



ASSESSMENT OF WATER QUALITY PARAMETERS IN A RIVERS USING QUAL2KW: A STUDY IN BANGKALAN RIVER

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ABSTRACT:

Increased human activity, shifts in land use and the increasingly diverse lifestyles of people in Bangkalan City have resulted in an increase in domestic waste and made the pollutant load in the Bangkalan River even greater over time. The Bangkalan River segmentation from the Tunjung Dam to the Bancaran River has indicated that the quality of river water has decreased. The purpose of this study was to determine the pollution level of the Bangkalan River, the condition of the Bangkalan River's water quality, and to obtain recommendations for treatment strategies for river water quality management in the future. This research approach uses descriptive, quantitative, and qualitative. The method used is calculating the Pollutant Index and Water Quality Index, simulates parameters in a scenario using QUAL2Kw modeling. In the results of this study it is known that the pollution level of the Bangkalan River is categorized as lightly polluted and the quality of the Bangkalan River is categorized as moderate. The results of the river water quality test in the simulation scenario with QUAL2Kw show that the water quality of the Bangkalan River is classified as class II water quality and is classified as medium water quality in the segment of the Tunjung Dam to the Bancaran River.

Keywords: strategy, water quality, QUAL2Kw, Bangkalan River

INTRODUCTION

The Bangkalan City River is one of the components of the hydrological cycle, along with springs and reservoirs (Rahmatullah et al., 2020). The Bangkalan City River stretches for approximately 12 km from the Pocong spring, passing through densely populated settlements, trade areas, industrial zones, and office areas, before flowing into the Madura Strait.

One of the functions of the rivers in Bangkalan City is to serve as a disposal channel for household waste, restaurants, and home industries. The waste generated by various activities of the community and industries in the Bangkalan City River watershed has the potential to increase river pollution and decrease water quality. The water quality of the Bangkalan City River does not meet Class II criteria for parameters such as COD, TSS, pH, fecal coliform, and detergents. Efforts to manage the water quality of the river can be carried out by determining the pollution load capacity of the Bangkalan River, with river segmentation starting from the Tunjung Dam in Tunjung Village, Burneh Sub-district, and ending at the Bancaran River segment in Bangkalan Sub-district. The determination of these segments is based on the direction of the Bangkalan river's flow, and there has been no previous study specifically focusing on these river segments.

According to (Oktarizal et al., 2022), if water pollution is left unaddressed, the environmental carrying capacity will decrease, and the water quality of the

Bangkalan River will worsen in the future. The seriousness of the Bangkalan city government in addressing environmental pollution, especially river pollution in Bangkalan, is hindered by several factors, including the lack of public awareness about waste disposal, the lack of wastewater treatment facilities in small to medium-sized industries, and the time required to achieve proper sanitation. Modeling can be defined as a logical representation of how a system functions or how its components interact (Albert & Thakar, 2014). In developing strategies for managing the water quality of the Bangkalan River, modeling using the QUAL2KW software is employed as a tool to simulate water quality in the river. The purpose of modeling a system is to facilitate analysis and understanding of the system's behavior (Ekoanindiyo, 2011). QUAL2KW modeling is a one-dimensional, steady-state flow modeling approach that is compatible with Windows operating systems (Parveen & Singh, 2016). Qual2Kw is able to simulate water quality parameters including temperature, conductivity, inorganic solids, dissolved oxygen, CBODslow, CBODfast, organic nitrogen, ammonia, nitrite, nitrate, organic phosphorus, inorganic phosphorus, pathogens, alkalinity, pH (Maghfiroh, 2016) (Ranjith et al., 2019). One advantage of QUAL2KW modeling is its ability to simulate both point source and non-point source pollution for various water quality parameters.

This QUAL2Kw modeling can also present a river path based on the impact of

two sources, namely those from point sources and non-point sources (Pambudi et al., 2022). The advantages of using the Qual2Kw application include Qual2Kw can simulate a shallow river (Kori et al., 2013), Qual2Kw can simulate a river with multiple branches in or out (Giraldo Buitrago et al., n.d.) and Qual2Kw can be calibrated automatically (Pelletier et al., 2006).

RESEARCH METHODS

The research aims to model the water quality of the Bangkalan River. The study begins with direct observations and identification of pollution sources, including both point sources and non-point sources. After these initial stages, specific river sections or segments for investigation are determined (Di Luzio et al., 2004). The study location is in Bangkalan Regency, East Java Province. The selected river section has a length of 4.7 kilometers, starting from the segmentation of the Tunjung River Dam to the lower reaches of the Bancaran River for the end of the segmentation. This river section is divided into four segments based on population and industrial density, and there are 10 sampling points along the river to represent point source and non-point source pollution categories.

The parameters used in the study include temperature, pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS). After collecting the Bankalan River data, data analysis was carried out with a modeling system using Qual2Kw software

version 5.1 to model and simulate scenarios per parameter study in testing.

RESULTS AND DISCUSSION

Identification of Existing Conditions of Bangkalan River Water Quality

The Bangkalan River has different characteristics and water quality. This is due to environmental conditions around the river which can affect the characteristics or quality of the water. Water sampling at each point and stored in a cooling box. The results of water sampling were immediately brought to the laboratory for testing according to the parameters. Temperature and pH parameters were carried out directly at the sampling location. The results of testing Bangkalan River water samples based on segmentation show that the water quality of the Bangkalan River is

classified as a class II river and even reaches class III at some points. The results of the sample water test are shown in Table 1.

Table 1

Bangkalan River Water Sampling Results

Sampling Point	BOD	COD	pH	Temperature	TSS
Point 1 (river)	2,4	4,68	7,1	27,3	10
Point Source 1	33,7	48,55	7,3	28,5	83
Point Source 2	21,3	51,08	6,8	29,1	95
Point 2 (river)	3,1	7,23	7,4	27,4	26
Point Source 3	11,4	24,83	7,4	28,7	74
Point 3 (river)	3,6	9,57	7,1	27,5	25
Point Source 4	23,1	39,72	7,1	29,0	52
Point 4 (river)	3,6	8,30	7,2	27,3	15
Point Source 5	13,6	26,80	7,2	28,2	69
Point 5 (river)	7,2	9,79	7,1	27,7	28
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KELAS II	3	25	6 - 9	Dev 3	50
KELAS III	6	40	6 - 9	Dev 3	100

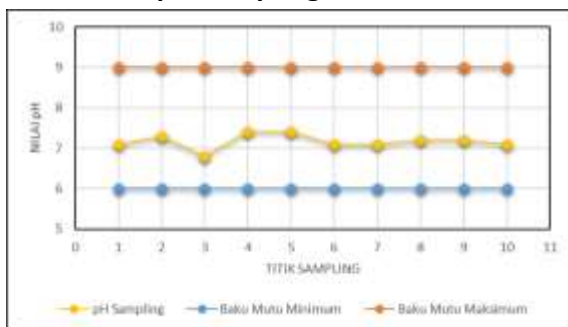
The primary data of the Bangkalan River is the result of laboratory sampling and analysis in 2023 which will be

compared with river water quality standards according to Government Regulation Number 22 of 2021 Appendix VI which has been stipulated by the government. The quality of the Bangkalan River in this segmentation belongs to class II water quality and is close to class III quality. This will have an impact on the river ecosystem in the Bangkalan River and will have a negative impact on the people around the riverbanks if they continuously use river water that is not fit for use by the community.

pH Value

The pH of water that is good or normal in accordance with Government Regulation Number 22 of 2021 Appendix VI for river bodies ranges from a pH value of 6 to pH 9, but it is better for pH parameters close to a neutral pH value or pH 7 which is the ideal condition for living things in rivers. The results of the pH sampling at the study sites are shown in Figure 1.

Figure 1
pH sampling results

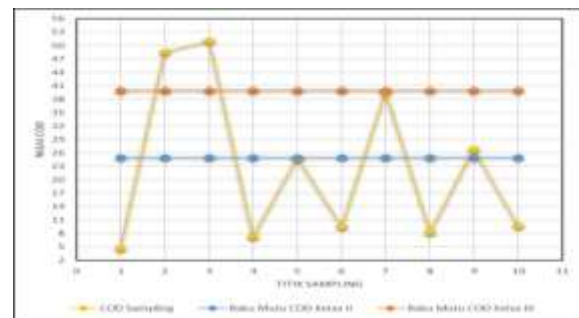


COD Concentration

The concentration of the COD parameter in water that is allowed or in accordance with Government Regulation Number 22 of 2021 Appendix VI in river

bodies ranges from a value of 25 for class II water quality to a value of 40 for class III water quality but it is best if the COD parameter is close to the class II water quality standard value or even below it which is ideal conditions for living things in the river. The results of COD sampling at the study sites are shown in Figure 2.

Figure 2
Concentration COD Sampling Results



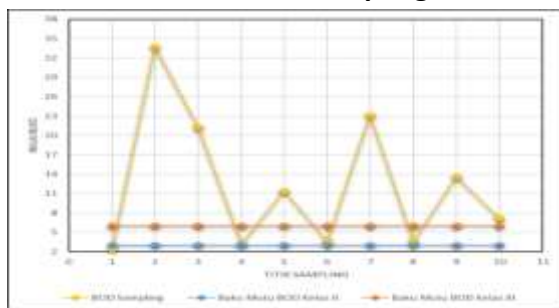
Based on Figure 2, the results of the Bangkalan River water quality sampling have a low COD concentration value at sampling point 1 in the Tunjung DAM with a value of 4.68 mg/L and belong to class II water quality standard, then at sampling points 2 to 5 it shows a COD concentration value of 7.23 until 9.79 mg/L. This shows that at the location of sampling points 1 to 5, the water quality of the Bangkalan River is classified as class II water quality standard for the COD parameter.

The sampling results at point sources 2 have the highest COD concentration value of 51.08 mg/L. The sampling results at point sources 1, 3, 4, and 5 have varying values between concentrations of 24.83 until 48.55 mg/L.

BOD Concentration

Permissible water BOD parameter concentrations or in accordance with Government Regulations Number 22 of 2021 Appendix VI in river bodies range from a value of 3 for class II water quality to a value of 6 for class III water quality but it is better for the BOD parameter to be close to class II quality standard values or even below, which is the ideal condition for living things in rivers. The results of the BOD sampling at the study sites are shown in Figure 3.

Figure 3
Concentration BOD Sampling Results



Based on Figure 3, the results of the Bangkalan River water quality sampling have a low BOD parameter value at sampling point 1 in the Tunjung DAM with a value of 2.4 mg/L and belonging to the class II water quality standard, while at sampling points 2 to 4 it shows BOD concentrations of 3.1 until 3.6 mg/L, and at sampling point 5 with a concentration value of 7.2 mg/L which indicates that at sampling points 2 to 4 it has exceeded the class II water quality standards, while at sampling point 5 it has exceeds the class III water quality standards.

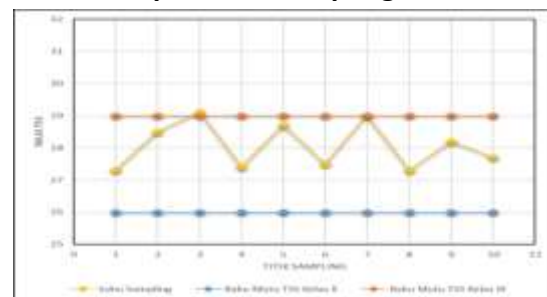
The sampling results at point sources 1 have the highest BOD

concentration value of 33.7 mg/L. The sampling results at point sources 2 to 5 varied between 11.4 - 23.1 mg/L. The increase in BOD concentrations in rivers is getting higher due to the large amount of waste containing organic matter dumped directly into good river bodies.

Temperature

Normal water temperature according to Government Regulation Number 22 of 2021 Appendix VI for river bodies is at deviation 3 but it is better for temperature parameters to be within the range of deviation 3 which is the ideal condition for living things in rivers. Sampling results The temperature of the research location is shown in Figure 4.

Figure 4
Temperature sampling results



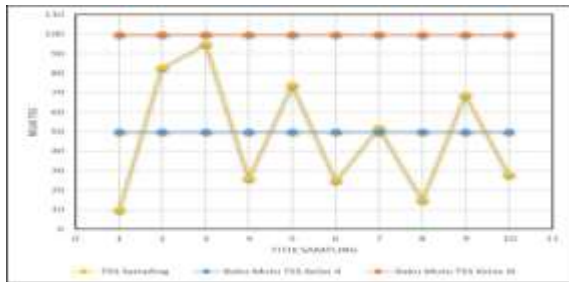
At point 2 point sources have the highest temperature value of 29.1°C. Sampling results on river water showed a value range of 27.3°C to 27.7°C which is still within the deviation limit of 3 in class II water quality standards.

TSS Concentration

The concentration of the permitted water TSS parameter or in accordance with Government Regulation Number 22 of 2021 Appendix VI in river bodies ranges from a value of 50 for class II water quality

to a value of 100 for class III water quality but it would be better for the TSS parameter to be closer to the class II quality standard value or even below it which is the ideal condition for living things in the river. The results of the TSS sampling at the study sites are shown in Figure 5.

Figure 5
Temperature sampling results



Based on Figure 5, the water quality sampling results for the Bangkalan River have a low TSS parameter value at sampling point 1 in the Tunjung DAM with a value of 10 mg/L and belonging to class II water quality standard, then at sampling points 2 to 5 it shows a COD value of 15 until 28 mg/L. This shows that at the location of sampling points 1 to 5, the quality of Bangkalan river water is classified as safe according to class II water quality standards for the TSS parameter.

The sampling results at point sources 2 have the highest TSS value of 95 mg/L which exceeds the class II water quality stone limit. TSS sampling results at point sources 1, 3, 4, and 5 have values varying between 52 until 83 mg/L. The concentration value of the TSS parameter affects the penetration rate of sunlight entering water bodies so that it can interfere with the activity of microorganisms

such as phytoplankton to carry out photosynthesis.

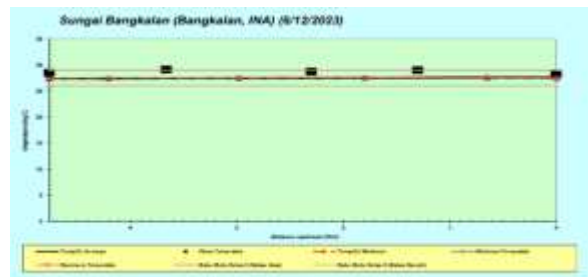
Simulation Scenario

Simulation scenario aims to create and calibrate existing data and water quality sampling data so that they can be used for other simulations (Daggupati et al., 2015). Simulation scenario is also used to obtain the river model coefficients. The input data used is the data used when establishing the model for the first time, namely data from river water quality sampling. Trial and error is carried out by testing the calibration model which aims to compare the model's prediction data with the observations (Tuan et al., 2007).

Simulation Scenario Parameters pH

The temperature simulation results from field observations have similarities with the simulation results at the sampling point shown in Figure 6.

Figure 6
Simulation pH



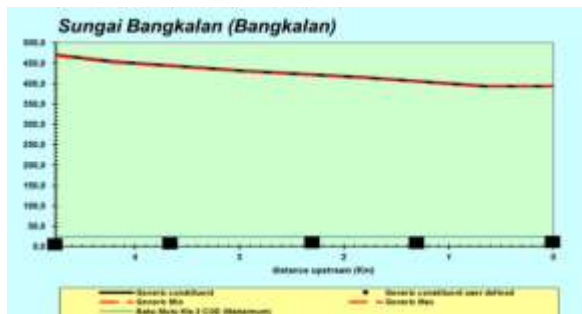
The results of the simulation comparison model with the data above show that the temperature parameter values in Bangkalan River water are in the value range 27.3°C – 27.7°C shown on the black line which is almost parallel to the black box (input data) with a value range of 28.2°C – 29.1°C, the red and black connected lines

above the black box are the maximum limits for class II and III water quality standards, namely deviation 3 in the temperature parameter.

Simulation Scenario Parameters COD

The COD value from field observations has similarities with the simulation results at the sampling point as shown in Figure 7.

Figure 7
Simulation COD



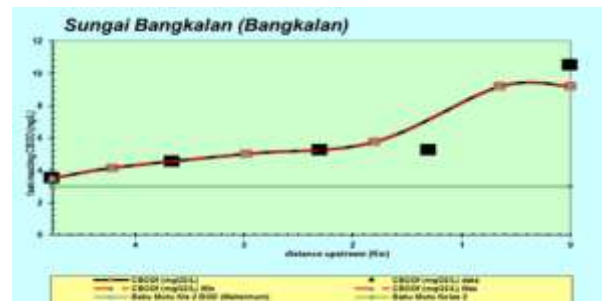
In Figure 7, there is a difference between the observed values and the Qual2Kw application simulation results at 5 sampling points. The COD parameter simulation results pass the class II river water quality standards. The results of field observations and simulation results have a value range of 4.68 mg/L – 51.08 mg/L. The river simulation results show a COD value of 470 mg/L in the upper reaches of the river and decreases further downstream with a value of 400 mg/L so that it is indicated that there is waste pollution with high COD parameters in unknown locations such as unidentified wastewater discharge routes.

Simulation Scenario Parameters BOD

In the BOD simulation, the results of field observations in scenario 1 have modeling results as shown in Figure 8.

Figure 8

Simulation BOD

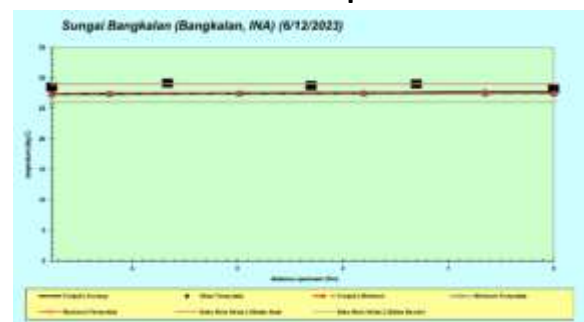


The simulation results in Figure 8 above show that the BOD parameter value in the Bangkalan River has increased the concentration of pollution at each sampling point. The simulation results show that the lowest BOD value is around 3.5 mg/L and there is an increase at sampling points 2 and 5 to 4.29 – 9.37 mg/L. The black box points (data) show a graphic flow shape that is almost the same as the red connecting line (river simulation).

Simulation Scenario Parameters Temperature

The temperature simulation results from field observations have similarities with the simulation results at the sampling point shown in Figure 9.

Figure 9
Simulation Temperature



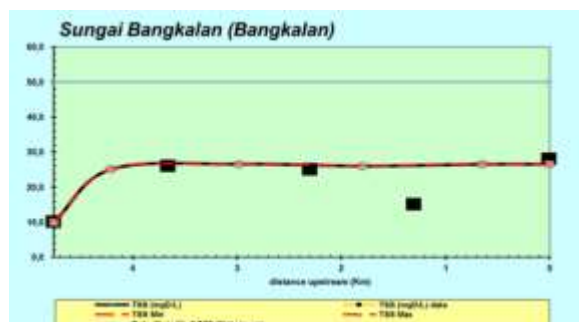
The results of the simulation comparison model with the data above show that the temperature parameter values in Bangkalan River water are in the value range

27.3°C – 27.7°C shown on the black line which is almost parallel to the black box (input data) with a value range of 28.2°C – 29.1°C, the red and black connected lines above the black box are the maximum limits for class II and III water quality standards, namely deviation 3 in the temperature parameter.

Simulation Scenario Parameters TSS

Pada simulasi TSS hasil observasi lapangan memiliki persamaan dengan hasil simulasi pada titik sampling seperti yang ditunjukkan pada Gambar 10.

Figure 10
Simulation TSS



In Figure 10, there is a similarity between the observed values and the Qual2Kw application simulation results at 5 sampling points. In the TSS simulation image the black point (data) has a value range of 10 - 26 mg/L which is almost the same as the black line (river simulation).

The QUAL2Kw simulation results have a fitness value < 1 , which means that the error value on the model is small or the model shows the suitability of the model with the existing data. The fitness value will increase in the model if the trend line (model) is getting closer to the input data (black box) (Hendrianti, 2015). The fitness

value is $0.6109 > 0.5$, which means that the model is reliable and can be continued in scenario simulations that will be applied next.

CONCLUSION

The results of the river water quality test in the simulation scenario with QUAL2Kw show that the water quality of the Bangkalan River is classified as class II water quality and is classified as medium water quality in the segmentation of the Tunjung Dam to the Bancaran River.

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