Water quality in Ci Lutung Watershed (Case study: Ci Jurey Sub-Watershed and Ci Deres Sub-Watershed)

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Abstract. Natural waters such as rivers are environmental components that need to be considered especially regarding the quality of river water. River water quality can decrease because landuse change as a form of increasing human activity. The purpose of this study is to assess the river water quality of the Ci Lutung Watershed, specifically the Ci Jurey-Sub-Watershed and Ci Deres Sub-Watershed. To assess the quality of the water, a water sample is taken directly from the specified river body. The water quality parameters tested consisted of TDS, pH, conductivity, and turbidity as physical parameters, and nitrate, phosphate, sulfate and chloride as chemical parameters. This water quality assessment is carried out using the STORET method, which is comparing the results of parameter tests with Class III Water Quality Standards as determined by Indonesian Government Regulation No. 82/2001. This research also identified the relationship between landuse and lithology as a watershed characteristic with the river water quality. To be concluded, the water quality of the Jurey River and the Deres River is categorized as light polluted according to the STORET calculation. Also, the water quality in both rivers are spatially influenced by each watershed’s characteristic. TDS value is calculated high because its lithology –age of oligocene Tertiary rocks, and nitrate value is calculated high because it is influenced by agricultural activities.

1. Introduction
Rivers are one of the important ecosystems that provide water for humans both for agricultural, industrial, and domestic activities [1]. In the drainage process, river water will receive various pollutants from domestic sources i.e. households, villages, cities, and markets, and also non-domestic sources i.e. factories, industries, agriculture, and livestock [2]. Water pollution is characterized by changes in physical, chemical and biological components that are not desired in aquatic ecosystems [3]. Rivers and lakes are the most studied environments, as these are the environments where freshwater is more accessible for population [4].

Water quality Ci Manuk Watershed as one of the potential rivers in West Java besides Ci Tarum Watershed and Ci Tanduy Watershed, experienced changes spatially and temporally that exceeded the water quality standard for certain uses in the range 1998 – 2002 [5,10]. Watersheds studied in this study is Ci Lutung Watershed, which is the Sub-Watershed of Ci Manuk Watershed. Ci Lutung Watershed covers two districts, that are Majalengka Regency and part of Sumedang Regency. Quoted from BBC Indonesia, Kertajati Airport was inaugurated as a new airport in northern West Java in 2018. The existence of an airport is expected to trigger development and influence the pattern of landuse, in this case is in Majalengka Regency [6] The decline in water quality is often caused by its use by humans for various purposes such as plantations, intensive cultivation, intensive deforestation, industrial plants and urban development which are disposed of in water bodies [7]. Changes in landuse
patterns and increased industrial activities will have an impact on hydrological conditions in a watershed [8]. River is a dynamic ecosystem, influenced by various activities in the river bank [9,10]. Various landuse activities in the Ci Lutung Watershed area i.e. settlements, rice fields, and plantation or mixed gardens are estimated to have affected the water quality of Ci Lutung Watershed. The assessment of river water quality in Ci Lutung Watershed, especially in Ci Jurey Sub-Watershed and Ci Deres Sub-Watershed, was carried out in the rainy season period of 2019.

2. Method

2.1. Research Area

The research area is located in Ci Lutung Watershed, especially in Ci Jurey Sub-Watershed and Ci Deres Sub-Watershed which is the Ci Lutung Sub-Watershed (Figure 1). Ci Lutung Watershed is one of the Sub-Watershed of Ci Manuk Watershed. Ci Lutung Watershed is located at the boundary of Majalengka District and Sumedang District, West Java, Indonesia. This watershed has an area of around 63,606 hectares. Ci Jurey Watershed and Ci Deres Watershed are Sub-watersheds of Ci Lutung Watershed which have an area of around 4,045 hectares for Ci Jurey Watershed and 7,734 hectares for Ci Deres Watershed.

![Figure 1. Location of the research area; (a) Ci Lutung Watershed, (b) Sampling location in research area](image)

Landuse and lithology were analyzed as characteristics of Ci Jurey Watershed and Ci Deres Watershed (Figure 2). Based on data that obtained from the Indonesian Geospatial Information Agency, landuse in Ci Jurey Watershed and Ci Deres Watershed consists of six types of landuse, that are forests, plantation/mix gardens, settlements, rice fields, shrubs, and non-irrigated fields. Shrubs is the major landuse in Ci Jurey Watershed with an area approximately 993 hectares, while in Ci Deres Watershed is plantation/mix gardens with an area approximately 1,781 hectares. Furthermore, based on the Arjawinangun Geological Map Sheet obtained from the Bandung Geological Research and Development Center, lithology in Ci Jurey Watershed consists of four types, that are metamorphic and igneous rocks, solid rock, volcanic rock and loose sediment, while for Ci Deres Watershed only consists of three types of lithology, there are solid rock, volcanic rock, and loose sediment. Solid rock is the type of rock that dominates Ci Jurey Watershed and Ci Deres Watershed.
2.2. Sampling Method

Water quality sampling is carried out on the part of the watershed that represents the upstream, middle and downstream parts of the two watersheds. Delineation of watershed sections is carried out based on slope class, with slopes > 15% (15-30%; 30-45%; 45-65%; and> 65%) as the upstream part, slopes 8-15% as the middle part, and slopes < 8% (0-3%; and 3-8%) as the downstream part. Sampling is done during the rainy season which is on April 21, 2019 until April 25, 2019. This activity is carried out once every morning (08.00 - 10.00) for five consecutive days. Total samples were collected and measured as many as 30 samples.

The upstream and middle parts of Ci Jurey River as the first and second sampling sites of the Jurey River are located in Majalengka Sub-District, while the downstream part of the river as the third sampling site of the Jurey River is located in Panyingkiran Sub-District. Furthermore, for the upstream part of Ci Deres river as the first sampling site of Ci Deres river is located in Argapura Sub-District, the middle part of the river as the second sampling site of Ci Deres river is located in Majalengka Sub-District, and the downstream part of the river as the third sampling site is located in Panyingkiran Sub-District.

Measurement the water samples that obtained from both rivers is based on physical parameters, that are Total Dissolved Solid (TDS), pH, conductivity, and turbidity, as well as chemical parameters, that are nitrate, phosphate, sulfate and chloride. Measurements of TDS, pH and conductivity content were carried out directly when taking water samples using the Hanna Instrument HI 98195 tool. For other parameters, measurements were carried out in the laboratory with certain test equipment. Turbidity was measured using the Lutron TU-2016 Turbidity Meter. Then, nitrate was measured using Hanna Instrument HI 96786. Measuring the nitrate content was carried out using the cadmium reduction method. Furthermore, the measurement of phosphate, sulfate and chloride content was carried out using the same test equipment, Hanna Instrument HI 83300. The phosphate content was measured using the azerkorbic acid method by adding phosphate reagent Low Range (LR), the sulfate content was measured using the prescription method with barium chloride crystals by adding sulfate reagent, and the chloride content was measured using the mercury thiocyanate method by adding chloride reagent A and chloride reagent B.
2.3. Storage and Retrieval of Water Quality Data System (STORET) Method

Determination of river water quality in this study using the Storage and Retrieval of Water Quality Data System (STORET) method. This method is carried out by comparing water quality data based on physical and chemical parameters with water quality standards established under the Indonesian Government Regulation Number 82/2001 (Table 1).

Table 1. Determination Value System for Determining Status of Water Quality

| Total Parameter | Value | Parameters |
|-----------------|-------|------------|
|                 |       | Physic     | Chemical | Biology |
| < 10            | Max   | -1         | -2       | -3       |
|                 | Min   | -1         | -2       | -3       |
|                 | Average | -3     | -6       | -9       |
| ≥ 10            | Max   | -2         | -4       | -6       |
|                 | Min   | -2         | -4       | -6       |
|                 | Average | -6     | -12      | -18      |

Ci Jurey Watershed and Ci Deres Watershed are included in the Class III Water Quality Standard Criteria. In this study, the parameters assessed by the STORET method were only TDS, pH, nitrate, phosphate, sulfate, and chloride parameters. Conductivity and turbidity parameters do not value because they do not have water quality standards. Each type of parameter is given a score based on the Decree of the Indonesian Minister of Environment Number 115/2003, so that afterwards it can be determined the quality of river water using a value system from "US-EPA (Environmental Protection Agency)".

3. Results and Discussion

3.1. Physical Parameters of Ci Jurey River and Ci Deres River Water Quality

TDS in Ci Jurey river shows a decrease if it goes to the downstream part, while TDS on the Ci Deres river shows the opposite. However, when compared, the TDS value in Ci Jurey river is still higher than in Ci Deres river. The high TDS value, especially in the upstream part of Ci Jurey river, is most likely influenced by the lithology that dominates this part of the river. The upstream part of the Ci Jurey river is dominated by solid rock and were described as a type of limestone sandstone, limestone, tuffaceous sandstone, clay, greywacke, and silt with oligocene tertiary rocks (To). Chemically occurring limestones are sedimentary rocks which generally occur from precipitation of calcium carbonate. TDS is usually caused by inorganic materials in the form of ions commonly found in waters [11]. Some examples of these ions include bicarbonate, sulfate, chloride, potassium, and carbonate. TDS showed the present of dissolved materials in water bodies such as detergents, solvents and fuel which cannot remove by general and conventional filtration [12].

Ci Jurey and Ci Deres river has the same average pH of around 5.5 to 5.6. Neutral pH (6.91-7.51) is very good to variety of aquatic life as found in the previous study [13], so if pH value were too high or too low such as Ci Jurey river and Ci Deres river pH values it means very harmful to variety of an aquatic life. Ci Deres river shows a insignificant decrease in pH if it goes downstream. Fluctuations in pH values are influenced by the presence of organic and inorganic wastes to the river.
Table 2. Average Measurement of Physical Parameters

| Parameter | Ci Jurey River | Ci Deres River |
|-----------|----------------|----------------|
|           | A  | B  | C  | D  | E  | F  |
| TDS       | 243 | 182 | 152 | 83 | 88 | 91 |
| pH        | 5.5 | 5.5 | 5.5 | 5.6 | 5.5 | 5.5 |
| DHL       | 485 | 364 | 303 | 174 | 176 | 182 |
| Tubidity  | 22  | 206 | 461 | 42  | 69  | 263 |

Conductivity in Ci Jurey river shows a decrease if it goes further to the downstream part of the river while conductivity in Ci Deres river shows an increase if it goes further to the downstream of the river. The conductivity in freshwater was between 0.1 and 10 μS / cm [14] or 60 and 130 μS / cm [15] were in a normal condition. But both rivers conductivity shows values that are far above normal conditions. The higher DHL is in water, the water will feel brackish to salty.

Both rivers show turbidity values which are increasing if they are heading the downstream part of the river. More turbidity is caused by suspended material in the form of a surface layer that is carried by the flow [11]. Overall, Ci Deres river average turbidity is smaller when compared to Ci Jurey river average turbidity. The high turbidity may be influenced by the amount of rain and riverbed material. High concentrations of turbidity are very dangerous because it is harmful to the variety of aquatic organism's life in the river, and the previous research was found that was high in decline in oxygen level in water [13].

3.2. Chemical Parameters of Ci Jurey River and Ci Deres River Water Quality

Ci Jurey river and Ci Deres river’s nitrate show a decrease if they were heading the downstream part, with Ci Jurey river which had a smaller nitrate value than Ci Deres river. Nitrate levels of more than 5 mg/L illustrate the occurrence of anthropogenic pollution originating from domestic waste [11]. The high level of nitrate indicates that there is contamination sourced from agricultural waste, fertilizers, animal feces and humans and so on. In addition, settlements are also one of the causes of the high and low levels of nitrate in river water [16]. The existence of agricultural activities on landuse in the form of rice fields on the upstream part of Ci Deres river causes high nitrate content. The water around the agricultural activities involving fertilizers and its concentration can reach 1,000 mg/l, while for drinking consumption, it should not exceed 10 mg/l [17,18].

Table 3. Average Measurement of Chemical Parameters

| Parameter | Ci Jurey River | Ci Deres River |
|-----------|----------------|----------------|
|           | A  | B  | C  | D  | E  | F  |
| Nitrate   | 8.4 | 3.9 | 3.9 | 18.4 | 4.9 | 1.9 |
| Phosphate | 0.6 | 0.2 | 0.2 | 0.5  | 0.4 | 0.3 |
| Sulfate   | 78  | 50  | 29  | 8    | 15  | 9   |
| Chloride  | 2   | 9   | 13  | 4    | 7   | 11  |

Ci Jurey river and Ci Deres river’s phosfate shows decrease if they were heading to the downstream part. One of the anthropogenic sources of phosphate is industrial and domestic waste [11]. Ci Deres watershed is a watershed with a larger settlement area compared to the Ci Jurey Watershed settlement area. The high phosphate level in Ci Deres river water is thought to be caused by household waste in the form of detergents that came from settlements around the watershed. Furthermore, the sulfate in Ci Jurey river shows decreases if it goes to the upstream part. Ci Deres river shows fluctuations from upstream to downstream. It starts with an sulfate’s increase from the upstream part to the middle part of the river and then decreases from the middle part to the downstream part of the river.
Chlorides in Ci Jurey river and Ci Deres river increase if they were heading to the downstream part. The average chloride content in Ci Jurey and Ci Deres ranged from 2 to 13 mg / L. The rock and soil weathering can release chloride into the waters; in natural water, it is about 2–20 mg/l [15]. For drinking water purposes and agricultural and industrial consumption, it should not exceed 100 mg/l [19].

3.3. Water Quality of Ci Jurey Watershed and Ci Deres Watershed based on STORET Method

From the assessment of water quality using STORET method, it was found that Ci Jurey river and Ci Deres river belong to the lightly polluted category (Figure 3) or Class B with a range of scores -1 to -10 (Table 4). Based on the criteria for Class III water quality standards, the average pH value in each part of the river does not meet the criteria for water quality standards of 6 - 7. Range of pH values, both average, minimum and maximum values are below the water quality threshold so they are given total score of 5.

| Sample | Total Score | Information         |
|--------|-------------|---------------------|
| A      | -7          | Lightly Polluted    |
| B      | -5          | Lightly Polluted    |
| C      | -5          | Lightly Polluted    |
| D      | -7          | Lightly Polluted    |
| E      | -5          | Lightly Polluted    |
| F      | -5          | Lightly Polluted    |

In the table above it can be seen that the sample points of the upstream part of Ci Jurey river and the upstream part of Ci Deres river have -7 as a total score. The maximum value of phosphate in the upstream part of Ci Jurey river is 1.55 mg/L, which exceeds Class III water quality standard which is 1 mg / L. Furthermore, the upstream part of Ci Deres river has a maximum value of nitrate of 29.2 mg/L which exceeds Class III water quality standards of 20 mg/L. This high nitrate value is caused by agricultural activities that are in the vicinity of the upstream Ci Deres river. The value of other parameters such as the average value, minimum value, and the maximum value of TDS, sulfate, and chloride from the two rivers is still far below the threshold so that the given score is 0.
4. Conclusion
The water quality of Ci Jurey river and Ci Deres river is spatially influenced by the characteristics of each watershed that represents the location of water sampling. TDS value in Ci Jurey Watershed is calculated high because it is influenced by lithology in the form of solid rock with the age of oligocene Tertiary rocks (To). Nitrate value in Ci Deres Watershed is calculated to be high because it is influenced by the presence of agricultural activities in the use of rice fields. The water quality assessment of Ci Lutung Watershed, especially in Ci Jurey Sub-Watershed and Ci Deres Sub-Watershed, was determined based on the calculation of Storage and Retrieval of Water Quality Data System (STORET). The calculation results show that the water quality values of Ci Jurey Watershed and Ci Deres Watershed are still in the range of -1 to -10, which means they are included in the category of lightly polluted or Class B. Parameters that affect the assessment so that the two rivers fall into the lightly polluted category are pH and phosphate parameters in Ci Jurey Watershed, and pH and nitrate parameters in Ci Deres Watershed.

5. References
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