

# Assessing the Operational Efficiency of the Tamale Landfill Site and Its Health Implications

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**Abstract** The increase in urban growth in Ghana has in tandem seen an increase in waste generation which has a telling effect on the quantum of solid waste generated and disposed off. This study investigates the operational efficiency of the Tamale Landfill site. The descriptive cross-sectional study design was employed for this survey. Two areas were delineated for the study: residential houses within a 500-metre radius of the landfill site and areas more than 500 metres away. The purposive and simple random sampling techniques were used to select 384 households, 16 scavengers and some key respondents for the study. The results of the study reveal that a majority (98.4%) of respondents and scavengers (100%) from the nearby community complain about the proximity of the facility to their residences which generates odour, breeds predators and insects, dust, litter and smoke. Some of the problems which also impede the smooth operation of the facility are inadequate funding, lack of key personnel, and a non-functional weighbridge. These problems lead to infrequent covering of waste which in effect creates litter, dust, odour and generates leachate as well as disease carrying vectors. Hospital waste is also not well managed on site. The study concludes that solid waste at the Tamale Landfill site is not well managed thereby creating poor conditions which generate a lot of nuisances ranging from choking smoke, putrefying odour, dust, leachate, litter, easy access, poor management of hospital waste and breeding places for insects and other pests. The repercussions are the high incidence of malaria, diarrhoea, respiratory diseases, skin diseases, still births and animal bites. Hence, considering that the Wuvugumani and Gbalahi communities are found within 500 metres of the landfill, the Tamale Landfill Site should be relocated because of its negative environmental and health effects on the lives of people in the nearby communities.

**Keywords:** landfill, tamale metropolis, environmental health, waste management, operational efficiency

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## 1. Introduction

Ghana has seen a steady increase in population since 1921 which has brought in its wake an increase in the proportion of the total population living in urban centers [1]. In addition, from a low of about 9% in 1921, the proportion of the total urbanised population almost tripled to reach 23% in 1960, and more than doubled to reach 49% in 2007. In sum, by 2000, the number of urban settlements had increased about sixteen folds from 41 in 1948 to 636 in 2010 while the corresponding population increased almost thirty times from 570,597 persons in 1948 to 12,545,229 in 2010 [2]. Accra, Kumasi, Tamale and Sekondi-Takoradi are the places where this concentration is found. This implies that Ghana's population is becoming increasingly urbanised. Also, this current urban population boom has telling effects on the quantum of waste generated in these urban areas which is the generation of unfathomable amounts of waste. While population densities in urbanised areas and per-capita

waste generation have increased, the available land for waste disposal has decreased proportionately.

In an attempt to reduce waste accumulation, most countries of the world have relied generally on landfill sites which appear to be relatively less expensive when compared with other options of recycling, incineration and composting used in disposing greater proportions of waste [3]. The operational procedures employed at any landfill site have a significant bearing on its planned development, performance, potential effects on the environment, and especially, its effects on neighbours [4]. In order for a landfill to operate efficiently and effectively, the daily operations of the facility should involve the application of manpower, plant and materials. When landfills are not properly managed, they pose a potential health hazard. Poorly managed landfill sites are generally very noisy, smelly and visually unappealing; pollution from the site can poison the air, rivers and soil and people working and living nearby can get ill from inhaling the poisoned air, drinking poisoned water and eating food which has been poisoned from the soil.

Tamale, the capital of the Northern Region of Ghana, has a rapid population growth rate of 2.9 percent resulting

in increased urban waste generation. The domestic and industrial waste generated in the Metropolis has increased beyond the management capacity of the Waste Management Department of the Tamale Metropolitan Assembly. As at 2004, the total population of the Metropolis (which was then Tamale Urban) had grown up to more than 20,000 and by World Bank standards qualified for metropolitan status and therefore required its own landfill site. The concept of Engineered Landfills for the disposal of Waste in Ghana was first tried in 1994, under the local Government Development Project (Urban III). This covered 11 medium sized district capitals in Bawku, Bolgatanga, Wa, Sunyani, Techiman, Koforidua, Ho, Keta/Anloga, Cape Coast, Elmina and Agona Swedru, with populations ranging between 30,000 and 50,000. Then in 1995, the Urban Environmental Sanitation Project, covering the 5 largest cities in Ghana - Accra, Tema, Sekondi-Takoradi, Kumasi and Tamale - with populations ranging from 200,000 to over 1,500,000 included components for the development of Engineered Landfill sites in Tamale, Kumasi and Sekondi-Takoradi. The Tamale Landfill Site was thus commissioned in 2004 at Gbalahi, a farming community on the north-eastern outskirts of the Metropolis. But indiscriminate dumping without recourse to source separation defeated the concept of the technology.

The disposal of waste at the TLS provides a lot of concern on the possible adverse health effects on populations living nearby. The media has been at the forefront of this crusade with articles which highlight waste and waste disposal issues in the national dailies. A few of them include: [5,6,7,8]. Considering the magnitude of the problem, the expected volume of research on the activities of landfill sites is not commensurate with what has been done in the Tamale Metropolis especially as regards operational efficiency. This study therefore seeks to assess the operational efficiency of the Tamale Landfill site (TLS) since its inception.

## 2 Methodology

A descriptive cross-sectional study design was used for this study.

### 2.1. Sampling Procedure

This study covered two locations in the Tamale Metropolis: residential houses within a five hundred metre (<500 metres) radius of the landfill site and an area more than 500 metres (>500 metres) radius away from the landfill site and the landfill. Representative samples were used based on a standard method of randomisation for the study population. The sample size was estimated with a confidence level at 95% (standard value of 1.96), a margin of error at 5% (standard value of 0.05) and 0.5% estimate that the landfill site is operated inefficiently. The sample size was rounded to 384. The study employed the purposive sampling, simple random sampling and convenient sampling techniques to select the study locations and the respondents. The two communities close to the TLS were purposefully selected while Sakasaka was randomly selected from a host of communities more than 500 metres radius away from the facility.

### 2.2. Data Collection Techniques and Tools

Data was collected using mixed methods (qualitative and quantitative). The qualitative data was collected through in-depth interviews, observations and focus group discussions. The quantitative part used questionnaires while an interview guide was used for the interview and focus group discussions. In-depth interviews were conducted with the Metropolitan Waste Management Department, staff of the landfill site, and scavengers while focus group discussions were held with the chiefs and opinion leaders, youth groups and women groups in the communities around the landfill site. The questionnaires were administered to the sampled households and scavengers in the selected communities. This was carried out to get information on the way the facility is being operated by management of the site. Data collection was done from July to August 2014.

### 2.3. Statistical Analysis

The Statistical Package for Social Sciences (SPSS) version 16.0 was used to process the quantitative data into percentages and tables for interpretation and discussion. The responses from the focus group discussion were reviewed to draw out themes in relation to the management of the facility and its attendant health implications.

## 3. Ethical Consideration

Due to low literacy rates in the study areas, verbal informed consent was sought from all household heads prior to administering the questionnaire. During the conduct of this research, permission for access to all premises such as communities, homes, and departments was duly sought from the appropriate authorities. Before interacting with key informants, letters were sent to institutions and organisations notifying them about the study and seeking their consent to visit their premises for interviews, review of records or discussions. In all cases, approval and consent were obtained before the research process was started.

## 4. Results

### 4.1. Socio-demographic Characteristics of Respondents

Majority of the respondents were female (54.7%). The data on age of the respondents from the households shows that those between the ages of 26 to 35 years (27.9%) were in the majority (see Table 1). A few (7.6 %) of the household respondents were above 66 years of age. A significant proportion of household respondents (52.3%) were married. Out of the total household respondents, 51.8% were not educated. Only 28.9% of the respondents had attained a basic education while only a few (6.8%) had attained tertiary education. Respondents who are petty traders constituted the majority (31.3%) while 23.7% are unemployed. From the total number of household

respondents interviewed, 54.9% had resided in their present location for over 16 years compared to only 7% who had stayed in their present location for less than a year.

**Table 1. Socio demographic characteristics of respondents**

Study parameters	Variables	Households	
		Frequency (n=384)	Percent (%)
Sex	Male	174	45.3
	Female	210	54.7
Age	5-14	-	-
	15-25	97	25.3
	26-35	107	27.9
	36-45	67	17.4
	46-55	49	12.8
	56-65	35	9
	66 +	29	7.6
Marital status	Single	94	24.5
	Married	201	52.3
	Divorced	41	10.7
	Widowed	48	12.5
Educational level	None	199	51.8
	Basic Level	111	28.9
	SHS/MSLC	48	12.5
	Tertiary	26	6.8
Employment status	Farming	108	28.1
	Business	37	9.6
	Petty Trading	120	31.3
	Government Workers	28	7.3
	Unemployed	91	23.7
	Duration of stay in the area	Less than a year	27
1-5 years		47	12.2
6-10 years		59	15.4
11-15 years		40	10.4
16 and more years		211	54.9

Table 2 below indicates that a majority of the scavengers (56.2%) were between the ages of 15 to 25 years. All 16 scavengers interviewed were single. A majority (81.2%) of the scavengers had attained basic education. Per the number of years of experience in scavenging, the range with the highest frequency was those who had worked on the landfill site for a period of between 1 to 5 years (62.5%).

**Table 2. Socio demographic characteristics of scavengers**

Study parameters	Variables	Scavengers	
		Frequency (n=16)	Percent (%)
Sex	Male	16	100
	Female	-	-
Age	5-14	5	31.3
	15-25	9	56.2
	26-35	2	12.5
	36-45	-	-
	46-55	-	-
	56-65	-	-
	66 +	-	-
Educational level	None	1	6.3
	Basic Level	13	81.2
	SHS/MSLC	2	12.5
	Tertiary	-	-
Duration of scavenging at the landfill site	Less than a year	5	31.2
	1-5 years	10	62.5
	6-10 years	1	6.3
	11-15 years	-	-
	16 and more years	-	-

## 4.2. Operational Efficiency of the Tamale Landfill Site

Table 3 below shows the responses of interviewees with regards to the operational efficiency of the TLS. Respondents who attributed the proximity of the facility to residences as one of the operational deficiencies of the landfill site constituted 98.4% for those near TLS and 18.2% for those farther off. This finding corroborates the response of the Chief of Gbalahi during the focus group discussion:

*“The siting of the landfill in this community is worrisome because of the nuisances it generates both in the raining season and the dry season. It is not fair that other people’s waste is dumped in our community” (Field Survey, 2014).*

Another problem identified by respondents is odour nuisance emanating from the landfill site as a result of waste not being covered daily. Respondents residing close to the TLS who identified odour nuisance as a problem were 93.2%. For those residing farther from the facility, only 2.1% mentioned odour nuisance as a problem.

As much as 72.9% of respondents from the group residing near the TLS identified the poor fencing as a problem hindering the smooth operations of the Tamale landfill.

While 85.9% of respondents residing near the landfill identified insufficient control of litter as one of the operational problems of the TLS, only 1% of those living farther away corroborated this assertion.

Out of the 384 respondents, 89.6% of them residing close to the TLS identified dust nuisance generated via activities at the site and from the road leading to the facility as an operational deficiency associated with the TLS. Only 1.6% of those staying farther could relate to this assertion.

About 94% of respondents near the facility identified the landfill site as a breeding place for predators and insects. Respondents in the urban group (more than 500 metres radius from the TLS) who supported this assertion were only 10.9%. The presence of insects and other predators in the community is a source of great worry as they are perceived to be the carriers of disease causing organisms. This point was re-echoed during a focus group discussion with the women’s group at Gbalahi, where an elderly woman noted:

*“During the raining season, cooking of meals becomes a problem because the flies usually invade the vicinity and are found on almost all the cooking utensils and the food items in the house. Can’t you see it for yourself?” (Field Survey, 2014).*

Another woman at Wuvogumani noted during a focus group discussion that:

*“The TLS site is a breeding ground for mosquitoes. This is because prior to its location, we used not to record so many cases of malaria but since the facility started operating, the cases of malaria complaints has shot up. There is no week that passes without a child getting malaria especially during this period (raining season)” (Field Survey, 2014).*

In a focus group discussion with the Chief and Elders at Wuvogumani, an elderly man also had this to say:

“...before the establishment of the landfill, you could sleep without using a cover cloth but since operation commenced at the facility, my son, you cannot even walk about without covering the entire body. Look at my body, ummm, scars and swells from mosquito bites and other black insects. The situation is even unbearable at night”. (Field Survey, 2014)

An elder had this to say during a focus group discussion about the invasion of the community by dogs:

“The dogs you see at the landfill are mostly from other communities and they sometimes bite our children either in the community or at the landfill site”. (Field Survey, 2014)

Observations made around and within the living

quarters of the communities near the TLS revealed the high presence of flies in the bedrooms, kitchens, courtyards and toilet areas.

Respondents who mentioned burning nuisance as an operational problem constitute 92.7% of those residing close to the facility. The identification of smoke as a nuisance produced by the TLS is corroborated by an observation made in a focus group discussion with the youth group at Wovugumani, when a youth leader opined that

“The TLS generates a lot of smoke. This problem worsens during the dry season when the wind blows towards this direction. The choking smoke usually makes it difficult to breath” (Field Survey, 2014).

**Table 3. Distribution of households responses of the operational problems of the TLS**

Study parameters	Variables	Near the TLS		Far from the TLS	
		Freq. (n=192)	Percent (%)	Freq. (n=192)	Percent (%)
Proximity to residence	Yes	189	98.4	35	18.2
	No	-	-	157	81.8
	Don't Know	3	1.6	-	-
Odour nuisance	Yes	179	93.2	4	2.1
	No	-	-	-	-
	Don't Know	13	6.8	188	97.9
Proper fencing of TLS	Yes	18	9.4	-	-
	No	140	72.9	-	-
	Don't Know	34	17.7	192	100
Litter nuisance	Yes	165	85.9	2	1
	No	13	6.8	172	89.6
	Don't Know	14	7.3	18	9.4
Dust nuisance	Yes	172	89.6	3	1.6
	No	18	9.4	178	92.7
	Don't Know	2	1	11	5.7
Breeding insects/pests	Yes	181	94.3	21	10.9
	No	-	-	-	-
	Don't Know	11	5.7	171	89.1
Burning nuisance	Yes	178	92.7	10	5.2
	No	3	1.6	14	7.3
	Don't Know	11	5.7	168	87.5
Scavenging	Yes	179	93.2	24	12.5
	No	13	6.8	-	-
	Don't know	-	-	168	87.5
Leachate flow	Yes	162	84.4	-	-
	No	28	14.6	173	90.1
	Don't Know	2	1	19	9.9

**Table 4. Distribution of operational problems of the TLS by the scavengers**

Study parameters	Variables	Scavengers	
		Freq. (n=16)	Percent (%)
Proximity to residence	Yes	16	100
	No	-	-
	Don't Know	-	-
Odour nuisance	Yes	16	100
	No	-	-
	Don't Know	-	-
Proper fencing of TLS	Yes	1	6
	No	14	88
	Don't Know	1	6
Litter nuisance	Yes	8	50
	No	7	43.8
	Don't Know	1	6.2
Dust nuisance	Yes	16	100
	No	-	-
	Don't Know	-	-
Breeding insects/pests	Yes	16	100
	No	-	-
	Don't Know	-	-
Burning nuisance	Yes	16	100
	No	-	-
	Don't Know	-	-
Leachate flow	Yes	11	68.8
	No	4	25
	Don't Know	1	6.2

Information gathered from managers of the TLS suggests that although they have adequate equipment to manage the facility, inadequate funds for fuel and repairs of the equipment constitute a huge setback. This problem impedes the daily operations of the facility. According to the landfill site manager:

*'These trucks you see here often breakdown and go without repair for months due to a lack of funds to purchase spare parts leading to dumping without compaction'. (Field Survey, 2014).*

The Landfill Manager stated that the Landfill Site is manned by eight (8) staff from ZoomLion<sup>1</sup> with assistance from staff of the Waste Management Department. It comprises a Landfill Supervisor, a Bulldozer Operator, a Wheel Loader Operator, three Trash Compactor Operators and two Security Personnel. It was observed that the weighbridge used to weigh incoming waste at the TLS had broken down. This was confirmed by the Site Manager. This means that waste that is received at the landfill was not registered according to category, weight (by tonne or by kilograms) and source, name of transporting company and time and date of delivery. During discussions with the Landfill Site Manager, it was also revealed that fire-fighting and emergency or first-aid equipment were not available on site.

It was observed that the practice of covering waste in the cells with soil on a daily basis was not being practised. The cells are usually over filled causing litter to rise above the bunds, thereby exposing them to the vagaries of the weather, animals and scavengers.

Of the 192 respondents from the group near the TLS, 93.2% attested that children scavenge at the Landfill Site. This is an indication of the preponderance of the phenomenon.

128 of the respondents staying near the TLS, representing 84.4% claimed that leachate from the landfill sites flows through the community into their dams which poses a high risk to residents and to both surface and underground water sources. All respondents residing far-off the facility answered negative to the question. In a focus group discussion, a resident living in close proximity to the TLS had this to say:

*"Whenever it rains, running water from the landfill site runs through our compounds leaving a lot of refuse in the process and the stench that goes along with it cannot be described. Even our animals die when they drink from the gutters that have been contaminated by the dark-coloured water draining from the site". (Field Survey, 2014)*

It was also observed at the landfill site that the drains constructed to transport leachate to the stabilisation ponds were choked with waste and gravel propelling the overflow of leachate whenever it rains. This accounts for the flow of leachate into the surrounding communities and water bodies such as the Kuula Dam.

All scavengers (100%) interviewed as shown in Table 4 below, assert that proximity of residences to the landfill site was an operational deficiency of the facility. All scavengers interviewed mentioned odour, dust and burning nuisances generated as a result of operational deficiencies associated with the landfill. 88% of

scavengers who primarily undertake their businesses there affirmed that the landfill site is not properly fenced-off. Half (50%) of the scavengers also identified litter nuisance as an operational problem at the landfill site while 6.2% were indifferent. Since the scavengers are always found at the site, it was appropriate to quiz them on the management of hospital waste at the landfill.

Respondents were asked about the handling and disposal of hospital waste. Majority of scavengers (81.3%) indicated that hospital waste was not well managed at the landfill site.

## 5. Discussion

The proportion of male to female respondents is 45.3% to 54.7% respectively. This implies that more females were interviewed than males. Most of the respondents were between 15 and 45 years of age while the majority among the scavengers was between 15 and 25 years. The data shows that the subjects are matured adults whose reasoning level and knowledge would allow them to make sound judgments about the TLS and bring to the fore some of the health implications arising from the operations of the site. Most of the respondents are married, while a few are either widowed or divorced. All scavengers interviewed are single; this is because most of them are still in their teens. More than half of the respondents have no formal education. The community closer to the TLS is rural in setting and has no residents with secondary or tertiary education; the population engages mostly in farming and petty trading. More than half of respondents resided in their respective communities before work commenced on the landfill site. This means that majority of respondents near the facility have a fair knowledge of issues concerning the operation, maintenance and nuisances created at the TLS and could therefore provide useful information since they knew the conditions that prevailed before commencement of operations at the dumpsite in 2004. Even though, a majority of the scavengers have plied their activities on the site for less than five years, this period is enough for them to have an adequate knowledge of the various effects.

One of the operational problems identified by respondents was the siting of the TLS close to communities and residences. They argue that waste from the dumpsite spills over into their homes and pollutes the environment. This has the potential of exposing community members to a lot of risk factors. The minimum distance of living quarters to landfill sites is given as at least 500 metres [9]. Based on this requirement, it is obvious that the location of the TLS less than 500 metres from the Wuvugumani and Gbalahi communities is unacceptable. This has the potential of exposing community members to a lot of risk factors.

The management of odour from landfills is an aspect of landfill operations and management that is of continuing concern to both the public and the regulatory authorities. Odour nuisance is one of the major operational problems complained about by community members, workers and scavengers on site. This finding corroborates [10,11] which establish that odours are often key issues for landfill sites, especially those receiving biodegradable waste. This is because landfill sites and dumpsites emit

<sup>1</sup> ZoomLion is a private Waste Management firm in Ghana.

obnoxious odours and smoke that cause illnesses to people living in, around, or close to them [12]. This flood of nauseating air over a long-term can cause loss of sleep, increased levels of stress and generally adversely affect the quality of health and life of the residents proximate to the TLS.

In the analysis on Table 4 above, 94.3% of respondents close to the landfill site listed the breeding of predators and insects on the site as an operational problem. Some of the common pests and insects found on the site are mosquitoes, houseflies, cockroaches, scorpions, snakes and dogs. This confirms the results of studies such as [13] which observe that pests are a great nuisance and a public health problem at any improperly managed landfill. Considering that cover placement is not frequently carried out, the deposited waste is exposed to disease vectors and pests. Furthermore, when the cells collect water they promote the rapid decay of organic waste which attracts these disease vectors.

Flies and mosquitoes can fly for a distance of up to five kilometres [14]. This implies that the Wuvugumani and Gbalahi residences, which are less than 500 metres from the TLS are exposed to the threat of diseases spread by these vectors.

The Landfill Site has a perimeter fence installed around it to catch wind-blown litter as well as prevent unauthorised entry into the site. About 72% of respondents living near the TLS opined that the facility is not properly fenced. During a visit to the site, parts of the fence, especially those facing the two nearby communities of Wuvogumani and Gbalahi are broken allowing scavengers and animals from the area free access onto the site. The broken fence and unlocked gate make it easy for cattle, sheep, goats and dogs to forage for food on the site any time of the day. Community members bemoan the death of some of their animals which ingest plastics and other poisonous materials dumped on the site. Many dogs which terrorise both man and beast have also taken possession of the site. Scavengers who also have free access to the waste have succeeded in bringing up and mixing the waste as they scavenge to salvage valuable material. The prevailing conditions are not in line with set guidelines for landfills such as is stipulated by the [15] 'landfills should be fully fenced along all boundaries to ensure the safety of the general public and to prevent unauthorised entry and disposal'. It states further that consideration should be given to the security of the site outside the hours of operation to prevent damage to buildings and equipment or danger to unauthorised personnel. Visits to the site showed that the security personnel were not often at post thereby leaving the gate to the facility open during and outside working hours.

Most respondents asserted that plastic bags, light-weight materials and paper are scattered all over the Landfill Site. Bushes, drains and trees some metres away had plastic bags hanging all over them. A landfill is not well managed if papers or other lightweight materials are blown away and spotted around [16]. Flying litter can be controlled on the site when the metal screens constructed for that purpose are put to proper use and waste deposited is regularly covered in order to reduce the impact of wind on them. Management admits that on-site litter is gathered together only once in a while.

Majority of respondents residing near the TLS identified dust generated by the activities of the landfill as a major local concern. Waste materials are transported through most of the communities enroute to the facility. However, the road to the site is not surfaced with tarmac, resulting in the production of massive quantities of dust on a daily basis by waste vehicles which ply the road. Also, huge amounts of dust is generated at the landfill when waste is offloaded. Other earthwork activities such as placing of cover material on waste as well as filling and compaction of dust-type refuse generate dust especially during dry periods. Dust emitted from landfill sites and untarred roads contain both fine and coarse particulates which when inhaled pose adverse health effects [17]. When this happens, people with pre-existing lung and heart conditions, the elderly and children become sensitive to particulate air pollution. This is an implication that wind-blown dust is an obvious potential health hazard from landfills.

It was also noted during field visits to the site that burning of refuse is a common event. Burning according to the Landfill Manager is as a result of live ashes deposited in skips which are transported to the facility. However, on-site scavengers report otherwise. They contend that the refuse is usually set on fire by officials of the facility in order to reduce the volume of solid waste. This practice produces prolonged and polluting fumes which reduce visibility on the site as the whole place usually becomes engulfed in smoke. A higher level of waste burning activity engenders increased risks associated with smoke inhalation. Fire at the site is also a potential danger since several discarded pressurised containers such as spray cans were found among the waste; these could explode when heated.

Inadequate funds to run the facility were also identified as an operational problem. This finding is consistent with [18]. Management contends that compaction and covering of waste, preferably, should be carried out on a daily basis, but due to insufficient and late release of funds, this activity does not take place frequently contributing to some of the inefficiencies in their operations.

Although the Supervisor claimed the staff strength was enough for the operation of the facility; the site lacks key personnel in engineering, administration, environmental health and finance. These roles are performed by the WMD who visit the facility only during major maintenance works. As regards the qualifications of the personnel, the Landfill Supervisor has a first degree (BSc.) in Applied Chemistry, one of the Trash Compactor Operators holds a Higher National Diploma (HND) while the rest of the staff do not have any formal education. This prevailing condition is contrary to a study by Tamakloe in 2006 cited in [19] who opines that satisfactory waste management requires a wide range of qualified professionals including engineers, mechanics, administrators, sanitation officers, finance and accounting staff and even researchers.

Good record keeping is an essential component of the effective and efficient management of a landfill. Both the WMD and the Zoomlion Landfill Supervisor purported that records are kept at the Landfill Site. The records in their keep are piles of papers which contain daily records of trucks that visit the site which are used to calculate an estimate of daily tonnage received at the facility. This is

however, contrary to the advice of the [4] that landfill operators should maintain an operating record that includes information on waste acceptance, on-site recycling, load inspection, and operational activities. Information on waste acceptance should include the quantity and, where possible, classification of wastes. Also, the date and time waste was received for inspection, sources of the waste, vehicle and driver identification, observations made by the inspector, notification of violations, and notification of authorities should also be undertaken.

According to the Supervisor at the TLS, he carries out on-site inspections on a daily basis while the WMD does same once every week. These inspections conform to the site inspection guidelines captured in the [16] which states that inspection should be carried out at least once every week. However, there are some reservations on the effectiveness of these inspections because if frequent inspections are carried out, most of the operational problems being discussed would have been identified and immediate action taken to resolve them.

A landfill site that is effectively and efficiently operated should have the following facilities: entrance notification, a weighbridge and a charging booth [4]. The TLS has a signpost which shows access restrictions, days and hours of operations; it however fails to give essential information such as acceptable (or prohibited) waste, disposal charges, documentation that must accompany waste loads, level of control and inspection of waste to be undertaken and emergency contact numbers of operators of the facility. To compound matters, the signpost, as at the time of the present study, had fallen and was lying close to the entrance of the landfill thereby limiting visibility of the site.

Findings by [4] contend that the most accurate way of obtaining required data is to weigh incoming refuse. This is done by use of a weighbridge which provides the most equitable method for assessing charges, particularly for commercial users. There is at the TLS, a non-functional weighbridge. This detracts from accurate record keeping and impedes proper management of waste received at the site. However, since the weighbridge is not functional, incoming waste is usually not inspected prior to disposal. According to the Landfill Supervisor, incoming waste is usually estimated using experimental values in place of the non-functional weight bridge. This is simply done by counting the number of trucks entering the Landfill and estimating their waste load. However, numerous visits to the landfill site showed that the security personnel who record the movement of vehicles were on most occasions, unavailable to record the number and type of incoming vehicles. This makes the figures used in their estimation questionable.

The following operational facilities were found at the Tamale Landfill Site: an administrative building with offices, washrooms and an unused workshop. Pertinent facilities that are conspicuously missing from the site include fire-fighting equipment, and emergency or first-aid equipment. In the event of any major disaster such as fire out-breaks the repercussions could be gargantuan.

On-site observation also showed that drivers did not have a particular method for discharging their waste; truck drivers often tipped their waste in a haphazard manner making it difficult for the waste compaction equipment to operate effectively and efficiently. This is not in line with

the recommendations of [20] that the “face tipping” method for waste discharge and emplacement should be employed. This method involves the creation of a horizontal or near horizontal platform by tipping over an advancing face with levelling and compacting from above.

Some residents from the group near the Tamale landfill claimed leachate run through the community. This could be attributed to the topography of the landfill in relation to the location of residents. Considering that the topography of the landfill site slopes towards the community, there is the probability that leachate could run towards the community. The flow of leachate through some parts of the communities around the TLS conforms with the results of other studies [21] which support the observation that leachate from poorly operated landfill sites runs through communities closer to it. The leachate which obviously contain pathogens are a direct risk to human health and a source of contamination to groundwater and surface waters. Observation of the TLS showed that there is a leachate collection system that discharges leachate into a pond together with septic waste deposited at the landfill site for treatment. The leachate at the landfill is usually collected via concrete drains into stabilisation ponds. It was observed that the drains were choked with waste and gravel propelling the overflow of leachate whenever it rains. This could account for the flow of leachate into surrounding communities and water bodies such as the Kuula Dam. The edges of the stabilisation ponds were however overgrown with weeds which could encourage the flourishing of malarial vectors.

Another finding of the study is that the TLS attracts and hosts vermin such as rats, lizards, snakes and street dogs which depend on the availability of food there (see for instance [22] for a similar discussion). These rodents and pests have all been identified as vectors of pathogens that have the potential of causing outbreak of diseases to neighbouring communities. The landfill also serves as feeding grounds for pet dogs and cats together with other rodents which carry diseases with them to nearby homesteads.

The improper disposal of hospital waste at the site is further proof of poor management. A similar study by [23] at the TLS revealed the same disturbing pattern where a majority of respondents attested to the fact that hospital waste was being indiscriminately dumped on the location. During interactions with the management of the WMD and the Landfill, both asserted that there is a special place for the disposal of hospital waste and that these are usually well received and disposed of by officials of the facility. However, on various visits to the location, hospital waste was found scattered all over the place and very close to the treatment stabilisation pond. The waste included swabs, medicine containers, syringes, and catheters among a host of others. Waste from hospitals and healthcare facilities are generally very contaminated and are potentially infectious. They may carry microorganisms that can infect the people and communities that come in contact with them. Dumping of hospital waste on the site is a source of worry to both community members and scavengers. Also, the area demarcated for hospital waste is very close to the stabilisation pond, thus chemicals and other harmful substances can run off into the pond and other nearby water bodies when there is leachate or flooding on the site.

Except the landfill site, assessments of the contents of various dumping points in the Gbalahi and Wuvogumani communities showed various hospital wastes. These included syringes, used infusion containers, catheters and other disposed products that children carried home from the TLS to use as toys. Children and other people therefore place themselves at risks when they come into contact with disposed hospital waste. Health care waste and other medical waste disposed in dumpsites and mixed with domestic waste, increase the risk of infection with Hepatitis B and HIV, and other related diseases [24].

It was also noted at the landfill site that waste pickers sort through waste from incoming garbage trucks immediately they are off loaded. Community members and scavengers at the site also salvage food items such as canned food, bread, and fruits among a host of others which they consume. These items are often contaminated or condemned goods from supermarkets, shops, hotels and restaurants in the Metropolis or from domestic household sources. Scavenging on-site is prohibited and attempts to discourage the practice have proved futile. Waste pickers also pose a safety hazard to themselves as they use their bare hands to dig into the waste in search of salvageable materials. They also risk caving in under the mountains of waste that are freshly deposited on the site. Community members during various focus group discussions also revealed that their children often get cuts and animal bites when they visit the landfill site.

Apart from the foregoing, observations made reveal that the abundance of disease-causing animals (rats, reptiles, and insects), dust and offensive odours in the landfill site, along with the lack of proper protective devices, makes working conditions even more unhygienic. Scavenging for salvageable materials from the landfill site is risky as scavengers are exposed to various infectious agents and toxic substances that may cause various illnesses.

## 6. Conclusion

The findings of this study revealed that the TLS is not well managed and does not conform to international standards thereby exposing nearby residents to sanitation-related diseases and other nuisances. Considering that the Wuvugumani and Gbalahi communities are found within 500 metres of the landfill, the current state of affairs at the site is not acceptable. For the efficient and effective operation and management of the Tamale Landfill Site, composting of food waste and recycling of plastic, paper, glass and metals should be carried out on-site in order to reduce the solid waste menace and the load on the landfill site. Residents should also be encouraged to separate waste at home. Ultimately, the Tamale Landfill Site should be relocated because of its negative environmental health impact on the lives of people in the nearby communities. Relocation will reduce if not remove all the nuisances discussed above and assure the people of a better quality of life.

## List of Abbreviations Used

TLS: Tamale Landfill Site

SPSS: Statistical Package for Social Sciences

WMD: Waste Management Department

HND: Higher National Diploma

## Competing Interests

No competing interest.

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