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Analysis of Illegal Gold Mining (PETI) Impact on The Environment with TDS, TSS, Mercury and Cyanide Parameters in Water and Sediment of Cikaniki River

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Abstract – Gold production from artisanal mining extraction reaches 120 tons annually, providing significant environmental and economic impacts for the community. The processing method used triggers environmental pollution, because it produces tailings in the form of metal mercury and cyanide. This research was conducted at the location of post Illegal gold mining (PETI), although PETI activities have been disciplined, but based on the characteristics of mercury which is difficult to dissolve in water, easily binds to suspended solids and easily deposited to the bottom of the waters, can pollute river sediments. The purpose of the study was to determine the levels of Total Dissolved Solid (TDS), Total Suspended Solid (TSS), mercury and cyanide in the Cikaniki River Watershed, based on Government Regulation No. 22 of 2021. The purposive sampling method was used in determining the sampling location at 3 observation stations for surface water and sediment, namely station 1 area where is former gold processing. Station 2 river body where former PETI produces mercury waste, station 3 is a place where there is no gold processing. TDS and TSS measurements using the gravimetric method, mercury and cyanide levels using ICP-OES. The results of laboratory sediment analysis of 3 observation location in Cisarua Village, Curug Bitung Village, and Lukut Village, for the TDS and TSS parameters, mercury was detected at the highest level at point 3 in Lukut Village. Luku Village is the most downstream location of the Cikaniki River which is located very far form the people's gold processing site. This concludes that after PETI activities occur, the distribution of mercury (Hg) waste spread to the most downstream areas of the Cikaniki River is always present even though its presence is still below environmental quality standards.

Keywords : cyanide, environmental, mercury, illegal gold mining, river.

Introduction

Indonesia's abundant natural resources in the from of minerals provide promising opportunities. So far, the mining sector has contributed greatly to state revenue. As of 2020, Non-Tax State Revenue (PNBP) touched 70% in the non-hydrocarbon sector. According to 2021 data, that the mining and extraction industry of gold and its follower minerals (dmp) contributes significantly to the country's economy, through taxes or Non-Tax State Revenue (PNBP). In 2022 PNBP from gold commodities, in the form of royalties and fixed fees received by the state, which is IDR 2.4 trillion, increased by 24% from the PNBP received by the state in 2019. However, in reality, the existence of Illegal artisanal mines or often called Illegal Gold Mining is increasingly widespread. In 2020, the results of synchronizing PETI inventory data by the Ministry of Energy and Mineral Resources, it was found that 18 PETI sites were located in Contract of Work (CoW) and mining business license areas. While PETI located outside the Mining Business License Area (WIUP), located in 13 provinces (Ditjen Minerba, 2021).

One of the provinces that has the largest gold abundance is West Java Province, this is in accordance with the MEMR report in 2021. The gold deposits produced from primary ore sources that experience the largest

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anomalies are in the Bogor Regency area, and currently the mining activity project is under the authority of WIUP PT ANTAM UBPE Pongkor. This gold mineral deposit was discovered by the geomine unit in 1981, which was then carried out a feasibility study, in 1992 a permit was granted to carry out development activities, and began to carry out production operations in 1994, two years after that the opening of lombong on ores that have a high level of geological confidence. In 1998-2016, there were many gold extraction activities from PETI activities in the Cikaniki River area in Bogor Regency. Illegal Gold Mining (PETI) activities usually use amalgamation and leaching processing methods. The amalgamation method is a type of method that uses the electrostatic force properties of mercury, conduction electrons that work to bind the gold component. (Sumarjono, 2020). The leaching method uses cyanide as a binder for the gold component. Illegal Gold Mining in Cikaniki River has the potential to be polluted by mercury and cyanide resulting from gold ore processing activities. Mercury in soil can migrate to groundwater through cracks carried by rainwater that seeps into the soil, then absorbed by plants and accumulated in fruits and seeds which are then consumed by herbivorous species (Mantey *et al*., 2020).

Mercury (Hg) is a toxic heavy metal element that can damage ecosystems and even living things including humans, animals, and plants (Mirdat *et al*., 2013). Mercury is emitted into the atmosphere from both natural and anthropogenic sources and deposited into terrestrial and aquatic ecosystems after long-distance migration. An estimated 2,320 tons of Hg are released into the atmosphere worldwide each year, mainly through artisanal gold mining, cement production, fossil fuel combustion, non-ferrous metal production, pig iron and steel production, and waste disposal (Pirrone *et al*., 2010). Metal Hg can enter the surrounding water environment through atmospheric deposition rainfall-runoff and leachate, contaminating water bodies. After entering into water bodies, some Hg may be deposited into sediments and then converted into the more toxic MeHg. MeHg can be accumulated and magnified by the food chain, leading to potential ecological risks (Zhang *et al*., 2022).

The river that flows through several villages in Nanggung District, Bogor Regency, West Java is a river that is utilized by local residents. The utilization of river water is used for agricultural, fisheries and household activities, Gold ore processing in Ciguha Village is carried out in the river using gelundung, mercury metal used to separate gold is around 0.5 - 1 kg for 1 gelundung has a capacity of 8 - 12 kg, there are more than 900 gelundungan used for gold ore processing which requires 16.2 tons / month of mercury metal (Halimah, 2002). According to (Yoga *et al*., 2014) in their research, the concentration of mercury in the Cikaniki River as a result of PETI has exceeded the concentration of Hg that is safe for aquatic ecosystems. The mercury concentration causes bioaccumulation in Trichoptera biota. In general, mercury in the form of elemental Hg (Hg°) which has a high density enters river waters, so that the mercury will sink at a depth of 5-15 cm below the sediment surface (Kitong *et al*., 2012). In water, mercury is methylated by bacteria in sediments to produce methyl mercury and accumulates in organisms such as fish (Liu *et al*., 2012). The results of research by Nst *et al*., 2012 mentioned that the concentration of mercury in Cikaniki River water has exceeded the quality standards of National and International standards, the mercury levels in river water in June and September were TDS - 0.046 ppm, and 0.002 - 0.265 ppm, while the concentration of mercury in sediment in June <0.0002 - 114.713; September 4.39 - 196 ppm. (Hidayati *et al*., 2009), has conducted research on mercury analysis along the Cikotok and Cikaniki Rivers, resulting in mercury levels in sediments of 0.1 ppm Hg and 0.15 ppm CN. Cikaniki River sediment is the main river in the PETI area. In addition, the Cipanas River sediment was contaminated with mercury at 27.61 ppm.

The PETI contest in Pongkor is one of thousands of small-scale gold mining sites across Indonesia. A special licensing system for small-scale mining or artisanal mining is set out in Law No. 3 of 2020 on Mineral and Coal Mining, but very few sites have obtained licenses. Difficulties are faced by communities in adjusting to the technical requirements of the regulated policy, hence the prospects for formalization often seem slim. As such, Illegal gold mining has grown and flourished over the past two decades, causing lasting friction with industrial operations (Libassi, 2024).

Although PETI activities in Ciguha village were curbed in 2016, based on the characteristics of mercury which is difficult to dissolve in water, easily binds, easily associated with suspended solids and easily settles into the water substrate, so it can pollute and accumulate in river sediments. (Nst *et al*., 2012). Illegal mining also often damages the environment, which can make the government pay more to repair and manage the damage. Therefore, based on this background, research is needed to determine the water quality of the Cikaniki River based on the parameters of TDS, TSS, mercury and cyanide levels in water and river sediments.

Materials and Methods

Tools and Materials

The tools used in testing water and sediment samples of Cikaniki River based on TDS, TSS parameters are sample bottles, filters, glassware, filter paper, ovens, PVC pipes, Generator Continous Flow Hydrid System Inductively Coupled Plasma Optical Emission Spectrophotometer (ICP - OES) Cold Steam. The materials used are water and sediment samples from 5 location points, and HNO3.

Research Location

The observation location was carried out along the Cikaniki Watershed in the upstream, middle, and downstream areas of Nanggung District, Bogor Regency. Determination of the sampling location was determined using purposive sampling method, namely the sampling point or location was determined based on the desired objectives. This research method uses quantitative methods. In this study, 3 observation stations for surface water (AP) and sediment (S) sampling were conducted referring to (Yoga *et al.*, 2014)(Tabel 1) and information from community leaders. Station 1 of the Cikaniki River body is a former PETI site that produces mercury and cyanide waste (AP1 and S1). Station 2 is a former PETI site that produces mercury and cyanide waste (AP2 and S2). Station 3 is the downstream area (AP3 and S3). The sampling locations can be seen in Figure 1.

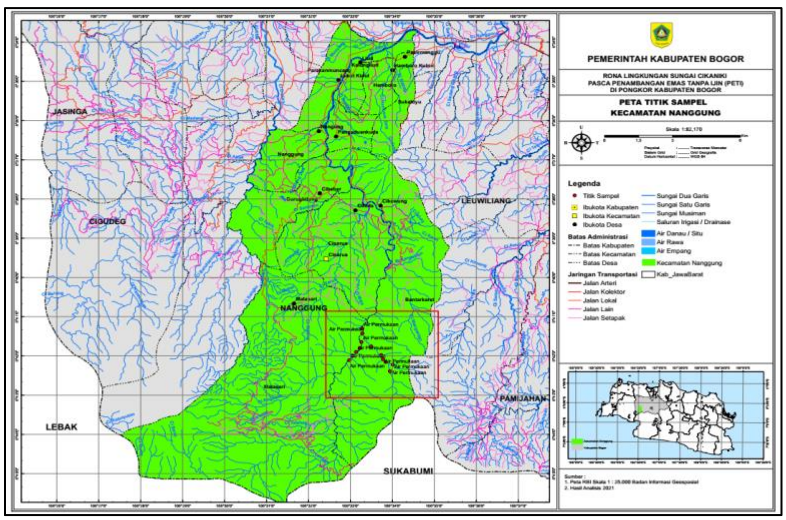

Figure 1. Sampling Location

Table 1. Details of Sampling Location

No	Location Name	Coordinate Point
1	Cisarua (Area/location of former Illegal gold processing)	6° 38' 15,16" LS 106° 33' 39,7" BT
2	Curug Bitung (Area/location of gold processing without a permit)	6° 37' 1,7" LS 106° 32' 31,4" BT
3	Lukut (Area/location where there are no gold processing activities)	6° 34' 47,85" LS 106° 32' 51,56" BT

Water and Sediment Sampling

Sampling was carried out at 3 point locations from upstream to downstream of the river, each of which took 1 water sample and 1 sediment sample. The first step was taken as many as 6 samples from 3 location points for testing TDS, TSS, mercury and cyanide. Samples of 50 ml were used for testing TDS, TSS, 2 gr sediment samples and 100 ml of water were used for testing mercury and cyanide levels. Water samples were taken using a water sampler in a grab sampling manner, put the sample into a bottle and put in a cool box then taken to the laboratory for analysis. Sediment samples were taken using an Ekman grab and Polyvinly Chloride (PVC) pipe at a sample point depth of 5-10 cm. Samples from each point were mixed and put into sample containers that

doi: 10.13170/aijst.14.1.43432

had been marked, then put into a cool box, and taken to the Karsa Buana Lestari (KBL) laboratory for analysis. The water and sediment quality parameters tested and the methods used for analysis can be seen in Table 2:

Table 2. Water and Sediment Quality Parameters tested and Analysis Methods

Test Parameters	Methods
TDS (water)	SNI 06-6989.27-2005
TSS (water)	SNI 06-6989.3-2004
Mercury (water and sediment)	IK No. 19-105/IK (ICP-OES, 2021)
Cyanide (sediment)	HACH Method 8027

TDS Measurement on Water (SNI 06-69(89.27-2005)

Shake the test sample until homogeneous, pipetted as much as 50 mL and put into a filtering device that has been equipped with a suction pump and filter paper. After the example is filtered, rinsing is carried out three times. The filter and rinse water were transferred into a fixed weight cup, then evaporated to dry. The dried test cup and sample, containing dissolved solids, were placed in an oven at 180 0C ± 20C for one hour. The cup is cooled in a desiccator, then weighed with an analytical balance. The test results are in the form of TDS levels in mg/L.

TSS Measurement on Water (SNI 06-6989.3-2004)

Filtered test samples using vacuum, the filter results are moistened with water and then stirred with a magnetic stirrer to make it homogeneous. Pipetted samples, filter paper washed with distilled water, allowed to dry completely. Vacuum filtration was continued for three minutes. The filter paper was removed and dried in an oven for one hour at 103 0C - 105 0C, then cooled in a desiccator and weighed to a fixed weight. The test results are TSS levels in mg/L.

Measurement of Mercury levels in Water (IK No. 19-105/IK (ICP-OES, 2021)

The filtered test sample is prepared with a 0.45 m porous membrane filter and preserved. Put 100 mL of test sample containing < 1.0 g mercury into a 300 mL bottle or similar. Added 5 mL concentrated sulfuric acid and 2.5 mL concentrated nitric acid, shaken after each addition. 15 mL of potassium permanganate solution is added to the bottle. Make sure to add the same amount of potassium permanganate to the standard or blank. Shake and add potassium permanganate if needed until the purple color persists for 15 minutes. Added 8 mL of potassium persulfate to each bottle and then heated for two hours in a water bath at 95∘C. The test sample was cooled then 6 mL of sodium chloride-hydroxylamine sulfate solution was added to reduce the excess permanganate. The test samples were analyzed using the ICP OES/ICP AES Continuous Flow Hydride Generator cold vapor technique.

Measurement of Mercury leves in Sediments (IK No. 19-105/IK (ICP-OES, 2021)

Weighed 2 grams of sample was put into the bottle, added 5 mL of distilled water and 5 mL of aqua regia solution. Heated on a water bath at 95oC for two minutes. The sample was cooled then added 50 mL of distilled water and 15 mL of potassium permanganate solution in each bottle. Shaken then placed back on the water bath for 30 minutes. The test sample was cooled then added 6 mL of sodium chloride-hydroxylamine sulfate solution to reduce excess permanganate. Measured in a 100 mL measuring flask with mineral-free water. The test sample is ready for analysis using the ICP OES cold vapor technique Continuous Flow Hydride Generator.

Measurement of Cyanide Content in Water

The sample was pipetted as much as 10 mL into the tube vessel and then added 1 sachet of CyaniVer 3 reagent and homogenized for 30 seconds. Then it was allowed to stand for 30 seconds. After that, 1 sachet of CyaniVer 4 reagent was added and homogenized. Then, 1 sachet of CyaniVer 5 reagent was immediately added and homogenized. The solution was allowed to stand for 30 min (until the color changed from pink to blue). The solution was measured at a wavelength of 612 nm. The concentration was measured directly by the spectrophotometer.

Aceh Int. J. Sci. Technol., 14(1) 74-83
April 2025
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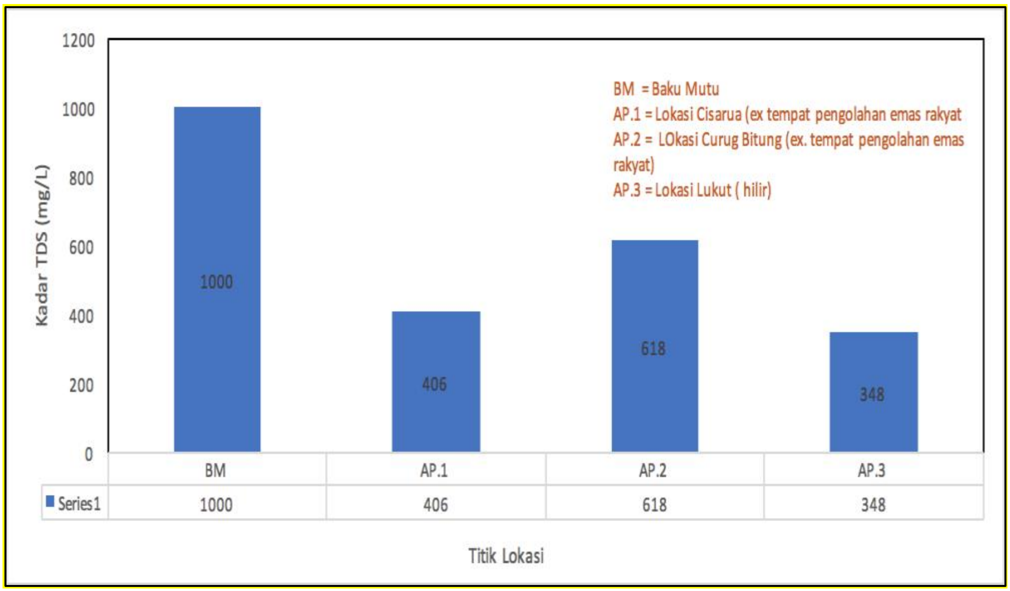
Measurement of Cyanide level in Sediment

The test sample was dissolved in a vessel and then placed in an extractor and ready to be extracted for 18 hours at a rotating speed of 30 rpm ± 2. The extracted solution was removed and filtered, and the filtered liquid was collected for analysis. The next step follows the procedure for measuring cyanide levels in water samples.

Results

Surface Water Quality in the former PETI area along the Cikaniki river in 3 (three) locations covering the upstream to downstream of the Cikaniki river, namely in Cisarua, Curug Bitung and Lukut. Water quality sampling is carried out at points that are estimated to be affected by PETI activities by paying attention to regional representation of activities. The results of surface water quality analysis based on TDS and TSS parameters can be seen in Figure 2.

(a)



(b)

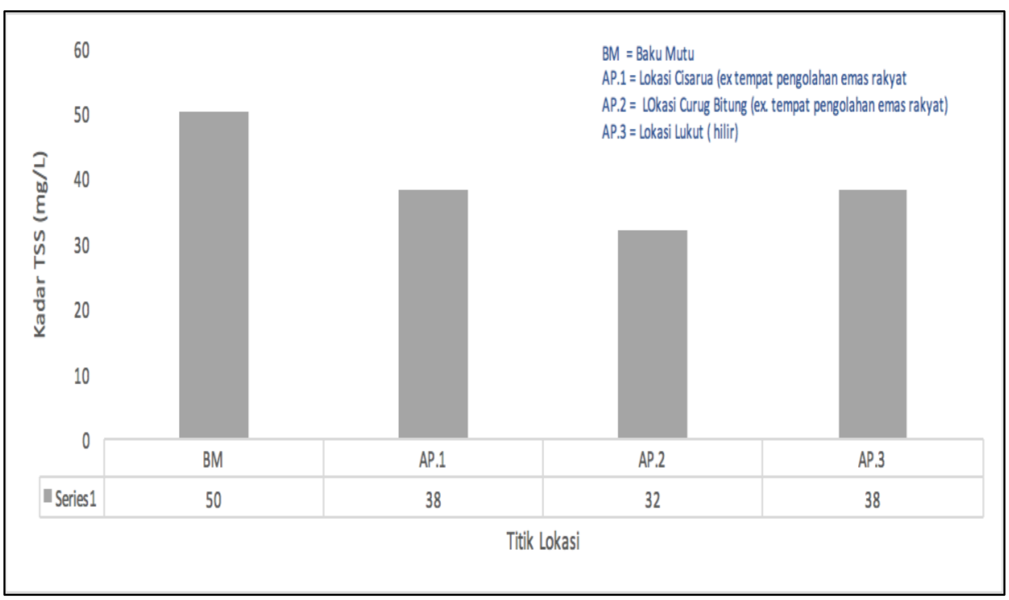


Figure 2. (a) TDS level in river water (b) TSS level in Cikaniki River

Aceh Int. J. Sci. Technol., 14(1) 74-83
April 2025
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Description of location points :

a. AP.1: Cisarua Village, Bogor Regency (Former PETI site)
   Coordinates (S: 06°38'15,16" E: 106°33'39,70")
a. AP.2: Curug Bitung Village, Bogor Regency (Former PETI site)
   Coordinates (S: 06°37'01,70" E: 106°32'31,40")
b. AP.3: Lukut Village, Bogor Regency (the most downstream area)
   Coordinates (S: 06°34'47,85" E: 106°32'51,56")

PETI activities were busy being carried out by local communities and people outside the area starting from 1998 until 2016, making the Cikaniki River polluted by mercury waste along the Cikaniki River and its surroundings, which will have an impact on the health level of the people who use the water.

Total Dissolved Solid **(TDS)**

TDS in all observation locations ranged from 348 mg/L - 618 mg/L. For surface water sampling location point 1 (AP1) is in the Cikaniki River, precisely in Cisarua Village, Bogor Regency, which in 1998 until 2016 was a place for people's gold processing with coordinates S: 06°38'15.16” E: 106°33'39.70 ”, from the results of laboratory analysis for surface water samples at point AP1 Cisarua Village TDS content of 406 mg / L, for the location of surface water sampling at point 2 (AP2) is on the Cikaniki river in Curug Bitung Village, Bogor Regency which according to local community leaders as a location for smallholder gold processing (PETI) in 1998 until 2016 with coordinates S: 06°37'01.70 ”E: 106°32'31.40”, from the results of laboratory analysis of surface water for TDS content at point AP 2 amounted to 618 mg/L. For the location of the surface water observation point at location 3 (AP3) is in Lukut Village, Bogor Regency which is the most downstream area of the Cikaniki River with coordinates S: 06°34'47.85” E: 106°32'51.56” from the results of laboratory analysis for surface water TDS content at point AP 3 amounted to 348 mg/L. The highest TDS content is found in location 2 (Curug Bitung village) at 618 mg/L which is a former community gold processing area. The range of TDS values for the 3 locations in the study area are all (3 locations) below the quality standards allowed according to PP-RI No. 22 of 2021 concerning National Water Quality Standards, which is 1,000 mg/L. The low level of TDS at the observation location is an indication that PETI activities no longer exist, it can be seen by the clear water color.

Total Suspended Solid **(TSS)**

TSS at all observation locations ranged from 28 mg/l - 38 mg/l. For surface water sampling location point 1 (AP1) is in the Cikaniki River, precisely in Cisarua Village, Bogor Regency, which in the 1998s until 2016 was a place for people's gold processing with coordinates S: 06°38'15.16” E: 106°33'39.70“, from the results of laboratory analysis for surface water samples at point AP1 Cisarua village TSS content of 38 mg/L, for the location of surface water sampling at point 2 (AP2) is in the Cikaniki river in Curug Bitung Village, Bogor Regency which according to local community leaders as a location for smallholder gold processing (PETI) in the 1998s until 2016 with coordinates S: 06°37'01.70” E: 106°32'31.40”, from the results of laboratory analysis of surface water for TSS content at point AP 2 amounted to 32 mg/L. For the location of the surface water observation point at location 3 (AP3) is in Lukut Village, Bogor Regency which is the most downstream area of the Cikaniki River with coordinates S: 06°34'47.85” E: 106°32'51.56” from the results of laboratory analysis for surface water TSS content at point AP 3 amounted to 28 mg/L.

The highest TSS value is at location AP1 (Cisarua village) which is a former smallholder gold processing area. The range of TSS values for the 3 locations in the study area are all (3 locations) below the quality standards allowed based on PP-RI No. 22 of 2021 concerning National Water Quality Standards, which is 50 mg/l. The low level of TSS at the observation location is an indication that PETI activities no longer exist, it can be seen by the clear water color.

Based on the results of laboratory analysis of mercury (Hg) metal parameters at 3 (three) points of surface water observation locations, the mercury content in the river is still below the quality standard according to PP 22 of 2021 Appendix VI.1 regarding water quality standards and the like, so there are several possibilities that heavy metal mercury has been distributed / spread to downstream areas, besides that the strong current of the Cikaniki river can accelerate the distribution of mercury to places that are more downstream in the Cikaniki river.

Aceh Int. J. Sci. Technol., 14(1) 74-83
April 2025
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Based on the results of research (Veiga *et al*., 1995), this happens because Hg that settles with sediments along the river creates a "hot spot" of pollution between the estuary area and the mining activity area, especially in rivers that are not heavily flowed or on riverbeds with sloping topography. Another possibility is that mercury has accumulated in the bodies of aquatic life such as fish, and another possibility is that mercury has been absorbed by plants, and deposited into the soil.

In river water there are colloidal particles that come from the erosion of rocks and suspended fine soil parts. These particles can absorb heavy metal ions that pollute the water. The heavy metals combine with solid particles and settle into sediments. When entering water bodies, heavy metals will undergo the process of precipitation, dilution and dispersion, adsorption and absorption by aquatic organisms (Connell and Miller, 1995).

Mercury (Hg) and Cyanide (CN) levels in River Sediment samples

The sediment samples analyzed consisted of 3 sampling points scattered within the Cikaniki river basin. The results of testing sediment samples at 3 (three) sampling locations showed mercury levels ranging from 0.004 - 0.007 mg/L as shown in Table 3. The largest mercury metal content was found in samples taken at Lukut.

Table 3. Sediment Sample Analysis Results

No.	Parameters	Unit	Analysis Results			PP RI No. 22 Tahun 2021
			S4	S5	S6	
1	Hg	mg/L	0.005	0.004	0.007	
2	CN	mg/L	< 0.002	0.003	0.005	

The analysis results show fluctuating values, mercury levels at points S.4 and S.5 are relatively lower than at point S.6. This is because S.4 and S.5 are former Illegal gold processing sites or upstream. The highest concentration is shown at location S.6, namely in the Lukut area which is a downstream area, which previously had no gold processing activities, because mercury has a higher molecular weight and specific gravity than water so that due to the current mercury is carried along with fine sediment particles and tends to settle downstream. This causes the accumulation of mercury downstream to be greater than the previous location which is a gold processing area/location (Nst *et al*., 2012). The mercury levels in the sediment samples were much higher than the mercury levels in the river water samples. This is because mercury is poorly soluble in water, but can easily bind to suspended solids and eventually settle to the bottom of waters and sediments.

The results of the mercury TCLP test on all samples at locations S.4, S.5, and S.6 still meet the TCLP-B quality standard based on PP RI No. 22 of 2021 of 0.05 mg/L. The results of the analysis obtained a TLCP value, which meets the quality standard with a much lower mercury content value in sediment. In general, the levels of heavy metals of mercury in sediment at each sampling point show numbers that are still below the sediment quality standards. This shows that the heavy metal mercury in sediments and the distribution of mercury in sediments have the potential to harm the environment. Low levels of mercury in sediments can result from the accumulation of mercury metal in aquatic organisms. People's gold mining activities can cause Hg and CN levels to be in river sediments (Widiastuti, 2018). Mercury metal pollution has a great influence on the ecosystem due to the stable properties of mercury metal in sediments. Sediments have a high ability to accumulate pollutants including heavy metals compared to river water. Accumulation occurs through *ion exchange* processes such as the exchange of chloride, sulfate, and carbonate ions contained in soil or sediment in rivers, which are colloids sourced from eroded rocks and suspended soils. These colloidal particles have the ability to adsorb heavy metal pollutants, then undergo precipitation, dilution is subsequently absorbed by organisms living in the waters. The low solubility of mercury metal in water, so that it is easily absorbed and bound to organic and inorganic compounds and accumulates in the body tissues of aquatic organisms, this is a factor causing the increasing mercury content in sediments in rivers (Wang *et al*., 2012).

Based on the analysis, the mercury content in the sediment is much higher than the mercury content in the water. According to Suoth *et al*., 2020, Sediment found at the bottom of the river is a deposit from activities around the river or land that enters the river. The concentration of pollutants in sediment is generally higher than the concentration of pollutants in water, this is because the mobility of water is greater than that of sediment, so that metal pollutants can easily accumulate in the sediment. Strengthened by the statement (Emilia *et al*., 2013), heavy metals in water will experience a dilution process caused by strong currents. In addition, the type of sediment in the river can affect the accumulation of mercury metal in the waters. The finer the type of sediment, the higher the heavy metal content will be because the fine type of sediment has a relatively large oxygen content. If the type of sediment is larger, there are likely to be air pores so that mixing with water can occur and is easily carried away by the current. While in the fine type of sediment, there are many nutrients that are preferred by aquatic biota at the bottom, the levels of heavy metals are higher because the nature of mercury metal is able to bind organic matter so that it can settle in the waters and unite with fine sediment. In addition, heavy metals such as mercury have a higher specific gravity than water, which tends to settle into fine sediment substrates.

Even though PETI activities no longer exist, Hg levels in sediment may increase to high levels or reach dangerous levels if there are illegal activities of gold mining and processing without permits carried out by the community, so it needs to be considered. The statement shows that gold extraction by the amalgamation technique can result in sediment in the river around the former mine being contaminated by mercury, sediment contaminated with mercury metal can have a negative impact on the environment and be harmful to the people around the river. Mercury metal can undergo a process of bioaccumulation and biomagnification because mercury metal is degraded by bacteria found in sediments in waters, so it can cause very harmful and detrimental effects for aquatic organisms such as fish and can even harm humans if the fish is consumed or enters the food chain system, and can accumulate in the human body. According to (Palar, 2008), The third most toxic element to humans is the metal mercury (Hg). Mercury compounds can cause several diseases such as hair and tooth decay, memory loss and nervous system disruption (Setiabudi, 2015).

Discussion

TDS and TSS values are presented in Figure 2, the results of sediment sample analysis in Table 3. Based on the environmental assessment of PETI activities around Cikaniki River, it shows that these activities have a negative impact on the surrounding environment.

Correlation between environmental damage caused by PETI activities in accordance with research (Tomiyasu *et al.*, 2013). The study was conducted around PETI along the Cikaniki River, West Java, on the distribution of mercury in soil, sediment and river water. However, temporal differences provide different research results because this study uses data from 2015 and 2021. Therefore, the significance of the data processing results regarding the sediment analysis results to the observation location is different.

The study (Tomiyasu *et al.*, 2013) found that the concentration of mercury in the Cikaniki River water was 9 times higher than the environmental standard in Indonesia, the concentration of mercury was also found in the forest soil which was about 20 times higher than the maximum permitted level in Indonesia. While the results of this study show that the highest mercury parameter was detected at observation point 3 in Lukut Village, Lukut Village is the most downstream location of the Cikaniki River which is located very far from the people's gold processing site.

This research is monitoring the water quality of the Cikaniki River, so it is necessary to monitor the Cikaniki River every period with the parameters of TDS, TSS, mercury and cyanide in the water and sediment of the Cikaniki River. Collaboration is needed between this research and the Public Health Institute to analyze mercury in humans or living things such as fish.

Conclusion

The results of sediment analysis in the laboratory of 3 observation locations in Cisarua Village, Curug Bitung village and Lukut village, for mercury parameters detected the highest presence in the observation location point 3 in Lukut Village, Lukut Village is the most downstream location of the Cikaniki river which is located very far from the people's gold processing site, this concludes that after PETI activities there is a distribution of mercury (Hg) waste distribution to the most downstream areas of the Cikaniki river even though its presence is still below environmental quality standards.

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