

LEVEL OF POLLUTION LOAD ALONG THE BATANG ARAU RIVER IN PADANG CITY IN 2019 AND THE ABILITY OF BIOFILTER IN IMPROVING THE WATER QUALITY

Sari Arlinda ^{1*}, Suksmerri ², Mukhlis ³ and Yulnafatmawita ⁴

¹ Poltekkes Kemenkes Padang, Jl. Raya Siteba, Surau Gadang,
Kec. Nanggalo, Kota Padang, Sumatera Barat.

*Corresponding Author Email: sariarlinda29@gmail.com

^{2,3} Poltekkes Kemenkes Padang.

⁴ Andalas University.

DOI: [10.5281/zenodo.13147800](https://doi.org/10.5281/zenodo.13147800)

Abstract

Batang Arau is a river passing urban area of Padang city, the capital of West Sumatra Indonesia, which is used by local people either for domestic, agriculture, or for industries. However, the river is also used by people for throwing their waste, liquid and solid waste, in increasing amount by time. Meanwhile, people still used the water of the river to fulfill their needs. Therefore, this research was aimed to determine the pollution load of the water along the Batang Arau River. Water samples were taken from 6 different locations (1. Ngalau Indarung, 2 Koto Lalang 3. Teluk Luas, 4. Jembatan Ujung Tanah, 5. Jembatan Kecamatan Padang Selatan, and 6. Muaro) from the upper to the lower part of the river. Parameters analyzed for the water were BOD, COD, TSS, pH and temperature. Based on laboratory analyses, it was found that the pollution load increased as the river became closer to the estuary. The water temperature ranged between 28 to 34, and the water pH was 5.5 to 7.0. The highest pollution load was found in the estuary (in Muaro) having BOD was 6,060.1 kg d⁻¹, COD was 28,537.9 kg d⁻¹, and TSS was 40,435.2 kg d⁻¹. Based on water quality standard published by PP_RI No.82 year 2001, it could be concluded that the river water along Batang Arau was polluted. The level of being polluted was categorized as level II at the upper part (location 1 and 2) and IV at the estuary. Among the parameters, the value of BOD was very bad. By using anaerob biofilter, the quality of the water of the Batang Arau River was improved from level IV to level II. This was due to the COD decreased by approximately 73%, BOD by 84%, and TSS by 77%. It was suggested people to process the water using the anaerob biofilter before using it, besides regulation from local government is strongly needed in managing the water of the Batang Arau River.

Keywords: Water Quality, Pollution Load, BOD, COD, TSS, Anaerob Biofilter.

INTRODUCTION

Water pollution, based on Law from Ministry of Environment Republic of Indonesia No.01 year 2010 on the process of water pollution control, a process in which pollutants such as living things, materials, energy, and/or other components enter or are entered into water due to human activities causing the quality of the water reaches above the quality standard being determined³.

River water pollution becomes a big problem in big cities around the world. It does not only affect the esthetic of the environment, the life of the living creatures in the river, but it also decreases the quality of the society life in the surroundings. It could be true, since the river is used by the people for their life either for domestic use, agriculture, or for industries such as Batang Arau river in Padang city, West Sumatra Indonesia. The water of this Batang Arau river was indicated being polluted from the upper to the lower part.⁴.

The Batang Arau river is potential to be highly polluted because it passes urban area and industries. From the upper to the lower part was found several industries such as cement industry, rubber, crude palm oil. The industries contribute the waste to the

river water quality, since they used Batang Arau river as their disposal, besides domestic waste, hospital waste, and market waste. Actually, each of the industry had licence for processing their waste, however, large amount of the processed waste being disposed to the river still caused the water river polluted. Therefore, the estuary of the Batang Arau river had been indicated to have low water and environment quality⁵.

Decreasing water quality of Batang Arau river was caused by the increase of pollutant load from many sources along the river. Based on Bapelda Sumbar (2000) and Nofrizal (2003), it was stated that water of Batang Arau, among the three main river in Padang city had been polluted along the river due to industrial waste. For Batang Arau river itself, based on the government law (PP-RI) No. 82 year 2001 on water controlling and pollution, the water quality was worse than that of grade 4 river. It means that the river water was not good anymore for either human or agriculture use. The water quality of the Batang Arau was found to be above the quality standard at all sampling location on which the concentration of TSS reached 130 mg/l, BOD was 10 mg/l, and COD was 72,00 mg/l (Coubout et al., 2014).

Yanti dan Afdal (2015) also reported that water quality of Batang Arau river in spot of Lubuk Begalung was polluted. It contained heavy metals Cu (0.034-0.039 mg/L) and Zn (0.055-0.062 mg/L) which was above the quality standard for river water based on PP-RI No.82 year 2001. Furthermore, in 2019 it was still stated that Batang Arau river was the most polluted river in Padang city (DLH Padang, 2019). The pollution was derived from waste from several industries, such as clay material from PT Semen Padang, liquid waste from rubber industry, CPO industry, hospital or medical center, as well as liquid and solid waste from market and from ship reparation.

Since the river water was still used by people to fulfill their basic needs every day, the water must be treated before it is used. A biofilter anaerob was introduced to improve the water quality by reducing the organic pollutant (BOD and COD) as well as total suspended solid (TSS). By using biofilter anaerob, organic pollutant found in liquid waste will be degraded into CO₂ and CH₄ gases and then emitted to the atmosphere (Zulkifli, 2019). The equipment is effective in processing wastewater, it could decrease COD parameters by 70.13% at intermediate and 74.60% at minimum discharge, BOD parameter by 54.59%, and TSS parameter by 50% (Hariyani and Sarto, 2018).

Based on the information above, a research conducted to determine the pollution load along the Batang Arau river in Padang city and then to determine the ability of biofilter anaerob in reducing pollution load from the river water.

MATERIAL AND METHODS

This research was in form of descriptive method by using *Cross-sectional* approach. Water samples were taken along the Batang Arau river based on purposive sampling, samples were taken as much as 6 L at each of 6 different spots after considering the place of main pollution source in September 2019. Water samples were brought into laboratory and then analyzed the quality especially the BOD, COD, and TSS (main parameters). Besides main parameters (BOD, COD dan TSS), water pH and temperature were also analyzed.



Figure 1: Batang Arau River passing Padang city, West Sumatra Indonesia

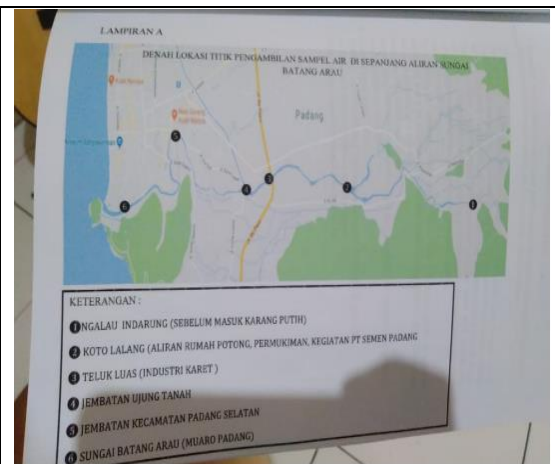


Figure 2: Sampling location along Batang Arau River in 2019

Sampling technique for the river water followed Indonesian National Standard (SNI) 6989.59.2008 through the following steps:

1. The equipment is prepared and then rinsed 3 times by the water being sampled
 2. Water samples are taken from several points in each location, and then mixed to make it homogeneous
 3. The mixed water is saved in a prepared container such as plastic bottles
 4. Parameter temperature, pH and dissolved Oxygen of the water must be measured soon after sampling
 5. Results from field parameter tests are noted in log book
 6. Water sample for laboratory analyses is added with concentrated sulfuric acid
- Data resulted from laboratory analyses was analyzed using univarieta data.

Methods used to analyze BOD, COD, and TSS

Parameter	Unit	Method	Reference
BOD	Mg L ⁻¹	Titrimetri	SNI 6989.72-2009
COD	Mg L ⁻¹	Refluks	SNI 06-6989.15-2004
TSS	Mg L ⁻¹	Gravimetri	SNI 06-6989.3-2004
pH		Potensiometri	SNI 06-6989.11-2004
Temperature	°C	Visual	SNI 06-6989.23-2005

Furthermore, supporting data such as river width, section area, and current velocity were also measured. The supporting data are important to calculate current debit as well as the amount of pollution load. Debit of river current is calculated using the following equation:

$$Q = A \times V$$

Q = river current Debit (m³/detik)

A = river section area (m²)

V = current velocity (m/dt)

Then, pollution load is calculated as follows

$$B = Q \times C$$

B = current debit (m³/detik)

C = concentration (mg/l)

RESULTS AND DISCUSSION

A. Results

1. Water quality along Batang Arau River in Padang city

In calculating pollution load from a river in determining the water quality, one factor which is important to measure is the debit. The debit data of Batang Arau river is presented in Table 1.

Table 1: Debit of Batang Arau River in Padang City in 2019

Location	Temperature °C	pH	River Current (m/det)	Surface Water Height (m)	River width (m)	A (m ²)	Q (m ³ /det)	Q (m ³ /hari)
Ngalau Indarung	28	6.0	0,035	0,4	9	3,6	0,126	10.886
Koto Lalang	30	5,5	0,024	0,7	20	14,0	0,336	29.030
TelukLuas	32	6,5	0,042	1,0	12	12,0	0,504	43.546
Ujung Tanah	34	5,5	0,110	1,0	12	12,0	1,320	114.048
Jembatan Kecamatan Padang Selatan	33	6.0	0,075	1,5	14	21,0	1,575	136.080
Muaro	34	7.0	0,120	2,0	25	50,0	6,000	518.400

Table 1 showed that the highest river current (518,400 m³/d) was found at the end or in Muaro (close to the estuary) of the river and the lowest (10,886.4 m³/d) was found at the upper river or in Ngalau Indarung.

Table 2: Water Quality of Batang Arau River in Padang City in 2019

Location	Discharge	PARAMETER				
	(m ³ /dt)	Temperature (°C)	pH	BOD (mg/l)	COD (mg/l)	TSS (mg/l)
Ngalau Indarung	0,126	28	6.0	2.3	10.32	58
Koto Lalang	0,336	30	5.5	2.9	11.91	62
TelukLuas	0,504	32	6.5	6.92	31.80	75
Ujung Tanah	1,320	34	5.5	9.03	44.80	105
Jembatan Kecamatan Padang Selatan	1,575	33	6.0	9.81	37.40	85
Muaro	6,0	34	7;0	11,69	55,05	114
Quality Standard (PP NO.82 Year 2001)	Class I	DEVIATION 3	6-9	2	10	150
	Class II	DEVIATION 3	6-9	3	25	150
	Class III	DEVIATION 3	6-9	6	50	400
	Class IV	DEVIATION 3	6-9	12	100	400

It can be seen that in the middle and lower parts of the river especially from Teluk Luas until Muaro the value of BOD, COD and TSS fulfilled the quality standard of level III and IV water based on PP 82 no. 2001, about water quality management and the pollution control.

2. Analisis of pollution load along Batang Arau River in Padang city.

Table 3: Pollution load of Batang Arau River, Padang city in 2019

Location	BOD (mg/l)	COD (mg/l)	TSS (mg/l)	Q (m3/hari)	Faktor Koreksi	BEBAN PENCEMARAN .Kg/hari			TOTAL Pollution Load (Kg/d)
						BOD	COD	TSS	
Ngalau Indarung	2.30	10.32	40	10886.4	0.001	25.04	112.35	435.46	572.84
Koto Lalang	2.90	11.91	47	29030.4	0.001	84.19	345.75	1364.43	1794.37
TelukLuas	6.92	31.80	52	43545.6	0.001	301.34	1384.75	2264.37	3950.46
Ujung Tanah	9.03	44.80	60	114048.0	0.001	1029.85	5109.35	6842.88	12982.08
Jembatan Kecamatan Padang Selatan	9.81	37.40	67	136080.0	0.001	1334.94	5089.39	9117.36	15541.70
Muaro	11.69	55.05	78	518400.0	0.001	6060.10	28537.92	40435.20	75033.22

Table 3 showed that the pollution load increased by lower part of the river. The highest value for total pollution load in the Batang Arau River was found in the Muaro (close to sea) which was 75,033.22 kg/d and the lowest one (572.84 kg/d) was found in the upper part of the river.

Based on the data resulted, the quality of the river water was much below the standard quality. Meantime, the water was still utilized by people living along the river for the agriculture as well as for the domestic need. Therefore, this research was continued with the method in improving the water quality. One of the methods being applied in this research was Anaerob Biofilter System. The water quality after being treated by Anaerob Biofilter System is presented in Table 4.

Table 4: Comparison water quality of Batang Arau river in Padang city between before and after being processed using Anaerob Biofilter System.

Parameter	Before (mg/l)	After (mg/l)	Difference (mg/l)	Equipment Efficiency (%)
BOD	11.69	1.84	9.85	84.26
COD	55.05	14.98	40.07	72.78
TSS	78.00	17.83	60.17	77.14

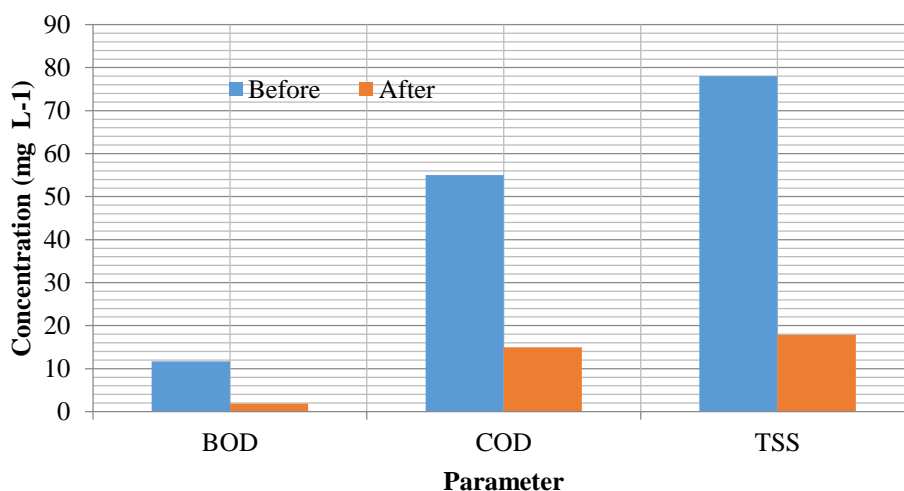


Figure 3: The effect of anaerobic biofilter on water quality of Batang Arau River

From Table 4 could be concluded that by using Anaerob Biofilter System, the quality of river water could be improved. This could be seen from the content of the water which decreased the BOD by 9.58 mg/l (84.26%) and COD by 40.07 mg/l (72.78%), and TSS by 60.17 mg/l (72.78%).

B. Discussion

1. Water quality along the flow of Batang Arau River in Padang City in 2019.

Based on laboratory analyses for the Batang Arau River, it was found that water quality at the upper part of the Batang Arau river especially in Ngalau Indarung (before PT Semen Indarung) was classified into level II based on PP No. 82 year 2001. The water was still allowed to use for agriculture or domestic because it was not highly polluted. The 1st source of pollution in the Batang Arau River was PT Semen Padang which was located after Ngalau Indarung.

Water pollution in The Batang Arau River happened in the middle and the lower parts, due to waste dump from several industries along the river. The waste was not reached the quality standard yet before it was thrown away to the river. The waste was thrown away to the river could be derived from industries, domestic, market, and other activities. Therefore, at the estuary (especially in Muaro) the water quality of the Batang Arau river was quite low or it was categorized as level IV.

Water pollution in Batang Arau increased from the upper to the lower part of the river. This was due to increasing sources of pollution received by the river. The many types of waste from several sources had increased the BOD, COD, and TSS content which decreased the quality status of the water river. As stated by Pryono (2011) that pencemaran air sungai terlihat dari peningkatan nilai BOD, COD, dan TSS as affected by high organic waste derived from industries or domestics.

Actually, Nofrizal (2003) and Bapedalda (2014) stated that the water of Batang Arau River had been polluted. They found that the BOD, COD, and TSS reached In this research was identified the pollution load in the water along the Batang Arau river.

2. Analysis Suspended Load in the Water Along Batang Arau River in Padang City

Based on total value of suspended load, the highest suspended load (75,033.22 kg/d) was determined in the lower part, it was in Muaro. The value of pollution load in water was counted by the flow discharge and by pollutant value. Yuliasuti (2011) explained that the higher the content of pollutant parameter as well as flow discharge was the higher the pollutant load value. As found in the Batang Arau river in which the highest discharge value (518.400 m³/d) correlated to the highest BOD (6,060.10 kg/d) which was found in the lower part (Muaro)

Increasing value of pollution load along the Batang Arau river from the upper to the lower was due to waste from several sources. Among the sources of the pollution were domestic waste, PT Semen Padang (Cement Industry), PT Teluk Luas (Rubber Industry), Tahu and Tempe industry, market waste, hospital waste, and ship dock waste.

On the other hand, some people living along the Batang Arau River still used the polluted river water for their daily life because they did not have any clean water source or any alternatives to be used. To anticipate the exposure of people to the toxic materials, an effort in improving water quality before being used was done by using

Anaerobic Biofilter. This simple process of water using the Anaerobic Biofilter is a kind of biological process without oxygen. Besides the price is low, operationally, this method is also easy to be applied by people, therefore, this water refinery process could be done by every family in the own house.

CONCLUSION

Based on the research conducted, it could be concluded that the water along the Batang Arau River was polluted (if it refers to PP No.82 year 2001 on Water Quality Management and Pollution Control). It was indicated by the BOD which was $>2 \text{ mg L}^{-1}$, COD was $>6 \text{ mg L}^{-1}$ but TSS was still $<150 \text{ mg L}^{-1}$. Pollution load increased in the water along Batang Arau river from the upper to the lower (estuary) part. The highest pollution load was determined at the estuary (Muaro) which was 75,033.22 kg/d, and the lowest which was 572.842 kg/d was found at the uppermost sampling location (in Ngalau Indarung).

It was suggested to the related government, especially BAPEDALDA (An institution of regional government in controlling environmental impact) of West Sumatra Province, to strictly monitor the quality of Batang Arau river water by regularly checking the quality as well as by controlling industry waste quality before being dumped into the river and to fine the industries which violate the rule.

References

- 1) Padang K, Sumatera P. *dwi wahyu*. 2013.
- 2) Status B, Hidup L. 2 (Sumber dari Buku Status Lingkungan Hidup Indonesia tahun 2009) . 2009.
- 3) MenLH. *Peraturan Menteri Lingkungan Hidup No 1 Tahun 2010 Tentang Tata Laksana Pengendalian Pencemaran Air.*; 2010.
- 4) Kamasela farhana D. Kualitas perairan muara sungai batang arau padang, sumatera barat berdasarkan kandungan bahan organik. 2017. <http://www.albayan.ae>.
- 5) Annisa P. Analisis Kualitas Air Sungai Berdasarkan Aspek Meteorologi (Studi Kasus : DAS Batang Arau, Kota Padang , Sumatera Barat). 2018;(October):0-6. doi:10.13140/RG.2.2.28141.23528
- 6) Coubout, R. 2014. DAS Batang Arau Padang Tercemar. <https://www.mongabay.co.id/2014/12/10/das-batang-arau-padang-tercemar/>
- 7) *UU No 32 Tahun 2009 Tentang Perlindungan Dan Pengelolaan Lingkungan Hidup*. Republik; 2009. doi:10.2174/138920312803582960
- 8) Air PP. Pencemaran Air : Pengertian , Sumber , Jenis dan Akibat. <https://ilmugeografi.com/ilmu-bumi/hidrologi/pencemaran-air>.
- 9) Negara M, Hidup L. *Keputusan Menteri Negara Lingkungan Hidup No 110 Tahun 2003.*; 2003.
- 10) Priyono A. Kajian Beban Pencemaran Limbah Usaha Kecil di Sungai Cilieung Segmen Kota Bogor. *Media Konserv.* 2011;16(1):32-40.
- 11) Pemerintah P. *Peraturan Pemerintah No 81 Tahun 2001.*; 2001.
- 12) Azhar A, Dewata I. Studi kapasitas beban pencemaran sungai berdasarkan parameter organik (BOD , COD dan TSS) di Batang Lembang Kota Solok , Provinsi Sumatera Barat. 2018;2(1):76-87.
- 13) Indonesia SN, Nasional BS. Air dan air limbah – Bagian 72 : Cara uji Kebutuhan Oksigen Biokimia (Biochemical Oxygen Demand / . 2009.
- 14) Badan Standardisasi Nasional. *Air Dan Air Limbah – Bagian 2: Cara Uji Kebutuhan Oksigen Kimiawi (KOK) Dengan Refluks Tertutup Secara Spektrofotometri.*; 2004. doi:SNI 06-6989.15-2004

- 15) Badan Standardisasi Nasional. *SNI 06-6989.3-2004 Air Dan Air Limbah – Bagian 3: Cara Uji Padatan Tersuspensi Total (Total Suspended Solid, TSS) Secara Gravimetri.*; 2004. doi:SNI 06-6989.3-2004
- 16) Badan Standardisasi Nasional. *Air Dan Air Limbah – Bagian 3: Cara Uji Padatan Tersuspensi Total (Total Suspended Solid, TSS) Secara Gravimetri.*; 2004. doi:SNI 06-6989.3-2004
- 17) Putri D, Afdal. Identifikasi Pencemaran Logam Berat dan Hubungannya dengan Suseptibilitas Magnetik pada Sedimen Sungai Batang Ombilin Kota Sawahlunto. *J Fis Unand.* 2017;6(4):341-347.
- 18) Fiskanita F, Hamzah B, Supriadi S. Analisis Logam Timbal (Pb) Dan Besi (Fe) Dalam Air Laut Di Pelabuhan Desa Paranggi Kecamatan Ampibabo. *J Akad Kim.* 2017;4(4):175. doi:10.22487/j24775185.2015.v4.i4.7868
- 19) Yanti, E.L. dan Afdal A. 2015. Profil Pencemaran Air Sungai Batang Arau Daerah Lubuk Begalung Kota Padang. *J. Fisika Unand.* Vol 5(2)::