Determination of Water Quality Status at Sampean Watershed Bondowoso Residence Using Storet Method

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Determination of Water Quality Status at Sampean Watershed Bondowoso Residence Using Storet Method

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Abstract. Sampean watershed has an important social and economic function for the people surroundings. Sampean watershed wich cover Bondowoso and Situbondo residence is an urban watershed that has strategic value for national context needs special traetment. Construction activity at upper and lower course of Sampean watershed is highly intensive and growth of inhabitant also increase. The change of land utilization and increase of settlement area at upper, midlle, and lower course caused polutant infiltration to Sampean river watershed so it has impact on water quality. The source of pollution at Sampean river comes from domestic waste, industrial waste, agricultural waste and animal husbandry waste. The purpose of this research is to determine load of pollution and analize the pollution load carrying capacity at Sampean watershed. The data used in this research are rainfall, river flow rate and water quality at 6 certain points within 3 years during 2014 until 2016. The method to determine overall pollution rate is STORET (*Storage and Retrieval of Water Quality Data System*) method. The analysis results for the first, second, third and forth grade are -24 (moderate quality), -12 (moderate quality), -2 (good quality), and 0 (good quality) respectively.

1. Introduction

Watershed is an integrated area with river and tributary rivers and has functioned for storing and flowing water derived from rainfall to the lake or sea naturally. The area covers the land border that is a topographical boundaries and sea border until waters area that is still influenced by land activities (Act No 7 Year 2004). Consideration of Environment carrying load in the spatial planning is a mandatory from Republic Indonesia Laws No. 26, Year 2007 about Spatial Planning and No. 32, Year 2009 about Enviromental Management. One of the activities should be done in the arrangement and establishment of spatial planning is to determine the development goal to achieved based on carrying and capacity load of environment. Carrying load of environment is the ability of environment to support human life and another living being.

Sampean watershed has social and economic function. Sampean watershed wich covered Bondowoso and Situbondo residence is an urban watershed that has a strategic meaning in national context that need special management. Building activities whether at upper or lower Sampean watershed is very intens and the growth of population is also high. The change of land utilization also the increase amount of residence area in the upper, middle, and lower Sampean watershed caused the infiltration of pollutant. The source of pollution at Sampean river comes from domestic waste, industrial waste, agricultural waste and livestock waste (Dewi, 2016).

Recently, the usage and exploitation of water at Sampean watershed is more intensive while the availability of water is limited and there is no new development or improvement. The availibility of water is still depends on climate or weather where the amount of water at rainy season is abundant while at dry season is decrease (Sari, 2011). The difference of water quantity between two season should be explore optimally with fair and equal distribution pattern using the right planting pattern according to the current season and the availability of water supply. Based on this situation, the carrying and capacity load environment, and water quality of Sampean watershed need to be studied.

2. Working Methodology

Data used in this research are primary and secondary data. Primary data achieved by conducting direct observation and giving questionnaire. Secondary data achieved from annual reports for various institute and survey data from previous research. Tools that used for data analysis, also tools for testing physical and chemical properties of water. *STORET* method is one of the method to determine water quality status. Storet method basicallly is to compare between water quality data with water quality standard adjust for the function to determine water quality status. The method to determine water quality status using value system from US-EPA (Environmental Protection Agency) to categorize water quality into four classes. Meanwhile to clasify water quality is based on EPA standard (Saraswati, 2016).

3. Result and Discussion

The reseach carried out at Sampean waterhed located at 113°48'27" BT 7° 27'41" LS. Sampean watershed covered Jember Residence (1 subdistrict / 4 villages) with area 4.115,36 Ha (3,05 %); Bondowoso Residence (17 subdistrict / 195 villages) with area 120.397,63 Ha (89,6 %); Situbondo Residence (4 subdistrict / 33 villages) with area 10.520,01 Ha (7,73 %). The total area of Pekalen Sampean watershed is 135.033 Ha with the length of main river 64 km, and divided into 30 sub watershed.

3.1 Source of Pollution and Characteristics

Source of pollution or pollutant can be found at certain location (point source) or random (non-point/diffuse source). Non-point source can be a point source in a large number such as : runoff from domestic area and runoff from urban area (Rasyiid, 2015). Sampean watershed area from Bondowoso residence until Bondowoso residence is a crowded area and posses a large amount of human population making the watershed area as garbage disposal for the resident.Domestic waste aside from garbage disposal also liquid waste that comes from human activities such as washing, bathing, and defecating. Livestock waste also become pollution source for the river if there is not further waste management for the feces, urines, woof waste and also water from livestock and stablecleansing. One of the effect of water pollution by livestock is increasing the level of nitrogen.

Decreasing of dissolve oxygen concentration due to nitrification process in the water can disturb the living of water biota. Generally, people along side Pekalen Sampean watershed using livestock waste as organic fertilizer for plants and worm feeding.The industry along side Sampean watershed also cause water pollution, decreasing water quality of river, and reducing the beneficial of river water for the people. industrial pollution is contribute by tofu,tempe and tapioka industry located at the side of the river. Agricultural waste can cause water pollution due to fertilizer and pestiside utilization. Chemical fertilizer and pestiside becomes source of pollution because contains phosphat, nitrogen, and others. Phosphate can stimulate the growth of water weeds such as algae and water hyacinth. Wafa (2015) states that amount of nitrogen loss from the farms each hectare is around 5 – 50 kg/N/ha/year and phosphate is around 0,05 – 0,5 kg P/ha/year. This condition depend on type of plant, frequency, and rainfall intensity.

3.2 Water Quality at Sampean Watershed during 2014, 2015 and 2016

Fluctuation of water quality at Sampean river watershed during 2014, 2015, and 2016 significant enough to some of the water quality parameters. The change of water quality tends to excess the standard. This are some condition of each parameter and calculation of water quality index explain below.

3.2.1. Physical Parameter

a.*Temperature*

Temperature change effect on physical, chemical, and biological of water bodies. Temperature has a role to control the ecosystem of the waters (Dewi, 2016). Increase of temperature can also increase viscosity, chemical reaction, evaporation, and volatility. Temperature increment also decrease gas solubility in the water, such as O_2, N_2, CO_2, NH_4.. Saraswati (2014) declare the temperature change limitation of waters no more than 2,8 ^oC. The minimum , average, and maximum temperature of the waters shown by Figure 1 :

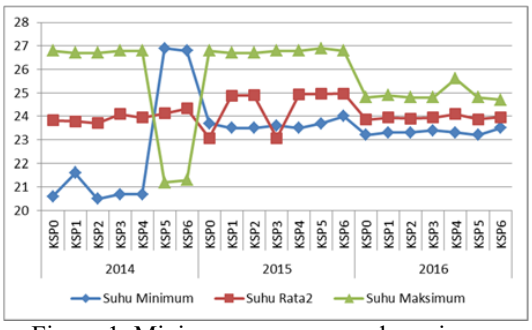

Figure 1. Minimum, average, and maximum temperature of the waters

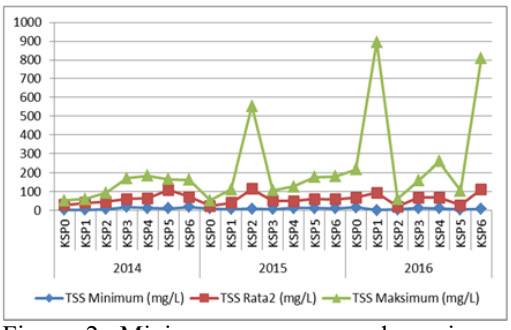

Figure 2. Minimum, average, and maximum TSS during 2014, 2015 dan 2016

Sources : Analysis data from UPT PengelolaanSumberDaya Air Bondowoso (2014, 2015, 2016)

Based on the observation of water quality from observation point KSP 0 until KSP 6, during 2014, 2015, and 2016 temperature tends to increase 24 ^oC, 24,4 ^oC, and 23,9 ^oC respectively. This condition is match with Wafa (2015) statement that temperature of water bodies influenced by season, latitude, and altitude from sea water surface. Temperature increment tends toward downstream because of the growth of population, industry and livestock. Pollution load caused by domestic waste from KSP 0 until KSP 6. Temperature increment caused by pollution or waste content entering the river as the consequence of domestic activities, agriculture, livestock, and industry also can increase decomposition of organic matters by microbe. Saraswati (2014) states that increase of industry and human activities will also increase water temperature.

b.Total Suspended solid (TSS)

TSS consist of muds and sands also microorganism, especially because of land erosion carried out to water bodies (Rasyiid, 2015). Observation result of TSS value during 2014, 2015, and 2016 can be viewed in figure 2. Based on the observation of water quality during 2014, 2015, and 2016 from obervation point KSP 0 until KSP 6, TSS value fluctuate significantly enough. TSS value increase due to various pollutant retain by water bodies and range of area is large. TSS value during 2014, 2015, and 2016 are 60,6 mg/L; 57 mg/L; and 65,9 mg/L respectively.

3.2.2 Chemical Parameter

a. pH

pH value is used to measure acidity level of water. Pure water have pH value of 7, while pH value for standard normal water is 6,5 – 7,5. Measurement of pH during 2014, 2015, and 2016 shows that pH value fluctuate between 7,6; 7,5 and 7,6 respectively. Fluctuation of pH value is still in the normal standard for living based on Government Act No. 82 Year 2001. Diagram for minimum, average, and maximum pH during 2014, 2015, and 2016 can be shown in figure 3.

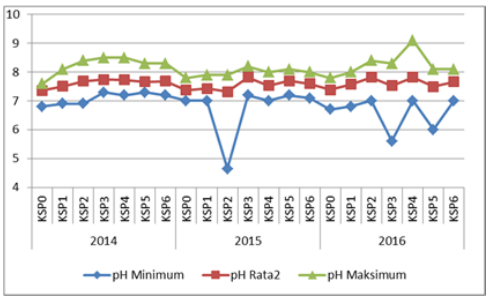

Figure 3. Minimum, average, and maximum pH during 2014, 2015 dan 2016

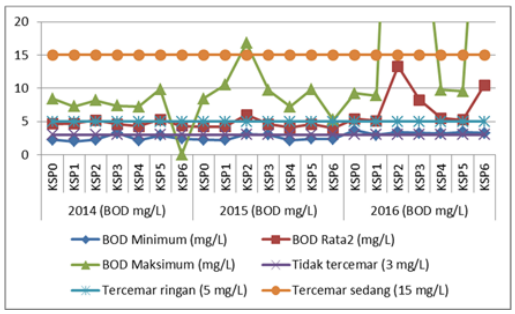

Figure 4. BOD value at Sampean River Year 2015

Source : Analysis data from UPT PengelolaanSumberDaya Air Bondowoso (2016)

b.Biological Oxygen Demand (BOD)

BOD is an illustration of organic matter content which is amount of oxygen required by aerob microbe to oxydize organic matters into carbondioxide and water (Rasyiid, 2015). The minimum, average, and maximum BOD can be viewed in figure 4. Nearly pure water have BOD value about 1 mg/L, and water with BOD value of 3 mg/L still consider pure but the purity of water is doubtful if the BOD value 5 mg/L or more.

Figure 4 shows average BOD value during 2014,2015, and 2016 are 4,71 mg/L, 4,53 mg/L, and 7,60 mg/L respectively. This condition shows that in the year 2014 and 2015, Sampean watershed retain light pollution while in 2016 retain medium pollution. BOD value increase caused by pollution load lies at the top of observation pointsuch as domestic waste, industrial waste and livestock waste also the water temperature increase at the downstream. Based on Government Act No. 82 Years 2001, average BOD value is above the standard (< 3 mg/L) for second class which is light pollution.

c.*Chemical Oxygen Demand (*COD)

COD value of non polluted waters usually less than 20 mg/L, and at the polluted waters COD value could excess 200 mg/L. The waters that have high COD is not suitable for fisheries activity (Mahyudin, 2015). Based on the observation, COD value during 2014, 2015, and 2016 show the value of 13,40 mg/L, 13,26 mg/L, and 27,03 mg/L respectively. This shows the incremental value of COD caused by infiltration of pollution load above observation point such as domestic waste and industrial waste. Minimum, average, and maximum COD during 2014, 2015, and 2016 can be viewed in figure 5. Observation of COD value shows that the average value is still in the range of water quality standard (< 25 mg/L), but in year 2016 the average value is 27,03 which is bigger than the standard.

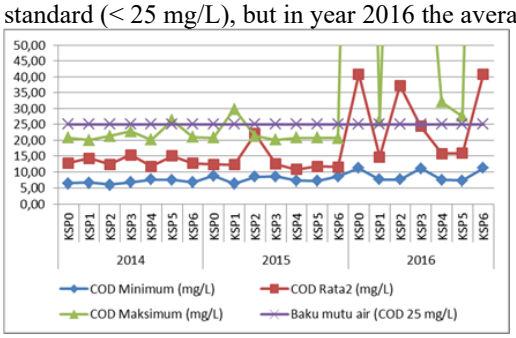

Figure5. Observation of COD value (mg/L) during2014, 2015dan 2016

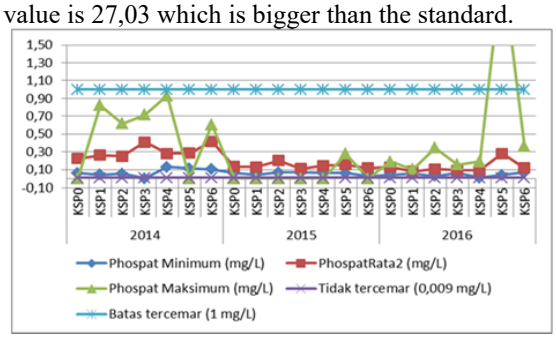

Figure 6. Minimum, average, and maximum value of phosphate during 2014, 2015 and 2016

Source : Analysis data from UPT PengelolaanSumberDaya Air Bondowoso (2014, 2015dan 2016).

d.Phosphate

Figure 6 shows the minimum, average, and maximum value of phosphate in the water.The change of phosphate during 2014, 2015, and 2016 shows the value of 0,30 mg/L, 0,14 mg/L dan 0,13 mg/L respectively. Observation on phosphate value shows that water at Sampean watershed is above minimum standard (0,009 mg/L) but slightly below maximum standard (1 mg/L). Phosphate pollution

is mainly caused by anthropogenic activities, industry, and livestock. Detergent, shampoo, and soap also industrial waste caused the waters is full of foam and reduce oxygen absorption in the waters.

3.2.3Water Quality Status Based on StoretMethod

To determine the pollutant level overall can be analyze using STORET (Storage and Retrieval of Water Quality Data System) method. STORET method can describe the parameters that fullfill or excess of water quality standard. STORET method principally is give comparation between water quality with the standard suitable with the function to determine the status. Based on the calculation using STORET method acquired water quality status Sampean river from 2014 until 2016 that can be viewed in table 1 and clasification of water quality status in table 2.

Table 1.Water quality status Sampean river between 2014-2016using STORET method

No.	Parameters	Unit	Standart I	Standart II	Standart III	Standart IV	2014	2015	2016	Max	Min	Average	Scores for Quality I	Scores for Quality II	Scores for Quality III	Scores for Quality IV
	PHYSICS															
1	Temperature	°C	normal ± 3	normal ± 3	normal ± 3	normal ± 3	23,97	24,94	23,90	**24,94**	*23,90*	**24,27**	0	0	0	0
2	TSS	mg/L	1000	1000	1000	1000	60,57	57,01	65,90	**65,90**	*57,01*	**61,16**	0	0	0	0
	CHEMICAL															
1	pH	-	6 sd 9	5 s/d 9	5 s/d 9	5 sd 9	7,65	7,56	7,61	**7,65**	*7,56*	**7,61**	**0**	**0**	**0**	**0**
2	BOD	mg/L	2	3	6	12	4,722	4,668	7,6	**7,60**	*4,67*	**5,66**	**-10**	**-10**	**-2**	**0**
3	COD	mg/L	10	25	50	100	12,965	12,82	27,029	**27,03**	*12,82*	**17,60**	**-10**	**-2**	**0**	**0**
4	DO	mg/L	6	4	3	<3	5,874	4,868	6,025	**6,03**	*4,87*	**5,59**	**-2**	**0**	**0**	**0**
5	PO4-P	mg/L	0,2	0,2	1	5	0,283	0,167	0,127	**0,28**	*0,13*	**0,19**	**-2**	**-2**	**0**	**0**
6	NO3-N	mg/L	10	10	20	20	2,343	2,077	1,8	**2,34**	*1,80*	**2,07**	**0**	**0**	**0**	**0**
7	NH3-N	mg/L	0,5	0,5	0,02	0,02	0,085	0,102	1,8	**0,10**	*0,09*	**0,09**	**0**	**0**	**0**	**0**
	MICROBIOLOGY															
1	TotalColi	jml/100ml	5000	5000	5000	5000	89,3	58,5	56,2	**89,30**	*56,21*	**68,00**	0	0	0	0
2	Fecal Coliform	jml/100ml	5000	5000	5000	5000	25,6	25,5	23,4	**25,60**	*25,54*	**25,57**	0	0	0	0
	ORGANIC COMPOUNDS															
1	Oil & Fats	mg/L				0,5	tt	tt	tt	**tt**	*tt*	**tt**	0	0	0	0
2	Phenol	mg/L				0,001	tt	tt	tt	**tt**	*tt*	**tt**	0	0	0	0
	Pollution Index												**-24**	**-14**	**-2**	**0**

Table 1 shows the water quality status of Sampean watershed during 2014 – 2016 using STORET method with the clasification of water quality status viewed in table 2. The description of water quality status in table 2 are ;

1. First class, water that can be used as a standard for drinking water and or other usage that required water quality for the same function, the conclusion is Bad (not qualified)
2. Second class, water that can be used for recretional water facilities, fresh water fish cultivation, livestock, garden watering, and or other usage that required water quality for the same function, the conclusion is Bad (not recommended)
3. Third class, water that can be used for fresh water fish cultivation, livestock, garden watering, and or other usage that required water quality for the same function, the conclution is Moderate (qualified)
4. Forth class, water that can be used for garden watering, and or other usage that required water quality for the same function, the conclusion is Moderate (qualified)

Table 2. Clasification of water quality status

	Water quality status			
	Class I	Class II	Class III	Class IV
Sampean Watershed	Bad	Bad	Moderate	Good
	-24	-14	-2	0

Water quality clasification based on *EPA* (Environmental Protection Agency) is categorized as Class A with the score amount of 0 is excellent; Class B with the score range of -1 until -10 is good; Class C with the score range of -11 until -30 is medium; and Class D with the score amount of -31 or

less is bad. Based on this criteria, so the water quality of Sampean river clasified as medium pollution. The weakness of STORET method is influenced by so many parameters to compared.

4. Conclusion

Based on data analysis using STORET method, the conclution of this research are :

1. Physical parameters of water which are temperature and TSS shows that the water of Sampean river is in good quality.
2. Biological parameter of water which are total Coli and Fecal Coliform shows that the water of Sampean river is in good quality.
3. Organic chemical parameter of water which are oils and fats also phenol shows that the water of Sampean river is in good quality.
4. Anorganic chemical parameter of water which are BOD, COD, DO and PO4-P shows that the water of Sampean river is in moderate polluted, so the quality for standard I and II categorized as medium.

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