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Microbiological Assessment of Selected Groundwater Wells in Agricultural–Residential Areas of Rajal Sur, Santa Rosa, Nueva Ecija

John Carlos Moya Torres[1], Moises John Tabor Diaz[2], Allan Renz Delacruz Garces[3], Ronie Ver Arances Rubio[4], Bernard Miguel Sioson Jr.[5], Rhens Mathew Huerta Valenzuela[6], Rosel V. Babalcon[7]

[1,2,3,4,5,6,7]Nueva Ecija University of Science and Technology, Sumacab Este, Cabanatuan City

ABSTRACT: This study evaluated the microbiological quality of selected groundwater wells in the agricultural-residential area of Rajal Sur, Santa Rosa, Nueva Ecija. It determined the levels of Total Coliform and Escherichia coli (E. coli), assessed compliance with the Philippine National Standards for Drinking Water (PNSDW), and described possible localized environmental and sanitary conditions observed near the sampled wells. A descriptive-assessment research design was employed. Water samples were collected from five purposively selected wells and analyzed using the Most Probable Number (MPN) method. Results showed that three out of five sampled wells exhibited microbiological contamination, while two met the acceptable laboratory reporting threshold. Based on PNSDW guidelines, 60% of the sampled wells were non-compliant and may pose health risks if consumed without treatment. No clear pattern was observed within the limited sample size regarding the relationship between contamination and recorded environmental factors. The findings suggest that contamination may be associated with localized sanitary conditions and multiple site-specific factors. This preliminary assessment provides baseline information relevant to groundwater safety, regular monitoring, proper well maintenance, and improved sanitation practices within the sampled wells.

KEYWORDS: Groundwater quality, wells, Total Coliform, Escherichia coli, microbiological contamination, PNSDW, water safety

CHAPTER I
THE PROBLEM AND ITS SETTING
INTRODUCTION

Groundwater is an important primary source of water for domestic consumption, agricultural use, and rural supply systems, particularly in farming communities where centralized water systems may be limited or inconsistent. It serves as a reliable and accessible resource for households and agricultural activities, especially during periods of limited surface water availability. Because of this role, protecting groundwater quality is essential for public health and community water security (Gleeson et al., 2016; Thomas & Famiglietti, 2019).

The quality of groundwater remains a concern because of the risk of microbial contamination. The presence of indicators such as Total Coliform and Escherichia coli (E. coli) suggests possible contamination from human or animal waste. These microorganisms are widely used as indicators because their detection may signal the possible presence of pathogens that can cause waterborne diseases, including diarrhea and gastrointestinal infections (Ashbolt, 2015; Cabral, 2010; World Health Organization, 2017).

This concern is relevant in agricultural-residential areas where wells are often located near crop fields, households, septic systems, animal areas, and other potential sources of contamination. Agricultural activities, including the use of fertilizers and animal manure, may contribute to surface runoff that can infiltrate groundwater sources. Poor sanitation, inadequate wastewater management, improperly maintained septic systems, animal waste, and improper waste disposal practices may also increase the vulnerability of shallow wells to contamination (Bagordo et al., 2024; Putri et al., 2024; Stoyanova & Harizanova, 2019).

Rajal Sur, Santa Rosa, Nueva Ecija, is an agricultural-residential area characterized by residential settlements located near farmlands. Some households rely on groundwater wells for domestic purposes, while the surrounding area is influenced by agricultural activity. These conditions raise concerns regarding groundwater safety for residents, especially because localized testing and monitoring data are limited.

The lack of localized information makes it difficult to determine whether existing groundwater sources meet safety standards for drinking water. It also limits the development of appropriate interventions and local sanitation practices that could help protect public health. Localized assessments are therefore useful for identifying possible contamination risks and improving groundwater management within the community.

In response to these concerns, this study assessed the microbiological quality of selected groundwater wells in Rajal Sur, Santa Rosa, Nueva Ecija. Specifically, it focused on the detection of Total Coliform and Escherichia coli (E. coli) as indicators of contamination. The study aimed to provide baseline data that may support future monitoring, guide local water management practices, and contribute to groundwater safety in the area.

Conceptual Framework

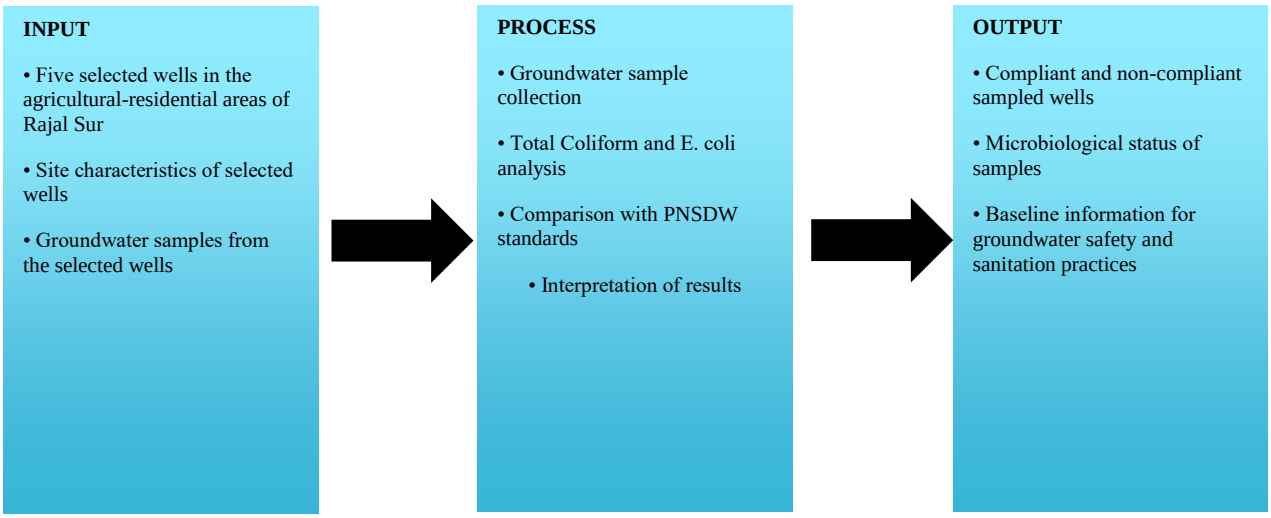

Figure 1. Research Paradigm

The study assessed the microbiological quality of selected groundwater wells in agricultural-residential areas of Rajal Sur, Santa Rosa, Nueva Ecija. It focused on the levels of Total Coliform and E. coli, compliance with drinking water standards, and possible localized conditions observed near the sampled wells, including septic tank proximity, nearby agricultural activity, and the surrounding residential environment. The output of the study provides baseline information relevant to groundwater safety and sanitation practices.

Statement of the Problem

This study aimed to assess the microbiological quality of selected groundwater wells in agricultural-residential areas of Rajal Sur, Santa Rosa, Nueva Ecija, in relation to groundwater safety. Specifically, it sought to answer the following questions:

1. What are the locational and environmental characteristics of the selected groundwater sampling sites in Rajal Sur, Santa Rosa, Nueva Ecija?
2. What are the levels of Total Coliform and Escherichia coli (E. coli) in the selected groundwater wells?
3. Which sampled wells comply with the microbiological standards of the Philippine National Standards for Drinking Water?
4. What possible localized environmental and sanitary factors may be associated with the observed contamination results, and what possible implications may be drawn for groundwater safety in the study area?

Objective of the Study

The study aimed to determine the locational and environmental characteristics of the selected groundwater sampling sites in Rajal Sur, Santa Rosa, Nueva Ecija. It also sought to identify the levels of Total Coliform and Escherichia coli (E. coli) present in the selected groundwater wells. In addition, the study evaluated which sampled wells complied with the microbiological standards set by the Philippine National Standards for Drinking Water. Furthermore, it assessed possible localized environmental and sanitary factors associated with the observed contamination results and discussed their possible implications for groundwater safety within the study area.

Significance of the Study

The findings of this study on the microbiological quality of selected groundwater wells in Rajal Sur, Santa Rosa, Nueva Ecija, are expected to benefit the following groups:

Residents - The study may help residents become more aware of the safety of their groundwater, particularly in relation to possible Total Coliform and E. coli contamination. It may encourage proper water handling and treatment practices at the household level.

Farmers - The study may highlight the importance of protecting nearby wells from possible contamination sources. It may also encourage practices that reduce the risk of groundwater pollution in agricultural-residential areas.

• Barangay / Local Government Unit (LGU) - The study may provide baseline monitoring data that can assist barangay officials and local government units in planning and strengthening water safety and sanitation programs.

Future Researchers - The research may serve as a reference for future studies related to groundwater quality, environmental contamination, and water resource management in similar rural or agricultural settings.

Students - The study may provide students with practical understanding of field sampling, data collection, laboratory analysis, and environmental research methods.

Scope and Limitation

The study focused on the assessment of the microbiological quality of five selected groundwater wells in Rajal Sur, Santa Rosa, Nueva Ecija. It specifically examined microbiological parameters, particularly Total Coliform and Escherichia coli (E. coli), through a one-time sampling procedure and laboratory-based coliform testing. The study provides a preliminary assessment of groundwater quality limited to the selected sampling sites only. The findings describe the microbiological condition of these specific wells only and should not be generalized to the entire groundwater condition of Rajal Sur or nearby communities.

The study was limited to five groundwater samples, which may not fully represent groundwater conditions across the wider community. The study also did not account for seasonal variation because sampling was conducted only once. It did not include hydrogeologic modeling to analyze groundwater flow or contamination pathways. Lastly, the study cannot establish direct causation between specific environmental or sanitary factors and the observed contamination results. It

only identifies possible associations based on observed site conditions.

CHAPTER II
METHODS AND PROCEDURE

Groundwater is one of the most important freshwater resources used in rural and agricultural-residential areas. It is commonly accessed through wells because it is available within local communities and can support both household and agricultural needs. However, groundwater quality can be affected by land use, agricultural practices, sanitation conditions, and the vulnerability of shallow aquifers to surface influence. Gleeson et al. (2016) explained that modern groundwater is widely distributed but remains sensitive to pressure from human use and environmental change. Thomas and Famiglietti (2019) also emphasized the importance of groundwater in water security and resource management.

Microbiological indicators such as Total Coliform and Escherichia coli (E. coli) are widely used in drinking water quality assessment. Total Coliform may indicate general contamination or problems in water source protection, while E. coli is a stronger indicator of fecal contamination from humans or warm-blooded animals. Since testing for all pathogens in water is difficult, indicator organisms are used to evaluate potential public health risks. Cabral (2010), Ashbolt (2015), and the World Health Organization (2017) support the use of these indicators in assessing microbial safety of drinking water.

Groundwater microbial contamination may arise from several interacting sources in mixed-use communities. These include septic leakage, agricultural runoff, animal waste, poor well construction, inadequate well sealing, and surface water infiltration. Bagordo et al. (2024) noted that microbial contamination of groundwater depends on interactions between human activities, soil and geological conditions, hydrology, and microbial survival. Putri, Notodarmojo, and Utami (2024) further identified land use and sanitation-related factors as important influences on coliform contamination in shallow groundwater.

Agricultural activity may also contribute to water pollution when fertilizer use, livestock activity, animal manure, and improper waste management are not controlled. Stoyanova and Harizanova (2019) described agriculture as a contributor to surface and groundwater pollution, while Garcia et al. (2015) showed that fecal contamination in irrigation water can affect the microbial quality of agricultural production. Within the Philippine context, Cortez et al. (2023) documented elevated thermotolerant coliform levels in water sources near agricultural and residential areas in the Pampanga River Basin, suggesting that land use may be associated with fecal contamination of water bodies in similar settings. These studies support the need to monitor wells located near agricultural and residential activities.

The Philippine National Standards for Drinking Water require strict microbiological protection for drinking water. The standard is intended to prevent waterborne disease and ensure that drinking water is protected from fecal contamination. The Department of Health (2017) identifies the Philippine National Standards for Drinking Water of 2017 under Administrative Order No. 2017-0010 as the basis for drinking water quality evaluation. WHO guidance also emphasizes the importance of microbial monitoring, risk-based management, and regular surveillance for drinking water safety (World Health Organization, 2024).

The following table summarizes verified local and international literature relevant to the present study. These sources support the use of microbiological indicators, the concern over agricultural and sanitation-related contamination, and the need for localized groundwater assessment.

The following table summarizes selected local and international studies relevant to the present research. These studies examine microbiological water quality in agricultural, rural, and mixed-use settings comparable to the conditions found in Rajal Sur, Santa Rosa, Nueva Ecija.

Table 1. Related Literature

Author / Year	Area	Parameters	Findings	Relevance to Study
Cabral (2010)	Water microbiology	Bacterial pathogens and indicators	Discussed bacterial pathogens and the role of indicator organisms in water quality assessment.	Supports the use of Total Coliform and E. coli as microbiological indicators.
Ashbolt (2015)	Community water systems	Microbial contamination	Linked microbial contamination of drinking water with human health risks.	Supports the public health relevance of microbial testing.
Garcia et al. (2015)	Metro Manila, Philippines	Fecal contamination in irrigation water	Reported fecal contamination concerns in irrigation water and vegetable production.	Relates agricultural water use to microbial safety concerns.
Stoyanova & Harizanova (2019)	Agriculture and water pollution	Agricultural pollution	Identified agricultural activities as contributors to surface and groundwater pollution.	Supports the concern over wells near agricultural areas.
Putri et al. (2024)	West Java, Indonesia	Coliform contamination in shallow groundwater	Identified sanitation, land use, and environmental factors related to coliform contamination.	Supports the study's focus on localized environmental and sanitary factors.

Author / Year	Area	Parameters	Findings	Relevance to Study
Bagordo et al. (2024)	Systematic review	Microbial contamination of groundwater	Noted that groundwater microbial contamination may be associated with human activities, environmental factors, and subsurface conditions.	Supports cautious interpretation of contamination as site-specific and multifactorial.
DOH (2017); WHO (2024)	Drinking water standards and guidance	Microbial safety and monitoring	Emphasized microbial safety standards, monitoring, and surveillance for drinking water.	Provides basis for comparing laboratory results with drinking water safety standards.
Cortez et al. (2023)	Pampanga River Basin, Philippines	Fecal indicator bacteria (thermotolerant coliform, E. coli, enterococci)	Found high thermotolerant coliform levels in water sources near agricultural and residential areas in Pampanga, suggesting possible associations between land use and fecal contamination of water bodies.	Provides Philippine-local evidence that agricultural and residential land use may be associated with elevated fecal indicator bacteria in water sources, supporting the relevance of localized monitoring in mixed-use areas such as Rajal Sur.

Synthesis of the Literature

The reviewed literature shows that microbial contamination of groundwater is a recognized concern in rural, agricultural, and mixed-use settings. Total Coliform and E. coli are commonly used as indicators because they help identify possible fecal contamination and potential health risks. The literature also shows that contamination may be associated with several interacting conditions, including sanitation, agricultural activity, well construction, surface runoff, and local environmental exposure. Evidence from the Philippines, including Cortez et al. (2023) and Garcia et al. (2015), further supports concern over microbial contamination in agricultural and mixed-use settings similar to Rajal Sur.

The reviewed studies support the need for localized groundwater assessment in Rajal Sur, Santa Rosa, Nueva Ecija. Although previous studies provide useful context, the available literature does not provide sufficient site-specific data for the selected wells in this area. This study addresses that gap by providing baseline microbiological data within the sampled wells and by identifying possible localized factors that may help guide future monitoring and community-level interventions.

CHAPTER III
METHODOLOGY

Research Design

The study utilized a descriptive-assessment research design to evaluate the microbiological quality of selected groundwater wells and describe selected environmental conditions, including distance from residential structures, rice or crop activity status, and distance from septic tanks. This design supported the identification of Total Coliform and Escherichia coli (E. coli) levels, the assessment of compliance with established standards, and the discussion of possible site conditions associated with groundwater contamination.

Study Area

The study was conducted in Rajal Sur, Santa Rosa, Nueva Ecija, an agricultural-residential area where groundwater wells are used for domestic and agricultural purposes. The site was selected to describe local environmental and sanitary conditions that may be associated with groundwater contamination.

Sampling Site

Five groundwater wells were purposively selected based on accessibility, permission from well owners, and representation of varying environmental conditions within the study area. The selection aimed to capture differences in proximity to residential structures, agricultural activity, and potential contamination sources. Because only five wells were included, the findings are limited to the sampled wells and should be treated as preliminary.

The characteristics of the sampling sites are shown below:

Table 2. Sampling Site Characteristics

Sample	Distance from Residential Structure	Rice/Crops Status	Distance from Septic Tank
1	Less than 8 meters	Inactive	Less than 25 meters
2	Less than 8 meters	Active	Less than 25 meters
3	Between 5 to 8 meters	Inactive	Less than 25 meters
4	Between 5 to 8 meters	Active	Less than 25 meters
5	More than 8 meters	Active	Less than 25 meters

These parameters were used to describe the selected sites and to support the discussion of possible factors influencing groundwater contamination.

Data Gathering Procedure

Data collection was conducted to document both environmental characteristics and groundwater quality. Site inspections were conducted to record locational and environmental conditions, including distance from residential structures, presence of agricultural activity, and proximity to possible contamination sources. Groundwater samples were collected using sterilized bottles to protect sample integrity. Each sample was labelled accurately, stored in a cooler with ice during transport, and submitted to a certified laboratory for microbiological analysis of Total Coliform and Escherichia coli (E. coli). This procedure

supported the collection of laboratory-based microbiological data.

Laboratory Analysis

The collected groundwater samples were analyzed for Total Coliform and Escherichia coli (E. coli). The Most Probable Number (MPN) method was used to estimate bacterial concentration. These parameters were selected because they are commonly used indicators of possible fecal contamination and overall microbiological water safety.

Data Analysis

The data were analyzed through descriptive analysis and tabulation of microbiological results. The laboratory results were compared with the Philippine National Standards for Drinking Water (PNSDW) to determine whether each sampled well was compliant or non-compliant. Frequencies and percentages were used to summarize the number of wells that passed or failed the microbiological standard. Recorded environmental and sanitary characteristics were then reviewed to discuss possible localized factors associated with the observed results. Because of the small sample size and one-time sampling design, the analysis did not establish statistical relationships or direct causation.

Basis of Evaluation

The results were evaluated based on the Philippine National Standards for Drinking Water (PNSDW) of 2017 under Administrative Order No. 2017-0010. For this study, laboratory results below the reporting threshold of <1.1 MPN/100 mL were treated as compliant, while any detected Total Coliform or E. coli result at or above the reporting threshold was treated as non-compliant. The presence of these microorganisms may indicate potential health risks and the need for treatment before consumption.

Ethical Considerations

Permission was obtained from well owners before sample collection. All gathered information was handled with confidentiality and integrity, and results were reported objectively. The study ensured that procedures were conducted responsibly without causing harm or unnecessary disruption to the community.

CHAPTER IV
RESULTS AND DISCUSSION

Table 3. Laboratory Results of Groundwater Samples

Sample Name	Address	Date and Time of Sampling	Total Coliform (MPN/100 mL)	E. coli (MPN/100 mL)	Remarks
Sample 1	Rajal Sur, Sta. Rosa	April 07, 2026 06:00 A.M.	>8.0	>8.0	Failed
Sample 2	Rajal Sur, Sta. Rosa	April 07, 2026 06:00 A.M.	<1.1	<1.1	Passed
Sample 3	Rajal Sur, Sta. Rosa	April 07, 2026 06:00 A.M.	>8.0	1.1	Failed
Sample 4	Rajal Sur, Sta. Rosa	April 07, 2026 06:00 A.M.	>8.0	4.6	Failed
Sample 5	Rajal Sur, Sta. Rosa	April 07, 2026 06:00 A.M.	<1.1	<1.1	Passed
PNSDW Limit AO 2017-0010	-	-	0/100 mL (<1.1 MPN/100 mL)	0/100 mL (<1.1 MPN/100 mL)	Compliant if not detected

Locational and Environmental Characteristics of Sampling Sites

The five selected groundwater wells were located within the agricultural-residential area of Rajal Sur, Santa Rosa, Nueva Ecija. The sites were characterized by residential households located near active or inactive agricultural areas. Based on the recorded field categories, all sampled wells fell within a potentially vulnerable proximity category of less than 25 meters from nearby septic tanks, while their distances from residential structures varied. These observed site conditions may be associated with increased contamination risk; however, the results should be interpreted cautiously because distance alone cannot explain groundwater quality within the limited sample size.

Levels of Total Coliform and Escherichia coli (E. coli)

Laboratory analysis showed varying levels of Total Coliform and Escherichia coli (E. coli) among the five groundwater samples. Sample 1 recorded values greater than 8.0 MPN/100 mL for both Total Coliform and E. coli, resulting in a failed classification. Sample 2 showed values less than 1.1 MPN/100 mL for both parameters and was classified as passed. Sample 3 recorded Total Coliform greater than 8.0 MPN/100 mL and E. coli at 1.1 MPN/100 mL, resulting in a failed classification. Sample 4 showed Total Coliform greater than 8.0 MPN/100 mL and E. coli at 4.6 MPN/100 mL, also resulting in a failed classification. Sample 5 showed values less than 1.1 MPN/100 mL for both indicators and was classified as passed. Reported values represent laboratory detection ranges using the MPN method and were interpreted based on PNSDW microbiological standards.

Overall, three out of five samples, specifically Samples 1, 3, and 4, showed microbiological contamination, while Samples 2 and 5 were within the acceptable laboratory reporting threshold. The presence of Total Coliform and E. coli indicates possible fecal contamination. The observed contamination may be associated with localized sanitary conditions and multiple site-specific factors such as surface runoff, well condition, surrounding hygiene practices, environmental exposure, and possible contamination sources near the wells.

Result Category	Frequency	Percentage
Passed	**2**	**40%**
Failed	**3**	**60%**

Table 4. Compliance with Philippine Drinking Water Standards

Based on the Philippine National Standards for Drinking Water, potable water should have no detectable Total Coliform and no detectable E. coli per 100 mL. The results show that only two out of five sampled wells complied with the microbiological standard, while three wells failed to meet the required criteria. This indicates that 60% of the sampled wells were non-compliant and may pose health risks if consumed without treatment.

Possible Localized Factors and Groundwater Safety Implications

No clear pattern was observed within the limited sample size regarding the relationship between contamination and the recorded environmental characteristics. Although the sampled wells were recorded within a potentially vulnerable proximity category of less than 25 meters from septic tanks, contamination was not uniform across all samples. This

suggests that septic tank distance alone cannot explain the observed results. The contamination may instead be associated with multiple localized environmental and sanitary conditions, such as inadequate well sealing, surface runoff from agricultural areas, presence of animal waste, poor hygiene practices around the well, and general well maintenance conditions.

The findings should be interpreted as a preliminary assessment because the study involved only five wells and one sampling event. The data cannot represent the overall groundwater condition of Rajal Sur, cannot establish seasonal patterns, and cannot prove direct causation between specific site conditions and contamination results. Additional sampling during dry and wet seasons, inclusion of more wells, and additional physicochemical testing would provide stronger evidence for identifying contamination patterns.

Summary of Findings

The study assessed five groundwater samples from selected wells in Rajal Sur, Santa Rosa, Nueva Ecija. Results showed that 60% of the samples failed to meet the microbiological standards of the Philippine National Standards for Drinking Water, while 40% passed. No clear pattern was observed within the limited sample size between contamination levels and the recorded distance from residential structures, crop activity status, or septic tank distance category. The findings suggest that local sanitary conditions, well maintenance, and environmental exposure may be associated with groundwater contamination observed within the sampled wells.

CHAPTER V
SUMMARY, CONCLUSION, AND RECOMMENDATION

Summary

The study assessed the locational and environmental characteristics of selected groundwater wells in Rajal Sur, Santa Rosa, Nueva Ecija. It determined the levels of Total Coliform and Escherichia coli (E. coli), evaluated compliance with the Philippine National Standards for Drinking Water, and described possible environmental and sanitary conditions observed near the sampled wells that may be associated with the microbiological results.

A descriptive-assessment research design was used. Five groundwater wells were selected based on accessibility, permission from well owners, and representation of varying site conditions. Samples were collected using sterilized containers, properly labeled, stored, and submitted for laboratory analysis using the Most Probable Number method.

Results showed that three out of five samples exhibited contamination with Total Coliform and E. coli, while two samples met the acceptable laboratory reporting threshold. Based on PNSDW, only two sampled wells complied with microbiological requirements for potable water. No clear pattern was observed within the limited sample size regarding the relationship between contamination levels and recorded site characteristics. The findings suggest that contamination may be associated with localized sanitary conditions and multiple site-specific factors.

Conclusion

Based on the findings, the selected groundwater wells in Rajal Sur, Santa Rosa, Nueva Ecija were located in mixed agricultural-residential areas where several environmental and sanitary influences may affect groundwater safety.

Microbiological analysis revealed that three out of five sampled wells were contaminated with Total Coliform and E. coli, indicating possible fecal contamination and potential health risks. Only two sampled wells complied with the Philippine National Standards for Drinking Water. Therefore, the non-compliant wells may pose health risks if consumed without treatment.

No clear relationship was observed within the limited sample size between contamination and the recorded site characteristics. This means that the results should be interpreted cautiously and should not be generalized to all wells in Rajal Sur.

Overall, the results suggest that contamination may be associated with localized sanitary conditions and multiple site-specific factors such as well maintenance, environmental exposure, and surrounding hygiene practices.

Recommendations

Based on the findings of the study, regular monitoring of groundwater wells is recommended to help identify possible contamination and maintain groundwater safety within the study area. Residents are encouraged to apply proper water treatment methods, such as boiling or filtration, before consumption, especially for wells with possible microbiological contamination. Proper well construction, sealing, sanitation, and regular maintenance practices should also be promoted to minimize the risk of contaminants entering the groundwater system. In addition, local government units may strengthen sanitation programs, well protection measures, and community awareness activities related to safe groundwater use and drinking water safety in accordance with the Philippine National Standards for Drinking Water (PNSDW). Future researchers are encouraged to conduct studies with larger sample coverage, repeated seasonal sampling, and additional physicochemical testing to provide a more comprehensive assessment of groundwater quality.

Acknowledgement

The researchers express their sincere gratitude to Almighty God for His guidance and strength throughout the completion of this study. The researchers also extend their appreciation to Nueva Ecija University of Science and Technology, the residents and well owners of Rajal Sur, and the laboratory personnel who assisted in the conduct of the study. Lastly, the researchers thank their families and friends for their encouragement and support.

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