POLLUTION LOAD CAPACITY STUDY ON BARITO RIVER, SOUTH KALIMANTAN, INDONESIA

by Tien Zubaidah Et Al

Submission date: 14-Sep-2020 11:09AM (UTC+0700)
Submission ID: 1386446613
File name: 2018_Poll_Res-34-1.pdf (637.38K)
Word count: 3528
Character count: 16470

Poll Res. 37 (3) : 794-800 (2018)

ISSN 0257–8050

POLLUTION LOAD CAPACITY STUDY ON BARITO RIVER, SOUTH KALIMANTAN, INDONESIA

T. ZUBAIDAH[1], N. KARNANINGROEM[1], A. SLAMET[1], M. RATODI[2] AND LENIE MARLINAE[3]

[1]*Dept. of Environmental Engineering, Institut Teknologi Sepuluh Nopember Surabaya, Indonesia*
[2]*Faculty of Science and Technology, Universitas Islam Negeri Sunan Ampel, Indonesia*
[3]*Public Health Department, Lambung Mangkurat University, Indonesia*

(Recieved 25 February, 2018; accepted 30 April, 2018)

ABSTRACT

Due to the domestic waste, mining, plantation, agriculture and industrial disposal, Barito river has experienced a very serious water contamination. Therefore the researchers intended to investigate Barito river's ability in accommodating the pollution load in order to improve the river quality. In this article, the Biological Oxygen Demand (BOD) parameter has been selected as an index that reflected the organic contamination, while the QUAL2Kw stream model was used in conjunction with a potential pollutants identification and inventory activities as an effort to calculate the Barito river's ability to contain pollution loads. The results have shown that the Barito river has no longer have assimilation capacity for BOD. We have determined that the distribution of pollutant loads and total quantity controls has been able to help the Barito river water utilization to be more efficient.

KEY WORDS : Pollutant load capacity, BOD, Pollutant sources, Barito river

INTRODUCTION

Rivers have become the main source for providing fresh water and have been widely used for agricultural irrigation, raw drinking water, rain and wastewater disposal, fisheries up to tourism activities in Indonesia (Soenarno, 2001). The river's environmental degradation arouse from multivarious subsystems influences such as human population, water resources, industrial, pollution, water quality, tourism, and agricultural (Guo *et al*., 2001), with each subsystem making an important contribution to the damage of the river that became life necessities for the peoples living along the riverbanks (Owa, 2014).

With 900 Kilometers length and located in an 18,600 square kilometers river basin, the Barito River has various activities running along its streams, from settlements, mining, plantations, agriculture to industrial activities. These activities have also utilized Barito river as the main source of water supply as well as wastewater disposal points. As the Barito river's environmental protection systems and facilities were not yet functioning properly, causing serious pollution to the river. For that, it was necessary to take pollution control steps in improving water quality, including through the policies implementation based on the water environment assimilation capacity.

Researchers have been studying the water assimilation capacity since the 1970s. Since then, major advances in water quality models and the theory of water-assimilation capacities have occurred and have been applied in comprehensive urban management (Xiao-de *et al*., 1999). The assimilation capacities determination (environmental capacity) in Indonesia was considered as a form of water quality-based control implementation (*The Laws of Indonesian Republic Number 32*, 2009). This approach aims to control pollutants from various sources entering the water by considering the water intrinsic conditions and the water quality standard establishment. This technology-based approach was unable to meet the established water quality targeted. Throughout our knowledge, when considering the theory and its

***Corresponding author's email:** arrasyid.hanif@gmail.com

practical application, however, the water-assimilation capacity theory has no breakthrough in many areas. For example, current research regarding the water-assimilation capacity was still limited in calculating the annual assimilation capacity only.

The models related to water resources management and protection developed by US-EPA have been divided into two categories: Receiving Water Model or Stream Model; and Watershed Models. Water quality modeling can be applied to calculate Pollutant Load Capacity (PLC) in water sources, such as; rivers, lakes or reservoirs while estuaries could be used in the Streams model. The model was able to model the physical, chemical and biological contaminants distribution and changes in the river.

This model also considers the local climate conditions factors, the river hydraulic conditions (depth, width, gradient, and rafting material) and the contaminants nature and behaviors. In addition, the model also calculated the river water extraction (abstraction), as well as the interaction between the river with groundwater (baseflow), can be integrated with the model.

This study was used a QUAL2Kw water quality model that includes stream models. QUAL2Kw modeling method is very efficient, simple and could be modeling the river water quality from upstream to downstream (Rusnugroho and Masduqi, 2012). In another hand the model also has a weakness in modeling the pollutants before it goes to the water bodies, causing the sources of the pollutantes could not be well traced. This weakness could be overcome by combining QUA2Kw water quality model with pollutants inventory and identified potential pollutants sources that go into Barito River. The directed study intended to determine the river water's current condition and its ability to accommodate pollution load based on the applicable quality standards as well as recommend various efforts to control river pollution.

MATERIALS AND METHODS

The assimilation capacity (pollution load capacity / PLC) calculation was carried out using BOD as the river quality key parameters. This parameter could show a water quality levels overview for various designations. PLC calculation was using computerized numerical water quality model. The estimated total pollutant load was carried out at every district/municipal area within the study area as well as the estimated contribution of each pollution sources were presented. Simulations also conducted with two different scenarios. The first scenario produces water quality as a response to existing pollutant load, while the second scenario resulted in water quality as the result of incoming pollutant load that meets with pollution load capacity (PLC).

RESULTS AND DISCUSSION

River Segmentation

The water bodies segmentation was divided based on several considerations, including current and future water usage, land topography, river morphology, potential water source and pollutions as well as administrative boundaries. The segmentation map can be further seen as in figure 1.

The Barito river segmentation in the study area was divided into 8 (eight) segments with the following conditions:

Rivers water quality

Observations along the Barito River, from the headwater at Buntok to until the 8th segment, has indicated that the rivers pH value was lower than the minimum quality standard. From the direct measurement results, it was known that the highest pH value (5.95) was in Palangkau Lama (V-3 sample point), while the lowest one was in Bangkuang with 5.32 pH value (II-3 sample point). Further observation on the Barito creeks showed the same trend with Barito River condition, except for Martapura river with the pH value of 6.70 (H1 point). The DO parameter values indicate a tendency that from upstream (headwater in Buntok

Table 1. Segment length and distances from downstream (zero point)

Segment	Code	Length (km)	Distance from downstream (km)
Headwater	Hw	0.86	287.65
1st	S-1	28.85	286.76
2nd	S-2	44.99	257.91
3rd	S-3	56.59	212.92
4th	S-4	11.23	156.33
5th	S-5	26.84	145.10
6th	S-6	41.91	118.26
7th	S-7	59.84	76.35
8th	S-8	16.51	16.51

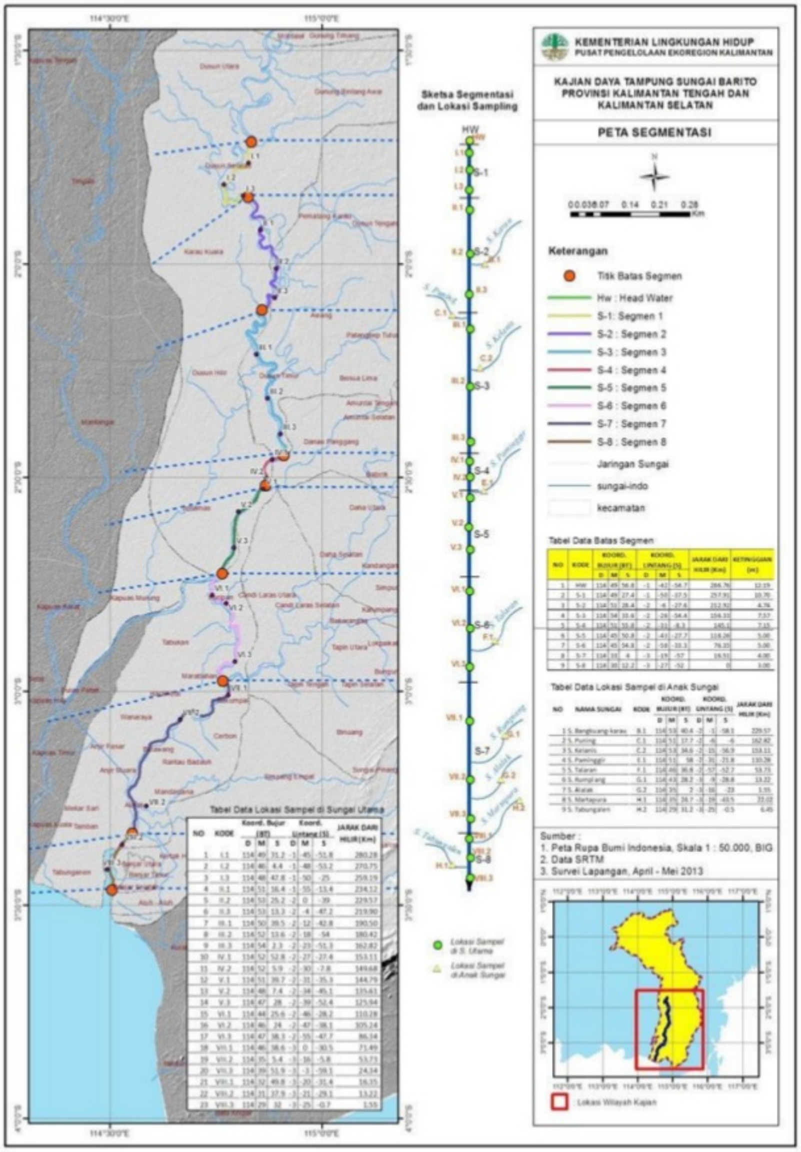

Fig 1. Segmentation map of Barito river

area) until the 4th segment was relatively low, with the values less than 6 mg/L, but in the 5th segment the DO value improved to 7 mg/L, while in the downstream area (8th segment) the DO value fell back into less than 5 mg/L. The overall DO values along the Barito river ranged from 3.5 mg/L to 7 mg/L, while for the Barito creeks condition showed a lower DO values, even in Paminggir creeks the DO reach the lowest values with 1.9 mg/L (see Table 3 and Table 4).

Pollutant sources Inventory and identification

The water pollution potential load in Barito basin was conducted through field measurement data combined with estimation approach since almost all pollutant sources were non-point source so it was quite difficult to make direct measurements. For industrial and mining data partly collected from direct measurement, while data for household, agriculture, livestock, fisheries, hotels, hospitals collected through emission factor estimation.

BOD as the pollutant load parameter was calculated by kilogram per day unit. The calculation showed the total potential pollution load (BOD) in Barito River reached 94,762.98 kg/day with the distribution tends to be concentrated in the downstream area of Barito river basin, where Barito Kuala, Banjarmasin and Banjar District has shown 43.51% of BOD value (see Table 5).

Overall, the largest potential contaminant burden came from the household sector with the value of 42.84%, followed by agriculture (23.40%) and livestock (19.79%). As in the region, South Kalimantan contributed as large as 82.50% to the potential pollutant for Barito basin while Central Kalimantan contributed 17.50%.

In order for the QUAL2Kw water quality model produce a quantified pollution load and an allowed amount of pollutant load discharged that goes into the Barito river, then a simulation with scenarios was conducted as can be seen in Table 7.

2,927 tons of total existing water pollutant load (in BOD parameter) goes into the Barito river daily

Table 2. Sample location data in creeks

Creeks name	Code	Dist. from downstream (km)
Bangkuang-Karau	B.1	229.57
Puning	C.1	162.82
Kelanis	C.2	153.11
Paminggir	E.1	110.28
Talaran	F.1	53.73
Rumpiang	G.1	13.22
Alalak	G.2	1.55
Martapura	H.1	22.02
Tabunganen	H.2	6.45

Table 3. pH values on Barito river and creeks

Segments	Locations	Points	pH	Min. Std	Max. Std
I	Buntok pier	HW	5.44	6	9
	Jelapat	I.1	5.48	6	9
	Dusun Talang	I.2	5.37	6	9
	Bintang Kurung	I.3	5.38	6	9
II	Talio	II.1	5.48	6	9
	Teluk Betung	II.2	5.35	6	9
	Bangkuang	II.3	5.32	6	9
III	Damparan	III.1	5.41	6	9
	Adaro	III.2	5.42	6	9
	Jenemas pier	III.3	5.43	6	9
IV	Rantau Bahuang	IV.2	5.43	6	9
		IV.3	5.52	6	9
V	Tabatan	V.1	5.92	6	9
	Kuripan	V.2	5.22	6	9
	Palangkau Lama	V.3	5.95	6	9
VI		VI.1	5.75	6	9
	Palangkau Bakumpai	VI.2	5.68	6	9
		VI.3	5.73	6	9
VII	Rumpiang bridge	VII.1	5.86	6	9
	Kali creek	VII.2	5.66	6	9
	Barito-Alalak bridge	VII.3	5.74	6	9
VIII	Alalak floating market	VIII.1	5.73	6	9
	Barito bridge	VIII.2	5.95	6	9
		VIII.3	5.82	6	9
	Tabunganen creek	H2	5.89	6	9
	Martapura creek	H1	6.70	6	9
	Air Sawah	G2	5.63	6	9
	Air Sawah	G1	5.96	6	9
	Talaran creek	F1	5.83	6	9
	Paminggir creek	E1	5.81	6	9
	Kelanis	C2	5.41	6	9
	Muara Puning	C1	5.33	6	9
	Bangkuang	B1	5.28	6	9

Table 4. DO values on Barito river and creeks

Segments	Sample location		DO	Quality standard			
	Locations	Points		Class 1	Class 2	Class 3	Class 4
I	Buntok pier	HW	5.80	6	4	3	0
	Jelapat	I.1	5.70	6	4	3	0
	Dusun Talang	I.2	5.60	6	4	3	0
	Bintang Kurung	I.3	5.70	6	4	3	0
II	Talio	II.1	5.70	6	4	3	0
	Teluk Betung	II.2	6.30	6	4	3	0
	Bangkuang	II.3	5.50	6	4	3	0
III	Damparan	III.1	5.90	6	4	3	0
	Adaro	III.2	5.40	6	4	3	0
	Jenemas pier	III.3	6.10	6	4	3	0
IV	Rantau Bahuang	IV.2	6.10	6	4	3	0
		IV.3	5.30	6	4	3	0
V	Tabatan	V.1	7.00	6	4	3	0
	Kuripan	V.2	4.40	6	4	3	0
	Palangkau Lama	V.3	3.80	6	4	3	0
VI		VI.1	4.00	6	4	3	0
	Palangkau Bakumpai	VI.2	3.50	6	4	3	0
		VI.3	4.00	6	4	3	0
VII	Rumpiang bridge	VII.1	4.20	6	4	3	0
	Kali creek	VII.2	4.90	6	4	3	0
	Barito-Alalak bridge	VII.3	4.10	6	4	3	0
VIII	Alalak floating market	VIII.1	4.50	6	4	3	0
	Barito bridge	VIII.2	4.60	6	4	3	0
	.	VIII.3	4.90	6	4	3	0
	Tabunganen creek	H2	5.00	6	4	3	0
	Martapura creek	H1	4.00	6	4	3	0
	Air Sawah	G2	4.10	6	4	3	0
	Air Sawah	G1	3.60	6	4	3	0
	Talaran creek	F1	4.40	6	4	3	0
	Paminggir creek	E1	1.90	6	4	3	0
	Kelanis	C2	2.40	6	4	3	0
	Muara Puning	C1	5.80	6	4	3	0
	Bangkuang	B1	5.60	6	4	3	0

started from upstream until the downstream. The biggest load contributed by the 7^{th} segment, which includes Barito Kuala and Banjarmasin area with total load reached 30.6% of the total pollutant load. At table 8 showed the existing contaminant loads across the Barito river segments.

The sampling results showed that BOD concentrations were much higher than the desired BOD concentrations, as a result of the existing contaminant load inclusion. The allowed BOD concentration was obtained from the simulation using scenario 4.

The Barito river pollution load reached 383,9 ton a day. If we compared it with the real incoming load, then there was 2,543 tons difference a day, which means each segment must reduce the average pollutant load by 86.34% to meet the PLC. The BOD-based PLC profile was obtained using 4th scenario, so the upstream BOD adapted to the Class 2.

In order to achieve an overall river PLC, the pollutant load in the upstream should also be reduced by 73.68% (BOD = 3 mg/L or Class 2) before it flows into the study area. In table 9 and table 10 shows the capacity as well as BOD pollutant load recapitulation for each segment.

Based on the simulation results analysis, it was seen that Barito river no longer had the capacity to accommodate BOD pollutant load. Generally, pollutants go into Barito river through creeks and through runoff directly as it can be seen with high BOD concentrations across creeks that led into the Barito River.

The high BOD concentrations of BOD may be due to a large number of solid and liquid waste disposal

Table 5. Potential pollution and potential pollution load between South and Central Kalimantan province

District/City	Potential Pollution Load (kg/day) BOD	Pollution Potential (%) BOD
South Barito	9,622.75	10.15
East Barito	6,958.35	7.34
Central Kalimantan	16,581.10	17.50
Tabalong	5,685.70	6.00
HSU	5,260.30	5.55
Balangan	2,943.82	3.11
HST	7,631.69	8.05
HSS	8,184.01	8.64
Tapin	7.248.19	7.65
Barito Kuala	11,132.38	11.75
Banjarmasin	13,139.87	13.87
Banjar	16,955.92	17.89
South Kalimantan	78,181.88	82.50
Barito river basin	94,762.98	100.00

activities by communities along the Barito creeks. This allegation was in line with what was presented by Osibanjo *et al*., (2011), which states that waste that goes into river waterbody, both solid and liquid, mostly came from industry, agriculture and domestic activities.

In addition, the Barito River has a very sloping hydraulic slope, causing the accumulation of incoming pollutants and slow reaeration processes. This condition causes the river's self-purification ability was very small, which ultimately leads to high concentrations of pollutants in the river.

CONCLUSION

Based on the potential pollutant load calculation, BOD value on Barito river has reached 94,762.98 kg/day with the load potentials distribution tends to be concentrated in the downstream area of Barito Basin

Table 6. The contribution of BOD Pollution Load base on Pollutant sources (%)

Pollutant Sources	Central Kalimantan	South Kalimantan	Barito river basin
Industrial/Mines	10,25	0,24	10,49
Hospitals	-	0,04	0,04
Hotels	-	0,11	0,11
Domestics	3,42	39,43	42,85
Livestock	2,12	17,66	19,78
Agriculture	1,64	21,76	23,40
Fisheries	-	2,36	2,36
Small industries	-	0,01	0,01
Restaurant	-	0,03	0,03
Mall	-	0,01	0,01
Waste	0,07	0,85	0,92
Total	17,50	82,50	100

Table 7. QUAL2Kw water quality modeling scenarios

Scenario	Upstream		Pollutant Load	Output
	Debit	Water Quality		
I	Measurement result Field	Observation result	Inputted based on field data Map assisted and secondary data	Observation result
II	Measurement result Field	Observation result	Trial and error	Class II at 1,2,3,4,5 segments Class I at 6,7,8 segments
III	Measurement result	Class 1	Trial and error	Class II at 1,2,3,4,5 segments
	Field		Trial and error	Class I at 6,7,8 segments
IV	Measurement result Field	Class 1	Inputted based on field data Map assisted and secondary data	Model

Table 8. The existing BOD pollutant load in Barito river

Segment	BOD pollutant load (kg/day)	Contribution (%)
I	128,800.00	4.26
II	316,123.00	10.80
III	237.358.39	8.11
IV	133,902.72	4.57
V	259,200.00	8.86
VI	462,116.80	15.75
VII	1,153,261.32	39.40
VIII	241,228.80	8.24
Total	2,926,991.23	100.00

Table 9. BOD Pollutant Loads Capacity (PLC) for each segment

Segments	BOD PLC (kg/day)
I	4,492.80
II	95,472.00.
III	64,281.00
IV	24,105.00
V	12,960.00
VI	24,624.00
VII	138,573.50
VIII	19,440.00
Total	383,949.50

Table 10. BOD Pollutant Load recapitulation

Segments	BOD Pollutant Load (kg/day)	BOD PLC (kg/day)	Pollution Load decreased (kg/day)	Decreasement percentage (%)
I	124,800.00	4,492.80	120,307.20	96.40
II	316,123.20	95,472.00	220,651.20	69.80
III	237,358.39	64,281.60	173,076.79	72.92
IV	133,902.72	24,105.60	109,797.12	82.00
V	259,200.00	12,960.00	246,240.00	95.00
VI	461,116.80	24,624.00	436,492.80	94.66
VII	1,153,261.32	138,573.50	1,014,687.82	87.98
VIII	241,228.80	19,440.00	221,788.80	91.94
Total	2,926,991.23	383.949,50	2.543.041,73	86.34

(43.51%), which include in South Kalimantan Province territories.

Overall, for BOD parameter, the biggest contaminant burden came from the household sector which reached 42.84%, followed by agriculture (23.40%) and livestock sector (19.79%). As for the same parameters, the total existing water contamination burden that flowS from Barito rivers upstream to downstream has reaches 2,927 tons in a day. While the biggest load was contributed by the 7^{th} segment (30.4% of all pollutant load) covering Barito Kuala and Banjarmasin areas.

Under those conditions, only 383.9 tons of BOD per day was allowed to flow across the entire Barito river segments. When compared with the real load, there were 2,543 tons differences per day. This means each segment must reduce pollutant load by 86.34% in average to meet the BOD water quality requirements.

REFERENCES

Guo, H., Liu, L., Huang, G., Fuller, G., Zou, R. and Yin, Y., 2001. A system dynamics approach for regional environmental planning and management: a study for the Lake Erhai Basin. J. Environ. Manage. 61 : 93–111. https://doi.org/10.1006/jema.2000.0400

Osibanjo, O., Daso, A.P. and Gbadebo, A.M. 2011. The impact of industries on surface water quality of River Ona and River Alaro in Oluyole Industrial Estate, Ibadan, Nigeria. Afr. J. Biotechnol. 10: 696– 702.

Owa, F.W. 2014. Water Pollution: Sources, Effects, Control, and Management. Int. Lett. Nat. Sci. 8, 1–6. https://doi.org/10.18052/www.scipress.com/ILNS.8.1

Rusnugroho, A. and Masduqi, A. 2012. Aplikasi QUAL2Kw sebagai Alat Bantu Perhitungan Daya Tampung Beban Pencemaran Kali Madiun (Segmen Kota Madiun), in: Advances in Agricultural and Municipal Waste Technology to Anticipate Food and Energy Crisis. Presented at the Scientific Conference of Environmental Technology IX - 2012 , Institut Teknologi Sepuluh Nopember Surabaya, Surabaya, pp. 1–6.

Soenarno, 2001. Pedoman Pengembangan SDA Pedoman Penunjang Pertanian & Perikanan. Dirjen SDA, Jakarta.

The Laws of Indonesian Republic Number 32, 2009. , The Environment Protection and Management.

Xiao-de, Z., Jin-long, G.U.O., Weng, C., Ce, S. and Gang, C.A.O. 1999. The Comparison of the Environmental Capacity Calculation Methods. J. XIAN Univ. Technol. 15 : 1–6.

POLLUTION LOAD CAPACITY STUDY ON BARITO RIVER, SOUTH KALIMANTAN, INDONESIA

ORIGINALITY REPORT

2%	2%	0%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	eprints.ulm.ac.id Internet Source	1%
2	journals.sagepub.com Internet Source	<1%

Exclude quotes On
Exclude bibliography On
Exclude matches < 12 words

POLLUTION LOAD CAPACITY STUDY ON BARITO RIVER, SOUTH KALIMANTAN, INDONESIA

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7