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Research Paper

Assessment of Dug Well Water Quality in the Vicinity of the Karya Jaya Landfill, Palembang

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Abstract
Dug wells serve as a primary source of water in many Indonesian communities due to their affordability and accessibility. However, their proximity to landfill sites raises concerns about potential contamination and health risks. This study aimed to assess the quality of dug well water near the Karya Jaya Landfill in Palembang and to explore community perceptions regarding water safety. A qualitative study design was employed, integrating in-depth interviews with eight key informants and laboratory testing of water samples from dug wells located around the landfill area. Laboratory analysis revealed that physical parameters such as color, turbidity, and total dissolved solids (TDS) exceeded national quality standards, while odor and temperature remained within acceptable limits. Chemical analysis showed low pH levels and high concentrations of iron (Fe), suggesting contamination potentially linked to landfill leachate. Biological examination confirmed the presence of excessive total and fecal coliform bacteria. Interviews indicated limited community awareness regarding specific contaminants and their health impacts, although most residents recognized general characteristics of clean water. Dug well water was primarily used for domestic purposes, while bottled water was preferred for drinking. Some residents reported minor health issues, including skin irritation, although no formal health diagnoses were documented. These findings highlight the need for stronger leachate management systems, expanded access to safe municipal water, and routine groundwater monitoring. Public health education is also essential to raise awareness of waterborne disease risks and promote safer water use behaviors.

Keywords
contamination, dug well, groundwater, landfill, public health, water quality

1. INTRODUCTION

Access to clean water is fundamental for human health and well-being, supporting essential activities such as drinking, hygiene, agriculture, and industry. According to the World Health Organization (WHO) (Howard et al., 2020), average daily water consumption ranges from 60 to 120 liters per person in developed countries and between 30 to 60 liters per person in developing countries, including Indonesia. However, disparities in water quality, particularly in areas lacking infrastructure, remain a significant public health concern. Access to clean water is crucial, as contaminated water can serve as a vector for waterborne diseases, posing significant public health risks (Shayo et al., 2023).

Groundwater plays a vital role in meeting global water demands, particularly in regions with limited surface water availability (Nation, 2022). In Indonesia, dug wells remain a common water source due to their affordability and ease of construction. However, their susceptibility to contamination, especially near landfills, raises concerns regarding water quality and potential health hazards (Salim et al., 2024). Among various groundwater sources, dug wells remain one of the most widely used for daily needs, particularly in Indonesia, due to their affordability and ease of construction (Widiyanto et al., 2015). However, dug wells are highly susceptible to contamination by physical, chemical, and biological pollutants, especially in areas near landfills, which serve as major sources of groundwater pollution (Igboama et al., 2022).

Several studies have examined the impact of landfill leachate on groundwater quality, primarily focusing on chemical contamination (Abd El-Salam and Abu-Zuid, 2015) (Benaddi et al., 2022). Landfill leachate contains hazardous substances such as ammonium, heavy metals (e.g., cadmium, chromium, cobalt, lead, zinc, nickel), and organic pollutants, which can significantly degrade groundwater quality (Qian et al., 2024) (Mariadi and Kurniawan, 2020). Prolonged exposure to contaminated groundwater poses severe health risks, including gastrointestinal diseases, skin infections, and long-term conditions such as cancer due to the bioaccumulation of heavy metals (Zhang et al., 2023).

While many studies have focused on the chemical aspects of groundwater contamination near landfills, limited research has comprehensively analyzed physical, chemical, and biological parameters simultaneously, particularly in the context of dug well water quality. Furthermore, few studies integrate community perceptions, usage patterns, and awareness of the health risks associated with consuming contaminated well water (Catherine et al., 2023) (Caputo et al., 2022) (Schuitema et al., 2020). Given that communities near landfill sites often continue to rely on dug wells for domestic purposes, it is crucial to assess both water quality and public understanding of its potential health impacts (Alao et al., 2023).

This study addresses these gaps by providing a comprehensive analysis of dug well water quality near the Karya Jaya Landfill in Palembang, integrating physical, chemical, and biological assessments. Unlike previous studies that primarily focus on chemical pollution, this research takes a holistic approach by including microbiological contamination (e.g., total coliform and fecal coliform) and physical indicators (e.g., turbidity and total dissolved solids [TDS]). Additionally, this study is the first to explore local community knowledge, perceptions, and usage patterns regarding dug well water contamination near this landfill site.

Therefore, this study aims to comprehensively evaluate the quality of dug well water near the Karya Jaya Landfill in Palembang by assessing physical, chemical, and biological parameters. Additionally, it seeks to explore the community's knowledge, perceptions, and behaviors regarding the safety of their water sources. By integrating environmental data with social perspectives, this research provides evidence-based insights to inform risk communication strategies and guide water resource management policies in vulnerable communities.

2. METHOD

2.1 Study Design

This study employed a qualitative research design to assess the quality of dug well water near the Karya Jaya Landfill in Palembang. The research combined laboratory analysis of water samples with in-depth interviews to provide a comprehensive evaluation of water quality and community perceptions. The study aimed to examine physical, chemical, and biological water quality parameters while also exploring residents' knowledge, perceptions, and usage patterns

2.2 Study Area and Sampling

The study was conducted in three residential areas located at different distances (approximately 100 m, 300 m, and 500 m) from the Karya Jaya Landfill. These sites were purposively selected based on their proximity to the landfill and dependency on dug well water for daily use. One dug well was sampled at each location, representing a gradient of potential leachate exposure.

2.3 Water Quality Analysis

Water samples were collected using sterilized sampling bottles in accordance with SNI 6989.58:2008 and transported in cool boxes to a certified environmental laboratory. The analyses followed the Indonesian Ministry of Health Regulation No. 2 of 2023. The parameters assessed included: Physical: Odor, temperature (°C), color, turbidity (NTU), and total dissolved solids (TDS, mg/L). Chemical: pH and iron (Fe, mg/L) concentrations measured using spectrophotometry. Biological: Total coliform and fecal coliform, analyzed using membrane filtration methods. The laboratory applied standard QA/QC protocols including calibration with certified standards, use of blanks, and duplicate analysis. The instruments were calibrated to acceptable detection limits, and the laboratory was accredited under ISO/IEC 17025 standards.

2.4 Data Collection : Community Perceptions

Qualitative data were gathered through in-depth semi-structured interviews with eight key informants selected through purposive sampling. Informants included local residents and community leaders who used or oversaw the use of dug well water. The interviews explored: a. Awareness of water quality parameters. b. Perceptions of water safety and contamination risks. c. Patterns of dug well water use. d. Health complaints potentially associated with water consumption. Each interview lasted 30–45 minutes and was conducted in Bahasa Indonesia. Interviews were audio-recorded and transcribed verbatim.

2.5 Data Analysis

Laboratory data were analyzed using descriptive statistics, including mean and standard deviation, and results were compared against the national water quality standards. Statistical analysis was performed using SPSS version 25.0. For qualitative data, thematic analysis was applied. Transcripts were coded inductively, and themes were developed through iterative comparison. The findings from laboratory tests and community interviews were integrated using triangulation to identify convergence and divergence across data sources.

2.6 Ethical Considerations

The study adhered to ethical research principles. Prior to participation, all informants provided informed consent after receiving a full explanation of the study's objectives, procedures, and potential risks. Confidentiality was maintained throughout the research process. Ethical approval was obtained from the Ethics Committee of the Faculty of Public Health, Universitas Sriwijaya, before data collection commenced.

3. RESULTS

This study assessed the physical, chemical, and biological quality of dug well water in the vicinity of the Karya Jaya

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Table 1. Results of Air Quality Examination of Dug Well Water

Parameter	Unit	Standard	Station 1	Station 2	Station 3
Physical*					
Odor	-	Odorless	Odorless	Odorless	Odorless
Temperature	^{o}C	Ambient Temp ± 3	27	27	27
Color	TCU Scale	10	196	68	57
Turbidity	NTU Scale	<3	248	63	26
Total Dissolved Solids (TDS)	mg/l	<300	472	200	265
Chemical*					
pH	-	6.5 - 8.5	4.4	4.8	6.8
Iron (Fe)	mg/l	1	6.15	0.44	0.07
Biological**					
Total Coliform	Count per 100 ml	0	25	25	0
Fecal Coliform	Count per 100 ml	0	34.5	18.7	0

Note:
* Based on the Indonesian Ministry of Health Regulation No. 2 of 2023b
** Based on the Indonesian Ministry of Health Regulation No. 416/Menkes/Per/IX/1990

Landfill, Palembang. The laboratory analysis results are summarized in Table 1. The parameters are categorized into physical, chemical, and biological indicators, and compared to the permissible limits set by the Indonesian Ministry of Health Regulation No. 2 of 2023 (for physical and chemical parameters) and Regulation No. 416/Menkes/Per/IX/1990 (for biological parameters).

3.1 The Physical Parameters

Odor and temperature at all sampling stations complied with national drinking water standards. However, substantial deviations were found in color, turbidity, and TDS values, particularly at Station 1. The color intensity reached 196 TCU, nearly 20-fold higher than the permissible limit. Turbidity levels were also substantially elevated, with Station 1 showing 248 NTU. Total dissolved solids exceeded the standard only at Station 1 (472 mg/L).

3.2 Chemical Parameters

pH levels at Station 1 (4.4) and Station 2 (4.8) were below the acceptable range, indicating acidic conditions potentially conducive to heavy metal mobilization. Iron levels were significantly elevated at Station 1 (6.15 mg/L), exceeding the maximum allowable concentration. Conversely, Stations 2 and 3 met the regulatory standards.

3.3 Biological Parameters

Microbiological tests revealed fecal contamination at Stations 1 and 2, with both total and fecal coliform counts surpassing acceptable limits. Station 3 showed no indication of microbial contamination, reflecting better water hygiene and likely less leachate infiltration.

3.4 Community Knowledge and Perceptions on Water Quality

Community insights were obtained through interviews with local leaders and residents. Several key informants, including neighborhood and community unit heads, demonstrated an understanding of clean water characteristics, mainly referring to sensory attributes such as odor, color, and clarity. Residents' perceptions of water quality varied. At Station 1, most informants claimed the water was clear and odorless, contrasting with laboratory findings showing high iron and turbidity levels. Station 2 residents described the water as mostly acceptable, though some noted its acidic nature. Station 3 respondents expressed concerns about potential leachate infiltration, although no biological contamination was detected.

3.5 Water Utilization and Community Complaints

Residents primarily use dug well water for domestic activities such as washing and bathing, while drinking water is sourced from bottled supplies due to concerns over water safety. Informants expressed the urgent need for government intervention to expand the municipal water (PDAM) network. Reported health impacts included skin irritation and sores, particularly in Station 1. However, local leaders emphasized that these issues may be compounded by frequent contact with landfill waste rather than solely water quality.

4. DISCUSSION

This study identifies significant concerns regarding the quality of dug well water near the Karya Jaya Landfill, particularly in relation to color, turbidity, pH, iron content, and biological contamination. These exceedances indicate po-

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tential environmental and public health risks, with landfill leachate identified as a primary factor contributing to groundwater deterioration. These findings align with previous studies on landfill-related water contamination (Huang et al., 2024) (Nagarajan et al., 2012)

The elevated color and turbidity levels at Station 1 suggest the infiltration of suspended and dissolved organic and inorganic matter, commonly associated with landfill leachate (Abdel-Shafy et al., 2024). The high iron concentration in the same station supports this assertion, as heavy metals are often leached from landfills due to the decomposition of organic waste and the acidification of leachate (Beinabaj et al., 2023). The low pH levels at Stations 1 and 2 further reinforce this hypothesis, as acidic conditions enhance the solubility and mobility of heavy metals, exacerbating groundwater contamination (Lu et al., 2017).

Microbiological contamination, particularly the presence of total coliform and fecal coliform bacteria at Stations 1 and 2, suggests fecal contamination, possibly from leachate percolation or inadequate sanitation facilities. This finding aligns with previous studies that report elevated microbial contamination in groundwater near waste disposal sites, increasing the risk of waterborne diseases (Bagordo et al., 2024). The presence of fecal coliform is particularly concerning, as it is a major contributor to gastrointestinal infections in communities relying on untreated groundwater sources (Javaid et al., 2022)

The spatial distribution of contamination suggests a strong correlation between proximity to the landfill and groundwater quality deterioration. Station 1, located closest to the landfill, exhibited the highest contamination levels, while Station 3, situated further away, demonstrated relatively lower pollutant concentrations. This pattern is consistent with studies on leachate migration, which indicate a decline in pollutant concentrations with increasing distance from the pollution source (Mavimbela et al., 2019) (Sun et al., 2022).

The combined presence of excessive iron and microbial contamination suggests multiple contamination pathways, including direct leachate percolation, surface water infiltration, and potential cross-contamination from poor sanitation infrastructure. The absence of a protective landfill lining system and an effective leachate collection mechanism likely exacerbates groundwater pollution. Additionally, soil permeability in the study area may facilitate the downward migration of contaminants, accelerating aquifer contamination (Bao et al., 2025).

4.1 Interpretation of Key Findings

This study provides critical evidence of groundwater contamination in dug wells located near the Karya Jaya Landfill in Palembang. Key parameters, including color (196 TCU), turbidity (248 NTU), total dissolved solids (472 mg/L), low pH (4.4), high iron concentrations (6.15 mg/L), and elevated microbiological counts (total coliform: 25 CFU/100 mL; fecal coliform: 34.5 CFU/100 mL), exceeded permissible limits, indicating significant environmental degradation and potential public health risks. These findings suggest the influence of acidic landfill leachate on groundwater chemistry, particularly in enhancing the solubility and mobility of heavy metals. Furthermore, the detection of fecal indicators implies possible infiltration of pathogenic organisms, raising serious concerns regarding waterborne disease transmission.

4.2 Comparison with Previous Studies

These results are consistent with numerous studies identifying landfill leachate as a primary source of groundwater contamination. For example, previous research has documented increased turbidity and total dissolved solids in proximity to waste disposal sites due to leachate migration (Igboama et al., 2022) (Abd El-Salam and Abu-Zuid, 2015) (Abdel-Shafy et al., 2024) (Parvin and Tareq, 2021). Similarly, high iron concentrations associated with low pH environments have been reported, indicating enhanced metal mobilization under acidic conditions (Beinabaj et al., 2023) (Król et al., 2020) (Ódri et al., 2025), The previous research also found that turbidity and TDS levels in groundwater near landfills tend to be significantly higher than in non-contaminated areas (Wang et al., 2021) (Amano et al., 2021). A distinguishing feature of the present study is the inclusion of microbiological analysis alongside chemical parameters. While prior investigations largely emphasized heavy metals (Shayo et al., 2023) (de Souza et al., 2023), this study reveals that microbial contamination—particularly fecal coliform—constitutes a significant health hazard, potentially linked to inadequate sanitation infrastructure or direct leachate infiltration. This integrated assessment offers a more comprehensive understanding of groundwater vulnerability in landfill-adjacent communities.

4.3 Limitations and Cautions

Despite its valuable contributions, this study is not without limitations. First, the sampling was limited to three stations, potentially restricting spatial generalizability. Future studies should incorporate a larger number of sampling sites to enhance representativeness. Second, this research was conducted during a single period, thereby excluding seasonal fluctuations that may influence contaminant transport and concentration. Longitudinal studies capturing wet and dry seasons are necessary to elucidate temporal variability. Finally, while landfill leachate is inferred as the contamination source, direct chemical characterization of the leachate was not performed. Inclusion of such analysis would provide stronger causal inference and enable more targeted policy recommendations.

4.4 Recommendations for Future Research

To address the aforementioned limitations, future investigations should adopt a more extensive spatial and temporal

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sampling framework. Incorporating detailed chemical profiling of landfill leachate is crucial to confirm its role in groundwater pollution and identify specific hazardous constituents. Interdisciplinary approaches involving hydrogeology, environmental engineering, and public health can offer a holistic perspective on risk assessment and mitigation strategies. Moreover, evaluating the efficacy of remediation technologies—such as constructed wetlands, leachate treatment systems, and biofiltration—will be essential to inform sustainable groundwater protection interventions. Collaborative efforts with local stakeholders and policymakers are recommended to translate research findings into actionable health and environmental policies.

5. CONCLUSION

This study evaluated the water quality of dug wells located near the Karya Jaya Landfill in Palembang. The findings indicate that while the odor and temperature of the water met regulatory standards, several physical, chemical, and biological parameters exceeded permissible limits. Specifically, the color (196 TCU), turbidity (248 NTU), total dissolved solids (472 mg/L), and low pH (4.4) levels, as well as high iron concentrations (6.15 mg/L), raised concerns regarding potential contamination. The elevated levels of total coliform (25 CFU/100 mL) and fecal coliform (34.5 CFU/100 mL) indicate significant biological contamination, which poses potential health risks.

Despite laboratory findings confirming contamination, community perceptions of water quality remain inconsistent. Some residents are aware of basic water quality criteria such as odorlessness and colorlessness, while others lack understanding of specific pollutants and their health implications. Water from dug wells continues to be used for daily activities like bathing and cooking, although bottled water is relied upon for drinking. Skin irritation and other health complaints have been reported, but no formal health impacts have been recorded.

Based on these findings, it is recommended that further investigation be conducted to assess the extent of landfill leachate infiltration into groundwater. Mitigation measures, including improving waste management practices, expanding access to the municipal water supply (PDAM), and increasing public awareness about water quality and associated health risks, are essential. Regular water quality monitoring and education initiatives are necessary to ensure safe and sustainable water resources for the community.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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