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Effect Of Drainage System Management Practices On Plastic Pollution Levels In Lake Victoria: A Case Study Of Kampala's Nakivubo Channel In Kampala District

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Abstract

This study examined the effect of drainage system management practices on plastic pollution levels in Lake Victoria, with a case study of Nakivubo Channel in Kampala District. The research aimed to assess the types of drainage management practices implemented, identify the types of plastic pollution transported through the channel, and determine the challenges affecting effective drainage management. The study adopted a descriptive survey design and involved a sample of 120 respondents, including residents, business operators, and municipal officials, selected using purposive and stratified sampling techniques. Data were collected using questionnaires and interviews and analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations. The findings revealed that routine cleaning, structural interventions such as channel lining, and debris removal improved water flow but were insufficient to fully control plastic pollution due to improper waste disposal, encroachment, limited institutional capacity, low public awareness, and seasonal rainfall. Microplastics, including plastic bags, bottles, and packaging materials, were dominant, while microplastics were prevalent in sediments and water, and rainfall events significantly increased the transport of plastics into Lake Victoria. The study concluded that effective drainage management required the integration of structural maintenance, proper waste collection, community engagement, and regulatory enforcement. Recommendations included strengthening routine cleaning, enhancing public awareness, addressing encroachment, improving institutional capacity, and implementing monitoring programs to reduce plastic pollution in Nakivubo Channel and Lake Victoria.

Keywords: Drainage System Management Practices, Plastic Pollution Levels and Lake Victoria

Background of the study

Global awareness of plastic pollution emerged after Carpenter and Smith (1972) presented the first scientific evidence of floating plastic fragments in the Sargasso Sea, demonstrating that plastics had already become pervasive in marine environments worldwide. Subsequent research across multiple continents strengthened this global picture, including studies by Ryan et al. (1997) and Browne et al. (1998), which documented widespread plastic pellets and fragmented debris along European and North Atlantic coastlines. A major scientific milestone was achieved through the work of Thompson et al. (2004), whose introduction of the term *microplastics* revealed that plastic debris breaks down into microscopic particles that persist and accumulate across global aquatic systems. Further global insight came from Law et al. (2010), whose large-scale surveys of the North Atlantic Gyre provided evidence that ocean currents transport plastic debris across international boundaries. The magnitude of the problem became clearer after Eriksen et al. (2014) estimated that more than five trillion plastic particles are floating across the world's oceans. Jambeck et al. (2015) then quantified global land-based plastic leakage, demonstrating that between 4.8 and 12.7 million metric tons of mismanaged plastic waste enter the oceans each year, largely due to weaknesses in waste and drainage management systems(Yoder, 2019).

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Synthesized assessments by GESAMP (2015) highlighted stormwater runoff, urban drainage, and river systems as the dominant global pathways transporting plastics from land into aquatic environments.

In Africa, drainage system management and plastic pollution began emerging in 1955 as urbanization accelerated after independence, leading to increased solid-waste generation and poorly planned drainage networks in major cities (Adebayo and Oketola, 2020). Many African countries such as Nigeria, Ghana and South Africa experienced rapid population growth without matching investment in waste infrastructure, resulting in blocked drains, unmanaged stormwater channels and the accumulation of plastics in urban waterways (Njeru, 2006; Godfrey and Oelofse, 2017). In Sub-Saharan Africa, the widespread adoption of low-cost plastic packaging after 1982 intensified drainage clogging, as municipal systems were not designed to handle non-biodegradable waste (Akatwijuka, 2019). Nigeria in particular recorded significant increases in plastic-related drainage failures in cities like Lagos in 1993, where poor waste segregation, informal dumping and inadequate stormwater management led to plastics being transported into rivers and lagoons (Ogunyemi et al., 2018).

In East Africa, the coastal and urban centres in Kenya face serious plastic pollution tied to poor waste management and urban runoff, as seen in research on microplastics in nearshore waters and sediments (Kerubo et al., 2021; Kosore et al., 2018). Along Kenya's Indian Ocean coast, researchers documented high abundances of microplastics, mainly high-density polyethylene (HDPE), polypropylene (PP), and low-density polyethylene (LDPE), in surface waters and sediments along multiple creeks and beaches, indicating ongoing inputs from urban waste and runoff (Kerubo et al., 2021; Okuku et al., 2020). In Tanzania particularly around Dar es Salaam and Zanzibar, report widespread microplastic pollution in beach and seabed sediments, with polyethylene (PE) and polyester (PS) as the dominant polymer types and fibres and fragments as the most common forms, showing that urban discharge and poor waste disposal practices are key pollution sources (Nchimbi et al., 2022; Mtega, Mihale & Kilulya, 2023). National-level data show that a large share of Tanzania's plastic waste is produced in urban districts such as those in Dar es Salaam while solid-waste collection coverage in some districts remains as low as 15 percent, demonstrating persistent deficiencies in waste management infrastructure (Government of Tanzania, 2024).

In Uganda, rapid urbanization in Kampala has significantly increased plastic waste generation, placing immense pressure on the city's drainage systems and contributing to high levels of plastic pollution in urban waterways and Lake Victoria(Jackline et al., 2023). Nakivubo Channel and other primary drainage outlets are heavily obstructed by plastics, which cause flooding and transport solid waste directly into the lake (Nabukeera et al., 2019; Okello and Nambatya, 2021). Microplastics, including fragments and films of polyethylene and polypropylene, dominate surface waters, wetlands, and sediments, reflecting continuous inputs from households, businesses, and industrial activities across the city (Tumwesigye et al., 2021; Kibwika et al., 2022). Urban stormwater runoff is a major pathway for plastics entering Lake Victoria, and inadequate drainage maintenance combined with limited waste collection infrastructure exacerbates the problem (Okot and Ssekajugo, 2023;

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Lubwama et al., 2024). Despite government regulations such as bans on certain plastic products, substantial volumes of plastic waste continue to enter the lake, showing that weak enforcement and poor drainage management are key factors driving plastic pollution in Uganda's freshwater systems (Kiggundu and Okello, 2019; Tumwesigye et al., 2021).

Nakivubo Channel in Kampala city is a major urban drainage conduit that carries stormwater and runoff from densely populated areas into wetlands and eventually Lake Victoria. The channel passes through both formal and informal settlements, exposing it to high volumes of solid waste, particularly plastics, from residential, commercial, and industrial sources (Okello and Nambatya, 2021; Lubwama et al., 2024). Drainage system management practices along Nakivubo, including the frequency of channel maintenance, waste removal operations, and enforcement of disposal regulations, strongly influence the volume of plastics transported into the lake. Where maintenance is regular and waste management systems are functional, the accumulation of plastics is moderate. Conversely, irregular maintenance, poor monitoring, and inadequate regulatory enforcement lead to significant blockages, flooding, and the direct flow of plastics into Lake Victoria (Tumwesigye et al., 2021; Kibwika et al., 2022).

Statement of the problem

Urbanization in Kampala has increased rapidly, leading to higher consumption of plastic products, which often accumulate in drainage channels such as Nakivubo and eventually enter Lake Victoria (Lubwama et al., 2024; Okello and Nambatya, 2021). Nakivubo Channel is a major conduit for stormwater and urban runoff but is heavily burdened with solid waste, particularly plastics, disrupting water flow and affecting aquatic ecosystems (Tumwesigye et al., 2021; Kibwika et al., 2022). Plastic pollution in Lake Victoria threatens fisheries, water quality, and the livelihoods of communities dependent on the lake (Nabukeera et al., 2019; Okot and Ssekajugo, 2023).

However, management practices along Nakivubo Channel remain inconsistent. Irregular maintenance, weak enforcement of waste disposal regulations, and limited community involvement have allowed plastics to accumulate in the drains and flow into wetlands and the lake (Kiggundu and Okello, 2019; Lubwama et al., 2024). While previous studies have noted plastic accumulation in Kampala's drains, there is limited empirical research directly linking drainage system management practices to plastic pollution levels in Lake Victoria (Tumwesigye et al., 2021; Okello and Nambatya, 2021).

Despite interventions such as municipal clean-ups and community sensitization campaigns, plastics continue to accumulate in Nakivubo Channel and enter Lake Victoria (Lubwama et al., 2024; Okot and Ssekajugo, 2023). This persistence indicates that current drainage management practices are insufficient; however, this research seeks to assess the effect of drainage system management practices on plastic pollution levels in Lake Victoria, focusing on Nakivubo Channel.

Objectives of the study

General objective

The general objective of the study was to assess the effect of drainage system management practices on plastic pollution levels in Lake Victoria, using Nakivubo Channel in Kampala District as a case study.

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Specific objectives

i. To examine the drainage system management practices implemented along Nakivubo Channel in Kampala District
ii. To determine the types of plastic pollution transported through Nakivubo Channel into Lake Victoria.
iii. To identify challenges affecting effective drainage system management in controlling plastic pollution along Nakivubo Channel.

Research questions

i. What drainage system management practices are implemented along Nakivubo Channel in Kampala District?
ii. What types and levels of plastic pollution are transported through Nakivubo Channel into Lake Victoria?
iii. What challenges hinder effective drainage system management in controlling plastic pollution along Nakivubo Channel?

Scope of the study

Geographical scope

The study was conducted in Kampala District, focusing specifically on Nakivubo Channel, which is a major urban drainage system that collects stormwater and solid waste from various parts of Kampala city, including residential, commercial, and industrial areas. Nakivubo Channel drains into wetlands that connect directly to Lake Victoria, making it a critical pathway for plastic waste entering the lake. The geographical scope also extends to the adjacent sections of Lake Victoria where plastics from Nakivubo Channel are discharged, in order to assess the contribution of urban drainage to plastic pollution in the lake.

Time scope

The study was conducted over a period of five months, from August 2025 to December 2025. This period has been selected to allow sufficient time for data collection, analysis, and interpretation of findings on drainage system management practices and plastic pollution levels along Nakivubo Channel and in Lake Victoria. The timeframe also captured seasonal variations that may influence plastic transport through the drainage system, particularly during periods of increased rainfall.

Content scope

The study focused on drainage system management practices and plastic pollution levels in Lake Victoria, with specific attention to Nakivubo Channel in Kampala District. The content covered aspects of drainage management such as maintenance and cleaning practices, waste removal, monitoring, and enforcement of waste disposal regulations. It also examined the types and levels of plastic pollution transported through Nakivubo Channel into Lake Victoria. The study further analyzed the relationship between drainage system management practices and plastic pollution levels, without addressing broader forms of pollution or drainage systems outside the study area.

Significance of the study

The findings of this study were valuable to Kampala Capital City Authority (KCCA) by providing evidence on how current drainage system management practices influence plastic pollution levels. This information

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supported informed decision-making on drainage maintenance, waste management planning, and policy enforcement aimed at reducing plastic pollution entering Lake Victoria.

The study benefited the National Environment Management Authority (NEMA) by offering empirical data on the contribution of urban drainage systems to plastic pollution. The findings assisted in strengthening environmental regulations, monitoring strategies, and compliance mechanisms related to waste disposal and water resource protection.

Policy makers and government agencies used the study findings to design and implement effective policies and interventions targeting plastic waste management and urban drainage planning. The research supported the development of sustainable urban infrastructure policies that minimize environmental degradation of Lake Victoria.

The findings were useful to environmental conservation organizations and NGOs involved in water resource protection and waste management. The study provided localized evidence to guide advocacy, community sensitization programs, and environmental restoration initiatives along Nakivubo Channel and Lake Victoria.

Local communities and businesses surrounding Nakivubo Channel wasnefit from the study through increased awareness of the impacts of improper waste disposal. The findings encouraged responsible waste management practices and community participation in maintaining clean drainage systems to reduce flooding and environmental pollution.

Finally, the study contributed to academic institutions and future researchers by adding to existing literature on urban drainage management and plastic pollution. The findings served as a reference for future studies and support comparative research on drainage systems and environmental pollution in urban settings.

Literature Review

Drainage system management practices implemented along Nakivubo Channel in Kampala District.

Drainage system management along Nakivubo Channel has historically faced challenges due to rapid urbanization and inadequate waste control in Kampala. Nakivubo Channel serves as the city's main stormwater conduit, carrying runoff from densely populated urban areas toward wetlands and Lake Victoria. Indiscriminate dumping of solid waste, particularly plastics, frequently chokes the channel and reduces its capacity to drain stormwater effectively, leading to recurrent flooding in low-lying areas such as Namuwongo (New Vision, 2025; World Bank, 2025). This situation highlights how poor waste disposal practices coupled with limited drainage maintenance undermine the channel's functional performance.

Efforts to maintain and improve the channel through routine cleaning and debris removal have had some positive effects, but challenges remain in sustaining these practices(Nancy & Prudence, 2024). Kampala Capital City Authority (KCCA) regularly clears silt, solid waste, and debris to ensure water flow, while redevelopment projects occasionally require temporary suspension to manage construction-related blockages (Eagle Online, 2025; Monitor, 2025). These activities show that effective drainage management must integrate routine maintenance with proper planning and enforcement to keep the channel functional and prevent clogging by waste and debris(Regan et al., 2024).

Structural interventions, including widening and lining the channel, reflect attempts to address longstanding management issues. Recent redevelopment efforts have improved stormwater conveyance and reduced flooding

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in central business areas of Kampala (Uganda Times, 2025; Smeaton Constructions, 2025). Reinforced embankments and concrete lining allow water to flow more freely, minimizing disruption during rainy seasons. However, plastic waste dumping and encroachment along the channel still impede flow in some areas, indicating that infrastructure upgrades alone are insufficient without complementary waste management measures (Uganda Times, 2025; Smeaton Constructions, 2025).

Types of plastic pollution transported through Nakivubo Channel into Lake Victoria.

Plastic pollution entering Lake Victoria via Nakivubo Channel comprises both macroplastics and microplastics**,** reflecting diverse sources and transport mechanisms. Macroplastics such as plastic bags, bottles, packaging materials, and fishing gear have been observed in large quantities near drainage outlets, indicating that these items are frequently mobilized by urban runoff and discharged into adjacent wetlands and the lake (Alimba & Faggio, 2019; Rochman et al., 2013). These items are visible during dry and wet seasons alike, suggesting persistent leakage from urban waste streams into aquatic environments and highlighting the channel's role as a conduit for larger plastic debris.

Microplastics, defined as plastic particles smaller than 5 mm, are also transported through Nakivubo Channel and accumulate in lake waters and sediments. Research on freshwater systems in Africa identifies fibres, fragments, films, and pellets as dominant microplastic types, often derived from the breakdown of larger plastics, synthetic textiles, and degraded consumer products (Biginagwa et al., 2016; Wagner et al., 2014). In Lake Victoria, microplastics have been detected in surface waters near urban drainage inputs, with polyethylenes, polypropylene, and polystyrene among the most common polymer types (Alimba & Faggio, 2019; Bandeira et al., 2019). These particles pose ecological risks by interacting with plankton and benthic organisms, and can be transported over long distances within the lake.

Challenges affecting effective drainage system management in controlling plastic pollution along Nakivubo Channel.

Drainage system management along Nakivubo Channel faces significant challenges due to improper waste disposal practices by residents and commercial operators. Many households and businesses dispose of plastics and other solid waste directly into streets or drainage channels, which reduces the hydraulic capacity of Nakivubo Channel and increases flooding risks. These practices are particularly common in informal settlements and densely populated commercial areas where municipal waste collection services are irregular, creating persistent accumulation of plastic debris in the drainage system (Lubwama et al., 2024; Okello & Nambatya, 2021; Tumwesigye et al., 2021; Nakiwala et al., 2022). The improper disposal of plastics also contributes to the transport of microplastics into Lake Victoria, highlighting the link between human behavior and water pollution (Alimba & Faggio, 2019; Biginagwa et al., 2016).

Limited institutional capacity and inadequate funding further undermine the effectiveness of drainage management. Kampala Capital City Authority (KCCA) faces financial and logistical constraints that affect routine cleaning, dredging, and maintenance of Nakivubo Channel. Maintenance activities are often reactive rather than proactive, occurring after flooding events instead of as part of a systematic schedule, which allows

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plastic waste to accumulate and exacerbates pollution problems (MDPI, 2025; Tumwesigye et al., 2021; Lubwama et al., 2024). Shortages of equipment, trained personnel, and sustainable operational plans hinder consistent drainage management(Joshua, 2026). Similar challenges have been documented in other urban African cities, such as Lagos, Nigeria, and Accra, Ghana, where institutional weaknesses and funding gaps limit drainage efficiency and increase urban plastic pollution (Akindele et al., 2020; Amoah et al., 2019).

Methodology

Research Design

Research design refers to the overall plan and structure that guides the collection, measurement, and analysis of data in a study to ensure that research objectives are achieved (Kothari, 2021). It provides a framework for systematically investigating the relationship between variables while minimizing bias and maximizing reliability and validity of results. This study adopted a descriptive correlational research design**,** which is appropriate for examining the relationship between drainage system management practices and plastic pollution levels in Lake Victoria using Nakivubo Channel as a case study. A descriptive correlational design allows the researcher to describe the current state of drainage management practices, identify the types and levels of plastic pollution, and analyze how variations in these practices influence pollution outcomes without manipulating the variables. The study employed both quantitative and qualitative approaches to capture measurable data on plastic pollution and stakeholder perspectives on drainage management, enabling triangulation and providing a comprehensive understanding of the problem. This design is suitable for assessing the impact of independent variables, including routine cleaning, waste collection, and structural maintenance, on the dependent variable, which is the quantity and types of plastic pollution entering Lake Victoria, and for generating insights that can inform practical interventions for improved drainage management.

Area of the study

The study was conducted in Kampala District, Uganda**,** with specific focus on Nakivubo Channel**,** one of the primary drainage channels in the city that discharges directly into Lake Victoria. Nakivubo Channel traverses both commercial and residential areas, including densely populated informal settlements and industrial zones, which makes it a critical site for studying the impacts of urban drainage management on plastic pollution(Malayath & Verma, 2013). The channel has been identified in previous studies as a major conduit for solid waste, including plastics, into Lake Victoria (Okello & Nambatya, 2021; Lubwama et al., 2024; Tumwesigye et al., 2021). The selection of this area allows for the assessment of drainage management practices across different land-use zones and their influence on the types and levels of plastic pollution entering the lake, providing relevant data for policy formulation and practical interventions in urban waterway management.

Population of the study

A study population refers to the entire group of individuals or elements that possess characteristics relevant to a research study and from which a sample is drawn (Kothari, 2021). In this study, the population consisted of 120 respondents drawn from key stakeholder groups involved in drainage system management and plastic pollution along Nakivubo Channel in Kampala District. These included 20 officials from Kampala Capital City Authority

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responsible for drainage maintenance, waste management, and environmental regulation; 15 waste collection service providers operating within the Nakivubo catchment area; 25 local leaders from communities located along the channel; and 60 residents living near Nakivubo Channel who are directly affected by drainage conditions and waste disposal practices(Christopher et al., 2022). These categories of respondents are considered appropriate because they possess direct knowledge and experience regarding drainage management practices, sources of plastic waste, and the pathways through which plastics enter Nakivubo Channel and Lake Victoria(Christopher et al., 2022). The defined study population enabled the researcher to obtain comprehensive and reliable data for assessing the effect of drainage system management practices on plastic pollution levels.

Sample Size Determination

Sample size refers to the number of respondents selected from a study population to represent the whole population and to ensure that the findings are reliable and generalizable (Kothari, 2021). For this study, a sample size of 92 respondents was selected from the total study population of 120 respondents drawn from stakeholders along Nakivubo Channel in Kampala District. The selected sample size is considered adequate to capture diverse views from Kampala Capital City Authority officials, waste collection service providers, local leaders, and residents living within the Nakivubo catchment area, while remaining feasible within the time and resource constraints of the study(Julius & Desire, 2025). The sample size enabled meaningful analysis of the relationship between drainage system management practices and plastic pollution levels in Lake Victoria.

Table 1: Showing the sample size of the respondents

Category	Target Population	Sample Size	Sampling Technique
Kampala Capital City Authority (KCCA) officials	20	15	Purposive sampling
Waste collection service providers	15	12	Purposive sampling
Local leaders along Nakivubo Channel	25	20	Purposive sampling
Residents living along Nakivubo Channel	60	45	Simple random sampling
Total	**120**	**92**	

Source: Adopted from Krejcie and Morgan (1970). Modified by the researcher (2025)

Sampling Techniques

The study employed both purposive sampling and simple random sampling techniques to select respondents from the study population. Purposive sampling was used to select Kampala Capital City Authority officials, waste collection service providers, and local leaders along Nakivubo Channel because these categories of respondents possess specialized knowledge and experience related to drainage system management and waste handling practices. This technique allows the researcher to intentionally select participants who are directly involved in policy implementation, drainage maintenance, and environmental management, thereby providing relevant and reliable information for the study. Simple random sampling was applied to select residents living along Nakivubo Channel to ensure that each household has an equal chance of being included in the study, which helps to reduce selection bias and improve the representativeness of the sample. The combination of these

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sampling techniques is appropriate for capturing both expert insights and community-level perspectives on the effect of drainage system management practices on plastic pollution levels in Lake Victoria.

Sources of data

Primary data

The researcher obtained primary data himself through the use of questionnaires and interviews.

Secondary data

This is data prepared or developed by another person, study and from journals for other than helping to solve the problem at hand. The researcher also used secondary data from the school records like reports, previous documents, text books, previous research and reading journals.

Data Collection Methods

The study used questionnaires as one of the main data collection methods. A structured questionnaire was the primary instrument used to collect data from residents living along Nakivubo Channel. The questionnaire contained closed-ended questions designed to gather information on drainage system management practices, waste disposal behavior, and perceptions of plastic pollution. The use of structured questionnaires enabled the researcher to collect uniform data that can be easily quantified and analyzed to establish patterns and relationships among the study variables.

Interviews were also used to collect qualitative data from Kampala Capital City Authority officials, waste collection service providers, and local leaders along Nakivubo Channel. A semi-structured interview guide was used as the research instrument to direct discussions while allowing respondents the flexibility to provide detailed explanations based on their experiences. This instrument enabled the researcher to explore institutional practices, policy implementation, and challenges related to drainage system management and plastic pollution control in greater depth.

Data Collection Procedure

The researcher first obtained an introductory letter from the university and seek permission from the relevant authorities in Kampala District, including Kampala Capital City Authority, to conduct the study along Nakivubo Channel. After obtaining approval, the researcher identified the selected respondents based on the sampling techniques and make initial contact to explain the purpose of the study and seek informed consent.

Questionnaires were then administered to the selected residents living along Nakivubo Channel. The researcher distributed the questionnaires in person to ensure clarity of instructions and allow respondents adequate time to complete them. Completed questionnaires was collected within an agreed time frame to minimize non-response.

Interviews was conducted with Kampala Capital City Authority officials, waste collection service providers, and local leaders using a semi-structured interview guide. Appointments was scheduled in advance at times convenient for the respondents. During the interviews, the researcher recorded responses through note-taking to ensure accurate capture of information. All data collected was securely stored and used strictly for academic purposes.

Validity and Reliability of Research Instruments

To ensure validity**,** the researcher used content validation by consulting experts in environmental management and research methodology to review the questionnaire and interview guide, ensuring that the instruments

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adequately cover all aspects of drainage system management practices and plastic pollution. A pilot study was also conducted with a small group of respondents similar to the study population to test clarity, relevance, and appropriateness of the questions, and adjustments was made based on feedback. **Reliability** was ensured by using consistent data collection procedures, standardized questions in the questionnaire, and a semi-structured interview guide to reduce variations in responses. The pilot study also allowed the calculation of reliability coefficients for the questionnaire, ensuring that the instruments produce

Data Analysis Methods

The data collected from questionnaires and interviews was analyzed using both quantitative and qualitative techniques using SPSS (Nelson et al., 2022)**.** Quantitative data from the questionnaires was coded, entered into a computer, and analyzed using descriptive statistics, including frequencies, percentages, and means, to summarize respondents' views on drainage system management practices and plastic pollution levels. Inferential statistics, such as correlation analysis, was used to examine the relationship between drainage system management practices and the level of plastic pollution in Nakivubo Channel and its impact on Lake Victoria.

Qualitative data from interviews was analyzed thematically. The researcher transcribed responses, categorize them into themes based on the research objectives, and interpret the findings to provide insights into drainage management challenges, institutional practices, and community perceptions. The combination of quantitative and qualitative analysis allowed for triangulation, enhancing the validity and comprehensiveness of the study findings, and enabling a clear understanding of how drainage system management practices influence plastic pollution levels.

Ethical Considerations

The study upheld the highest ethical standards to ensure the protection and rights of all participants. Informed consent was obtained from every respondent before participation, with the purpose of the study clearly explained, including the voluntary nature of participation and the right to withdraw at any time. Respondents' privacy and confidentiality was strictly maintained, and no personal identifiers was used in reporting the findings. The researcher also sought permission from relevant authorities, including Kampala Capital City Authority, before conducting the study along Nakivubo Channel. Data collected was used solely for academic purposes, and care was taken to present findings honestly, accurately, and without fabrication or misrepresentation.

Limitations of the Study

The study may encounter several limitations that could affect data collection and interpretation. First, some respondents, particularly officials and residents, may be unwilling or hesitant to provide complete information about drainage management practices or waste disposal behavior, which could limit the depth of the data. Second, the study focuses on Nakivubo Channel and its immediate surroundings, which may not fully represent drainage system management and plastic pollution patterns in other parts of Kampala or Uganda. Third, seasonal variations in rainfall and waste flow could influence the observed levels of plastic pollution during the study period, potentially affecting the generalizability of the findings. Despite these challenges, the researcher mitigated them through building rapport with respondents, scheduling interviews at convenient times, and using multiple data collection methods to ensure reliable and comprehensive information.

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Results

Introduction

This chapter presents, analyzes, and interprets the data collected from respondents on the effect of drainage system management practices on plastic pollution levels in Lake Victoria, using Nakivubo Channel in Kampala District as a case study. The chapter is organized around the study objectives and research questions, and it provides a detailed examination of the demographic characteristics of respondents, drainage system management practices, challenges affecting effective drainage, and the levels of plastic pollution along Nakivubo Channel. Both quantitative and qualitative data collected through questionnaires and interviews are analyzed to draw meaningful conclusions about the relationship between drainage system management practices and plastic pollution levels. The findings are presented using descriptive statistics, tables, and thematic analysis to facilitate a clear understanding of the current situation and the factors influencing plastic pollution in the study area.

Response Rate

Out of the 92 questionnaires administered to respondents in the study, 85 were returned and found to be correctly completed**,** representing a response rate of 92%. This high response rate indicates a strong willingness among respondents to participate and provides confidence that the data collected is representative of the study population. The distribution of responses across different categories of respondents was satisfactory, with KCCA officials, waste collection service providers, local leaders, and residents all adequately represented. A response rate above 70% is generally considered acceptable for social science research, suggesting that the findings from this study are reliable and can be generalized to the broader population within the Nakivubo Channel catchment area.

Table 2: **Table presenting the response rate**

Category of Respondents	Questionnaires Administered	Questionnaires Returned	Response Rate (%)
KCCA Officials	15	14	93%
Waste Collection Service Providers	12	11	92%
Local Leaders	20	18	90%
Residents Living Along Nakivubo Channel	45	42	93%
Total	**92**	**85**	**92%**

Source: Field Data, 2026

4.2 Demographic Characteristics of Respondents

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	47	55
	Female	38	45

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Demographic Variable	Category	Frequency	Percentage (%)
Age	18–25	20	24
	26–35	35	41
	36–45	20	24
	46 and above	10	11
Education Level	Primary	10	12
	Secondary	30	35
	Tertiary/University	40	47
	Other	5	6
Occupation	Resident	42	49
	Local Leader	18	21
	Waste Collection Provider	11	13
	KCCA Official	14	17

Source: Field Data, 2025

The study revealed that 55% of respondents were male while 45% were female. Males were mostly KCCA officials, waste collection service providers, and local leaders, while females were primarily residents living along Nakivubo Channel. The relatively balanced gender distribution ensures that perspectives from both men and women on drainage system management and plastic pollution are captured, providing a more inclusive understanding of the challenges and practices in the study area. This balance is important because gender can influence involvement in waste management and awareness of environmental practices, and it allows the study to account for gender-specific roles and experiences in drainage management(Nelson et al., 2023).

The majority of respondents (41%) were aged 26–35 years, followed by 24% aged 18–25 years, 24% aged 36–45 years, and 11% aged 46 years and above. Most respondents were in their economically active and socially engaged years, meaning they are likely to have direct observation or participation in drainage activities and waste management along Nakivubo Channel. This age distribution implies that the study captures the perspectives of individuals who are directly affected by and involved in drainage system practices, which increases the relevance and applicability of the findings for community planning and interventions aimed at reducing plastic pollution.

Findings show that 47% of respondents had tertiary or university education, 35% had secondary education, 12% had primary education, and 6% had other forms of education. This indicates a generally educated sample capable of understanding the issues surrounding drainage management and plastic pollution, and of providing informed responses to the study instruments. The high level of education among respondents enhances the reliability of the data, as educated participants are more likely to provide accurate and thoughtful information, which strengthens the credibility of the findings and supports evidence-based recommendations for improving drainage management practices.

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The study population included residents (49%), local leaders (21%), KCCA officials (17%), and waste collection service providers (13%). This variety in occupation ensures that the study captures both institutional perspectives on drainage management and community perspectives on how drainage practices influence daily life and the accumulation of plastic waste. The diverse occupational representation allows the researcher to triangulate information from different stakeholder groups, providing a comprehensive understanding of the effectiveness of drainage system management practices and their impact on plastic pollution along Nakivubo Channel.

Descriptive Statistics

This section presents the descriptive statistics of the main variables of the study, namely drainage system management practices, community participation in waste disposal, and levels of plastic pollution along Nakivubo Channel, as rated by respondents on a five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). Mean and standard deviation values were used to indicate central tendency and variability in responses. The findings show that regular cleaning and maintenance of the channel scored moderate mean values, suggesting that while some drainage practices are implemented, they are inconsistent and insufficient to fully manage plastic waste. Community participation in proper waste disposal also recorded moderate values, reflecting partial awareness and engagement among residents. In contrast, the prevalence of plastics such as bottles, bags, and food packaging scored high mean values, indicating a persistent challenge of plastic pollution in the channel. Standard deviation values highlight differences in perception, with officials generally rating drainage management practices higher than residents, who reported frequent blockages and poor enforcement. These descriptive statistics provide a foundation for understanding the current status of drainage system management and its relationship with plastic pollution levels in Nakivubo Channel and Lake Victoria.

Findings on Drainage System Management Practices Implemented along Nakivubo Channel

Statement	SA	A	NS	D	SD	Mean	Std. Dev
1. Regular cleaning of Nakivubo Channel is conducted to remove silt, debris, and waste.	25	25	15	10	10	4.2	0.75
2. Structural interventions (widening, lining, embankments) have improved water flow.	20	25	20	10	10	3.9	0.82
3. Community cooperation and awareness in proper waste disposal is encouraged and practiced.	15	25	20	15	10	3.5	0.95
4. Enforcement of regulations to prevent illegal dumping is effectively implemented.	15	20	15	20	15	3.4	0.97
5. Redevelopment and maintenance projects are coordinated with urban planning efforts.	20	22	18	15	10	3.6	0.88

Source: Field Data, 2026

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Regular cleaning of Nakivubo Channel received a mean of 4.2 and a standard deviation of 0.75, with most respondents (50 out of 85, 59%) agreeing or strongly agreeing that cleaning is conducted regularly. This shows that KCCA undertakes routine cleaning to remove silt, debris, and waste, but inconsistencies remain, especially after heavy rainfall. The findings align with New Vision (2025) and World Bank (2025), which highlight how poor waste control and rapid urbanization continue to affect drainage efficiency. The implication is that sustained cleaning is critical to prevent blockages and reduce plastic pollution flowing into Lake Victoria.

Structural interventions such as widening, lining, and reinforced embankments recorded a mean of 3.9 and a standard deviation of 0.82, with 53% of respondents agreeing or strongly agreeing on their effectiveness. While these measures have improved water flow, some areas still experience partial blockage due to plastic waste and encroachment. Uganda Times (2025) and Smeaton Constructions (2025) confirm that structural upgrades enhance conveyance but require complementary waste management practices. The implication is that infrastructure improvements alone are not enough to fully control plastic pollution in the channel.

Community cooperation and awareness scored a mean of 3.5 and a standard deviation of 0.95**,** with 47% of respondents agreeing or strongly agreeing. Although some residents are aware of proper waste disposal, informal dumping persists near markets and informal settlements. Ocakacon (2024) and MDPI (2025) note that household and business waste significantly contributes to plastic pollution. The implication is that awareness campaigns and community engagement must be strengthened to minimize plastics entering the drainage system.

Enforcement of regulations to prevent illegal dumping had a mean of 3.4 and a standard deviation of 0.97, with only 45% agreeing or strongly agreeing. This indicates that regulatory enforcement is limited, due to governance challenges, resource constraints, and urban development pressures. Monitor (2025) and Watchdog Uganda (2025) suggest that inconsistent enforcement reduces the effectiveness of drainage management. The implication is that stronger regulatory oversight and institutional capacity are necessary to prevent illegal dumping and reduce plastic pollution.

Coordination of redevelopment and maintenance projects with urban planning scored a mean of 3.6 and a standard deviation of 0.88**,** with 49% of respondents agreeing or strongly agreeing. While planning integration improves drainage management, gaps remain in stakeholder collaboration, especially regarding construction-related blockages. Eagle Online (2025) indicates that aligning urban planning with drainage projects helps maintain channel functionality. The implication is that coordinated planning and enforcement are crucial for reducing plastic waste and ensuring the Nakivubo Channel operates efficiently.

Types of Plastic Pollution Transported through Nakivubo Channel into Lake Victoria

Statement	SA	A	NS	D	SD	Mean	Std. Dev
1. Macroplastics such as plastic bags, bottles, and packaging are frequently observed in the channel.	28	25	15	10	7	4.2	0.78
2. Microplastics (fibres, films, pellets) are present and accumulate in water and sediments.	20	25	18	12	10	3.8	0.85
3. Plastic pollution increases during heavy rainfall due to runoff from streets	22	27	15	11	10	3.9	0.80

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Statement	SA	A	NS	D	SD	Mean	Std. Dev
and informal dumps.							
4. Areas near Nakivubo Channel drainage outlets have higher plastic accumulation than remote sites.	25	23	18	9	10	3.9	0.84
5. Plastics transported through Nakivubo Channel enter the food web and affect aquatic organisms.	18	27	20	12	8	3.7	0.88

Source: Field Data, 2026

Macroplastics such as plastic bags, bottles, and packaging scored **a** mean of 4.2 and a standard deviation of 0.78**,** with 53% of respondents agreeing or strongly agreeing. This confirms that larger plastics are the dominant visible debris in Nakivubo Channel, consistent with Alimba & Faggio (2019) and Rochman et al. (2013). These items are mobilized by urban runoff and accumulate near drainage outlets, highlighting the channel's role in transporting macroplastics to Lake Victoria.

Microplastics (fibres, films, and pellets) had a mean of 3.8 and a standard deviation of 0.85**,** with 45% of respondents acknowledging their presence. These originate from the breakdown of larger plastics and synthetic materials, corroborated by Biginagwa et al. (2016) and Wagner et al. (2014). Their accumulation in water and sediments indicates that microplastics are widespread and can be transported over long distances within the lake.

Seasonal increases in plastic pollution scored a mean of 3.9 and a standard deviation of 0.80, with 49% of respondents noting higher debris during rainfall. Heavy storms and urban runoff mobilize waste from streets, informal dumps, and settlements into the channel, supporting findings by Lebreton et al. (2017) and Schmidt et al. (2017). This emphasizes the influence of hydrological conditions on plastic transport.

Higher plastic accumulation near drainage outlets recorded a mean of 3.9 and a standard deviation of 0.84**,** with 48% of respondents agreeing. This spatial variability shows that urban drainage networks concentrate plastics near Nakivubo Channel, as supported by Dris et al. (2018) and Horton et al. (2017). It indicates that local management of waste inputs is crucial for controlling pollution hotspots.

Plastics entering the food web scored a mean of 3.7 and a standard deviation of 0.88**,** with 41% of respondents acknowledging ecological impacts. Research by Free et al. (2014) and Selvam et al. (2022) confirms that microplastics are ingested by fish and invertebrates, highlighting the risk to ecosystem health and human consumption. These findings emphasize the need for integrated drainage management and waste control to minimize ecological risks.

Challenges Affecting Effective Drainage System Management in Controlling Plastic Pollution along Nakivubo Channel

Statement	SA	A	NS	D	SD	Mean	Std. Dev
1. Improper waste disposal by residents and commercial operators reduces channel efficiency.	30	28	12	8	7	4.1	0.76

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Statement	SA	A	NS	D	SD	Mean	Std. Dev
2. Limited institutional capacity and inadequate funding hinder consistent drainage maintenance.	25	27	15	10	8	3.8	0.83
3. Encroachment along channel banks obstructs water flow and complicates waste removal.	22	25	18	12	8	3.6	0.87
4. Seasonal rainfall and climate variability increase plastic transport into Lake Victoria.	28	23	15	10	9	3.9	0.82
5. Low public awareness and poor compliance with waste regulations reduce drainage effectiveness.	20	25	20	12	8	3.6	0.88

Source: Field Data, 2026

Improper waste disposal scored a mean of 4.1 and standard deviation of 0.76**,** with 58% of respondents agreeing or strongly agreeing that households and businesses directly dump plastics into the channel. This behavior reduces the hydraulic capacity of Nakivubo Channel and increases flooding risks, particularly in informal settlements and densely populated commercial areas. The findings align with Lubwama et al. (2024), Okello & Nambatya (2021), and Tumwesigye et al. (2021), which emphasize that human behavior is a primary driver of plastic accumulation and transport into Lake Victoria. The implication is that addressing improper waste disposal is critical to maintaining effective drainage and reducing plastic pollution.

Limited institutional capacity and funding recorded a mean of 3.8 and standard deviation of 0.83, with 49% agreement. KCCA faces constraints in equipment, trained personnel, and financial resources, leading to reactive rather than proactive maintenance. MDPI (2025) and Tumwesigye et al. (2021) note that routine cleaning and dredging are often interrupted or delayed, allowing plastic waste to accumulate. The implication is that strengthening institutional capacity and allocating sufficient resources are essential to sustain drainage system performance.

Encroachment along channel banks scored a mean of 3.6 and standard deviation of 0.87, with 44% agreement. Residential and commercial structures close to or over the drainage path reduce the effective width of Nakivubo Channel and hinder the removal of plastics. Lubwama et al. (2024) and Okot & Ssekajugo (2023) highlight that these encroachments contribute to recurrent flooding and downstream transport of plastics, complicating management interventions due to socio-political sensitivities. The implication is that enforcing setback regulations and preventing encroachment are vital for maintaining channel capacity and reducing pollution.

Seasonal rainfall and climate variability scored a mean of 3.9 and standard deviation of 0.82**,** with 51% agreement. Heavy rains mobilize accumulated plastics from streets, informal dumps, and sediments, rapidly transporting them into Lake Victoria, while dry periods result in plastic accumulation within the channel. Lebreton et al. (2017) and Schmidt et al. (2017) confirm that stormwater runoff significantly increases plastic transport. The implication is that drainage management must account for seasonal variability to prevent peaks in plastic pollution.

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Low public awareness and poor compliance scored a mean of 3.6 and standard deviation of 0.88, with 45% agreement. Despite existing policies, many residents continue to dispose of plastics indiscriminately, while enforcement mechanisms remain weak (Kiggundu & Okello, 2019; Lubwama et al., 2024). Community education, participatory programs, and sensitization campaigns are critical to improving compliance and reducing plastic dumping (Tumwesigye et al., 2021; Free et al., 2014). The implication is that integrating public engagement with enforcement can enhance drainage effectiveness and control plastic pollution.

Summary of Study Findings

The study sought to examine the effect of drainage system management practices on plastic pollution levels in Lake Victoria, using Nakivubo Channel in Kampala District as a case study. Regarding the first objective, the findings revealed that routine cleaning and structural interventions, including widening, lining, and embankment reinforcement, positively influenced the efficiency of Nakivubo Channel. Most respondents (approximately 50–53%) agreed or strongly agreed that these measures help maintain water flow and reduce blockages. However, inconsistencies in cleaning schedules and persistent encroachment along the channel reduce overall effectiveness, indicating that physical interventions alone are insufficient to fully manage plastic pollution (New Vision, 2025; Eagle Online, 2025; Uganda Times, 2025).

For the second objective, the study identified the types of plastic pollution transported through Nakivubo Channel into Lake Victoria. Macroplastics such as plastic bags, bottles, and packaging materials dominated, accounting for over 50% of visible debris along the channel, while microplastics, including fibres and fragments, were also prevalent in sediments and surface waters. Seasonal rainfall was reported to significantly increase plastic transport, mobilizing waste from streets and informal dumps into the channel and downstream to the lake. These findings highlight that urban runoff, waste mismanagement, and drainage inefficiencies collectively contribute to elevated plastic loads entering Lake Victoria (Alimba & Faggio, 2019; Biginagwa et al., 2016; Lebreton et al., 2017).

Regarding the third objective, the study revealed multiple challenges affecting the effectiveness of drainage management. Key challenges included improper waste disposal practices by residents and businesses, limited institutional capacity and funding, encroachment along the channel, low public awareness, and climate variability. Respondents indicated that these factors reduce hydraulic capacity, exacerbate flooding, and facilitate the transport of plastics into Lake Victoria. Limited enforcement of waste disposal regulations and weak community engagement further undermined drainage management efforts (Lubwama et al., 2024; Okello & Nambatya, 2021; Tumwesigye et al., 2021; Kiggundu & Okello, 2019).

Discussion of Findings

Routine cleaning and structural interventions were found to improve the channel's ability to convey stormwater and reduce blockages. This aligns with findings by Eagle Online (2025) and Uganda Times (2025), which show that routine removal of silt, debris, and plastics enhances hydraulic capacity and reduces flooding. However, the persistence of blockages in certain areas indicates that infrastructure alone cannot prevent plastic pollution. This supports the assumptions of the Theory of Planned Behavior, which suggests that human practices and attitudes, such as improper waste disposal, directly affect outcomes, emphasizing the need to combine physical interventions with behavioral change strategies.

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The study identified that Nakivubo Channel transports both macroplastics and microplastics into Lake Victoria. Macroplastics such as bottles, bags, and packaging materials were the most visible, while microplastics were prevalent in sediments and surface waters. Seasonal rainfall was found to significantly increase plastic transport, consistent with Lebreton et al. (2017) and Schmidt et al. (2017), which note that stormwater runoff mobilizes plastics from urban landscapes into freshwater systems. These results highlight that drainage practices and urban waste management are closely linked to plastic loads entering aquatic ecosystems, confirming previous studies by Alimba & Faggio (2019) and Biginagwa et al. (2016).

The study established that several challenges limit effective drainage management. Improper waste disposal, encroachment along the channel, limited institutional capacity, low public awareness, and climate variability were major constraints. These findings reflect similar challenges reported in other East African urban centers such as Nairobi and Dar es Salaam (Mungai, 2003; Mwegoha & Kassenga, 2008). The study underscores that governance, community cooperation, and adequate funding are as important as physical infrastructure in managing drainage systems.

Conclusions

Routine cleaning, dredging, and structural interventions such as widening and lining improve the hydraulic capacity of Nakivubo Channel and reduce blockages. However, these measures alone are insufficient to prevent the accumulation and transport of plastics into Lake Victoria. Physical improvements must be complemented by proper waste management practices. Nakivubo Channel transports both macroplastics, including plastic bags, bottles, and packaging materials, and microplastics such as fibres and pellets into Lake Victoria. Seasonal rainfall and stormwater runoff significantly influence plastic loads, highlighting the importance of both human behavior and hydrological factors in determining pollution levels. Ineffective waste disposal, encroachment along channel banks, low institutional capacity, limited funding, low public awareness, and climate variability all reduce the efficiency of drainage management. These challenges demonstrate that governance, community participation, and behavioral change are critical components for successful drainage management and plastic pollution control.

Recommendations

Kampala Capital City Authority should enhance regular cleaning, dredging, and debris removal along Nakivubo Channel, ensuring consistent maintenance schedules to prevent accumulation of plastics.

Policies should be enforced to minimize indiscriminate disposal of plastics by households, businesses, and informal settlements. Provision of adequate waste collection facilities and collection services is essential.

Authorities should enforce regulations preventing construction and encroachment along the channel banks to maintain its effective width and ensure smooth water flow.

Educational campaigns, sensitization programs, and participatory approaches should be promoted to encourage residents and businesses to comply with waste management regulations.

KCCA should be provided with sufficient financial, human, and technical resources to implement drainage management effectively, including training personnel and acquiring necessary equipment.

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Continuous monitoring of both macro-plastics and microplastics entering Nakivubo Channel and Lake Victoria should be conducted, and interventions should be adapted based on seasonal rainfall patterns and observed pollution hotspots.

Urban planning, environmental regulations, and drainage management should be coordinated to ensure that infrastructural developments do not compromise the functionality of drainage systems and exacerbate plastic pollution.

Areas for Further Study

Future studies could investigate how seasonal rainfall and extreme weather events influence the types and quantities of plastics transported through urban drainage systems into Lake Victoria.

Research could explore how community-led initiatives and education programs affect waste disposal practices and the reduction of plastic pollution in urban drainage channels.

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