

THE EFFECT OF MOTORED HOUSES ON COLIFORM POLLUTION IN MARINE WATERS AND ITS IMPACT ON PUBLIC HEALTH, JAYAPURA CITY

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ABSTRACT

The Effect of Motored Houses on Coliform Pollution in Marine Waters and Its Impact on Public Health, Jayapura City. An anchored house, which stands above seawater, is common in North Jayapura and South Jayapura. Wooden foundations support these houses. People frequently contract waterborne diseases when they use or consume water that is contaminated with pathogenic bacteria, such as coliform bacteria from human feces. In these areas, high levels of coliform bacteria can have an impact on water quality and public health. This study looks into how anchored houses affect total coliform contamination, the number of cases of waterborne disease (WBD), and the link between demographic factors, water quality, and WBD cases. We use the Most Probable Number (MPN) method to detect total coliform bacteria in marine waters. It consists of an initial test using LBS and LBD media for prediction, followed by a second test using Brilliant Green Lactose Bile Broth (BGLBB) media for confirmation. We also use observation and interview methods to identify WBD cases in anchored housing in North Jayapura and South Jayapura districts. North Jayapura has the highest coliform bacteria contamination in marine waters, with an average of 25.7 MPN/100 mL. Similarly, the highest contamination in clean water is in North Jayapura, averaging around 347.6 MPN/100 mL. The demographic characteristics in both districts are mostly men aged 18–65 years with high school education and occupations such as housewives and fishermen. The South Jayapura sub-district has the highest incidence of WBD. Anchored houses have no significant effect on water quality or the incidence of WBD, and there is no correlation between water quality and WBD incidence.

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INTRODUCTION

An anchored house, or floating house, is a house that is typically found above sea and lake waters. Houses anchored in the sea waters of Jayapura City are usually found in South Jayapura District and North Jayapura District. An anchored house is a house made of wood with a foundation embedded in the seabed and built like a house in general. In one anchored house, there are more than two families, with one latrine in each house ⁽³⁾. According to BPS Jayapura City (2021), communities around South and North Jayapura's sea waters already have their own latrines or toilets. Generally, anchored houses use a type of plunge latrine that has final disposal directly into sea waters.

The Government Regulation of the Republic of Indonesia Number 66 of 2014 concerning Environmental Health, Article 31, defines environmental sanitation as an environmental health unit that includes housing conditions, waste disposal or healthy latrines, the provision of clean water, waste management facilities, and more. A latrine is basic sanitation that every household must have in good condition, with the condition that it must have a gooseneck and a septic tank ⁽⁹⁾, whereas the average anchored house has a plunge latrine, thus indicating that the anchored house's latrine is not included in good latrine condition.

Water-borne diseases are the transmission of diseases caused by the use of water contaminated with bacteria. Bacteria found in water can be caused by human activities that throw feces directly into water bodies. Transmission of disease through contaminated water can be caused by human activities such as washing eating utensils, bathing, and washing hands before eating. According to research conducted by Augustina et al. (2018), 11 respondents were affected by diarrheal disease (WBD) due to contaminated water quality. Respondents used water to brush their teeth, wash their hands before eating, and make ice cubes ⁽¹⁾. According to BPS data from Jayapura City in 2021, diarrhea is one of the complaints of health problems suffered by the people of Jayapura City; the biggest complaint is 8.93% of the male population and 7.90% of the female population.

Therefore, this research was carried out to determine demographic characteristics, water quality, the influence of anchored houses on water quality, and the incidence of waterborne disease in North Jayapura and South Jayapura Districts in Jayapura City.

MATERIALS AND RESEARCH METHODS

This qualitative descriptive study was conducted by observing and interviewing people who live in anchored houses to determine the relationship between demographic characteristics, cases of waterborne disease (WBD), and water quality in North Jayapura district. The data on demographic characteristics, water quality characteristics, and incidence of waterborne disease (WBD) are presented in tabular form and analyzed based on Minister of Environment Decree No. 51 of 2004 and Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017 concerning Environmental Health Quality Standards and Water Health Requirements for Sanitation Hygiene Purposes ⁽¹⁰⁾. This research was carried out in anchored house settlements in North Jayapura and South Jayapura Districts in April–May 2022. Data collection was conducted primarily through questionnaires and interviews with 195 respondents in the South Jayapura area and 319 respondents in the North Jayapura region. We used the Slovin formula to determine the sample size for data collection through questionnaires and interviews. Water quality data was collected directly at each sampling point, and MPN and nitrate tests were carried out at the Papua Province Regional Health Laboratory. There are two types of water sampling: clean water and sea water.

RESULTS OF RESEARCH AND DISCUSSION

Demographic Characteristics

Table 1. Demographic Characteristics of the Community of South Jayapura and North Jayapura Districts

Variable	Category	North Jayapura District Number of respondents	Percentage	South Jayapura District Number of respondents	Percentage
Gender	Woman	149	46.7%	77	35.86%
	Man	170	53.3%	118	64.14%
Age	Number of samples	319	100%	195	100%
	0 - 17	3	0.9%	3	1.53%
	18 - 65	298	93.4%	116	59.49%
	66 - 79	16	5.1%	72	36.93%
	80 - 99	2	0.6%	4	2.05%
	Number of samples	319	100%	195	100%
	No school	13	4.1%	11	5.64 %
Education	elementary school	64	20.1%	35	17.95 %
	JUNIOR SCHOOL HIGH	77	24.1%	44	22.56 %
	SENIOR SCHOOL HIGH	142	44.5%	91	46.67 %
	S1, S2	23	7.2%	14	7.17 %
	Number of samples	319	100%	195	100%
	Doesn't work	35	11%	22	11.28 %
	Fisherman	91	28.5%	51	26.15 %
Work	IRT	126	39.5%	57	29.23 %
	Private	45	14.1%	49	25.12 %
	Civil servants	22	6.9%	15	7.69 %
	Number of samples	319	100%	195	100%

Based on the results of demographic characteristics in the North Jayapura and South Jayapura sub-districts, it is known that there are no significant differences in variables in demographic characteristics. In both sub-districts, men dominate the gender variable, with 53.3% of respondents from North Jayapura and 64.14% from South Jayapura. This could be caused by the large number of respondents in the two sub-districts who work as fishermen: 28.5% of respondents from North Jayapura and 26.15% of respondents from South Jayapura. Apart from that, there are many respondents who work as housewives in both sub-districts, namely 39.5% of respondents from North Jayapura and 29.23% of respondents from South Jayapura. The respondent age variable is dominated by respondents aged 18–65 years in both sub-districts, ranging from 93.4% of respondents in the North Jayapura sub-district to 59.49% in the South Jayapura sub-district. The education variable is dominated by respondents who have completed high school education, namely 44.5% in North Jayapura sub-district and 46.67% in South Jayapura sub-district.

In this study, the age and gender of respondents were dominated by those aged 18–65 years and by male respondents. Among respondents who were predominantly aged 18–65 years, there were not many diarrheal diseases in the two sub-districts. According to observations and interviews, the percentage of respondents aged 18–65 years is higher because respondents in North Jayapura and South Jayapura have started families at a young age and have their own anchored houses. According to WHO (2017), diarrhea can attack all age groups, but toddlers (1-4 years) are the age group most affected by diarrheal diseases. Based on the results of observations and interviews, people living in anchored house settlements work as fishermen, leading to a predominance of male respondents.

In this study, people in both sub-districts had on average, a high school education. This means that people in both sub-districts understand well how to maintain environmental sanitation and cleanliness. However, the results of observations and interviews show that the community has poor basic sanitation because they still like to throw rubbish at random and have pit latrines, which can pollute the marine environment. This aligns with the table above, revealing a high percentage of respondents with elementary, middle, or no formal education, a sign of poor behavior. Higher education makes it easier for people to accept information and have good knowledge about maintaining environmental cleanliness and health ⁽⁹⁾.

There are several factors that influence people to live a clean and healthy lifestyle and have awareness of maintaining environmental sanitation, namely employment and income ⁽¹¹⁾. Based on the results of interviews and observations, the majority of people in both sub-districts work as fishermen, a profession that typically generates a low income. This causes people to choose not to use good and healthy latrines because the cost of making a good latrine requires a large amount of money. Respondents in anchored houses are dominated by fishermen because anchored houses are generally built by people who work as fishermen, so the percentage of respondents who work as fishermen is higher.

Sea Water Quality Characteristics

Table 2. Sea Water Quality in South Jayapura and North Jayapura Districts

No	Parameter	Unit	Quality standards	North Jayapura District	South Jayapura District
				Range	
1.	Temperature	°C	Natural3(e)	30.4-32.2	30.3° - 32.6
2.	PH	-	-	7.45-8.20	7.00 - 8.31
3.	Dissolved Oxygen (DO)	Mg/L	>5	7.11-7.90	6.72 - 7.90
4.	Nitrate (NO3-N)	Mg/L	0.008	4.50-6.00	2.00 - 4.50
5.	Salinity	%	Natural3(e)	11.41-12.60	11.46 - 12.33
6.	Total coliforms	MPN/100ml	1000	2-99	0-53

According to the seawater quality characteristics, there were no significant differences between the two sub-districts tested. The amounts are relatively similar to the results of parameters tested in situ, such as temperature, pH, DO, and salinity. The temperature in North Jayapura district ranges between 30.4 and 32.2, and the temperature in South Jayapura ranges between 30.3° and 32.6°. The pH range of water in the North Jayapura subdistrict is between 7.45 and 8.20, and in the South Jayapura subdistrict, between 7.00 and 8.31. Dissolved oxygen (DO) levels in North Jayapura range from 7.11–7.90 mg/l, and in South Jayapura, they range from 6.72–7.90 mg/l. This value aligns with the quality standard, which is greater than 5 mg/l.

Nitrate (NO3-N) levels in North Jayapura sub-district ranged from 4.50-6.00 mg/l and in South Jayapura ranged from 2.00-4.50 mg/l. Nitrate levels in both sub-districts are above the quality standard value of 0.008 mg/l. Salinity in the North Jayapura sub-district is around 11.41–12.60% and in the South Jayapura sub-district around 11.46–12.33%. The total results of coliform contamination in North Jayapura are around 2-99 MPN/100 ml, and in South Jayapura, around 0-53 MPN/100 ml. These results are still below the quality standard, namely 1000 MPN/100 ml.

The results of measuring seawater quality parameters for pH, DO, temperature, salinity, and coliform parameters are still below the quality standards, according to Minister of Environment Decree No. 51 of 2004. However, the nitrate parameter has a value that is above the quality standard. Nitrates can be found in waters for a variety of reasons, including plant decomposition, land waste disposal in the form of agricultural waste, and food waste thrown into the sea ⁽¹³⁾. This statement aligns with the circumstances of the residents in the two sub-districts, where nearly every household has plants growing on their terraces. According to interviews, people also often throw leftover food they consume into the sea on the grounds that it will be eaten by the fish under the sea.

Well Water Quality Characteristics

Table 3. Well Water Quality in South Jayapura and North Jayapura Districts

No	Parameter	Unit	Quality standard s	North Jayapura District	South Jayapura District Range
1	Temperature	°C	±30°C	29.1-33.4	27.3 - 32.2
2	PH	-	6-9	7.40-7.70	6.86 - 7.78
3	Dissolved Oxygen (DO)	Mg/L	≥6	7.30-7.68	6.33 - 7.56
4	Nitrate (NO ₃ -N)	Mg/L	10	1.30-1.90	0.90 - 3.90
5	Salinity	%	-	0.45-1.40	0.30 - 4.44
6.	Coliforms	MPN/100ml	1000	55-494	5 - 390

Clean water quality characteristics show no significant differences between the two sub-districts. The results of parameters tested in situ, such as temperature, pH, DO, and salinity, are relatively similar. The temperature of clean water in the North Jayapura sub-district ranges from 29.1 to 33.4, and in South Jayapura, it ranges from 27.3 to 32.2. The pH of well water in the North Jayapura sub-district is between 7.40 and 7.70, and in the South Jayapura sub-district, it is between 6.86 and 7.78. The levels of dissolved oxygen (DO) in the clean water in North Jayapura range from 7.30 to 7.68 mg/l, while in South Jayapura, they range from 6.33 to 7.56 mg/l, indicating that they meet the quality standards, which are defined as > 6 mg/L. Nitrate (NO₃-N) levels in clean water in North Jayapura district range from 1.30 to 1.90 mg/l, and in South Jayapura, they range from 0.90 to 3.90 mg/l. According to this value, the amount of nitrate in both sub-districts is below the quality standard value, which is 10. The total salinity of clean water in the North Jayapura sub-district is around 0.45–1.40 and in the South Jayapura sub-district, around 0.30–4.44. The results are above the quality standard threshold because the amount is greater than the quality standard, which is 0%, or there is no salinity in clean water. The total results of coliform contamination in North Jayapura are around 55–494 MPN/100 ml, and in South Jayapura, around 5–390 MPN/100 ml. These results are below the quality standard threshold of 1000 MPN/100 ml.

The measurements of well water quality parameters reveal that the parameters of temperature, pH, DO, and nitrate fall below the quality standards set by the Decree of the Minister of Environment No. 51 of 2004 and the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017 concerning Environmental Health Quality Standards ⁽⁶⁾ and Water Health Requirements for Sanitation Hygiene Purposes ⁽¹⁰⁾. The salinity and coliform parameters have values that are above the quality standards. High salinity in clean water can be caused by wells that are close to seawater. The brackish water category is a mixture of sea water and clean water if the salt content is more than 0.5% in the clean water ⁽⁵⁾. Well water in both sub-districts is included in the brackish water category because, based on salinity measurement results, it has a value of more than 0.5%. The coliform measurements indicate that the average value exceeds the quality standard. This is attributed to the well's proximity to residential homes on land and nearby ditches, which in turn contributes to the high levels of coliforms in the water. Hadijah's research indicates that settlements with non-watertight septic tanks and a distance of less than 10 meters influence the occurrence of coliform bacteria in well water ⁽⁴⁾.

The effect of anchored houses on water quality and the incidence of water borne disease (WBD)

Table 4. The effect of anchored houses on water quality and the incidence of WBD in North Jayapura and South Jayapura sub-districts

Variable	North Jayapura District	South Jayapura District
Number of respondents	319	195
Toilet	Eligible: 7.5% Not eligible: 92.5%	Eligible: 4.39 % Not eligible: 95.60%
Waste disposal facilities	Eligible: 48.2% Not eligible: 51.8%	12.08% is thrown away in landfill 20.87% burned 67.03% discarded at sea
Clean water	Using PDAM: 32.2%, PDAM & wells: 67.8%	Using PDAM: 87.7%, PDAM & wells: 1.53 %
Water quality	Seawater quality that meets the parameter requirements: temperature, pH, DO, salinity and coliforms and seawater quality that does not meet the parameter requirements: nitrate, namely 4.50-6.00 mg/l. Meanwhile, the quality of well water meets the parameter requirements: temperature, pH, do, nitrate and does not meet the parameter requirements: salinity, namely 0.45-1.40 o/oo and total coliform, namely 55-494 MPN/100ml.	Sea water quality that meets the parameter requirements: temperature, pH, DO, salinity and coliforms and sea water quality that does not meet the parameter requirements: nitrate, namely 2.83 – 4.50 mg/l. Meanwhile, the quality of well water meets the parameter requirements: temperature, pH, do, nitrate and does not meet the parameter requirements: salinity, namely 0.30-3.90 o/oo and total coliform, namely 5-390 MPN/100ml.
WBD incidence	diarrhea 26.4%, cough/cold 5.7%, fever/fever 2.03%, malaria 2.2%, itching 0.27%.	Diarrhea: 28.33%, Malaria: 48.66% and itching and fever 23.01%
Intervention	Jayapura city government: Communal Ipal Kotaku program Pertamina: Waste bank	There is no program yet from the Papuan Government to build IPALs. In several areas in South Jayapura, the waste will be taken by the village DKKP

According to the table above, the population variable in North Jayapura sub-district is 319 respondents, and in South Jayapura, it is 195 respondents. High residential density and clean water sources close to waste disposal sites or human and animal feces will affect water quality (2).

In both sub-districts, a high percentage of latrine ownership and waste collection facilities do not meet the required standards. People who do not have healthy latrines have a higher percentage of diarrheal diseases than people who have healthy latrines (12). People in the North Jayapura sub-district who use clean PDAM water and wells have a higher percentage, 67.8%, compared to those who use clean PDAM water alone, 32.2%. However, in contrast, the community in South Jayapura sub-district that only uses PDAM water has a high percentage, namely 87.7%, compared to the community that uses clean PDAM and well water, namely 1.53%. According to observations and interviews with people in North Jayapura, PDAM water only flows at certain times or once a week. This is what causes people to use well water as a source of clean water. In the South Jayapura area, PDAM water still flows two to three times a week, so people use it more as a source of clean water. Waste disposal facilities in both sub-districts show that many people throw rubbish carelessly into the sea or without prior processing. According to observations and interviews, the community said that the location of the TPS, which was far from residential areas of anchored houses, meant that people preferred to throw their rubbish directly into the sea. Careless disposal of rubbish will pollute the aquatic environment and invite disease vectors carried by insects (8), which will affect human health. In accordance with the results of this study, respondents not only had diarrhea, but some of them also had malaria.

The sea water quality in both marine water sub-districts is either below the quality standard or meets the requirements in terms of temperature, pH, DO, salinity, and total coliform parameters. However, the nitrate parameter exceeds the quality standard, and the parameter measurements in well water fall short of the requirements, particularly in terms of coliform bacteria and salinity parameters. Based on the results of the table above, the variable number of respondents in North Jayapura is higher than respondents in South Jayapura, so if we look

at the water quality, the level of coliform contamination in North Jayapura is much higher than the water quality in South Jayapura, but the total coliform contamination in sea waters in both sub-districts is still below quality standards. Both sub-districts have an incidence of water-borne disease (WBD). The highest type of WBD is diarrheal disease, with the highest percentage of diarrheal disease found in the South Jayapura area. According to observations and interviews, there are several people who use well water contaminated with coliform bacteria in carrying out activities such as washing hands before eating without using soap, washing eating utensils, and making ice cubes using water that has been that has not been previously boiled. In the North Jayapura area, there are several people who consume well water as drinking water, which is what causes the WBD rate to be high. Unsanitary latrines are the primary factor in the spread of bacteria carried by animal agents, such as insects, and can be transmitted through water so that bacteria can enter the body ⁽¹²⁾.

In the North Jayapura sub-district, the only government program interventions are communal wastewater treatment plants and waste banks, whereas in South Jayapura, there is no government program. However, there is a village DKKP that disposes of rubbish from the community's anchored houses. According to surveys and interviews, there is a KOTAKU program in the North Jayapura area that creates communal IPALs in North Jayapura-anchored housing complexes. This program has been in place since 2020, but the community has only used the IPAL for about a month. Residents claim that the IPAL disturbs the community due to its unpleasant odor. Communities that use the IPAL need a lot of water to flush out feces in the latrine, so the community chooses to disconnect the pipe connected to the communal IPAL and chooses to continue using the pit latrine.

CONCLUSIONS AND RECOMMENDATIONS

There are various demographic characteristics; the majority are dominated by men, respondents aged between 18 and 65, respondents who work as housewives and fishermen, and respondents whose last education was in high school. The anchored house has no effect on seawater quality or waterborne disease incidence. Anchored houses have an influence on the amount of nitrate in sea water but do not influence the incidence of WBD because the incidence of WBD is caused by the presence of coliforms in well water.

The government is advised to continuously improve its program on basic sanitation until all houses in residential housing complexes in the city of Jayapura have good IPALs. In addition, when developing a community program like IPAL, it is crucial to conduct frequent and thorough inspections.

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