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Solid Waste Management in Ghana: The Case of Tamale Metropolitan Area

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Abstract
The main objective of the study was to establish the underlying factors affecting effective solid waste management in the Tamale metropolis and suggest possible measures to tackle the problem. The research gathered data from two main sources namely: secondary and primary sources. The three main techniques employed in gathering the primary data were: preliminary field investigation, questionnaire survey and face-to-face interview. The following key findings were established to be the factors affecting effective solid waste management in the Metropolis. These are: inadequate skip supply for storing waste, lack of routine collection of waste, poor methods of waste management and inadequate resources for waste management institutions to effectively collect the waste generated.
Keywords: Solid waste management, solid waste collection, solid waste disposal

1. Introduction

In the early days, waste disposal did not pose much problem as it is today. This is because habitations were sparse and land was in abundance. But this became an issue with the rise of towns and cities where large numbers of people started to congregate in relatively small areas in pursuit of livelihoods (Shafiul & Mansoor, 2003). While the population densities in urbanised areas and per capita waste generation increased, the available land for waste disposal decreased proportionately. Solid waste management thus emerged as an essential, specialised sector for keeping cities healthy and liveable. In the light of this, solid waste management is an important environmental health service, and an integral part of basic urban services. This is because, the health implications of poor waste management can be very damaging to the people exposed to these unsanitary conditions. Diseases such as cholera, typhoid, dysentery and malaria are associated with the practice of poor waste management.

Solid waste management thus became the responsibility of metropolitan governments in both developed and developing countries of which the Tamale Metropolitan Assembly is not an exception. In the Tamale Metropolis, it is estimated that 810 tonnes of waste is generated a day and out of this, 216 tonnes are hauled daily. This leaves a backlog of 594 tonnes uncollected a day resulting in littering, heaping of waste and overflowing of skips with waste in the Metropolis most especially in the low class residential and peri-urban areas. The recent proliferation of polythene bags for packaging has seriously aggravated the situation in the study area. This makes the above mentioned residential areas filthy and unattractive for living. Therefore, if the situation is left unchecked it could result in the outbreak of communicable diseases such as cholera, typhoid and this will affect people exposed to this unsanitary conditions. On the basis of this, the study intends to examine how people dispose of their solid waste, how it is collected by waste management companies and how it is finally dispose of.

As shown in figures 1.1 and 1.2, the Tamale Metropolitan Area is located at the centre of the Northern Region of Ghana. It shares common boundaries with Savelugu/Nanton District to the north, Tolon / Kumbungu District to the west, Central Gonja District to the south-west, East Gonja District to the south and Yendi Municipal to the east. The Tamale Metropolis occupies approximately 750 square kilometres which is 13 per cent of the total area of the Northern Region. Tamale became a district in 1988 by Legislative Instrument 1453. It was called West Dagomba District Assembly. It was then promoted to West Dagomba Municipal Assembly in 1994 and finally elevated to the status of a Metropolitan Assembly in 2004 by legislative instruments (LI) 1801 of the Local Government Act 1993, (Act 462).

2. Concept and Theory of Solid Waste Management

The term solid waste management has been viewed differently by various authors. Kumah (2007: 2) defines solid waste management as "the administration of activities that provide for the collection, source separation, storage, transportation, transfer, processing, treatment, and disposal of waste". However, Tchobanoglous *et al* (1993: 7), provide a more comprehensive definition of solid waste management. According to them, solid waste management is:

> ".....that discipline associated with the control of generation, storage, collection, transfer and transport,

processing and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations and that is also responsive to public attitudes".

Therefore, if solid waste management is to be accomplished in an efficient and orderly manner, the fundamental aspects and relationships involved must be indentified and understood clearly (Tchobanoglous *et al*, 1993). On the basis of this solid waste management incorporates the following: source separation, storage, collection, transportation and disposal of solid waste in an environmentally sustainable manner.

2.1 Solid Waste Management Processes

As in figure1, the key elements in solid waste management include: waste generation, storage, collection, transfer and transport, processing and recovery and final disposal. This means that when waste is generated it is first stored in either dustbins or skips. It is then collected and finally disposed of in landfill. Also, when waste is collected it can be transfered from small collection equipment like the tricycle to a bigger truck for final disposal. On the other hand, waste collected can be processed and recovered for materials to be reused. These elements are further elaborated below.

2.1.1 Waste Generation

Waste generation encompasses those activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal (Momoh & Oladebeye, 2010). According to UNEP (2009), in 2006 the total amount of municipal solid waste (MSW) generated globally reached 2.02 billion tones, representing a 7 per cent annual increase since 2003. It is further estimated that between 2007 and 2011, global generation of municipal waste will rise by 37.3 per cent, equivalent to roughly 8 per cent increase per year (UNEP, 2009). The programme also says that, as per WHO estimations, the total health-care waste per person per year in most low income countries, is anywhere from 0.5 kg to 3 kg. That not withstanding, the causes of this increased should have enumerated by the organisation and therefore, has not exhausted the issue on discussion. It is accepted that solid waste generation is increasing at a faster rate globally as indicated by UNEP and this is confirmed by Mensah & Larbi (2005) concerning solid waste generation in Ghana.

2.1.2 Storage

Tchobanoglous *et al* (1977) explain storage to mean where solid waste is stored before it is collected. It could be stored in a skip or dustbins and not thrown away indiscriminately. According to them, storage is of primary importance because of the aesthetic consideration.

2.1.3 Collection

The element of collection includes not only the gathering of solid waste, but also the hauling of waste after collection to the location where the collection vehicle is emptied (Kreith, 1994). According to Kreith (1994), the most common type of residential collection services in the United States include "curb", "setout-setback" and "backyard carry". According to the USPS (2000), in the city of Thimphu in Bhutan the collection of solid waste from households, commercial set-ups was done in concrete receptacles placed at strategic points and conveyed by trucks/tractors. Accordingly, there were concrete bins and containers provided at various locations from where the waste was lifted for disposal. Individual bins/containers were also placed alongside the shops in certain areas, which were emptied directly into the trucks/tippers. This prevents people from dumping waste indiscriminately. On the other hand, the building of these concrete bins and containers may be expensive to do in Ghana and for that matter TAMA.

2.1.4 Transfer and Transport

According to Kreith (1994), transfer and transport involves two steps: (1) the transfer of wastes from the smaller collection vehicle to the larger transport equipment and (2) the subsequent transport of the wastes, usually over long distances to the final disposal site.

2.1.5 Processing and Recovery

The element of processing and recovery includes all the technology, equipment, and facilities used both to improve the efficiency of other functional elements and to recover usable materials, conversion products or energy from solid wastes (Tchobanoglous *et al,* 1977). In the recovery, separation operations have been devised to recover valuable resources from the mixed solid wastes delivered to transfer stations or solid waste processing plants (Tchobanoglous *et al*, 1977)

2.1.6 Disposal

It is the ultimate fate of all solid wastes whether they are residential wastes collected and transported directly to landfill site. Having explained the various elements by some authorities, the next section analyses in further details the final disposal methods of solid waste. Several methods of solid waste management have evolved over the years. These methods according to the Centre for Environment and Development (2003) vary greatly with types of wastes and local conditions.

2.2 Methods of Managing Solid Waste

In the contemporary era, the methods of managing solid waste include source reduction, sanitary landfills, composting, recycling, and incineration (Denison & Ruston, 1990). These methods are examined below.

2.2.1 Source Reduction

Denison Ruston (1990) viewed source reduction as any action that reduces the volume or toxicity of solid waste prior to its processing and disposal in incinerators or landfills. This view is similar to the one given by Kreith (1994). According to him, source reduction focuses on reducing the volume and /or toxicity of waste generated. Source reduction includes the switch to reusable products and packaging, the most familiar example being returnable bottles. According to USPS (2000) in the city of Thimphu in Bhutan to reduce waste problems in future, reduction in waste generation would be the most important factor. Examples of possible reduction at the consumption level include reuse of containers (including bags), better buying habits, and cutting down on the use of disposable products and packaging (USPS, 2000).

It is agreed that, source separation and resource recovery is an important method in waste management. This is because there is nothing like waste on this earth. Wastes that are discharged may be of significant value in another setting, but they are of little or no value to the possessor who wants to dispose of it. According to Tsiboe & Marbel (2004), Austria, the Netherlands, and Denmark developed a waste management processes to efficiently resolve the waste disposal problem by essentially coaxing their citizens to separate their domestic solid waste into glass, paper, plastic categories; thereby enabling easy collection and consequently reuse. As suggested by the three authors, one way of effectively managing solid waste is to minimise solid waste generation through source reduction.

2.2.2 Sanitary Landfill

Sanitary land filling includes confining the waste, compacting it and covering with soil. It not only prevents burning of garbage but also helps in reclamation of land for valuable use (Centre for Environment and Development, 2003). The placement of solid waste in landfills is the oldest and definitely the most prevalent form of ultimate waste disposal (Zerbock, 2003:16). He further argued that “landfills” are nothing more than open, sometimes controlled dumps. According to him the difference between landfills and dumps is the level of engineering, planning, and administration involved. Open dumps are characterized by the lack of engineering measures, no leachate management, no consideration of landfill gas management, and few, if any, operational measures such as registration of users, control of the number of “tipping fronts” or compaction of waste (Zerbock, 2003).

Furthermore, landfills are one form of waste management that nobody wants but everybody needs (Kreith, 1994: 2.8) According to him, there are simply no combinations of waste management techniques that do not require landfilling to make them work. Of the basic management options of solid waste, landfills are the only management technique that is both necessary and sufficient. According to Kreith (1994) some wastes are simply not recyclable, many recyclable wastes eventually reach a point where their intrinsic value is completely dissipated and they no longer can be recovered, and recycling itself produces residuals. He further highlighted that the technology and operation of modern land fill can assure the protection of human health and the environment.

In contrast to what the various authors have said about sanitary landfill as an option for waste management, they have failed to recognize that land fill in itself has some disadvantages as it is costly to construct and maintain, can pollute ground water through leaching, location is a problem in terms of availability of land particularly in the cities. Other critical factors such as gas recovery, composting, waste to energy recovery, storm water control, distance to any settlement and water body were not clearly spelt out by the authors. Therefore, there could be an alternative which is recycling. This method is discussed in the next sub-section.

2.2.3 Recycling

According to Momoh and Oladebeye (2010: 1) recycling has been viewed as a veritable tool in minimizing the

amount of household solid wastes that enter the dump sites. It also provides the needed raw materials for industries. According to them, it has been established that, it is the best, efficient and effective method of solid waste management system. However, this may not be cost effective in developing countries like Ghana. The United States Environmental Protection Agency (USEPA) (1999) has recommended recovery for recycling as one of the most effective waste management techniques. According to USEPA, recycling turns materials that would otherwise become waste into valuable resources and, it yields environmental, financial, and social returns in natural resource conservation, energy conservation, pollution prevention, and economic expansion and competitiveness. More importantly, a sizeable portion of what is thrown away contains valuable resources—metals, glass, paper, wood, and plastic—that can be reprocessed and used again as raw materials (USEPA, 1999).

Kreith (1994) has also added that, recycling is the most positively perceived and doable of all the waste management options. According to him recycling will return raw materials to market by separating reusable products from the rest of the municipal waste stream. The benefits of recycling are many, he added. It saves precious finite resources, lessens the need for mining of virgin materials which lowers the environmental impact for mining and processing. For example, according to the Institute of Waste Management cited by Tsiboe and Marbel (2004), UK recycles only 11per cent of its household waste, Italy and Spain only 3 per cent, Netherlands 43 per cent, Denmark 29 per cent, and Austria 50 per cent respectively. Having proposed recycling by different authors as the best option to manage solid waste in modern times; they have forgotten about the cost component which is key to successful implementation of any recycling project. Even developed countries are not able to successfully do it. But alternatively, it may be the best option for effectively managing solid waste in Ghana.

2.2.4 Composting

Composting process uses microorganisms to degrade the organic content of the waste. Aerobic composting proceeds at a higher rate and converts the heterogeneous organic waste materials into homogeneous and stable humus (Centre for Environment and Development, 2003: 9). United Nations Environmental Progam (UNEP) (2009) has also defined composting as a biological decomposition of biodegradable solid waste under controlled predominantly aerobic conditions to a state that is sufficiently stable for nuisance-free storage and handling and is satisfactorily matured for safe use in agriculture. According to the UNEP (2009), composting is the option that, with few exceptions, best fits within the limited resources available in developing countries. A characteristic that renders composting especially suitable is its adaptability to a broad range of situations. According to Zerbock (2003), a low-technology approach to waste reduction is composting. He further says that in developing countries, the average city's municipal waste stream is over 50 per cent organic material.

2.2.5 Incineration

According to the Centre for Environment and Development (2003: 9), incineration is a controlled combustion process for burning combustible waste to gases and reducing it to a residue of non-combustible ingredients. According to the Centre, during incineration, moisture in the solid waste gets vapourised and the combustible portion gets oxidised and vapourised. C02, water vapour, ash and non-combustible residue are the end products of incineration. Incinerators have the capacity to reduce the volume of waste drastically, up to nine fold than any other method (Kreith, 1994). According to him incineration can also recover useful energy either in the form of steam or electricity. He however recognised that the main constraints of incineration are high cost of operation, relatively high degree of sophistication needed to operate them safely and economically as well as the tendency to pollute the environment through emissions of carbon dioxide. Having assessed the major methods that have been proposed by the various authors, literature has further revealed that there is an alternative method of managing solid waste effectively which is synonymous to waste reduction and recycling as mentioned earlier on. This forms the next section of the review.

2.2.6 Integrated Solid Waste Management

Although considerable efforts are being made by many Governments and other entities in tackling waste-related problems, there are still major gaps to be filled in this area (UNEP, 2009). According to UNEP (2009), the World Bank estimates that in developing countries, it is common for municipalities in developing countries to spend 20 to 50 percent of their available budget on solid waste management, even though 30 to 60 percent of all the urban solid wastes remain uncollected and less than 50 percent of the population is served. The programme (UNEP) suggested that if most of the waste could be diverted for material and resource recovery, then a substantial reduction in final volumes of waste could be achieved and the recovered material and resources could be utilized to generate revenue to fund waste management. This forms the premise for the Integrated Solid Waste Management (ISWM) system based on 3Rs (reduce, reuse and recycle) principle**.** ISWM system has been pilot tested in a few locations (Wuxi, PR China; Pune, India; Maseru, Lesotho) and has been well received by local

authorities. It has been shown that with appropriate segregation and recycling system significant quantity of waste can be diverted from landfills and converted into resource (UNEP, 2009). Similarly, the United States Environmental Protection Agency (1999) has said that if a state or local government wants to plan for and implement ISWM, they have to consider a hierarchy of methods which are reduce, recycle, and incinerate/landfill.

2.3 Solid Waste Management in Ghana

Over the years, solid waste disposal in Ghana has become a major challenge to MMDAs. As a result of urbanisation and rapid increases in population, Metropolitan Assemblies find it difficult to deal with the large quantities of solid waste generated. This is due to the fact that, people resort to indiscriminate dumping as the only means to managing their domestic solid waste thus resulting in littering and heaping of waste. This section of the review analyses solid waste management processes in Ghana with Accra Metropolitan Assembly (AMA) and Kumasi Metropolitan Assembly (KMA) as a case. These include collection and disposal as well as waste management regulation and policy in Ghana. The next sub-section discusses solid generation in AMA and KMA.

2.3.1 Solid Waste Generation

According to Mensah & Larbi (2005), based on an estimated population of 22 million and an average daily waste generation per capita of 0.45 kg, Ghana generates annually about 3.0 million tonnes of solid waste. Boateng & Nkrumah (2006) have further added that, solid waste generated daily in Accra was between 1500-1800 tonnes. According to Anomanyo (2004) about 1800 tonnes of municipal solid wastes were generated per day in the Accra Metropolis and the average waste generated per capita per day was estimated at 0.5 tonnes. He attributed this to the rate of population growth in the Metropolis which stood at 3.5 per cent. Waste from domestic sources included food waste, garden waste, sweepings, ash, packaging materials, textiles and electric and electronic waste with organic waste being the major component. This constituted about 65 per cent. According to him, the high proportion of food and plant waste was due to the fact that Ghana's economy largely depended on agricultural products for export and domestic consumption. But the waste rate of AMA was about 2000 tonnes a day with per capita waste generation of 0.45kg (AMA, 2009). Also, according to KMA (2009), the current domestic waste generation in Kumasi rate was approximately between 1000-1500 tonnes a day. This was based on the projected population of 1,610,867. According to Ketibuah *et al* (2010), in Kumasi the bulk of household waste is found to be organic waste which includes food waste and pustrecible waste with an average of 55 per cent. Having discussed the quantities and composition of waste generated in the two Metropolis, this leads the discussion on solid waste collection in the next sub-section.

2.3.2 Solid Waste Collection

According to Tsiboe & Marbel (2004), there are basically three methods of household waste collection in Accra:

- Waste Management Department (WMD) curbside collection by trucks directly outside each house.
- WMD collected from communal containers to which people must bring their own waste. These were restricted to low-income areas like Niima and amounted to some 200 communal containers. Households that could not afford the house to house collection service took their waste to any of these 200 communal containers and from which the WMD collected the waste and disposed of it at the landfill site (Stephens *et al* 1994: 25) cited in Tsiboe & Marbell (2004) and
- Door-to-door collection services in middle-income areas like Labadi.

According to Anomanyo (2004), for the purpose of effective waste collection, the city was demarcated into waste collection districts where a company was contracted by AMA to collect waste in one district or two. Fifteen (15) waste collection companies were contracted. These included: Liberty Waste Service Company, Vicma Waste Construction, Ako Waste Management Limited, Gee Waste Limited and Daben Cleansing Construction Services Limited. The main types of vehicles used by AMA were compaction and skip trucks. The wastes were taken by road directly to the disposal sites. There were no waste transfer stations.

According to him, solid waste collection in the city was carried out both on franchise and contract basis. On the franchise basis, a house-to-house collection was done in high income areas and the contractors charged the households some fees with weekly collection frequency. These areas were well-planned residential areas with access roads described as first and second class areas and include areas as Airport residential area and Cantonments. Each household had plastic containers with covers. These contractors then paid a tipping fee to the AMA for the use of its dump site. The user fees charged form about 20 per cent of general service to the beneficiaries whose wastes were collected. On contract bases, waste contractors were paid by AMA to perform both block and communal container collection. Block collection occurred in middle-income residential areas including Dansoman, Adabraka, Kaneshie and other parts of Accra. Approximately 75 per cent of the waste

generated was collected in these areas. Central communal skip collection occurred in low income high population density and deprived residential areas such as James Town, Nima and other parts of Accra where houses were not well planned with poor or even no access roads (third class areas). Market places were also covered under this arrangement. Residents deposited their waste in such communal containers and the frequency of collection was at least once daily. Waste generators here did not pay user charges. He added that despite the strategies put in place for the collection of waste in Accra, maximum waste collection was not achieved. Between 65 and 75 per cent of waste was collected per day.

According to KMA (2006), there are two modes of waste collection in the Kumasi Metropolis. These are house-to-house and communal collection. According to Metropolitan Assembly, Aryetey Brother Company Limited (ABC), Waste Group Ghana Limited (WGG), Sak-M Company Limited (SAK-Mo Meskworld Limited (ML) and Kumasi Waste Management Limited (KWML) were contracted for solid waste collection. About 33 per cent of the population enjoys this service but payment for the service was irregular.
It is on franchise basis for a monthly fee of GH¢1 to GH¢3 per house. Additionally, the communal collection was awarded to Kumasi Waste Management Limited (KWML), Waste Group Ghana Limited (WGG), Meskword (ML) and Aryetey Brother Company Limited (ABC). The total quantities collected were weighed at the disposal site and payment was based on a rate of GH¢ 9 per tonne.

From the above assessment, it can be deduced that there are basically, two main modes of waste collection in AMA and KMA. These are door-to-door or house-to-house collection and communal collection which are carried out in the high class and low class residential areas respectively. Unlike the door-to- door collection which attracts some fee from households, the communal collection is carried out at no cost to the households in AMA. In the case of KMA waste collection is charged per house. However, the door-to-door collection may not favour the poor or low income areas and therefore there is the likelihood of poor waste collection services in these areas. Additionally, attention on collecting solid waste in these areas will be less. So there is the tendency for residents to dump waste any how because of poor collection service.

However, to use income as measure to stratify residential areas in a city like Accra may be misleading. This is because those living in the supposedly low income residential areas may be well to do than those residing in the high income areas as indicated by Stephen *et al* (1994) in Tsiboe & Marbell (2004). This means that Tsiboe & Marbell did not critically examine the text before accepting it. Instead, the class of buildings, willingness and ability of the people to pay for the collection service should have been considered.

2.3.3 Solid Waste Disposal
According to Anomanyo (2004), waste disposal from households in AMA took different forms. These were: burning by households, public dump, dumping in gutters, buried by households and waste collection by agents. Anomanyo (2004), further added that between 1991 and late 2001, the AMA's Municipal solid waste in the Accra metropolis was deposited at Mallam, a suburb of Accra. This dumping at the Mallam site however was stopped in late 2001 as the dump capacity had been exceeded and objections from nearby residents. Waste dumping was henceforth shifted to Djanman which unfortunately could not last as it was filled to capacity in just three months. These abandoned Mallam and Djanman sites were mountains of dumps and since they were neither landfills nor were there controls to their spread and emissions, they are of great concern as a result of their threat to human health, leachate and landfill gas formation. According to him the dump site was an old stone quarry at Oblogo in the McCarthy Hills of Accra. Before it begun to be used in early 2002 there was an installation of clay lining. The site had no engineered containment of leachate. AMA was only able to compact the waste to guarantee some level of proper dumping and hence "this site was considered a controlled dump rather than a properly engineered landfill" (Anomanyo, 2004). He further added that since the formal systems of solid waste disposal could not cope with the ever-increasing volume of solid waste being generated in Accra, the public itself employs various means of waste disposal. Waste was thus disposed off indiscriminately especially in watercourses and drainage channels and also through burning.

According to KMA (2006), a well-engineered sanitary site was used at Dompoase where waste was placed compacted and covered at the site. A weighbridge was also available and attached to a control room where the waste was weighed and inspected before being accepted into the landfill. A maintenance bay and offices were also at the site. Heavy-duty equipment were available for spreading of waste, compaction and covering. Grading and gravelling of access roads were other vital activities at the landfill site.

Comparing the two Metropolis in terms of waste disposal in landfill, KMA has well designed sanitary landfill which meets all the requirements. These include weighbridge, access roads, maintenance bay, leachate measures,

heavy duty equipment for spreading waste, compacting and covering.

2.4 Waste Management Regulation and Policy

According to the Ministry of Local Government and Rural Development (MLGRD) (2004), general waste management in Ghana is the responsibility of the MLGRD, which supervises the decentralized Metropolitan, Municipal and District Assemblies (MMDAs). However, the ministry indicates that, regulatory authority is vested in the Environmental Protection Agency (EPA) under the auspices of the Ministry of Environment and Science. The Metropolitan, Municipal and District Assemblies are responsible for the collection and final disposal of solid waste through their Waste Management Departments (WMDs) and their Environmental Health and Sanitation Departments (EHSD). The policy framework guiding the management of hazardous, solid and radioactive waste includes the Local Government Act (1994), Act 462, the Environmental Protection Agency Act (1994), Act 490, the Pesticides Control and Management Act (1996), Act 528, the Environmental Assessment Regulations 1999, (LI 1652), the Environmental Sanitation Policy of Ghana (1999), the Guidelines for the Development and Management of Landfills in Ghana, and the Guidelines for Bio-medical Waste (2000). All these Acts and Regulations emanate from the National Environmental Action Plan (MLGRD, 2004).

Furthermore, the ministry had published the National Environmental Sanitation Policy (NESP) since May 1999. Accordingly, the policy looks at the basic principles of environmental sanitation, problems and constraints. The role and responsibilities assigned to communities, ministries, departments and agencies and the private sector impinge on environmental management and protection, legislation and law enforcement and the criteria for specifying services and programmes, funding, equipment and supplies. Out of the National Sanitation Policy, the MLGRD also developed a technical guideline document titled 'The Expanded Sanitary Inspection and Compliance Enforcement (ESICOME) Programme guidelines. The programme guidelines which are implemented by the MMDA's, routinely looked at four broad areas namely; effective environmental health inspections (Sanitary Inspections), dissemination of sanitary information (Hygiene Education), pests/vector control and law enforcement. All MMDAs have developed waste management and environmental health plans to help solve the numerous sanitation problems. Generally, the National Environmental Sanitation Policy Co-ordination Council (NESPoCC) is responsible for coordinating the policy and ensuring effective communication and cooperation between the many different agencies involved in environmental management in their respective Districts (MLGRD**,** 2004).

The ministry further indicates that in an effort to address the problem of waste management, Government has over the years put in place adequate national policies, regulatory and institutional frameworks. Due to this the Environmental Sanitation Policy (ESP) was formulated in 1999. This policy has currently been amended and strategic action plans developed for implementation according to the report. Various relevant legislations for the control of waste have also been enacted. These include the following.

- Local Government Act, 1990 (Act 462)
- Environmental Assessment Regulations, 1999 (LI 1652).
- Criminal Code, 1960 (Act 29).
- Water Resources Commission Act, 1996 (Act 522).
- Pesticides Control and Management Act, 1996 (Act 528).
- National Building Regulations, 1996 (LI 1630).

The Ministry also collaborated with the Ministry of Environment, Science and Technology (MEST), EPA and the Ministry of Health have prepared the following guidelines and standards for waste management:

- National Environmental Quality Guidelines (1998)
- Ghana Landfill Guidelines (2002)
- Manual for the preparation of district waste management plans in Ghana (2002)
- Guidelines for the management of healthcare and veterinary waste in Ghana (2002)
- Handbook for the preparation of District level Environmental Sanitation Strategies and Action Plans (DESSAPs).

It is observed from the above that, despite the numerous sanitations regulations and policies that have been put in place by the MLGRD to deal with the solid waste menace in the country, there has not been any improvement in the area of solid waste management. Rather it has moved from bad to worst and therefore has failed to achieve its goal of clearing filth in the country. Secondly, drawing from the views given by the Sanitation Country Profile Ghana and the National Report for Waste Management in Ghana, it can be said with certainty that MMDAs are the primary authorities to manage solid waste at the local level.

3. Methodology

The study gathered data from two main sources namely secondary and primary. Details of these are discussed below.

3.1 Secondary Data

Secondary data were obtained from the District Medium Term Development Plan (DMTDP) of the Metropolitan Assembly. The data obtained include: objective of waste management by the Assembly, strategies, activities, time frame, implementing agencies, collaborators and indicative cost. Records of the waste management company (Zoomlion Ghana Limited) on the resources they have in for solid waste collection and disposal in the study area.

3.2 Primary Data Collection

Primary data were collected through preliminary field investigation, questionnaires survey and face- to-face interviews. These are further discussed in the sub-sections below.

3.2.1 Preliminary Field Investigation

The field observation involved scouting through the study area to assess the following.

- Communal waste collection skips.
- Dustbins in the selected areas of study in the metropolis.
- Dump sites.
- Landfill site
- Informal contacts with Tamale Metropolitan Assembly, WMD and ZoomLion Ghana Ltd.

During this process, pictures were taken of heaps of solid waste in dump sites, solid waste skips overflowing with solid waste, scattered solid waste in between houses.
This was included in the analysis of data gathered from the field. This process weighed the problems and guided the formulation of questionnaire survey and interview schedule.

3.2.2 Questionnaire Survey

As the adage goes "No survey is better than its questionnaires". Therefore, household data were collected through questionnaire survey. Data collected were on the following variables: Types of solid waste, Place of disposal, Availability of skips and bins for storing waste, Mode of collection and Payment for collection and distances covered to dispose of waste in skips.

Target population for the questionnaire survey were women between the ages 20 years and above. This is because they were mostly in charge of sweeping and gathering of all sorts of domestic solid waste in homes and disposing of them. Men were excluded because they were not culturally bound to perform such duties at home.

3.2.2.1 Sample Frame and Sample Size Determination

A total number of eighty thousand, five hundred and ninety-nine (80,599) female population between the age group of 15 and 64 was obtained from Ghana Statistical Service (GSS) for TAMA. This represented the sample frame of the questionnaire survey. Furthermore, the mathematical method was used to determine the sample size for the survey. Below is the procedure.

Formula: $n = \frac{N}{1+N(\alpha)^2}$, Where **n**=sample size, **N**=sample frame (**80599**) and **α** represented the margin of error which is **0.08** with confidence level of **92%.** By substituting 80599 and 0.08 into the formula: $= \frac{80\,599}{1+80599(0.08)^2}$, **n=156.**

Therefore, the sample size for the survey was one hundred and fifty six (156). This was to ensure that the sampled mean was closer to the population mean and minimise errors.
It is however important to note that the sample size depended on financial resources and the stipulated period of the study. In the light of this, the distribution of the sample size in the study area was considered critical to the study.

3.2.2.2 Sampling Techniques

The following sampling techniques were employed to select the respondents for the study. These were: cluster, purposive, stratified, systematic and accidental sampling. Firstly, the study area was zoned into three clusters namely: Central Sub-Metro, North Sub-Metro and South Sub-Metro. Secondly, purposive sampling was used to select twelve (12) areas from the three sub-metros for the survey as in figure 1.2. See table 1 for details.

The selected areas were further stratified into low class, middle class and high class residential areas in the metropolis. See table 3.2 for details. Due to lack of census data for the female population of each listed area, the sample size of 156 was divided equally among the 12 selected areas. This gave a sample size of thirteen (13) for each selected area. This means that 13 women were interviewed in each selected area in the metropolis. Furthermore, systematic sampling technique was used to select houses in each selected area. See table 2 for details.

Because most of the houses in selected areas were not well planned with serial numbers, a serpentine movement was used to select every Kth house starting from the direction of the first point of contact with any house in the selected area. With this approach a respondent was interviewed in each Kth house until the required sample of 13 women was obtained in each area. Finally, accidental sampling method was used to select the respondents for interview. That is, the first woman to be contacted in each selected house was interviewed. If the first woman contacted was not ready, the next available woman was interviewed. Since some of respondents did not understand English language people who understood both the English and the local dialect were trained and employed to administer the questionnaires. The questionnaires were pre-tested in the study area before the full survey was carried out. The pre-testing gave the opportunity for certain pertinent issues which could not be captured initially to be included in the final questionnaire. The questionnaire survey was carried out before the interview because certain new issues came up during the survey which could not be captured in the questionnaire survey.

3.3 Face-to-face Interview

Face-to-face interviews were used to collect data from the following key stakeholders as far as solid waste management is concerned in the study area.

- Assemblymen in the selected areas
- Tamale Metropolitan Assembly (Metropolitan Budget Officer)
- Waste Management Department (Landfill Manager) and
- Zoomlion Company Limited (Assistant Regional Operations Supervisor).

3.3.1 Purposive Sampling

Purposive sampling technique was used to select the above. As the name implies, in trying to adhere to the objectives of the study, respondents who can answer the research questions best are selected. In this case, these key stakeholders had the necessary information, adequate knowledge and experience on solid waste management in the study area. Below is the type of data collected from each key stakeholder.

1. Assemblymen: Solid waste collection and disposal, availability of dustbins and skips, place of disposal of waste by households, mode and regularity of collection
2. Tamale Metropolitan Assembly: Revenue and solid waste management. Revenue generated in a month, amount spent on waste management as well as the DACF and the amount spent on solid waste management
3. Waste Management Department and Zoomlion Ghana Ltd.: mode of collection, provision of dustbins and skips, availability of waste management equipment. frequency of collection Disposal site and management options.

3.4 Data Processing and Analysis

Administered questionnaires were examined to check completeness, accuracy and consistency of responses in order to detect and eliminate errors. The Statistical Package for Social Sciences (SPSS) was used to process the quantitative data. The data were processed into statistical tables and charts for interpretation and discussion. Processed data were analysed both quantitatively and qualitatively. Data analyses were further disaggregated into the various classes of residential areas in the Metropolis.

4. Analysis and Discussion of findings

This section analyses the data collected from the study areas in the Metropolis through preliminary field investigation, questionnaire survey and face-to-face interviews. In all, 156 respondents were surveyed and interviews were carried out with 15 key respondents including institutional heads and Assemblymen of the study areas. Data were collected on the following issues:

- Disposal sites of household solid waste.
- Solid waste collection and final disposal.
- Cost involved in managing solid waste and

- Capacity of the waste management institutions in managing solid waste in the area

4.1 Methods of Disposal of Household Solid Waste

The disposal of household solid waste is one of the functional elements in the management of waste. The field data showed that the commonest place of waste disposal by the people in the metropolis was the skip (37.8 per cent). This method was used in the low class residential areas in the metropolis. These areas include: Sakasaka, Choggu, Moshi Zongo, Lamashegu and Aboabo. This was followed by storing waste in dustbins (21.8 per cent) mostly in the high class residential areas and some middle class residential areas in the Metropolis. These areas were: Vitting Estates, Russian Bungalows, SSNIT flats and Kalpohin Estates. The rest of respondents (40.5 per cent) resorted to dumping waste in either the roadside, dump, open spaces, nearby gutter or backyard. These methods of waste disposal also happened in the low class residential areas as mentioned above. This resulted in littering and heaping of waste thereby making the environment filthy. Therefore, the possibility of outbreak of cholera and other environmental related diseases is high if such practice continues.

4.2 Availability of Skips and Dustbins for Waste Storage

An interview with the Assemblymen in the twelve (12) selected areas revealed that lack of skips and dustbins was major problem in the Metropolis. ZoomLion Ghana Ltd. which was the main company in charge of waste collection has been unable to supply skips and dustbins to areas they served.

The field data showed that the skip ratio to the population in the low class residential areas was 1:9378 as opposed to the acceptable standard of 1:700 (as indicated by ZoomLion). This means that the average population a skip served was 13 times greater than the standard maximum population a skip was supposed to have served. This explained why 40.5 per cent of the respondents in figure 2 resort to dumping waste at roadside, dump sites, open spaces, nearby gutter, backyard or burning as means to deal with their domestic waste in the Metropolis. This scenario is not different from waste disposal in the low income areas in AMA. In terms of availability of skips in the low class residential areas, Aboabo had the highest number of skips in the Metropolis because there was a market sited in the heart of the settlement. In this case, a lot of waste was produced in the area. To avoid indiscriminate dumping, a lot of skips had to be provided. However, this was still not adequate as 14 more skips were required. In effect skips were seen overflowing with waste.

In the middle class residential areas, no skip container existed and door to door services were not rendered. This also explains why the respondents in figure 2 resorted to dumping waste at unapproved sites. It is also important to add that very few households used dustbins in these areas (Middle class). The rest resorted to dumping their waste in front of their houses and burning them. However, the average household income earned by respondents monthly was GH¢ 460. This means that people could afford for the door-to-door collection service as it cost GH¢ 7.00 a month per household.

In the high class residential areas, dustbins were strictly used by households. Therefore, the dustbin ratio to the household was 1: 3 as compared to acceptable standard of 1:1. This means that very few households did not use dustbins for storing their waste. Therefore, in these areas where dustbins were used the environment looked very clean and serene. Waste was not dumped indiscriminately compared to the situation in the low class residential areas. This also implied that those people in these areas had the capacity to pay and were committed to ensure effective and sustainable waste management. The average income earned monthly by respondents was GH¢ 400.See table 4 for details.

4.3 Time Spent to Dispose of Waste in Skip

The survey showed that 53 respondents (representing 34 per cent) have access to skips in the low class residential areas. Out of this, 11 of them spent between 5 and 10 minutes to dispose of waste at skip site, and the rest of the 42 (66 per cent) spent above 10 minutes. The study further revealed that 79.2 per cent of respondents spent above 10 minutes to dispose of their household waste in the skip. Out of the 79.2 percent, 63.3 per cent of them responded that, it inconveniences them to spend such time to dispose of waste in the skip. As a result, 57.9 per cent of them burnt their household waste, 31.6 per cent dumped their waste in the nearest gutter and 10.5 per cent dumped their waste in nearest available space. Therefore, the time spent to dispose of waste in the skip goes to add up the dumping of waste at unapproved sites though the attitudes cannot be completely ruled out in this case. The field investigation also confirmed that, there were about 17 skips available in the selected areas of study that were visited particularly in the low class residential areas. This further explains why people resort to burning of waste, dumping of waste in open spaces and in gutters. In the light of the discussion above, solid waste collection is inevitable in solid waste management. Therefore, the next section discusses solid waste collection in TAMA.

4.4 Solid Waste Collection

Solid waste management includes the hauling and final disposal at landfills. The study showed that there were three modes of waste collection in TAMA. These were: door-to-door and curb (primary waste collection), communal dumpsites (secondary waste collection). The waste collected was finally disposed of in a landfill located at Gbalahi, a suburb of Tamale Metropolis. These are further elaborated in the sub-sections below.

4.4.1 Primary Waste Collection

From the survey, 19.0 per cent of the respondents indicated that, waste was collected directly from their yards (door-to-door) while 8.3 per cent indicated waste was collected outside their yards (curb). These are displayed in figure. The door-to-door and curb modes of waste collection were carried out mainly in the high class residential areas such as Kalpohin Estates, SSNIT Flats and Vitting Estates. These modes of waste collection were verified with key stakeholders (the Assemblymen, WMD and ZoomLion Ghana Ltd.). See figure 3 for illustrations.

The beneficiaries of the doo-to-door collection paid a monthly charge of GH¢ 7 per 120 litre dustbin. According to the Assemblymen this charge was exorbitant and this accounted for the lack of patronage in the Metropolis. Secondly, there was lack of patronage because ZoomLion did not regularly collect waste in these areas. In effect some people resorted to burning as a means of dealing with their waste.

4.4.2 Secondary Waste Collection

The study also indicated that the main mode of waste collection in TAMA was communal. This was carried out mainly in the low class residential areas as in the case of AMA and KMA. The survey further showed that, 63.2 per cent of the respondents were not asked to pay for the collection of waste in their residential areas particularly those living in the low class residential areas by ZoomLion Ghana Ltd. though 76.5 per cent of respondents were prepared and could pay for the collection of waste in their area or at homes. This is because the average income earned monthly by respondents was about GH¢ 260. If the residents were charged for collection it could improve upon waste collection in these areas. See figure 4 on communal waste collection.

4.5 Regularity of Waste Collection

Regular collection is an important exercise in solid waste management. In this regard, 35.2 per cent of respondents indicated that waste was collected twice a week and in some instances once a week as indicated by 30.4 per cent of the respondents. In some areas like Russian bungalows and Education Ridge collection did not take place at all. Five times a week which should have been the required number of times waste was collected was rather the least particularly in the low class residential areas. This brought about heaping of waste in dumpsites and skips overflowing with waste particularly in the low class residential areas.
Table 5.4 above, suggests that, the average number of times that waste was collected in low class residential areas was thrice a week as opposed to the minimum of four times a week. It is also important to add that waste was collected six (6) times a week in Aboabo because there was a market located in the heart of the settlement. Therefore, a lot of waste was generated in this area. This explains why an extra 14 skips were demanded.

In the middle class residential areas, waste was collected once a week. This is because these areas were supposed to demand door-to-door collection in the Metropolis which they did not do. As a result ZoomLion did not find it prudent to communally collect waste from these areas like the low class residential areas. This is because ZoomLion felt the people in the middle class were capable of paying for the door-to-door collection. But respondents also gave a contrary view. According to them, door-to-door services were expensive. Additionally, though indicated by ZoomLion waste was collected at least once in the middle class residential areas, the survey revealed a different view. In some areas like Education Ridge and Russian bungalows, collection did not take place at all. This resulted in respondents dumping their waste at unapproved sites and in some cases burning the waste. The interview with ZoomLion showed that 216 tonnes were hauled every day out of the 810 tonnes generated daily. This means that a backlog of 594 tonnes was left uncollected in the entire Metropolis. During the field investigation it was observed that a lot of skips were overflowing with waste uncollected for days in the low class residential areas. This has the tendency of breeding diseases such as typhoid, cholera, chicken pox which are sanitation related diseases.

4.6 Final Disposal of Waste

The final disposal site of solid waste in the Metropolis was landfill site at Gbalahi, about 13 kilometres away from the city centre. A visit to the site showed that, it was in a bad shape. Ideally, a sanitary landfill should have the following functional elements:

- Weighbridge
- Internal access

- Treatment plant
- Leachate collection system
- Gas recovery and
- Location should be far away from human settlement and existing water body.

This was not the case with the landfill in Tamale Metropolis. Though there was presence of the facilities mentioned above they were not functional. Additionally, the landfill has no internal access and the site was closed to a community called Wovuguma. This community is about one kilometer (1km) away from the site. (See figure 1.2 for location of landfill site). Almost all the cells at the site were filled to capacity. Waste dumped in the cells was not leveled and compacted as required of a sanitary landfill. This left a mountain of waste at the site. Worst of it all burning of waste occurred at the site. Therefore, the description of the landfill site in Tamale Metropolis was similar to the one described by Anamanyo (2004) in Accra Metropolis.

According to the WMD and ZoomLion, waste separation which is one of the initial steps to reduce the volume and/or toxicity of waste was not carried out before final disposal. This is because plastic waste takes approximately two-hundred (200) years to decompose. In addition, other components of waste such as metals may not decompose at all. In this case if waste is not segregated before dumping in landfill, the intention of decomposition of waste in the landfill for reclamation of land for use will fail since about 57.5 per cent of the waste in the Metropolis is plastic. Similarly through waste disaggregating, reusable products and packaging such as returnable bottles will be diverted from the landfill. That notwithstanding, waste management involving collection, transportation and disposal at the landfill site has huge financial implications. In the light of this the next section analyses the cost of managing solid waste in TAMA.

4.7 Cost of Managing Waste

An amount of GH¢ 15,000 was spent on solid waste by the Waste Management Department (WMD). This amounted to GH¢ 60,000 in a month. Out of this 60 per cent went into fuel for collection, 25 per cent for maintenance of vehicles and equipment and 15 per cent for other administrative duties. However, this amount was given to the WMD by the Metropolitan Assembly monthly. Also, ZoomLion spent approximately GH¢ 2,700 a week on waste collection and maintenace (GH¢ 108,000 a month). An interview with the Metropolitan Assembly showed that an amount of GH¢ 1,711,984.2 was spent on waste management out of the total revenue of GH¢ 4,003,158.64 received in 2009. That is, both Internally Generated Fund (IGF) and District Assembly Common Fund (DACF). This represents 42.8 per cent of the Metropolitan revenue spent on solid waste management.

The field data further showed that the IGF by the Assembly per month was GH¢ 22,178.40. However, an amount of GH¢ 120,340.61 was spent on waste management per month by the Metropolitan Assembly which was far greater than the revenue earned. Because the IGF alone could not be used to finance waste management, an amount of GH¢ 1,177,946.52 was taken from the Common Fund to finance the deficit. This implies that 31.5 per cent of the DACF went to support waste management in 2009. In effect waste management is taking a chunk of the Metropolitan Assembly revenue which could have been used for other infrastructural development. Having analysed the cost involved in managing solid waste by the Metropolitan Assembly; the next section assesses the capacity of the waste management institutions in the Metropolis.

4.8 Capacity of Waste Management Institutions

An understanding of the capacities of WMD and the ZoomLion Ghana Ltd. will enable conclusions to be drawn regarding their effectiveness. This section assesses the capacities of the WMD and ZoomLion Ghana Ltd. in terms of equipment and technical staffing.

An interview with the WMD and ZoomLion Ghana Ltd. revealed the equipment base of the two waste management institutions in the Metropolis. Analyses of the equipment base from the field are grouped into their respective uses namely storage, collection and transportation. In terms of waste storage two-hundred and thirty (230) skips were required by ZoomLion Ghana Ltd. and WMD to be supplied in both the middle and low class residential areas. However, one hundred and eighty-six (186) were available and supplied for storing waste in the Metropolis. In effect, if this extra skips were not supplied this could result in people dumping waste at unapproved sites. Also, about four-thousand (4000) dustbins were needed for storing waste in the high class residential areas for effective service in the Metropolis particularly those living in the high class residential areas. This is because dustbins are the main equipment for storing waste in order to prevent dumping of waste at unapproved sites.

In terms of waste collection and transportation in the Metropolis Oboafo tricycle, motorist, skip loaders, roll on/roll off and compaction trucks were mainly used. The Oboafo tricycle and motorist were used for primary collection and transferring of waste collected into a compaction truck for final disposal at the landfill. However, these were not enough to ensure regular collection and transportation of waste to the landfill. For instance about two-hundred (200) Oboafo tricycles were needed by the waste management institutions for the door-to-door collection. Also, the compaction trucks which were used for the door-to-door collection were only two (2) for the entire Metropolis. In effect if the few existing core waste equipment for collection and transportation like skip loaders, compaction trucks and roll on/roll off trucks are broken down for just a day or two it will result in heaping of waste. This can lead to outbreak of communicable diseases such as cholera, typhoid and chicken pox.

5. Key Findings

Through the analyses, the following are the key findings of the study. These are discussed below.

5.1 Waste Disposal

Inadequate skip supply was a major factor affecting waste disposal in TAMA especially among the low class residential areas. The survey established that about 66 per cent of respondents had no access to skips for disposing their waste particularly those living in the low class residential area. This implies that respondents resorted to dumping waste in nearby gutters, by roadside, opened spaces and other unapproved ways of managing their domestic waste.

Additionally, the skip ratio to population was very high. That was 1: 9378 compared to the maximum number of seven hundred people to a skip (1:700). These include high populated areas like Moshi Zongo, Aboabo, Lamashegu and Sakasaka. This goes to reaffirm the inadequacy of skip supply in the Metropolis. Also, the time spent by residents to dispose of waste at the few existing skip sites was a latent factor influencing dumping of solid waste at unapproved sites.

5.2 Waste Collection

Indeed there was irregular or lack of routine collection of waste by ZoomLion Ghana Ltd. especially in the low class residential areas in the Metropolis. Waste collection was mostly carried out twice a week and in some areas like middle class residential areas no collection took place. Even in the high class residential areas collection was done once a week. This resulted in people dumping their waste in opened spaces and in most cases burning was the alternative to final disposal at the landfill. Unlike the door-to-door collection which attracted a monthly charge of GH¢ 7.00 in the high class residential areas, the communal collection was carried out at no cost to the residents in all the low class residential areas. This is because respondents in these areas were not requested to pay for waste collection though their monthly average monthly income (GH¢ 260) earned could support the payment.

5.3 Final Disposal

The landfill did not meet the requirement of a sanitary landfill as in the case of KMA and therefore could be described as an open dump. Though the landfill had a weighbridge, gas recovery system, leachate collection system they were not functioning. The landfill too had no internal access and sited near a settlement. Additionally, waste was not usually separated into their various components before final disposal. This led to burying of some valuable resources in the landfill which could have been otherwise re-used. More so, burning of waste occurred in the landfill.

5.4 Resources for Waste Management

The waste management institutions were unable to deliver efficient services as they were under resourced. Skips for storing waste generated were woefully inadequate. In the whole Metropolis one hundred and eighty six (186) skips were supplied particularly in the low class residential areas. However, about 230 extra skips were required by WMD and ZoomLion Ghana Ltd. to be supplied to the low class residential areas. Also, about four thousand (4000) dustbins extra were required to be supplied in the middle and high class residential areas in the Metropolis as against about one thousand, five-hundred and ninety-seven (1,597) dustbins distributed.

Equipment for waste transportation were also inadequate. These include: oboafo tricycle, compaction trucks, roll on/roll off trucks and skip loaders. For instance two hundred (200) oboafo tricycles were needed by the waste management institutions for the door-to-door collection. However, about one hundred (100) tricycles were available. Furthermore, the compaction trucks which were used for the door-to-door collection were only two (2) for the entire Metropolis. Therefore, four (4) were required to ensure regular collection.

6. Conclusion

In the study, the following objectives were set to be achieved. The first objective was to examine means of waste disposal by households (place of disposal). The survey revealed that the commonest place of waste disposal in the Metropolis was the skip. However, this was woefully inadequate. Secondly, the research seeks to analyse the mode and frequency of solid waste collection in TAMA and the commonest mode of waste collection is communal. On the other hand, the collection was irregular. The study also meant to analyse how the waste collected was finally disposed off. It can therefore be said that waste collected was finally disposed in the landfill. However, the landfill was in a poor state. Furthermore, the study intended assessing the capacity of waste management institutions particularly in terms of physical resources to effectively manage waste in the Metropolis. Therefore the main equipment used for waste storage and collection were: dustbins, skips, oboafo tricycle, skip loaders, compaction trucks and roll on/ roll off trucks. But these equipment were not enough to ensure effective waste collection and disposal.

Therefore, all the objectives set were achieved and with regard to the main objective of the study it can be concluded that the following are indeed the key factors affecting effective waste management in the Tamale Metropolis. These include inadequate skip supply for storing waste; high population to skip ratio; lack of routine collection of waste, poor methods of waste management and inadequate resources for waste management institutions to effectively collect the waste generated.

References

Anomanyo, D.E (2004). "Integration of Municipal Solid Waste Management in Accra, Ghana: Biofactor treatment technology as an integral part of the management process". *Masters Thesis, Lund University, Sweden.*

Boateng, C. and Nkrumah, D. (2006). "Managing Waste! The Attitudinal Change". *Daily Graphic, 16th December. Page 20.*

Centre for Environment and Development (2003). "Study of the Attitude and Perception of Community towards Solid Waste Management. A case study of Thiruvananthapuram city-Phase II". *Kerala Research Programme on Local Level Development.*

Denison, R.A. and Ruston, J.(1990). "Recycling and Incineration". *Island Press, Washington D.C.*

KMA (2006). "www. Ghanadistricts.com/districts/1on 1/kma/?arrow". Accessed on 12th June, 2013.

Kreith, F. (1994). "Handbook of Solid Waste Management". McGraw Hill, USA.

Kumah, A.M.(2007). "The Situation of Solid Waste in Ghana". Accra, Ghana.

Mensah, A. and Larbi, E. (2005). "Solid waste disposal in Ghana". (www.trend.wastsan.net) Accessed on 24th April, 2012.

MLGRD(2004)."SanitationCountryProfileGhana".(www.un.org/esta/agenda21.../ghana/sanitationGHANA04.pdf). Accessed on 12th October, 2012

Momoh, J.J. and Oladebeye, D.H. (2010). "Assessment of Awareness of Attitude and Willingness of People to Participate in Household Solid Waste Recycling Programme in Ado-Eketi, Nigeria" *Journal of Applied Sciences in Environmental Sanitation*.

Shafiul, A.A. and Mansoor, A. (2003). "Partnerships for solid waste management in developing countries: Linking theories to realities" *Institute of Development Engineering, Water and Development Centre (WEDC), Loughborough University, U.K.*

Tamale Metropolitan Assembly (2007). "Medium-Term Development Plan (2006-2009) under the Growth and Poverty Reduction Strategy". Tamale, Northern Region.

Tchobanoglous, G., Theisen, H. and Eliason, R. (1977). "Solid Wastes: Engineering Principles and Management issues*". McGraw-Hill Publishing Company, USA.*

Tchobanoglous, G., Theisen, H. and Vigil, S. (1993). "Integrated Solid Waste: Engineering principles and management issues". *McGraw-Hill Publishing company, USA*.

Tsiboe, I.A. and Marbell, E.(2004). "A Look at Urban Waste Disposal Problems in Accra". *Masters Thesis,Roskilde University, Denmark.*

United Nations Environmental Programme (UNEP) (2009). "Developing Integrated Solid Waste Management Plan Training Manual, Volume 2: Assessment of Current Waste Management Systems and Gaps Therein". Osaka/Shiga, Japan.

United States Environmental Protection Agency (USEPA) (1999). "State and Local Solutions to Solid Waste Management Problems". (http://www.epa.gov). Accessed on 18th July,2013

USPS (2000). "Solid Waste Management Plan for Thimphu City", *Bhutan, Draft version, April 2000 .Bhutan: Urban Sector Programme Support Secretariat.*

Zerbock, O. (2003). "Urban Solid Waste Management: Waste Reduction in Developing Nations". (www.cee.mtu.edu). Accessed on 18th July,2013.

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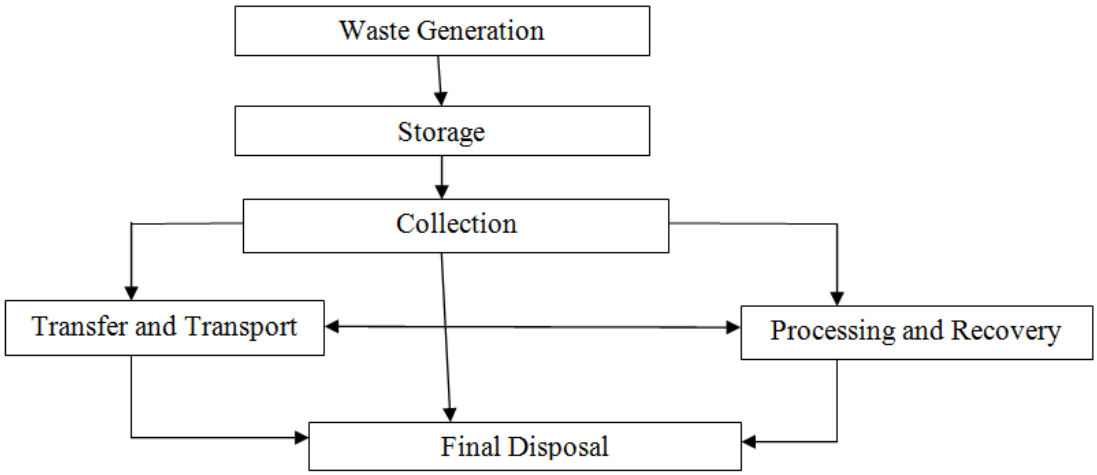

Figure 1: Key Elements of Solid Waste Management

Table 1: Sub-Metros and Selected Areas of Study (Cluster Sampling)

Sub-Metro	Selected Areas	Total
Central	Moshi Zongo, Aboabo, Choggu	3
North	Education Ridge, Kalpohin Etates, SSNIT Flates, Sakasaka	5
South	Vitting Estates, Nyohini, Lamashegu, Ghanasco	4
Total		**12**

Table 2: Stratification of Selected Areas of Study

No.	Low Class	Middle Class	High Class
1.	Aboabo	Education Ridge	Kalpohin Estates
2.	Choggu	Ghanasco	SSNIT Flats
3.	Lamashegu	Russian Bungalows	Vitting Etates
4.	Moshi Zongo		
5.	Nyohini		
6.	Sakasaka		
Total	**6**	**3**	**3**

Table 3: Systematic Sampling Procedure

Selected Area	No. of Houses (Sample frame)	Total women to be surveyed (Sample Size)	Sample fraction(Kth house)
Aboabo	165	13	Every 13th house
Choggu	243	13	Every 19th house
Lamashegu	235	13	Every 18th house
Moshi Zongo	160	13	Every 12th house
Nyohini	198	13	Every 15th house
Sakasaka	166	13	Every13th house
Education Ridge	120	13	Every 9th house
Ghanasco	50	13	Every 4th house
Russian Bungalows	48	13	Every 4th house
Kalpohin Estates	98	13	Every 8th house
SSNIT Flats	61	13	Every 5th house
Vitting Estates	43	13	Every 3rd house

Table 4: Distribution of Dustbins and Skips in Selected Areas of Study

Residential Area/Section	Estimated Population	Number of Dustbins available	Number Required	Number of Skips available	Number required
Low Class Residential Areas					
Aboabo	25,555	-	500	8	14
Choggu	36,682	-	100	3	12
Lamashegu	41,001	-	500	3	30
Moshi Zongo	35,131	-	1000	3	6
Nyohini	30,219	2	400	3	16
Sakasaka	47,317	9	300	3	6
Total	**215,905**	**11**	**2800**	**23**	**84**
Middle Class Residential Areas					
Education Ridge	3500	50	1400	-	6
Ghanasco	5000	-	200	-	15
Russian Bungalows	10000	5	300	-	10
Total	**18500**	**55**	**1900**	**-**	**31**
High Class Residential Areas					
Kalpohin Estates	2000	130	300	1	4
SSNIT Flats	1500	300	-		4
Vitting Estates	6000	15	40		20
Total	**9500**	**445**	**340**	**1**	**28**

Source: Assemblymen of selected areas, April, 2010.

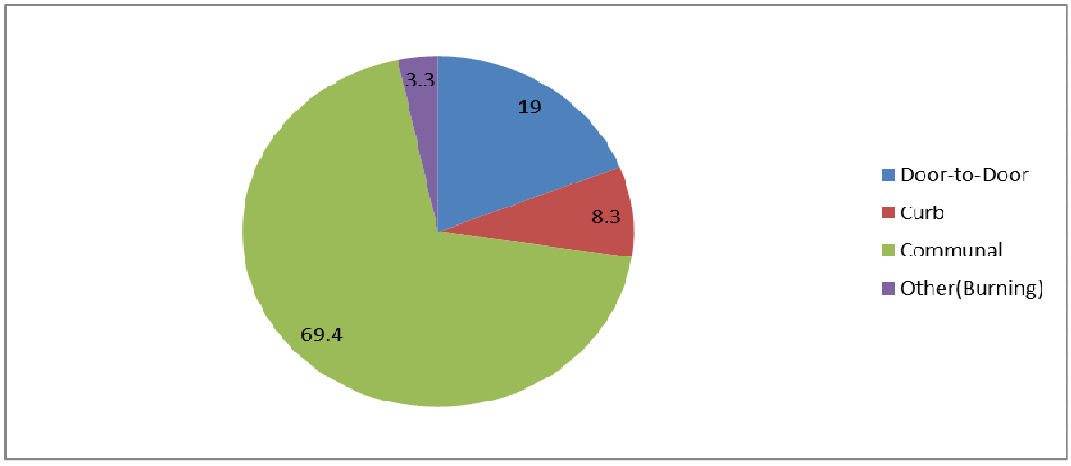

Figure 2: Mode of Solid waste Collection

Figure 3: Curb collection at SSNIT Flats in Tamale

Figure 4: Secondary Mode of Waste Collection at Sakasaka

Figure 5: Solid waste container overflowing with waste at Choggu

Figure 6: Burning at landfill site, Gbalahi, TAMA

Table 5: Equipment Base of Waste Management Institutions (WMD and ZoomLion)

Equipment	WMD (number available)	Number required	ZoomLion (number available)	Number required	Total available	Total required
Dustbins	550	1000	1047	3000	1,597	4000
Skips	118	200	68	30	186	230
Oboafo tricycle	-	-	100	200	100	200
Motorist	-	-	8	50	8	50
Graders	1	2	-	2	1	4
Skip Loaders	3	4	3	3	6	7
Compaction trucks	1	2	1	2	2	4
Roll on/Roll off trucks	3	4	2	4	5	8

Figure 1.1: Map of Northern Region showing TAMA

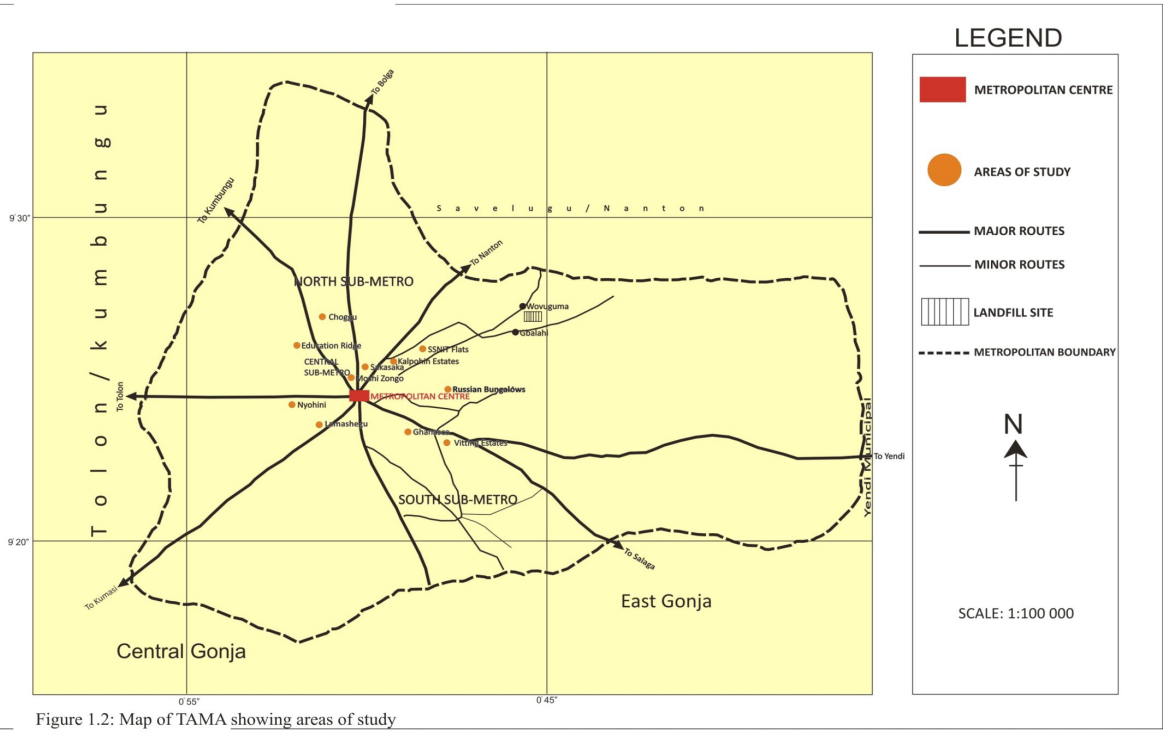

Figure 1.2: Map of TAMA showing areas of study

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