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River Water Pollution Control Strategy Due to Coal Mining Activities (Case Study in Kungkilan River West Merapi District, Lahat)

Eddy Suroso[1*], Muhammad Said[1], dan Satria Jaya Priatna[1]

[1]*Program Pengelolaan Lingkungan, Pascasarjana Universitas Sriwijaya*
**Corresponding Author: hisyameddy@gmail.com*

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Abstract: Kungkilan River is under the administration of West Merapi Sub-district, Lahat, which is potential to degrade its water quality, resulted from the activity of coal mining. This research is aimed to analyze the quality of water in Kungkilan River in every segment of coal mining campany and proposing a recommendation of management strategy of river pollution. This research applied the descriptive analysis with the quantitative approach using sample survey method. The analysis of the recommendation of management strategy of river pollution was conducted through SWOT method. The sample of water in Kungkilan River was collected from 5 stations. The sample of waste water was collected from 7 spots of Sludge Sedimentation Pond of the coal mining campany. It was collected during the dry and rainy season. It can be concluded that the quality of water in Kungkilan River has been degrading right after streaming through the area of coal mining. In the dry season, each segment meets the calculation of the capacity of water pollution for TSS parameter, while in the rainy season, segment IV exceeds the capacity. In the rainy season, the quality of water in Kungkilan River in the station S-02, S-03 and S-04 encounters a self-purification process, while in Station S-05 is in the condition of moderate pollution. Based on hose finding, it is recommended that the management strategy of Kungkilan River pollution can be conducted through having research on the determination of water classification and the capacity of water pollution in Kungkilan River and supervising the quality of water periodically and continually; improving the frequency of supervision by PPLH/PPLHD personnel and functionally; moving the water disposal canal to other spots and conducting vegetation; regulating law administratively, both civil and criminal law, to the companies violating the regulation of water pollution management; and benefitting the CSR program of the company.

Keywords: Kungkilan River, the quality of river, management strategy

Abstrak (Indonesian): Sungai Kungkilan berada di wilayah administrasi Kecamatan Merapi Barat, Kabupaten Lahat yang berpotasi terjadi penurunan kualitas air akibat kegiatan pertambangan batubara. Penelitian ini bertujuan menganalisis kualitas air Sungai Kungkilan di setiap segmen perusahaan pertambangan batubara, serta memberikan rekomendasi strategi pengendalian pencemaran air sungai. Penelitian ini memakai analisis deskriptif dengan pendekatan kuantitatif dengan *sample survey method*, dan analisis rekomendasi strategi pengendalian pencemaran air dengan metode SWOT. Pengambilan sampel air Sungai Kungkilan dilakukan di 5 stasiun, dan sampel air limbah dan/atau air limpasan dari di *outlet* Kolam Pengendap Lumpur (KPL) lokasi perusahaan pertambangan batubara berjumlah 8 dan 7 titik. Pengambilan sampel air limbah dan atau air limpasan, dan air Sungai Kungkilan dilakukan pada musim kemarau dan musim hujan. Dapat disimpulkan bahwa kualitas air Sungai Kungkilan telah terjadi penuruan setelah melintasi kegiatan pertambangan batubara, Perhitungan daya tampung beban pencemaran air untuk parameter TSS, pada musim kemarau di setiap segmen masih memenuhi daya tampung, namun pada musim penghujan di segmen IV telah melebihi daya tampung. Status mutu air Sungai Kungkilan di stasiun S-02, S-03, dan S-04 pada musim penghujan terjadi proses *self purification*, sedangkan di stasiun S-05 tetap dalam kondisi cemar sedang. Rekomendasi strategi pengendalian pencemaran air Sungai Kungkilan, yaitu: melakukan kajian penetapan kelas air dan daya tampung beban pencemaran air Sungai Kungkilan, serta pemantauan kualitas air secara periode dan kontinu; peningkatan frekuensi kegiatan pengawasan oleh personil PPLH dan/atau PPLHD dan berstatus fungsional; pemindahan saluran pembuangan air limbah ke badan air lainnya dan pelaksanaan revegetasi; penerapan sanksi penegakan hukum baik secara administratif, perdata dan/atau pidana bagi perusahaan pelanggar peraturan pengendalian pencemaran air; dan pemanfaatan program CSR perusahaan.

Kata kunci: Sungai Kungkilan, kualitas air sungai, strategi pengendalian

1. Introduction

Lahat coal mining is generally conducted with an open pit mining system. Open pit mining system held in the soil surface will change the landscape and the ecological balance of the soil surface and water bodies. Open coal mining activities are commonly carried out by transfer the material from one location to another, so it will produce emergence of hills or quite deep valleys and destruction of small rivers in the vicinity [16].

Coal mining with open system is a mining activity that has important implications for environmental baseline [19]. The main issue of coal mining activity is the formation of acid mine drainage (AMD). Acid Mine Drainage (AMD) or in the coal mining industry is also called the Coal Mine Drainage (CMD) is an acidic water formed where the reaction between water, oxygen, and rocks containing sulphide minerals as a result of open and closed pit mining activities [10].

Sources of AMD from mining activities, i.e. manufacture of mining roads activities, opening of overburden, mining operations either underground mining or open pit mining, the landfill of overburden (waste dump / disposal area), the location of the storage / accumulation of coal (stockpile), and tailings disposal sites [3]. AMD within in the mine pit surface, middle and bottom/sediment have physical and chemical characteristics, such as the parameters of pH, Fe, Mn, and TSS [5]. The probability of acid mine drainage in the rock pile/overburden is greater, it is because the rocks contain open sulfide elements [6]. At the coal mining site, the most common sulphide minerals found are pyrite and markasit (FeS2) which it present at the coal seams, overburden, and interburden is very significant [11]. AMD in coal mining environments that have low pH and high sulfate characteristics, will causing the dissolution of heavy metal elements [15]. This condition is endangering the lives of aquatic biota include plankton, benthos, fish, plants, and eventually disrupt the human health [3].

In recent years, research about the quality of river water or strategy or control efforts have been done by Herlambang (2006) [4], Rahmawati (2011) [14], Mahyudin, et al. (2015) [9] and Rosiana, et al. (2016) [17]. The study, carried out in general water body that affected by industrial and domestic waste water effluent.

Kungkilan River is a place of collecting, storing and draining waste water and /or runoff water that contaminated from coal mining activities in the surroundings. There are four active coal mining activities located around the Kungkilan River. The active coal mining activities will provide an enormous contribution as a source of pollution for the Kungkilan river. Therefore, in-depth research about water quality of Kungkilan River is needed in order to obtain water pollution control strategy in the Kungkilan River due to coal mining activities.

The purpose of this study is to analyze the waste water quality and runoff from coal mining activities and water quality of Kungkilan River, estimating the pollution load capacity and determine the status of Kungkilan river water quality, and setting the strategy of pollution control of the Kungkilan River.

2. Experimental Sections

The research method used in this study was descriptive analysis with quantitative approach based on the condition of river water quality and recommendation analysis of water pollution control strategy was carried out with a SWOT analysis (Strength, Weakness, Opportunity, and Threat). This research was conducted in September and December 2016. The length of the river Kungkilan as a test site along the ± 12.3 km in the District of West Merpai, Lahat.

2.1. Sampling location

The sampling method is done by setting the sampling stations of water called sample survey method. Determination of sampling points of Kungkilan River water and wastewater is based on the consideration of the ease of access, cost and time, so that the dots are determined to be the representative quality of waste water and/or water runoff contaminated with coal mining company's activities and Kungkilan River water quality. Sampling sites in the waste water outlet (KPL) and water Kungkilan River in the District of West Merapi, Lahat in this study (Figure 1), as follows:

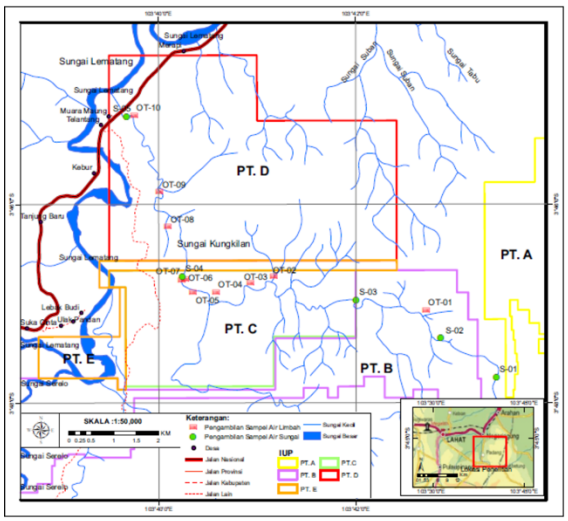

Figure 1. Sampling Map of Wastewater and Kungkilan River Water

1. Station S-01: Water sampling point in upper Kungkilan River prior to being influenced or contaminated by wastewater from the activities of coal mining companies.
2. Station S-02: Water sampling point at Kungkilan River after crossing and / or affected by coal mining

activities of PT. A (PT A. does not have MPA) and before crossing coal mining company PT. B;
3. Station OT-01: Point of sampling of wastewater at MPA outlet of coal mining company PT. B. PT. B only has 1 MPA that flows into Kungkilan River;
4. Station S-03: Water sampling point in Kungkilan River after crossing and affected by PT. B and before crossing coal mining company PT. C;
5. Station OT-02, OT-03, OT-04, OT-05, OT-06 & OT-07: OT-02 and OT-03 Stations: Sampling points of contaminated waste water / comes from PT. C and coal mining company PT. D that flows into the Kungkilan River. OT-04 Station, OT-05, OT-06 and OT-07: Point of wastewater / water runoff contaminated with coal mining activities at MPA outlet PT. C that flows into the Kungkilan River.
6. Station S-04: Sampling point in Kungkilan River after crossing PT. C and partly affected by PT. D, and before crossing coal mining company PT. D;
7. Station OT-08, OT-09, & OT-10: Point of wastewater / water runoff contaminated with coal mining activities at MPA outlet PT. D that flows into the Kungkilan River.

Station S-05: Water sampling point at downstream of Kungkilan River after passing PT. D, a point representing changes in water quality of the Kungkilan River after being impacted by the activities of coal mining companies, and / or downstream waters of the Kunglilan River before being utilized by Muara Maung Village, Merapi Barat District and flowing into the Lematang River.

Table 1. Coordinate Point of Sampling Location of Kungkilan River (S) and outlet (OT) of Wastewater

Segment	Location Name	Coordinate Point	
		S	E
I	S-01	3°47'44,6"	103°43'26,0"
II	S-02	3°47'20,7"	103°42'50,1"
	OT-01	3°47'04,3"	103°42'42,8"
III	S-03	3°47'00,0"	103°42'00,2"
	OT-02	3°46'44,0"	103°41'09,6"
	OT-03	3°46'48,5"	103°40'55,7"
	OT-04	3°46'53,6"	103°40'35,1"
	OT-05	3°46'53,4"	103°40'20,9"
	OT-06	3°46'46,1"	103°40'17,3"
	OT-07	3°46'45,5"	103°40'14,2"
IV	S-04	3°46'43,6"	103°40'14,8"
	OT-08	3°46'14,4"	103°40'06,0"
	OT-09	3°45'53,2"	103°40'00,7"
	OT-10	3°45'06,3"	103°39'45,4"
	S-05	3°45'07,2"	103°39'40,7"

Water sampling point on the Kungkilan river amounted to 5 points. For sampling of wastewater at MPA outlets and / or runoff water contaminated with coal mining activities by 10 points, but due to MPA repair and maintenance activities, removal or change of MPAs, as well as dry MPA conditions, the sampling of wastewater and / or water Runoff contaminated with coal mining activities in MPA outlets is done by 8 and 7 points.

2.2. Collecting Research Data and Sample Analysis

Methods of research data collection conducted by observation, interview, documentation, and literature study, as presented in Table 2.

Table 2. Sample collection method

No.	Data Type	Method
A	Primary data	
	1. Test results of river and wastewater quality samples in the field (insitu) pH parameters, and water discharge, and laboratory (exsitu) parameters TSS, Fe and Mn.	Observation, Documentation, Sampling and Analysis in the Laboratory
	2. Water Pollution Control Policy	Interviews, and Observations
B	Secondary Data	
	1. Industrial Profile, Rainfall, Population and Map	Literature review
	2. Regulation on Water Pollution Control	Literature review
	3. Environmental Feasibility Documents and / or Environmental Permits	Literature review
	4. Result of river water quality monitoring	Literature review

Wastewater and water samples of Kungkilan River are analyzed both in the field (insitu) and in the laboratory (exsitu), as presented in Table 3.

Table 3. Parameters of water quality and analysis method

No.	Parameter	Unit	Methods	
1.	pH	Unit	SNI-06-6989-11-2004/pH Meter	*Insitu*
2.	TSS	mg/l	SNI-06-6989.03-2004	*Exsitu*
3.	Fe	mg/l	SNI-6989.04-2009	*Exsitu*
4.	Mn	mg/l	SNI-6989.05-2009	*Exsitu*
5.	Debit	m^3/dt	Manual Alat *Current meter*	*Insitu*

2.3. Data analysis method

2.3.1. Comparative Analysis of Wastewater Quality Standard (BMAL) of Coal Mining Company

The data of the waste water quality test of the coal mining company is tabulated and compared with the water quality standard that has been determined, based on the Governor Regulation of South Sumatera Number 8 Year 2012 on the Liquid Waste Quality Standard for Industrial, Hotel, Hospital, Domestic and Coal Mining Activities.

2.3.2. River Water Quality Analysis

A. Data from the River Kungkilan water quality analysis are presented in graphic form compared to river water quality standard. Based on the Governor Regulation of South Sumatera Number 16 Year 2005 on Water Allocation and Water Quality Standard of River, Kungkilan River water is set in Class I.
B. Approximate Capacity of Water Pollution Expense based on Decree of State Minister of Environment Number 110 Year 2003 concerning Guidance to Determine Capacity of Water Pollution at Water Source. To estimate the pollution load capacity of river water using mass balance method. The average concentration in the final stream after the flow mixes with the pollutant source with the calculation:

$$C_R = \frac{\sum Ci\ Qi}{\sum Qi} = \frac{\sum Mi}{\sum Qi} \quad (1)$$

Where: CR: The average concentration of constituents for combined flow; Ci: The

concentration of constituents in the i-th flow; Qi: i-flow rate; Mi: Constituent mass at i-th flow. Capacity load of water contamination of Kungkilan River due to coal mining activity is calculated based on TSS parameter. For Fe and Mn parameters cannot be used, because the results of Fe and Mn analysis on wastewater and river water have different requirements. Analysis of Fe and Mn parameters in the wastewater in the form of Fe and Mn total, while in the water of Fe and Mn dissolved.

C. Determining the Status of Water Quality with the Pollution Index (IP) based on Decree of State Minister of Environment Number 115 Year 2003 regarding Guidance on Determination of Water Quality Status. The formula used to determine the level of pollution on the River Kungkilan used formulation as follows:

$$PIj = \sqrt{\frac{\left(C_i/L_{ij}\right)_M^2 + \left(C_i/L_{ij}\right)_R^2}{2}} \quad (2)$$

Where: Lij: The concentration of water quality parameters listed in water quality standard (J); Ci: Concentration of water quality parameters in the field; Pij: pollution index for designation (J); (Ci / Lij) M: Value, maximum Ci / Lij; (Ci / Lij) R: Value, Ci / Lij average. Evaluation of pollution index (PI) or Pollution Index (PI) consists of 4 values of water quality status ie $0 \leq PIj \leq 1.0$ means good water conditions, $1,1 < PIj \leq 5.0$ means lightly contiguous, $5.0 < PIj \leq 10$ means moderately polluted, and $PIj > 10$ means the status of the waters is heavily polluted.

2.3.3. The recommendation of Pollution Control of River Kungkilan was analyzed by using SWOT Analysis.

SWOT analysis is one of the planning models. SWOT analysis can be used as a basis for designing work strategies and programs. The stages of SWOT matrix formulation are SWOT factor selection, SWOT factor rating determination, SWOT factor weight determination [17]. The identification of internal and external factors in the SWOT analysis is used to formulate management strategies [15].

3. Results and Discussion

3.1. Comparative Analysis of Wastewater Quality with BMAL Coal Mining Company

The results of wastewater quality analysis and debit measurements at MPA outlets representing dry and rainy seasons can be seen in Table 4 and Table 5 below. In the dry and wet seasons the characteristic quality of wastewater and / or runoff water in MPA outlets for each parameter has no significant difference, but that distinguishes the flow of waste water and / or runoff water. For TSS parameters as a whole still meet BMAL, but pH, Fe, and Mn parameters in some MPA outlets do not meet or have exceeded BMAL.

Table 4. Results of Wastewater Quality Analysis at Research Sites (Sepetember 2016)

No	Parameter	Unit	Analysis Result/Measurement								Standar Quality
			OT-01	OT-02	OT-03	OT-04	OT-05	OT-06	OT-07	OT-08	
1	TSS	mg/l	3,5	123	197	3,48	2,45	6,05	3,26	12	300
2	pH	-	3,12	6,45	6,58	6,03	7,87	6,82	5,05	5,31	6 - 9
3	Fe	mg/l	0,4404	9,1367	4,5293	0,0270	0,0209	0,2468	5,3498	1,8211	7
4	Mn	mg/l	7,6177	1,8446	9,8410	6,6699	0,5417	4,8404	7,3887	3,9162	4
5	Debit	m^3/dt	0,0001	0,0030	-	-	-	0,0048	-	0,0015	

Sorce: Primary data, 2016. *) Governor Regulation of South Sumatera Number 8 Year 2012

Table 5. Results of Wastewater Quality Analysis at Research Sites (December 2016)

No	Parameter	Unit	Analysis Result/Measurement							Standard Quality*)
			OT-01	OT-02	OT-03	OT-04	OT-06	OT-07	OT-08	
1	TSS	mg/l	3,08	5,82	190,00	9,40	31,83	139,70	9,17	300
2	pH	-	3,80	5,15	6,95	5,49	7,55	4,81	5,80	6 - 9
3	Fe	mg/l	0,7495	0,7311	4,5031	1,4581	0,5451	14,5590	1,4712	7
4	Mn	mg/l	4,2042	0,1583	0,3169	6,7079	1,1707	9,6667	3,3949	4
5	Debit	m^3/dt	0,0018	0,0261	0,0256	0.0063	-	0.0001	0,0044	

Sorce: Primary data, 2016. *) Governor Regulation of South Sumatera Number 8 Year 2012

The presence of streams of sewage and / or runoff water contaminated with coal mining activities is highly dependent on rainfall and the presence of pumping activities. For coal stockpile areas, mine roads and disposal of waste water areas in the form of rainwater runoff contaminated with activity in the area, while the waste water pit comes from rain pumping or ground water activities in the pit.

Acidity in the coal mine area is estimated because coal mines leave sulfur-dominated acidic acid and reinforced with very large rainfall and far exceeding evapotranspiration, causing soil to become eroded and heavily leached. The formation of acidic water causes a decrease in the value of pH which is capable of dissolving and carrying heavy metals contained in rocks traversed by the acidic water stream [1].

3.2. Water Quality Analysis of Kungkilan River

A. The results of water quality analysis of River Kungkilan compared with river water quality standard

Based on the Governor Regulation of South Sumatera Number 16 Year 2005, Kungkilan River water is set in Class I as a designation of clean water raw water. Comparison of data result of water quality analysis of River Kungkilan with river water quality standard, as follows:

1) Total Suspended Solid Parameters (TSS)

TSS from coal mining activities can come from roads, workshops, offices, overburden, top soil, and mining areas. TSS caused by surface run off [18].

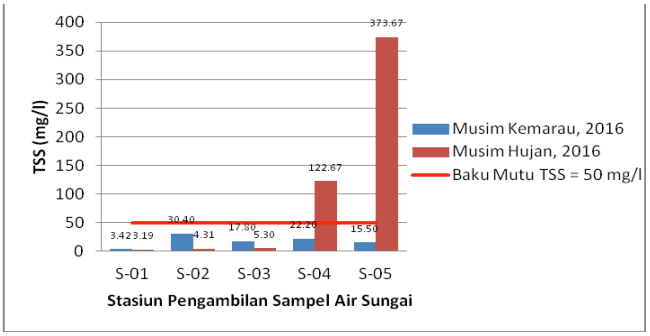

Figure 2. Result of water quality analysis of River Kungkilan for TSS parameter

Based on the result of water quality analysis of Kungkilan River for TSS parameter in dry season still in each station observation point still fulfill the standard of river water quality that is 3,42 - 30,40 mg / l with the standard value of river water 50 mg / l. In the rainy season, the value of TSS has increased considerably, especially in the downstream part of the River Kungkilan. For TSS values at S-01, S-02 and S-03 stations still fulfill the river water quality standard of 3.19 - 5.30 mg / l, due to disposal of land cover has been trimmed and location of company activity Coal mining crossed by the Kungkilan River has not operated or stopped temporarily. The quality of Kungkilan River water after crossing the S-04 and S-05 stations has a very high increase, as in the third segment (between S-03 and S-04) and segment IV (between S-04 and S-05) Location of activities of active coal mining companies and the presence of runoff wastewater and / or running water without processing and or bypassing. The value of TSS in S-04 and S-05 stations is 122,67 mg / l and 373,67 mg / l, which means that it has exceeded the standard of river water quality which is 50 mg / l. High TSS values can cause siltation of the body resulting in the formation of land and growing by water plants that progressively cause water bodies to die (eutrophication) [2].

2) Degree of acidity (pH)

The results of KKilan River water quality analysis for pH parameters can be seen in Figure 3. In the dry and rainy seasons, the water quality of River Kungkilan before crossing the activities of coal mining companies has a pH value of 6.42 and 6.59 which means still in good condition or Meet the river water quality standard that is 6 - 9. However, after crossing the location of coal mining company activities pH parameter value in 5 lowest observation stations with the value of 5.41 and 5.67 or not meet the quality standards of river water. The decrease in pH to tingakat parameters did not meet the quality standards in S-04 and S-05, due to the influence of the quality of waste water and / or runoff water from the disposal area of the coal mining company which is actively operating and also visible on the edge of the brown Kungkilan River water Or brownish red. The brownish-brown color indicates the height of heavy metals, especially Mn. This is because the waste water and / or runoff water is in a corrosive acidic condition [4]. The degree of acidity in the coal mine area can be derived from the landfill area (disposal area) derived from sulphide rocks. Potential acid rock drain mine is larger, because rocks have an open sulfite element [6].

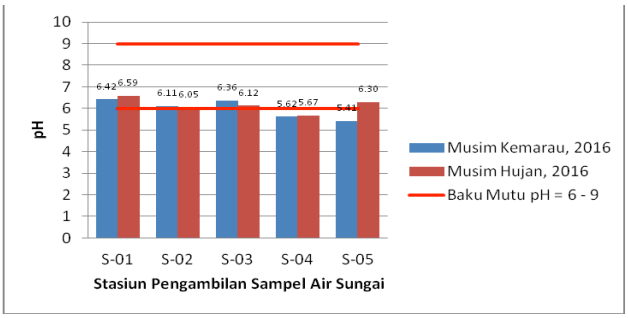

Figure 3. Result of water quality analysis of River Kungkilan for pH parameter

3) Iron (Fe)

In dry season and rainy season, overall Fe parameters at 5 observation stations have soluble Fe (Fe) which still meet the water quality standard of the river that is below 0.3 mg / l, except dry season at S-04 station Fe value equal to 0.5096 mg / l, which means that it has exceeded the quality standard of river water. This condition is of course influenced by water disposal area at the location of one of the activities of coal mining company that has pH 5.05 and the total Fe value of 5.3498 mg / l, and the pH value at S-04 station itself is worth 5.62 (acid), so Can dissolve the deposited Fe. With this neither too acidic nor near neutral pH, the quality of waste water and / or runoff water (pollution sources) with low Fe, and the presence of natural oxidation processes, Fe causes the Fe in the Kungkilan River to undergo deposition. Waters with a pH of about 7 and contained dissolved oxygen, the dissolved Fe will be easily oxidized to become ferric ions that easily precipitate [2].

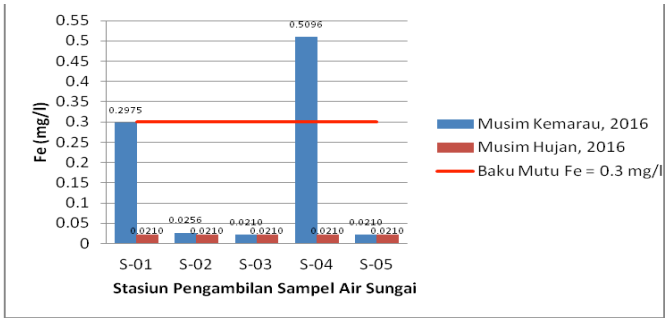

Figure 4. Result of water quality analysis of River Kungkilan for Fe parameter

4) Manganese (Mn)

In the dry and rainy season, the water quality of Kungkilan River for Mn parameters before crossing the location of coal mining company activities is 0,0060 mg

/ l which means still fulfill the water quality standard of river water is 0,1 mg / l. The quality of Kungkilan River water for the Mn parameter during the dry season in each observation station after crossing the location of the coal mining company activities has increased, thus exceeding the quality standard of river water with the value between 0.3457 - 5.6553 mg / l. In the rainy season, the water quality of Kungkilan River for Mn parameters at S-02 and S-03 observation stations still meet the water quality standard of river water ranging from 0.0072 - 0.0342 mg / l, but in S-04 and S- 05 remains beyond the standard of river water quality ranging from 0.6987 - 1.2592 mg/l.

If the Mn value in the dry season is compared with the rainy season, then the Mn value decreases. This condition is also influenced by the relatively neutral pH value and turbulent and shallow river flow that allows the process of infiltration of oxygen from free air, so that Mn^{4+} can form [2].

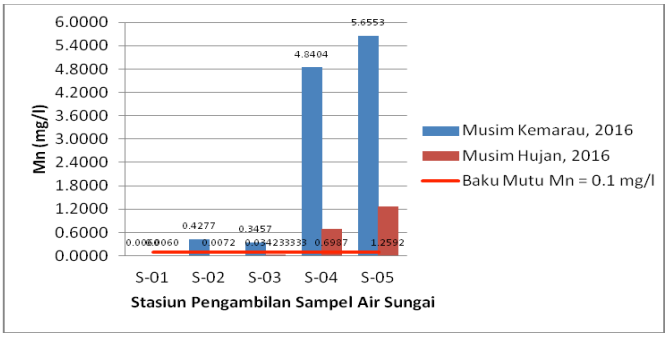

Figure 5. Result of water quality analysis of Kungkilan River for Mn parameter

B. Estimated Capacity of Water Pollution Load by Decree of State Minister of Environment Number 110 Year 2003.

The result of mass balance calculation for the average concentration of TSS parameters in each water segment of Kungkilan River during dry season stated that, Kungkilan River still has capacity for TSS parameter that ranged from 3,43 - 30,07 mg / l. This condition is caused by TSS value in Kungkilan River and waste water and / or runoff water still meet the quality standard and flow rate from coal mining activity which flow to Kungkilan River is very small, so that Kungkilan River can still accommodate pollutant load for TSS parameters.

The calculation of mass balance in the rainy season, for the average concentration of TSS parameters in segments I, II, and III has a value of 3.19 - 27.46 mg / l, which means that the Kungkilan River still has the capacity for TSS parameters, but in the segment IV value of TSS equal to 117,69 mg / l, meaning that in segment IV of River Kungkilan no longer have capacity for TSS parameter. Segments I, II and III still have capacity due to the water quality of Kungkilan River and the flow of waste and / or runoff water from coal mining activities are still in accordance with the quality standards and small flow debit. Segment IV has no more capacity because the water quality of River Kungkilan before entering or upstream segment IV (S-04) TSS parameter has exceeded the standard of river water quality that is 122,67 mg / l with debit 0,096 m3 / dt. The capacity of river water pollution load for TSS parameters is exceeded, due to the running water flow from the disposal area and mining road of coal mining company which is flowing without bypass and the settling process which is still not optimal in MPA.

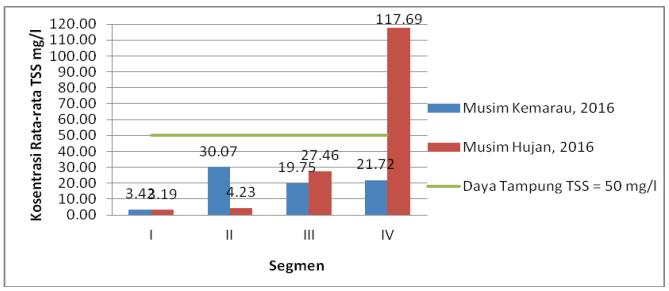

Figure 6. Results of Mass Calculation of TSS Parameters in Each Segment

C. Determining Water Quality Status with Pollution Index (IP) based on Decree of State Minister of Environment Number 115 Year 2003.

The status of water quality is the level of water quality condition which indicates the condition of pollutant or good condition at a water source within a certain time by comparing with the water quality standard specified. Calculation of water quality status of River Kungkilan using pollution index method for parameters of TSS, pH, Fe, and Mn, with water quality standard of river I.

Result of analysis of water quality status of River Kungkilan in dry season is higher than in rainy season. The status of the water quality of the Kungkilan River during the dry season is in 3 (three) status ie good condition ($0 \leq PIj \leq 1.0$), mild pollutant ($1.0 \leq PIj \leq 5.0$), and medium pollutant ($5.0\ PIj \leq 10$), while in the rainy season is in good condition ($0 \leq PIj \leq 1.0$) and moderate pollutant ($5.0 \leq PIj \leq 10$). In the dry season and the rain water quality condition of River Kungkilan in good condition category is at the point before crossing the activity of coal mining company (station S-01), but at station S-02 and S-03 status of water quality decrease / In the dry season is a mild contaminant, but in the rainy season becomes a good condition. Water quality status of Kungkilan River increased / water quality decreased after being in station S-04 and S-05 or after crossing the location of coal mining company that actively operate with medium pollutant category.

Calculation of pollution index in dry season is higher, when compared to rainy season. This is because, in the dry season as a whole heavy metal, especially Mn in River Kungkilan is very high value of river water quality standard, while in the rainy season the overall

parameter of Mn and TSS is not too high when compared with the standard water quality of class I river.

The status of the water quality of the Kungkilan River has increased, during the dry season at S-02 and S-03 stations in mild contamination conditions, but in the rainy season it is a good condition. This means that the influence of the disposal area and activities of coal mining companies that are in temporary stop operating conditions do not affect significantly, resulting in the process of self-purification in the river water Kungkilan. The process of self-purification or the process of restoring river water quality naturally takes place physically, chemically, and biologically. In natural streams (not concrete channels) can significantly support the process of naturally purifying themselves and leading to improved water quality from its original state [20].

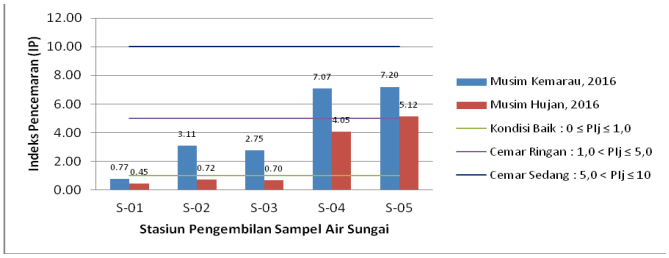

Figure 7. Contamination Index of River Kungkilan Water Quality Standard of Class I River

3.3. The recommendation of Pollution Control of River Kungkilan was analyzed by using SWOT Analysis (Strength, Weakness, Opportunity, and Threat).

River Kungkilan Water Pollution Control Strategy from observation, water quality analysis of Kungkilan River, waste water and / or water analysis of coal mining activities, interview and literature study, to obtain information that can be described aspects and indicators of water pollution control of River Kungkilan, as presented In Table 6.

Based on the result of SWOT Analysis, water pollution control of River Kungkilan is obtained, that S <W and O> T which means to be in Quadrant III (-, +) or in Weakness-Opportunity (WO) strategy. The policy of river water pollution control strategy can be done by utilizing the opportunity to overcome the weakness in controlling the water pollution of the affected River Kungkilan due to coal mining activities, so there should be a strategy change to minimize the weaknesses and take advantage of the opportunities.

The recommendation of control strategy of river water pollution in West Merapi District, Lahat Regency that can be used as a direction is as follows:

A. Study of water class determination and load capacity of water pollution based on result of identification and inventory of source of water pollution of River Kungkilan, and monitored water quality periodically and continuously;
B. Increasing the frequency of environmental monitoring activities with personnel as Environmental Supervisory Official (PPLH) and / or Regional Environmental Supervisory Officer (PPLHD) and functional status;
C. Transfer of sewerage and / or running water from coal mining activities to other water bodies and implementation of revegetation activities;
D. Implementation of law enforcement sanctions either administratively, civil and / or criminal for corporate offenders, and rewarding companies compliance with water pollution control regulations;
E. Utilization of Corporate Corporate Social Responsibility (CSR) Program for the manufacture of clean water facilities and bathing, washing and toilet activities (MCK) with water sources from wells.

Table 6. Water pollution strategy

No	Aspects of River Pollution Control	Indicator
1.	Condition of Kungkilan River	1. In the upper reaches of Kungkilan river, there are protected forest areas. 2. The quality of Kungkilan River water is set in the criteria of class I designated for use as raw water for drinking water. 3. The water quality of Kungkilan River before crossing the activities of coal mining company for parameters of TSS, pH, Fe, and Mn stil meet the water quality standard of class I river. 4. The quality of Kungkilan River water in some has exceeded the standard water quality of class I river, in dry season of pH, Fe, and Mn parameters, and rainy season parameters of TSS, pH, and Mn. 5. At some point in the rainy season the capacity of the Kungkilan River for TSS parameters has already surpassed, but in the dry season does not go beyond. 6. Water quality status of the Kungkilan River in good condition up to medium pollutants. 7. The quality of Kungkilan River water at some point and certain parameters have experienced self-purification process. 8. Kungkilan River downstream after crossing the activities of coal mining companies are still used by some communities Muara Maun Village, West Merapi District.
2.	Government Role	1. Inventory and identification of sources of water pollution of Kungkilan River not yet available. 2. Determination of the capacity of water pollution load has not been done. 3. Regulations on river and wastewater quality standards have been established. 4. Licensing regulations concerning the disposal of wastewater already exist. 5. Water quality monitoring activities of River Kungkilan have been done, but only at the time of public complaints. 6. Monitoring activities of environmental compliance have been carried out, but not by the Regional Environmental Supervisory Official (PPLHD) with functional status. 7. Information and supporting data related to Kungkilan River is not complete. 8. Coordination between agencies in the control of river water pollution is still lacking. 9. The granting of environmental permits to coal mining companies is in accordance with the RTRW and AMDAL Review.
3.	Role of Coal Mining Company	1. Three of the four companies already have KPL, and there is still a potential for waste and / or runoff water that flows bypass to the Kungkilan River. 2. Coal mining companies already have Environmental Permits, but not yet based on water pollution load capacity. 3. There are several coal mining companies that have submitted the Implementation Report of the Environmental Management Plan (RPL) and the Environmental Monitoring Plan.

4. Conclusion

1. The quality of wastewater and / or running water from the activities of coal mining companies has not been optimally processed, so it tends to acid and contains heavy metals, especially Mn, and potentially as a source of water pollution of the River Kungkilan.

2. The quality of Kungkilan River water after crossing the coal mining company's activities for TSS, pH, and Mn parameters, has generally exceeded the river water quality standard.
3. Capacity of water pollution load of River Kungkilan for TSS parameter in dry season still have capacity, but in rainy season Kungkilan River has exceeded the capacity of 67,69 mg/l.
4. The status of water quality of Kungkilan River at S-02 and S-03 stations was carried out by self-purification process, but in S-04 and S-05 stations remain in the medium quality of polluted water status.
5. Based on the results of SWOT analysis, the recommendation of water pollution control strategy of Kungkilan River in West Merapi District, Lahat Regency is Weakness-Opportunity (WO) strategy or change strategy.

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