International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 9 Issue 3, May-Jun 2025 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Impacts of Solid Waste Management Practices on Environment and Public Health in Juba County, South Sudan

Chol Daniel Deng Garang[1]*, John Leju Celestino Ladu[2], Yahya Ibrahim Said[3]

[1,3]Department of Geography, School of Education,
[2]Department of Environmental Studies, School of Natural Resources and Environmental Studies,
[1,2,3]University of Juba, Juba, South Sudan
(*Corresponding Author: Chol Daniel Deng Garang)

ABSTRACT

Generating solid waste and final disposal present a unique problem in almost every country. It is evidenced by the impacts on human health and the environment when it is not properly managed. On the other hand, if there are inadequate financial resources, solid waste management is enhanced. Many cities in the developing world cannot meet the need for solid waste management, although they invest a large proportion of their budget. Yet still, the service coverage is less than fifty percent of the total area allocated, as a result of ineffective solid waste management, there are risks to public health and societal well-being. There is a great problem in the household management of solid waste in the rapidly growing Juba in South Sudan. It is important to note that Juba City is one of the fastest-growing towns in South Sudan in terms of socioeconomic activities and infrastructural development. It is also considered one of the fastest-growing cities globally (UNEP, 2013). There is no exact figure for the population of the city, but according to the Sudan population census conducted in 2008 reported that the population of the city was 230,192. The UN estimated the population of the city as well above one million (The Sudd Institute 2012). Coupled with this socio-economic growth and industrial development, the city is experiencing rapid growth in its population due to the influx of returnees, internally displaced persons, and foreign technical experts seeking job opportunities in the industrial and business sectors. The population growth of the city was estimated to be 2.71% per annum, and it is projected to reach 305,319 by 2015 (NBS, 2015).

KEYWORDS: *Solid Waste, Management practice, Environment, Public health*

How to cite this paper: Chol Daniel Deng Garang | John Leju Celestino Ladu | Yahya Ibrahim Said "Impacts of Solid Waste Management Practices on Environment and Public Health in Juba County, South Sudan" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-9 | Issue-3, June 2025, pp.1263-1273, URL: www.ijtsrd.com/papers/ijtsrd97161.pdf

IJTSRD97161

Copyright © 2025 by author (s) and International Journal of Trend in Scientific Research and Development Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0) (http://creativecommons.org/licenses/by/4.0)

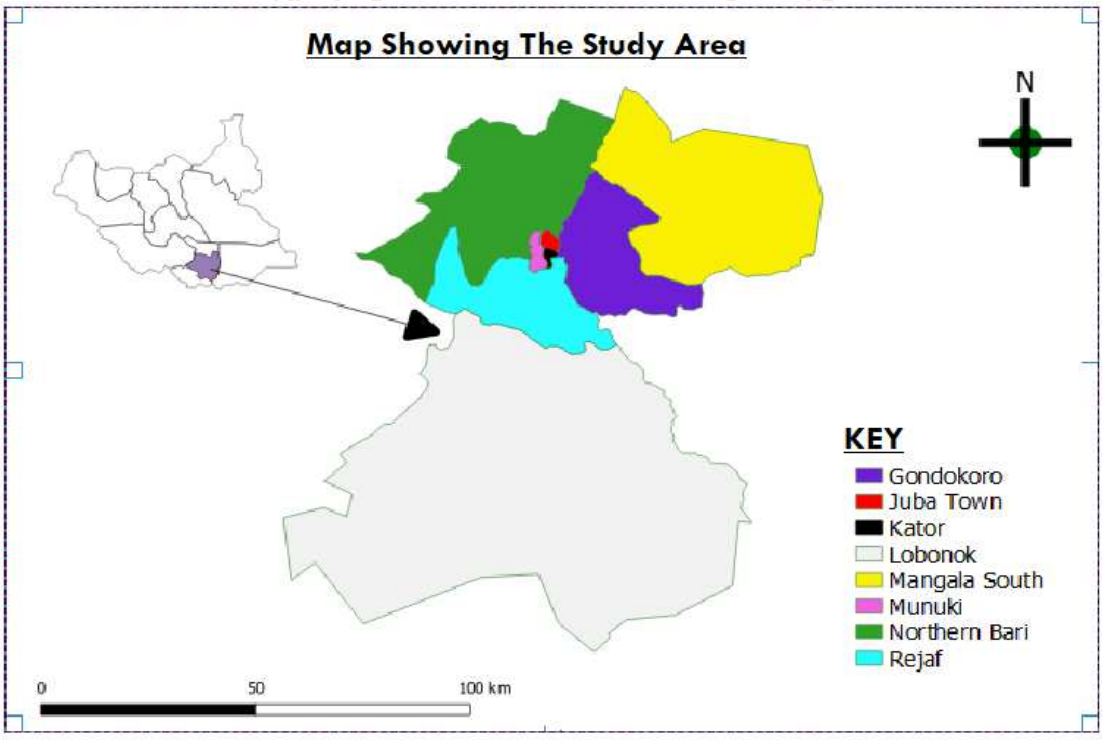
INTRODUCTION

Solid waste Management generally refers to the application of techniques that ensure an organized execution of various functions of collection, transport, processing, treatment, and disposal of municipal solid waste (Henry, Yongsheng, & Jun, 2006). The management of Municipal solid waste encompasses planning, engineering, organization, administration, financial, and legal aspects of activities related to solid waste management. Solid waste refers to any useless, unwanted, or discarded material that is not a liquid or gas. Solid waste is also known as garbage and is not different from municipal waste. Additionally, it refers to "organic and inorganic waste materials produced by households, institutional, industrial, and commercial activities (UN-HABITAT 2010). Solid Waste In this study, the term has been used to refer to all activities of controlling of generation, storage, collection, transport, and disposal of solid wastes. According to NEMA (2015), it also includes all the necessary institutional operations and individual actions to remove solid wastes from the sources of generation to the disposal sites and the activities performed at the landfill to ensure environmental safety.

Solid Waste: Any item/material that is discarded by its owner and that is not discharged in gaseous form

to the atmosphere, to a pit latrine, or via a pipe or channel. According to UN-HABITAT (2010), solid waste also refers to any useless, unwanted, or discarded material that is not a liquid or gas. Solid waste is also known as garbage and is not different from municipal waste. Additionally, it refers to "organic and inorganic waste materials produced by households, commercial, institutional, and industrial activities that have lost value in the sight of the initial. Waste: as used in this study, waste refers to any item or substance that is either damaged beyond repair or can no longer be put to its intended use and is therefore to be discarded or parted with (KENAO, 2006/2007). Waste also refers to refuse (resources that are to be discarded and are perceived as useless). According to UNEP, waste refers to substances or objects that are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law. Waste: as used in this study, waste refers to any item or substance that is either damaged beyond repair or can no longer be put to its intended use and is therefore to be discarded or parted with (KENAO, 2006/2007).

Management: the term used in this study refers to a cyclical process of setting objectives, establishing long-term plans, programming, budgeting, implementation, operation and maintenance, monitoring and evaluation, cost control, and revision of objectives and plans (Najeeb, 2014). The term has been broadened to cover all functions of an organization. Municipal Waste: Municipal waste refers to refuse from households and industrial, commercial, and institutional establishments. Others are market waste, yard waste, and waste from street sweepings. According to Cointreau-Levine and Coad (2000), municipal waste refers to" wastes from domestic, commercial, institutional, municipal and industrial sources, but excluding excreta, except when it is mixed with solid waste". Management: the term used in this study refers to a cyclical process of setting objectives, establishing long-term plans, programming, budgeting, implementation, operation and maintenance, monitoring and evaluation, cost control, and revision of objectives and plans (Najeeb, 2014). Currently, the term has been broadened to cover all functions of an organization; hence, it also refers to general organizational management. Municipal Waste: Municipal waste refers to refuse from households and industrial, commercial, and institutional establishments. Others are market waste, yard waste, and waste from street sweepings. According to Cointreau-Levine and Coad (2000), municipal waste refers to" wastes from domestic, commercial, institutional, municipal and industrial sources, but excluding excreta, except when it is mixed with solid waste.



Source: Adapted from NBS Map, 2015

METHODOLOGY

Study Areas: Juba County is in Central Equatoria state, with its headquarters in Juba, the national capital of the Republic of South Sudan. It is a Centre for International organizations, diplomatic missions, and the business community, and it is also regarded as a unifying city for residents of all sixty-four (64) South Sudanese tribes

who either migrated here or served in the government. City officials estimate that Juba probably occupies a 12-kilometer area in diameter from the Centre of the City (approximately 11,300 hectares). Juba City, including the surrounding rural lands, encompasses roughly 100 kilometers in diameter. The city is located along the western bank of the White Nile. Its geographical coordinates are 4° 51' 0" North and 37' 0" East. Juba City is made up of three Payams, Juba, Kator, and Munuki, and is directly administered by the Juba City mayor. It was reported that Juba is perhaps currently among the fastest-developing places in the world (UNEP, 2013). More specifically, growth in its population is noticeable. In 2011, the population of the city of Juba was estimated to approximately more than 500,000 people (Global Water Intelligence, 2011). Juba was characterized by rapid population growth due to the influx of returnees, investors, and businessmen from the neighboring Countries, urban sprawl, and inadequate service provision. This very development, in turn, yields its odd reciprocals, among which the non-existence of a proper waste management infrastructure seems to be at the lead.

Juba City is a corporate body that is divided into three blocks: Juba, Munuki, and Kator. Each block, for administrative purposes, is further divided into Quarter Councils. The city council is headed by a mayor, who is also the head of the city council's executive organ as the state governor's representative at the city council level. The city council has a legislative organ to which the mayor is accountable. The legislators are the representatives of the people of the city who are the direct residents of the respective blocks or quarters councils. The city council has two key departments: the Department of Environmental and Sanitation and the Department of Public Health. The former is responsible for water and environmental sanitation, and the latter is responsible for solid waste management, including solid waste collection, collection of charges from service beneficiaries, inspection of the facilities of the beneficiaries, and their regulation. The City Council does have the legal mandate to employ technical staff. The staff for the Department of Environmental and Sanitation is seconded by the Ministry of Health, Environment, and Sanitation, while the administrative officers, who do the administrative and regulatory work, are seconded by the Ministry of Local Government and Law Enforcement. The salaries of those technical and administrative officers are paid by their respective ministries, but not by the city council (Luate, 2015).

The target population for Juba was 5017 people. The study populations, therefore, included the residents of Munuki, Kator, Juba town, Gondokoro, Rejaf, Mangalla, Luri, Lobonon, and Ladu Payams/Blocks. The categories of the likely population studied or respondents sampled were mostly the Youth, Women, Elderly people, Universities, Hospitals, NGOs, UN Agencies, big Companies, and government officers. These people are presumably assumed to know Solid Waste Management (SWM) in Juba. The researcher used Population Projection for South Sudan by Payams (NBS, 2015/2020). The main livelihood activities in Juba include farming, hunting, trading, fishing, and a small number of livestock keeping.

Data collection methods: The study employed the following quantitative and qualitative methods to gather data. The study used qualitative data was that data which included non-numerical data such as interviews and observation in the sampled areas. Approaches that were used in this study were qualitative data in words by key informant interviews and quantitative data in numerical form by survey because of the need to clarify the results and to examine the consistency of findings obtained from both the survey with those from key informant interviews as noted by Amin, (2005) in addressing the research question of this thesis study. Specifically, it can be faster compared to qualitative methods for it is possible since the thesis has limited time, the quantitative method is therefore appropriate for this thesis.

The instrument of the questionnaire, a data collection instrument given to respondents to fill in and return as stated by Dudley (2011 was drafted following recommendations by Kothari (2005), Saunders et al (2009), and Sekaran and Bougie (2010). It was used to collect quantitative data, and instructions on how to tackle the various sections of the questionnaire were provided. Primary data comprised local views, perceptions, and opinions related to solid waste management at Juba among the local community household members. The study used three methods of data collection (questionnaire, Interview guide, and observation checklist) to obtain the required data concerning the research. Close and open-ended questionnaires (Appendix I) were used to collect data on the sources and types of solid waste, solid waste disposal methods and quantity of solid waste generated, the most common types of diseases and disease vectors associated with solid waste, financial status and willingness to pay for Solid Waste, the gaps in the management of solid waste and the roles of Stakeholders engagement in successful Solid Waste Management.

The key informant Interview guide was the second method that was used in the collection of qualitative data for this study. Key informants who were respondents selected the study because of their special knowledge and

experience on the study topic, as noted by Dudley (2011 was consulted in the research study. The researcher conducted a semi-structured interview where the researcher had a list of questions to be covered, often referred to as an interview guide, as described by Bryman (2001. Therefore, in this study, the researcher drafted the instrument of a key informant interview guide which began with an introduction message about the study and its rationale, a question on the gender and position of the respondent, and open-ended questions aiming at collecting the key informant's views in regards to this research study. Interview guide (Appendix II) were used in the five sites (Juba city council, Juba County, Ministry of Environment and Forestry, Solid waste companies, Ministry of Health and University of Juba, Directorate of Waste Management, Hygiene and Water Supply) to collect data on the types of solid waste generated, knowledge level, perception and practices of the community toward solid waste management, disposal method, financial status and existing policies on solid waste management to give an in-depth information on those areas of solid waste management.

Result and Discussion

The Sources, Types, Methods, and Quantity of Solid Waste Generated and Disposed

Municipal solid waste involves all materials except hazardous waste, liquid waste, and atmospheric emissions. Solid waste can be further subdivided into two common categories: private and commercial waste. The private sector refers to the waste that is assigned as 'garbage. The trash class can be depicted as the waste assembled by the community administrations, and the commercial category contains industrial and agricultural waste. The amount and composition of solid waste in Vietnam show that total waste and plastic waste were the major types of waste generated. This waste generation had remarkable seasonal variation. It is also noted in a study of solid waste generation and composition in Botswana, Gaborone that closed to 45,000 tons of the annual amount of solid waste to landfill were textile, food, metals, glass, electronic waste, paper, garden, wood waste, and plastics Badran M and Haggar (2006).

Nabegu (2010), Negabooshnam (2011), and Okot-Okumu (2012) noted that household wastes are often generated from several sources where various human activities are encountered. They argued that most solid waste from developing countries is generated from households (55-80%), followed by commercial or market areas (10-30%), with varying quantities from streets, industries, and institutions. Waste from these sources is highly heterogeneous (Valkenburg et al., 2008) and have variable physical characteristics depending on their sources, notably in their composition are food waste, inert materials, yard waste, paint containers, wood, batteries, plastics, papers, rubber, metals, textiles, leather, construction and demolishing materials.

According to Sujaudin et al. (2008), CED (2003), solid waste is classified based on its origin, risk potential, food waste, rubbish, plastic, wood, metals, papers, ashes and residues, agricultural waste, municipal service, industrial process waste, and demolition and construction wastes. With regards to characteristics, it also classifies as biodegradable and non-biodegradable. However, based on their risk potential, they can be categorized into hazardous and non-hazardous wastes. However, solid wastes are usually classified based on their sources. It can be categorized into domestic and household, commercial, institutional, industrial, municipal services, construction and demolition, and agricultural wastes.

Solid waste storage facilities in the house.

The finding of the study showed that the majority (50.3%) of the respondents don't have solid waste storage facilities in their households but they store their household's solid wastes through wastes in rubbish pits, burning, burying, and digging a holes around the house as their traditional ways for solid waste disposal in their households while 49.7% of the respondents that stored their wastes in dustbins and polythene papers, drop bags and the disposed their solid wastes in open dumping site and dumping site as indicated in table.1.

Table 1. Solid waste storage facilities in the house.

Respondent	Frequency	Percentage
Yes	298	49.7
No	302	50.3
Total	**600**	**100.0**

Source: Field data (2023)

Major sources of solid waste are generated and disposed off

The findings of the study showed that agricultural waste was the major source of solid waste generated in Juba, which had 50%, while Residential waste had 22%, followed by commercial waste had 17% which included markets, hospital clinical wastes, hotels, and restaurants. Institutional wastes, such as universities, colleges, schools, and government ministries, had 6% of the respondents. About 3% of the respondents for Construction

wastes including street sweeping, and drain cleaning but excluding treatment facilities and other wastes (2%) were other wastes in Juba, a significant portion of the population does not have access to waste collection services, and only a fraction of the generated wastes are collected by the door to door collection systems introduced by Juba City councils, Non-Governmental Organizations (NGOs), Community-Based Organizations (CBOs) and Private companies which is now for a decade in Juba, Central Equatoria State - South Sudan for tiny payment moreover, due to a lack of commitment, motivation, and awareness, a considerable of wastes are not properly disposed of in the designated places for ultimate disposal. As a result, there is an unmanageable increasing quantity of Solid waste management (SWM), which creates alarming environmental problems in Juba.

These results are consistent with Badran and Haggar (2006), who identified various sources of solid waste as commercial, industrial, agricultural, and residential. Nabegu 2010, Nagabooshnam (2011), and Okot Okumu (2012) widely known and esteemed that household wastes are often generated from several sources where various human activities are encountered. They argued that most solid waste from developing Countries is generated from households (55-80%), followed by market or commercial areas (10-30%), with varying quantities from streets, industries, and institutions. Waste from these sources is highly heterogeneous (Valkenburg et al., 2008). The variable physical characteristics, depending on their sources, are food waste, wood, plastics, yard waste, metals, papers, leather, batteries, paint containers, materials, rubbers, textiles, construction, and demolition materials, as indicated in the table. 2.

Table. 2. Major sources of solid waste generated and disposed of

Respondents	Frequency	Percentage
Residential	132	22.0
Commercial	102	17.0
Institutional	36	6.0
Agriculture	300	50.0
Construction	18	3.0
Others	12	2.0
Total	**600**	**100.0**

Source: Field data (2023)

Types of wastes generated and disposed off

The characterization of solid waste from two dumpsites in Juba. The finding showed that majority (33%) of the respondents from agriculture wastes, 17.2% of the respondents from plastic bags, 14%, food wastes, 8% of the respondents from containers, 6%, paper wastes, 4.2%, medical wastes, 4%, all the types of waste, 2.7%, wooden wastes and glass, 2.3%, demolition wastes, 2%, worn wastes, metallic waste and others, and hazardous wastes (1%) of the total wastes generated and disposed. The human health risks that may result from e-waste include breathing difficulties, coughing, respiratory infections, convulsions, and death. E-waste workers are exposed to other hazards leading to physical injuries and chronic ailments such as asthma, skin diseases, eye irritations, and stomach diseases (Raghupathy et, 2010).

The results agree with Phuc (2010), who, in a study that sought to characterize the amount and composition of solid waste in Vietnam, observed that total wastes, food wastes, and plastic wastes were major types of waste generated. The results also agreed with Nagabooshnam (2011) whom in a study on solid waste generation and composition in Gaborone, Botswana noted that closed to 50,000 tonnes of the annual amount of solid waste to landfill was paper, garden and wood waste, textile, food, metals, glass, electronic waste, plastics and fines. These waste categories were then classified into four types: housing, commercial, industry, and others. More than half of the waste received at the landfill originates from households. Waste from the commercial sector accounts for approximately 30% of the generated waste, while the remainder is mainly waste from other sectors, that is, defense waste, institutional waste, and industrial waste, which constitutes a minor part of the waste generated in Gabon. Solid waste is classified based on its origin, risk potential, food waste, rubbish, ashes and residues, agricultural waste, municipal service, industrial process waste, and demolition and construction wastes. It is also classified as biodegradable and non-biodegradable. Based on their risk potential, it is categorized as hazardous and non-hazardous wastes (CED, 2003).

It was found that out of 343 kg/day waste generated by 401 households, organic form almost half (47.25%), which is in line with previous studies conducted within Nepal (ADB, 2013; SWMRMC, 2004, 2008). Organic waste from developing countries, in general, consists of more than 50% of the total waste composition (Aleluia

& Ferrao, 2016; Hoornweg & Bhada-Tata, 2012). However, the average municipal organic waste composition in Nepal was found to be 66.4% (ADB, 2013), but the organic waste composition in the study area is rather similar to the global municipal organic waste composition of 46% (Hoornweg & Bhada-Tata, 2012). Organic waste included both kitchen and yard waste. Paper and paper products comprised 10.38%, followed by glass (9.88%), metal (6.92%), plastic (5.39%), textile (3.57%), and rubber and leather (1.38%). Other waste comprised a significant share of 15.23%, which also included hazardous 63 waste like batteries and light bulbs. Hazardous waste contains corrosive or toxic ingredients and is prone to catch fire, react, or explode under certain circumstances (Table 3).

Table 3. Types of wastes generated and disposed off

Types of wastes	Frequency	Percentage
Paper wastes	36	6.0
Plastic bags	103	17.2
Containers	48	8.0
Food wastes	84	14.0
Agriculture wastes	198	33.0
Worn clothes	12	2.0
Wooden wastes	16	2.7
Demolition wastes	14	2.3
Metallic wastes	9	1.5
Medical wastes	25	4.2
Hazardous wastes	6	1.0
Glass	16	2.7
Others	9	1.5
All of the Above	24	4.0
Total	**600**	**100.0**

Source: Field data (2023)

Solid waste disposal methods

The results show that the majority (35%) of the respondents burn their waste at home. 20.3% of the respondents digging a hole around the house and disposed their waste, 14.2% of the respondents knew disposal of wastes on the dumping site while 8.3% of the respondents had no knowledge of on solid waste disposal methods the throw it in an open space or street, 8.2% of the respondents said all the above method are apply in solid wastes disposal methods. About 4.7% of the respondents bury their solid wastes at homes, 4% of the respondents disposed their wastes on the backyards of the house, 3% of the respondents throw it wastes in to the nearby the river or streams as their method waste disposal and 1.3% of the respondents throw it wastes in to the nearby ditches. Only 1% of the responsibility was from other wastes.

This indicated that the majority of people in Juba lack adequate knowledge of solid waste disposal, which might lead to poor waste management in the area. This agrees with Jurczark's (1997) study, which observed that, generally, the generation of total municipal solid waste had significantly increased in Poland due to poor management of waste, which in turn was attributed to a lack of knowledge. These results were also similar to Ndum (2013), who noted that in most municipalities in Western African Countries, 65% had no information on solid waste disposal methods. The relevant councils took very little effort to provide households with information concerning waste management. Also, this agreed with the study done in Guinea that the environmental pollution that is associated with indiscriminate waste disposal has serious negative impacts on public health and safety (Mamady & Mafoul, 2014; Mamady & Hu, 2011).

Table 4. Solid waste disposal methods

Solid waste disposal methods	Frequency	Percentage
Throw it in an open space or on the street	50	8.3
Digging a hole around the house and disposing of	122	20.3
Disposing of the backyards of the house	24	4.0
Throw it into the nearby river/streams	18	3.0
Disposing of the dumping site	85	14.2
Throw it into nearby ditches	8	1.3
Burn	210	35.0

Bury	28	4.7
All of the above	49	8.2
Other Specify	6	1.0
Total	**600**	**100.0**

Source: Field data (2023)

The Most Common Types of Diseases and Disease Vectors Associated with Solid Wastes

Solid waste comprises all the waste arising from animal and human activities and by-products of the process, which are commonly solid and are discarded as unwanted or useless materials that may be required by law to be disposed of. Solid waste can be classified in some ways based on its sources, environmental risks, utility, and physical properties. Based on the source and origin, solid waste is classified as industrial solid waste, Agricultural solid waste, and municipal solid waste. Urban towns and rural communities nowadays struggle to clear heaps of solid waste from their environments. These strategic centers are now being overtaken by overflowing dumps and uncollected heaps of solid waste emanating from household or domestic sources, shopping, markets, and business centers. The local government councils are unable to carry out their statutory responsibilities of managing municipal solid waste in the towns and cities, which is a clear violation of the environmental sanitation edicts and regulations. These solid wastes have become threats to the health of the dwellers, and it is no longer in doubt that Nigerian cities are overwhelmed with the challenge of uncleared solid waste (DI Omang, 2021).

Improper solid waste disposal causes air, water, and soil pollution. Indiscriminate dumping of waste contaminates surfaces and groundwater supplies. In urban areas, solid waste clogs drains, creating stagnant water for insect breeding and floods during the rainy season. Uncontrolled burning of solid wastes and improper incineration contribute significantly to urban air pollution. Greenhouse gases are generated from the decomposition of organic wastes in landfills, and untreated leachate pollutes the surrounding soil and water bodies. Health and safety issues, moreover, arise from improper solid waste management. Insect and rodent vectors are attracted to the waste and can spread diseases like cholera and dengue fever. Water polluted by municipal solid wastes for bathing, drinking, and food irrigation can also expose individuals to disease organisms and other contaminants. The United States Department of Public Health Services identified 22 human diseases that are linked to improper solid waste management. In addition, waste workers and pickers in developing countries are seldom protected from direct contact and injury, also exhaust fumes from waste collection vehicles and dust stemming from disposal practices and the open burning of waste contribute to overall health problems (Rajput et al, 2009).

Elizabeth et al (2014). Disclose that indiscriminate waste dumping practice caused the increasing incidence of diarrhea among underage children in Odukpani, Akamkpa, and the local government areas of Cross River State in Nigeria. Despite significant investments in the waste management sector, solid waste management remains one of the major environmental sanitation challenges facing the Country today and has continually remained at the lowest level because industrialization and rapid population growth in many towns and cities have led to waste being generated faster than they are collected and disposed of. The major issues affecting the Bekwarra local government area of Cross River state in Nigeria include the absence of proper solid waste collection services and a growing number of uncontrolled heaps of rubbish in the communities, constituting hazards to public health. In Cross River State, for instance, studies have shown that the Calabar Urban Development Authority (CDA) is saddled with the responsibility of refuse collection and evacuation, but the situation is different in the rural areas, including Bekwarra local government. Poor public attitude resulting in indiscriminate waste dumps on the street corners, and in the drains increases the rate of pest and vector breeding, vectors, and pollution of the environment, water, air, and soil. According to Bassey et al., the disposal of solid waste in the Ikot Effanga Area of Cross River State has caused the pollution of underground water, leading to a high mortality rate. Thus, it is in this context that the present study was carried out to assess the level of environmental pollution and the potential impacts on public health concerning solid waste management in the Bekwarra local government Area of Cross River State in Nigeria and proffer a solution to which would help change the negative attitude of the people and lead to improved waste management practices as well as ensure clean environment (Elizabeth A.G., Richard. W.R., Gregory M.H. Asuquo T.S., (2014).

Risks can originate from the nature of the waste or the process of collecting, processing, recycling, and disposing of it. Informal waste pickers are undoubtedly exposed to increased risk as basic principles of occupational health and safety are disregarded. Scavenging in open dumps is considered to be the most detrimental to health.

Relevant literature is surprisingly limited, with comparative data on health and accidents almost non-existent, and studies often suffering from methodological flaws. It is widely recognized that further research is needed in this important area. The occupational health risks to waste pickers in developing countries are high because of manual handling and a lack of protective clothing/equipment, resulting in direct contact with waste. Risks from manual handling of mixing waste may come, e.g., from direct contact with broken glass, human/animal feces matter, and paper that may have become saturated with toxic materials, containers with residues of chemicals, pesticides, and needles, bandages from the hospital. Inhalation of bio-aerosols, smoke, and fumes produced by the open burning of waste can cause health problems. Although there are insufficient data on the long-term effect of exposure to airborne bacteria as well as infectious or toxic materials present in solid waste, studies have shown that respiratory and dermatological problems, eye infections, and low life expectancy are common, vulnerable groups such as children, the elderly and women are in many cases the most exposed, as they often play critical roles in informal recycling activities (EERD, 1996).

This presents the outcomes of four studies examining the relationship between waste picking in developing countries and impacts (EERD, 1996). In many cases, it is difficult to distinguish between the health implications of work and living conditions. Personal behavior and hygiene can also have an important effect on the risk posed. It has been claimed that in certain cases, waste pickers have better health than unemployed people who live in the same shanty town (Kungskuniti, 1991). It could thus be argued that, under certain conditions, working with waste may be less detrimental to health than not having the financial means to survive. Community health risks of informal recycling can be posed to both related communities and the general public. There is no clear evidence for the degree of such risk. The most severe cases of adverse health effects have been reported for communities that live and work in shanty towns (EERD, 1996). Mexico City dumpsite scavengers were reported to have a life expectancy of 39 years, while that of the general population was 67 years (Medina, 2000). Manual sorting of mixed waste near the living space can create very unsanitary conditions. This attracts disease-carrying animals and increases the exposure of vulnerable sections of the population, such as children, to risk. Open burning of waste in dumps or backyards constitutes another community health hazard. The proximity of waste accumulations to living space is often combined with low sanitation, poor personal hygiene, and poor or nonexistent urban infrastructure and health care services.

The most common types of diseases associated with solid waste management

The finding showed the respondent's knowledge of diseases caused by poor waste disposal was concerned. This study noted that majority of the respondents (24.5%) stated malaria was the major types of diseases caused by poor disposal of wastes followed by 23.7% of the respondents were on respiratory infections, 16.7% of the respondents interviewed for Cholera, 15% of the respondents were for Typhoid, 5% of the respondents were for Eye diseases and 2% of the respondents were for Skin diseases. These are dependent on the study done by Mamady (2016), who is well known that most residents in Guinea are not aware that improper waste disposal leads to diseases such as typhoid, malaria, cholera, eye diseases, skin diseases, and respiratory infections, as indicated in Table 5.

Table 5. The most common types of diseases are associated with solid waste.

Types of Diseases Associated with Solid Wastes	Frequency	Percentage
Malaria	147	24.5
Typhoid	89	14.8
Cholera	100	16.7
Respiratory infection	142	23.7
Skin diseases	42	7.0
Eyes diseases	56	9.3
Other Specify	24	4.0
Total	**600**	**100.0**

Source: Field data (2023)

The disease vectors associated with solid waste management

The findings of the study showed that the majority (39%) of the respondents' flies are disease vectors associated with solid waste management. Followed by mosquitoes, represented by (25%) of the respondents, while 16% of the respondents were for rodents, 9% of the respondents were for cockroaches, and 6% of the respondents interviewed were from other sources. Only 5% of the respondents were represented on scorpions. The finding of the study from the interviews showed that residents of Juba are not aware of disease vectors associated to solid

wastes and even there was no awareness given to them on the general hygiene and sanitation on effect of disease vectors associated for flies, mosquitoes, rodents, cockroach and scorpions as shown on table 6.

Table 6. Disease vectors associated with solid waste management

Disease vectors	Frequency	Percentage
Flies	234	39.0
Mosquitoes	150	25.0
Rodents	96	16.0
Scorpions	30	5.0
Cockroach	54	9.0
Other specify	36	6.0
Total	**600**	**100.0**

Source: Field data (2023)

Conclusions

Solid waste management (SWM) in most developing countries is often characterized by inadequate service coverage, operational inefficiencies of services, limited utilization of recycling activities, inadequate management of non-industrial hazardous waste, and inadequate landfill disposal (Zurbrugg and Schertenleib, 1998). Although distinct differences exist between waste management in developed and developing countries, as developing countries achieve economic growth coupled with population growth, the environmental and economic burden of solid waste management will increase. The significant strides made in achieving the current level of success in the developed countries' waste management systems are broadly due to their belief that a sustainable waste management system is based on sound guiding principles, strong service delivery values, with as many locally based solutions as possible, and moving at a fiscally responsive pace. This mindset is needed to move waste management in cities and largely in developing countries towards achieving higher levels of sustainability, and any substantial change in the Solid Waste management will require close cooperation between the government, private sector, and citizens. However, analysis of the several studies' result indicated that Solid Wastes Management by a public to private partnership was more advantageous for dealing with urban solid waste than management by other practices since it provided a strong selective collection programs, reduce the amount of solid waste sent to sanitary embankments, led to the recovery an area of land previously degraded by the incorrect disposal of urban solid waste and stimulated the installation of an energy recovery unit.

Based on the findings of the study, the following conclusions were made: Major sources, types, methods and quantity of solid wastes that were generated and disposed in Juba include residential wastes such as streets sweeping, follow by Agriculture such as food waste, Commercial waste which was the markets, hospital medical wastes, hotels and restaurant, Institutional wastes such as universities, colleges, schools and government ministries and construction wastes including demolition waste, and others wastes in Juba include: worn wastes, metallic wastes, hazardous wastes, plastic wastes, container wastes a significant portion of population does not have access to waste collection services and only a fraction of the generated wastes are collected by door to door collection system introduced by Juba City Councils (JCC), Japanese International Cooperation Agent (JICA) Non-governmental Organization (NGOs) and private companies.

The majority of the respondents knew solid waste disposal methods as represented by those digging a hole around the house and disposing, dumping, or burning. Some throw it in open space or on street of Juba for the collection, disposed on the backyards of the house, bury their wastes, throw it wastes in to the nearby the rivers/streams and throw in to the nearby ditches, most of the residents had little knowledge on solid wastes disposal, types of diseases and diseases vectors associated to solid wastes which is caused by poor waste disposal while small portion of the respondents had moderate advanced knowledge on solid waste disposal, types of diseases and diseases vectors caused by poor wastes disposal in Juba Controlled Dumping Site (JCDS) and Mogoro Illegal Dumping site.

Open dumping was the popular method of waste disposal. Others are digging a hole around the house and disposing of, burning, throwing it on the streets, composting, and reusing. The majority of the respondents were not aware of the segregation of solid waste. Long distance to the JCDs dumping site, lack of environmental policies, lack of equipment, lack of vehicles, lack of skill, lack of environmental bills, lack of collection points, lack of awareness, lack of protective equipment for workers, misused of funds collected for solid wastes management and lack

of understanding with National and State Ministries of Environment and forestry were the major challenges faced on solid waste management efforts by residents.

Recommendations

To Policy Makers

Given the findings and the conclusion drawn above, this study makes the following recommendations. Since the bulk of the solid wastes generated can be recycled, such as metals, glass, and plastics, efforts should be made to link up with local and international agencies dealing with waste recycling. Also, waste can be a resource, the recyclable waste can form a source of livelihood for unemployed and idle youth who can collect it from premises where it is generated.

The National, State government, Juba city Council (JCC), and Japanese International Cooperation (JICA) should vigorously launch a widespread awareness campaign to deal with the negative perceptions and low knowledge of the community toward solid waste disposal methods. Government and JICA efforts to build more waste disposal sites in the study area should be supported, and the necessary budget allocated for solid waste in the Country. Improve on dumping sites road infrastructures in the area to support waste disposal. Since there are no waste collection bins, these should be strategically placed in identified central sites to reduce indiscriminate dumping and ease waste collection by Juba City Council and Juba County vehicles.

The state government has to educate the residents on solid waste management. Government efforts to formulate policies on the solid waste Management, other types of solid waste, and incorporate with the existing order that will ban the use of plastic bags in Juba. The best arrangement is a public and private partnership working together to educate the people about the service providers and services. Organized cooperative solid waste companies should be encouraged to run their daily activities; the local authorities could provide the private collectors with the facilities or grant funding, and give them advice on how to run the services effectively.

The private sector can be contracted for waste service and treatment, local government needs to focus more on administration, monitoring, public education, and planning. Local governments need to enhance their capacities to arrange and support waste planning by coordinating with various agencies within the government, improving information transparency for public consultation, and collecting reliable basic data on waste properties and market demand for recycled products.

Privatization is seen as important in the general process of improving and modernizing urban waste management systems, so that any city interested in having an effective solid waste management (SWM) system can emulate it. However, to institutionalize the active participation of other private service providers, regulations about SWM must be formulated to promote and enhance partnership between the Juba City council and other private service providers.

To address these three aspects in practice, city and provincial governments need to alter their role and mindset, no longer acting only as service providers but rather as managers and coordinators. MSWM is an expensive undertaking if it is conducted in an environmentally sound manner. Involving the private sector should result in greater efficiencies. Preparing a strategic, integrated solid waste management plan for the city. The plan should be drawn taking into account the waste generation sources, quantity, characteristics, and the socio-economic and cultural structure of the city.

Evaluating the real impacts of the waste management system. It will be good to measure the extent of pollution or environmental impacts associated with the existing waste management system to better appreciate the need for instituting adequate measures to prevent its occurrence. With this background, the policies, regulations established will be aimed at closing cycles of materials and the establishment of environmentally compatible methods for the disposal of wastes.

Recycling and composting activities should be encouraged in cities where waste components are largely organic matter and recyclables and it has also been reported to be an approach of a right measure in attaining sustainability in waste management (Chung and Poon, 1999)

To Future Researchers

The findings of this study would act as a base for more research on solid waste handling practices in the study area. This study was not exhaustive and recommends further research on:

1. Willingness to pay for waste collection services fees by the residents of Juba City and Juba County.
2. The community integrated waste management and converted waste into revenue
3. Improvement of Juba Controlled dumping site (JCDS) and construction of additional dumping sites in Juba and the Counties in central Equatoria State.

ACKNOWLEDGEMENT

The author acknowledges and highly appreciates the support offered by Rumbek University of Science and Technology and, particularly, the School of Education, School of Natural and Environmental Studies, University of Juba, South Sudan.

REFERENCES

[1] Aleluia, J., & Ferrão, P. (2016). Characterization of urban waste management practices in developing Asian countries: A new analytical framework based on waste characteristics and urban dimension. Waste Management, 58, 415–429. https://doi.org/10.1016/j.wasman.2016.05.008.

[2] Badran, M; and El-Haggar, S. (2006). Optimization of Municipal Solid Waste Management in Port Said-Egypt. Waste Management, 26, 534-545.

[3] CED (2003) Study of the Attitude and Perception of Community towards Solid Waste Management: A Case Study of Thiruvananthapuram City – Phase II. A project submitted to Kerala Research Program on Local Level Development, Centre for Development Studies, Thiruvananthapuram.

[4] Global Water Intelligence, 2011. South Sudan faces up to its water challenges. Market-Leading Anal. Int. Water Ind.., 12(3).

[5] Jurczak, M. G. (1997). Ecological Awareness of Nature Teachers in Poland: Kraków: Jagiellonian University.

[6] Mamady, K; and Hu, G. (2011). A step forward for understanding the morbidity burden in Guinea: A national descriptive study. BMC Public Health, 11, 436.

[7] Mamady, K; and Mafoule, S. (2014). Cholera in Guinea: The implications for safe water sources and sanitation. Open Journal of Preventive Medicine, 4, 535-544.s

[8] Nabegu, A.B. (2010). An analysis of municipal solid waste in Kano metropolis, Nigeria. Journal of Human Ecology, 31 (2), 111–119.

[9] Nagabooshnam, J.K. (2011). Solid Waste Generation and Composition in Gaborone, Botswana, Potential for resource recovery, Master thesis, Energy and environmental engineering, Department of Management Engineering, Linköping University, Sweden.

[10] Ndum, A.U. (2013). Bottom-Up Approach to Sustainable Solid Waste Management in African Countries. PhD thesis. Brandenburg University of Technology in Cottbus.

[11] Okot-Okumu, J. (2012). Solid waste management in African cities, East Africa, Waste Management, An Integrated Vision, ISBN: 978-953-51-0795-8, Intech, http://dx.doi.org /10.5772/50241.

[12] Sujauddin, M., Huda, S. M. S., & Hoque, A. T. M. R. (2008). Household solid waste characteristics and management in Chittagong, Bangladesh. Waste Management, 28(9), 1688–1695. https://doi.org/10.1016/j.wasman.2007.06.013.

[13] Raghupathy, L; Krüger, C; Chaturvedi, A; Arora, R; and Henzler, M.P. (2010). E-waste Recycling in India: Bridging the Gap between the Informal and Formal Sector. Available: http://www.iswa.org/fileadmin/galleries/General%20Assembly%20and%20WC%202010%20%20Hamburg/Presentations/Krueger.pdf.

[14] UNEP, 2013. Municipal Solid Waste Composition Analysis Study, Juba, South Sudan. Available at http://postconflict.unep.ch/publications/UNEP South Sudan Juba Waste composition 2013.pdf.

[15] Valkenburg, C; Walton, C.W; Thompson, B.L; Gerber, M.A; Jones, S; and Stevens, D.J. (2008). Municipal Solid Waste (MSW) to Liquid Fuels Synthesis, Volume 1: Availability of Feedstock and Technology. PNNL 18144, Pacific Northwest National Laboratory, Richland, WA.