Determining Water Quality Status in University of Indonesia Depok Campus Lakes with STORET Method

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Abstract. The University of Indonesia has six artificial lakes around Depok Campus Area, namely Lake Kenanga, Agathis, Mahoni, Puspa, Ulin, and Salam (KAMPUS). These campus lakes have an area of about 17.5 hectares with an average depth varying between 1.5-3 meters with capability store waters up to 52,500 m³ of water. The University of Indonesia has its commitment to observe and evaluate the environmental quality as a part of an environmental monitoring program every semester. The observation data of lake water quality can provide information about parameters which has exceeded the environmental quality standard only, but not for the whole information about its water quality status. STORET Method is the common method which can be used to determine the water quality status. In principle, it compares the data of water quality measurement against national water quality standard appropriate with its purpose to determine the status of water quality. Based on the measurement data from 2017 to 2018, we obtained that Kenanga Lake, Agathis Lake, Ulin Lake, and Salam Lake has A Class quality status and meet the quality standard. However, Mahoni Lake and Puspa Lake are in C Class moderately polluted.

1. Introduction

The University of Indonesia has six artificial lakes around Depok Campus Area, namely Lake Kenanga, Agathis, Mahoni, Puspa, Ulin, and Salam (KAMPUS). Lakes and urban forests in Depok Campus Area are potential buffers of groundwater conservation for the DKI Jakarta and Depok areas. The lakes in the Depok Campus Area also function as a reduction in the problem of flooding shipments to the city of Jakarta by transferring some of the river flow from the Bogor and Depok areas into the lakes that are inside University of Indonesia campus. These campus lakes have an area of about 17.5 hectares with an average depth varying between 1.5-3 meters with capability store waters up to 52,500 m³ of water [1]. The University of Indonesia has its commitment to observe and evaluate the environmental quality as a part of an environmental monitoring program every semester. The observation data of lake water quality
can provide information about parameters which has exceeded the environmental quality standard only, but not for the whole information about its water quality status.

![Figure 1. Overview University of Indonesia Depok Campus Lakes](image)

**2. Materials and methods**

2.1. **Data collection**

Data on the water quality of Lake Kenanga, Agathis, Mahoni, Puspa, Ulin, and Salam were collected from monitoring and evaluation reports on the Environmental Monitoring and Management Plan of the University of Indonesia Depok Campus and Srengseng Sawah Campus for the period 2017 to 2018 [2]. Water quality measurements for six lakes are carried out every semester.

2.2. **Data analysis**
Determination of the water quality status in the UI Depok Campus Lakes determined by the STORET method [3]. The principle of the STORET method is to compare water quality data with water quality standards that are adjusted to their designation to determine water quality status. Determining the status of water quality is by using a value system by classifying water quality in four classes, namely:

**Table 1. Water quality Classification from the US-EPA value system**

| No. | Class | Category | Score  | Quality Status          |
|-----|-------|----------|--------|-------------------------|
| 1   | A     | very     | 0      | meet the quality standard |
| 2   | B     | good     | -1 s/d -10 | lightly polluted   |
| 3   | C     | medium   | -11 s/d -30 | medium polluted |
| 4   | D     | bad      | ≥ -31  | heavily polluted         |

Determination of water quality status using the STORET method is carried out by periodically collecting water quality data to form data time series data. Comparing the measurement data from each water parameter with the value of quality standard following the water class. The measurement data from each water parameter is compared with the value of quality standard following the water class. If the measurement results meet the water quality standard, then a score of 0 is given. If the measurement results do not meet the water quality standard, then the score is given in the following table:

**Table 2. Parameter Scoring System[4]**

| Number of parameters | Value of Parameter | Physical | Chemical | Biology |
|----------------------|--------------------|----------|----------|---------|
| < 10                 | maximum            | -1       | -2       | -3      |
|                      | minimum            | -1       | -2       | -3      |
|                      | average            | -3       | -6       | -9      |
| ≥ 10                 | maximum            | -2       | -4       | -6      |
|                      | minimum            | -2       | -4       | -6      |
|                      | average            | -6       | -12      | -18     |

The sum of the scores from all parameters is used to determine the quality status according to the number of scores obtained using the value system (Table 1).

3. Results and discussion

Data on water quality measurements were carried out on six lakes in the UI Depok Campus Area. Water quality parameters based on Government Regulation no. 82 of 2001 in Class III category, except Salam Lake, refers to the Decree of the Governor of DKI Jakarta in 1990 in category D because it is in the DKI Jakarta area. The measurement data used for the analysis were 12 out of 29 water quality parameters because most of the concentration of water quality measurements were not detected but still met water quality standards. The selection of parameters does not affect the overall score of determining the quality status because it still meets water quality standards.

3.1. Kenanga Lake

Kenanga Lake is located between the Rectorate Building, University Hall and UI Mosque. This lake was built in 1992 with an area of 42,851 m², a depth of 2.5 m. The Lake Kenanga inlet originates from a water channel from around Pondok Cina Station, and the outlet section flows into Lake Puspa via a water channel that passes through the Faculty of Law and Psychology. All Lake Kenanga water quality parameters meet the quality standard so that the quality status meets class A with a score of 0 (zero).
### Table 3. Water quality status lakes in the UI Depok Campus Area

| No. | Lakes   | Score | Class | Quality Status               |
|-----|---------|-------|-------|------------------------------|
| 1   | Kenanga | 0     | A     | meet the quality standard    |
| 2   | Agathis | 0     | A     | meet the quality standard    |
| 3   | Mahoni  | -12   | C     | medium polluted              |
| 4   | Puspa   | -12   | C     | medium polluted              |
| 5   | Ulin    | 0     | A     | meet the quality standard    |
| 6   | Salam   | 0     | A     | meet the quality standard    |

3.2. **Agathis Lake**

Lake Agathis was built in 1995 located between FMIPA and the Jakarta State Polytechnic. This lake has an area of 12,210 m² with an average depth of 2.5 m. Lake Agathis is upstream and is connected to Lake Mahoni, Puspa, Ulin, and Salam. The Lake Agathis inlet comes from waterways around the East Beji area. Based on the results of the analysis of the quality status of Lake Agathis meet the quality standard with a score of 0 (zero).

3.3. **Mahoni Lake**

Mahoni Lake was built in 1996 located east of the Faculty of Cultural Sciences and the Center for Japanese Studies, west of the Faculty of Economics and Business. Mahoni Lake has an area of 52,996 m² with an average depth of 1.5 m. The Mahoni Lake inlet originating from Lake Agathis and the water channel around the Beji and East Beji area which was collected became a swamp located between the Jakarta State Polytechnic and Vocational Program. Most water quality parameters meet quality standards, except Fecal Coliform and Total Coliform. Fecal coliform usually lives in human and animal feces. Other coliform bacteria come from animals, and dead plants are called non-fecal coliforms [6]. It is possible that the two high microbiological parameters are influenced by upstream inputs originating from residential drainage channels outside the UI Campus that enter the UI Campus drainage system [5]. The upstream flow provides a load of domestic waste contamination. The quality status of Mahoni Lake was polluted with a score of -12.

### Table 4. Water quality status of the Mahoni Lake using the STORET method

| No. | Parameter         | Unit   | Standard | Concentration | Parameter Score | Score |
|-----|-------------------|--------|----------|---------------|-----------------|-------|
| I   | Physical          |        |          |               |                 |       |
| 1   | TSS               | mg/l   | 400      | 162           | 139             | 147,33| 0   |
| 2   | TDS               | mg/l   | 1000     | 15            | 9               | 11,67 | 0   |
| II  | Chemical          |        |          |               |                 |       |
| 1   | pH                |        | 6 - 9    | 8,4           | 6,17            | 7,09  | 0   |
| 2   | DO                | mg/l   | 3        | 4,4           | 3,3             | 3,77  | 0   |
| 3   | Total phosphates (PO₄) | mg/l | 1        | 0,2           | 0,07            | 0,12  | 0   |
| 4   | Nitrate (NO₃)     | mg/l   | 20       | 6             | 4               | 5     | 0   |
| 5   | Nitrite (NO₂)     | mg/l   | 0,06     | 0             | 0               | 0     | 0   |
| 6   | Detergent (MBAS)  | mg/l   | 0,2      | 0,06          | 0,02            | 0,04  | 0   |
| 7   | BOD               | mg/l   | 6        | 3             | 2,3             | 2,63  | 0   |
| 8   | COD               | mg/l   | 50       | 22            | 10              | 17,33 | 0   |
| III | Microbiological   |        |          |               |                 |       |
| 1   | Fecal Coliform    | MPN/100 ml | 2000  | 4900          | 270             | 1833,33 | -6      |
| 2   | Total Coliform    | MPN/100 ml | 10000 | 1100          | 0               | 7100  | -6    |

**Total Scores** -12
3.4. Lake Puspa

Puspa Lake was built in early 2000 located north of Mahoni Lake with an area of 17,229 m$^2$ with an average depth of 2 m. The Lake Puspa inlet comes from Mahoni Lake, Kenanga Lake, and waterways around Pondok Cina Station. Most water quality parameters meet quality standards, except Fecal Coliform and Total Coliform. It is possible that the height of the two microbiological parameters is influenced by the input of Mahogany Lake flow and drainage channels around Pondok China Station originating from the Kemiri Muka including drainage from Kemiri Depok Market [5]. The quality status of Mahoni Lake was polluted with a score of -12.

| No. | Parameter          | Unit  | Standard Concentration | Parameter Score |
|-----|--------------------|-------|------------------------|-----------------|
|     |                    |       | Max       | Min       | Average | Max   | Min   | Average | Score |
| I   | Physical           |       |           |           |         |       |       |         |       |
| 1   | TSS                | mg/l  | 400       | 142       | 134     | 137.33| 0      | 0      | 0      | 0     |
| 2   | TDS                | mg/l  | 1000      | 15        | 15      | 10    | 0      | 0      | 0      | 0     |
| II  | Chemical           |       |           |           |         |       |       |         |       |
| 1   | pH                 | mg/l  | 6 - 9     | 6.56     | 4.6     | 4     | 0      | 0      | 0      | 0     |
| 2   | DO                 | mg/l  | 3         | 0.2      | 0.2     | 0.19  | 0      | 0      | 0      | 0     |
| 3   | Total phosphates   | mg/l  | 1         | 0.18     | 0.18    | 0.19  | 0      | 0      | 0      | 0     |
| 4   | Nitrate (NO$_3^-$) | mg/l  | 20        | 7        | 7       | 5.33  | 0      | 0      | 0      | 0     |
| 5   | Nitrite (NO$_2^-$) | mg/l  | 0.06      | 0        | 0       | 0     | 0      | 0      | 0      | 0     |
| 6   | Detergent (MBAS)   | mg/l  | 0.2       | 0.03     | 0.03    | 0.04  | 0      | 0      | 0      | 0     |
| 7   | BOD                | mg/l  | 6         | 3        | 3       | 2.53  | 0      | 0      | 0      | 0     |
| 8   | COD                | mg/l  | 50        | 22       | 22      | 18    | 0      | 0      | 0      | 0     |
| III | Microbiological    |       |           |           |         |       |       |         |       |
| 1   | Fecal Coliform     | MPN/100 ml | 2000  | 4900     | 22      | 1684  | -6    | 0      | 0      | -6    |
| 2   | Total Coliform     | MPN/100 ml | 10000 | 1100     | 0       | 350   | 3963.3 | -6    | 0      | 0      | -6    |

Total Scores: -12

3.5. Lake Ulin

Lake Ulin has an area of 47,502 m$^2$ with an average of 2.5 m. The location is located between Puspa Lake and Salam Lake. The inlet comes from Puspa Lake and the waterways around Pondok Cina Station. All water quality parameters meet the quality standard so that their quality status meets the quality standard with a score of 0 (zero).

3.6. Lake Salam

Salam Lake is located in the northern part of the UI Campus which is within the DKI Jakarta area with an area of 53,123 m$^2$ with an average depth of 3 m. Lake Salam is an outlet of all lakes on the UI Campus. All water quality parameters meet the quality standard so that their quality status meets the quality standard with a score of 0 (zero).

4. Conclusions

From the results of calculations with the STORET method the quality status of Lake Kenanga, Agathis, Ulin and are in Class A with an excellent category with a score of 0 (zero). All parameters analyzed by the STORET method meet Class III water quality standards Government Regulation no. 82 of 2001. The quality status of Salam Lake is also in Class A with an excellent category with a score of 0 (zero) and meets the quality standards of the Decree of the DKI Jakarta Governor in the category of Group D.
Whereas Mahogany and Salam Lake are in the Class C medium category with a score of -12 with medium polluted quality status.

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