried out at the upstream base using sediment-original analysis. While in different studies where the patterns accumulated from sediments were determined through the middle girder and were found to be in a critical condition. Pneumatic cleaning systems can reduce the total sediment deposits contained in ballast tanks by up to 45% (Güney *et al.*, 2020). The evaluation of environmental conditions conducted in Northern Chile recently aims to evaluate the levels of Cu, Zn, Pb, Ni, V, Cd, As, and Al and their correspondence (Valdés & Tapia, 2019). Overall results reported that bays without industrial activity concentrations of contaminant elements are much lower than bays with industrial activities. Meanwhile, evaluations of sediments in several different places have also been carried out (Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Ce, Pr, Nd, Pd, & Cd) (Aslam *et al.*, 2020; Müller *et al.*, 2019; Wang *et al.*, 2020; Wu *et al.*, 2019). From most of the research conducted, some of the sites analyzed show that it has been contaminated by sediment. Thus, more serious supervision is needed so that the contaminated area can be reduced and always well maintained.

Investigations about sediments in several places have been carried out both individually and in groups. However, in recent years contaminated sediment has shown a significant increase. So we need more serious solutions to suppress the increase that continues to occur. The work in this research focuses on investigating heavy metals on water quality and sediment caused by industrial activities in the open environment. The analysis of environmental conditions was carried out by a survey method in several areas suspected of being contaminated by heavy metals against clean water. Also, this analysis is conducted to determine the level of environmental pollution

so that several policies can be taken to reduce the increasing pollution occurs.

2. MATERIALS AND METHODS

This study uses a survey method that aims to analyze environmental conditions, especially surface water contaminated by industrial waste. The location of the environmental condition analysis survey in this paper took a case study in the Bireuen District,

Lhokseumawe City, and Aceh Utara District shown in Figure 1. This location was chosen because it was the most industrial development site in Aceh Province. Analysis through field surveys in research aims to investigate heavy metals in clean water and on the surface of the water caused by industrial activities. Besides heavy metal analysis was also carried out on sediments and odors in clean water.

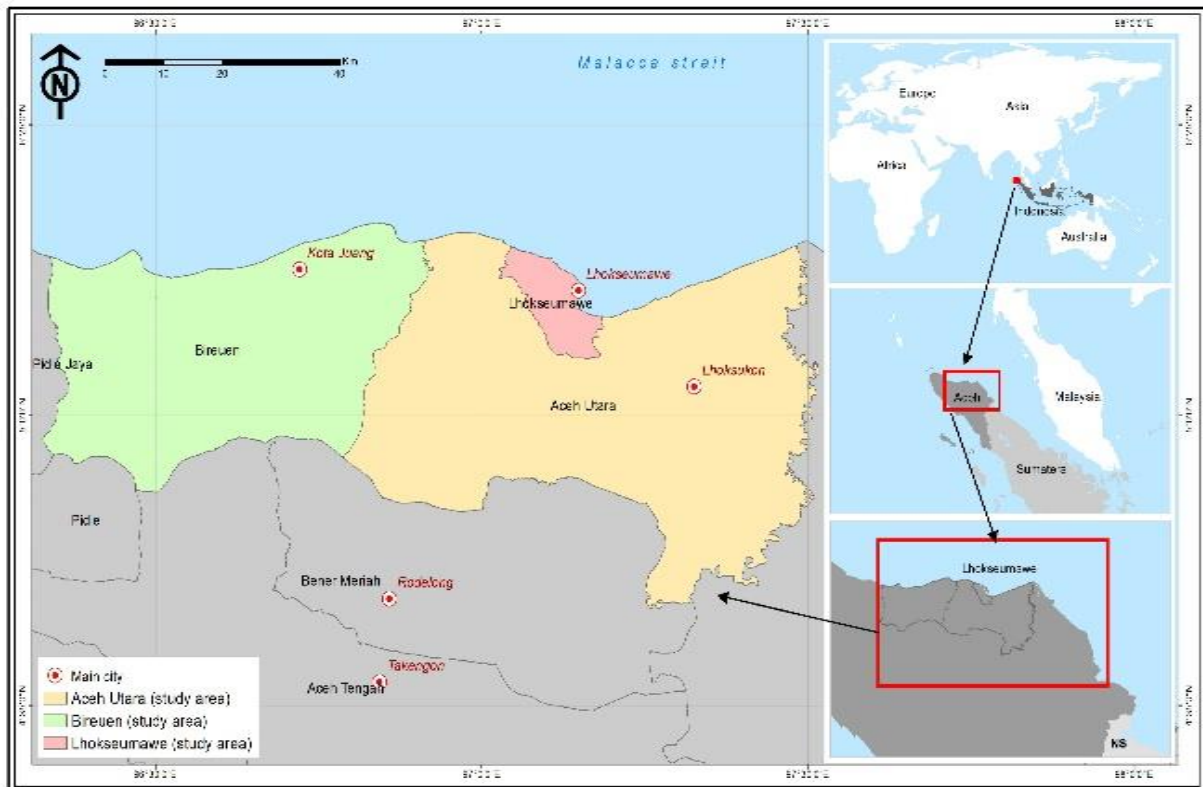


Figure 1. Map of location sampling

3. RESULTS AND DISCUSSION

The survey method used in this study aims to analyze the quality of the environment and heavy metal contamination on the surface of the water and clean water. Also, an analysis was conducted to analyze heavy metal pollution in sediments and odor in clean water. The analysis was carried out in stages that were adjusted to the environmental conditions of the study. Analysis by testing surface water samples is implemented to determine the level of heavy metal pollution caused by industrial activities. Water sample testing is executed at four locations as shown in Figure 2.

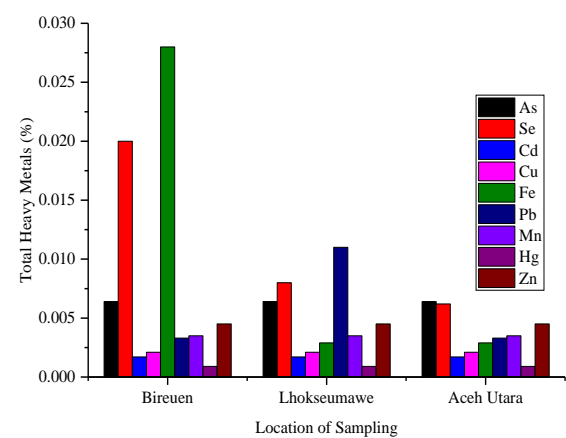


Figure 2. Heavy metals in the surface of the water for different places

The highest heavy metal pollution such as Fe and Se was found in samples taken from the Bireuen Regency. The highest Pb heavy metal was recorded in the Muara Dua area of Lhokseumawe City. As for the heavy metals and Hg show evenly at the four locations where the survey was conducted. Heavy metal pollution in the Samudra region is lower than in Lhokseumawe City as a whole. Investigations regarding heavy metals have also been carried out by several previous researchers. However, in general, previous research was carried out at different locations and places. Thus, results reported also have differences and the levels of heavy metals found are also different.

Furthermore, an analysis was carried out to determine the level of heavy metal pollution in clean water in three different districts which were the study sites. The level of heavy metal pollution in the three regions shows that it has been contaminated in general. However, heavy metals such as the lowest Pb were found in the Aceh Utara region compared to Bireuen District and Lhokseumawe City. While heavy metals other than Pb show the same results for the three regions shown in Figure 3. Industrial activities that do not pay attention to the surrounding environment have an impact on pollution to the environment, especially clean water. Therefore, to prevent the increase in pollution in the future it is necessary to have supervision and policy from the government. With effective supervision, environmental pollution can be reduced and the availability of clean water sufficient. Good environmental conditions also greatly affect human health.

Meanwhile, the analysis of heavy metals in clean water has been carried out. This can be caused by several factors including the lack of supervision and policies from the government. Besides, the lack of awareness from industry managers on environmental conditions and also increasing population. Increasing the population also increases the amount of waste. Waste discharged without good management can cause pollution thereby increasing heavy metals in clean water and surface water. Thus, to reduce environmental pollution, awareness is needed from various parties, especially from the public, industry managers, and also governments who are sensitive to waste management. Analysis of heavy metals in clean water has also been carried out by (R. Li *et al.*,

2020). Where results are reported that heavy metals in water are lower than sediment. While research conducted by (Kumar *et al.*, 2019), reported that heavy metals such as Cr, Ni, As and Cd have a very high risk of cancer occurring through consumption compared to the dermal route. Analysis of heavy metals in the Shagan River conducted by (Gorlachev *et al.*, 2020) it is reported that the Shagan River has been contaminated by high enough heavy metals.

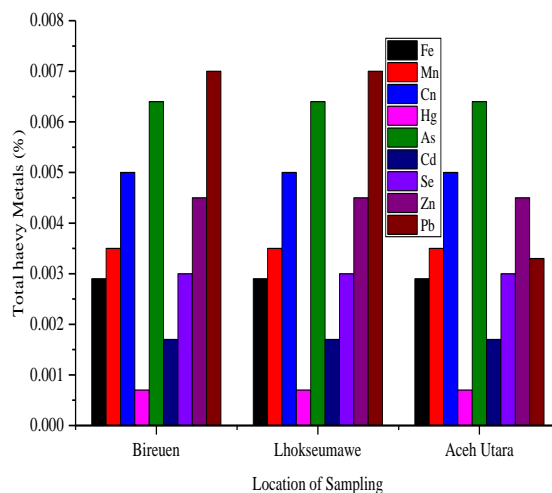


Figure 3. Total heavy metals for different locations

Environmental pollution caused by industrial activities has affected several needs of living things. In addition to heavy metals that are contaminated with water can also cause changes in the smell of water. The highest level of water odor found in ammonia for Bireuen District and followed by Lhokseumawe City and Aceh Utara are shown in Figure 4. Of the five categories analyzed, hydrogen sulfide showed the second-highest after ammonia. While for the methyl sulfide, methyl mercaptan and styrene categories showed the same results in the three regions studied. The smell of clean water also determines whether or not the water can be consumed. However, in reality in the last few years, clean water has been contaminated so that the smell of clean water has changed. This happens because the source of clean water has been damaged by people who seek their benefits. So to reduce this happening in the future there must be better supervision. This supervision can be done by providing regulations for environmental protection. So that environmental awareness can be further increased.

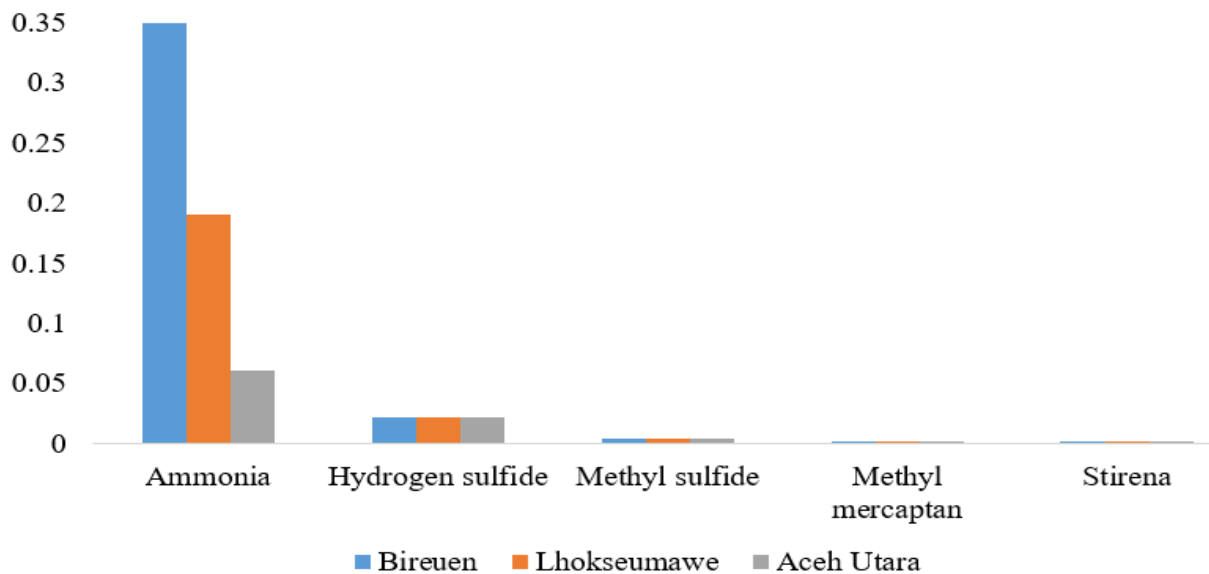


Figure 4. Total odor in the water for different districts

Heavy metal sediment analysis was also carried out in this study. Sediment samples were taken at three different locations with the same regency as in the surface analysis of water and clean water. The highest total sediment heavy metals were found in Aceh Utara District and followed by Lhokseumawe City and Bireuen District. Heavy metal Cu which reaches 45.02% is recorded in Aceh Utara Regency 25% higher than Lhokseumawe City are shown in Figure 5. Overall sediment heavy metals found in Aceh Utara show higher compared to Lhokseumawe and Bireuen.

This increase is very closely related to higher industrial activity in the Aceh Utara region. Industrial managers in the area do not consider environmental conditions. Besides that, the garbage thrown away by the surrounding community is also one of the problems that have not been resolved. While the level of sediment heavy metal pollution in the Bireuen Regency shows that it is still stable and is still at a safe point. So that the environmental conditions in this region must always be maintained and preserved.

Analysis of heavy metals in sediments has been carried out at different locations and case studies. However, in general, the results reported indicate that the level of contamination that occurred has been at a very alarming level. Analysis of heavy metals such as Cd, Cr, As, Cu, Hg, Ni, Pb, and Zn in Taihu Lake sediments as carried out by (Niu *et al.*, 2020). The results of the analysis carried out

that the level of pollution was found to reach 53.6%, 34.9%, and 18.7%. Also, there are several studies of heavy metals in sediments (Dai *et al.*, 2018; Lee *et al.*, 2019; Xia *et al.*, 2018; Yan *et al.*, 2020). Based on the results of several studies in general, reported that the location of the case studies analyzed was contaminated by heavy metals. However, the level of pollution reported indicates a different level. Several policies and supervision to reduce the level of pollution have also been implemented including policies made by stakeholders and the government. These policies such as prohibitions and fines to industrial managers.

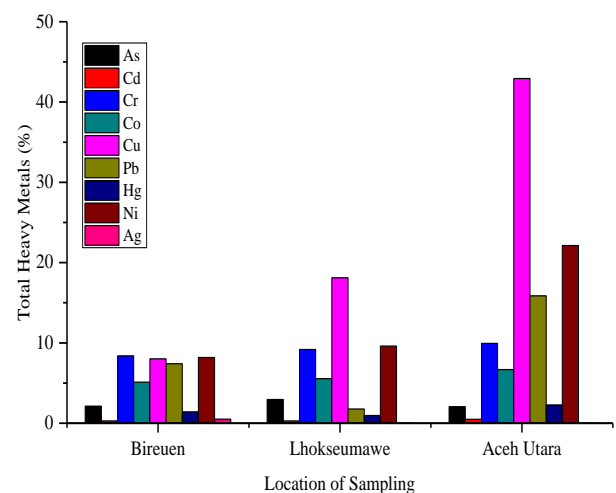


Figure 5. Total heavy metals in the sediment for different districts

Analysis by conducting a direct survey of spaciousness aims to determine the level of environmental conditions in the region. The analysis of this survey can be used as a material consideration for industrial development in the future. This analysis is very important so that when industrial development is truly carried out steps and supervision can be carried out on reducing pollution caused by various industrial activities. Thus, good and healthy environmental conditions can always be maintained in the future.

4. CONCLUSION

Analysis of environmental conditions by conducting field surveys directly has been completed. The highest pollution of heavy metals at the surface of the water by 0.28% was found in Bireuen District. The highest heavy metals such as Fe and Se, respectively 0.28 and 0.02%. While in Lhokseumawe City Fe 0.0029% and Se 0.008%, and North Aceh Fe 0.0029% and 0.0062%. The highest heavy metal pollution found in clean water for Bireuen and Lhokseumawe is Pb and As respectively 0.007% and 0.0064%. Whereas the heavy metals found in clean water in northern Aceh are As and Cn respectively 0.0064% and 0.005%. The highest sediment heavy metal with Cu type of 42.93% was found in Aceh Utara. While in Bireuen and Lhokseumawe they were 8.02% and 18.12%, respectively. Also, heavy metals such as Pb and Ni in North Aceh were highest at 15.87% and 22.13% compared to Bireuen and Lhokseumawe.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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