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Analysis of Baru River water quality due to disposal of domestic waste in the Sub District of Central Banjarmasin, South Kalimantan

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Abstract

The inclusion of wastewater into water bodies will lead to quality deterioration of the receiving water bodies, due to the substances contained in the wastewater. Moreover, wastewater can disrupt river ecosystem. If waste containing pollutants is discharged into clean and clear water, the water quality will change. This study aims to determine status of Baru River water quality using Pollution Index (IP) method and to analyze impact of domestic waste pollution on public health. According to Government Regulation no. 82 of 2001 Class II on Water Quality Management and Water Pollution Control, the results indicates that Baru River water quality for DO, BOD, Phosphate, Fe, Cd and Total Coliform bacteria parameters generally exceeds the water quality standard. According to Pollution Index (IP) calculation, water quality status of downstream area of Baru River is classified as Mildly Polluted (1≤PI <5) with the highest IP value of 4.97; and decreasing Pollution Index occurs between upstream and middle areas with IP value of 9.89 of which water quality status is classified as Fairly Polluted (5≤PI <10) according to Decree of the Minister of State for the Environment No. 115 of 2003 on Guidelines on the Determination of Water Quality Status. Domestic waste in Baru River brings negative impact on public health such as itchy skin which is significantly affecting public health that reaches 95.6% of all health problems. The problem is derived from community lack in maintaining river cleanliness which brings disadvantages for the community. Thus, evaluation on Baru River water quality status should be carried out periodically for further studies.

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Introduction

Water is part of life on the earth, either it is ground or surface water. River water is one of water sources for daily use. River is a natural resource that has a variety of functions for different needs such as for domestic, industry, agriculture, fisheries, sports and transportation needs. River water is used for irrigation, washing, fish ponds, disposal site, power plants, wildlife's living places, water transport and recreation as well.

The presence or inclusion of wastewater into water bodies will result in quality degradation of receiving water bodies, the river ecosystem will be disrupted due to materials or substances contained in water. For all this time, most parts of the world suffer from water problem and it needs to get real attention. Obtaining good water that meets the required quality standards has been difficult to do as many sources of water have been polluted by various kinds of human activities. Human activity and waste disposal into water bodies cause water flowing above the ground to get polluted. Water bodies are the balance of a complex life. Ecosystem in these water bodies has certain refining capacity. In natural stream of water, balanced cycle occurs between the life of water flora and fauna. Water quality will change if wastes containing pollutants are disposed into clean and clear water bodies.

Community health may be achieved through education, among others, to change underdeveloped community attitude and behavior toward environmental health. One of the aforementioned environmental health scopes is human waste disposal site or latrines that are used by the community. Adverse conditions, as well as less hygienic attitudes and behaviors may cause various illnesses. When waste disposal is continuously carried out, it will damage river environment. River is naturally capable of treating waste. However, homeostatic properties it possesses are limited, so when waste exceeds the limit, pollution problems will occur.

Baru River is an area of origin of Baru River Village which includes four urban villages namely Pekapuran Laut Urban Village, Pekapuran Raya Urban Village, Karang Mekar Urban Village and Sungai Baru Urban Village. Baru River is also known as ketupat village as the community activities in Baru River are mostly making ketupat (a type of dumpling made from rice packed inside a diamond-shaped container of woven palm leaf pouch) throughout the day and night. They frequently serve ketupat or lontong (a dish made of compressed rice cake in the form of a cylinder wrapped inside a banana leaf) ranging from the skin of ketupat to ready-to-eat ketupat. Baru River is currently used for washing, bathing and toilet. There are still found latrines belong to the community along the river. Moreover, community behavior of littering will affect the water quality as well as affecting the life of the river biota and the surrounding environmental aesthetics. Therefore, closer attention toward analyzing the water quality status of Baru River should be paid.

Materials and methods

Materials

The study was conducted in a laboratory scale using pH, Winkler for titration, AAS tools, microscopes, analytical balance, spectrophotometry and incubators. This equipment was used to analyze the water samples in the Baru River. There were 13 parameters to be analyzed, namely pH, Temperature, DO, TSS, BOD, COD, Ammonia, Phosphate, Iron, Cadmium, Chromium and Total Coliforms. Analysis on quality of Baru River water is performed using Pollution Index calculation.

Research Design

Types of data collected for the purposes of this study included the primary data that included water sampling carried out by taking water into sample bottles. The water handling of the sample was performed using a sealed water sample bottle and inserted into a cooler containing ice. For the total phosphate parameter, the water samples were stored in ice-cooled containers without preservatives. It was then stored in a cooler to be analyzed. Prior to the analysis process, sample water should be rested until their temperatures were at normal room temperature between 26-28^{o}C.

In situ parameter measured was pH. Sample water tests in laboratory were COD, total phosphate (PO4), chromium (Cr), cadmium (Cd), iron (Fe) and e-coli tests. Meanwhile, samples which were used to test fatty oils required additional 2-3 drops of H_2SO_4 then it was cooled up to ± 4°C; while to test BOD and TSS, the samples were only cooled up to ± 4°C then they were labeled and put into the ice box to subsequently be analyzed in the laboratory.

Method

This was a descriptive study using quantitative and qualitative approach. Descriptive study using quantitative approach was used to describe the condition of Baru River water quality.

This study was also supported with qualitative data to provide an in-depth description of activities resulting water pollution in Baru River at Central Banjarmasin Sub District. The research method used was case study, a method where all aspect must be completely observed, while results of data analysis were only valid for certain places and period of time.

Data Analysis

Data analysis that had been carried out included water quality analysis, determination of water quality status, and analysis of impact on surrounding community health.

a. Water Quality Analysis

Is an analysis to determine quality of Baru River water by analyzing the test results of parameters in water pollution including physical parameters [Temperature and Total Suspended Solid / TSS), chemical parameters [Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, NH 3 -N (Ammonia), PO 4 -P (Phosphate), Metals Fe, Cd and Cr) and biological parameters (Total Coliform Bacteria). Measurement of parameter concentration of river water quality using the method as shown in Table 1.

Table 1. Water Quality Parameter Analysis Method.

Parameter		Unit	Method of Analysis
I.	Physics		
1.	Temperature	°C	SNI 6989. 23 : 2005
2.	TSS	mg/l	SNI 6989. 3 : 2004
II.	Chemical		
1.	pH	-	SNI 6989. 11 : 2004
2.	DO	mg/l	SNI 6989. 14 : 2004
3.	Fe	mg/l	SNI 6989. 4 : 2009
4.	Cd	mg/l	SNI 6989. 16 : 2009
5.	Cr	mg/l	SNI 6989. 17 : 2004
6.	NH_3-N (Ammonia)	mg/l	SNI 6989. 30 : 2005
7.	PO_4 – P	mg/l	SNI 6989. 31 : 2005
8.	BOD	mg/l	SNI 6989. 72 : 2009
9.	COD	mg/l	SNI 6989. 2 : 2009
10.	Oil & Fat	mg/l	SNI 6989. 10 : 2004
III.	Microbiology		
1.	Total Coliforms	MPN/100ml	MPN Method

The results of the test parameters are then compared with the water quality standard in accordance with Government Regulation of the Republic of Indonesia no. 82 of 2001 on the Management of Water Quality and Control of Water Pollution.

b. Identification of River Water Quality

Identification of Baru River waters quality is performed by calculation using pollution index method. Measured parameter value of the river compared to designated water quality standard, that is environmental water quality standard in accordance with government regulation No. 82/2001 on water quality management.

Calculation of pollution index uses formula of:

$$Ipj = \frac{\sqrt{(Ci/Lij)^2M + (Ci/Lij)^2R)}}{2}$$

Information:

Lij = Concentration of water quality parameters specified in water quality standard (j)

Ci = Concentration of water quality parameters surveyed

Ipj = Pollution index for designation (j)
(Ci / Lij) M = Maximum Ci / Lij value
(Ci // Lij) R = Average Ci / Lij value

Based on calculation of contamination index result, the level of contamination is then analyzed to determine the status of water quality according to the Minister of Environment Decree no. 115 of 2003 on Guidelines on the Determination of Water Quality Status.

c. Analysis of Health Impacts on the Community

Analysis of domestic waste water pollution impacts on the environment can be performed by observing environmental conditions, such as that generated from domestic activities, a number of latrines belonging to the community and changes in water conditions affecting water quality. Therefore, to determine the impact of pollution on environmental health can be performed through field observation and distributing questionnaire to the community surrounding Baru River. Then, to obtain data of the impact of public illness, percentage formula which can be seen as follows is used.

$$\text{Score} = \frac{B}{N} \times 100\%$$

Information:
B = Number of items correctly answered
N = Number of items

More than 70% of people suffering from illness are considered experiencing diseases with negative impacts. River water pollution has direct impacts on environmental health. One of the diseases caused by lack of clean water is skin disease.

Results and discussion

Result of Pollution Source Identification

The data shown are data of field observation and secondary data as supporting data. The result of the identification is presented in the form of a map as shown in Fig. 1.

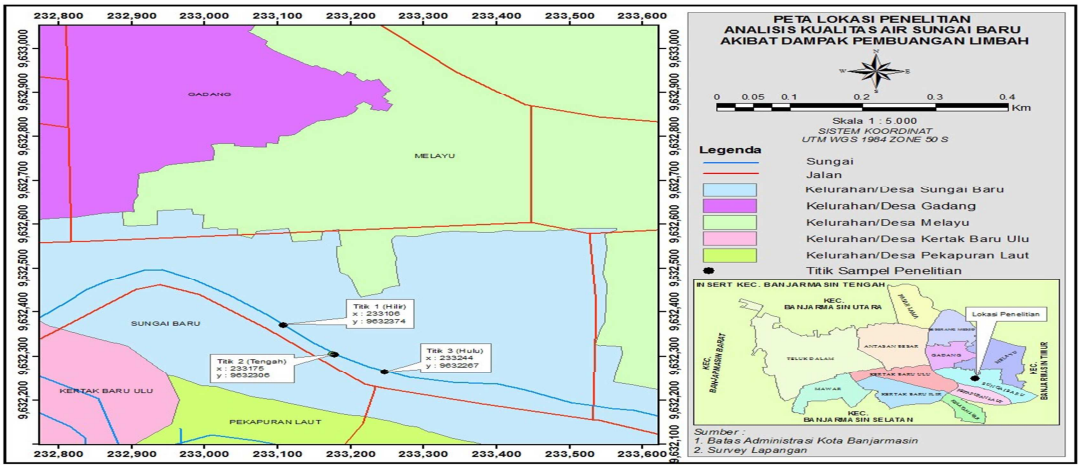

Fig. 1. Map of Research Locations.

Water Quality Analysis Results

Results of the study of Baru River at high tide time which was conducted both in the field (in situ) and a laboratory analysis (ex situ) are presented below:

Table 2. Laboratory Analysis Result Data for High Tide condition.

No.	Parameter	Units	Baru River Upstream	Baru River Middle stream	Baru River Downstream	Quality Standard
1	pH	-	6.1	6.0	5.97	6 – 9
2	DHL	µmhos/cm	131.6	123.3	142.7	
3	DO	mg/L	4.72	4.47	4.36	4
4	BOD	mg/L	5.81	4.81	8.61	3
5	COD	mg/L	8.424	9.085	20.49	25
6	NH_3-N	mg/L	0.273	0.251	0.167	-
7	PO_4-P	mg/L	5.7	3.7	3.1	0.2

No.	Parameter	Units	Baru River Upstream	Baru River Middle stream	Baru River Downstream	Quality Standard
8	Fatty oils	mg/L	0.5	0.3	0.2	1000
9	Fe	mg/L	2.67	2.27	1.62	-
10	Cd	mg/L	0.004	0.005	0.005	0.01
11	Cr	mg/L	0.005	0.005	0.005	0.05
12	Temperature	mg/L	29.2	27.8	27.6	Deviation 3
13	TSS	mg/L	24	20	26	50
14	E-Coli	MPN	9,900	23,300	5,000	5,000

* Quality Standard according to Government Regulation No. 82 of 2003, Class II

* Minimum Limit Number

Meanwhile, results of the study of Baru River at low tide time which was conducted both in the field (in situ) and laboratory analysis (ex situ) are presented below:

Table 3. Results of Laboratory Analysis on Baru River at low tide time.

No.	Parameter	Units	Baru River Upstream	Baru River Middle stream	Baru River Downstream	Quality Standard
1	pH	-	5.96	5.96	5.94	6 – 9
2	DHL	µmhos/cm	288	260	259	
3	DO	mg/L	2.66	2.25	5.15	4
4	BOD	mg/L	7.21	7.91	5.92	3
5	COD	mg/L	19.91	24	12.31	25
6	NH_3-N	mg/L	0.526	0.661	0.342	-
7	PO_4-P	mg/L	3.7	3.8	2.6	0,2
8	Oil, Fat	mg/L	0.6	0.8	0.5	1000
9	Fe	mg/L	1.15	1.67	1.68	-
10	Cd	mg/L	0.003	0.004	0.003	0,01
11	Cr	mg/L	0.005	0.005	0.005	0,05
12	Temperature	mg/L	38.6	27.7	16.8	Deviation 3
13	TSS	mg/L	21	20	25	50
14	E-Coli	MPN	1,900,000	1,900,000	380,000	5,000

* Quality Standard according to Government Regulation No. 82 of 2003, Class II.

* Minimum Limit Number.

Based on the results of Baru River water test, parameters exceeding the class II water quality standards are DO, BOD, Phosphate, Fe, Cd, and Coliform Total Bacteria. The highest DO concentration is 5.15mg/L at low tide time. The highest BOD concentration is 8.61mg /L at high tide time and 7.91mg/L at low tide time. The highest concentration of phosphate is 5.7mg /L at high tide time. The highest concentration of Fe is 2.67mg /L at high tide time. The highest Cd concentration is 0.005mg/L at high tide time and the highest E-Coli concentration is 1,900,000 MPN at low tide time.

Result of Pollution Index (IP) Analysis

To obtain the status of river water quality, method of Pollution Index as presented in Decree of State Minister of Environment no. 115 of 2003 on Guidelines for Determination of Water Quality Status is used by comparing the concentration of water quality parameters listed in the quality standard of a water designation with the concentration of water quality parameters obtained from the analysis of water samples at sampling locations from Baru River line. The following table shows Pollution Index describing the status of water quality.

Table 4. Value of Baru River Pollution Index.

No.	Sampling Locations	Value of Pollution Index	Category
1	Baru River Upstream (high tide)	5.90	Fairly Polluted
2	Baru River Middle stream (high tide)	5.26	Fairly Polluted
3	Baru River Downstream (high tide)	4.97	Mildly Polluted
4	Baru River Upstream (low tide)	7.04	Fairly Polluted
5	Baru River Middle stream (low tide)	9.89	Fairly Polluted
6	Baru River Downstream (low tide)	7.45	Fairly Polluted

Calculation data are attached

Based on the calculation of water quality status of Baru River using Pollution Index method, it indicates that the quality of Baru River water is in fairly polluted status, except in the downstream area at high tide which is in the status of Mildly Polluted. The level of pollution obtained does have a low water debit and the flow of household waste is directly disposed into the river body. Waste runs from upstream to downstream and is piled up in the downstream area before entering Barito River as to increase pollution in the downstream area. Based on the value of pollution index (IP) for the highest middle area reaching IP value of 9.89 which was occurred on sampling when the river was at low tide time, and is classified as Fairly Polluted (5 ≤ IP <10). For upstream area when river was in low tide time, IP value obtained is 7.45 and while IP value in downstream area is 7.45 which also belong to the category of Fairly Polluted (5 ≤ IP <10). The high IP in the middle stream of the river is due to parameters of Coliform Total bacteria that is too high from the allowed limit of 1.900.000 MPN.

Meanwhile, the value of pollution index (IP) for the highest upstream area reaches the IP value of 5.90 occurred on sampling during tidal conditions, and including the category of Medium Danger (5 ≤ IP <10), for the middle region of 5.26 also included polluted category Medium (5 ≤ IP <10). However, for the lowest downstream areas it reaches IP value of 4.97 and belongs to the category of Lighter Contaminants (1.0 < IP ≤ 5.0). The decrease in the area between upstream and downstream occurs due to the dilution due to the increase of discharge in rainy season, while the highest IP value is affected by the increasing concentration of pollutant sources derived from community activities such as defecation around the river. However, the decrease of IP value is classified as Fairly Polluted, so pollution control in Baru River is required.

Public Health surrounding Baru River

Public health questionnaires in Sungai Baru aims to know the health impacts of communities as a result of Baru River wastewater.

The public health questionnaire contains 10 items with yes / no choice and was given toward 45 respondents, those were 15 respondents surrounding Baru River Upstream, 15 respondents surrounding Baru River Middle stream and 15 respondents surrounding Baru River Downstream. Community health surrounding Baru River are presented in Table 5 below:

Table 5. Responses on community health surrounding Baru River

No	Statement	Yes	No
1	Do you use the river water?	100	0
2	Have you ever experienced any skin complaints after using Baru River water?	100	0
3	Have other family members ever or any experienced skin complaints after using Baru River water?	100	0
4	Does the complaint include itching?	95.6	4.44
5	Does the complaint include red spots?	24.4	75.6
6	Does the complaint include pain?	4.44	95.6
7	Does the complaint include hot/warm on the body?	4.44	95.6
8	Does the complaint include scaly skin?	31.1	68.9
9	Are there any other health complaints that may be more dangerous after using the water of the Baru River?	2.22	97.8
10	Is treatment to cure the problems carried out?	22.2	77.8

Based on results of interviews by distributing questionnaires to respondents, it shows that 95.6% (the highest percentage) of respondents have complaints in itchy skin. Itchy and red skin are symptom of dermatitis and skin response to the various types as are associated with allergies (Djuanda, 2002).

About 22.2% of the people go to health workers such as doctors or community health personnel and 77.8% of the respondents choose not to seek treatment because they do not mind with the problems and that most people are poor. Researchers argue that the longer a person uses contaminated water, the less they are likely to have skin problems. This is because the body that has accustomed to pollutants will be more resistant to various toxic substances. On the contrary, the less a person uses contaminated water, the more the person will get a change to have skin problems.

The results also show that 100% people live surrounding the river use Baru river water. This suggests that there is a relationship between contaminated water source and skin problems. Baru River used by the community as a source of water, has been polluted. So it may cause various kinds of diseases, one of them is a skin problem such as itchy skin. Skin problems can be transferred to others through water, it can also spread directly from phase to mouth or through dirty or polluted foods, as a result of lack of clean water for personal hygiene (Purbowarsito, 2011). When viewed from the results of chemical parameters, there is a parameter exceeding the water quality standard that is BOD. For BOD inspection results, all sample points exceed the quality standards resulting from settlement activities with increasingly populated area. Biochemical Oxygen Demand which is oxygen needed by microorganisms to decompose organic compounds in the wastewater (Ward, 2004) is required. BOD inspection is required to determine the pollution load caused by wastewater. The BOD reaction is slower compared to COD reactions, because the BOD test results depend on how the bacteria work (Sunu, 2001). Water that holds high organic material has high BOD value, then dissolved oxygen content in the water becomes low and will result in water biota to die and can cause various diseases to humans. Widowati (2008) states that metals are pollutants. They cannot be destroyed by living organisms in the environment, so the metal forms complex compounds with organic and inorganic materials. This can cause skin disruption when it is used as a source of water for the community. Moreover, high values of Total Coliform Bacteria parameter found in the Baru Riverwill cause more dangerous human diseases. So it is necessary to provide counseling to the community, so they do not to use Baru River water until its quality meets health requirements.

Conclusion

In general, water quality exceeds class II water quality standard for DO, BOD, Phosphate, Fe, Cd and Coliform Total Bacteria. The main source of pollutants comes from domestic waste of densely populated settlements, community activities and trade.

The status of the quality of the Baru River water at high and low tide times based on pollution index calculations indicates the general river condition which is "Fairly Polluted". Based on the results of water quality analysis, downstream area is classified as Mildly Polluted (1≤PI <5) with the highest IP value of 4.97. However, there is a decrease in the Baru River Pollution Index (IP) between upstream and middle stream areas which are classified as “Fairly Polluted” (5≤PI <10) with the highest IP score of 9.89. Domestic waste has a negative impact on public health. It is indicated by 95.6%, 24.4%, 4.44% and 31.1% of people who live surrounding the riverbank suffering from itching, red spots, pain, body heat and scaly skin, respectively.

Acknowledgement

The use of polluted water has a detrimental effect on human health. Therefore, it is expected that the community will take care of the cleanliness of the river so that the river water can be utilized properly without causing any harm to its users. It is therefore expected not to dispose of waste and waste products from household waste, factory and industrial products to river bodies.

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