Determination of Water Quality Status of Stored Method in Tlogo Ampel Watershed

Saiful Anwar1*, M. Joko Wibowo1, Sugiyarto2, Budi Hariono3, Rizza Wijaya3
1 Department of Engineering, Politeknik Negeri Jember
2 Department of Agricultural Production, Politeknik Negeri Jember
3 Department of Agriculture Engineering, Politeknik Negeri Jember

*sanwar2512@yahoo.com

Abstract. The research station is located in Wonokoyo Village, Kapongan Subdistrict, Situbondo Regency at 7°07'44" South Latitude and 114°08'99" East Longitude. Common problems faced by watersheds in Indonesia are increased activities household, industrial, land conversion of which have a detrimental effect on water quality. This research is important to get a picture of water quality in Tlogo Ampel watershed so that it can be maintained for its sustainability. The evaluation of water quality in a Watershed is a complex thing which involves various influential parameters. This parameter study is divided into three parts that are physical property (Temperature and TSS), chemical property (pH, BOD, COD, DO, PO4P, NO3N, NO2N), and microbiological property (total coliform and Fecal coli). Determining Water Quality Status, one of the methods used to determine the status of river water quality is by the Storet Method. With this Storet Method, we can know the parameters that meet or exceed the Water Quality Standard. The result of the research using Storet method shows the water quality of Tlogo Ampel watershed in the period of January - December 2017 for class I, II, III and IV quality respectively are bad, bad, medium and good. Water quality at Tlogo Ampel Watershed from the result of this research is good and recommended for livestock, fish cultivation and agriculture.

1. Introduction
Water is an important part of human life to support all the activities carried out. Monitoring of water quality is absolutely needed to prevent any deviation use of the water itself. One of the water sources which is widely utilized by Indonesian people is river. River is an open water space that can be utilized and accommodate the waste of households, industry, livestock, and agriculture activities around the river. Tlogo Ampel Watershed is located on Wonokoyo Village, Kapongan District, Bondowoso Regency. The water quality of Tlogo Ampel Watershed needs to be examined to find out its utilization for the surrounding society [1].

The evaluation of water quality in a Watershed is a complex thing which involves various influential parameters. This parameter study is divided into three parts that are physical property (Temperature and TSS), chemical property (pH, BOD, COD, DO, PO4P, NO3N, NO2N), and microbiological property (total coliform and Fecal coli). The rapid development around Tlogo Ampel Watershed causes the changes of the cropping pattern and land use both for businesses and settlements which grow so fast, so that it causes the problem of water quality in the Watershed. The pollutant loads are extraneous to the nature or sourced from the nature itself that enter into an ecosystem and disrupt the function of ecosystem itself [2].
The sources of pollution material that enter into the water can come from the classified waste that are: (1) Point Source Discharges (point source) that is a point source or a pollutant source which can be known with certainty, can be in the form of a location such as industrial or domestic waste water and drainage channels. Waste water is the remainder of a business and/or an activity in the form of liquid (Government Regulation Number 82 of 2001); (2) Non-Point Source (distribution spread) come from the unknown source. Pollutants enter into the water through run off from the agricultural, residential, and urban areas [3].

This research aimed at finding out the water quality of Tlogo Ampel Watershed that became a reference for determining the water quality and the parameters that meet the water quality standard according to the Government Regulation Number 82 of 2001 concerning water quality management and pollution control.

2. Literature Review

Literature review that will be used for this research are

2.1 Watershed (DAS)
According to the experts, the notion of Watershed is very diverse, some call it drainage basin, watersheds, or catchment area. Based on those definitions, the Watershed can be defined as the unity of space which consists of abiotic elements (land, water, air), biotic elements (vegetation, animal, and other living organisms) and the human activities which interact and interdependence one to another so that it becomes an ecosystem unit, this means that if the links are already established, then the management of forest, land, water, society, and so on must concern on the role of the ecosystem components.

The land boundary is a topographic separator and the sea boundary until the water area that are still affected by the land activities (Law Number 7 of 2004). Therefore, the Watershed is a natural unit area which provides the production benefits as well as supplies the water through river, land water and/or spring to fulfill various life needs both for human and flora and fauna. The water utilization for life are for irrigation, agriculture, industry, household consumption, tourism, river transportation, and other needs [4].

2.2 Water Resources
Watershed is one of water resources which is widely used by the community. To support this continuity, it is necessary to do a sustainable management. The management of water resources adheres to seven principles as follows [5]:

The Principle of Preservation, implies that the utilization of water resources is done by maintaining the preservation of water resources function sustainably. Principle of Balance, contains the understanding to always place social function, environmental function and economic function in harmony. The principle of Public Benefit, implies that the management of water resources is done to provide maximum benefit for public effectively and efficiently. The principle of integration and harmony, contains the understanding that the management of water resources is done in an integrated in realizing harmony for various interests by paying attention to the dynamic nature of water. The Principle of Justice, implies that the management of water resources is done equally to all levels of society in the territory of the country so that every citizen has the right to have equal opportunities to play a role and enjoy the results in real terms, by still providing protection to the layers of society whose economic level is lacking. The principle of independence, contains the understanding that the management of water resources is done by taking into account the ability and the superiority of the local norms and resources. The principle of Transparency and Accountability, implies that the management of water resources is done transparently and accountably.
2.3 Pollution Source
The pollution source in watershed can be divided into 2 categories, which are domestic and non-domestic.

2.3.1 Domestic
The domestic pollution source comes from village, market, city, terminal, hospital, and others. This pollution source later will produce domestic waste. Domestic waste is all waste that comes from bathroom, kitchen, laundry waste, hospital, pharmacy, and restaurant. This domestic waste contains organic materials in the form of liquid or solid, hazardous material, toxic material, dissolved salt, and bacteria.

2.3.2 Non-Domestic
Non-domestic pollution source is a pollution source comes from factory, industry, livestock, transportation, agriculture, fishery, and others. Agricultural waste consists of solid material of plant residual which are organic, pesticides, fertilizers that contain nitrogen, phosphorus, sulfur, minerals K and Ca. Meanwhile, the agricultural and livestock products waste are the by-products of fisheries and agriculture management.

2.4 Water Quality standard
Water quality standard is basically divided into four classes, namely 1) First class water, which is water that can be used for drinking water and/or other uses that require the same water quality, 2) Second class water, which is water that is designated to be used as water recreation infrastructure/facilities, freshwater fish cultivation, livestock, water to irrigate plants, and/or other uses that require the same water quality as these uses, 3) Third class water, which is water that can be used for freshwater fish cultivation, livestock, water to irrigate plants, and/or other uses that require the same water quality as these uses, 4) Fourth class water, which is water that is designated to be used to irrigate plants and/or other uses which require the same water quality as this uses [6].

2.5 Storet Method
Referring to the State Minister of Environment decree No. 115 of 2003 concerning Guidelines for Determining Water Quality Status, one of the methods used to determine the status of river water quality is by the Storet Method. With this Storet Method, we can know the parameters that meet or exceed the Water Quality Standard. In principle, Storet Method used to compare between water quality data and water quality standard that are adjusted to the designation to determine the Water Quality Status [7].

3. Research Methodology
3.1 Research Procedure
The research procedure was done through literature study to find any suggestions to support this research, the supporting data collection was the conventional data obtained from the institution which supported the objective and the target of the research, as well as field survey and report arrangement. In the survey preparation, there was a research area determination as well as tool and material preparation.

3.2 Research Location
This research was conducted at Tlogo Ampel Watershed with the observed station located at Wonokoyo Village, Kapongan District, Situbondo Regency.
3.3 Tool and Material
The used research tool was Excel 2010 software. The used materials were: (1) the physical properties data (Temperature and TSS), (2) the organic chemical properties data (pH, BOD, COD, DO, PO4P and NO3N, NO2N), and (3) the microbiological properties (total coliform and fecal coliform).

3.4 Analysis Data
3.4.1 The Framework of the Research Approach
This research was conducted by collecting the needed data to know the water quality of Tlogo Ampel Watershed. Then, the water quality analysis was done by using storet method. Next, the trend determination from the storet water quality status of each monitoring station. The data needed in the study was water quality supporting data of the monitoring station at Tlogo Ampel Watershed from January-December 2017. The used parameter were temperature, TSS, BOD, COD, DO, PO4P, NO3N, NO2N, Total coliform dan Fecal Coli.

3.4.2 Storet Method Data Analysis
The data obtained through Storet Method was analyzed and concluded by enclosing the literature as the support. The water quality class II based on the government regulation Number 82 year 2001 about Water Quality Management and Water Pollution Control was used as the reference for water quality properness. The water quality determination was based on the assessment system of US-EPA (Environmental Protection Agency). The procedures of water quality determination by using Storet Method as shown in Table 1 were as follow:
1. Collecting the data about water quality periodically.
2. Comparing the data from the measurement results of each water parameters to the threshold value which appropriate to the water class.
3. If the result fulfilled the water quality standard value (measurement result ≤ water quality standard), then it scored 0.
4. If the result did not fulfill the water quality standard value (measurement result > quality standard), then it scored 1.
5. Counting up all the negative scores from each counted parameter and deciding the quality status from the total.

Table 1. The Value System determination to decide the water quality status

| Sample Quantity | Score | Parameter |
|-----------------|-------|-----------|
|                 |       | Physic    | Chemical | Biology |
| <10             | Max   | -1        | -2       | -3       |
| Minimum         | -1    | -2        | -3       |
| Average         | -3    | -6        | -9       |

After that, the classification was done based on the obtained value as follows:
1. Class A : Excellent, Score = 0 fulfilled quality standard
2. Class B : Good, Score = -1 s/d -10 light polluted
3. Class C : Moderate, Score = -11 s/d -30 moderately polluted
4. Class D : Bad, Score = ≥ -31 badly polluted

4. Experiment and Result
The water quality determination of Tlogo Ampel Watershed by using the decided parameters obtained from January-December 2017 was shown in Table 2. Table 2 showed that the physical parameter (Temperature and TSS) and microbiology (Total coliform and Fecal coli) were not the sources of the pollution at Tlogo Ampel Watershed. It could be seen that the data distribution obtained from January-December 2017 was still in suggested quality standard. The temperature parameter data tended to be constant every month, while the highest TSS parameter data was in December as much as 255.40
mg/L. The total coliform parameter reached the highest point in October-November as much as 210 population/100ml, while the Fecal coli parameter was high in October-November as much as 120 population/100ml.

The biggest pollution was caused by the chemical pollution such as BOD, COD, DO, and NO$_2$N. The data obtained from BOD parameter reached the highest point in May as much as 14.45 mg/L. The COD parameter tended to rise, yet it reached its highest point in November as much as 30.18 mg/L. The DO parameter tended to be constant every month but in April it decreased as much as 2.61 mg/L. The NO$_2$N parameter obtained from the research result was about 0-0.16 mg/L, therefore it can be said that the NO$_2$N content was not really different every month.

Table 2. The parameter observation data of water quality determination

| PARAMETER         | JAN   | FEBR  | MARCH | APRIL | MAY   | JUNE  | JULY  | AUGST | SEPT  | OCT   | NOV   | DEC   |
|-------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Temperature       | 24.00 | 23.50 | 23.40 | 23.60 | 23.90 | 23.60 | 23.40 | 23.70 | 24.60 | 24.70 | 24.60 | 24.30 |
| TSS               | 117.20| 116.40| 50.80 | 22.80 | 82.40 | 35.10 | 20.80 | 73.30 | 38.00 | 40.90 | 94.10 | 255.40|
| pH                | 8.20  | 7.50  | 7.70  | 6.90  | 8.10  | 6.60  | 6.30  | 6.60  | 6.60  | 6.50  | 6.30  | 6.70  |
| BOD               | 6.25  | 4.60  | 4.80  | 4.70  | 5.80  | 7.30  | 6.20  | 8.15  | 4.60  | 9.55  | 8.85  |       |
| COD               | 16.87 | 18.28 | 22.55 | 26.14 | 34.21 | 14.75 | 19.84 | 18.94 | 24.38 | 11.76 | 30.18 | 27.19 |
| DO                | 5.70  | 6.50  | 6.50  | 2.61  | 3.90  | 7.00  | 6.30  | 6.30  | 4.90  | 6.90  | 5.00  | 3.30  |
| PO4-P             | 0.26  | 0.26  | 0.15  | 0.10  | 0.08  | 0.07  | 0.25  | 0.15  | 0.19  | 0.21  | 0.10  | 0.13  |
| NO3-N             | 2.80  | 1.16  | 2.84  | 2.41  | 1.04  | 2.77  | 2.55  | 7.93  | 2.36  | 1.93  | 1.67  | 2.19  |
| NH3-N             | tt    | 0.44  | tt**  | 0.09  | 1.03  | 0.10  | 0.09  | 0.24  | 0.11  | 0.05  | 0.04  |       |
| NO2-N             | 0.08  | 0.01  | 0.03  | 0.00  | 0.00  | 0.03  | 0.02  | 0.06  | 0.11  | 0.16  | 0.13  |       |
| Total Coliform    | 150.00| 25.00 | 75.00 | 150.00| 39.00 | 240.00| 93.00 | 93.00 | 150.00| 210.00| 210.00| 150.00|
| Fecal Coliform    | 28.00 | 14.00 | 15.00 | 75.00 | 20.00 | 43.00 | 75.00 | 43.00 | 93.00 | 120.00| 120.00| 39.00 |

Storet method was very good to be used in deciding the water quality status of Tlogo Ampel Watershed. The measurement result of storet method in January-December 2017 could be seen in Table 3.

Table 3. The storet measurement result in January-December 2017 Period

| No. | Parameter    | Result          | Score Class I | Score Class II | Score Class III | Score Class IV |
|-----|--------------|-----------------|---------------|----------------|-----------------|---------------|
|     | Max          | Min             | Average       |                |                 |               |
| Physic |              |                 |               |                |                 |               |
| 1   | Temperature  | 24.700          | 23.400        | 24.050         | -1              | -1            | -1            | 0            |
| 2   | TSS          | 117,200         | 20,800        | 69,000         | -4              | -4            | 0             | 0            |
| Chemical |            |                 |               |                |                 |               |
| 1   | pH           | 8,200           | 6,300         | 7,250          | 0               | 0             | 0             | 0            |
| 2   | BOD          | 14,450          | 4,600         | 9,525          | -10             | -10           | -8            | -2           |
| 3   | COD          | 34,210          | 14,750        | 24,480         | -10             | -2            | 0             | 0            |
| 4   | DO           | 7,000           | 0,261         | 3,631          | -8              | -8            | -2            | 0            |
| 5   | PO4-P        | 0,264           | 0,069         | 0,167          | -2              | -2            | 0             | 0            |
| 6   | NO3-N        | 7,932           | 0,140         | 4,036          | 0               | 0             | 0             | 0            |
| 7   | NH3-N        | 1,026           | 0,088         | 0,557          | -2              | -2            | 0             | 0            |
| 8   | NO2-N        | 0,075           | 0,002         | 0,039          | -8              | -8            | -8            | 0            |
Microbiology

|                | TotalColi | Fecal Coliform |
|----------------|-----------|----------------|
| 1              | 240,000   | 120,000        |
| 2              | 25,000    | 14,000         |
|                | 132,500   | 67,000         |
|                | 0         | -3             |
|                | 0         | 0              |
|                | 0         | 0              |
|                | 0         | 0              |

Index Pollution

|                | -48       | -37          | -19  | -2   |

The water quality data of Tlogo Ampel Watershed was not classified into class I or class II as shown in table 3. This was shown by the pollution index that had been discovered. Therefore, the water in Tlogo Ampel Watershed was not suitable to be used as water consumption as well as freshwater fish cultivation. The total number of pollution index in class I was -48, if it was referenced to the classification value from US-EPA, then it was worse and badly polluted. The biggest contributor of the pollution in class I were BOD, COD, DO, and NO2N.

|                | -48       | -37          | -19  | -2   |

Class II category obtained from the pollution index as much as -37, this could be categorized as a worse and badly polluted. The biggest contributor of the pollution in this class was dominated by BOD, DO, and NO2N. In class III category which was allocated to be used for freshwater fish cultivation, livestock, and irrigate planting, and/or another usage that required the same water quality with the allocation got -19 on the total pollution index. This category was classified into moderate polluted. The contributed pollutant was dominated by BOD and NO2N, while the other parameters were still in the determined threshold.

Water quality data of Tlogo Ampel Watershed was not classified into class I or class II as shown in table 3. This was shown by the pollution index that had been discovered. Therefore, the water in Tlogo Ampel Watershed was not suitable to be used as water consumption as well as freshwater fish cultivation. The total number of pollution index in class I was -48, if it was referenced to the classification value from US-EPA, then it was worse and badly polluted. The biggest contributor of the pollution in class I were BOD, COD, DO, and NO2N.

5. Conclusion

From the results of this study it can be concluded if water quality status at Tlogo Ampel Watershed is not recommended for water drink and water recreation. Water quality at Tlogo Ampel Watershed is good for livestock or fish cultivation and very good for agriculture.

Acknowledgments

Our thank goes to Department of Agricultural Engineering, Politeknik Negeri Jember, who has helped support for this research.
References

[1] Costa D, Burlando P, Priadi C 2016 *Sustainable Cities and Society*:20: 199-209.
[2] Sutriati, Armita 2018 *Journal of Water Resources* 8: 81-94.
[3] Sahabuddin, Hartina, Donny Harisuseno and Emma Yuliani 2014 *Water Resources Engineering Journal* 5: 19-28.
[4] Bachrein, Saeful 2015 Bina Praja Journal: *Journal of Home Affairs Governance* 4: 227-236.
[5] Pasandaran, Effendi 2017 *Agricultural Policy Analysis* 3: 217-235.
[6] Macbub, Badruddin 2018 *Journal of Water Resources* 6: 129-144.
[7] Novita Sari, Ratna, Titik Istiokhatun and Sudarno Sudarno 2017 *Journal of Environmental Engineering* 3: 1-9.