Abyss. J. Bus. Soc. Sci. Vol. 9, No. 1, 2024,13-29
ISSN 2707-1340 (Online); 2707-1332 (Print)
DOI: https://doi.org/10.20372/ajbs.2024.9.1.1043
Publisher: Wollo University, Dessie, Ethiopia

Abyssinia Journal of Business and Social Sciences

Assessing Liquid Waste Management Practices in Dessie City, Amhara National Regional State, Ethiopia

Alem-meta Assefa*
Department of Geography and Environmental Studies. Wollo University, Dessie, Ethiopia

ABSTRACT

Liquid waste is a global problem because of its ability to enter watersheds, pollute ground and drinking water when improperly handled and disposed. Liquid wastes generated from housing units, municipal services, businesses and institutions hotels, restaurants, condominium, public toilet, bathrooms, government and non-governmental organizations create a huge environmental and health problems. This study evaluated the major sources, types and nature of liquid waste generated in Dessie City. The study used a mixed research method. Both primary and secondary data sources were used for data collection. A stratified multistage sampling procedure was used to select 300 sample households. The data were analyzed both quantitatively and qualitatively. The result of the study revealed that about 64% of the toilets were privately owned and the rest 32% and 4% were communal and public toilets respectively. The lack of public toilets is compounded by the poor management and improper usage of the existing facilities by the community. This indicates there is shortage of public toilets in the city. As a result most of them are damaged and not providing the required services. The by-products of Dessie City abattoir are disposed of by sewerage canals that are connected to Borkena River. Moreover, Dessie Referral Hospital is discharging its waste water through pipelines into the surrounding settlements and it is also gradually percolates down into Borkena River. Therefore, the study recommends repair and properly maintain the existing public toilet facilities to ensure they are functional and provide the required services to the community; implement proper treatment and disposal mechanisms for the waste by-products from the Dessie City abattoir before discharging them into the Borkena River. This would help mitigate the environmental pollution of the river.

Key words: Liquid Waste; Waste management; Dessie city; Sewerage canal

INTRODUCTION

Waste is any material that is discarded, either purposefully or accidentally, from residential, commercial, industrial, and other human activities. Waste generally includes materials that are no longer useful or desired and are discarded or discharged to the environment (EPA, 2022). It is abundant in densely populated urban areas. It affects the health and safety of the people and makes urban centres unsuitable for living and working. On the contrary, it can be used as resource to support livelihood of people and growth of the country. Liquid waste management is increasingly becoming one of the major social and environmental challenges in most of developing countries including Ethiopia. Some of the factors are rapid population growth, urbanization and increased demand towards industrial development and limited resources to cater for the growing quantity and pollutants of liquid waste generated. This is why there is a growing concern manifested in Millennium Development Goals calling to address environmental infrastructures in developing countries by 2015 (Simon, 2008). Municipal waste management is an important issue in today's world as it deals with budget allocations of local municipality, public acceptance and adverse impacts on environment (Ramakrishna, 2013). Similarly, Ethiopia as a developing country is also facing such situations in urban waste management.

Waste management is a critical issue faced by many urban centers globally, as the generation of various types of waste continues to rise due to population growth, urbanization, and economic development. Proper waste management is essential to protect public health and the environment, as improper

***Corresponding author:** alexasfaw23@gmail.com
Received: 16-10-2023, **Accepted**: 12-6-2024, **Published**: 30-6-2024

Journal-homepage:https://abjol.org.et/index.php/ajbs

disposal can lead to the contamination of air, water, and soil resources (Hoornweg and Bhada-Tata, 2012).

According to the United States Environmental Protection Agency (EPA), liquid waste is defined as "any waste material that is determined to be a liquid or requires a liquid medium for handling and/or conveyance." The key characteristics of liquid waste include:

High water content: Liquid waste typically contains a significant amount of water, which can range from a few percent to nearly 100% of the total volume.

Contaminants: Liquid waste may contain a variety of contaminants, including organic matter, inorganic compounds, heavy metals, pathogens, and other potentially harmful substances, depending on the source.

Fluidity: Liquid waste has the physical property of being able to flow easily, unlike solid waste, which has a more defined shape.

Potential environmental impact: Improper management of liquid waste can lead to the contamination of soil, surface water, and groundwater, as well as the release of harmful gases into the atmosphere. Examples of common types of liquid waste include domestic sewage, industrial effluents, agricultural runoff, medical waste (e.g., blood, bodily fluids) and chemical waste from laboratories or manufacturing processes.

Proper handling, treatment, and disposal of liquid waste are essential to mitigate its environmental and health-related risks, such as water pollution, soil contamination, and the spread of waterborne diseases.

Improper management of liquid waste can have serious environmental and public health consequences. When released into the environment without proper treatment, liquid waste can contaminate surface water bodies, groundwater, and soil, leading to the degradation of water quality and ecosystems (Tchobanoglous *et al*., 2003). Additionally, exposure to untreated liquid waste can increase the risk of waterborne diseases and other health issues for the local population (Fewtrell and Bartram, 2001).

Liquid Waste Management in Dessie City

Dessie City, located in the Amhara National Regional State of Ethiopia, is a rapidly growing urban center that faces significant challenges in managing its liquid waste. As the city's population and economic activities have expanded, the generation of liquid waste has increased, putting a strain on the city's waste management infrastructure and capacities (Desta *et al.*, 2019).

One of the primary issues in Dessie City is the lack of a comprehensive and effective liquid waste management system. Many households and businesses in the city lack access to adequate sanitation facilities, leading to the indiscriminate discharge of liquid waste into the environment, including open drains, rivers, and land (Desta *et al.*, 2019). This has resulted in the contamination of water sources and the spread of waterborne diseases, posing a threat to public health and the local ecosystem. Furthermore, the city's wastewater treatment facility is often unable to keep up with the growing volume of liquid waste, resulting in the direct discharge of untreated effluents into nearby water bodies (Desta *et al.*, 2019). This has further exacerbated the environmental and public health concerns in the region.

Assessing Liquid Waste Management Practices in Dessie City

To address the challenges in Dessie City, it is crucial to conduct a comprehensive assessment of the current liquid waste management practices. This assessment should include an evaluation of the city's waste generation patterns, existing collection and transportation systems, treatment and disposal methods, as well as the overall institutional and regulatory framework governing liquid waste management (Tilley *et al.*, 2014).

By understanding the current gaps and limitations in the liquid waste management system, policymakers and municipal authorities can develop targeted interventions and strategies to improve the situation. This may involve investments in infrastructure development, such as the construction of centralized wastewater treatment facilities, the expansion of sewer networks, and the implementation of decentralized treatment solutions for areas without access to the sewer system (Tilley *et al.*, 2014).

Additionally, the assessment should also consider the involvement and capacity of local communities, the private sector, and other stakeholders in the liquid waste management process. Strengthening collaboration and building the capacities of these stakeholders can contribute to the development of a more sustainable and inclusive liquid waste management system in Dessie City (Desta *et al.*, 2019).

The *Borkena* River, a major water body in Dessie City, has become severely polluted due to the discharge of untreated liquid waste from households, industries, and commercial establishments (Desta *et al.*, 2019). A study found the river's water quality was unfit for any beneficial uses, such as irrigation and livestock watering, due to high levels of organic matter, nutrients, and microbial contamination (Desta *et al.*, 2019). The main sources of pollution were the direct discharge of domestic wastewater and effluents from small-scale industries and commercial activities along the river banks, leading to the degradation of the aquatic

ecosystem and posing health risks to local communities (Desta *et al.,* 2019).

In the absence of a comprehensive sewer system, many households and businesses rely on poorly constructed and maintained on-site sanitation systems, such as septic tanks and pit latrines, resulting in the overflow and leakage of untreated liquid waste (Desta *et al.,* 2019). During the rainy season, this situation was particularly prevalent in densely populated and low-income areas, contaminating the soil, groundwater, and surface water sources (Desta *et al.,* 2019).

Due to the lack of efficient liquid waste collection and treatment services, some households and businesses have resorted to illegal dumping and improper disposal of their liquid waste, including discharging wastewater into open drains, canals, and vacant land, as well as the indiscriminate disposal of septic tank sludge (Getahun *et al.,* 2020). This practice was observed in the industrial areas of Dessie City, where small-scale manufacturers lacked proper waste management facilities (Getahun *et al.,* 2020). The inadequate enforcement of environmental regulations and limited public awareness about proper liquid waste management have contributed to the persistence of these issues in Dessie City (Getahun *et al.,* 2020).

The disposal of liquid waste (sewage) such as drain cleaning (waste water), human urine and defecation, and the effluent from domestic animals are among the major problems of urban centres of Ethiopia. Moreover, the disposal of liquid waste such as brine from desalination/industries has also an adverse impact on the natural environment (Panagopoulos, 2021). As a result, the Government of Ethiopia is committed to meeting the public health needs of its population by providing grass-root health extension services in both rural and urban areas.

The Urban Health Extension Program (UHEP) targets the wellbeing of urban populations through selected high-impact interventions, which include improving sanitation and waste management services and practices. Because of the existing poor waste management systems in Ethiopia, cities have neither adequate nor acceptable levels of practice in waste handling and disposal systems. Even if there is drinking water supply, sanitation, and hygiene sector policies and strategies, there are serious challenges to their implementation and enforcement (UHEP, 2018).

Approximately 18% of Ethiopia's population reside in urban areas. However, with the current trend of urbanization, the Ethiopian urban population is expected to grow to 35% by 2030 and 42% by 2050 (MOH, 2017). With such a growing urban population, cities in Ethiopia are facing complex health and environmental challenges. Improper disposal of wastewater plays a significant role in contaminating surface water, groundwater, and soil, leading to the spread of waterborne diseases. In cities like Dessie, there is a lack of proper sewerage and sanitation infrastructure, resulting in residents, institutions, and organizations directly releasing liquid waste into rivers, roads, and bare lands. This not only pollutes water sources but also recharges groundwater with disease-causing agents like giardia, typhoid, and cholera. The management of liquid waste at the household level, particularly in condominium housing, is also poor, with issues related to septic tank size, sanitation system layout, and lack of proper maintenance.

Furthermore, the liquid waste disposed from the Dessie Municipal abattoir negatively impacts the environment and residents' health. Water quality tests on the *Borkena* River have revealed the presence of bacteria like E. coli, posing significant public health risks. Inadequate treatment or disposal of human excreta and other waste can lead to the transmission and spread of diseases. Polluted water and inadequate sanitation cause 5.7% of all epidemics (Huuhtanen and Laukkanen, 2016). Moreover, accumulation of pollutants in water bodies may cause potentially irreversible environmental problems, especially groundwater pollution. Pollution of rivers, lakes, oceans and groundwater with sewage damages aquatic biodiversity and as a result, only a few forms of life survive (Nadkarni, 2004).

The disposal of liquid waste (sewage) such as drain cleaning (waste water), human urine and defecation, and the effluent from domestic animals are among the major problems of urban centres of Ethiopia. As a result, the Government of Ethiopia is committed to meeting the public health needs of its population by providing grass-root health extension services in both rural and urban areas. The Urban Health Extension Program (UHEP) targets the wellbeing of urban populations through selected high-impact interventions, which include improving sanitation and waste management services and practices. Because of the existing poor waste management systems in Ethiopia, cities have neither adequate nor acceptable levels of practice in waste handling and disposal systems. Even if there is drinking water supply, sanitation, and hygiene sector policies and strategies, there are serious challenges to their implementation and enforcement.

Urban sanitation has no clear institutional 'home,' which means responsibilities are diffused among several agencies, the sector is under-financed, facilities for the treatment of liquid waste are almost non-existent, and there is no clear implementation approach. In addition, existing practice and enforcement of urban sanitation is far behind the

provisions of sanitation policy frameworks. In this context, the role of sanitary experts would be limited and unclear. They likely struggle to coordinate effectively, lack the resources to drive meaningful improvements, and face challenges in translating policy into practice on the ground.

The improper disposal of wastewater poses significant health problems in developing countries like Ethiopia. In Dessie, Ethiopia, all waste is drained directly into small streams and rivers, leading to water pollution. There is a complete lack of proper sewerage or sanitation infrastructure to safeguard the community from the hazardous effects of liquid waste. Residents, institutions, and organizations in Dessie discharge their liquid waste directly into the environment, contaminating groundwater and causing waterborne diseases like giardia, typhoid, diarrhoea, cholera, and typhus.

The management of liquid waste at the household level is also severely lacking in Dessie, particularly in condominium complexes. Issues such as inadequate septic tank size, poor sanitation system design and maintenance, absence of manholes, and low-quality sanitation pipes and utilities exacerbate the problem. Additionally, the liquid waste from the Dessie Municipal abattoir further pollutes the *Borkena* River, with test results showing the presence of harmful bacteria like E. coli, posing significant public health risks to the community.

Liquid wastes generated from institutions like Hospitals, Schools, Universities and industries also negatively affect the residents and environment. For example, Wollo University, which is located in Dessie City released wastes without adequate treatment so that it has been affecting downstream areas particularly the nearby *Borkena* River. The University has tried to establish its own liquid waste treatment site. However, the problem is continuing as an environmental threat of the city, currently and in the long run unless proper treatment plant installed. Furthermore, the liquid waste generated from condominiums is also one of the potential areas for creating public health and environmental problems because for the liquid waste (sewage), there is no system to receive and treat the sewage emptied from septic tanks from different blocks of the condominium. They are deposited into pits at the foot of each condominium block so that they have become like small lakes (ponds) of sewage. Disposal methods used at such places still expose the city to the environmental and health hazards.

The Dessie City Administration has recognized the need to address the city's liquid waste management challenges and launched the Dessie Wastewater Management Project in 2021 to develop a centralized sewerage system and treatment plant (Dessie City Administration, 2021). However, the project's progress has been slow, and the city remains largely dependent on problematic on-site sanitation systems (Desta *et al.,* 2019). While the government's efforts continue, local NGOs, such as the Dessie City Development Organization, have also been working with communities to improve the management of on-site systems (DCDO, 2022).

The overall purpose of this study was to review and analyse the management of liquid waste in Dessie City. Moreover, the study deals with the policies and strategies on liquid waste management; assess availability and enforcement of regulations, institutional capacities, and existing/potential financing mechanisms for liquid waste management; and describe the current sanitation and waste management-related knowledge, perspectives, and practices among urban communities. This study intends to:-

1. Review and analyze the existing policies, strategies, and regulations related to liquid waste management in Dessie City,
2. Assesses the availability and enforcement of regulations, the institutional capacities, and the existing/potential financing mechanisms for liquid waste management in the city.
3. Describe the current knowledge, perspectives, and practices of urban communities in Dessie City regarding sanitation and waste management. By addressing these research areas, the study intends to provide decision-makers, policymakers, and planners with the necessary insights to inform the redesign of the city's structural plan and improve the overall sanitation policy in Dessie City, as well as potentially nationwide.

Spatial and Thematic Scope of the Study

The spatial scope of the study was conducted within Dessie City administration of the Amhara National regional state of Ethiopia, which is confined to 5 sub-cities of Dessie City inhabitants. The thematic scope of the study is limited to analysing the existing conditions of liquid waste management systems and infrastructure, liquid waste generation and disposal patterns, environmental and public health impacts, institutional and regulatory frameworks, and community engagement and awareness.

LITERATURE REVIEW

The hierarchy of laws in Ethiopia starts with the constitution and follows the proclamations, the regulations and the directives. The highest law in Ethiopia is the Constitution (Proclamation No.1/1995) which was adopted by the highest legislative body (parliament) and signed by the head of state in 1995. The proclamations are acts of parliament, discussed and voted on in the HPR

(House of Peoples' Representative) and signed by the president of Ethiopia. International treaties that have been ratified by Ethiopia have similar status to proclamations because they are also enacted by the HPR. The regulations are issued by the Council of Ministers to supplement a proclamation, providing detailed descriptions of the provisions of the respective proclamation. The directives provide the description of implementation procedures; usually they are developed by a ministry or a department within a ministry. At regional level, there is a similar hierarchy of state laws that includes proclamations, regulations and directives. Policies are important statements of government plans and lie outside the hierarchy of laws whereas a strategy provides details for implementing a given policy (Alemayehu and Yirga, 2018). The following Figure 1 provides a structured approach to organizing and analysing the relevant policy and strategic documents that will inform the study on the management of liquid waste in Dessie City.

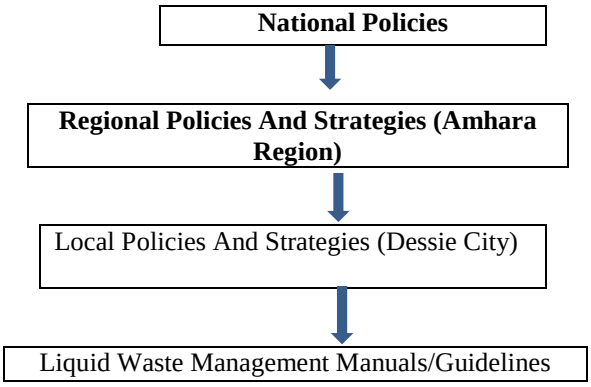

Fig.1 Review of Relevant Policies, Strategies and Manuals

Environmental Policy and Strategies

These policy and strategy documents recognized and addressed environmental issues in a more or less holistic manner, and were adopted as well as approved in 1997. The overall policy goal is to improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs. Under the rubric of this overall policy goal, it has specific policy objectives including the improvement of the environment of human settlements, prevention of pollution of land, water and air, the improvement of the cultural and natural heritage of the country, to ensure empowerment and participation of the society in environmental management, the need for environmental education and environmental impact assessment. The policy consists mainly of guiding principles to harmonize sectorial development plans and various sectorial and cross-sectorial policies and environmental elements of other macro policies for sustainable environmental management (FDRE, 1997). The following Figure 2 shows the hierarchy of environmental policy, strategies, action plans, and implementation and monitoring systems. The study should review the relevant environmental policy and strategies at the national, regional, and local levels that guide and influence liquid waste management in Dessie City.

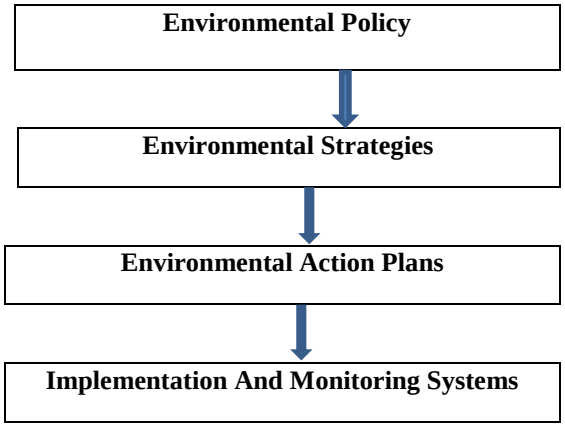

Fig. 2 Environmental Policy and Strategies Framework

The Ethiopian Environmental impact assessment (EIA) Regulation (Official Gazette No. 26939, 17.07.1987) was enacted in view of the national environmental policies as a result of the accepted need of identifying environmental impacts of the defined types of plants, before they are realized. The EIA process in Ethiopia starts with applying to the ministry of environment and forestry with a file prepared according to the general project presentation form. Accordingly, relevant laws that promote environmental management in Ethiopia have been adequately reviewed by the EIA team including the following:

- Water Pollution Control Regulation (Date:31.12.1996, No. 25687);
- Regulation On Water For Human Consumption (Date:17.02.1987, No. 22730);
- Environmental Impact Assessment Regulation(Date: 17.07.1989,No. 26939);
- Regulation on Control Of Hazardous Wastes (Date:14.03.2001, No. 25755);
- Environmental Law (Date: 9.8.1986, No. 2872).

According to the Ethiopian Urban Planning Proclamation No. 574/2008, a structure plan is a legally binding plan along with its explanatory texts formulated and drawn at the level of an entire urban boundary that sets out the basic requirements regarding physical development the fulfilment of which could produce a coherent urban development

in social, economic and spatial spheres. Any structure plan shall indicate mainly the following:
a) The magnitude and direction of growth of the urban centre;
b) Principal land use classes;
c) Housing development;
d) The layout and organization of major physical and social infrastructure;
e) Urban redevelopment intervention areas of the urban centre;
f) Environmental aspects;
g) Industry zone.

Structure plan shall have an implementation scheme, which comprises the institutional setup, resource and legal framework. Structure plans shall be valid for a period of 10 years from the date of approval.

According to the Ministry of Urban Development, Housing and Construction (MUDHCo, 2014) adequate urban planning is seriously needed to organize waste collection centres and sufficient landfills for dumping of liquid wastes. Moreover, the Environmental Protection Agency (EPA) recommends criteria for the proper liquid waste dumping sites.

According to the Federal Democratic Republic of Ethiopia (FDRE) constitution Article 44, sub- article 1, all persons have the right to live in a clean and healthy environment. However, in Ethiopia it is a common practice to see the community suffering from environmental problems. Lack of proper liquid waste collection and disposal is one of the problems of Ethiopian towns and cities including Dessie. Accordingly, liquid wastes are thrown everywhere and become sources for breeding of disease causing insects. Generally, the liquid wastes generated from different sources are imposing different type of social, economic and environmental problems in Dessie City. According to Dessie City Administration's Enforcement Directive No. 1/2008:

a) It is prohibited for any person or organization to discharge sewage from their home or enterprise on roads, squares, wells, ponds, canals, pipes or other means in the city administration area.
b) No person or organization can flush or flush toilets or other sewers into adjacent areas.
c) Anyone on the streets outside the toilet, in the squares, in flowing waters, in channels, in parks it is forbidden to defecate under the fences in the woods.
d) Any person or organization engaged in sewage collection and disposal shall use the sewage treatment system and shall respect and fulfil its obligations with public institutions.

MATERIALS AND METHODS

Description of the Study Area

Dessie City as one of the prominent urban centers of the Amhara National regional state is an autonomous local government with a metropolitan city administration status. It is one of the oldest cities in the country and one of the three metropolitan cities in the Amhara region. It was founded in 1885 by *Nigus* Michael. The city is responsible for the development of the city and service delivery to its residents. To carry out its functions, the city has the responsibility to initiate development activities through plan led urban development and implement it with the participation of communities and other stakeholders.

Dessie is one of the oldest cities in the North-eastern part of Ethiopia with many public and private Hospitals, health centres, small industries, Hotels and small scale enterprises. It is located about 401km from Addis Ababa (the capital city of the country). Its astronomical location is 11º8’North latitude and 39º38’East longitude with an elevation between 2470 and 2550 meters above mean sea level (Fig. 3). According to the Ethiopian agro-ecological classification, the City has a '*Dega*' agro-ecological climatic condition. The city has a total area of 17,723 hectare and it serves as a capital city of South Wollo Zone. It is placed at the foot of *Tossa* Ridge which runs along the north-south direction on its western border and is surrounded by and also incorporates a number of hills within its boundary. Due to its location the city has good development opportunities but also faces several challenges. On the south eastern side *Karagutu*, *Azwa Gedel* and *Doro Mezleya* hills bound the city. The city is characterized by undulating and rolling topography.

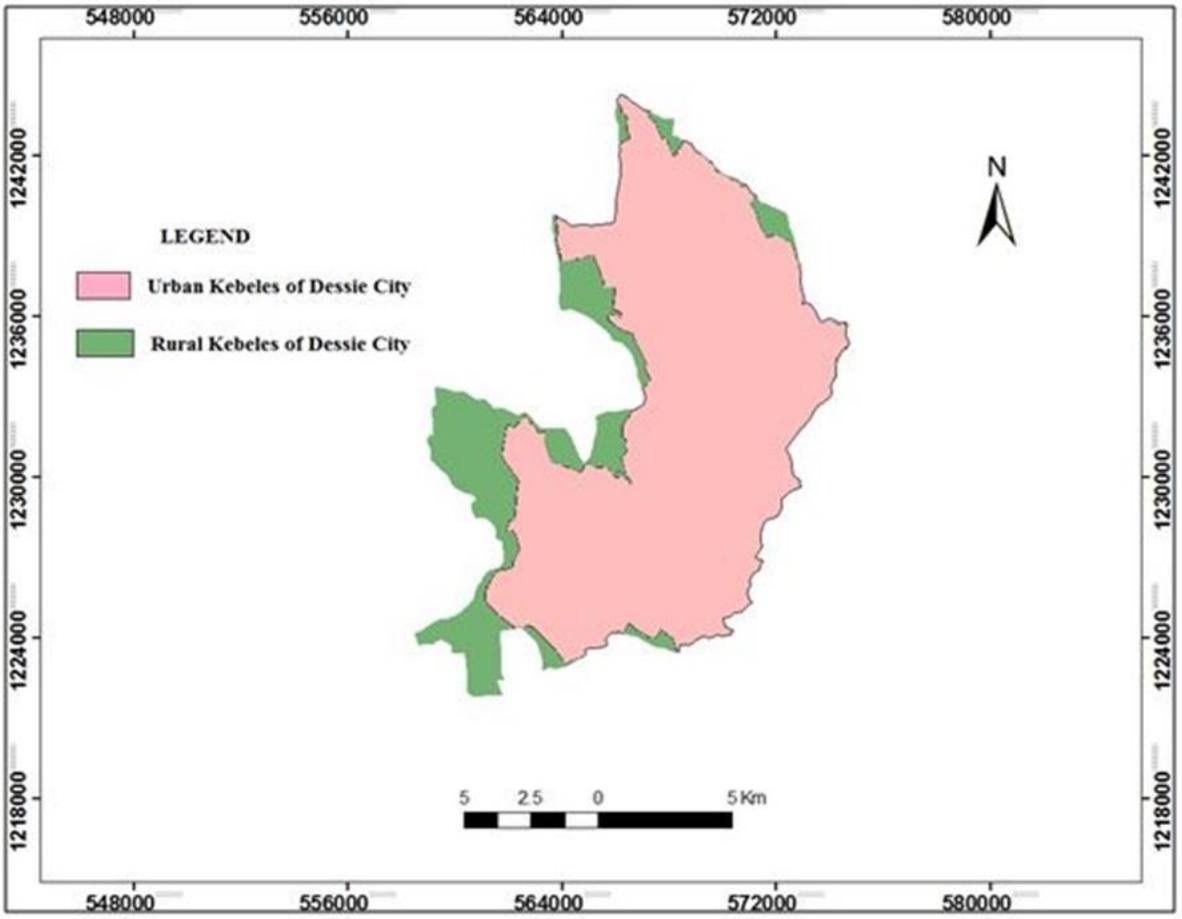

Fig. 3 Map of the Study Area

Dessie City is sub-divided into 5 sub-cities (*Kifle-ketema*), 18 urban *Kebeles*, and 8 rural *Kebeles* that are included as a result of urban expansion processes into the Northern and South-western directions towards the peripheral rural communities. The sub-cities include *Segno-gebeya, Arada, Hotie, Menafesha, and Bwabawuha*. The rural *Kebeles* are *Tita-turcina, Kurkur, Boru-selassie, Boru-meda, Tossa, Gerado-kelena, Gerado-endodber, and Gerado-tesfanacheru.*

The physical growth of the city is mostly horizontal into the outlying areas, where both formal and informal settlements are observed. The contemporary structural plan of the city encompasses largely peri-urban and rural agricultural land included into the city administration.

Rapid Urbanization in Dessie City

Dessie City, the capital of the South Wollo Zone in the Amhara National Regional State, has experienced rapid urbanization over the past few decades. The city's population has grown significantly, from around 140,000 in the 1990s to over 300,000 as of 2020 (Central Statistical Agency of Ethiopia, 2021). This rapid population growth has been driven by a combination of natural increase and rural-to-urban migration, as people seek better economic and educational opportunities in the city (Woldeyohannes, 2012).

The influx of people has led to the expansion of residential areas, commercial activities, and industrial zones in Dessie City. However, the city's infrastructure and service delivery systems, including liquid waste management, have struggled to keep pace with this rapid urbanization (Desta *et al.*, 2019). The increasing population and the expansion of settlements have resulted in a higher generation of liquid waste, which has overwhelmed the existing waste management facilities and capacities.

Growth of Industry and Commercial Activities in Dessie City

In addition to the rapid urbanization, Dessie City has also experienced significant industrial and commercial growth in recent years. The city has attracted various types of industries, such as food processing, textile manufacturing, and construction materials production, to support the regional and national economy (Getacher and Etana, 2021).

The expansion of these industrial and commercial activities has contributed to the increased generation of liquid waste in the city. Industrial processes often produce large volumes of wastewater that may contain a variety of pollutants, including heavy metals, organic matter, and chemicals (Desta *et al.*, 2019). Additionally, the growth of commercial activities, such as restaurants, hotels, and car washes, has also led to the increased discharge of liquid waste into the city's drainage systems and water bodies.

Challenges of Liquid Waste Management in Dessie City

The combination of rapid urbanization and the growth of industrial and commercial activities has exacerbated the liquid waste management challenges in Dessie City. The existing wastewater treatment infrastructure and services have struggled to keep up with the increasing volume and complexity of liquid waste generated in the city (Desta *et al.*, 2019).

Many households and businesses in Dessie City lack access to adequate sanitation facilities, such as sewer connections or septic tanks. As a result, they often resort to discharging their liquid waste directly into open drains, rivers, or onto the land, leading to the contamination of water sources and the spread of waterborne diseases (Desta *et al.*, 2019).

Furthermore, the city's wastewater treatment plant, which was designed to handle a limited capacity, is often overwhelmed by the growing volume of liquid waste. This has resulted in the direct discharge of untreated effluents into nearby water bodies, further contributing to environmental degradation and public health concerns (Desta *et al.*, 2019).

In summary, the rapid urbanization and the growth of industrial and commercial activities in Dessie City have significantly contributed to the challenges in managing liquid waste. The increasing generation of liquid waste, coupled with the inadequate infrastructure and services, has led to the contamination of water resources and the deterioration of environmental and public health conditions in the city.

METHODOLOGY

The researcher employed mixed method of research approach. Qualitative data, such as interviews with local officials and residents, can provide insights into the social, cultural, and political factors influencing waste management practices. Quantitative data, including waste generation rates, treatment capacity, and environmental impact assessments, can offer measurable evidence of the scale and nature of the challenges. By combining these complementary perspectives, policymakers and stakeholders can develop more informed and effective strategies to address the complex issues of liquid waste management in Dessie City (Zewdie and Getahun, 2021; Demissie *et al.*, 2020).

Consequently, both primary and secondary data sources were used to collect the required data. The primary data were collected through field observation, household survey questionnaire, and key informant interview. The key criteria for selecting observation sites in the study area include accessibility, representation of different waste sources, and potential environmental impact. On the other hand, the key criteria for selecting informants in the Dessie City liquid waste management study include: diverse stakeholder representation, knowledge of the local context, and involvement in waste management decision-making. While secondary data were collected from published books, unpublished documents, Journal articles, thesis, structural plan documents, reports and internet sources. The secondary documents reviewed for the Dessie City liquid waste management study included municipal reports, environmental regulations, and previous research - providing context, policies, and baseline data.

Data Collection Methods

The data collection methods used for conducting liquid waste management study as part of Dessie City Structure Plan include sample household survey, key informant interview, field observation, and review of literatures (IDP, GTP I and II) (2010-2015, 2015-2020), Strategic plan, annual plans and reports and Guidelines and standards. A structured questionnaire was designed to collect information on socio-demographic factors and liquid waste collection, disposal and transportation practices by the sample households. Semi-structured questions were also used to collect information from Dessie City water and sewerage service office. In-depth interviews were made with three key informants to triangulate the information gained from other sources. The researcher had also conducted observations in order to get relevant information on how different institutions and households in the sample *Kebeles* and *Ketenas* (in the Ethiopian context, a *Ketena* refers to the smallest administrative unit or neighbourhood within a city or urban area. *Ketenas* are the sub-divisions below the *Kebele* level and are used for local governance and service delivery purposes) managed the liquid waste disposal and transportation mechanisms. The researcher also observed the conditions of some public and communal toilets.

Respondents for household survey were selected with stratified multistage sampling. The stratified multistage sampling method was suitable as it ensured representative coverage of Dessie City's diverse neighbourhoods and socioeconomic groups, allowing for a comprehensive understanding of liquid waste management challenges. Thus, 10

Kebeles (two from each Sub-cities) were randomly selected in the first stage. In the second stage, two *Ketenas* were also randomly selected from each *Kebele*. Finally, 300 sample households were selected from the two *Ketenas.* These 300 sample households were selected using systematic random sampling, which ensured an unbiased and representative sample based on criteria like household size, income level, and waste generation patterns. The sample size of 300 households was chosen to balance statistical reliability and feasibility, allowing for comprehensive data collection while ensuring the study remained manageable within the given time and resource constraints.

Data Analysis Methods

The data were analysed both quantitatively and qualitatively and then summarized and presented in tables, graphs, and percentages. The data were analysed using descriptive statistics derived from the Statistical Package for Social Sciences (SPSS-IBM software, version 21). The researchers chose SPSS statistical software to analyse the quantitative data collected, as it enabled them to conduct descriptive statistics, correlations, and regression analysis to gain insights into waste generation patterns, management practices, and environmental impacts in Dessie City (Zewdie and Getahun, 2021). Data from surveys, interviews, observations, and secondary sources were triangulated to corroborate findings and strengthen the study's reliability. Conflicting data points were reconciled through follow-up interviews and cross-checking with municipal records.

RESULTS AND DISCUSSIONS

Results

Socioeconomic and Demographic Analysis

The age category of the sample households ranges from 20 to 80 years. Ages between 20 to 40 years account 50.7%, while 49.3% were aged above 41 years. On the other hand, the statistical analysis of gender of the sample household heads indicated that 48.7% and 51.3% of them were male-headed and female-headed household respectively. The educational background of the respondents revealed that 10%, 35.3%, 29%, 22.7%, 2.7%, and 0.3% were illiterate, primary education completed, secondary education completed, first degree, second degree and third degree holders and above respectively. This implies that majority of the respondents were primary education completed. Therefore, there is a need to work on access to education because it could allow sample households for more information about the importance of liquid waste management, environmental cleanness and personal hygiene. The result further revealed that majority of the sample households (67.7%) were married, (9.6%) were single, (14.7%) were widowed, (4.3%) were divorced, and (3.7%) were separated. The average family size of the sample households was found to be 4.5 ranging from 1 to 10 persons with a standard deviation of 1.6. The minimum and maximum average monthly income of the sample households was found to be 1,000 and above 10,000 Ethiopian birr respectively. In terms of employment majority of them (29.3%) were found to be engaged in various activities like daily-based and temporary or seasonal duties. The remaining 28%, 24.3%, 9.7%, 6% and 2.7% of them were found to be employed in private/NGO, government employee, and unemployed, engaged in their own business and involved in small informal business respectively.

The following Table 1 provides a general overview of the perceptions and engagement levels of different educational groups in Dessie City regarding liquid waste management. The data suggests that higher levels of education are associated with a more comprehensive understanding and active participation in addressing the challenges of liquid waste management in the community.

Table 1. The perceptions and engagement levels of different educational groups in Dessie City regarding liquid waste management

Educational Level	Perception of Liquid Waste Management
Illiterate (10%)	- Lack of awareness and understanding of proper liquid waste disposal methods - Reliance on traditional and unsafe practices for liquid waste management - Limited participation in community-based initiatives for liquid waste management
Primary (35.3%)	- Some awareness of the importance of liquid waste management - Challenges in adopting improved practices due to resource constraints and cultural norms - Moderate level of participation in community-based activities
Secondary (29%)	- Better understanding of the environmental and health impacts of improper liquid waste disposal - Some engagement in advocating for improved liquid waste management systems - Willingness to participate in training and awareness programs

First Degree (22.7%)	- Strong awareness of the need for comprehensive liquid waste management strategies - Active involvement in community-based initiatives and collaboration with local authorities - Advocacy for policy reforms and investment in infrastructure
Second Degree (2.7%)	- In-depth understanding of the technical, institutional, and regulatory aspects of liquid waste management - Engagement in research, planning, and implementation of sustainable liquid waste management solutions - Participation in policy dialogue and capacity-building efforts
Third degree and above (0.3%)	- Expertise in the latest scientific and technological advancements in liquid waste management - Involvement in innovative research and development of cost-effective and environmentally friendly solutions - Providing technical guidance and supporting policy formulation and implementation

Sanitation Regulations

The Amhara National Regional State has established the Regional Hygiene and Environmental Executive Committee which has issued regional environmental sanitation regulations. As per the regulation, residents of the region and establishments/institutions must: construct and use latrines; not release liquid waste to flow onto roads, public places, running waters, wells, lakes, ponds and the like; not use open fields (instead of latrines); and not wash clothes and other similar things in unauthorized places (The Hygiene and Environmental Health Executive Committee Regulation No.16/2000, 2000). In this regard, sample households were asked which type of liquid wastes has affected their health most. Consequently, majority of them (59%) replied other factors (wastes generated from condominium houses and wastes splashed on road sides and sewerage lines). While 14.7%,13.3%, 4.7%,4.3%, and 4% of them replied wastes from health centres, hotels, industries, garages, and car washing service respectively, are type of liquid wastes that affected their health most.

Table 2 Type of liquid wastes affecting sample households health most

Alternatives	Frequency	Percent
Wastes from industries	14	4.7
Wastes from health centres	44	14.7
Wastes from Hotels	40	13.3
Wastes from Garages	13	4.3
Wastes from Car washing	12	4.0
Other	177	59.0
Total	300	100.0

Availability of Toilets in Dessie City

Sanitation as a method of containment and sanitization of human excreta is of utmost importance as it prevents spread of diseases and protects both human and environmental health. In other words, sanitation systems form a barrier against the spread of diseases caused by pathogens and other organisms present in human excreta. Therefore, sanitation and human health are closely linked together. This fact has been known already for decades. A provision of the infrastructure, basic services, sanitation systems, which meet user's requirements, and promotion of hygiene has proven to be one of the most effective ways of improving health and preventing diseases. Inadequate treatment or disposal of human excreta and other waste can lead to transmitting and spreading of diseases originating form excreta. Polluted water and inadequate sanitation cause 5.7% of all epidemics (Huuhtanen and Laukkanen, 2006).

Sample households of the study were requested to describe about availability of toilets in Dessie City. Accordingly, they replied that the percentage of ownership of the toilets in the city is variable (**Fig. 4**). About 64% of the toilets were privately owned and the rest 32% and 4% of the toilets were communal and public toilets respectively. This indicates there is a shortage of public toilets in the city.

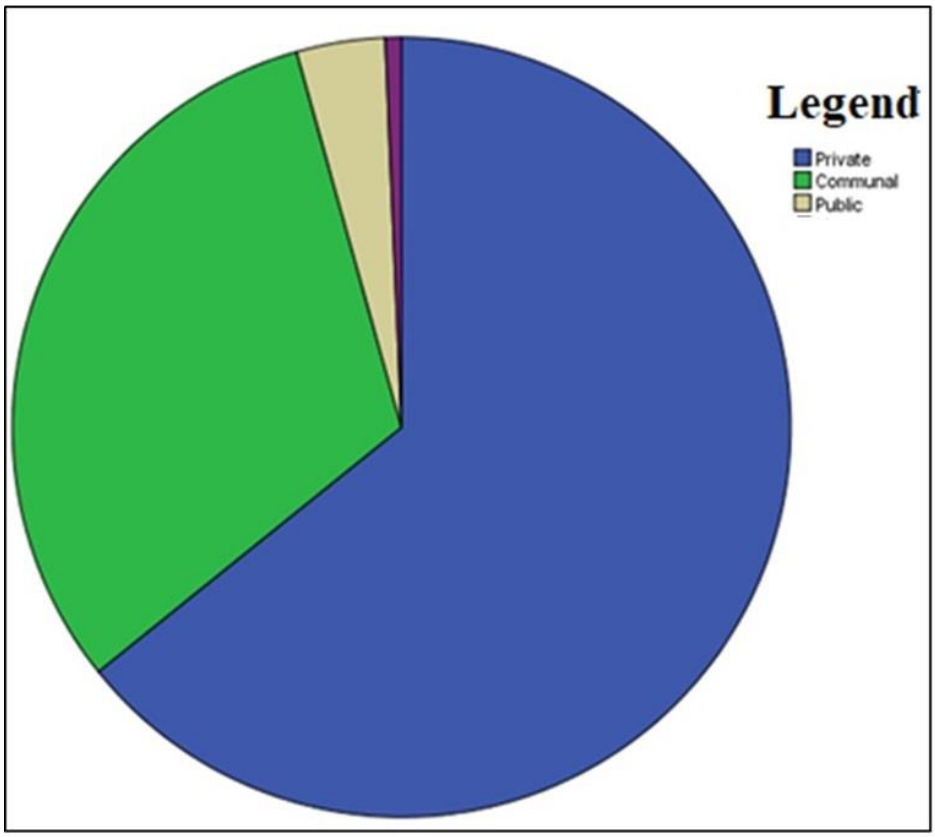

Fig. 4 Ownership share of toilets in Dessie City

Public Toilets in Dessie City

There are some public toilets in Dessie City. However, most of these toilets are not properly managed and used by the community. As a result most of them are damaged not providing the required services (Fig. 5). According to Dessie City Water Supply and Sewerage Service Office, 2021, report, such toilets are found in Dessie bus terminal, *Arada* and *Salayish* areas. According to the report these toilets are constructed with brick buildings and administered by associations. The major problems of these toilets include they are few in number, constructed in low standard, inappropriate use of the society, and lack of close supervision and monitoring mechanisms.

Fig. 5. Sample public toilets in Dessie City

In cities like Dessie, residents do not have adequate private and public toilets. Given that the population of the city is growing rapidly, the current sewerage system is backward and low which is not enough to meet the rapidly growing demand for sewerage and create a clean living environment. Moreover, the awareness of the community regarding waste management is low. This is confirmed from the respondents reply via questionnaire. For example look at Figure 6 below. It shows how wastes are thrown carelessly in the compound of Dessie City bus terminal. This is a place where many passengers coming from different parts of the country are using.

Fig. 6 Carelessly Splashed and Thrown Wastes at Dessie Bus Station

In Dessie City liquid wastes are collected both by private and government owned vacuum trucks. The sample households were also asked to express how they dispose their toilet waste. Thus, they replied that most of them (42%) disposed by municipal liquid waste vacuum trucks, while the remaining 25%, 24%, and 9% of them were disposed by underground sewerage pipeline, by private liquid waste vacuum trucks, and other means respectively (Fig. 7). However, all respondent confirmed the absence of any services from Dessie City water and sewerage service for transporting and disposing their liquid waste. Thus, their response for the survey questionnaire is considering the normal time i.e. the time when the Dessie City water and sewerage service office was providing the service.

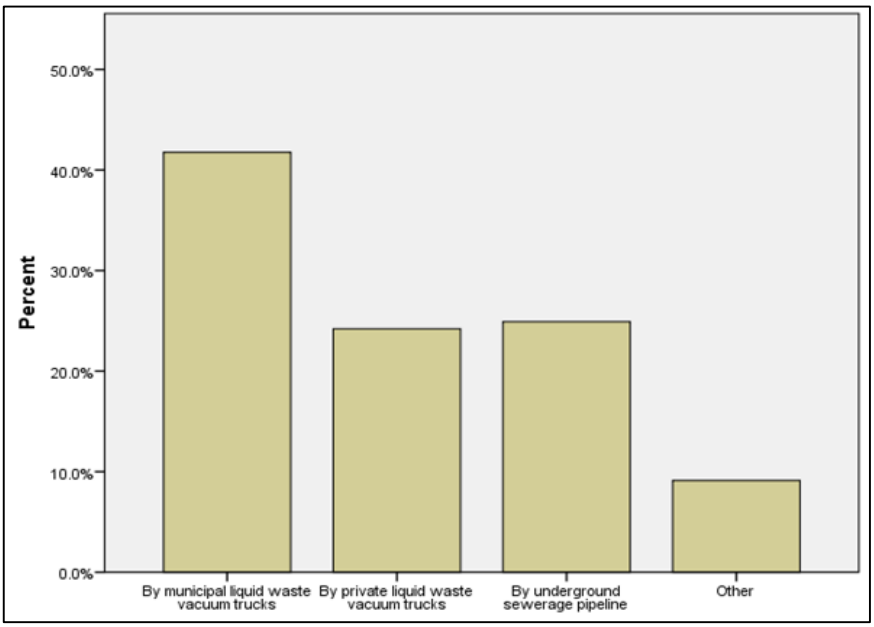

Fig. 7 Mechanisms of disposing toilet wastes

The following Table 3 shows the total amount of liquid wastes collected in meter cube within the past five years. As indicated below in Dessie City formal liquid waste collection was started in 2016

.

Table 3 Amount of Liquid Wastes Collected in Dessie City in the past five years

Months	Liquid Wastes Collected in Dessie City (m^3)				
	2016	2017	2018	2019	2020
July		940	2,390	940	560
August			1,120	1,260	1,170
September		2,500	1,020	1,160	1,090
October			1,020	1,170	1,230
November			1,520	1,130	1,440
December		2,610	2,110	860	1,220
January			2,720	2,240	1,140
February			750	2,080	650
March		4,130	1,420	1,720	1,140
April			2,830	1,270	580
May			2,250		730
June	1,740	2,390	1,580	180	770
Total	1,740	12,570	20,730	14,010	11,720

The distribution of toilet ownership in Dessie City likely has significant implications for the study on liquid waste management practices. A high proportion of private/household toilets, compared to public facilities, would suggest a greater reliance on decentralized liquid waste collection and disposal methods. This could pose challenges for coordinated liquid waste management at the city level, potentially leading to improper disposal practices and sanitation issues. Understanding the toilet ownership distribution is crucial for developing effective liquid waste management strategies that address the needs of both private and public sanitation facilities in Dessie City.According to Dessie City water supply and sewerage service office responses all of the liquid waste generating sources (condominium houses, private households, industries, hotels and restaurants) are causing sanitation and environmental problems in the City .

Fig. 8 a photograph taken from *Erisha-sebel* condominium site (Right) and *Borumeda* condominium site (Left)

According to a 2021 report by the United Nations Environment Programme (UNEP) titled "Neglected: Environmental Justice Impacts of Marine Litter and Plastic Pollution", industrial liquid waste is a major source of pollution in many urban areas around the world. The report states: Industrial liquid waste, if

not properly treated and managed, can contain a wide range of contaminants such as heavy metals, organic compounds, acids, and other hazardous substances. These pollutants can negatively impact water quality, soil, and ultimately human health when discharged into the environment without adequate treatment (Fig. 9). The UNEP report goes on to highlight the disproportionate impacts that such industrial pollution has on marginalized and underserved communities living in urban areas. Proper waste management and treatment is identified as a key step in addressing these environmental justice issues.

Fig. 9 Liquid wastes released from MOHA Soft Drinks Industry Share Company

Hospitals as a health institution should be able to release their wastes properly. Wastes from Hospitals and healthcare facilities may be contaminated (potentially infectious) or non-contaminated. Dessie Referal Hospital has no waste treatment plant and is discharging its waste through pipelines into the surrounding settlements and it is gradually percolates down into *Borkena* River (Fig. 10). This discharge affects the health of the surrounding residents and also pollutes the environment and is damaging the ecosystem.

Fig. 10 Liquid Waste Problems at Dessie Referral Hospital

Liquid Wastes Released From Religious Institutions

Religious places should be safe and clean because these are places where large number of its followers are frequently coming and pray. However, most of these places are not to the standard in Dessie City. This is confirmed from the interview conducted with selected religious individuals. For example, Figure 11 below shows the manhole of *St. Gebriel* church in Dessie City. It is opened and releasing its waste into the main highway so that church service providers, the communities who come to prey including passengers are suffering from the bad smell and environmental pollution.

Fig. 11 The Manhole opened and release liquid waste at the main gate of St. Gebriel Church

Sample household's response for the question of how they dispose their liquid wastes revealed that 39% of them used infiltration pit. The remaining 17.7%, 13%, 12.7%, 8.3%, 7%, and 2.3% of them discharging in the sewage channel outside of the compound, septic tank, discharging on the road outside of the compound, discharging on the open spaces inside the compound, discharge into a toilet, and used other means respectively (Table 4).

Table 4 Sample households way of disposing their liquid wastes

S.No	Alternatives	Frequency	Percent
1	Discharging on the open spaces inside the compound	25	8.3
2	Discharging on the road outside of the compound	38	12.7
3	Discharging in the sewage channel outside of the compound	53	17.7
4	Infiltration pit	117	39.0
5	Septic tank	39	13.0
6	Discharge into a toilet	21	7.0
7	Other	7	2.3
	Total	300	100.0

Analysis of Liquid Waste Disposal Mechanisms

The liquid waste generated in Dessie City is disposed of through various means, including municipal and private vacuum trucks, as well as underground pipelines. A liquid waste disposal site was established in the *Karagutu* area in 2018, with support from the World Bank. However, the site faced several issues, including resistance from the local community, lack of commitment from the municipal authorities, and the overflow of waste, which led to the demolition of the structures. Despite these problems, the new structure planning team has again selected the *Karagutu* area, specifically the '*Roba'ger'* site, as the appropriate location for Dessie City's liquid waste treatment plant.

Discussions

The study on liquid waste management in Dessie City reveals significant socioeconomic and demographic challenges that need to be addressed to improve the overall liquid waste management system in the city. The findings indicate that the majority of the respondents have a relatively low educational background, with 10% being illiterate and 35.3% having only primary education. This suggests a need to enhance community awareness and education on the importance of proper liquid waste management, environmental cleanliness, and personal hygiene.

Furthermore, the rapid urbanization and population growth in Dessie City have outpaced the development of the sewerage system and the availability of private and public toilets. This has led to the indiscriminate disposal of liquid waste, as evident from the waste dumping observed at the Dessie City bus terminal. The formal liquid waste collection system, which was only introduced in 2016, is still inadequate to meet the growing demand, leading to environmental and sanitation issues.

Additionally, the study highlights the lack of proper waste treatment facilities, particularly at the Dessie Referral Hospital, where untreated liquid waste is directly discharged into the surrounding settlements and the *Borkena* River. This practice not only poses a significant health risk to the local community but also contributes to the degradation of the ecosystem.

To address these challenges, a comprehensive and integrated approach to liquid waste management is needed in Dessie City. This should involve investment in the expansion and upgrading of the sewerage system, the construction of additional private and public toilet facilities, the implementation of effective liquid waste collection and treatment mechanisms, and the strengthening of community education and awareness programs on proper liquid waste management practices.

Addressing the socioeconomic and demographic factors that influence liquid waste management, such as the educational attainment and employment status of the residents, will be crucial in ensuring the long-term sustainability and effectiveness of the city's liquid waste management strategies.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

In Dessie City, there are 14 condominium sites built in different places. Most of these houses septic tank is directly discharged into *Borkena* River. Thus, contents of the latrine also flow into the surface outside the compound of the condominium buildings and drains directly into *Borkena* River. These produce offensive smell to the surrounding community and polluted the ecosystem of the River. Majority of the existing communal sanitation systems are pit latrines.

It must be appreciated that it is not possible to provide conventional waterborne sewerage in low income countries like Ethiopia. Thus, it is better to develop well-designed sewerage systems that could be a feasible alternative for newly developed condominium housing projects as there is an opportunity to use shared backyard plots for sewer laying space as well as shallow depth of sewers as there is no traffic. But, the provision of settled sewerage systems, where the solids are settled out in interceptor tanks thus allowing small diameter sewers with negative gradients is not recommended. If the interceptor tanks are not regularly emptied, the sewer system blocks and becomes unusable.

Recommendations

Based on the findings of the study, the following recommendations are forwarded:

1. Policy and Regulatory Reforms:
   - Review and strengthen existing policies, strategies, and regulations related to liquid waste management in Dessie City.
   - Ensure effective enforcement mechanisms are in place to hold stakeholders accountable for compliance.
2. Institutional Capacity Building:
   - Assess and address the gaps in institutional capacities to manage liquid waste effectively.
   - Improve coordination and collaboration among the various agencies and stakeholders involved in liquid waste management.
3. Infrastructure Development:
   - Ensure the construction and maintenance of liquid waste management infrastructure, such as septic tanks, sewage treatment plants, and drainage systems, meet the required standards.
4. Financing Mechanisms:
   - Identify and secure sustainable financing sources for the development and maintenance of liquid waste management infrastructure and services.
   - Explore innovative financing models, such as public-private partnerships, to mobilize resources for the sector.
5. Community Engagement and Awareness:
   - Engage with the urban communities in Dessie City to promote awareness abou proper liquid waste disposal and sanitation practices.
   - Encourage active community participation in the planning, implementation, and monitoring of liquid waste management.

Acknowledgements
The author would like to thank the Dessie City Municipal Authority Office for its financial support.

REFERENCES

Alemayehu, T., and Yirga, T. (2018). The hierarchy of laws in Ethiopia: Implications for environmental governance. *Ethiopian Journal of Environmental Studies and Management*, 11(1): 1-12.

Central Statistical Agency of Ethiopia. (2021). Population Projection of Ethiopia for All Regions at Wereda Level from 2014 - 2017. Retrieved from https://ethiopia.opendataforafrica.org/ETOPOPP2021/population-projection-of-ethiopia-for-all-regions-at-wereda-level-from-2014-2017

CSA. (2020). Population projection of towns as of 2020.

Demissie, T., Gebrehiwot, M., Gebremedhin, B., and Worku, H. (2020). Challenges and opportunities of liquid waste management in urban areas of Ethiopia: The case of Dessie City. *Cogent Environmental Science*, 6(1): 1-16

Dessie City Administration. (2021). Dessie Wastewater Management Project.

Dessie City Development organization (DCDO) (2022). WASH program.

Dessie City Water Supply and Sewerage Service Office. (2021). The 2021 annual report of the office.

Desta, A. T., Campisano, A., Modica, C., and Loggia, G. L. (2019). Assessing the performance of on-site sanitation systems in Dessie City, Ethiopia. *Water Science and Technology*, 80(2): 371-380.

Federal Democratic Republic of Ethiopia. (1997). Environmental policy of Ethiopia, Addis Ababa, Ethiopia.

Fewtrell, L., and Bartram, J. (Eds.). (2001). Water quality: Guidelines, standards and health: Assessment of risk and risk management for water-related infectious disease. World Health Organization, IWA Publishing.

Getacher, T., and Etana, D. (2021). Determinants of industrial location in Dessie City, Ethiopia. *African Journal of Economic and Management Studies*, 12(1): 132-148.

Getahun, T. T., Tesfaye, G., and Negash, D. (2020). Challenges of liquid waste management in Dessie City, Ethiopia. *Cogent Environmental Science*, 6(1):1-13

Hoornweg, D., and Bhada-Tata, P. (2012). What a waste: A global review of solid waste management. The World Bank.

Huuhtanen, S., and Laukkanen, A. (2006). A guide to sanitation and hygiene for those working in developing countries. Global Dry Toilet Club of Finland Tampere Polytechnic, University of Applied Sciences. ISBN 952-5264-49-1.

MOH. (2017). Ministry of Health's annual report 2017.

MUDHCo. (2014). National report on housing and sustainable urban development. Addis Ababa, Ethiopia.

Nadkarni,M.(2004).The meaning of sanitation: An ecosystem approach. Paris. http://www.cerna.ensmp.fr/cerna_globalisation/Documents/Manoj.pdf

Panagopoulos, A. (2021). Energetic, economic and environmental assessment of zero liquid discharge (ZLD) brackish water and seawater desalination systems. *Energy Conversion and Management*, vol. 235.doi:
https://doi.org/10.1016/j.enconman.2021.113957

Ramakrishna, V. (2013). 'Life cycle assessment model for integrated solid waste management'. *International Journal of Engineering Research and Technology*, 2(9):1742-1748.

Simon, A. M. (2008). Analysis of activities of community based organizations involved in solid waste management, investigating modernized mixtures approach: The case of Kinondoni Municipality, Dar es Salaam, Tanzania (MSc. Thesis). Wageningen University and Research Centre, Wageningen, Netherlands.

Tchobanoglous, G., Burton, F. L., and Stensel, H. D. (2003). Wastewater engineering: treatment and reuse. McGraw Hill.

The Urban Health Extension Program (UHEP). (2018). Strategy document from the Ethiopian Federal Ministry of Health, Addis Ababa, Ethiopia.

Tilley, E., Ulrich, L., Lüthi, C., Reymond, P., and Zurbrügg, C. (2014). Compendium of sanitation systems and technologies. Eawag.

United Nations Environment Programme (UNEP). (2021). Neglected: Environmental justice impacts of marine litter and plastic pollution. Nairobi, Kenya: United Nations Environment Programme.

United States Environmental Protection Agency (EPA). (2022). Sustainable materials management: Non-hazardous materials and waste management hierarchy. Retrieved from https://www.epa.gov/smm/sustainable-materials-management-non-hazardous-materials-and-waste-management-hierarchy on 2024-06-29 .

Woldeyohannes, A. D. (2012). Urbanization in Ethiopia: Migration and development. *International Journal of Asian Social Science*, 2(2): 311-320.

Zewdie, A., and Getahun, T. (2021). Characterization and management of liquid waste in Dessie City, Ethiopia. *Environmental Challenges*, 4 (1):1-12