Water quality evaluation used to function feasibility case study on Babon river in Semarang, Central Java, Indonesia

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Abstract. Semarang City, is Capital of Central Java Province Indonesia, has many watersheds which it’s still unknown about water quality, water class and function. The other hand, the people need to water resources for some utilization. Babon Watershed is one of them, and located at north slope of Ungaran Mount. The main river is about 33.76 km length. Base on its function, from upstream to downstream, Babon Watershed can be divided into 8 segments. Data collection of river water quality is done by taking samples on the representative location. The parameters analysed included physical parameters (TDS, TSS, temperature, DHL, brightness), inorganic chemical parameters (pH, BOD, COD, total P, NO2, NO3, N total, NH3, Cl, F, Sulphate, H2S, chlorine free, sulfur as H2S), organic chemical parameters (oil-fat, detergent as MBAS, phenol), and biological parameters (fecal coliform and total coliform). According to the analysis results obtained that in segment number I, II, III of Babon Watershed is recommended to function in class II, while segments number IV, V, VI, VII, VIII are recommended to function in class III.

1. Introduction
Babon River is one form of ecosystem that is divided into upstream, middle and downstream areas. The people need to water resources for some utilization in each area. The upstream area is dominated by dryland and forest farming activities, the middle area by settlements and in the downstream region is dominated by industry and settlements. The community in the Babon River Basin have various and changed rapidly, therefore water needed to support its development. One of the change effects is the pattern of utilization of natural resources around the river [1].

Indonesian Government Regulation No. 82 of 2001 concerning Management of Water Quality and Water Pollution Control stated that to ensure good water quality, it is necessary to carry out efforts to manage water quality [2]. Efforts to manage water quality in rivers, among others, by determining the capacity of the river, determine the designation of the river accompanied by the application of water quality standards.

2. Methods
Data collection of river water quality is done by taking samples on the representative location. The parameters analyzed included full physical parameters (TDS, TSS, temperature, DHL, brightness), inorganic chemical parameters (pH, BOD, COD, total P, NO2, NO3, N total, NH3, Cl, F, Sulphate, H2S,
chlorine free, sulfur as H\textsubscript{2}S), organic chemical parameters (oil-fat, detergent as MBAS, phenol), biological parameters (fecal coliform and total coliform) \cite{3}. According to application needed, in the research, the parameters observed are TSS, BOD and COD.

Calculation of pollution levels using Pollution Index Method as in Kep-MENLH No. 115/2003 by Nabiel Makarim from Indonesia Ministry of Environment \cite{4}. The method provided to assess and to decide the quality of water level for a utilization allocation. Then, an action can be made to improve quality due to the presence of polluting compounds. The pollution index includes various independent and meaningful quality parameters \cite{5}.

Water sampling is carried out to determine the condition of water quality from upstream to downstream area. Sampling is done in each segment by purposive sampling methods \cite{6}. Data collecting done from 2015 and 2019. To decide water sampling representative, the researcher consider to standard method, access available, cost and time Figure 1 describes the location of water river and wastewater samples in the watershed.

![Figure 1. Sampling location.](image)

In addition to river water quality sampling, wastewater samples from point sources (several industrial locations) were also taken. The samples types and locations are shown in the following table 1.

**Table 1. Sampling location.**

| No. | Name   | Segment | Location                                                   |
|-----|--------|---------|------------------------------------------------------------|
| 1.  | Point  | P1      | V Outlet of slaughterhouse, Pedurungan, Semarang           |
| 2.  | Point  | P2      | VII Outlet of PT. Horison Gil, Kudu, Semarang              |
| 3.  | Point  | P3      | VIII Outlet of PT Rodeo, Demak                            |
| 4.  | Point  | P4      | VIII Flavoring Factory, Terboyo Industrial Area, Semarang  |
| 5.  | Point  | P5      | VIII Leather Factory, Terboyo Industrial Area, Semarang    |
3. Description of location

Babon River or “Kali Babon”, passes through 3 administrative regions, namely Demak Regency, Semarang Regency and Semarang City according to [7]. Babon River is often also called the Penggaron River in the upper of Pucang Gading dam. The Babon River has several tributaries that are quite large, namely Talang River, Sinanas River and Ketokan River. Whereas Kali Dolok and Kali Banjir Kanal Timur become separate watershed systems, but they are in a network controlled by sluice gates [8].

Babon watershed coverage is quite extensive, starting from several tributaries in Semarang Regency, meeting upstream areas in the Meteseh and Gedawang areas of Banyumanik District, Semarang until flowing eastward through the Pedurungan City of Semarang, Sayung District, Demak Regency, finally heading the area of Genuk Subdistrict and into the north coast of the Java Sea [9].

Babon watershed consists of three sub-watersheds, namely the Gung Sub-watershed (covering an area of 8,372 Ha), the Collector's Watershed (covering an area of 7,010 Ha) and the Lower Babon Watershed (an area of 9,202 Ha) with a main river length of 44,679 km. Geographical position, Babon watershed is located between 60° 55' 15" - 07° 00' 00" SL (South Latitude) and 110° 24' 42" - 110° 30' 24" EL (East Longitude).

4. Result and discussion

Based on the results of processing of maps using a geographic information system, Babon River has 44,679 km length of upstream to downstream. The river water samples were taken by observing the watershed that forms the river fragments using only TSS, BOD and COD based on SNI 03-7016-2004 [10]. River segmentation was conducted in advance to determine the area that affected the river with a certain distance. In Figures 2 and 3 present the Babon watershed map, and the division of segments starting from upstream to downstream.

![Figure 2. Babon River segmentation map.](image-url)
Segment determination is based on consideration of water use (current and future), river morphology, topography, potential water sources and potential pollutant sources [11]. By considering these conditions, the Babon River is divided into 8 division segments. Calculation of pollution load capacity uses a comparison of simulation. The simulation uses scenario 1 and scenario 2. In scenario 1 is a condition without pollutant load, while simulation scenario 2 is a condition of pollution. The load condition assessed according to class II river quality standards. This value is presented in table 2.

Generally in the downstream areas TSS contamination loads tend to be higher [12]. However, the graph in figure 4 shows that TSS is highest in the upstream area of the dam. This is due to the large area of agricultural land in the upstream area according to data from the Central Statistics Agency [13].

The graph in Figure 5 shows a significant increase the BOD in segment 8. This is due to the accumulation of previous segments as well as several point sources. The segment 8 or precisely in Genuk Subdistrict is found in a number of industries that have the potential to contribute to production waste, including point source textile industry (PT. Rodeo), fishing industry (PT. Aorta), food / beverage industry (PT Kino and PT. Sukasari), cigarettes industry (CV. Living Heritage), and leather industry (PT. Puspita).

| Seg. | Distance (km) | TSS  | BOD  | COD  |
|------|---------------|------|------|------|
|      | Up | Down | kg/day | kg/day | kg/day |
| 1    | 40,70 | 38,60 | 331,50 | 3,7 | 165,75 |
| 2    | 38,60 | 33,50 | 568,69 | 6,92 | 298,92 |
| 3    | 33,50 | 27,60 | 165,27 | 36,26 | 179,45 |
| 4    | 27,60 | 22,90 | 93,65  | 21,04 | 96,77  |
| 5    | 22,90 | 20,70 | 46,45  | 48,38 | 43,55  |
| 6    | 20,70 | 19,00 | 44,70  | 46,56 | 41,91  |
| 7    | 19,00 | 15,50 | 11,64  | 26,86 | 71,62  |
| 8    | 15,50 | 10,90 | 82,86  | 388,36 | 653,97 |
Similar to the BOD chart, the COD chart in figure 6 shows a significant increase in segment 8 due to accumulation in the previous segment and effluent in several industries. In addition, it can be seen that the COD contamination load for the upstream area is quite high due to the high Potential Domestic COD Pollution Load in the upstream area.

Based on the results of calculations shown in Table 2 and Figures 4 to 6, it can be seen that the minimum and maximum capacity for each test parameter is in accordance with the existing river segment [14]. For TSS parameters the minimum capacity is 11.64 kg / day in segment 7, BOD parameters are 3.69 kg / day in segment 1 and COD parameters are 41.91 kg / day in segment 6. The maximum capacity of TSS parameters is 568.69 kg / day in segment 2, BOD parameters of 388.36 kg / day in segment 8 and COD parameters of 653.91 kg / day also in segment 8.

The resulting water classes proposed for each segment on the Babon River are as follows in table 3.

**Table 3. Proposed water class for each segment.**

| Segment | Proposal of Water Class |
|---------|-------------------------|
| I       | II                      |
| II      | II                      |
| III     | II                      |
| IV      | III                     |
| V       | III                     |
| VI      | III                     |
| VII     | III                     |
| VIII    | III                     |

According to the result in Table 3 considered that Class II is used for water recreation facilities/infrastructure, freshwater fish farming, livestock, and utilization for plants or other uses. While Class III is used for freshwater fish farming, livestock and irrigation.
5. Conclusion
(1) Based on land use and pollutant distribution, Babon river is divided into 8 segments.
(2) The resulting TSS is large in the upstream of the dam, gradually lower towards downstream, and slightly increase at nearing the estuary area.
(3) The value of BOD and COD tends to increase from upstream to downstream or estuary.
(4) In the upstream area class II is proposed, while water in the downstream area proposed to be utilized for class III.

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