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ANALYSIS OF BUDURAN RIVER WATER QUALITY USING QUAL2KW AS RAW MATERIAL FOR SIWALANPANJI IPA

Putri Ayu Wardani[1] dan Mohammad Mirwan[2*]

[1,2] Environmental Engineering Study Program, Faculty of Engineering, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Jl. Rungkut Madya No. 1, Gunung Anyar, Kota Surabaya 60294, Indonesia
*corresponding Email: mmirwan.tl@upnjatim.ac.id

ABSTRACT

Buduran River, Sidoarjo Regency, is one of the rivers in Sidoarjo City, which has various functions. The primary function of the Buduran River at the moment is to supply raw material water for one of the PDAM Delta Tirta Sidoarjo, namely the Drinking Water Treatment Plant (IPAM) branch in Siwalanpanji. For this reason, efforts are needed to maintain and monitor river quality using the Qual2Kw method. QUAL2Kw method begins with the determination of 3 segments. Furthermore, an analysis of hydraulic data, water quality, and pollutant sources was carried out, determining the scenarios used, running the QUAL2Kw program, and calculating the carrying capacity of pollution loads. River water quality parameters include pH, BOD, COD, TSS, Phosphate, and Nitrate. Applying the QUAL2Kw method in evaluating the Buduran River with three scenarios according to existing conditions, initial conditions according to quality standards, and trial & error with maximum pollutant load. The capacity value is determined based on the calculation of the difference in pollutant load in scenario three and scenario 2. The result is that the Buduran River is classified as a polluted river, and the negative (-) pollutant load capacity indicates that management is necessary to reduce pollutant loads.

Keywords: *Pollution load, capacity, water quality, QUAL2Kw modeling.*

1. INTRODUCTION

The river is a system where if there is Activity around a body of water, the water quality from upstream to downstream, can change. These activities can be in the form of industry, settlements, and agriculture, which can cause contaminants to enter water bodies (Tanjung *et al*., 2018). Based on PP No. 22 of 2021 concerning the Implementation of Environmental Protection and Management, Water Pollution is the entry or inclusion of living things, substances, energy, and other parts into the water by human activities so that it exceeds the established Water Quality principles. Pollution sources can be divided into mechanical waste, household waste, and waste from shops and metropolitan (business areas). This pollution results from the lack of municipal wastewater treatment facilities and the inclusion of waste loads from these various activities without the support of adequate river capacity, causing pollution (Yohannes *et al*., 2019)

Buduran River, Sidoarjo Regency, is one of the rivers in Sidoarjo City with various functions. The primary function of the Buduran River at the moment is to supply raw water for one of the PDAM Delta Tirta Sidoarjo, namely the Drinking Water Treatment Plant (IPAM) branch in Siwalanpanji. For this reason, efforts are needed to maintain and bring together the quality of the river.

Based on observations made around the Buduran River, there are sources of pollution that enter the air body from rice fields and household waste originating from residents' activities, including the habit of residents who often throw garbage in the riverbanks. Based on direct observation of the physical condition of the Buduran River due to this pollution, the color of the river is no longer clear but brownish green. Based on this, it is necessary to manage rivers as a basis for improving environmental conditions in rivers by determining the capacity to carry pollution loads.

From determining the capacity to accommodate the pollution load, it can determine the maximum limit of waste that can be put into the river so it can naturally improve its water quality conditions (self-purification). Determination of the capacity to accommodate pollution loads in the Buduran River using the Qual2Kw programs, which is very efficient and able to model river water quality from upstream to downstream (Rusnugroho & Masduqi, 2012).

Besides that, it can scenario parameters, maximize or minimize depending on the quality standards applied, and simplify an event (Cho & Ha, 2010). The test parameters used in this study are (pH, TSS (Total Suspended Solids), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrate ($N0_3N$), and Phosphate (PO_4^{3-}). This Qual2kw program also presents a river based on the impact of two sources, originating from point and non-point sources (Chapra & Pelletier, 2008).

The QUAL2Kw model is a development of the QUAL2E model using the Visual Basic for Application (VBA) programming language, which can be run with the Microsoft Excel program (Chapra & Pelletier, 2008). This model can screen several parameters, including pH, Sediment Oxygen Demand (SOD), Carbonaceous Biochemical Demand (CBOD), Dissolved Oxygen (DO), organic nitrogen, ammonia (NH_4^+), nitrite (NO_2^-), nitrate (NO_3^-), organic phosphorus, inorganic phosphorus, phytoplankton, total nitrogen and total phosphorus (Camargo et al., 2010).

Based on PERMEN LH Number 01 of 2010, the QUAL2Kw model uses scenario techniques. The scenario is used to calculate the pollution load-carrying capacity and predict the water quality of the Buduran River. From these calculations, it can be seen the ability of the Buduran River to accommodate incoming pollution loads.

2. METHOD

Type of Research

The type of research used in the study entitled "Analysis of Water Quality in Buduran River Sidoarjo Using Qual2Kw As Raw Material for Siwalanpanji IPAM" is a quantitative descriptive study. The descriptive approach is to give an overview of the water quality of the Buduran River at each station. The quantitative approach is based on calculating the water quality status, pollution load, and pollutant load capacity.

Determining the Research Location

Field Observations

Observations in this study aim to determine the conditions around the river banks and the things that affect the river pollution load so that they can determine the point source originating from industrial activities around the river banks and non-point source originating from domestic waste and rice fields.

Determination of Segments

River segmentation divides the river into smaller sections to make it easier in terms of research. In this study, Kali Buduran is divided into four river segments.

Figure 1. Segmentation Buduran River
(Source : Google Earth)

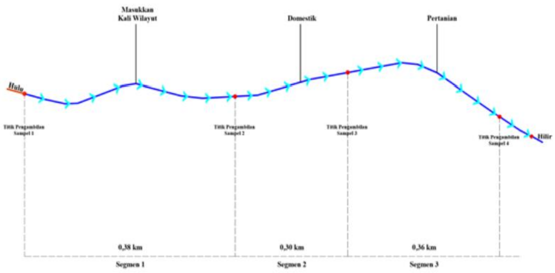

Figure 2. Research sites
(Source : Research, 2022)

Table 1. Location of Segment Distribution

Segment	Elevation (m) Upstream,	Downstream	Length (km)	Information
1	2	3	0,51	This segment is divided based on the entry point of water originating from Kali Wilayut. The water sampling point is at TS-A. Then TS B is segment one sampling.
2	3	2	0,46	This segment is the second-order segment divided due to the presence of domestic waste disposal channels. In this segment, there are densely populated residential areas. Meanwhile, TS C is a collection point in segment 2.
3	2	2	0,37	This segment is the third-order segment determined based on the presence of domestic and agricultural waste channels. In comparison, TS D is the point of collection for segment 3.

Data Collection

Data collection is divided into primary data and secondary data. For primary data collection, field orientation was carried out by following the river to determine the condition of the river, point sources, and non-point sources of pollution based on direct observation and testing of river water quality. While the secondary data collected includes maps of the Buduran River, climatological

data (air temperature, rainfall, and wind speed), profiles of the Buduran River, river discharge, geography, and climate in the Buduran area

Materials and Tools

Several tools and materials to support the measurement of test parameters based on the standard method, namely:

1. Winkler bottles or plastic bottles to store samples so that no contaminants and oxygen enter the bottles.
2. Measuring tools to make measurements accurately.
3. A thermometer to measure the temperature of the water.
4. Cooling box is used to store samples with a temperature range of 2°- 4°C
5. Camera as a tool to document sampling activities.
6. A rope to assist the sampling process.
7. Plastic bucket to collect water from the Buduran River h) pH meter to measure the pH of the water.

Working Method

River Segmentation

The first step in Qual2kw's modeling is dividing the river into reaches. These sections are grouped into segments according to field conditions (topography) and the location of the sampling points.

Determination of Model Parameters and Assumptions

The determination of parameters, models, and assumptions is done through a literature search and comparison with field measurement data. This is mainly done in determining the rearrangement model close to field conditions. The quantitative statistical criterion used to assess the closeness of the model to field measurement data is the model validity coefficient.

Input data into the Qual2kw program

A series of processed data and the results of determining the model parameter values in the previous stage are input into the Qual2kw program.

Data analysis Qual2kw output model

The next step is analyzing the data obtained from the output of the Qual2kw program. The running result parameter data will be processed and displayed in graphical form through data calibration, which aims to obtain the predicted value of the data according to the desired model. This calibration is done by trial and error and running the program repeatedly by setting the data. Verification is the data used to determine the model that has approached the data and can be seen from the resulting model graph. If the line (model) has followed the black box dots (data) trend, it can be concluded that the model has approached the actual conditions starting from rainfall to the parameters to be used.

Analysis

The analysis in this study uses scenarios. The scenarios in this study are divided into three scenarios that will be used to obtain quality and capacity results by the Buduran River.

Scenario 1

This scenario compiles data input into the program from existing data on water quality from upstream. The data is obtained from river water quality and uncertain and certain pollutant sources. Indeterminate pollutant sources come from household and agricultural waste that enters the river.

Scenario 2

Scenario 2 is the initial condition without any pollutant load by eliminating pollutant sources of domestic waste and rice fields. Under the condition that the water conditions in the upstream area use Class 2 Quality Standards, the inflow discharge of pollutant loads from non-point sources will be eliminated so that no pollutant loads enter the Buduran River. The purpose of having scenarios 2 is to know the self-purification ability of the Buduran River.

Scenario 3

While in scenario 3 is a condition where the model results are by the quality standards of class two water bodies because the Buduran River is used as one of the PDAM's raw materials. Pollutant sources from point sources and non-point sources are trial and error until the model data approaches the results of the second-class quality standard.

3. RESULTS AND DISCUSSION

Hydraulic Conditions of the Buduran River

The hydraulic data of the Buduran River are in the form of average velocity data, average water depth, and average water discharge. Hydraulic data is required to satisfy model calibration in the QUAL2Kw program. The hydraulic data of the Buduran River in Sidoarjo can be seen in Table 2.

Table 2. Buduran River Hydraulic Data

Point	Discharge (m3/s)	Water depth (m)	Velocity (m/s)
Hulu (A)	4,580	1,050	0,213
B	4,578	1,080	0,191
C	6,719	1,280	0,167
D	7,915	1,330	0,156

Water Quality Conditions in Buduran River

River water have their quality and characteristics. This is influenced by the quantity and quality of pollutants that enter the river water. Buduran River water quality. It is obtained from primary and secondary data (PU Bina Marga & Water Resources Sidoarjo Regency). Primary data collection was carried out by taking samples from 4 points, namely point A upstream, point B, point C, and point D, on the connecting bridge between JL.KH Abbas and KH.Hamdani. Primary data collection was carried out on August 2, 2022, starting at 10.00 WIB. A sampling at each point is carried out using the distance function and average speed. Sampling is seen based on river discharge.

Table 3. Class II Water Quality Standards

Parameters	Units	Class I Quality Standard
pH	-	6 - 9
COD	mg/L	10
BOD	mg/L	2
TSS	mg/L	40
Nitrat	mg/L	10
Fosfat	mg/L	0,2

Source: PP No 22 of 2021

Table 4. Buduran River Water Quality Test Results

Sampling point	pH	Tempe-rature	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	Nitrate	Phosphate
Hulu (A)	7,03	27,5	4	2,92	9,85	0,34	3,72
B	7,43	27,5	14	2,73	9,85	0,13	3,86
C	7,59	27,5	12	4,58	9,85	0,42	4
D	7,75	27,5	8	2,31	9,85	0,092	5,56

<u>pH</u>

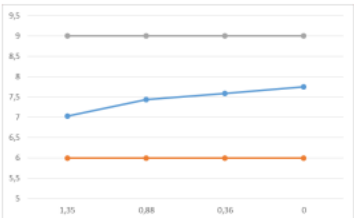

Figure 3. Graph of pH values.
(Source : Research, 2022)

Figure 3. shows pH data, which shows that the pH at each point meets the pH value of class II water quality standards.

<u>Total Suspended Solid (TSS)</u>

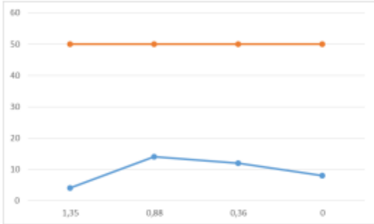

Figure 4. Graph of TSS values.
(Source : Research, 2022)

The Total Suspended Solid (TSS) level is below the set quality standard because the upstream and downstream parts are only polluted by household and agricultural wastewater. Household liquid waste is liquid waste originating from household activities. The average composition of household wastewater contains organic, inorganic and mineral compounds from food scraps, urine and soap (Sa'adah & Winarti, 44 2009). TSS has decreased due to reduced water flow velocity so that some Total Suspended Solid (TSS) is precipitated (Dewa *et al*., 2016)

<u>Dissolve Oxygen (DO)</u>

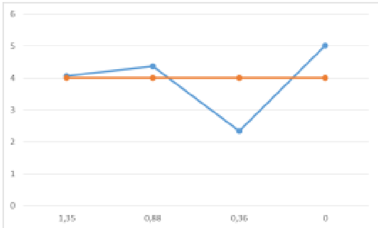

Figure 5. Graph of DO values.
(Source : Research, 2022)

In the dissolved oxygen (DO) data and graphs, it can be seen that DO values were low at all points and DO did not meet the minimum quality standards. The low DO value is affected by the increasing number of pollutant sources that enter the Buduran River, both from household and agricultural waste. Dissolved oxygen (dissolved oxygen) dramatically influences the water's pollutant load..

<u>Biological Oxygen Demand (BOD)</u>

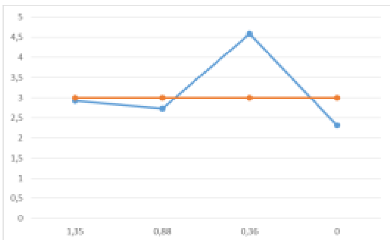

Figure 6. Graph of BOD values.
(Source : Research, 2022)

The BOD value in the graph above shows an increase in the BOD value, and the BOD value does not meet class II water quality standards. With so much effluent entering the river water, the concentration of BOD increases. This can happen because the wasted effluent contains high organic matter. With the increase in the content of organic matter in waters, the oxygen used to oxidize organic matter to carbon dioxide and water also increases. Therefore, the water's biological oxygen content increases (Vandra et al., 2016).

Chemical Oxygen Demand (COD)

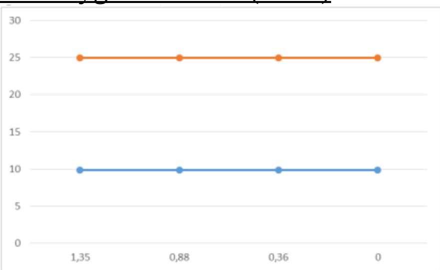

Figure 7. Graph of COD values.
(Source : Research, 2022)

COD is the amount of oxygen needed in the oxidation process. Based on the above observational data from segment 1 to segment 3, the COD level in the Buduran River does not exceed the quality standard of 25 mg/L. The decrease in the COD value indicates that the lower the COD value means the lower the pollution in the water because if the content of organic substances decreases, less oxygen is needed to degrade these organic substances (Poniman, 2021).

Nitrat

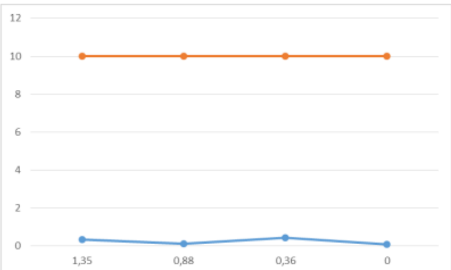

Figure 8. Graph of Nitrate values.
(Source : Research, 2022)

The graph (Figure 8) shows that the nitrate value meets class II water quality standards. Nitrate also comes from the infiltration of residential wastewater, animal waste, and human waste (Ali et al., 2013). Residential waste contains organic compounds and proteins that bacteria can decompose into nitrates.

Phosphate

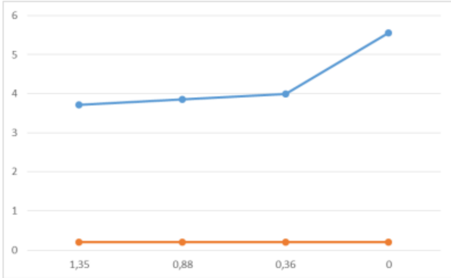

Figure 9. Graph of Phosphate values.
(Source : Research, 2022)

The graph above shows that the Phosphate value exceeds the class II water quality standard of 0.2 mg/l. The high phosphate value is caused by several factors, including an increase in phosphate in the form of polyphosphate, which enters rivers through residents' wastewater in the form of waste from detergent ingredients. In addition, other factors also come from the high organic phosphate contained in the wastewater (faeces) and food scraps that enter the river (Yogiarti *et al*., 2014).

Pollutant Source Conditions

Pollutants that enter the Buduran River are non-point sources and point sources. According to the Regulation of the Minister of the Environment Number 1 of 2010, point sources can be precisely located, while non-point or diffuse sources cannot be located precisely and generally consist of many individual sources. Relatively small. Non-point sources come from residential and agricultural waste, while the point sources in the Buduran River study come from input from the drainage canal.

Table 5. Non-Point Source Pollutant Data

Name	location		Outgoing Debt	Incoming debit	TSS	BOD	COD	Nitrate	phosphat
	Upstream (Km)	Down-stream (Km)	(m3 /s)	(m3/s)	mg/L	mg/L	mg/L	mg/L	mg/L
Domestic	1,16	1,10	0	0,8243	32,85	1,49	19,8	1,23	0,32
Ricefield 1	0,24	0,10	0	0,8998	29,83	1,24	25,56	1,49	0,75
Ricefield 2	0,27	0,13	0	0,7263	29,83	1,50	27,76	1,49	0,75

Formation of the Model

Formation stage is the stage after dividing the segments of the Buduran River, measuring the hydraulic conditions of the Buduran River, and analyzing the water quality of the Buduran River. In forming the program model used is QUAL2Kw. The available data is then entered on a worksheet in the QUAL2Kw program as an initial step in model building. Worksheets on QUAL2Kw have different colours on each worksheet. The colour difference certainly provides different information for each worksheet, including :

1. Blue worksheet: represents the data and parameters needed for model formation
2. Green worksheet: results of data released by the QUAL2Kw model
3. Yellow worksheet: data output as a graphic by the QUAL2Kw model.

The data includes general data about rivers (river name, time of sampling, etc.), headwater quality data, reach data, point source pollutant data and diffuse sources (non-point sources).), river hydraulic data (velocity, depth and river discharge), water body quality data (pH, temperature, TSS, BOD, COD, Nitrate, and Phosphate), as well as supporting data such as air temperature, dew temperature, and wind speed. The point pollutant source comes from the drainage canal, and water flows from the Wilayut River that enters the Buduran River. River quality parameters to be measured and modelled must be adjusted to the parameters in the QUAL2Kw program, shown in Table 6 below.

Table 6. Water Quality Parameters in Qual2kw

Parameter Name	Parameter Name in QUAL2KW
pH	pH
Suhu (°C)	Suhu (°C)
BOD_5 (mg/l)	CBOD fast (mg/l)
COD (mg/l)	Generic Constituent (mg/L)
TSS(mg/l)	ISS (mg/L)
Nitrat (mg/l)	NH4 (µg/L)
Fosfat (mg/l)	Inorganic P (µg/L)

Use of River Water Quality Scenarios

Scenarios are steps taken to estimate the quality of existing river water according to the scenario technique in Table 3.4. In this study, there are 3 scenarios that will be used. The scenario that will be carried out uses the existing conditions and conditions according to class II water quality standards. Water quality in the upstream is inputted into the headwater worksheet at QUAL2Kw. The scenario results from the program will be displayed from the WQ output worksheet which is the result of scenario data for the formation of river water quality graphs and the source summary worksheet which is the result of scenario data discharge and pollutant quality per river segment.

Scenario 1

Scenario one is carried out by scenario the upstream conditions in the form of existing data obtained from laboratory tests and water quality (WQ) data using a data model that has been carried out by trial and error. The condition of the pollutant source is obtained from the existing condition. Data processed from scenario 1 according to the model of pH, TSS, BOD, COD, Nitrate, and Phosphate. The following results of modeling from scenario 1 can be seen in the following figure.

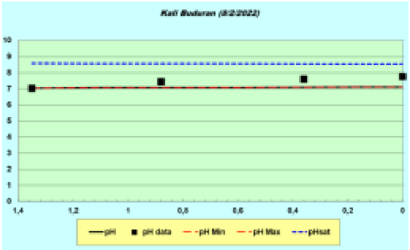

Figure 10. Graph of Scenario Model 1 pH
(Source : Research, 2022)

Figure 10. shows that the trend line (model) is close to the pH parameter's black box (input data). The pH data for the Buduran River for all segments is in the range of 7.03-7.75. This value is a stable pH value and meets class II water quality standards. The pH saturation obtained from the WQ output of scenario 1 is 8.58. The pH saturation is in the form of a blue dotted line.

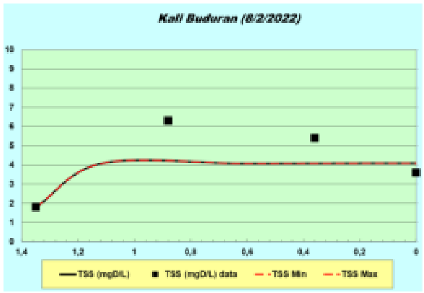

Figure 11. Graph of Scenario Model 1 TSS
(Source : Research, 2022)

Figure 11 shows the TSS value in the Buduran River. The TSS value for all segments still meets the class II water quality standard based on PP RI Number 22 of 2021, which is 40 mg/l. This is because from upstream to downstream, it is only polluted by household and agricultural wastewater.

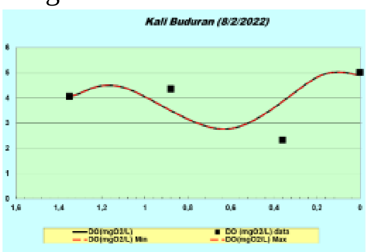

Figure 12. Graph of Scenario Model 1 DO
(Source : Research, 2022)

In Figure 12 above, the DO values at points 1,2 and 4 tend to be higher than the existing minimum quality standard values based on Government

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Regulation No. 22 of 2021, which is four mg/L, although not significant. Whereas at point 3, the DO value is low. This indicates that there is a small amount of oxygen at that point.

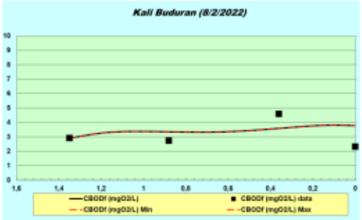

Figure 13. Graph of Scenario Model 1 BOD (Source : Research, 2022)

Figure 13 above shows that the trend line (model) is close to the input data. The BOD value increases in segment 3. This is due to pollutant sources originating from agriculture and garbage accumulated at point 3.

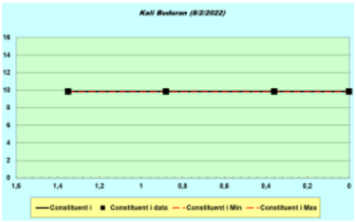

Figure 14. Graph of Scenario Model 1 COD (Source : Research, 2022)

Figure 14 shows that the trend line (model) is close to the input data. The data shows the BOD value of Buduran River from segment 1 to segment 3, which is 9.85 mg/l.

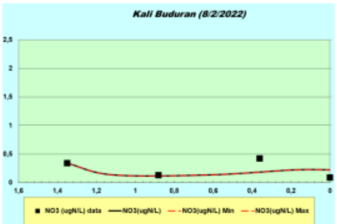

Figure 15. Graph of Scenario Model 1 Nitrate (Source : Research, 2022)

Figure 15 above shows that the value of nitrate still meets class II water quality standards. Nitrate values were between 0.09-0.42 mg/l in all research segments. Nitrate concentration in water is also affected by climate change, accompanied by changes in temperature, quantity and distribution of rain (Rao et al., 2017). Water nitrate levels fluctuate seasonally, and higher nitrate levels also occur after heavy rains (Ismail, 2011).

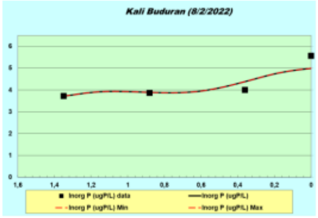

Figure 16. Graph of Scenario Model 1 Phosphate (Source : Research, 2022)

Figure 16 shows that the Phosphate value has a value of 3.72 and 3.86, 4 and 5.56 mg/l. This value exceeds the class II water quality standard in Government Regulation 22 of 2021, 0.2 mg/l. The phosphate parameter's trend line (model) is close to the black box (input data). Phosphate sources can come from 7% industry, 10% from natural processes, 17% from agricultural fertilizer, 34% from the household, and 32% livestock waste. The presence of excess phosphate in water bodies causes the phenomenon of eutrophication (Yogiarti *et al.*, 2014)

Scenario 2

In scenario 2, the upstream data is adjusted to class II water quality standards based on PP No 22 of 2021. The inflow discharge of pollutant loads from non-point sources will be eliminated so that no pollutant loads enter the Buduran River. The sampling data on the WQ Data and Hydraulics Data worksheets are also removed, as in scenario 2. The purpose of scenario 2 is to determine the self-purification capability of the Buduran River in Sidoarjo.

Based on the scenario 2 for the parameters pH, TSS, COD, and Nitrate, most of them have met the quality standards of class II PP No. 22 in the Year 2021. This is due to the condition of the Buduran River, where there are only natural pollutant loads from tributaries so that the self-purification process can run well. While the BOD and Phosphate parameters still exceed the quality standards caused by factors other than waste due to the presence of high organic matter. The oxygen used to oxidise organic matter into carbon dioxide and water increases with the increase in the organic matter content in waters. Therefore, the water's biological oxygen content increases (Vandra et al., 2016). In addition, another factor also comes from the high organic phosphates contained in the water, namely food waste that enters the river (Yogiarti *et al.*, 2014)

Scenario 3

This scenario is based on the value of water quality parameters that are by the quality standard limits Class II water bodies according to Government Regulation No. 22 of 2021. In the existing conditions in scenario 1, the values of the river water quality parameters are several parameters that exceed the quality standards for class II water bodies. Scenario 3 will use the trial and error method on the value of pollutant sources at non-point sources. In scenario 3, the results show that all river water quality parameters meet class II water quality standards, and the resulting water quality is better than in scenario 1. This is because the water quality in the upstream (headwater) meets the quality standards. In scenario 3, This trend line result (model) must also be adjusted to class II quality standards.

Correlation between the results of the research parameters and the observation results of Buduran River water in each scenario in the Qual2Kw method.

A. pH

The pH parameters at all points still meet the maximum quality standard according to Government Regulation 22 of 2021. The data shows that the pH at each point from the initial and scenario data still meets the pH value of class II water quality standards, namely 6-9.

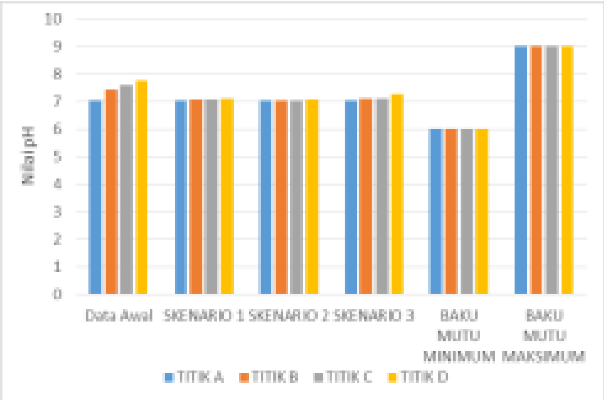

Figure 17. Graph of parameters pH
(Source : Research, 2022)

B. TSS

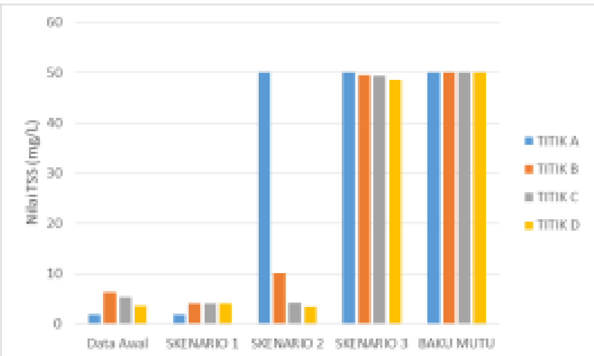

Figure 18. Graph of parameters TSS
(Source : Research, 2022)

In this study, the TSS parameter test was carried out to determine the solids that cause turbidity in water. This research test was conducted to determine the chemical content contained in the Buduran River water body. In the graphic image, the TSS parameter shows scenario values 1, 2, and 3, and the initial data shows that the TSS value is below the quality standard. Based on PP 22 of 2021, according to the criteria for water based on its class, class II, the allowable TSS value has a threshold of 50 mg/L.

When analyzing the initial data and scenario 1, the TSS test has a value of <10 mg/L.Meanwhile, scenarios 2 and 3 fluctuate. The initial and test data for each segment in each scenario show that the TSS value does not exceed the existing quality standards. This means, in segments 1, 2 and 3, the Total Suspended Solid (TSS) content is below the established quality standard. Because in the upstream and downstream parts, it is only polluted by household and agricultural wastewater. Household liquid waste is liquid waste originating from household activities. The average composition of household wastewater contains organic, inorganic and mineral compounds from food scraps, urine and soap (Sa'adah & Winarti, 2009). TSS has decreased due to reduced water flow velocity so that some of the Total Suspended Solid (TSS) is precipitated (Dewa et al., 2016)

C. DO

Based on the quality standards regarding the Quality of Water bodies and adjustments to the test parameters in the Qual2KW method, the DO parameter is included in the test parameters. The DO measurement aims to determine dissolved oxygen in the water body of the Buduran River so that it can be identified whether there is aquatic biota. Based on the graphic image above, the DO values generated from the initial data and scenarios at points A-B (segment 1) are higher than the existing minimum quality standard values, at points B-C (segment 2) show a significant difference in value. At point B, the DO value is 4-4.36 mg/L, while at point C, the DO value is 2-3 mg/L. This can happen because at point C; there is garbage has accumulated, thereby reducing the oxygen level contained at that point. At point C-D (segment 3), the DO value at point D shows the DO value is higher than the current minimum quality standard value, although it is not significant. This indicates a slightly higher oxygen content in the segment area. According to PP 22 of 2021 concerning Water Quality Management and Water Pollution Control, the water criteria based on its class, namely class II, the minimum DO value is 4. The decrease in the DO value that occurs indicates that there is little oxygen content.

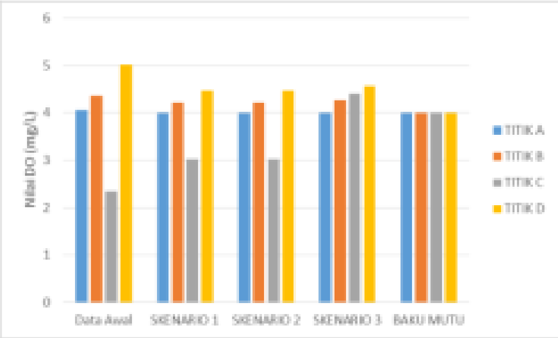

Figure 19. Graph of parameters DO
(Source : Research, 2022)

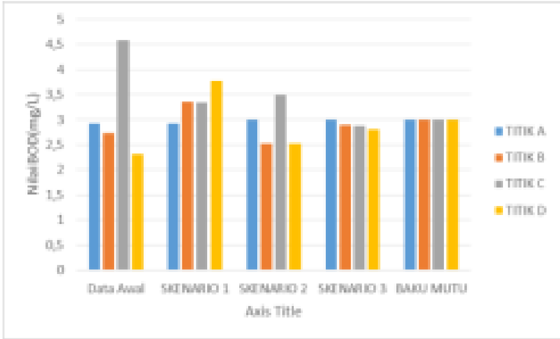

Figure 20. Graph of parameters BOD
(Source : Research, 2022)

D. BOD (Biological Oxygen Demand)

In this parameter, the biological oxygen content in Buduran River water is tested to determine whether the existing water quality is polluted. Based on preliminary data and scenario data, the BOD content contained in the Buduran River water body at point C has a BOD that exceeds the quality standard. Based on PP 22 of 2021 concerning the Management of Water Quality and Control of Water Pollution, the criteria for water based on its class are class II. The BOD value is 3 mg/L. Each scenario, namely scenarios 1, 2 and 3, which consist of 3 segments, shows that the BOD values in water bodies from the initial data and scenario data are in the range of values between 2-4 mg/L. The difference between the initial data and the scenario results depends on the type of effluent changed in the diffuse source worksheet. At Point A-B (Segment 1), the BOD value in the initial data, scenario two and scenario three, does not exceed the quality standard.

In contrast, in scenario one, at point B, the BOD value is 3.36 mg/L, so the highest BOD value is only at one point, which means that the pollutant entering segment one is not too high. At Point B-C (Segment 2), the BOD value for point C in the initial data, scenario one and scenario two, still exceeds the quality standard. In contrast, in scenario three, the BOD value at point C is 2.88 mg/L, which means that the pollution load entering the river is high in this segment. At Point C-D (Segment 3), the BOD value in the initial data, scenario two and scenario three, does not exceed the quality standard. In contrast, in scenario 1, the BOD value is 3 .78 mg/L, which means that the pollution load that enters the river is not too high in this segment. The difference in the BOD value can be caused by the influence of waste or natural factors, such as flow velocity, which are different at each point.

E. COD

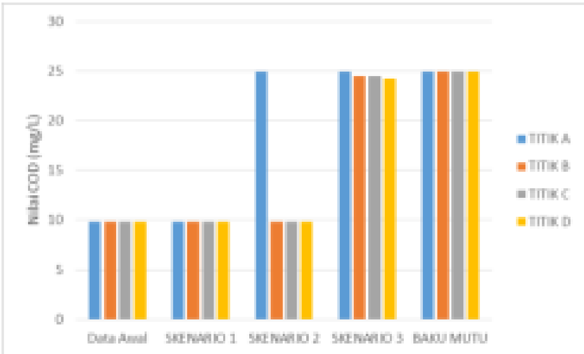

Figure 21. Graph of parameters COD
(Source : Research, 2022)

In this study, the COD parameter test was carried out to determine the chemical oxygen demand contained in water. This research test was conducted to determine the chemical content contained in the Buduran River water body. To find out this, a COD measurement test was carried out. COD value is below the quality standard. Initial and test data for each segment in each scenario indicate that the COD value does not exceed the existing quality standards. So that it can be seen if the highest pollution is due to the influence of household waste, and no industrial waste is detected along the test segment, which discharges its waste into water bodies. When analyzed, in each scenario, the COD mg/L value has the same value in each segment, except for the COD values that occur in scenarios 2 and 3, the COD value is in the range of 25 mg/L.

F. Nitrate

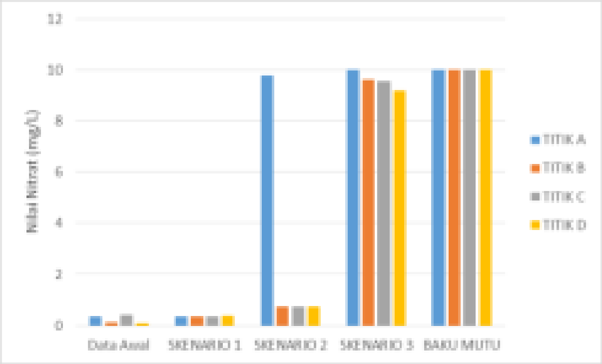

Figure 22. Graph of parameters Nitrate
(Source : Research, 2022)

Based on the preliminary data and scenario results in the graphical figure, the Nitrate content contained in the Buduran River water body has a Nitrate content below the quality standard. Based on PP 22 of 2021 concerning the Management of Water Quality and Control of Water Pollution, the criteria for water based on its class are class II, and the Nitrate value is 10 mg/L. However, if you look at the figure, the Nitrate value is 0.09-0.4 mg/L.

<u>G. Phosphate</u>

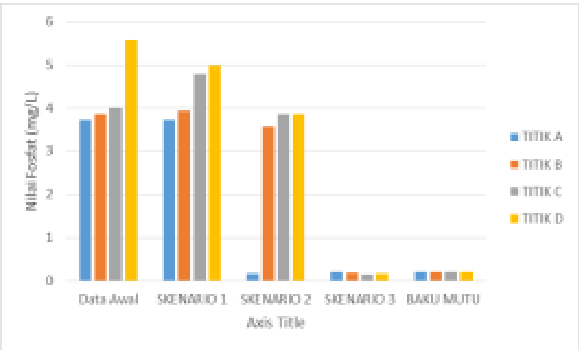

Figure 23. Graph of parameters COD
(Source : Research, 2022)

Based on the picture on the graph, the results of the analysis of the measurement of the phosphate parameter show that the test results and the results of scenarios 1 and 2 show that the value of phosphate is above the quality standard, while for scenario three the value of phosphate is below the quality standard according to PP No. 22 of 2021, which is 0.2 mg/L. In each segment, it indicates that in the test results and scenarios, the resulting value exceeds the quality standard, which means that the phosphate content in that segment is significant, except for scenario 3, wherein in each segment, phosphate still meets the quality standard.

Analysis of River Capacity Against Pollutant

Based on the capacity calculation it can be seen that the parameters TSS, DO, COD, and Nitrate still have a pollutant load capacity in the Buduran River. Meanwhile, the BOD parameters in segment two and Phosphate in each segment no longer have a pollutant load capacity. This is due to the piles of garbage in the river body in segment 2. Apart from that, there is no longer a capacity to accommodate pollutant loads in the Buduran River. This can also be caused because the location is dominated by densely populated settlements and agriculture around the river.

4. CONCLUSION

The water quality of the Buduran River is by Government Regulation No. 22 of 2021 for each segment. The following results are obtained:

a) The TSS parameter from point 1 to point 4 is considered to have met the class II water quality standard, namely 50 mg/L with successive concentrations of 1.8 mg/L, 6.3 mg/L, 5.4 mg/L, and 3.6 mg/L.
b) DO parameters from point 1 to point 4 fluctuated from point 1 to point 4 with concentrations of 1.06 mg/L, 4.45 mg/L, 2.77 mg/L, and 4.9 mg/L, respectively L
c) The BOD parameter from point 1 to point four is considered to exceed the class II water quality standard, which is 3mg/L with concentrations respectively 2.92 mg/L, 2.73 mg/L, 4.58 mg/L and 2.31 mg/L
d) The COD parameter from point 1 to point 4 is considered not to exceed the class II water quality standard, which is 25 mg/L with concentrations successively from point 1 to point 4, namely 9.85 mg/L.
e) The Nitrate parameter from point 1 to point 4 is considered not to exceed the class II water quality standard, which is 10 mg/L with concentrations respectively 0.34 mg/L, 0.13 mg/L, 0.42 mg/L and 0.09 mg/L
f) Phosphate Parameters from point 1 to point 4 are considered to exceed the class II water quality standard, which is 0.2 mg/L with concentrations respectively 3.72 mg/L, 3.86 mg/L L, 4 mg/L and 5.56 mg/L.

5. REFERENCES

Camargo, R. de A., Calijuri, M. L., Santiago, A. da F., Couto, E. de A. de, & Silva, M. D. F. M. e. (2010). Water quality prediction using the QUAL2Kw model in a small karstic watershed in Brazil. Acta Limnologica Brasiliensia, 22(4). https://doi.org/10.4322/actalb.2011.012

Chapra, S., & Pelletier, G. (2008). A Modeling

Framework for Simulating River and Stream Water Quality. Documentation and User Manual.

Cho, J. H., & Ha, S. R. (2010). Parameter optimization of the QUAL2K model for a multiple-reach river using an influence coefficient algorithm. Science of the Total Environment. https://doi.org/10.1016/j.scitotenv.2010.01.025

Dewa, C., Susanawati, L. D., & Widiatmono, B. R. (2016). Daya Tampung Sungai Gede Akibat Pencemaran Limbah Cair Industri Tepung Singkong di Kecamatan Ngadiluwih Kabupaten Kediri. Jurnal Sumberdaya Alam Dan Lingkungan, 2(1), 35–43

Ismail, Z. (2011). Monitoring trends of nitrate, chloride and phosphate levels in an urban river. International Journal of Water Resources and Environmental Engineering, 3(7), 132–138.

Poniman, L. (2021). PEMANFAATAN ARANG SEKAM PADI DAN KULIT PISANG KEPOK SEBAGAI ADSORBEN UNTUK MENURUNKAN COD (Chemical Oxygen Demand) DAN BOD (Biological Oxygen Demand) PADA AIR SUNGAI ENIM. Jurnal Redoks, 6(2), 92–99.

Rao, E. V. S. P., Puttanna, K., Sooryanarayana, K. R., Biswas, A. K., & Arunkumar, J. S. (2017). Assessment of nitrate threat to water quality in India. In The Indian nitrogen assessment (pp. 323–333). Elsevier.

Rusnugroho, A., & Masduqi, A. (2012). Aplikasi QUAL2Kw sebagai Alat Bantu Perhitungan Daya Tampung Beban Pencemaran Kali Madiun (Segmen Kota Madiun). SCIENTIFIC CONFERENCE OF ENVIRONMENTAL TECHNOLOGY.

Sa'adah, N. R., & Winarti, P. (2009). Pengolahan limbah cair domestik menggunakan lumpur aktif proses anaerob. Jurusan Teknik Kimia Fakultas Teknik Universitas Diponegoro Semarang.

Tanjung, R. H. R., Maury, H. K., & Suwito, S. (2018). Pemantauan Kualitas Air Sungai Digoel, Distrik Jair, Kabupaten Boven Digoel, Papua. JURNALBIOLOGI PAPUA, 8(1). https://doi.org/10.31957/jbp.43

Vandra, B., Sudarno, & Nugraha, W. D. (2016). Studi analisis kemampuan self purification pada sungai progo ditinjau dari parameter biological oxigen demand (BOD) dan dissolved oxigen (DO). Jurnal Teknik Lingkungan, 5(4).

Yogiarti, N., Setiawan, D., & Parthasutema, I. A. M. (2014). Analisis Kadar Fosfat Air Sungai di Desa Beng. Gianyar dengan Metode Spektofotometri Uv-Vis. J. Chemistry Laboratory, 1(2).

Yohannes, B. Y., Utomo, S. W., & Agustina, H. (2019). Kajian Kualitas Air Sungai dan Upaya Pengendalian Pencemaran Air. IJEEM - Indonesian Journal of Environmental Education and Management, 4(2). https://doi.org/10.21009/ijeem.042.05