Assessment of Waste Management Practices and Sanitation Services at the District Level - A Case Study in the Prestea-Huni Valley Mining Communities of Ghana*

[1]E. A. A. Kwesi, [1]M. S. Aduah, [2]G. Piedu and [1]C. Assencher
[1]University of Mines and Technology, Tarkwa, Ghana
[2] Norweigian University of Science and Technology, Norway

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Abstract

One of the major waste management and sanitation challenges facing developing countries is achieving the universal goals of replacing unacceptable disposal practices (such as open dumping and burning at unsafe sites) with internationally acceptable methods (such as engineered landfilling and recycling) and climbing up on the waste management ladder for improvement. A number of intervention efforts towards achieving this have not yielded the needed results at the local levels and these have been attributed to sustainability problems regarding funding, technological and political support. However, prevailing local conditions can have significant influence on success or otherwise of intervention efforts and methods. There is therefore the need to periodically assess prevailing local conditions against intervention efforts and methods to ascertain modifications that may be necessary to help achieve intended objectives. This paper discusses the methods and results of an example of such assessment and the lessons that can be learnt from it, using a case study approach at the mining areas of Prestea-Hinivalley Municipality of Ghana. Field surveying and mapping, interviews, and documentary analysis were employed to gather relevant data for the study. The data was processed and analysed using GIS, statistics and graphs to provide sanitation maps and other useful information on the distribution of dumping sites, waste collection and disposal, environmental sanitation conditions and services, and how these influence interventions efforts in the area. Difficulties in land acquisition and tenure security, uneven distribution of waste disposal facilities and services, unreliable support from city authorities, local opposition towards landfill siting and crude disposal practices are among the major factors influencing waste management efforts in the area. The paper recommends that the effects such local factors on intervention efforts should be assessed to ascertain necessary modifications prior to or during their implementation, using spatial-based methods as demonstrated in this study.

Keywords: Waste Disposal; Sanitation, Survey and Mapping, Local Factors, Prestea-Hunivalley

1 Introduction

Waste management problems in Ghana, and in particular at the municipal levels, continue to be alarming despite intervention measures put in place to deal with the situation. It is common to come across open dumpsites and piles of domestic waste, discarded electrical appliances, polythene bags, old and broken oil and gas containers, abandoned tyres and metallic scraps, rubbles from demolished or collapsed structures, etc., in most of the towns and cities. Most of these dumpsites are at unsafe locations (close to food selling points, playing grounds, near surface water courses, roads, undeveloped plots, etc.) with negative consequences to the environment, human health and socio-economic development.

The Municipal Assembly and waste management contractors have fallen short of their duty to collect and dispose off all waste generated in the cities and towns due largely to the overwhelming increases in the volumes of waste as compared to the existing facilities. At the national level, the Metropolitan, Municipal and District Assemblies (MMDAs) collect just about 40% of the total refuse generated daily, leaving huge backlog of refuse to pile up within the communities (Anon, 2010; Anomanyo, 2004). The situation is even worse at the mining centres like Tarkwa and Prestea where waste collection is less than 20% (Kwesi *et al.*, 2018). Other major challenges to waste management in the municipalities are lack of funds, suitable equipment for waste collection and handling, and qualified personnel (Anon., 2010). A number of national and local targets set forth in the early 2000s to be achieved within a decade have not yet materialized despite huge resources committed to that (Kwesi *et al.*, 2018; Anon., 2010; Anon., 2008). These targets include increasing waste collection beyond 75%, ensuring fair and even distribution of waste management services, phasing out unsafe waste disposal sites and practices, and replacing them with engineered landfill and other improved disposal sites and facilities by 2020.

In the light of the foregoing needs, a research was undertaken to explore and demonstrate the application of Geospatial Information Technology (GIT) as useful tools in analyzing and evaluating the prevailing waste management situation against some of the targets set, and assessing local factors that

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may contribute to the failures or successes achieved. A case study approach was adopted, using the mining communities of the Prestea-Hunivalley Municipality (PHMA) of Ghana as the study area. GIT is being used extensively in many countries to perform necessary geospatial analyses required in solving complex waste management problems (Malczewski and Rinner, 2015; Demesouka, *et al*, 2013; Kwesi and Asabere, 2010; Wang, *et al.*, 2009; Tinmaz and Demir, 2005). The present paper discusses aspects of the research that deal with the use of sanitation maps and graphs to assess the locations and distributions of waste disposal sites, practices and services in the study area against some of the national targets set for 2010 to 2015. Efforts by the municipal authorities in dealing with the waste management problems and challenges faced in the study area are also discussed.

1.1 Geographical and Economic Setting of Study Area

The study area is the mining areas of the Prestea-Hunivalley Municipality of Ghana with Bogoso as the administrative capital. It is located in the Western Region of Ghana between latitudes 5° 15′ N and 5° 40′ N and longitudes 1° 45′ W and 2° 15′ W (Fig. 2). It has an area of about 1200 km^2 and a population of about 159, 300 (Kwesi, *et al*, 2018; Anon., 2014). The area is an important mining centre that attracts many people from other parts of the country, Africa and the world. Some of the big mining operations in Ghana are located in the area. (Kusi-Ampofo and Boachie-Yiadom, 2012; Kuma and Ewusi, 2010; Anon., 2009). The economy of the area thus revolves around mining and its allied services. It is also an important commercial and transit centre linking the western and coastal towns to other parts of Ghana, and travelers from Cote dIvoire to Burkina Faso (Kwesi, *et al.*, 2014). These factors draw many people to the city daily to look for jobs and do business. Some of these people settle, giving rise to rapid urbanisation with a high population growth rate of about 3.0%. One direct social impact of this is the huge volumes of waste generation that is beyond the resources and capabilities of the Municipal Assembly to handle effectively (Kwesi, *et al.*, 2014; Anon., 2014).

1.2 Topography and Geology of Study Area

As part of the Tarkwa mining areas, the topography of the study area is generally undulating with some scarps ranging from 150 - 300 meters above sea level with small scale mining operations frequently taking place along the ridges and valleys (Kwesi *et al.*, 2018; Mantey, 2014; Anon., 2009, Asante, 2011; Adjei *et al*., 2012; Kusi-Ampofo and Boachie-Yiadom, 2012). Geologically, the area forms part of the Birimian and Tarkwain formations. Aquifers in the area are considered possessing dual and variable porosity and limited storage capabilities (Kuma and Ewusi, 2009; Asklund and Eldvall, 2005).

1.3 Waste Management at Study Area

The Municipal Assembly that has the mandate to manage the waste (collect, transport and dispose of waste from the city to safe final disposal sites) and the few private contractors that have been engaged for that, have not been able to carry out the task satisfactorily (Kwesi, *et al.*, 2014; Anon., 2014). This is largely due to lack of funds, logistics and other resources. Improper or unscientific planning and allocation of the scarce resources (e.g. distribution of waste collection containers and scheduling of collection vehicles) are additional factors. The Assembly collects only about 40% of the total waste generated daily, leaving about 60% to pile up in the communities (Kwesi, *et al.*, 2014; Anon., 2014). This is also limited to few areas, usually along the commercial or ceremonial streets and the communities of the elite few. There are no sanitation maps that show the locations of waste dumps within the communities and this has left most of the waste dumps unattended to. While some communities have two or more waste containers and enjoy waste collection services from the assembly, others have none.

2 Resources and Methods Used

The materials used for this work consist of survey and waste management data sets and equipment. The field equipment includes Garmin eTrex hand-held GPS receivers (3-8 m positional accuracy), measuring tapes, field books and digital cameras (sony cyber shot (8.1)). Software used were Microsoft Excel, Photoshop CS4, ArcGIS and Microsoft Word. The data used includes the coordinates of the waste dumps, town layout plans, topographic maps, photographs of the waste dumps and information from interviews and observations about waste management in the study area.

The methods used include review and analysis of relevant literature and policy document, visits and examination of available records at relevant waste management offices; interviews and discussions with officials, land developers and residents near waste dump sites and other stakeholders, as well as field visits and observations at waste disposal sites. Comparative evaluations were also made between the observed data (existing situation) and the waste management targets set for the decade.

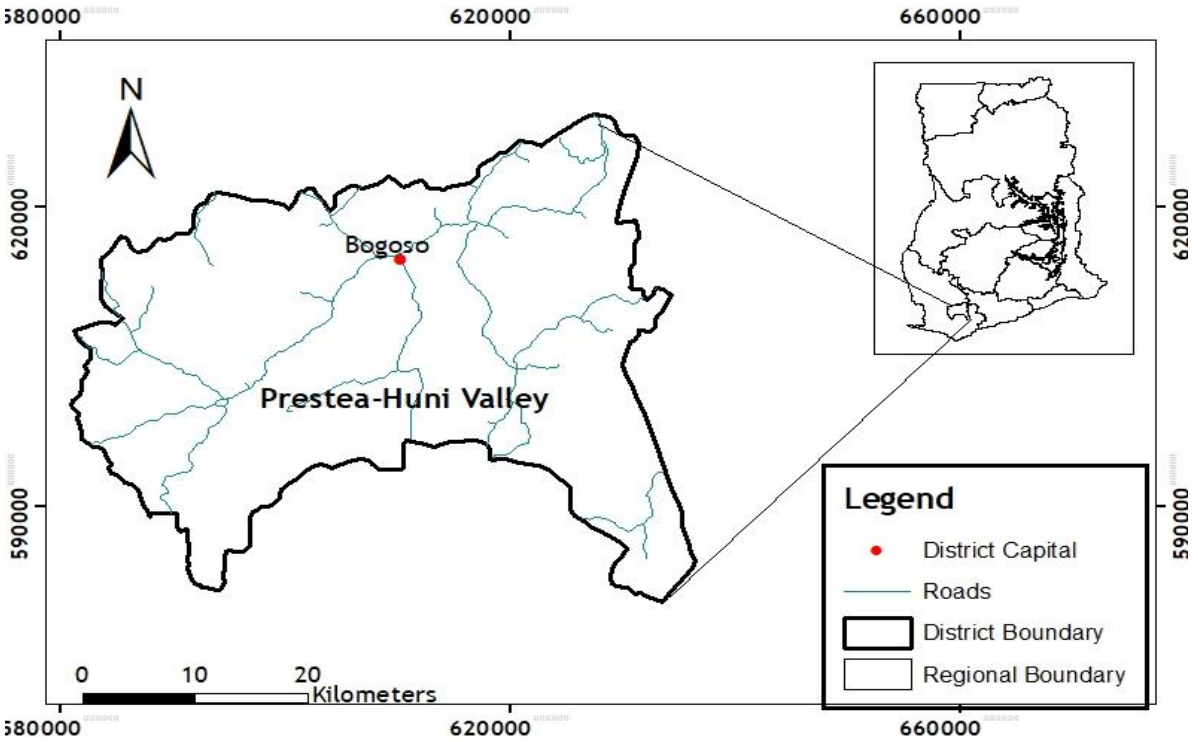

Fig.1 Map Showing Location of Study Area (Prestrea-Hunivalley Municipality of Ghana)

2.1 Data Collection

The data collection was planned and organised around three phases, based on the main objectives of the project (i.e. producing sanitation maps for analysing the distribution of waste disposal sites, their management and environmental sanitation impacts), and the requirements of the spatial tools employed for the collection, processing and analysis. Details of the data collection and processing methods are explained under these three phases namely the point data, attribute data and base-map data.

2.1.1 Point Data

The point data comprises the coordinates of waste disposal sites, survey control points and points of topographic interest for easy identification of the geographical region of the waste dumps and for topographical features picked during cross-validation of the secondly and primary data collected. This data were measured with a Garmin handheld GPS receiver. The coordinates of the control points were necessary for assessing and controlling the accuracy of the instrument, survey work and for transformation between the GPS and the local (Ghana) coordinate systems. The the field survey include road intersections and roundabout, soccer fields and railway lines that were visible on the base maps and on the ground. Table 1 shows a sample of the point data collected along with some site attributes.

2.1.2 Attribute Data

The attribute data collected during the survey include photographs of the dumping sites to capture the state of sanitation and waste management at the site and its impacts on the surrounding environment. The photos were taken with the help of digital cameras. Interviews and discussions were also conducted with the residents, landlords and community leaders living around or close to the waste dumps to get their views on the history, ownership and waste management at the sites and how they were being affected by the situation. Among the attributes of interest were proximity of sites to sensitive environmental features, road accessibility and nature of waste disposal and sanitation conditions at the sites. Fig. 2 shows examples of the attributes observed during the survey.

Table 1 Sample of the Point and Attribute Data on Waste Dump Sites

Location/ Area	Coordinates (UTM)		Remarks/Attributes
	Eastern (m)	Northern (m)	
Prestea, Tuobodom	595095	600355	Large waste dump; road accessible, no collection containers; within town, low maintenance and sanitation conditions, close to houses
Bogoso, Hassankrom	610160	615466	road Accessible, no collection containers; within town, poor maintenance and sanitation conditions, very close to residential houses
Aboso, Compound-Kesse	616557	592947	Community Waste dump with Container services but stays overfilled for weeks; low maintenance and sanitation conditions
Damang, Market Area	625951	609379	road Accessible, no collection containers; near main market within town, fair maintenance and sanitation conditions
Huni-Valley, Bosomtwe Jhs	620559	604169	road Accessible, no collection containers; near to school, low maintenance and sanitation conditions
Bogoso Junction	613195	589516	Survey Control Point and Road Junction for location identification

Fig. 2 Examples of Waste Dump Sites Situation in Study Area

2.1.3 Base Maps

The base maps used include topographical maps (in feet and 1:10000) and town development plans or schemes (in meters and 1: 1250). These were in analogue forms at different scales and units but contained the necessary base information for the preparation of the needed thematic maps about

waste dump sites. Conversion into digital formats and coordinate transformation were thus required.

2.2 Data Processing

The data collected were processed using Microsoft Office Suite and ArcGIS. The field data were organized and classified into suitable groups (based maps, point data, images/photos, spatial and non-spatial attributes) for the construction of a spatial database and needed analysis in a GIS. The aspects of data collected in soft copy were transformed into appropriate formats and captured into ArcGIS environment. The hard copy aspects, including the base maps used, were converted into digital forms and captured into the GIS environment via scanning, geo-referencing, digitizing and transformation into common coordinate systems (UTM and the Local National Grid in meters). The attributes about the waste management situations at the various disposal sites and the site photos were incorporated into the GIS database via linkages to the inbuilt attribute tables and image attachment tools in the ArcGIS software. The database was then used to prepare and generate the desired sanitation maps and spatial analysis. The comparative evaluations by tables and graphs were done with the help of Microsoft Office.

2.3 Data Analysis and Presentations

2.3.1 Distribution Maps and Analysis

The data on waste dumps were classified and analysed under the following groups for the distribution mapping and analysis purposes:

I. Approved verses Unapproved Dump Sites

The approved sites refer to the communal waste dumps and waste containers that were located at sites chosen or approved by the communities and or the municipal assembly. Unapproved Sites refer to waste dumps located at sites not chosen or approved by the communities or the municipal authorities for waste management.

II. Accessible verses Inaccessible Dump Sites

The accessible sites were those located near roads and thus can be accessed by waste collection vehicles, while the inaccessible ones are those located at sites difficult or impossible to reach by waste collection vehicles.

III. Collection verses No-Collection Dump Sites

The collection sites were those at which waste collection services to final disposal sites were provided on regular basis while those without these services were classified as no-collection sites.

IV. Public verses Private Waste Dumps

The public waste dumps refer to those that come or fall under the responsibility of the general public and the District Assembly to manage while the private ones are those created and controlled or owned by private individuals and bodies such as the mining and financial companies.

V. Managed verses Unmanaged Waste Dumps

The managed waste dumps consist of those having the attributes of waste being located at safe or approved sites; kept properly in waste containers; collected regularly to final disposal sites; surroundings properly kept to maintain good sanitation conditions; site accessible by road and well enclosed or fenced to reduce public eye-saw. Those missing three or more of these conditions were classified as not managed (properly). These include those located at environmentally unsafe locations and are usually left unattended to (such as in marches, valleys and in close proximity to dwellings).

VI. Data Symbolization and Presentation

The fifth classification of the waste dumps into *managed and unmanaged* groups were used for the symbolization and mapping purposes. The other classes were placed in the attribute tables for other site analysis other than for symbolisation and presentation on the maps.

2.3.2 Evaluation Analysis

Regarding the evaluative analysis, tables and graphs were used to present and compare the observed data against the set values or goals for the period of observation (2005-2015). In some cases the observations at the study area were compared with those at national level to assess the performance made. Factors observed as contributing to the performance were then highlighted and discussed. The factors used for the evaluation were mainly based on the international, national and local (municipal) waste management goals or targets set for the 2005-2015 (Anon., 2010; Anon., 2008; Anon., 2002). Among these factors were:

(a) Waste collection coverage in terms of extent (in percentage of households or population). This was to be increased to 50% and beyond by 2015.

(b) Even and fair distribution of waste management and sanitation services to both rich and poor areas in the community. This was to be improved significantly by 2015.

(c) Phasing out unsafe waste disposal sites and practices by 2015.

(d) Provision of engineered landfill and other improved disposal sites and facilities by 2020.

3 Results and Discussion

3.1 Sanitation Maps and Graphs Generation

Fig. 3a and Fig. 3b show examples of the sanitation maps generated for areas with and without layout schemes respectively. The map at Fig. 3a is in UTM and that at Fig. 3b is in Ghana meter Grid. These maps were produced at a scale comparable with those of the town layout plans used as a base map. The damp sites were modelled as point data and thus appear smaller than their real sizes at the scale indicated. They are therefore exaggerated but their true relative positions have been preserved. The symbology of the waste dumps reflect the two main categories of managed and unmanaged sites into which the data was grouped. The legends on the maps indicate the symbol for each category.

Fig. 4 and Fig. 5 are examples of the graphs generated for the comparative and evaluation analysis to add visual emphasis to the tabular information. Together with the maps, tables and field photographs, they provided greater consistencies and reliabilities on the observations and deduction made from the study.

3.2 Distribution of Dump Sites and Waste Management Services

From the maps, it could be noticed that most of the waste dumps were left unmanaged. The approved sites provided by the Assembly were not enough to serve some of the communities as shown by large portions of the maps having no proper dumping sites (Fig. 3). This shows that waste management objectives (a) and (b) above are far from realization. Another observation was that new communities had sprung up that did not have spaces for locating public waste collection containers or adequate access routes for waste collection vehicles. These were among the local factor hampering the municipal authorities efforts to improve conditions and achieving the targets set for 2005-2015 (evaluation factor (a), above). However, other waste dumps were located at safe sites that were accessible and were serving many people but had no management support from the municipal Assembly.

A number of the waste dumps were located at areas that were inappropriate for human and ecological health and safety, inaccessible by road for waste collection and difficult to control any negative impacts emanating from the waste (Fig. 2). This observation clearly indicates that the local authorities and the country as a whole are far from realizing goals (c) and (d) above regarding phasing out unsafe disposal sites and practices.
The various types of waste disposal sites and practices, their locations, proportions and distributions can be seen on or inferred from the sanitation maps and the associated attribute Tables and graphs (Fig. 3, Fig. 4, Fig. 5 and Table 1). These can be used to assess the waste management situation and draw the attention of the appropriate authorities for necessary remedial actions as demonstrated in this study.

3.3 Observations from Sites and Interviews

From the site observation and the interviews and discussions with residents, the main problems cited include:

(i) Unsightly scenes of the dumps, bad odors, flies, mosquitoes and other disease vectors, and leachates from the waste dumps into the environment. Some of the waste dumps were inaccessible by roads, making waste collection difficult or impossible at such sites. Open burning which pollutes the environment was thus the main management methods reported and observed. Such practices were observed at all the dump types maintained by the communities, individuals and the Municipal Assembly (Fig. 2). This again indicates how far goal (c) is from achievement.

(ii) Some communities complained of being ignored by the authorities in the provision of sanitations services and necessary remedial actions in their locations despite repeated request. Large waste dumps in some of the communities resulted from failure of the authorities to provide and enforce disposal facilities at appropriate locations or failure to provide regular waste collection and maintenance services at the sites (Fig. 2). Such perceived injustice and lack of support from the city authorities was found to contribute to ill cooperation towards the abolition of crude disposal practices in some of the communities. This also indicates that a lot still needs to be done in order to progress towards achieving goals (b) and (c) above.

(iii) The local municipal authorities (waste management and environmental Sanitation Departments, Town and Country Planning Department and Waste Management Contactors) cited rising population pressures, lack of funds, inadequate personnel and other resources for maintaining and expanding waste

management and sanitation facilities and services as major factors inhibiting efforts towards achieving targets set for the period. Lack of adequate cooperation from landlords, mining companies and some of the communities for land was also cited as one of the problems.

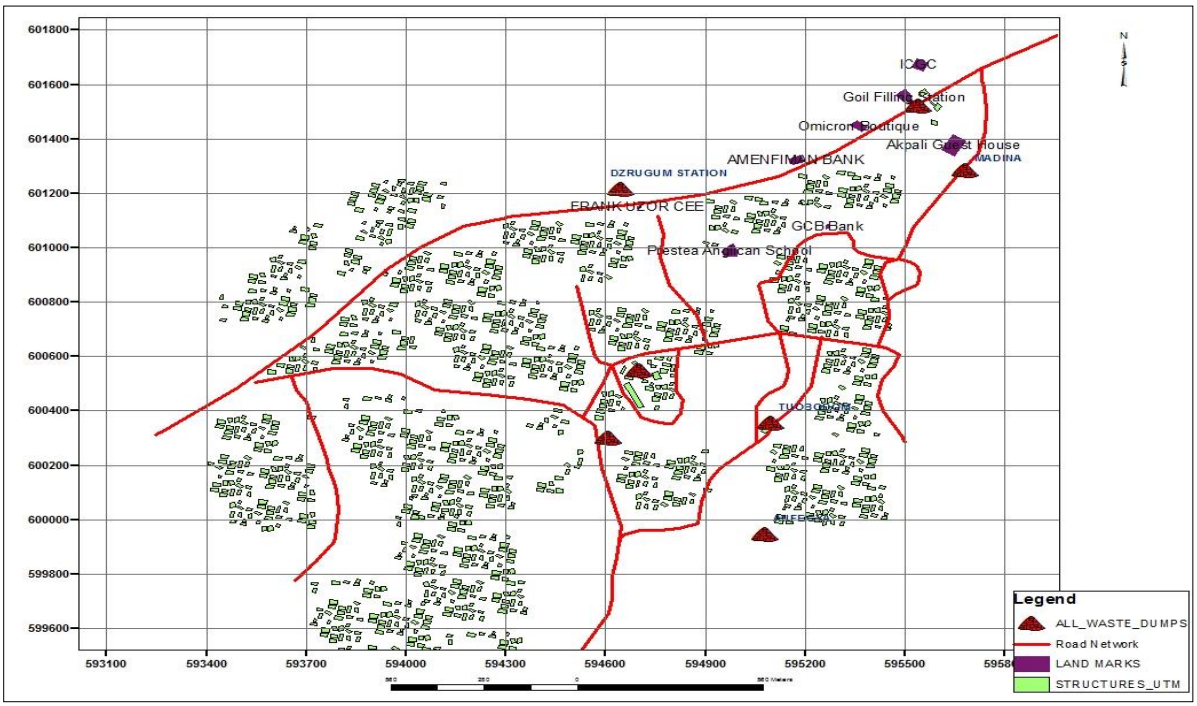

Fig. 3a Waste Dumps Distribution Maps in Areas with No Planning Schemes (in UTM)

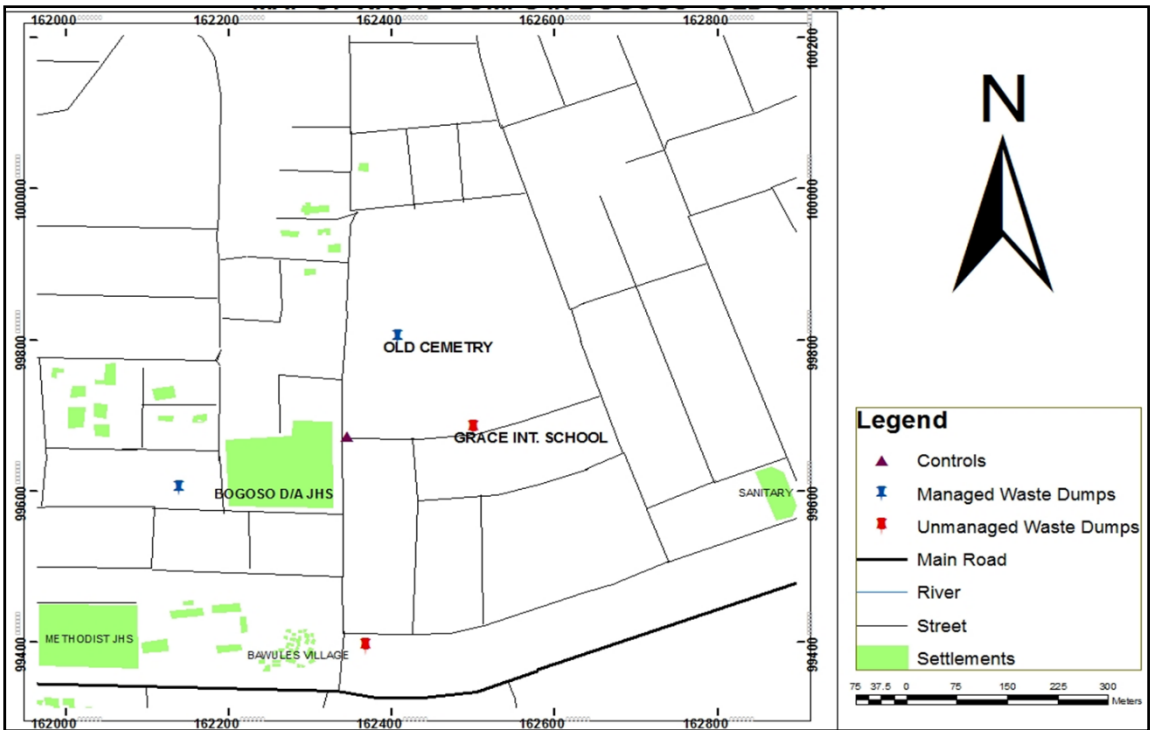

Fig. 3b Waste Dumps Distribution Maps in Areas with Planning Schemes (in Local National Grid (meters)

3.4 Quantitative Assessment

Fig. 4 and Fig. 5 show examples of the quantitative assessment of the waste management situation as against the target goals set for the 2005 to 2015. From the graphs it could be seen that all the goals set could not be achieved. The study area is doing just about 17% of waste collection as against the national and regional figures of about 40% and 30% respectively. The distribution of this low waste collection coverage is also very uneven, concentrated at the commercial areas (Fig. 3). The levels of inaccessible dumping sites, unsafe dumping locations, bad (poor/very poor) site sanitation and site management (open community dumping with little or no control measures) registered during the survey were generally high respectively measuring about 18%, 48.7%, 94.9% and 89.8% from the graphs (Fig 5). No engineered landfill sites were available, despite efforts by the Municipal Authorities to acquire land for the purpose. Nimby attitude by existing mining companies which control a large percentage of the available land is cited as a contributing factor to this. Road accessibility to most of the dump sites at Hunivalley-Damang areas were good (about 53.8%) but those communities were getting very little or no waste collection services from the municipal assembly. One reason for this was that those communities are far away from Bogoso, the administrative capital, where waste collection services take place. Another reason is that the only officially authorized landfill site nearby is around Abosso, about 100 km away, making the transportation cost too high for waste collection in the area.

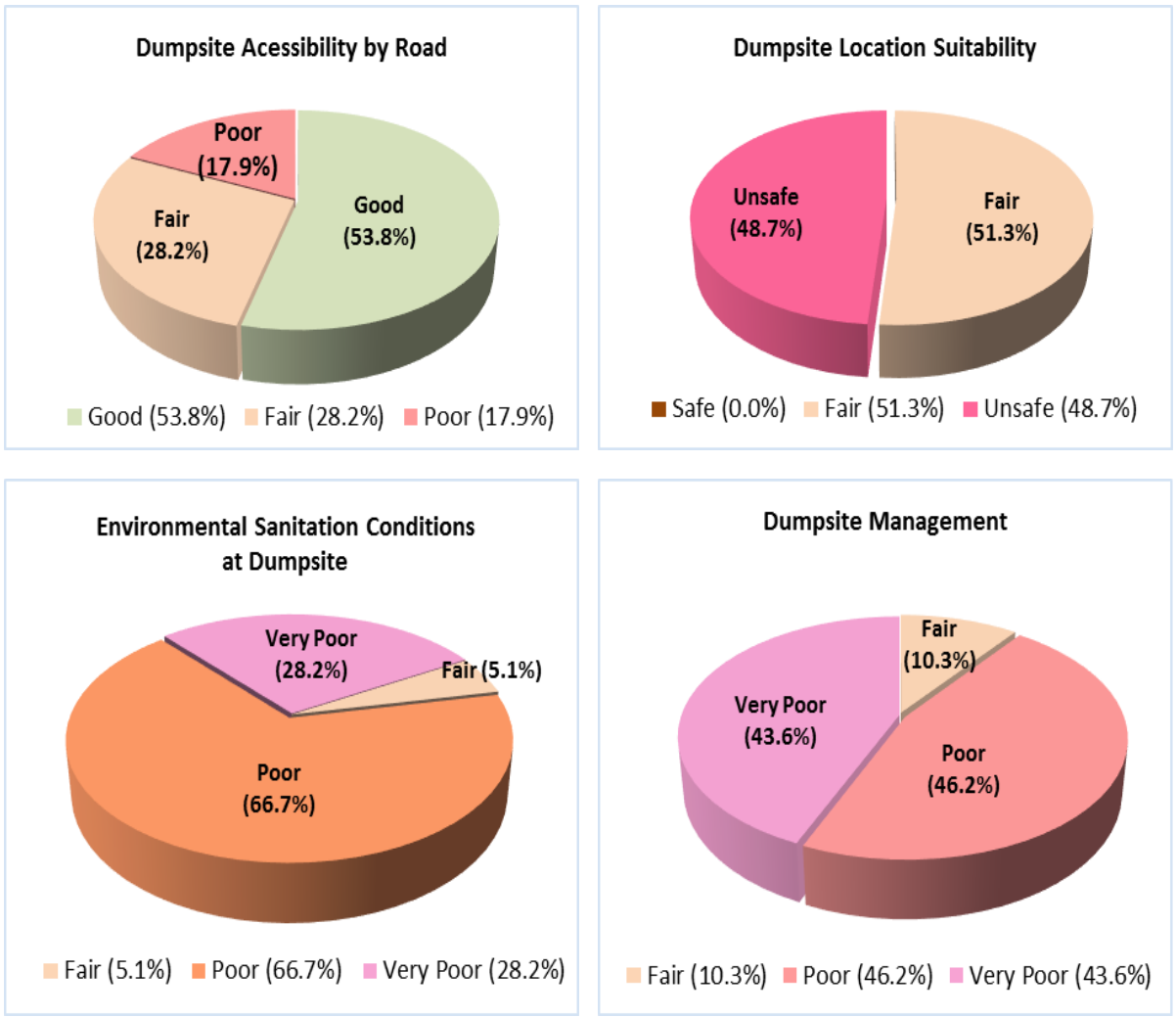

Fig. 4 Waste Disposal Assessment at Some Communities in Study Area (Hunivalley-Damang)

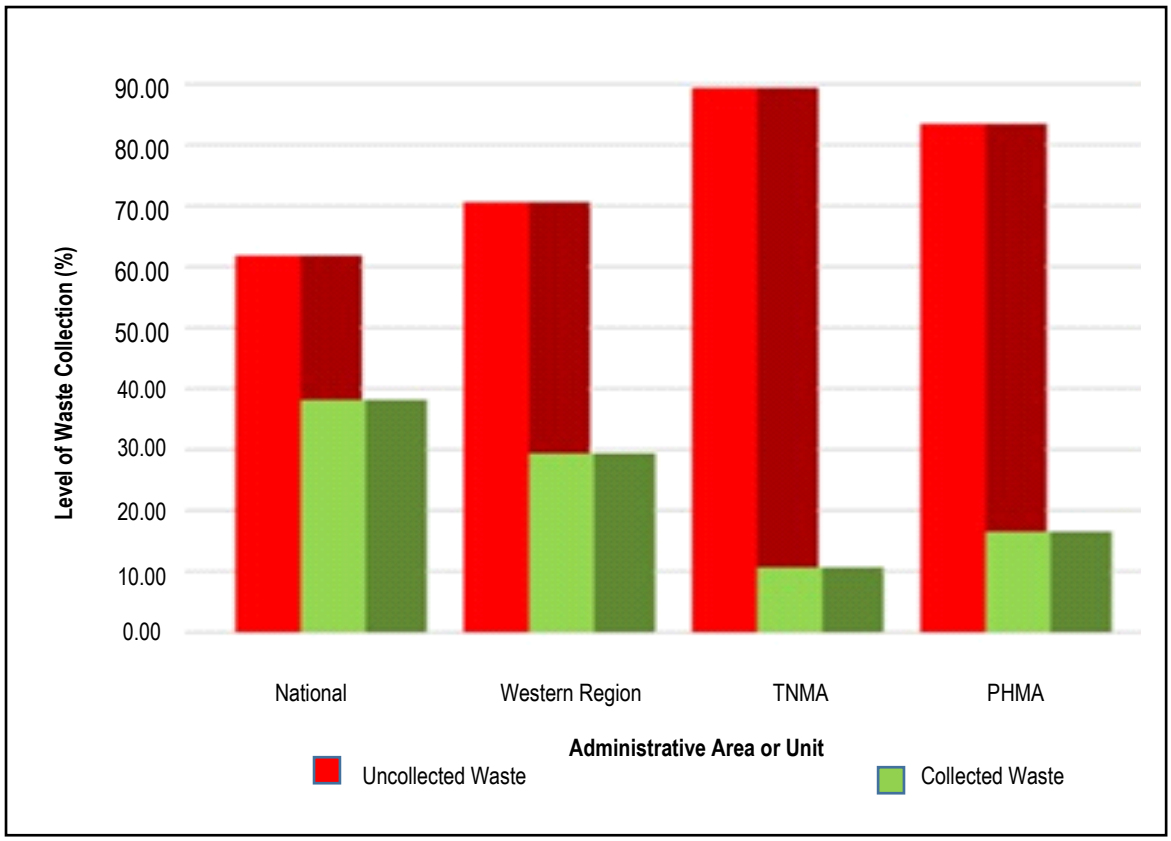

Fig. 5 Comparison of Waste Collection at Study Area with Other Parts of Ghana

4 Conclusions and Recommendations

This study has demonstrated some of the important roles that mapping and spatial analysis can play in assessing waste management and sanitation activities at the local (municipal) level to ascertain whether intended goals are being met or not and what local factors may be contributing to that. In the current study, local land tenure and nimby attitude by land holders, lack of sanitation maps and spatial analysis in the distribution of sanitation services, lack of adequate support to local communities in phasing out inappropriate sites and practices, increasing urbanization and pressure on land are noted as some of the contributing local factors hampering the achievements of waste management goals. The paper recommends the integration of such local factors and survey, mapping and spatial analysis into the existing waste management system to support effective data collection and analysis efforts to improve the planning, distribution and evaluation of waste management services and intervention efforts at the local level.

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Authors

E. A. A. Kwesi is currently a Lecturer at the Geomatic Engineering Department of the University of Mines and Technology (UMaT), Tarkwa, Ghana. He holds MPhil. Degree in Mining Engineering from UMaT and BSc Degree in Geomatic Engineering from the Kwame Nkrumah University of Science and Technology (KNUST), Ghana. He is a member of Ghana Iinstitue of Surveyors (GhIS), Ghana Iinstitute of Geosciences (GhIG), Federation of International Geomaticians (FIG), Society of Mining, Metallurgy, and Exploration (SME) and Global Land Programme (GPL). His research and consultacy works cover Surveying and Mapping, Community Involvement and Multicriteria Decision Making and their applications in Sustainable Management of Land, Agriculture, Solid Waste and Community Development in Mining Areas

Michael S. Aduah is a Senior Lecturer at the Department of Geomatic Engineering of the University of Mines and Technology, Tarkwa, Ghana. He obtained a PhD degree in Hydrology from the University of KwaZulu Natal (UKZN), South Africa and a double MSc degree in Geo-information Science and Earth Observation from University of Lund (Sweden) and ITC (The Netherlands).

G. Piedu is a Lecturer at the Institute of Distant and e-Learning, University of Education, Winneba, Ghana. He holds both Bachelors and Masters Degree Certificates in Sociology and Education from the Kwame Nkrumah University of Science and Technology (KNUST), Ghana and from the Norweigian University of Science and Technology, Norway. He also holds Certificate in General Drilling from the University of Mines and Technology, Tarkwa, Ghana. His research interest includes Social and Environmental Justice, and Public and Community Empowerment through Education and Advocacy.

C. Assencher is currently working at Fiaseman Senior High Secondary School in Tarkwa, Ghana. She holds a Bachelors Degree and Certificate in Education from the University of Winneba, Certificate in Commuinity Health Education from the Kwame Nkrumah University of Science and Technology (KNUST) and Teachers Certificate A from the University of Cape Coast. Her research interest involves Community Health and Environmental Sanitation, Public Education and Community Involvement in Development.