

Water Quality Index of Cisadane River and Ciujung River

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Abstract—River water is a source of raw water that can be treated to meet the community needs of clean water and drinking water. The declining quality of river water caused by pollution will have an impact on the lack of clean water supply and drinking water. Water Quality Index monitoring is needed to ensure that river water conditions remain good. Cisadane River and Ciujung River are two rivers in Banten Province which are highlighted in monitoring the water quality index because of their location in industrial areas and densely populated settlements. The calculation of the Water Quality Index follows the guidelines of the Indonesian Ministry of Environment and Forestry which is a concept development from Virginia Commonwealth University (VCU) and BPS. The parameters assessed in the water quality index are TSS, DO, COD, BOD, Phosphate, Total Coliform and E.Coli / Fecal Coli. Based on the calculation results, it is known that in 2017 the Cisadane River has a Water Quality Index value of 50 (very less) and dropped to 46.7 (alert) in 2018. Ciujung River Water Quality Index in 2017 has a value of 49.17 (alert), the value increased to 56.7 (very less) in 2018.

Keywords: *Water Quality Index, Cisadane River, Ciujung River*

I. INTRODUCTION

Environmental quality can be measured quantitatively using the Environmental Quality Index (IKLH) adopted from several sources including the Environmental Performance Index (EPI) developed by a study center at Yale University [1]. The IKLH concept, as developed by BPS, only takes three indicators of environmental quality, namely river water quality, air quality, and forest cover [2, 3, 4].

Unlike the BPS, IKLH is calculated at the provincial level so that it can produce a national level index. Another difference from the concept developed by BPS and VCU [5] is that each parameter in each indicator is combined into one index value. Merging these parameters is possible because there are provisions that govern them, such as:

- Decree of the State Minister for the Environment No. 115 of 2003 concerning Guidelines for Determination of Water Quality Status. This guideline also regulates the procedure for calculating the water pollution index (IPA).
- Decree of the Minister of Environment Number Kep-45 / MENLH / 10/1997 concerning Air Pollution Index.

Water is a very important requirement for living things, both humans, animals and plants that allow all this to survive.

Surface water is one of the sources of raw water from various alternative sources of raw water on this earth, to be processed into drinking water at a drinking water treatment plant.

River water quality is one of the parameters for the calculation of the Environmental Quality Index (IKLH). The calculation of the Water Pollution Index (IPA) is based on the decision of the State Minister for the Environment No. 115 of 2003 concerning Guidelines for Determination of Water Quality Status, which also regulates the procedure for calculating the IPA. The guidelines explain, among others, the determination of water quality status by the Pollution Index (PI) method [6].

II. METHOD

Pollution Index PI_j is a pollution index for designation j which is a function of C_i / L_{ij} , where C_i represents the concentration of water quality parameter i and L_{ij} states the concentration of water quality parameter i stated in the water allotment standard j . In this case the designation that will be used is the classification of class II water quality based on Government Regulation No. 82 of 2001 concerning Management of Water Quality and Water Pollution Control.

Water quality monitoring is carried out in rivers that cross districts / cities in one province. Generally, the river used as a benchmark has six monitoring points and is carried out at least three times during the monitoring period. Each monitoring point is assumed as one data and will have water quality status. The measured parameter concentration is compared with the water quality standard, if the C_i / L_{ij} value is greater than 1.0, then the new C_i / L_{ij} value is used with the following formula:

$$(C_i/L_{ij})_{\text{new}} = 1,0 + P.\log(C_i/L_{ij}) \quad (1)$$

Then the pollution index is calculated, using the following formula:

$$PI_j = \left(\frac{\left(\frac{C_i}{L_{ij}} \right)_M^2 + \left(\frac{C_i}{L_{ij}} \right)_R^2}{2} \right)^{\frac{1}{2}} \quad (2)$$

Information:

- $C_i / L_{ij} M$: the maximum value of C_i / L_{ij}
- $C_i / L_{ij} R$: average value of C_i / L_{ij}

Evaluation of the PI_j value:

- Meets quality standards if $0 < PI_j \leq 1$
- Lightly polluted if $1.0 < PI_j \leq 5.0$
- Moderately polluted if $5.0 < PI_j \leq 10.0$
- Heavily polluted if $PI_j > 10.0$

The transformation of the IPA value into the water quality index (IKA) is done by multiplying the weight of the index value by the percentage of compliance with quality standards. The percentage of fulfillment of quality standards is obtained from the sum of sample points that meet the quality standard to the number of samples in percent. While index weights are given the following limits: 70 to meet quality standards, 50 for lightly polluted, 30 for moderately polluted, and 10 for heavily polluted.

TABLE 1. VALUE RANGES OF WATER QUALITY INDEX

| Water Quality | Value Ranges |
|---------------|---------------------|
| Excellent | $X > 90$ |
| Very Good | $82 < X \leq 90$ |
| Good | $74 < X \leq 82$ |
| Sufficient | $66 \leq X \leq 74$ |
| Less | $58 \leq X < 66$ |

TABLE 2. MONITORING POINT OF CISADANE RIVER IN 2017

| Monitoring Point | Allocation | | | | | | | | | | |
|---------------------|------------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|
| | Class | PI | Status | PI | Status | PI | Status | PI | Status | PI | Status |
| Bridge Cisauk | ii | 3.2 | Light | 4.7 | light | 3.2 | light | 1.3 | light | 2.8 | light |
| Bridge PT. Indorama | ii | 3.0 | Light | 5.0 | light | 3.9 | light | 1.3 | light | 2.5 | light |
| Bridge Gading | ii | 2.6 | Light | 4.8 | light | 3.3 | light | 2.7 | light | 2.8 | light |
| Bridge Cikokol | ii | 3.0 | Light | 4.8 | light | 4.4 | light | 2.5 | light | 2.8 | light |
| Bridge Robinson | ii | 3.1 | Light | 4.8 | light | 4.7 | light | 2.1 | light | 2.9 | light |
| Dam Pintu Air | ii | 2.6 | Light | 4.8 | light | 4.7 | light | 2.8 | light | 2.8 | light |

TABLE 3. WATER QUALITY INDEX OF CISADANE RIVER IN 2017

| No | Status | Total | Percentage | Weight Index | Value |
|----|----------------|-------|------------|--------------|-----------|
| 1 | Meets standard | 0 | 0 | 70 | 0 |
| 2 | Light | 30 | 1 | 50 | 50 |
| 3 | Moderate | 0 | 0 | 30 | 0 |
| 4 | Heavy | 0 | 0 | 10 | 0 |
| | | 30 | | | 50 |

TABLE 4. MONITORING POINT OF CISADANE RIVER IN 2018

| Monitoring Point | Allocation | 22-May-18 | | 27-Jun-18 | | 27-Jul-18 | | 24-August-18 | | 12-Sep-18 | |
|---------------------|------------|-----------|----------|-----------|--------|-----------|--------|--------------|----------|-----------|----------|
| | Class | PI | Status | PI | Status | PI | Status | PI | Status | PI | Status |
| Bridge Cisauk | ii | 5.3 | moderate | 4.6 | light | 4.3 | light | 4.7 | light | 4.1 | light |
| Bridge PT. Indorama | ii | 4.8 | light | 4.9 | light | 3.5 | light | 4.6 | light | 4.1 | light |
| Bridge Gading | ii | 5.3 | moderate | 4.7 | light | 2.8 | light | 4.3 | light | 5.0 | moderate |
| Bridge Cikokol | ii | 4.8 | light | 4.7 | light | 2.8 | light | 5.3 | moderate | 4.8 | light |
| Bridge Robinson | ii | 4.1 | light | 4.1 | light | 4.3 | light | 2.6 | light | 4.7 | light |
| Dam Pintu Air | ii | 4.9 | light | 4.9 | light | 4.3 | light | 5.3 | moderate | 5.0 | light |

| | |
|-----------|------------------|
| Very Less | $50 \leq X < 58$ |
| Alert | $X < 50$ |

The parameters assessed in the water quality index are TSS, DO, COD, BOD, Phosphate, Total Coliform and E. Coli / Fecal Coli [6].

III. RESULTS AND DISCUSSION

A. Water Quality Index of Cisadane River

Table 2 shows the pollution status data at each monitoring point in Cisadane River in 2017, based on these data it can be seen that Cisadane River has 30 light status in order to obtain an IKA value of 50 / very less (Table 3), this value is quite different from the results calculation in 2018 that is equal to 46.7 / alert (Table 5).

TABLE 5. WATER QUALITY INDEX OF CISADANE RIVER IN 2018

| No | Status | Total | Percentage | Weight Index | Value |
|----|----------------|-------|------------|--------------|-------|
| 1 | Meets standard | 0 | 0 | 70 | 0 |
| 2 | Light | 25 | 0.83 | 50 | 41.7 |
| 3 | Moderate | 5 | 0.17 | 30 | 5 |
| 4 | Heavy | 0 | 0 | 10 | 0 |
| | | 30 | | | 46.7 |

B. Water Quality Index of Ciujung River

Ciujung River water quality index in 2017 has a weight of 49.17 / alert (Table 7) because there are 2 monitoring statuses

that are moderate (Table 6), the value increased to 56.7 / very less (Table 9) in 2018.

TABLE 6. MONITORING POINT OF CIUJUNG RIVER IN 2017

(a)

| Monitoring Point | Allocation | | Status | PI | Status | PI | Status | PI | Status |
|------------------|------------|-----|----------|-----|--------|-----|--------|-----|--------|
| | Class | PI | | | | | | | |
| Hulu cisalaraja | ii | 4.6 | Light | 3.0 | light | 3.9 | light | 2.6 | light |
| ciberang | ii | 7.6 | moderate | 2.7 | light | 4.1 | light | 3.3 | light |
| Bridge baru 3 | ii | 8.8 | moderate | 2.8 | light | 4.2 | light | 3.1 | light |
| Kragilan | ii | 3.4 | Light | 2.7 | light | 4.7 | light | 3.4 | light |
| Jongjin | ii | 3.4 | Light | 3.0 | light | 4.4 | light | 3.4 | light |
| Dam pamarayan | ii | 2.6 | Light | 2.7 | light | 3.9 | light | 2.6 | light |

(b)

| Monitoring Point | | | PI | Status | PI | Status | PI | Status |
|------------------|-----|--------|-----|--------|-----|--------|-----|--------|
| | PI | Status | | | | | | |
| Hulu cisalaraja | 3.5 | light | 4.2 | light | 1.6 | light | 2.5 | light |
| ciberang | 2.7 | light | 3.5 | light | 1.3 | light | 2.5 | light |
| Bridge baru 3 | 2.9 | light | 4.2 | light | 2.1 | light | 2.1 | light |
| Kragilan | 2.9 | light | 3.2 | light | 1.9 | light | 3.9 | light |
| Jongjin | 4.7 | light | 3.5 | light | 1.6 | light | 3.7 | light |
| Dam pamarayan | 2.5 | light | 2.8 | light | 1.9 | light | 3.1 | light |

TABLE 7. WATER QUALITY INDEX OF CIUJUNG RIVER IN 2017

| No | Status | Total | Percentage | Weight index | Value |
|----|----------------|-------|------------|--------------|-------|
| 1 | Meets standard | 0 | 0 | 70 | 0 |
| 2 | Light | 46 | 0.96 | 50 | 47.92 |
| 3 | Moderate | 2 | 0.04 | 30 | 1.25 |
| 4 | Heavy | 0 | 0 | 10 | 0 |
| | | 48 | | | 49.17 |

TABLE 8. MONITORING POINT OF CIUJUNG RIVER IN 2018

| Monitoring Point | Allocation | 18 July 2018 | | 03 Augs 2018 | | 04 Sept 2018 | |
|------------------|------------|--------------|----------------|--------------|----------------|--------------|----------------|
| | Class | PI | Status | PI | Status | PI | Status |
| Hulu cisalaraja | ii | 1.7 | light | 1.9 | light | 2.1 | light |
| ciberang | ii | 2.1 | light | 2.5 | light | 2.4 | light |
| Bridge baru 3 | ii | 0.9 | meets standard | 0.7 | meets standard | 0.8 | meets standard |
| Kragilan | ii | 1.5 | light | 2.1 | light | 2.0 | light |
| Jongjin | ii | 0.7 | meets standard | 1.1 | light | 0.7 | meets standard |
| Dam pamarayan | ii | 0.8 | meets standard | 1.2 | light | 1.4 | light |

TABLE 9. WATER QUALITY INDEX OF CIUJUNG RIVER IN 2018

| No | Status | Total | Percentage | Weight index | Value |
|----|----------------|-------|------------|--------------|-------|
| 1 | Meets standard | 6 | 0.3 | 70 | 23.3 |
| 2 | Light | 12 | 0.7 | 50 | 33.3 |
| 3 | Moderate | 0 | 0 | 30 | 0 |
| 4 | Heavy | 0 | 0 | 10 | 0 |
| | | 18 | | | 56.7 |

IV. CONCLUSION

It is known that in 2017 the Cisadane River has an Water Quality Index value of 50 (very less) and dropped to 46.7 (alert) in 2018. Ciujung River Water Quality Index in 2017 has a value of 49.17 (alert), the value increased to 56.7 (very less) in 2018.

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