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Analysis of Land Use on Water Quality in Merjosari Village, Lowokwaru Subdistrict, Malang City

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Malang City faces several environmental challenges, including inadequate sanitation and water management, which have not been fully addressed across all aspects of life. This is not in line with the Sustainable Development Goals, which aim to ensure the availability and sustainable management of clean water and sanitation for all people. Malang City is also experiencing increasingly massive land use changes, from green open land to housing, which can impact clean water quality. This study aims to assess the quality of clean water from the non-Local Water Supply Utility in Merjosari Village, Lowokwaru Subdistrict, Malang City, which is undergoing land-use transformation. A quantitative observational approach was employed using the National Sanitation Foundation's Water Quality Index (NSF-WQI) method, which evaluates water quality based on physical, chemical, and biological parameters. The results showed that the water quality index in Merjosari Village, Lowokwaru District, Malang City, analyzed using the NSP-WQI method, has a value of 77.53 and falls within the good criteria. However, several parameter values exceed the clean water standard. The average value of the DO parameter, at 5.85 mg/,L is less than the quality standard of 6 mg/L. The average value of the BOD parameter, at 8.12 mg/,L exceeds the quality standard of 2 mg/L. The pH parameter at several sample points exceeds the quality standard of above 8.5, and the Nitrate Parameter at several sample points exceeds the quality standard of 20 mg/L. In conclusion, the land cover change in the Merjosari area, Lowokwaru District, Malang City, does not significantly affect the quality of clean water. However, the values of several water parameters exceed the clean water standard, which has the potential to impact public health negatively.

Keywords: Water quality, Land use change, National Sanitation Foundation's-Water Quality Index

INTRODUCTION

The Sustainable Development Goals (SDGs), also referreed to as environmentally sustainable development, are an action framework promoted by the United Nations (UN) as a crucial step in achieving global development (Humaida N. et al., 2020). Based on Presidential Regulation of the Republic of Indonesia Number 59 of 2017 concerning the Implementation of the Sustainable Development Goals, one of the goals of the SDGs is to ensure the availability and sustainable management of clean water and sanitation for all. The availability of clean water plays a crucial role in enhancing environmental welfare and improving people's quality of life. Water and sanitation are basic needs of society that are vital for survival, and the availability of water and sanitation must be adequately met in terms of quantity and quality (Oktafiani, 2024). Based on this, it is necessary to periodically test the water quality used by the community to ensure its maintenance.

However, achieving this goal is increasingly complex in urban areas that are experiencing rapid land-use change, especially cities. Along with population growth and accelerated urbanization, pressure on land is increasing, leading to a shift in land use from green open spaces to built-up areas, such as housing and infrastructure (Wijayanto & Maryono, 2021). These changes significantly alter surface runoff, infiltration patterns, and pollutant loads, impacting the quality of water sources (Setyowati, 2016).

In Indonesia, this phenomenon is evident in Malang City, East Java's second-largest city, where population growth and housing demand have triggered extensive land conversion. Ajie and Tri (2020) report that the Malang City Government continues to struggle to provide adequate sanitation and clean water services, particularly in areas experiencing rapid spatial development. Rofi'i (2021) notes that from 2004 to 2014, built-up land in Malang increased by 45%, and projections suggest a 61% increase by 2030. Rising demands for water and a corresponding risk of pollution from various anthropogenic activities accompany this shift in land-use. Urgent action is needed to address this issue and prevent further degradation of water quality.

For instance, Dyah and Arina (2017) documented that those changes in the Bengawan Solo River's watershed were linked to increased concentrations of BOD, COD, nitrite, and other pollutants. Closer to the study area, Bahriyah et al. (2018) revealed signs of pollution in the Metro River, Merjosari Village, with key parameters exceeding water quality standards.

Despite these findings, limited research has been conducted on the quality of water sources from the Local Water Supply Utility in peri-urban areas such as Merjosari, which are not connected to formal water supply networks. This represents a crucial gap, as many residents in such areas rely on these alternative sources for their daily needs. The findings of this study could have significant implications for the health and well-being of these communities, as well as for local environmental policies and water management practices.

This study aims to fill this gap by analyzing the quality of clean water from the Local Water Supply Utility in Merjosari, a peri-urban area in Lowokwaru District, Malang City, which is experiencing significant land-use transformation, as evidenced by a 17.85% decrease in rice fields and a 2.86% increase in built-up land between 2016 and 2024. We hypothesize that these specific land-use conversions alter hydrological processes and increase pollutant loads. For instance, the reduction in permeable surfaces, such as rice fields, may reduce infiltration and increase surface runoff. At the same time, the expansion of built-up areas and agriculture likely elevates the input of organic matter and chemicals. The assessment uses the NSF-WQI method, which integrates physical, chemical, and biological parameters to evaluate overall water quality, allowing us to directly test these hypotheses by examining parameters such as BOD and nitrates. The study adopts a land-use–water quality interaction framework, which posits that spatial changes in land cover directly affect hydrological processes and pollutant accumulation in surface and groundwater systems. Stakeholders can use the findings as critical consideration or input for implementing sustainable development strategies that prioritize water quality sustainability.

METHOD

Study Area and Period

This research was conducted in Merjosari Village, Lowokwaru Subdistrict, Malang City, East Java, Indonesia. The area was selected due its reliance on the Local Water Supply Utility water sources, and its significant land use changes. Primary water quality data collection began in April 2025. The Data on land changes at the research site used data from the last 10 years (2016-2024).

Over the past few years, there have been many changes in land use, with an increase in the number of farms, built-up Land, and a decrease in the amount of open space. Land use changes in an area can impact water parameters and lead to a decline in water quality, (Rasyiid et al., 2015). Land use changes reduce the land's ability to absorb water, causing increased surface runoff, erosion, and sedimentation. It also increases the influx of pollutants from agriculture and waste, contaminating water bodies such as rivers.

Research Design

A quantitative observational research method was employed to calculated the quality of the Local Water Supply Utility in areas experiencing land use changes at the research site using several variables. Following this, a descriptive analysis was carried out to identify the factors contributing changes in the quality of clean water from the Local Water Supply Utility.

Data Collection

The data types used in the analysis include primary and secondary data. Primary data included direct field monitoring of environmental conditions and laboratory analysis of water samples. Secondary data were obtained from various literature studies, including previous water quality test in Merjosari Village at 2016 and 2019, which is presented in Table 2. This water quality data was collected in the same area, Merjosari Village, and both utilized groundwater, however, the sampling locations differed, and not all parameters in this study were included in the secondary data.

Table 1. Historical water quality parameters from previous studies in Merjosari Village (2016 and 2019**)** (Istipsaroh et al., 2016 and Mulyana, 2019)

Parameter	2016						2019
	Results						Results
Temperature	26.8	26.3	24.3	26.4	27.3	27	24.9
Turbidity	No data						1.16
TSS	0.08	0.06	0.02	0.05	9.3	9.3	No data
pH	7	7	6.7	7	7.6	7.3	7.86
DO	8.6	11.3	13	11.6	6.6	7.6	No data
Nitrate	No data						23.69
Total Coliform	<2	<2	<2	<2	<2	<2	<2

Sampling Technique and Points

The sampling points were determined using the purposive sampling method, which is based on specific criteria considered relevant by researchers, such as ease of access, cost, and research time (Putu, 2024).

The selection of sample locations was determined based on distance and spread across the research area, ensuring they were sufficiently representative of the study area. The distance between sample points has been determined by considering the surrounding environmental conditions. Additionally, each point represented a specific type of land use, including residential, agricultural, and school land.

Location and point Sampling locations are presented in Figure 1, and Table 3. Five sampling points were selected to represent the dominant land use variations and different environmental conditions in Merjosari Village, thereby providing a representative picture of water quality under various site conditions. The specific criteria for site selection were (1) Each sampling point was selected to represent the primary land use categories found in the study area, namely densely populated residential areas, agricultural/plantation land, and areas close to public facilities such as schools; (2) Sampling points were geographically distributed throughout the study area to capture spatial variation and prevent bias from any particular location; (3) Location selection also considered proximity to potential sources of water pollution, such as densely populated residential areas (domestic waste), agricultural areas (fertilizer and pesticide waste), and locations adjacent to landfills (leachate waste). (4) Ease of access for sampling and permission from water source owners were also taken into consideration, without compromising the research objectives.

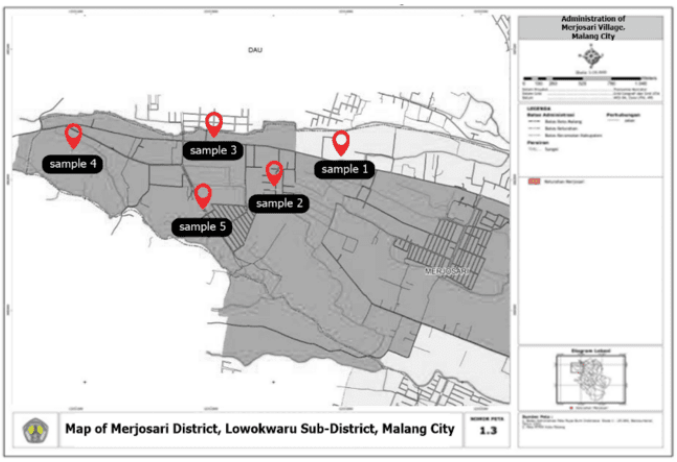

Figure 1. Map of research sample locations

Each sampling point represents the type of land change that has occurred in the study area. Sampling point 1, located next to the highway, is used as a school, sampling point 2 is located in a new residential area surrounded by farms, sampling point 3 is used as a sports area, sampling point 4 is used as a school and is close to a landfill site, sampling point 5 is located in a densely populated residential area.

Sampling conducted at five points within the research location. Furthermore, households that still use healthy water (non-DPAM) took samples based on the use of water sources. Water sample sourced from a drill well. Water samples from all location points were collected on the same day, between 10:00 am and 2:00 pm. Each sample were collected 3 times, stored in a cool box, and transported to the laboratory for analysis.

Laboratory Analysis Methods

The analysis of clean water quality from the Local Water Supply Utility in this study was conducted independently and through a third-party contractor (PT Jasa Tirta I, Malang).

The independent analysis was conducted at the Brawijaya University laboratory using the SNI method. This method was chosen because it provides accurate, standardized results that comply with applicable quality standards for water consumption safety and environmental management. The parameters tested using the SNI method are Temperature, turbidity, Total Suspended Solid (TSS), pH, Dissolved Oxygen (DO), Total Phosphate and Total Coliform.

The third-party analysis used the APHA and QI methods because they have reliable, accurate, and internationally recognized standards for analyzing various water quality parameters. Biological Oxygen Demand (BOD) and Nitrate are parameters tested by third parties.

Data Analysis (NSF-WQI and Statistical Tests)

Water quality was assessed using the National Sanitation Foundation's Water Quality Index (NSP-WQI) method. The NSP-WQI was chosen because, in general, this method can assess water quality using nine measured parameters, including physical, chemical, and biological parameters. In addition, in the NSF-WQI method, each parameter has a corresponding weight value (Rasyiid et al., 2015).

For calculating the Water Quality Index, the raw analysis results for the selected water quality variables, which have different units of measurement, are then converted into unitless sub-index values (Ii). The sub-index values are obtained by plotting or plugging each IKA INA parameter's water quality analysis results into the mathematical equation for the IKA-INA sub-index curve (Dewi et al., 2020). This index is generally determined by the Delphi method, which is based on the weights (Wi) and sub-indices (Ii) of nine water quality parameters (Oram, 2014). The WQI was calculated using the formula:

$$WQI = \sum_{i=1}^{n} (Wi \; x \; Ii)$$

Keterangan:
WQI = *Water Quality Index*
W_i = Weight of parameter up to i
I_i = Sub index value for i
n = Number of water quality parameters

The weight values of water quality parameters in the Water Quality Index system, as used by Dhok, (2020), can be determined using the mathematical equation of the sub-index curve. The sub-index values of the parameters can then calculate. Based on this equation, the value of the Water Quality Index can be determined, and its status can then be classified according to the Water Quality Index criteria table (NSF-WQI) in Table 2.

Table 2. Water Quality Index Criteria (NSF-WQI) (Dhok, R. 2020)

Index Value Range	Water Quality
0 - 25	Very Poor
26 - 50	Bad
51 - 70	Medium
71 - 90	Good
91 -100	Very Good

Following this, an analysis was conducted to assess the impact of land use changes on various water quality parameters in Merjosari Village. The Paired T-Test method was used to determine the impact of land use changes on the quality of clean water from the Local Water Supply Utility. The Paired T-Test using IBM SPSS Statistics 27 software began with a normality test, followed by the Paired T-Test.

RESULT AND DISCUSSION

Overall Water Quality Index (NSF-WQI)

The comprehensive assessment of nine water quality parameters yielded a final NSF-WQI score of 77.53 for the non-Local Water Supply Utility in Merjosari Village (Table 3), classifying the overall water quality as "good". This indicates that, from an integrated perspective, the water quality in the study area is acceptable.

Table 3. Summarizes of NSF-WQI calculation results

No	Parameter	Unit	Test Result	Weight (Wi)	Sub Indeks (Li)	NSF-WQI
1	Temperature	°C	27.1	0.10	20	2
2	Turbidity	NTU	0.68	0.08	98	7.84
3	Total Suspended Solid (TSS)	mg/L	0.53	0.07	96.02	6.72
4	pH	-	8.48	0.11	73.82	8.11
5	Dissolved Oxygen (DO)	mg/L	5.85	0.17	88.69	15.07
6	Biological Oxygen Demand (BOD)	mg/L	8.12	0.11	52.86	5.81
7	Nitrate	mg/L	16.9	0.10	63.89	6.38
8	Total Phosphate	mg/L	0.06	0.10	95.77	9.57
9	Total Coliform	MPN/100ml	0	0.16	100.0	16
					Total Water Quality Index =	77.53
					Water Quality =	Good

However, a detailed analysis of individual parameters reveals several key parameters exceeding clean water quality standards, potentially linked to ongoing land-use changes.

Physical Water Quality Parameters

Temperature

The first parameter measured was temperature. Temperature is one of the physical parameters of water quality that indicates the level of heat or cold in water samples. The temperature parameter is set according to the quality of clean water standards, with a tolerance of +/- 3°C from the air temperature (Vindi and Fretes, 2016). At the time of sampling, the air temperature was approximately 28°C.

All sample points recorded temperatures within the acceptable range for clean water quality range. Temperature plays a crucial role in aquatic ecosystems, as it influences dissolved oxygen levels; higher temperatures reduce oxygen solubility (Ningrum, 2018). The stable temperature readings, despite land-use changes, are consistent with findings from groundwater studies in peri-urban areas, which often show minimal temperature fluctuations due to the insulating properties of the subsurface. The temperature measurement results are shown in Figure 2.

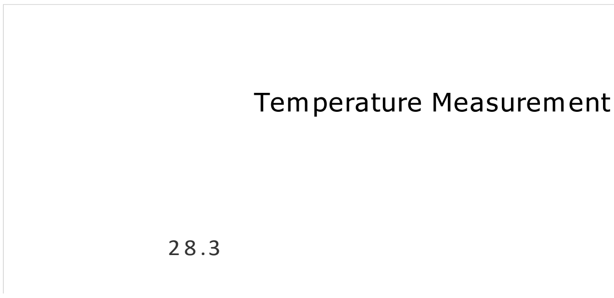

Figure 2. Water temperature recorded at five sampling points in Merjosari Village.

Turbidity

The second parameter observed was turbidity. Turbidity is the amount of suspended matter in water. Various types of suspended material can cause turbidity. The turbidity parameter set according to the standard quality of clean water is <3 mg/L. Based on the test results, the turbidity level at the Location 5 sampling point has met the quality of clean water standards. This is a significant finding, particularly when compared to surface water studies in transforming watersheds, such as those in the Citarum River, Indonesia, which often report elevated turbidity due to erosion from construction and agriculture. Sugianti and Astuti (2018) state that higher turbidity inhibits oxygen diffusion, lowering dissolved oxygen concentration. The results of the turbidity parameter measurements are presented in Figure 3.

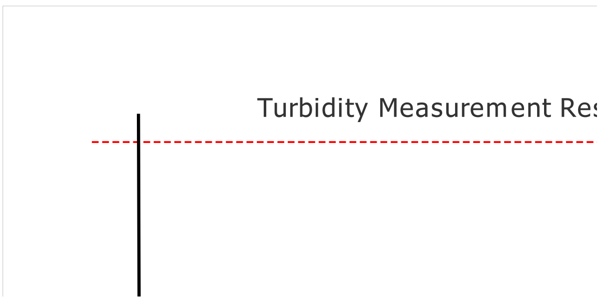

Figure 3. Turbidity Measurements at Sampling Locations

Total Suspended Solids (TSS)

TSS, a term for substances that can cause water to cloud, has unique characteristics. It is insoluble and does not settle. The TSS parameter, set at a maximum of 40 mg/L according to clean water standards is. All sampling locations met these standards, was met by all sampling locations. However, an increase in TSS leads to water turbidity, as it obstructs sunlight from entering the water. This increase in TSS further intensifies turbidity and hinders sunlight penetration into the water column (Winnarsih et al., 2016). The results of the TSS parameter measurements are depicted in Figure 4, highlighting the implications of increased TSS on water quality.

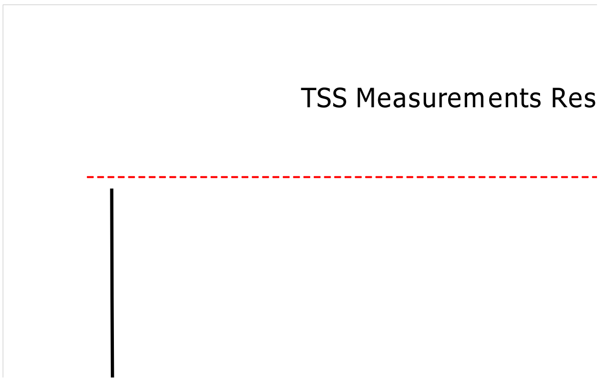

Figure 4. TSS Measurements at Sampling Locations

Chemical and Biological Water Quality Parameters
pH (Power of Hydrogen)

pH indicates the acidity and alkalinity of water. The pH parameter, set according to the clean water quality standards, is between 6.5 and 8.5. Based on the test results, the pH parameter at sampling point locations 2 and 3 meets the standard quality of clean water, but sampling points 1, 4, and 5 exceed the standard quality of clean water.

When the water has a pH below 6.5, it becomes too acidic, and when the pH is above 8.5, it becames too alkaline, which can harm the body when consumed over time (Handayani et al., 2023). The results of the pH parameter measurements are presented in Figure 5.

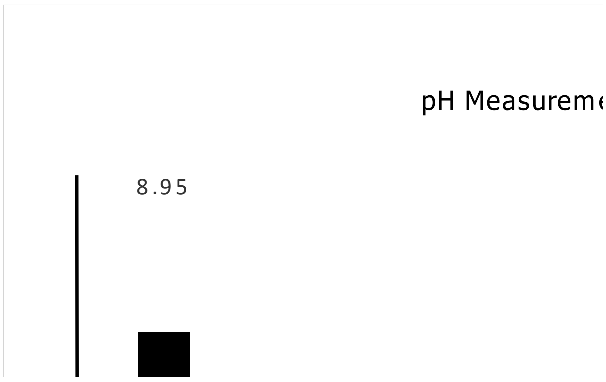

Figure 5. pH Measurements at Sampling Locations

According to Febri, et al (2021), high pH values can be caused by the large amount of alkaline substances found in soap, shampoo, and detergents that are often used in daily human activities. This is consistent with the location of the samples, which are mostly residential areas.

Dissolved Oxygen (DO)

DO is a key parameter for assessing water hygiene. The clean water standard for DO is a minimum of 6 mg/L. Only sampling point 2 met this standard, while points 1, 3, 4, and 5 recorded lower values. Low DO levels can inhibit organism growth and reproduction, as well as degrade aquatic ecosystems (Napitupulu et al., 2024). DO measurement results are shown in Figure 6.

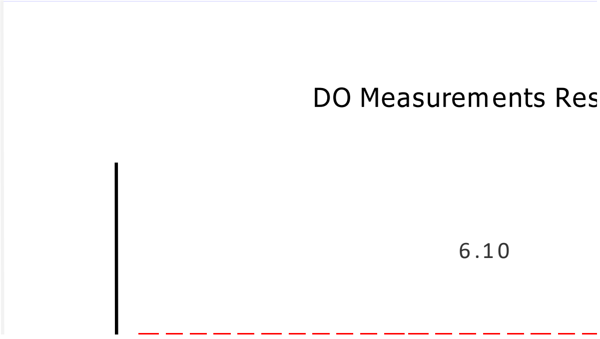

Figure 6. DO Measurements at Sampling Locations

Only sampling point 2 met the clean water standard for DO (minimum 6 mg/L), while points 1, 3, 4, and 5 recorded lower values. According to Idayani (2023), the decrease in DO levels in water is caused by the large amount of organic matter produced from liquid waste, both from factories and household waste, which is directly discharged into waterways. This is consistent with the location of the samples, which are primarly residential areas and close to a landfill area.

Biological Oxygen Demand (BOD)

BOD indicates the amount of dissolved oxygen microorganisms require to decompose organic matter. The BOD parameter set according to the quality of clean water standards is a maximum of 2 mg/L.

Alarmingly, the BOD parameters at the collection point locations all surpass the standard quality of clean water, indicating a serious issue. High BOD levels lead to a significant decrease in dissolved oxygen concentration, creating hypoxic or anoxic conditions that are detrimental to aquatic life. The results of the BOD parameter measurements are presented in Figure 7, underscoring the urgency of the situation.

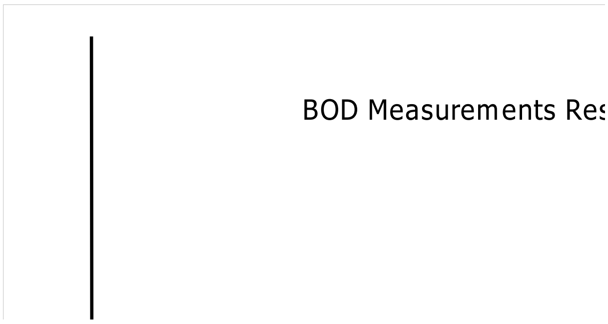

Figure 7. BOD Measurements at Sampling Locations

Human activities such as rice field irrigation, plantations, fisheries, and domestic activities , as highlighted by Nafiatus et al. (2024), significantly contribute to the increase in BOD level in water. This is consistent with the location of the samples, which are primarily residential areas and close to a landfill and plantation area. It's crucial for us to understand and address our role in maintaining water quality.

Nitrate

Determine water quality. Nitrate can disrupt aquatic ecosystems and harm living organisms if its levels exceed the threshold. The Nitrate parameter is set according to clean water quality standards, with a maximum of 20 mg/L.

Based on the test results, the Nitrate parameter at sampling point locations 1, 4, and 5 meets the standard quality of clean water, but at sampling points 2 and 3, it exceeds the standard quality of clean water. High nitrate levels generally come from chemical pollution (urea fertilizer, ZA, etc.) in the upstream section. In high concentrations, nitrate compounds that enter the human body can affect hematology and neurology. The hematological effect of nitrate is Blue Methemoglobinemia disease (Ardhaneswari & Wispriyono, 2022). The measurement results of the Nitrate parameter are presented in Figure 8.

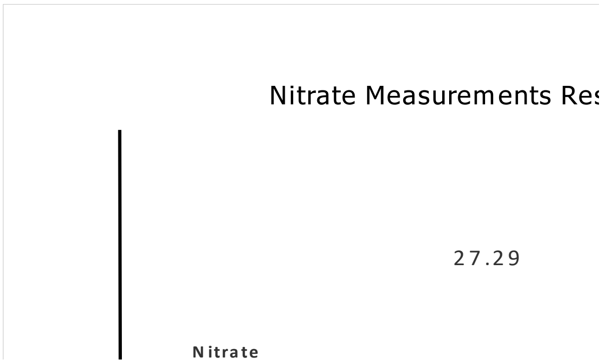

Figure 8. Nitrate Measurements at Sampling Locations

According to Rista (2023), water near domestic and industrial areas has higher nitrate levels. High DO levels in water will also result in high nitrate levels. This is consistent with the location of the samples, which are primarily residential areas. To reduce nitrate levels, it is recommended to minimize the use of chemical fertilizers and manage waste disposal properly.

Phosphate

Furthermore, the Phosphate parameter significantly affects the balance of aquatic ecosystems. When phosphate levels in water are high, the amount of dissolved oxygen in the water can be reduced. The Phosphate parameter set according to clean water quality standards is a maximum of 0.2 mg/L.

Based on the test results, the phosphate parameters at the sampling point locations all meet the standards for clean water quality. The presence of phosphate in water that exceeds the quality standard limits can disrupt aquatic ecosystems and other living things. Excessive phosphate concentration in water causes environmental problems, negatively impact industry, and poses risks to human health (Hashim et al., 2019). The measurement results of the Phosphate parameter are presented in Figure 9.

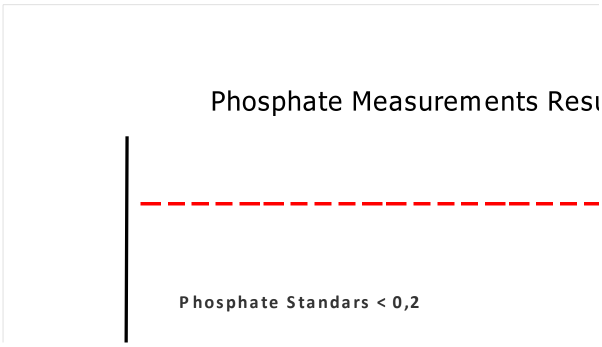

Figure 9. Phosphate Measurement at Sampling Location

Total Coliform

The last parameter measured was the total coliforms count. Based on the test results, no total coliforms were found in any of the sample tests, indicating that all met clean water quality standards.

Coliform bacteria are a class of intestinal bacteria that live in the human digestive tract and can cause various diseases, such as diarrhea, as seen with *Escherichia coli* (Febriyossa and Rhamadani, 2024). The results of the total coliform parameter measurements are presented in Figure 10.

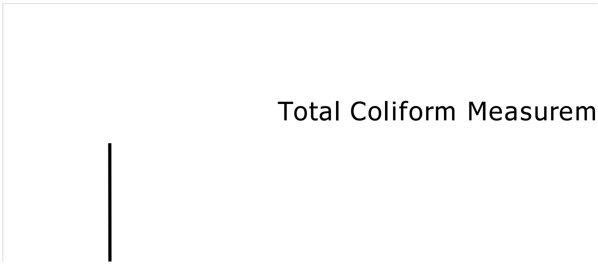

Figure 10. Total coliform concentration across five sampling points in Merjosari Village.

Although the overall water quality falls into the good category, a critical analysis of the contributing parameters reveals a more nuanced picture that can be linked to ongoing land-use transformations. The decrease in built-up land by 2.86% and the conversion of 17.85% of rice fields to other uses appear to have a direct impact on hydrological. The significantly low DO (5.85 mg/L) and high BOD (8.12 mg/L) levels, which were key factors contributing to the low index score, are classic indicators of organic pollution. This is a common consequence of increased domestic wastewater from denser settlements and the decomposition of organic matter from the remaining agricultural activities, a pattern observed in other peri-urban aquifers undergoing similar transitions (e.g., Shrestha et al., 2018).

According to (Napitupulu et al., 2024), low dissolved DO concentrations can inhibit the growth and reproduction of organisms and can cause damage to the aquatic ecosystem as a whole. Meanwhile, if BOD levels are high, microorganisms will use more dissolved oxygen to decompose the organic matter. This can result in a significant decrease in dissolved oxygen concentration in the water, potentially harming aquatic life.

In addition, water with a pH below 6.5, is too acidic, and water has a pH above 8.5 is too alkaline, which can potentially harm the body when consumed daily (Handayani, S. et al., 2023). As highlighted by Ardhaneswari & Wispriyono, (2022), high concentrations of Nitrate compounds in the human body can have profound health implications, particularly in hematology and neurology. The potential risk of diseases like Blue Methemoglobinemia underscores the urgent need for stringent water quality management and regulation.

Analysis of the Impact of Land Use Change on the Quality of Clean Water from the Local Water Supply Utility

This analysis employs the Paired T-Test to determine whether there is a statistically significant difference in the mean between two paired data groups. The choice between the parametric Paired T-Test and the non-parametric Wilcoxon Signed Rank Test is determined by the results of the normality test (Shapiro-Wilk and Kolmogorov-Smirnov) performed on the dataset comparing the values for 2016 and 2025. To quantitatively assess the impact of land use change on water quality, a statistical comparison was made between historical data from 2016 (Istipsaroh et al., 2016) and primary data collected in 2025. The choice of statistical test was based on data distribution, using the Shapiro-Wilk and Kolmogorov-Smirnov normality tests. Parameters with normally distributed data ($p > 0.05$) were analyzed using the parametric Paired-Sample T-test. In contrast, TSS parameters that were not normally distributed were analyzed using the non-parametric Wilcoxon Signed-Rank Test.

The analysis revealed no significant difference between the 2016 and 2025 measurements for the temperature parameter ($t(4) = -1.334$, $p = 0.253$). The average difference was 0.88 °C, indicating a slight but statistically insignificant increase in temperature during that period. For the pH parameter, no significant difference was observed in pH values ($t(4) = -0.343$, $p = 0.749$). The average difference of -0.2 indicates a negligible decrease in pH, which is not statistically significant. Furthermore, the Dissolved Oxygen (DO) parameter showed a statistically significant decrease between 2016 and 2025 ($t(4) = 4.013$, $p = 0.016$). The average DO concentration decreased by 4.37 mg/L, indicating a substantial decrease in oxygen levels in the water source.

The value of the temperature parameter testing is 0.253. This value is greater than the reference standard (0.253 > 0.05). It can be concluded that there is no significant difference between 2016 and 2025 in terms of temperature parameters. Based on the results of the Paired T-Test, a positive difference of 0.88 (mean) was obtained, meaning that the difference is minimal, indicating that the temperature in 2016 was lower than in 2025. Thus, it can be concluded that there was no significant decrease in temperature from 2016 to 2025.

The sig. value on pH parameter testing was found to be 0.749. This value is greater than the reference standard (0.749 > 0.05), indicatingthat there is no significant difference in the pH parameter between 2016 and 2025. Based on the results of the Paired T-Test, a negative difference of 0.2 (mean) was obtained, indicating that the pH level in 2016 was lower than in 2025. Thus, it can be concluded that there was no significant increase in pH levels from 2016 to 2025.

The sig. Value on DO parameter testing was 0.016. Since this value is less than 0.05, it can be concluded that there is a significant change in the DO parameter between 2016 and 2025. Based on the results of the Paired T-Test, a positive difference of 4.37 (mean) was obtained, indicating that the DO level in 2016 was higher than in 2025. Therefore, it can be concluded that there was a significant decrease in DO levels from 2016 to 2025.

TSS levels testing between 2016 and 2025 using the Wilcoxon Signed Rank Test because the data was not normally distributed (p-value < 0.05). Based on the results of the Wilcoxon Signed Rank Test, a Z value of -2.023 was obtained with $p = 0.043$ ($p < 0.05$). Thus, there is a significant difference between TSS in 2016 and 2025. The negative sign on the Z value indicates that the TSS value in 2025 is lower than in 2016. This indicates that water quality has improved, as evidenced by a decrease in TSS levels.

Analysis of turbidity and nitrate parameters is conducted using descriptive analysis, as the 2019 data consists of only one observation point, and therefore, statistical significance testing is not applicable. The turbidity value of water in Merjosari in 2019 was recorded at 1.16 NTU. Meanwhile, in 2025, samples were taken at five different points in the same area, with an average water turbidity value of 0.679 NTU. This shows a decrease in turbidity compared to 2019. Based on these results, it can be concluded that water quality in terms of turbidity has improved. The turbidity value of the water is decreasing and approaching the level of clear water, in accordance with applicable clean water quality standards.

The nitrate concentration in the Merjosari area in 2019 was recorded at 23.69 mg/L. The measurement results in 2025 at five locations showed an average nitrate level of 17.776 mg/L. This indicates a decrease in nitrate levels compared to the values in 2019. In general, there has been a decrease in nitrate content in the water. This indicates a quality improvement.

Based on the results of the water quality tests and statistical analysis above, the graph showing illustrating the relationship between land use change and water quality is presented in Figure 10.

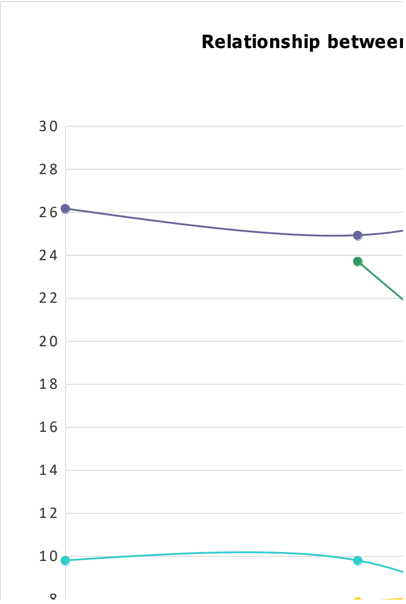

Figure 10. Relationship Between Land Use Change And Water Quality

Secondary data on water quality from previous studies conducted in 2016 (Istipsaroh et al., 2016) and 2019 (Mulyana, 2019) within Merjosari Village were utilized in this study. The primary purpose of incorporating this data was to establish a preliminary historical context and observe broad temporal trends in water quality in the area. However, it is crucial to acknowledge the limitations concerning its comparability with the primary data collected in 2025. Key inconsistencies include differences in the precise locations of sampling points, variations in the suite of parameters analyzed, and potential differences in analytical techniques and laboratory protocols between the studies. For instance, the 2019 data point offers limited spatial representation. Therefore, this secondary data is framed as providing supplementary context rather than being suitable for direct, detailed statistical comparison. The core temporal analysis for this study relies on the paired comparison between the 2016 secondary data and our 2025 primary data, for which a more consistent and justifiable comparative framework could be applied.

CONCLUSION

Based on the analysis using the NSP-WQI method, it can be concluded that the overall water quality of the non-Local Water Supply Utility in Merjosari Village is "good" and land cover changes have not critically degraded the water quality index. However, the exceedance of specific parameters, particularly the low DO and high BOD, indicates organic pollution pressure. The significant statistical decrease in DO in 2016 and 2025 reinforces this concern. Furthermore, elevated pH and nitrate levels at several points pose potential risks. Therefore, while the overall quality is acceptable, the deterioration in specific chemical parameters requires attention from stakeholders to safeguard public health and aquatic ecosystems.

SUGGESTION

Based on the findings of water quality analysis, it is recommended to conduct regular and systematic monitoring (time series analysis) of water quality to observe temporal fluctuations in parameter values. Water sampling should be conducted at least twice annually to capture seasonal variability, once during the dry season and once during the rainy season. This approach will provide a more comprehensive understanding of water quality dynamics, supporting the development of more effective water resource management and mitigation strategies.

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