

Analysis of Marine Water Quality to Support Mangrove Conservation in Kayo Batu Village, Jayapura City

Gaviota Maturbongs¹, Hotnida Nainggolan², Sarah Rumawak³
Universitas Sains dan Teknologi Jayapura

E-mail : gaviotamaturbongs32@gmail.com

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ABSTRACT

The study purpose was to analyse marine water quality based on physico-chemical parameters such as pH, DO, TDS, DHL, salinity, and temperature, and assess its role in supporting mangrove conservation.

Materials and methods. A quantitative approach was used by measuring water quality at eight sampling points during morning and afternoon sessions, combined with a questionnaire distributed to 88 respondents to capture community perceptions of environmental changes.

Results. The results indicate that marine water quality in Kayo Batu Village is classified as lightly polluted but remains within the permissible threshold according to the Minister of Environment Decree No. 51 of 2004. Some parameters, such as DO and pH, slightly exceed the optimal range for healthy mangrove ecosystems. Community perceptions reveal concerns about declining water quality due to poor sanitation and domestic pollution. Therefore, a mangrove conservation strategy based on adaptive and participatory approaches is necessary, particularly through the control of pollution sources, environmental education, and improved sanitation infrastructure.

Conclusions. The findings of this study are expected to serve as a scientific basis for policy formulation to sustainably preserve the coastal ecosystem.

Keywords: Mangrove, conservation, marine water quality, sustainability, coastal ecosystem.

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INTRODUCTION

Indonesia is the largest archipelago in the world with the second longest coastline after Canada (Yoswaty et al., 2024). Indonesia's coastal areas are vast and have tremendous natural resource potential, including mangrove ecosystems, coral reefs, and seagrass beds. Mangrove ecosystems in particular have a strategic role, both ecologically, economically, and socially. Ecologically because it serves as a shoreline protector from abrasion, stabilises the mud substrate, becomes a place of life and breeding for various marine life (nursery, spawning, and feeding ground), and an effective blue carbon store in mitigating climate change (Luo et al., 2024). From an economic perspective, mangrove forests support the livelihoods of coastal communities through the fisheries sector, nature tourism, and the provision of local raw materials (Hilmi et al., 2017).

Kayo Batu Village, located in North Jayapura District, Jayapura City, Papua, is one of the coastal areas that has extensive mangrove cover. The uniqueness of this village lies in its geographical condition, where the houses stand on the sea (floating village) and are directly adjacent to the mangrove forest area. Besides having ecological value, this area also has great potential in the development of marine tourism and community-based local economy. However, population activities that are not supported by an adequate sanitation system, as well as increasing domestic waste into the waters, cause a decrease in marine water quality that has the potential to disrupt the sustainability of mangroves.

The government and community have made efforts to rehabilitate mangroves through planting, but they have failed to grow. This is thought to be due to marine water quality that does not support optimal mangrove growth (Amalo et al., 2025). Therefore, it is important to conduct a scientific study to determine the extent of marine water quality conditions in the area, as well as how it impacts mangrove conservation.

METHOD

The research was conducted in Kayo Batu Village, North Jayapura District, Jayapura City, Papua Province. Using a descriptive quantitative approach (Yoswaty et al., 2024) (Satheeshkumar & Khan, 2012), this study aims to measure and describe marine water quality based on physico-chemical parameters and examine its relationship with mangrove conservation in Kayo Batu Village, North Jayapura District, Jayapura City.

1. Water Quality Analysis

The measurement data of physico-chemical parameters were compared with the Marine water Quality Standard for marine biota (KepmenLH, 2004) based on:

- Decree of the Minister of the Environment No. 51 of 2004 concerning Marine water Quality Standards for marine biota.
- Environment Ministerial Regulation No. 27 of 2021 and Government Regulation No.22 of 2021 for Pollution Index analysis.

The analysis was carried out by calculating the Pollution Index (IP) value using the formula:

$$IP_j = \sqrt{\frac{(C_i / L_{ij})^2_M + (C_i / L_{ij})^2_R}{2}}$$

Description:

- IP = Pollution Index
- C_i and C_j = measured parameter concentration values
- S_i and S_j = parameter quality standard values

Pollution Index Category:

- $IP \leq 1.0$: Not polluted
- $1.0 < IP \leq 5.0$: Lightly polluted
- $5.0 < IP \leq 10.0$: Moderately polluted
- $IP > 10.0$: Heavily polluted

2. Community Perception Data Analysis

Questionnaire data were processed by descriptive statistics (mean, mode, frequency) to determine the level of understanding and concern of the community towards the quality of the aquatic environment and mangrove conservation efforts.

3. Development of Conservation Strategies

Mangrove conservation strategies were developed based on the results of water quality analyses and community perceptions. The strategy development process refers to the principles of:

- Adaptive: in accordance with local ecosystem conditions
- Participatory: actively involving the community

FINDING AND DISCUSSION

1. Marine Water Quality Pollution Index

Measurement results using water quality pollutant parameters namely: Temperature, TDS, pH, DO, Salinity and DHL. These parameters are then compared with Government Regulation Number 22 of 2021 Appendix VIII concerning Sea Water Quality Standards to determine the quality of river water based on the Pollution Index method. The results of the Pollution Index analysis can be seen in **Figure 1**.

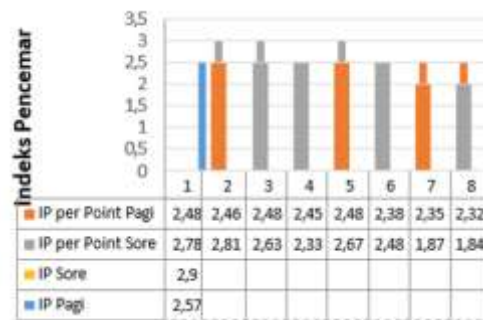


Figure 1. Diagram of the results of the seawater pollution index analysis in kayo batu village

Marine water quality parameters as an effort to conserve mangroves in Kayo Batu Village were obtained based on field measurements and through community perceptions using a questionnaire instrument with a Likert scale. From the data obtained, there are five parameters of seawater quality, namely: turbidity, unpleasant odour, seawater colour, domestic waste, and vegetation condition. The results of data processing can be seen in **Figure 2**.

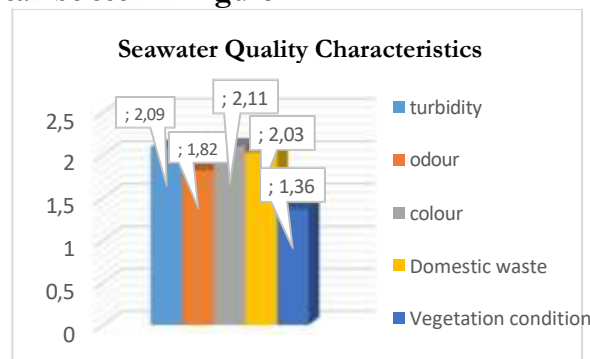


Figure 2. Seawater Quality Characteristics

Based on the results of the analysis, there are four main factors that influence changes in seawater quality in Kayo Batu Village, namely: sanitation infrastructure, sea transportation and port activities, socio-economics and government policies. as shown in Figures 3 to 6.



Figure 3. Sanitation Infrastructure factors

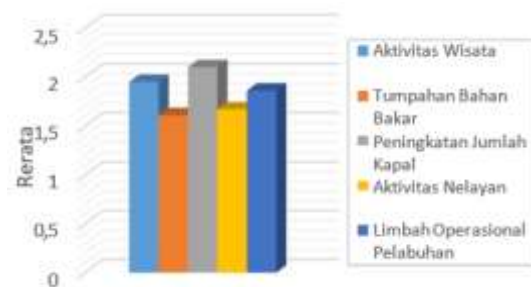


Figure 4. Sea transportation and port activities factors

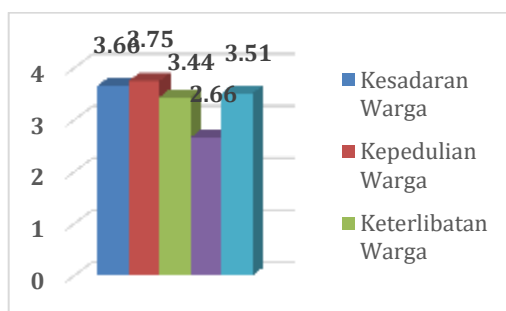


Figure 5. Socio-economics factors

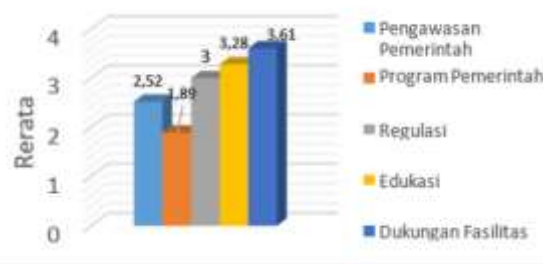


Figure 6. Government policies factors

2. Statistical Test

Multiple Linear Regression Test is used to determine the effect of sanitary infrastructure factors, marine transportation activities, social & economic and government policies on sea water quality in Kayo Batu village (Figure 7).

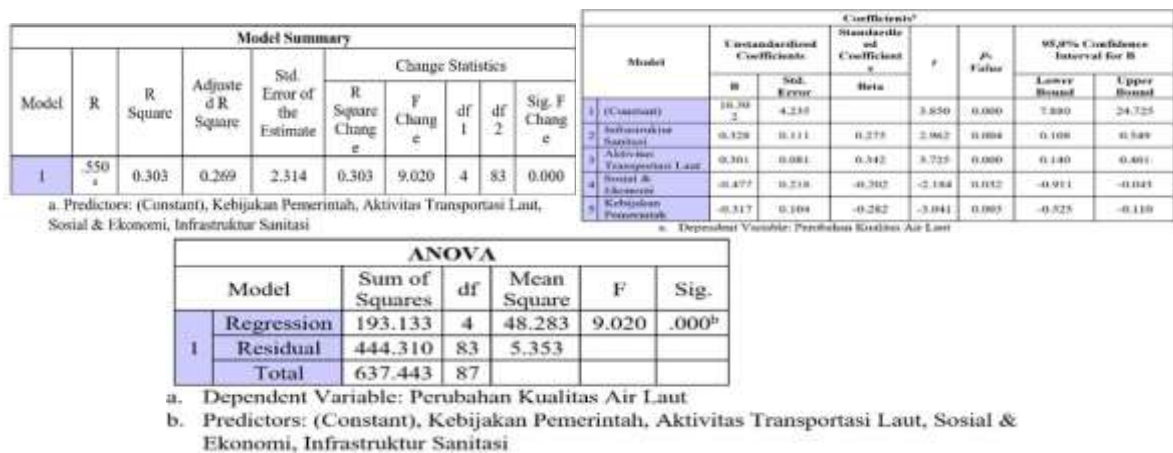


Figure 7. Multiple Linear Regression Test Results

From the output Analysis of the Coefficient of Determination, it is known that the Adjusted R Square value is 0.27, it concludes that the contribution of the influence of the independent variable on the dependent variable simultaneously is 27%. Based on the F Test Output Analysis (simultaneous), it is known that the results of the F test (Simultaneous) show the Sig level. 0.000 < 0.05, it concludes that there is a Significant Influence of the Independent Variables of Sanitation Infrastructure, Sea Transportation Activities, Social & Economic and Government Policy on the dependent variable of Sea Water Quality simultaneously.

Sanitary Infrastructure Factor with P- value 0.004 < 0.05 means Significant or there is an influence between the Sanitary Infrastructure variable on changes in seawater quality to support mangrove conservation. Marine Transportation Activity Factor with P- value 0.000 < 0.05 means significant or there is an influence of the marine transportation activity factor on changes in seawater quality to support mangrove conservation. Social and Economic Factors with P- value 0.032 < 0.05 means Significant or there is a significant influence between Social & Economic Factors on changes in sea water quality to support Mangrove Conservation. Government Policy Factor with P- Value 0.003 < 0.05 means significant or there is an influence between government policy variables on changes in seawater quality to support mangrove conservation.

The Regression Equation is obtained:

$$16,302 + 0,328x_1 + 0,301x_2 - 0,477 x_3 - 0,317 x_4$$

Based on the regression equation can be explained as follows:

- The constant value obtained is 16.302, it means that if the independent variable is worth 0 (constant) then the dependent variable Seawater Quality is worth 16.302.
- The coefficient value of variable x1 (Sanitary Infrastructure Factor) is 0.275, it means that any increase in variable x1 (Sanitary Infrastructure Factor) will increase variable Y (Seawater Quality).
- The coefficient value of variable x2 (Sea Transportation Activity) has a value of 0.342 which means that if the variable x2 (Sea Transportation Activity) will also increase.
- The coefficient value of variable x3 (Social & Economic) has a value of -0.202 which means that if variable x3 (Social & Economic) increases, variable Y (Sea Water Quality) decreases.
- The coefficient value of variable x4 (Government Policy Factor) is -0.282, which means that if variable x4 (Government Policy Factor) increases, variable Y (Seawater Quality) decreases.

Statistical Significance

t test: for each independent variable.

Sanitary Infrastructure Factor ($p < 0.05$), Marine Transportation Activity Factor ($p < 0.05$) significant, Social & Economic Factor ($p < 0.05$) significant and Government Policy Factor ($p < 0.05$) significant effect on Sea Water Quality in Kayo Batu Village.

F test: The significance of $F = 0.000$ was obtained, where $p < 0.05$ so that overall or together the factors of sanitation infrastructure, marine transport activities, social & economic and government policies have a significant effect on seawater quality in Kayo Batu village.

3. The Mangrove Conservation Strategy, includes:

1) **Mangrove rehabilitation in the clean water zone.** Mangrove planting is carried out in stages, starting from zones that based on measurements of water quality are closest to ideal or relatively good conditions. This is so that successful rehabilitation of planting seedlings has a greater chance of survival. Other locations are handled after water quality improvements are made. 2) **Monitoring sources of seawater pollution.** This effort is carried out by directly involving the community through a simple and affordable approach. This control can be done through: (a) installation of rubbish nets is useful for filtering, holding or blocking plastic and inorganic waste from being carried into mangrove areas; (b) implementation of floating toilet with septic drum system; socialisation to reduce the use of detergents and household chemicals that are harmful to coastal ecosystems; (c) rehabilitation of drainage channels and prevention of sedimentation, to reduce runoff of polluting materials that contribute to water turbidity. 3) **Integration of Conservation with Aquatic Ecosystem Improvement,** 4) **Education and Community Participation,** and 5) **Policy Strengthening and Collaboration.**

CONCLUSIONS

Based on the measurement of physical and chemical parameters of seawater (pH, DO, TDS, Salinity, DHL, and Temperature), in general, the quality of seawater in Kayo Batu Village is still within the quality standard limits set by the Decree of the Minister of Environment No. 51 of 2004. However, pH values at several points showed numbers above the normal threshold, which could be an early indication of changes in the coastal environment.

Sustainable mangrove conservation requires a holistic approach through education and community involvement in maintaining environmental sanitation. It is also recommended to strengthen regulation and supervision of domestic waste and shipping activities and revitalise mangrove rehabilitation programmes based on coastal environmental quality.

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