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Investigating Solid Waste Management in the Bolgatanga Municipality of the Upper East Region, Ghana

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Abstract

Management of domestic solid waste is one of the challenges facing many metropolitan municipal and district Assemblies in Ghana because uncollected and improperly disposed waste results in the clogging of most public areas, streets, and gutters and has a grave implications on health. In the Bolgatanga municipality, as a result of increasing urban population, a high consumption and disposal lifestyle that has no need for reuse, negative attitude by individuals and households in the handling of waste and the inadequate financial and logistical requirements on the part of the local authorities to combat this menace has had a negative impact on waste management in the municipality. This research conducts a social survey in five (5) major settlements in the municipality namely; Bolgatanga town, Zuarungu, Yikene, Sumburungu and Tindonsobligo to ascertain attitudes in waste management, perceptions on the value and reuse of waste and the management of waste at the household and local levels. Also we determined the rates and trend in increase of population and waste levels for the municipality at a four (4) year interval for the years; 1993, 1997, 2001, 2005, and 2009 and measure the strength of association using Pearson's Product Moment Correlation Coefficient. The study revealed that the most predominant waste disposal is the communal disposal at sites normally not approved in the peri-urban communities. This is followed by the door-to-door services which was prevalent in the urban residential areas. Despite the dominant nature of communal skips and door-to-door services mostly in the Bolgatanga community, inhabitants still practice improper disposal from disposal in nearby bush to open dumps due to lack of enforcement of regulatory policies and programmes irrespective of income levels. These problems are compounded by inadequate proper storage receptacles, unavailability of community storage receptacles and the long distance of travel for disposal of household waste which discourages dumping at common and approved sites. For the period under consideration (1993-2009), the population for the municipality increased from 188,690 to 295,333 representing an increase of 36%, while waste generated increased from 46,015 to 101, 823 tons, an increase by 55% which results in an average per capita waste generation (kg/person/daily) of 0.70 kilogrammes for the period under consideration. The Pearson's Product Moment Correlation Coefficient (r) between population and waste generated in the municipality revealed a high and a strong association of 0.88 which confirms the distribution of communal skips by the municipal assembly with concentration in high population urban zones within the Bolgatanga town.

Keywords: solid waste, storage receptacles, municipality, household, sanitary site

1. Introduction

Human endeavours at various level and forms are interactions with the natural environment which results in changes that affect the natural equilibrium. One of such endeavours is the daily activities of humans in order to obtain their basic needs and nutritional requirements to sustain a healthy life which generate a lot of unwanted materials. These unwanted materials loosely referred to as waste are by-products of the processes of exploiting the natural resources of the earth and converting them into finished goods. The left-over that results from consumption at the individual, household and community levels are classified as solid and liquid waste. Solid wastes are the by-products of human activities which include the processes of preparation, manufacture, packing, repacking, unpacking, construction and renovation of structures. Solid wastes fall under the following classes: domestic wastes, industrial wastes, street wastes, commercial wastes and hospital wastes (Otchere et. al., 2014).

They are materials that have no further apparent use for the owner or industrial process because they are deemed to be useless, unwanted or discarded but are not liquid or gas (Notaro, 2000; Miller, 1999)

Due to the rapid increase in population, migration from rural areas to urban areas and the expansion in industries, much pressure has been placed on solid waste management and the task of solid waste management has become challenging for Municipal Administrators in most developing countries. Volumes of solid waste in towns will run in millions of tons and would accumulate if no proper management schemes are put in place to collect them (Songsore & McGranahan, 1993). Assessing the benefits and costs of various solid waste management policies and projects is complex because it involves numerous, interconnected, economic, social, and biological components. The barriers to effective Municipal Solid Waste (MSW) management is not simply lack of policy but lack of infrastructure, education, social awareness of problems and solutions, and lack of institutions promoting sustainable actions (Barret & Sue, 2001).

Urban solid waste and sanitation management is a matter of grave concern to most Metropolitan, Municipal and District Assemblies in Ghana. The challenge in waste management emanates from the various levels of handling waste from the individual, household and community levels (Puopiel, 2010; Otchere et al., 2014; Puopiel & Owusu-Ansah, 2014). Among the plethora of reasons that are attributable to this menace are passive attitude towards waste disposal, low level of enforcement of bye-laws, lack of financial resources and the absence of the technical capacity to manage waste (Mariwah, 2012; Asamaa, 2007).

In Ghana, the two major cities of Accra and Kumasi with a population of more than 1,000,000 have an estimated Municipal Solid Waste (MSW) generation rate of (kg/capita/day) 0.40 (2003) for Accra and 0.60 (2009) for Accra and Kumasi, respectively (World Bank, 2013). This does not contrast sharply from the national average generation rate of 0.45 (GIM, 2009) which translates into an estimated total MSW generated (kg/day) of about 10,800,000 for the country which gives a total waste generated (tons/day) of 10,800.

The shortfall in the unaccounted waste represents solid waste which does not end up at landfill sites and clogs communities as heaps burnt day and night. The other component that is accounted for also represents the challenge of efficient transportation and disposal with almost no-existent well engineered disposal site (World Bank, 2013). Buttressing the above point is the fact that, as low as 15% of total waste generated in the municipality is collected for disposal, of which 4.5% is solid waste collected from households (Ghana Statistical Service, 2000). This raises an alarm as to what happens to the large volumes of unrecovered solid waste and how it is handled at the household level. This problem necessitates a study for immediate solution.

Poor waste management particularly with regards to waste disposal creates serious issues of environmental contamination of water and soil, air pollution from waste burning, sanitation and hygiene challenges which go a long way to pose serious environmental health risk and aesthetic burdens (Attipoe, 1996). There are no proper solid domestic waste management practices in some urban areas in Ghana and Bolgatanga municipality is no exception. People deliberately ignore dump sites dotted in the communities and throw solid waste into the open spaces and gutters. Some people regrettably defecate into polyethylene bags and leave them as litter in the environment. Flies are attracted to them and may spread pathogens. Health and social side effects are equally as important as environmental impacts when considering Municipal Solid Waste Management (Gladding, 2002).

The prime objective of this study is to assess the challenges with the management of solid waste at the household and municipal level, within the Bolgatanga municipality in the Upper East region of Ghana. The specific objectives are; a) to review the methods used to collect, transport and dispose of domestic solid waste b) to identify the factors contributing to improper domestic solid waste management c) to ascertain public perception on the consequences of improper domestic solid waste management and d) to determine trends and relationship between population and domestic solid waste generation.

2. Methods

2.1 Study Area

Bolgatanga Municipality is located centrally within the Upper East Region (Figure 1), and Bolgatanga the capital of the municipality is also the Regional capital. The location of the municipality and its capital in the centre of other adjoining district makes it the hub of the road transportation network in the region. The municipality is bordered to the North by the Bongo District, South and East by Talensi and Nabdam District and Kassena-Nankana District(s) to the West. The Bolgatanga Municipality was established by Legislative Instrument (LI 1797) in the year 2004. Before this period the Talensi-Nabdam district was part of the then Bolgatanga District.

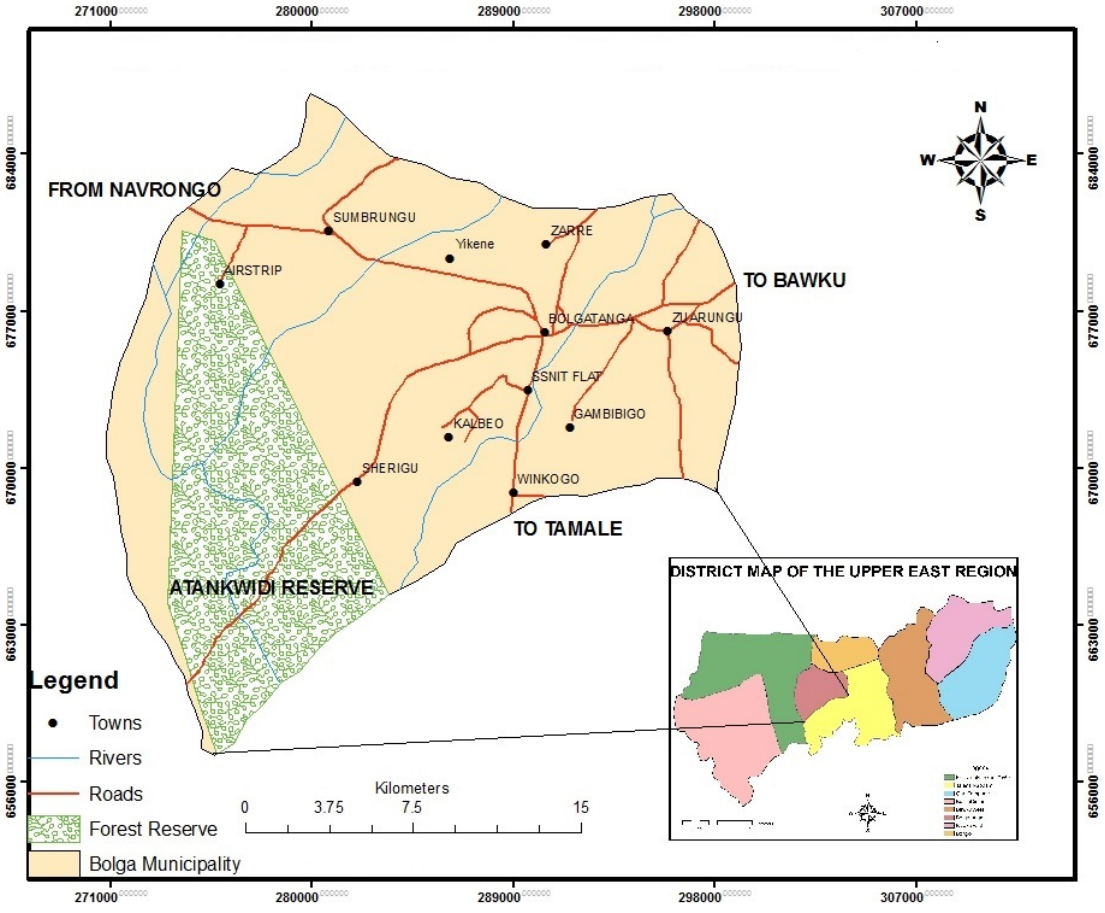

Figure 1. Map of the Upper East region showing the location of the study area

The municipality has a population of about 228,815 with a sex ratio of 48.7 male to 51.3 females and a population density of about 155 persons per km^2 over a land area of 1479 km^2. The Frafra's constitute the majority group of about 83.8% and the remainder being the other migrant tribes. There are 39,655 households, 20,416 houses with an average household size of 5.8 and household per house of 1.9. The municipality receives about 37% of the regions share of both migrants within and outside the region (Ghana Statistical Service, 2000). Agriculture and animal husbandry are the main economic activity and it engages about 80% of the population. The main agricultural produce are cereals like millet, guinea-corn, maize, groundnut, beans, sorghum and vegetables like tomatoes, and onions. Other prominent economic activities in the municipality include craft works such as basket weaving and leather works.

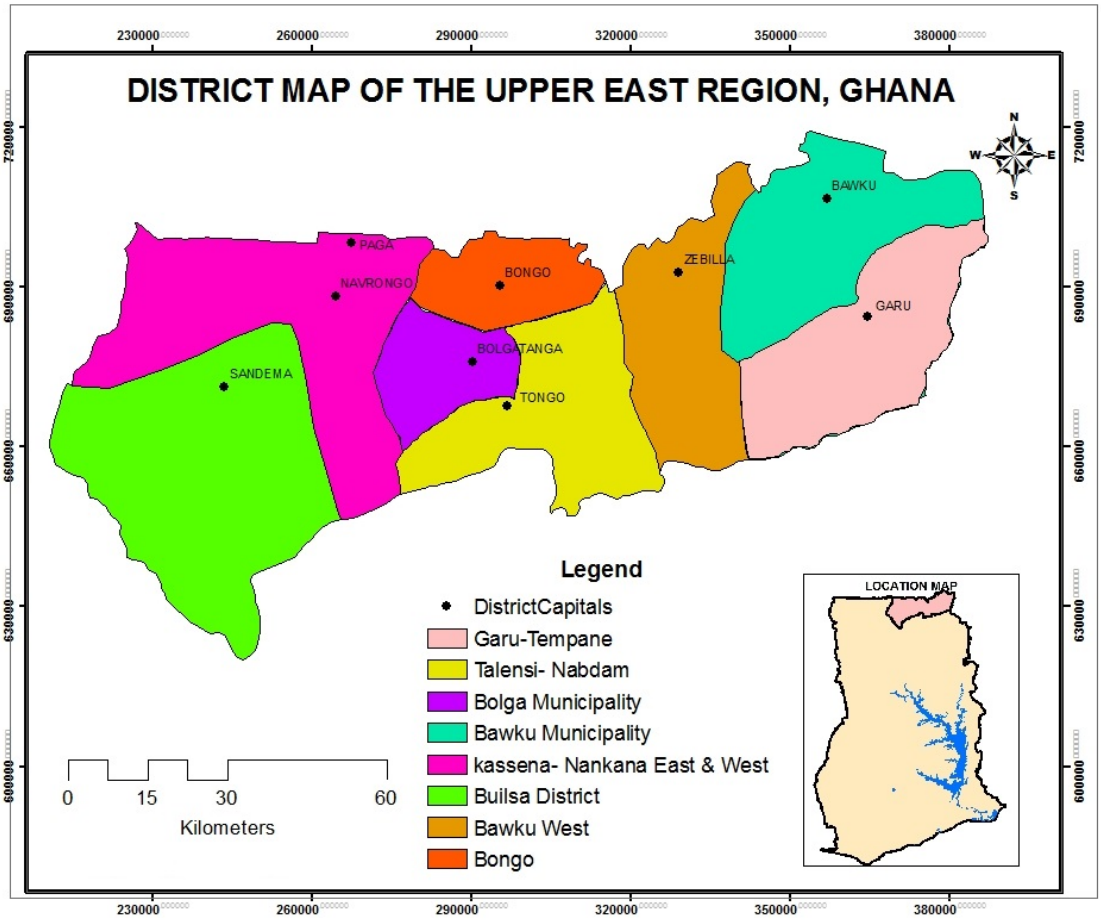

Figure 2. Map of the Ghana showing the the Upper East region

2.2 Data Sets and Characteristics

Data sets used for this research is shown in Table 1. These include population estimates and projections for dates between inter-censal periods, solid waste statistics from local government agencies and private sector actors, field study surveys for location of communal sanitary sites and household survey.

The population data for determining the population sizes of the municipality and subsequent projections were derived from the Population Census Report of Ghana by the Ghana Statistical Service (G.S.S.), for 1960, 1970, 1984 and 2000. However, projections were needed for this study, since actual collection of solid waste commenced in 1993 in the municipality. The following projected years have been considered as the basis for projection in the study (1993, 1997, 2001, 2005 and 2009).

The inter-censal growth rate (r) between 1984 and 2000 was estimated by using the model given by Cudjoe (2005a) as:

$$r = ln\ (P_2/P_1)^1/t * k \quad (1)$$

where;

P_1 is the Population of the initial census year

P_2 Population of the latter census year

t Time interval and

K is a constant

The population projection for the years 1993, 1997, 2001, 2005 and 2009 was estimated by using the equation given by Cudjoe (2005a) as:

$$P_x = P_y * e^{tr} \quad (2)$$

Where;

P_x is the projected population for the year X

P_y Census population for year y and

e^{tr} is the time interval as a factor of growth rate

The volume of solid waste in tons collected for disposal by the Environmental Health and Sanitation Unit of the Bolgatanga Municipal Assembly corresponding to the projected years shown in the parenthesis (1993, 1997, 2001, 2005 and 2009) have been used alongside the projected population in determining trends and relationships. Geographic coordinates of all sanitary sites in the municipality were taken using a Global Positioning System receiver (GPS) at an accuracy of ±10m. The raw data was processed into a map using ArcGIS 9.3® by ESRI©. The map was then superimposed on the municipal map to show the distribution of sanitary sites and also the location of the final disposal site at Sherigu.

Table 1. Data sets and characteristics

S/N	Data sets	Type of data	Years (s)	Application	Source
1	Population	Secondary	1993, 1997, 2001, 2005 & 2009	Trend and correlation analysis	GSS
2	Solid waste	Secondary	1993, 1997, 2001, 2005 & 2009	Trend and correlation analysis	EHSU & Zoomlion
3	Spatial data	Primary	May, 2011	Distribution of communal sanitary sites	Field survey
4	Household survey	Primary	May, 2011	Measure of perception and attitude	Field survey

2.3 Social Survey

A social survey was undertaken to understand waste management at the local level in terms of attitudes, resources available and challenges. This was done using a structured questionnaire with both closed and open-ends. The survey was undertaken among households heads in the five (5) main electoral and local council zones consisting of; Bolgatanga, Zuarungu, Sumburungu, Yikene and Tindonsobligo. The study variables included population, types of receptacles for waste, frequency of disposal, distance of refuse dump, availability of community storage receptacles, disposal methods and methods of waste transport, attitude and behaviour towards sanitation and land for dump site as the independent variables and methods of solid domestic waste management being the dependent variable.

2.4 Sampling

The sample size for the study was estimated by using the statistical formula for sample size determination by Puopiel (2010) which is given as follows:

$$n=N/[1+N(\alpha)^2] \quad (3)$$

where n is the sample size and N the sample frame and α represent the margin of error.

In this study using a margin of error of 0.01 with a 90% confidence level and sample frame of 14,138 households, hundred (100) households was estimated as the sample size for the socio-economic survey. Sample size selected using this statistical approach ensured minimisation of errors in the data collection (Puopiel, 2010). The estimated sample size was distributed among five selected communities. The selection of the five (5) communities in the district was done purposively because they represented the main suburbs (local councils) in the municipality whilst the selection of households for the survey was done randomly among the heads of households. The 100 households sample size was further broken down into a proportional representation of the communities based on their population estimates for the year of the research which provided a factor 0.0071(100/14,138 = 0.0071) per household in each community. Results from the socio-economic survey, based on the sampled population were generalized to give a fair representation of the municipality (Table 2).

Based on the number of sampling units in the communities (Table 2); sixty-one (61) households were selected from the Bolgatanga community, seventeen (17) households from the Zuarungu, thirteen (13) from the Sumburungu, five (5) from the Yikene community and four (4) from Tindonsobligo, by simple random probability sampling, based on a sample fraction.

Table 2. Data sets and characteristics

Communities	Population	Households	Sampling	Sample size
BOLGATANGA	49,162	8,520	8,520 x (0.0071)	61
ZUARUNGU	14,167	2,455	2,455 x (0.0071)	17
SUMBURUNGU	10,895	1,888	1,888 x (0.0071)	13
YIKENE	4,134	716	716 x (0.0071)	5
TINDONSOBLIGO	3,228	559	559 x (0.0071)	4
TOTAL	81,586	14,138	14,138 x(0.0071)	100

2.5 Data Analysis

Data acquired in the study was processed in a computerised system using the Statistical Package for the Social Sciences (SPSS) version 17. This provided a means of deriving useful inferences and summaries of the respondents to the questionnaires with regards to preferences of households, resources, attitudes and perceptions and aggregations representing community position. ArcGIS 9.3© by ESRI® was used for mapping of the location of sanitary sites to show the spatial distribution pattern and was also used to produce a map of the study area.

Statistical analysis of the data on waste and population was done using Microsoft® Excel 2007. This allowed for the determination of trend and pattern of population growth and waste generation within the Bolgatanga Municipality. Additionally, Pearson's Product-Moment correlation coefficient was used to measure the strength of association and whether the association is positive or negative.

3. Results and Discussion

3.1 Demographic Characteristics

Social characteristics of the respondents who were mostly household heads indicated a mixed of variation based on sex, education and religion. There was a 100% response rate, as all the respondents turned in their completed response with an average age of the respondents being 49.5 years. The minimum age was 22 years and the maximum 90 years. Eight percent (8%) of the respondents had no formal schooling at all and 10% had Primary education. Middle school Form 4 and Junior High School had the highest percentage of 37%.

Thirty-one percent (31%) went through Secondary/Vocational/Technical institutions with 14% having had tertiary education. Forty-eight percent (48%) were government employees, 35% had private employment and 17% were unemployed. Majority had average income (63%) and 37% had low income. None of them recorded receiving high income. Seventy-seven percent (77%) of the respondents were married and 17% were single. Four percent (4%) and 2% were divorced and separated, respectively.

3.2 Solid Waste Disposal Methods in Households

About 28% of the households practiced door-to-door collection method; this was recorded from almost all the communities except Tindonsobligo. Bigger containers for refuse are placed by certain selected houses and refuse from individual houses in the catchment area are sent into these containers. Paid staff (ZoomLion employees) transport and dispose of the waste at the refuse dump. Collection and transport by communal skip was recorded by 38% of households, this came mostly from respondents in Bolgatanga, where individual household wastes are carried directly to larger community storage receptacles for onward transmission to the dump site by paid workers. About 17% respondents used the wheelbarrow to transport their waste to the dump site (Open dumps in the community), this method got admirers from all the communities. Additionally, 17% used other methods such as sending their waste to a nearby bush or the farm using head pans, this practise was recorded by most respondents from Tindonsobligo, Sumburungu and Zuarungu with very few from Bolgatanga and Yikene.

The factor identified for contributing to improper domestic solid waste management is the inadequacy of information on proper solid waste disposal. Other paramount factors as listed below were considered and analysed using Pearson's product-moment correlation coefficient (p). No significance was seen between income level and types of domestic waste disposal practices. The level of use of community waste storage receptacles was very low for all the other four communities but was marginally high in Bolgatanga, the administrative seat because of the predominant influence of Zoomlion Ghana Ltd a private sector actor which has a higher operation presence. It was observed that majority of the respondents lived closer (less than 100 metres) to the community disposal sites and they practiced proper dumping as against those that lived farther away (more than 250 metres). On the whole there was no Significance between distance to dump site and the type of dumping practiced by households, proper or otherwise ($p = 0.148$)

The main type of receptacle used by households was plastic bins without cover (37%). About 35% used plastic bins with covers mostly those provided by Zoomlion Ghana Ltd. and self acquired bins and 14% used others such as truncated open containers, boxes, buckets etc. Old baskets without lids had 9% and those with lids had 5%, respectively. Of all the factors that were considered as affecting waste disposal methods and efficiency, frequency of disposal was the least ranked.

A total of 36% of households had no use for waste generated, with Bolgatanga recording the highest of 29% (Figure 2). However, 26% of households had agricultural uses such as application of compost made from groundnuts and soya bean shells, animal waste (e.g. Cow dung) and ashes as either a natural fertilizer or soil conditioner; this was recorded highly in Zuarungu, Sumburungu and Tindonsobligo. Some households derived their fuel needs in terms of cooking, from stalks of millet, maize, and guinea corn; this represented 9% of total response. A similar 9% was recorded for revenue generated from the sale of empty bottles and other containers. Other uses including bottles for refrigeration of water, bigger containers for water storage was recorded by 20% of households.

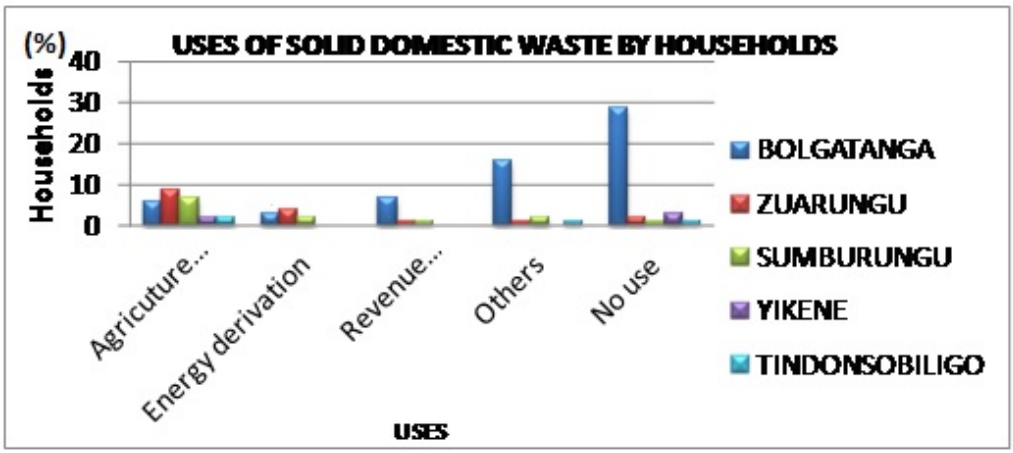

Figure 3. Uses of solid domestic waste

With regards to domestic solid waste disposal methods, twenty-four (24) households corresponding to 24% disposed off their refuse on their farmlands with 21% at the dump site. Some 33% and 22% dispose waste into

nearby bush and gutters, respectively. Seventy-three percent (73%) of the households recorded non-availability of land for dump site. The remaining 27% had land for dump site. Basically, the concerns of households on improper waste management were its effect on health and environment, irrespective of method of disposal in the community. In all, it was a mix expression of the two effects as respondents were not tied to a specific option. By ranking households views, health was the most important issue of concern followed by environmental concerns.

3.3 Population Increase and Waste Management

The incidence of population change was considered solely under growth rate excluding the effects of net migration. The period 1960-1970, and 1970-1984 and 1984-2000 experienced a national growth rate of a 2.9, 1.9, and 1.7%, respectively (Ampofo, 2008). These growth rates for the country for various periods have been the basis for making projections for population of the study area. The inter-censal growth rate for the municipality was calculated as 2.8%.

For the period under consideration there was a steady rise in the population of the study area, rising from a figure of 188,690 in the year 1993 to 295,333 in the year 2009 representing an increase of about 57% in a period of 16 years. Between the years 1993-1997, 1997-2001, 2001-2005 and 2005-2009 the population increased at a constant rate of 12% for each four year interval. Figure 3 shows the projected population for the study.

Table 3. Population, waste generated and per capita waste

Year	Population	Waste generated (tons)	Per Capita waste (tons/person/year)	Per capita waste (kg/person/year)
1993	188,690	46,015	0.24	0.67
1997	211,052	51,468	0.24	0.67
2001	236,064	50,764	0.22	0.59
2005	264,041	60,410	0.23	0.63
2009	295,333	101,823	0.34	0.94

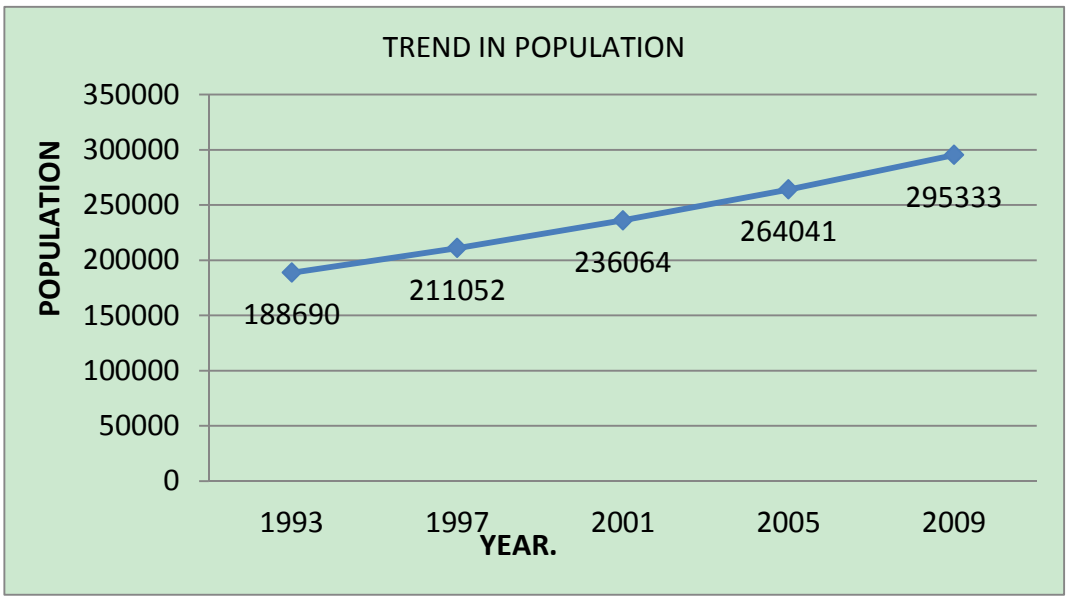

Figure 4. Trend in population 1993-2009

The collection of solid waste in the municipality commenced in 1993 (Source: Environmental Health and Sanitation Unit, Bolga Municipal Assembly (B.M.A), with the introduction of few communal skips dotted at strategic points. That year, the authorities recorded 46,015tons of waste collected. Four years afterwards between the years 1993-1997, the volume of waste collected increased appreciably to 51,468 tons representing 12%

increment (Figure 4). There was a dip in collection by 704 tons (1.37%) in 2001 attributable to increases in fees charged for disposal within residential areas as people resorted to burning of waste where possible. Figure 4 indicates that a remarkable volume of 101,823 tons was recorded in 2009 about twice the size of the value of 2001 representing 68.6% increase.

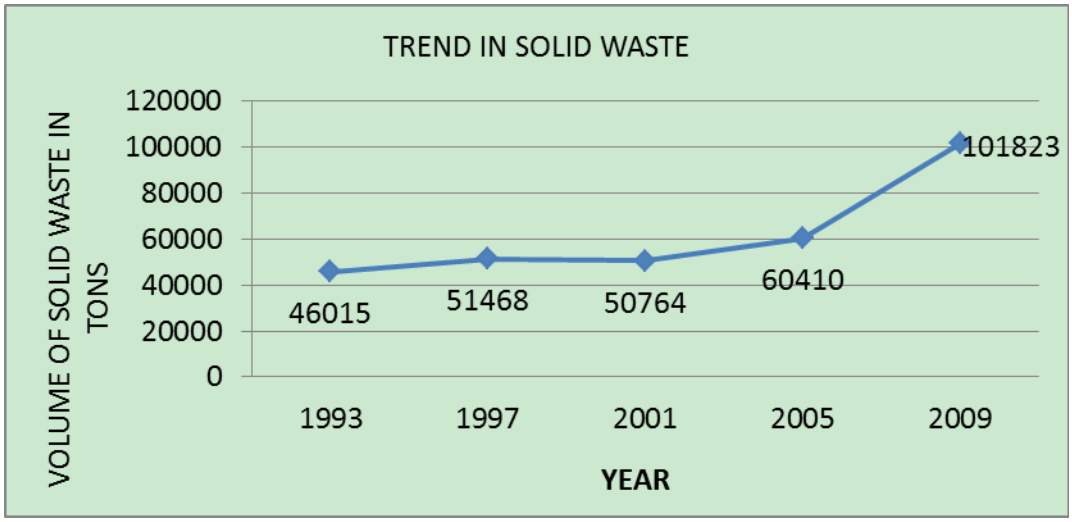

Figure 4. Trend in solid waste collection

3.4 Relationship between Population Increase and Solid Waste Generation

Figure 5 shows that there was a strong positive correlation between population and volume of solid waste collected. This was made clear by a Pearson's correlation (r) of value 0.889.

The derived regression model was used in making predictions by simply substituting any of the variables and this was applied as in Cudjoe (2006) in the following estimations for the study year 2011. Per capita waste generated per person in the municipality was estimated at 4.2 tons/person/year, but per capita waste per household was estimated from Ghana Statistical Service (2000) and Cudjoe (2006), by simple proportion to give 24.1tons/household/year. The total volume of solid waste collected was put at 7.5% out of 1,306,240 tons of waste generated, compared to the national average of 4.5% (Ghana Statistical Service, 2000). With a coefficient of determination of 0.792, suggesting much of the variation in volume of solid waste collected was associated with population, thus 79.2% of the variation in the volume of solid waste generated was accounted for by population.

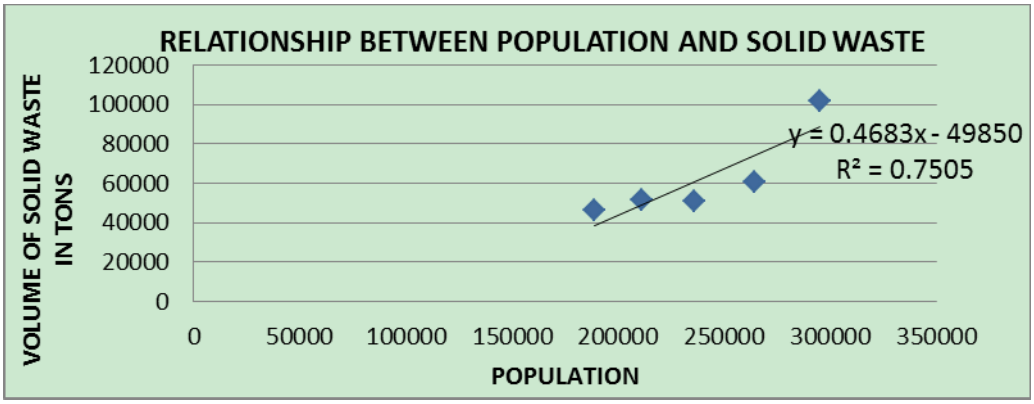

Figure 5. Correlation between population and solid waste collection

3.5 Distribution of Sanitary Sites

Sanitary sites are generally open spaces in communities which are used as dumping sites. They are sometimes provided with large metallic containers (communal skips) as receptacles for waste collection and transportation

periodically, while sometimes they are just open dumping areas (Figure 6). Sanitary sites are usually the sites where public toilets are located in communities where there are no toilet facilities in the houses. They are useful points in assessing the efficiency of waste management in the municipality as it indicates the frequency of waste disposal, level of waste disposal by households, rates of collection by municipal authorities. It is also useful in the determination of the efficiency of the management system in place as it relates to the number of sites available and the population of a community and waste generated.

Figure 6. Sanitary sites - An open dump and communal skip

Geographic coordinates of thirty-six (36) Communal skips and five (5) open dumps were taken from sixteen (16) suburbs within the Bolgatanga municipality, these represented a total of 41 sanitary sites. Out of the total number of skips, thirty-three (33) were located in Bolgatanga township, with two (2) in Soe and one (1) in Sumburungu. There is a final waste disposal site at Sherigu which is not a well engineered landfill site with no waste treatment facilities except an open-air incineration, where leaching occurs in the rainy season with its accompanying negative health impacts. This is located about 10.5 kilometres from the Central Business District of the Municipality.

Mapping of the location of these sites using ArcGIS 9.3® by ESRI© revealed a clustered distribution with most communal skips located in the Bolgatanga community and an insignificant proportion located in the other four (4) communities (Figure 7). The peri-urban communities such as, Yikene and Zuarungu had no skips at all.

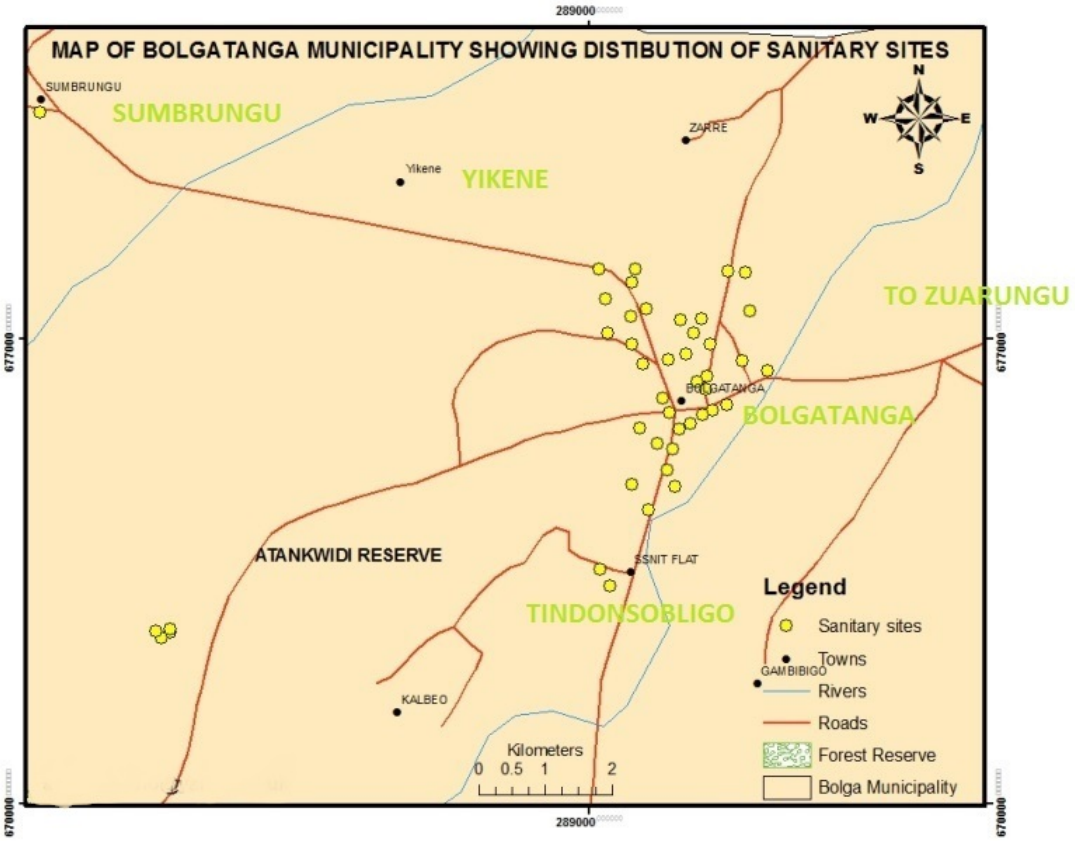

Figure 7. A point distribution of sanitary sites

3.6 Factors Contributing to Improper Domestic Solid Waste Management

About a third of the households in the study area collected and transported their waste by the door-to-door method, by paying a fee to a private waste contractor (ZoomLion Ghana Ltd) for final disposal. From the study, the door-to-door method comes next to the communal method of open dumping and according to local authorities; the method would soon be replaced through a waste commercialisation programme. The door-to-door method was practiced mostly in Bolgatanga and few areas in the remaining communities. Collection and transportation by wheelbarrow and others such as carrying waste on the head can lead to pollution in situations where the medium of carriage leaks. Also the two methods encourage indiscriminate dumping as people turn to evaluate distance of travel and weight of the load.

A remarkable number of the respondents had average and low incomes. The number of unemployed household heads contributed significantly to the low income bracket. The insignificant difference between income level and the type of domestic solid waste management practiced was attributed to lack of regulatory policies and programmes on proper waste disposal. Thus the rich and the poor alike turn to practice improper waste disposal which is less costly. Satterthwaite (1998) asserted that, the waste problem emanates from poverty and lack of funding as a result of low level of economic growth. Though financial constraints undoubtedly is a factor that contributes to improper waste management, this study contradicts the above assertion with reference to the situation at the household level as without the implementation of the necessary enforcement policies funding of waste management programmes will still fail.

Significant proportion of households had inadequate proper storage receptacles. This attracted flies and also served as breeding place for many insects and vermin which transmit diseases. The stench emanating from these open receptacles become a nuisance to people. A study conducted by Benneh et al. (1993) showed that the problem of solid waste in Accra begins at the home where open storage of solid waste was practiced by about 42% of households in Accra as against 44% in this study.

The observed 65% of the households who have no community storage receptacles were in low population zones because, as shown in the correlation analysis earlier (Figure 5), waste collection was highly related to population size of an area. Thus Bolgatanga with the highest population received the highest number of communal skips than any other community. Within Bolgatanga, some areas do not have the facility, due to the same factor stated above and these contributed to the number of communities without storage receptacles. The presence or otherwise of community storage receptacles influence the kind of domestic solid waste management practiced.

Gourlay (1992) stated that, " Environmentalists should not only join scientists and other responsible sectors of industry and agriculture to find better ways for disposing of wastes, but to locate convenient places for their disposal. Fasida (1996) stressed that the paramount consideration in the management decisions involving waste disposal is site location. To eliminate the problem involved in indiscriminate disposal of waste, sites located for waste disposal must be paramount. The results therefore suggest that distance is dependent on one method of disposal in the community and partly on convenience.

Data on the schedule of waste collection by the Environmental Health and Sanitation Unit of the municipal assembly suggests that waste is collected and disposed once or twice a week for communal skips and thrice for door-to-door services. This was not the case on the ground as many of the households (65%) answered other times ranging from several weeks to months. The situation compels residence and sometimes human scavengers to burn the over flowing waste *in-situ* generating smoke and making such places uncomfortable to live. This phenomenon is attested by Evan (1994), thus "Garbage is often burned in residential areas and in landfills to reduce volume and uncover metals". Burning creates thick smoke that contains carbon monoxide, soot and nitrogen oxides, all of which are hazardous to human health and degrade urban air quality.

All the communities except Bolgatanga and Yikene, had majority of use for waste. The reasons being that these areas were less urbanised and had a lot of farmers who depend mostly on their farm produce to make a living. They therefore turn to maximize profit from materials that they obtained ranging from; increasing yield, obtaining cooking fuel (energy) and making cash from waste. This affirms Tetteh (1997) point of view that waste is becoming wealth, refuse is becoming resource and trash is turning into cash. The situation in Bolgatanga was different as waste management is been compounded by a diverse urban population with a high level of consumption and disposal lifestyles. These urban populations have very little value for packaging materials after consumption since the same could be acquired at no significant cost. Yikene is a fast developing area because of numerous construction projects by the affluent in society who mostly have little use for waste.

Fifty-five percent (55%) of the households practiced improper disposal by way of disposing waste into nearby bushes and gutters. The waste becomes exposed when the vegetation cover is ripped off in the dry season causing mass littering and during the rainy season those in gutters are compounded by eroded ones contributing significantly to non-point source of water pollution. Disposal on farm lands is seen beneficial for the improvement of soil if waste is of organic constituent. Dumping at site (communal skips) can be classified as proper waste management method. The problem perceived with the latter was that its practice was quite dependent on distance, as one can switch to improper disposal (nearby bush and gutters) on the grounds of distance. Specifically, the percentage of respondents who practiced disposal at dump sites was twenty-one (21).

A greater percentage of households mentioned non-availability of land for dump sites (73%), the reason being that such areas are rendered unusable and also there are no compensations. Kendie (1999) agrees in principle that, the recent upsurge in waste disposal problems stems from the fact that attitude and perceptions towards wastes and the rating of waste disposal issues in people's minds and in the scheme of official development plans have not been adequately considered. Without doubt, this situation would promote indiscriminate or crude dumping with its attendant negative public health effects. Fasida (1996) also emphasized that the paramount consideration in the management decisions involving waste disposal is site location.

Most households expressed concern on breeding of disease vectors such as mosquitoes, houseflies, cockroaches and rodents. As a consequence of improper solid waste management in the Bolgatanga Municipality, the inhabitants suffer from poor environmental sanitation related diseases such as malaria, diarrhoea, cholera, typhoid fever, worm infestation and others (Municipal Health Directorate Annual Report, 2007).

3.7 Trend Analysis and Correlation between Population and Domestic Solid Waste

The incremental change in population of 12% over the period of consideration depicted that not only the new births but also the interplay of the push and pull factors of urbanisation. A pull factor such as the prevailing peace in the municipality attracted migrants from conflict prone areas such as Bawku, traders from other adjoining districts and various workers posted to the municipality which also serves as the regional capital. However, due to the one season of farming, a significant number of persons mostly farmers and the unemployed

leave the area for southern Ghana in search of other sources of livelihood especially at the off-farming season and come back during the rains and this creates a cycle.

The undulating trend in the pattern of solid waste from 1993 to 2001 (Figure 4) was attributed to initial operational constraints on the part of the assembly**,** stemming from factors such as lack of logistics (communal skips and trucks) and the habit of open dumping which was on the rise. This resulted in the meagre volume of waste collected in 1993. The drop in waste collection in 2001 was attributed to infrequent collection as a result of mechanical break downs of Skip trucks.

The remarkable volumes retrieved in 2009 (see Figure 4), were the total recorded volume of solid waste by ZoomLion Ghana Limited and the Assembly. It was recorded two years after the former had started operation in the municipality. This agrees with Tsiboe (2004) view on privatization of waste handling in Accra which is seen as a way to make waste management efficient, cheap, dynamic and free from political interference.

The strong positive correlation (Figure 5) denotes that, as population increased much volume of waste was collected accordingly. However, it was realized that the percentage increase in solid waste collected was 3.0% (i.e. from 4.5% in 2000 to 7.5% in 2011) out of a total volume of 1,306,240 tons generated, denoting under performance by the authorities.

3.8 Spatial Distribution of Sanitary Sites

Figure 7 shows that the distribution of sanitary sites that have communal skips was uneven, and it was partly attributed to differences in usage of domestic solid waste and population. With as many as thirty-three (33) skip sites all concentrated in the Bolgatanga township out of a total number of thirty-six (36) skip sites, this accounts for the level of improper disposal methods practiced in the remaining communities. Communal skips are served by four skip trucks with two each from the Municipal authority and ZOOMLION Ghana Limited. The long distance of 10.5km, suggested the amount of fuel consumed in the final disposal of waste, is a drain on municipal revenue. According to World Bank Report (2013) and Habitat news (1991), waste disposal may absorb 1% of the Gross National Product (GNP) of a country, 20% to 40% of municipal budget of cities in the developing world. It is worth emphasizing that the location of skips near public places of convenience was appalling as it compounded the risk of disease outbreak, as some people turn to defecate around for their inability to pay toilet tolls.

4. Conclusion and Recommendations

The study revealed that the communal method of disposal is the most predominant method of solid waste management system in the municipality but the system is gradually paving way for the door-to-door service which runs second in the municipality. Despite the dominant nature of communal skips and door-to-door services mostly in the Bolgatanga community, inhabitants still practice improper disposal from nearby bush to open dumps due to lack of enforcement of regulatory policies and programmes irrespective of income levels.

The problem was compounded by inadequate proper storage receptacles, unavailability of community storage receptacles and long distance discourages dumping at site. Issues of none re-use of waste in most households contributes significantly to massive waste generation of which less is collected by authorities. Lastly, the non-availability of land properly selected and demarcated for use as dump site resulted in all manner of improper disposal in various communities.

The study discovered that much of the information on proper waste management does not emanate from the Environmental Health and Sanitation Unit of the Municipal Authority, but rather through schools, electronic media and parents. As a result people held different perceptions on consequences of improper waste management. The widest notion held was that on health and environment which the communities associated with the incidence of diseases such as malaria, typhoid, cholera and environmental impacts ranging from air, water to land pollution.

Clearly, it is not only issues of population increase that constrains proper waste management but also the lack of logistics and societal attitude. This contributed significantly to the low collection of 7.5%. The unevenness in the distribution of communal skips in the municipality was as a result of differences in population and different level of usage of domestic solid waste in a given area.

Community by community, it can be said that the peri-urban areas such as Tindonsobiligo, Zuarungu and Sumburungu turn to have much use for waste thereby cutting down on their waste output and thus improving on general waste management. Introduction of a few communal skips could help make this even better. In Bolgatanga, much of the waste generated has not been utilised and ends up in the environment. It was not strange to have much skips in this area in ensuring proper waste management. Yikene which is in a transitional phase in

urbanisation was gradually turning out much waste, but this could be remedied by providing door-to-door service. In summary re-use of domestic solid waste is a better means of managing waste at the household level.

Notwithstanding the challenges with waste management at the household and community level and its impact for the entire municipality, solutions to these problems are very real and achievable. To this end we make the following recommendations;

- The development of a properly engineered landfill site at a suitable location as the current location encourages indiscriminate waste disposal as a result of distance and cost.
- The allocation of skips should be based on the population of a locality and not the size of an area as the research proves a strong positive correlation between waste generated and population particularly within the Bolgatanga township.
- Lastly, waste segregation would encourage reuse and facilitate recycling and more importantly reduce the volume of waste that is transported to final disposal site.

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