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Research Article

Environmental Impact of Domestic Waste on Soil and Water Quality in St. Thomas Parish, Jamaica

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ABSTRACT

Purpose of the study: This study aimed to analyze the impact of domestic waste on environmental conditions in St. Thomas Parish, Jamaica, from environmental and public health perspectives.

Methodology: A mixed-methods approach with a cross-sectional design was employed, combining environmental sampling (soil and water analysis) and field observations with community-based insights. Data were collected from multiple sampling sites representing coastal, residential, and semi-urban areas and analyzed using descriptive statistical and qualitative techniques.

Main Findings: The findings revealed that domestic waste is dominated by organic (46–55%) and plastic (30–39%) components, with daily waste volumes reaching up to 35 kg per site. Soil quality showed acidic conditions (pH 5.6–6.2) with moderate to high contamination, while water quality was characterized by elevated turbidity (18–25 NTU) and microbial presence. Environmental assessments indicated degraded to severely degraded conditions, which were supported by community reports of inadequate waste management practices, such as open dumping and burning.

Novelty/Originality of this study: This study provides a localized, integrative analysis linking environmental degradation with community waste practices in a less-explored parish-level setting, offering new insights into the intersection of environmental science and public health.

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1. INTRODUCTION

The rapid advancement of science and technology has long been expected to improve human welfare and quality of life [1]-[3]. However, these developments often come at a significant environmental cost, particularly when economic and individual interests outweigh ecological considerations [4]-[6]. Expanding industrial activities, increasing population settlements, and intensified land use practices have collectively contributed to environmental degradation, including soil erosion, water contamination, and air pollution [7]-[9]. Within the scope of environmental science, these issues highlight the imbalance between human development and ecological sustainability, raising concerns about the long-term resilience of natural systems.

Domestic waste, as a byproduct of daily human activities, represents a critical yet frequently underestimated source of environmental pollution [10]-[12]. Unlike industrial waste, which is often regulated, household-generated wasteranging from organic refuse to detergents and plastics tends to be poorly managed, especially in semi-urban and rural regions [13]-[15]. In coastal and developing areas such as St. Thomas Parish in Jamaika, inadequate waste management infrastructure exacerbates the accumulation of pollutants in soil and water systems. This condition threatens not only environmental quality but also ecosystem services that are vital for community livelihoods.

Previous studies have demonstrated that domestic waste significantly contributes to nutrient loading, microbial contamination, and chemical pollution in aquatic and terrestrial environments [16]-[18]. Research in a similar geographical context conducted by Sharma et al. [19] shows that poorly managed household waste causes eutrophication in coastal waters, degradation of soil fertility, and increased public health risks. However, most of these studies have predominantly focused on urban or industrialized regions, leaving a critical gap in understanding the localized impacts in less-developed administrative areas such as parish-level regions. This gap limits the applicability of broader environmental management strategies to specific local contexts.

This study addresses this gap by focusing on the environmental consequences of domestic waste in St. Thomas Parish, a region characterized by relatively low levels of urbanization and proximity to sensitive coastal ecosystems. The novelty of this research lies in its localized and context-specific analysis, which integrates environmental indicators such as soil quality, water contamination, and waste accumulation patterns with socio-environmental dynamics. Thus, this study offers a deeper understanding of how domestic waste affects environmental conditions in a region underrepresented in the environmental science literature.

The urgency of this research is underscored by the increasing pressure on natural resources and the limited capacity of local systems to manage waste effectively. As population growth and consumption patterns continue to rise, the volume of domestic waste is expected to increase, potentially exacerbating environmental degradation if not addressed promptly [20]-[22]. Furthermore, the vulnerability of coastal ecosystems in St. Thomas Parish amplifies the risk of irreversible environmental damage, including biodiversity loss and declining ecosystem services [23]-[25].

Therefore, this study aims to analyze the impact of domestic waste on environmental conditions in St. Thomas Parish, Jamaica, by examining key environmental parameters and identifying the underlying factors contributing to pollution. The findings are expected to contribute to the field of environmental science by providing evidence-based insights that can inform sustainable waste management policies and practices, particularly in less-developed and environmentally sensitive regions.

2. RESEARCH METHOD

This study employed a mixed-methods approach within the scope of environmental science to comprehensively assess the impact of domestic waste on environmental conditions in St. Thomas Parish, Jamaika. The integration of quantitative and qualitative methods was intended to ensure analytical depth, data triangulation, and methodological transparency [26]-[28]. The research design combined field-based environmental assessments with community-level observations to capture both ecological and socio-environmental dimensions of domestic waste pollution [29]-[31].

The study adopted a convergent mixed-methods design, in which quantitative environmental measurements and qualitative field observations were conducted simultaneously and integrated during the interpretation stage. A cross-sectional research design was applied to represent the existing environmental conditions during the period of data collection [32]. Primary data were obtained through environmental sampling and structured observations, while qualitative insights were collected through field notes and informal community engagement. The research focused on three major environmental compartments, namely soil, water, and residential surroundings, because these areas are directly affected by domestic waste disposal activities.

To ensure systematic and measurable data collection, several research variables were identified and operationalized based on commonly used environmental quality indicators [33], [34]. Environmental indicators included physical, chemical, and biological parameters commonly used in environmental science studies to assess pollution levels. The selection of these variables was based on their relevance to domestic waste contamination and their sensitivity in reflecting environmental degradation.

Table 1. Research Variables and Indicators

Variable	Indicator	Measurement Method
Domestic Waste	Volume, type (organic/inorganic)	Observation, field recording
Soil Quality	pH, texture, contamination level	Soil sampling and laboratory test
Water Quality	pH, turbidity, microbial content	Water sampling and lab analysis
Environmental Condition	Cleanliness, waste accumulation	Visual assessment checklist

The variables presented in Table 1 served as the foundation for the data collection process and ensured consistency across all sampling locations. Each indicator was measured using standardized environmental assessment procedures to improve reliability and comparability of findings. Soil pH was measured using a digital soil pH meter, while water turbidity was analyzed using a turbidity meter. Microbial analysis was conducted through standard laboratory testing procedures to identify contamination levels in water samples [35]. Structured observation sheets were also used to document waste accumulation patterns, disposal behavior, and general environmental cleanliness.

Sampling was conducted using a purposive sampling technique by selecting locations that exhibited visible domestic waste accumulation or were categorized as environmentally vulnerable areas, such as residential settlements near rivers, drainage systems, and coastal zones. A total of 12 sampling points were selected to represent diverse environmental settings, consisting of residential areas, water bodies, and surrounding public environments. The selected locations were considered representative of the environmental conditions in the study area. To ensure data validity and minimize contamination risks, all soil and water samples were collected following standard environmental sampling protocols. Environmental measurements were conducted twice at each sampling point to improve data reliability and consistency. All laboratory procedures followed standardized environmental testing techniques to maintain accuracy and reproducibility.

Data collection procedures were conducted in several sequential stages. The first stage involved a preliminary field survey to identify critical waste accumulation areas and establish baseline environmental observations. The second stage involved environmental sampling, where soil and water specimens were collected from each selected location for laboratory analysis. The third stage involved structured environmental observations to document waste disposal patterns, waste types, environmental cleanliness, and visible signs of pollution. Simultaneously, qualitative field notes and informal community interactions were carried out to obtain contextual information regarding local waste management practices and environmental awareness. Figure 1 illustrates the overall research procedure, including preliminary surveys, environmental sampling, laboratory analysis, field observation, data processing, and interpretation.

Figure 1. Structure research

Data analysis was performed using both quantitative and qualitative approaches. Quantitative environmental data were analyzed using descriptive statistical techniques, including mean values, percentages, and standard deviations, to determine the level of pollution and environmental degradation [36]. Qualitative data obtained from field observations and community interactions were analyzed through thematic interpretation to identify patterns related to waste disposal behavior and environmental conditions [37], [38]. The integration of quantitative and qualitative findings enabled a more comprehensive understanding of the relationship between domestic waste and environmental quality. To maintain ethical research practices, all field observations and informal community interactions were conducted with respect for participant privacy and environmental ethics. All research procedures were documented systematically to ensure transparency, consistency, and reproducibility of the study.

3. RESULTS AND DISCUSSION

This section presents the findings of the study on the impact of domestic waste on environmental conditions in St. Thomas Parish, Jamaika. The results are organized according to the research variables, including domestic waste characteristics, soil quality, water quality, and overall environmental conditions. Both quantitative measurements and qualitative observations are integrated to provide a comprehensive understanding of the environmental impacts. Initial observations focused on identifying the types and distribution of domestic waste across selected sampling locations. The findings indicate that waste composition varies slightly between inland and coastal areas but is generally dominated by organic and plastic waste.

Table 2. Composition and Volume of Domestic Waste at Sampling Sites

Sampling Site	Organic Waste (%)	Plastic Waste (%)	Other Waste (%)	Estimated Daily Volume (kg)
Site A (Coastal)	48	37	15	32
Site B (Residential)	55	30	15	28
Site C (Near River)	51	34	15	30
Site D (Semi-urban)	46	39	15	35

The data in Table 2 show that organic waste constitutes the largest proportion across all sites, followed by plastic waste. These averages indicate that organic waste remains dominant; however, plastic waste constitutes a substantial proportion, particularly in coastal (37%) and semi-urban areas (39%). Notably, coastal and semi-urban areas exhibit higher plastic waste accumulation, indicating potential risks for marine pollution.

The higher plastic waste concentration in coastal and semi-urban areas suggests a direct relationship between population density, consumption patterns, and inadequate waste management systems. In particular, areas with higher waste volume (up to 35 kg/day) also show increased plastic accumulation, indicating a positive correlation between waste generation intensity and environmental pressure. To better illustrate waste distribution patterns, the comparison is presented in the following figure 2.

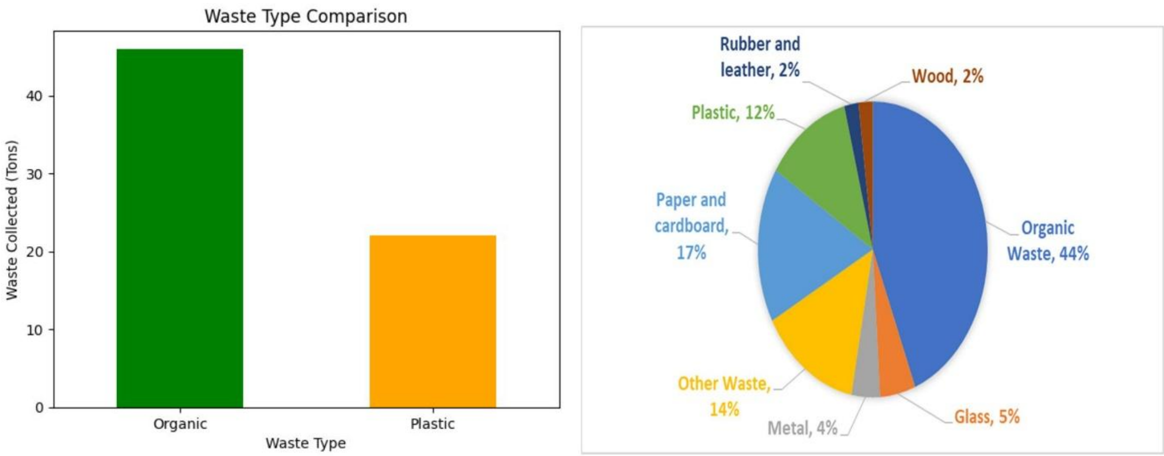

Figure 2. Composition of Domestic Waste Across Sampling Sites

The visualization confirms that plastic waste is relatively higher in coastal and semi-urban zones, supporting the hypothesis of environmental leakage toward aquatic systems. The relatively high daily waste volume reflects inadequate waste management practices and increasing consumption patterns within local communities. Soil samples were collected to evaluate the extent of contamination associated with domestic waste disposal. The analysis focused on pH levels and visible contamination indicators.

Table 3. Soil Quality Parameters at Sampling Sites

Sampling Site	Soil pH	Texture	Contamination Level
Site A	6.2	Sandy loam	Moderate
Site B	5.8	Clay loam	High
Site C	6.0	Silty soil	Moderate
Site D	5.6	Clay	High

Natural soil pH for productive land typically ranges from 6.0–7.5. The observed values indicate that several sites (Site B and D) fall below optimal conditions, suggesting soil acidification. As presented in Table 3, soil pH across all sites tends to be slightly acidic, particularly in residential and semi-urban areas. Higher contamination levels were observed in Site B and Site D, which correspond to areas with more concentrated domestic waste disposal. Higher contamination levels correspond with lower pH values, indicating a possible relationship between domestic waste accumulation and soil chemical degradation. Sites with higher waste exposure show increased acidity, likely due to decomposition of organic matter and leachate infiltration.

These findings suggest that prolonged exposure to household waste may alter soil chemical properties and reduce soil quality. Water samples were analyzed to determine the extent of pollution in nearby water bodies affected by domestic waste. Key parameters included pH, turbidity, and microbial presence.

Table 4. Water Quality Measurements

Sampling Site	pH	Turbidity (NTU)	Microbial Presence
Site A	6.5	18	Detected
Site B	6.3	22	Detected
Site C	6.6	20	Detected
Site D	6.2	25	Highly Detected

According to general clean water standards, turbidity for safe water conditions is typically < 5 NTU. All sampling sites significantly exceed this threshold, indicating severe water quality degradation. Table 4 indicates that water quality in all sampling sites is compromised. Turbidity levels exceed typical clean water standards, and microbial contamination is present across all locations, with the highest level observed in semi-urban areas.

These results confirm that domestic waste contributes significantly to water pollution, particularly through runoff and improper waste disposal near water sources. A clear pattern is observed where sites with higher waste accumulation (Site D and B) also exhibit higher turbidity and microbial contamination. This indicates a strong relationship between domestic waste discharge and water pollution through surface runoff and improper disposal near water bodies.

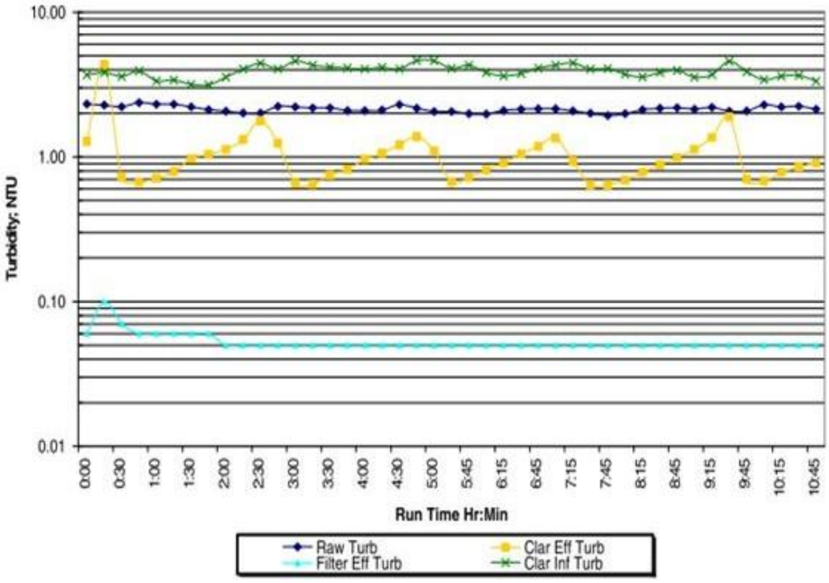

Figure 3. Water Turbidity Levels Across Sampling Sites

The figure highlights that Site D exhibits the highest turbidity level, confirming severe environmental stress in semi-urban areas. Environmental conditions were evaluated through direct observation using a structured checklist to assess cleanliness and waste accumulation.

Table 5. Environmental Condition Assessment

Sampling Site	Cleanliness Level	Waste Accumulation	Environmental Condition
Site A	Low	High	Degraded
Site B	Very Low	Very High	Severely Degraded
Site C	Low	High	Degraded
Site D	Very Low	Very High	Severely Degraded

The findings in Table 5 reveal that environmental conditions across all sites are generally poor. Residential and semi-urban areas exhibit the most severe degradation, characterized by high waste accumulation and low levels of cleanliness. This pattern highlights the direct relationship between domestic waste disposal behavior and environmental quality. To complement environmental data, informal interviews were conducted with local residents to understand waste management practices and perceptions.

Table 6. Result Community Responses

Respondent Code	Main Issue Identified	Waste Disposal Practice	Awareness Level
R1	Lack of waste facilities	Open dumping	Low
R2	Irregular waste collection	Burning waste	Moderate
R3	Limited government support	Disposal near river	Low
R4	Increasing plastic use	Mixed disposal	Moderate

The responses summarized in Table 6 indicate that inadequate infrastructure and limited environmental awareness are key factors contributing to improper waste management. Most respondents reported reliance on informal disposal methods such as open dumping and burning, which further exacerbate environmental degradation. The findings of this study demonstrate that domestic waste significantly contributes to environmental degradation in St. Thomas Parish, Jamaika, with clear implications for public and environmental health. The accumulation of organic and plastic waste, as observed across all sampling sites, reflects inadequate waste management practices that directly affect soil and water quality [39]-[41]. From the perspective of general health professionals, these environmental conditions are closely linked to increased risks of communicable diseases, exposure to harmful pathogens, and reduced quality of life [42]-[44]. Poor environmental sanitation, particularly in residential and semi-urban areas, creates pathways for disease transmission through contaminated water, vectors, and direct human contact with waste [45]-[47].

These findings are consistent with previous research indicating that unmanaged domestic waste contributes to microbial contamination and environmental health risks, especially in low-resource settings. Studies conducted in similar coastal and developing regions have shown that improper household waste disposal leads to increased turbidity, bacterial proliferation, and chemical imbalance in water systems [35], [48], [49]. Research also Tytova [50] focuses on urban centers or large-scale environmental systems, often neglecting the local context at the parish level. This study bridges this gap by providing empirical evidence from a less developed administrative area, thereby strengthening the contextual relevance of environmental health research.

The novelty of this study lies in its integrative approach, combining environmental measurements with community-based observations to reveal the interconnectedness between environmental degradation and public health risks. Unlike conventional environmental assessments that focus solely on physical or chemical indicators, this research incorporates behavioral and infrastructural dimensions, highlighting how community practices and limited waste management systems contribute to environmental decline [51]-[53]. This approach aligns with the interdisciplinary nature of general health professions, where environmental, social, and behavioral determinants of health are considered simultaneously [54]-[56]. The localized focus on St. Thomas Parish further enhances the originality of the study by addressing an underrepresented geographical area in the literature.

From a practical standpoint, the implications of this study are both immediate and long-term. In the short term, the presence of microbial contamination in water sources and high levels of waste accumulation indicate an urgent need for public health interventions, including community education, improved sanitation practices, and accessible waste disposal facilities. Health professionals play a critical role in promoting environmental health awareness and preventive strategies to reduce exposure risks [57], [58]. In the long term, sustained environmental degradation may lead to chronic health issues, ecosystem imbalance, and reduced access to clean water resources [59], [60]. Therefore, integrated policies that combine environmental management with public health strategies are essential to ensure sustainable development and community well-being.

Despite its contributions, this study has several limitations that should be acknowledged. The cross-sectional design provides a snapshot of environmental conditions but does not capture seasonal variations or long-term trends in waste accumulation and environmental impact. Additionally, the scope of laboratory analysis was limited to basic parameters, which may not fully represent the complexity of chemical pollutants present in domestic waste. The qualitative component, while valuable, relied on a relatively small number of respondents, which may limit the generalizability of community perspectives. Future research should consider longitudinal designs, expanded laboratory testing, and larger sample sizes to provide a more comprehensive understanding of environmental and health impacts.

4. CONCLUSION

This study aimed to analyze the impact of domestic waste on environmental conditions in St. Thomas Parish, Jamaica, and the findings clearly demonstrate that unmanaged household waste significantly contributes to environmental degradation. The results indicate high proportions of organic (46–55%) and plastic waste (30–39%), which are associated with declining soil quality (pH 5.6–6.2, moderate to high contamination), deteriorating water conditions (turbidity 18–25 NTU with microbial presence), and overall poor environmental cleanliness. These conditions highlight a direct link between domestic waste practices and environmental health risks, particularly in residential and semi-urban areas, where waste accumulation is most severe. In conclusion, domestic waste has a measurable and adverse impact on environmental quality, affecting soil, water, and overall ecosystem conditions, which in turn poses significant risks to public health. Strengthening community-based waste management systems and improving environmental health education are essential to mitigate these impacts. Future studies are recommended to adopt longitudinal designs and expand environmental parameters to better understand long-term ecological and health consequences.

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AUTHOR CONTRIBUTIONS

Conceptualization, Methodology, Formal Analysis, Investigation, Resources, Data Curation, Writing – Original Draft Preparation, and Visualization, CC.; Writing – Review & Editing, CC and DRCM; Supervision and Project Administration, CC and DRCM. All authors have read, reviewed, and provided approval for the final version of the manuscript submitted for publication.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

INFORMED CONSENT STATEMENT

Prior to participation, each subject was provided with a detailed explanation of the study's objectives, procedures, potential risks, and benefits. All participants voluntarily agreed to participate and signed a written informed consent form. All images in this article have been authorized and are the property of the authors.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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