



## Using geographical information systems (GIS) to examine sanitary implications of rubbish dump locations at human activity centres

*Lenos Koku Ankrah<sup>\*1</sup>, Desmond Ayim Aboagye<sup>2</sup>, Benjamin Edem Zogbator<sup>3</sup>*

### ABSTRACT

This study sought to investigate health risks that refuse dump locations have on people. The global positioning systems (GPS) were used to take location coordinates of 28 rubbish dump centers and human activity centers (clinics, restaurants, markets etc) spread across a university campus in Ghana. The ArcGIS software was used to plot the coordinates and draw a buffer of 50 meters around the rubbish dump locations (RDL) to show the closeness between the dump sites and the human activity centers (HAC), and the sanitary implications of the closeness. More than 90% of the HACs fell within the 50 meters buffer zone of the rubbish dump sites. The findings indicated that some sensitive HACs like food joints, laundries etc. were less than 15 meters from rubbish dump sites. The findings confirmed that the location of rubbish dump sites pose serious threat to the health of the human community in the university. The findings of this study can be used to make evidence-based decisions about possible relocation of rubbish dump containers in the university. This study is also an initiative to set the tone for more detailed research work on the health implications of rubbish disposal management on Ghanaians.

**Keywords:** Human Activity Centre, Geographical Information Systems, Global Positioning Systems, Rubbish Dump, Health Risks, Health Related Illnesses, University Environment

### INTRODUCTION

As human population increases, the volume of waste produced also increases. Safe disposal of waste is increasingly becoming a problem in many countries, particularly the developing ones, which have to rely on scarce resources to have their wastes disposed off safely. The problem has become even worse in urban areas like Accra, where migration from rural to urban areas has resulted in urban population explosion, without corresponding social infrastructural growth. Poor waste disposal practices can have a detrimental effect on the health of people and the environment. For example, a United Nations report has indicated that most of the cholera outbreaks in Africa in 2007

were caused by piles of rubbish not properly disposed off.<sup>1</sup>

There were instances of poisonous materials from rubbish dumps infiltrating into pipe lines when it rained and the consequences of such situations were fatal. There have already been serious accidents arising from such poisonous wastes in Ghana in the past.<sup>2</sup>

Some countries are discovering too late that many old rubbish dumps are time bombs of poisonous chemicals that are now starting to leak into the environment as their containers disintegrate.<sup>3</sup>

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<sup>1</sup>Lecturer in Geographic Information System, Learning Resource Centre, Regent university College, Ghana

<sup>2</sup>Professor and Head of Department, Human Development and Psychology, Regent university College, Ghana

<sup>3</sup>Head of Department, Institute of Languages and General Studies, Regent university College, Ghana

\*Corresponding Author:

Lenos Koku Ankrah  
Learning Resource Centre, Regent  
university College, Ghana  
[lenos.ankrah@reagentghana.net](mailto:lenos.ankrah@reagentghana.net)

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**Fig. 1 Congested and rubbish filled Kojo Thompson Road in front of the Makola Market (The central market of Accra, the capital city of Ghana) - Picture taken on Tuesday, May 13, 2008**

The most serious aspect of the problem was that people accepted the condition as normal and therefore did not complain about it. The practice of living with piles of rubbish had become part of the culture of communities in the country. This sanitation issue had never been emphasized in national political

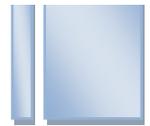
campaign messages or by any aspirant of an office in the universities, be it a Presidential election, a student leadership election, worker or environmental control group elections. There is an immediate functional need to demonstrate the seriousness of the problem through the results of a study like this.



**Fig 2 Mensah Sarbah main Hall Rubbish Dump Site of the University of Ghana**

Waste, rubbish, trash, garbage, or junk is unwanted or undesired material. According to Amil,<sup>4</sup> "Waste" is the general term; rubbish or trash are mixed household waste and include paper and packaging; garbage is kitchen and table waste; and junk or scrap

is metallic or industrial material. Sewage, ash, manure, and plant materials are other categories of waste. Any community produces waste. A traditional community produces waste that come from the local environment and which can usually be absorbed and disposed of by that environment. A more modern



community imports many things which are usually thrown away locally after use and some such wastes do not easily decay and remain in the environment for a long time.

Some components of waste can be recycled once recovered from the waste stream, e.g. plastic bottles, metals, glass or paper. The biodegradable component of waste (e.g. paper and food waste) can be composted or anaerobically digested to produce soil improvers (fertilizers) and renewable fuels. If not dealt with in a sustainable manner, biodegradable waste can contribute to greenhouse gas emissions and by implication climate change. Greenhouse emissions are dangerous to humans and the environment and people living close by dumps are more likely to be affected than others in the communities.<sup>5</sup>

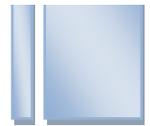
The solid waste produced in any modern community is of several kinds - organic wastes such as paper, kitchen garbage, and garden cuttings, decay with time and may even enrich the soil. These may, however, be contaminated with disease organisms and poisons. In an environment where dustbins and garbage lie next to residences, it is likely that the people living in those residences are not using safe water.<sup>6</sup> Rainy seasons, only make matters worse. Infectious diseases are rife, especially diarrhea and acute respiratory infections. Malaria and typhoid are also a problem caused by the unsanitary conditions of living near dumps.<sup>7</sup> Metal exist in various forms, including steel and aluminum cans, old automobiles and appliances, and metals used in construction. Some, like steel, will slowly rust away or oxidize, while others may remain permanently in their state. A few metals, like the heavy metals (e.g. lead and mercury) may be poisonous and may contaminate the environment. The poison generated may be the source of contamination of water sources close to the dumps. Glass is usually in the form of bottles, which may break but not rot, and which frequently cause serious cuts - most likely to people who are living close to the dump. The glasses accumulate water in which malaria vectors, mosquitoes, can breed. The mosquitoes cause malaria disease.

The increasing numbers of poisons and toxic chemicals imported to communities create disasters. We need to know that any poison used in communities will eventually end up in the waste.<sup>8</sup> The developed countries are discovering too late that many old rubbish dumps are time bombs of poisonous chemicals that are now starting to leak into the environment as their containers disintegrate and people who live near dumps become prone to the dangers that the poisons pose to human health.<sup>9</sup> It is important to note that some domestic wastes like some rotten food items can become poisonous, therefore special care must be taken in the disposal of all poisonous or potentially poisonous materials. If solid wastes are just dumped or used as landfill, they can become a breeding place for flies, rats, cockroaches and mosquitoes, which find their ways into residences and offices of people who live close by. People in various communities have died after eating food found at the dump.<sup>10</sup>

Studies carried by Researchers of Democritus University in Greece on public health hazard posed by approximately 2000 rubbish dumps operating in Greece, showed that in Tagarades, east of Thessaloniki, where burning of rubbish took place regularly, there were dangerous levels of dioxin pollution in milk and poultry produced in the area.<sup>11</sup> The hazard does not just lie in the stench and curable diseases arising from the air pollution they create, but also in their cancerous effects - it takes one tiny iota of dioxin to cause cancer. There are sophisticated techniques for destroying solid waste, like high temperature incinerators, but these may be beyond the means of many communities. The most widely used disposal method is the sanitary landfill. A site is chosen where there is no risk of contaminating important water supplies or coastal waters. The wastes are dumped, compacted, and immediately covered with a layer of dirt or other fill. The method is simple and relatively cheap; availability of fill material is sometimes the biggest constraint.

#### SIGNIFICANCE OF THE STUDY

The findings of this project work can be used to make evidence-based decisions about possible relocation of rubbish dump sites nationwide and on our university campuses; the thematic map produced



from the project work is both a visual power and an analytical tool – it therefore serves as a powerful graphical tool for communicating to any lay person the seriousness of the problems of poor rubbish disposal practices in our communities; the project is also an initiative to set the tone for a more comprehensive work on the impact of sanitation management practices on the health fortunes of our communities; especially our University campuses.

The main objectives of this study are to: raise national awareness of poor waste disposal practices in the country; specifically, to ascertain the location of rubbish dump sites in the University of Ghana, using GIS with GPS; finding out the closeness of the location of the HACs to the rubbish containers; examine the implications of the location of the rubbish dump sites on the health of members of the university community; and recommend measures required to improve rubbish disposal management practices.

## RESEARCH METHODOLOGY

### Study Site: The University of Ghana

The University of Ghana, Legon (UG) is the premier University of Ghana and has grown rapidly since the 1970s and its student population is now estimated to be above 30,000. Lack of effective waste disposal management practices in our country generally and in the UG in particular has led to a proliferation of poorly-managed rubbish dumps in our communities and this poses serious public health risk. It is against this background that this study looks at the problem of waste disposal in the University. The choice of this area of work was the result of personal observations made by the Author of this study on the location of rubbish disposal sites and the concerns about the possible health risks that they pose to members of the university community. The campus of the UG, has a size of 3,188 acres. The university lies about 13 kilometers north-east of Accra, the capital of Ghana, at an altitude of between 300 and 400 feet. From the main university gate along the Tetteh Quarshie - Dodowa Road, the university avenue extends to Commonwealth Hall on Legon Hill. Along it are grouped other halls of residence such as Akuafo Hall, Legon Hall, and Volta Hall and also some faculties, departments, lecture rooms and laboratories. Mid-

way, an open space – the University Square, with an ornamental pool is over-looked by the main University Library. Across from the University Square are sports fields, a central cafeteria, the University Clinic, halls of residence and student hostels. The university primarily provides accommodation in Halls of residences and hostels for students as well as flats, bungalows and guest rooms for senior members and guests. Each Hall has a kitchen and a dining hall to cater for students' feeding.

### The procedure of waste disposal in the University of Ghana (UG)

Waste bins were provided on all floors and compounds of the University's residential halls, hostels, offices and lecture theaters to ensure that wastes generated at various points in the University were primarily disposed off. Bins were provided at various strategic points on the UG Campuses to provide waste disposal facility to campus goers. Cleaners who were assigned to undertake cleaning work in the various facilities were made to cart the wastes generated in those facilities, manually, to various designated areas in the University where they were dumped either in containers, on bear floor, or in both. All the locations chosen for the dumps in the University were close to HACs. The rubbish from these dumps were expected to be cut away by refuse trucks to a permanent dump site outside the University campus known as Mempeasem on regular basis, but they were left for long periods before they were cart creating very nasty scenes and stench at the sites.

### Health Impact Assessment

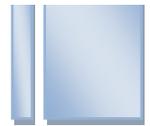
Methods used to assess impact of location of dump sites near HACs included:

#### Existing patient records

Patients' records that provided information on the frequency of which dumpsites related diseases such as malaria, respiratory tract diseases, dysentery, food poisoning etc. reported to the clinic, were taken by the researcher.

#### Surveys

The other methods of Information gathering tools used were; personal interviews and questionnaires.



Questionnaires were developed with a mixture of structured and open-ended questions. There were in-briefings with the Director of the Municipal Services Department of the UG, which was the unit directly responsible for rubbish disposal on the campus, some Medical Officers of the UG Clinic and some occupants of the close HACs.

### Selection of Participants and Data Gathering

Three categories of people were interviewed – 2 Medical Personnel (1 Doctor and 1 Nurse) of the university clinic, the Acting Director of the Municipal Services, 8 individuals - either residents or workers of some of the HACs. The method used in getting the sample of respondents was a non-probability sampling method known as **convenience sampling**. The researcher interviewed individuals who met the requirements for providing the information needed. Few numbers of respondents were selected because of pressure of time and resources.

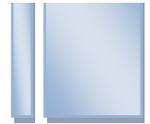
Procedures outlined by Lincoln and Guba<sup>12</sup> and Miles and Huberman<sup>13</sup> were used to categorize, code, and interpret the data collected. Data collected from the University Clinic, personal interviews and observations were listed and analyzed. Analysis of the distribution of data from each perspective revealed which elements occurred often, which appeared significant, and which seemed to go together. The results of the analyses provided different perspectives from which to identify frequencies, relationships, themes, and patterns. The process began with close examination of data collected from the UG clinic, narrative responses collected from the interviews and personal observations to identify elements that appeared with some frequency as well as anomalies - elements that did not seem to fit with the rest of the data. Clusters of data that emerged from this examination were organized into broad categories (i.e. position of dump sites, position of HACs, measured distances between dump sites and HACs, environmental hazards suffered by residents close to the dump sites, diseases that are likely to be linked to the location of rubbish dumps etc.) and then into subcategories. The data were displayed in tables and processed into a thematic map to reveal relationships.

### GIS Applications for Data Analysis

The following were the steps taken to collect field data, plot the coordinates, draw buffers and develop a thematic map to show locations of dump sites and their closeness to HACs;

The GPS was used to take location coordinates of 28 rubbish dump sites and HACs (clinics, restaurants, halls of residences, markets and laundries.) closest to the dump sites, spread across the university campus. ArcGIS 9.2 version application software was used to plot the coordinates. The plotted coordinates were projected onto an existing base map, showing the road infrastructure of the university and a thematic map of the rubbish dump locations of the UG was developed. Rubbish may be left at dumps established by local authorities, but according to the country's Environmental Protection Agency (EPA) regulations the dumps should be at least 100 meters away from the closest HAC.

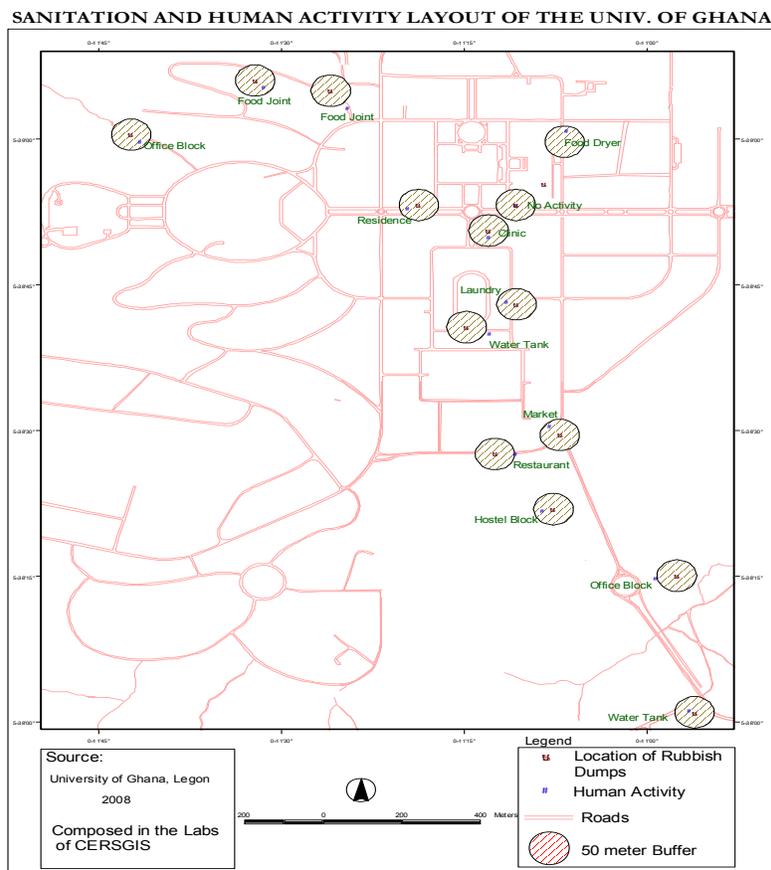
A buffer of 50 meters was generated around each of the rubbish dump locations to show the closeness between the dump sites and the human activity centers. The 50 meters zone selected for the buffer was not arbitrary. It was observed that most of the HACs were less than half (50 meters) the recommended 100 meters away from the dumps. The 50 meters was chosen because it makes it easier to show in the analysis how seriously the regulations of 100 meters distance have been violated. It was also meant to emphasize a point that even at half the recommended distance of 100 meters the UG still failed to meet the convention by a large percentage. The distance measuring feature of the ArcGIS 9.2, "measure tool" was used to measure the distance from the dump sites to the HACs. The results show that the convention that 100 meters distance should be kept away from human activity centers had been grossly violated. The map indicated that more than 90% of the human activity centers fell within the 50-metre buffer zone of the rubbish dump sites. The HAC closest to the dump at Commonwealth Hall was a food joint and was sited less than 30 meters away from the rubbish dump. The closest HAC to the dump at Volta hall is also a food joint. It is at least 50 meters away from the dump, but the location clearly violates the recommended 100 meters buffer by



about 50 meters. At the Akufo Hall, the food dryer at the Odor Rice restaurant is less than 30 meters away from the dump site. The location of the dump site at the Legon Annex A hall of residence is only about 30 meters. At the Mensah Sarbah Main Hall the location of the dump site is less than 30 meters away from the laundry.

The location of the dump site at the Jubilee night market is more than 40 meters away from the market. At the Valco Hostels the dump site is more than 50 meters away from the hostels' water tank, but the location clearly violates the recommended 100 meters buffer zone by about 40 meters.

The location of the dump site at the International Students' Hostel Phase 1 is about 50 meters away from the hostel's restaurant, meaning the location violates the regulation by about 50 meters. At the International Student's Hostel Phase 2, the location of the dump site is less than 30 meters away from the closest block. At the Malaria Center the dump site is more than 50 meters away from the closest office block, meaning the location violates the EPA regulations by about 50 meters. The findings indicate that some HACs like food joints, laundries, students' hall of residence etc. were less than 30 meters away from some of the rubbish dump sites.



**Fig 3 Thematic Map Produced from the use of the GIS**

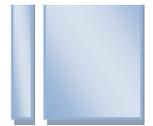
### Ethical Standards

This research was carried out with high level of ethical standards, especially in relation to data collection and use of the data. The principle of voluntary participation was strictly adhered to; no respondent was pressurized in any way to participate in any of the interviews and the participants were

fully informed about the risks involved in participating in the interviews.

### RESULTS

Table 1 shows the number of cases of rubbish sites, related diseases such as malaria, respiratory tract infection (RTI), dysentery and food poisoning



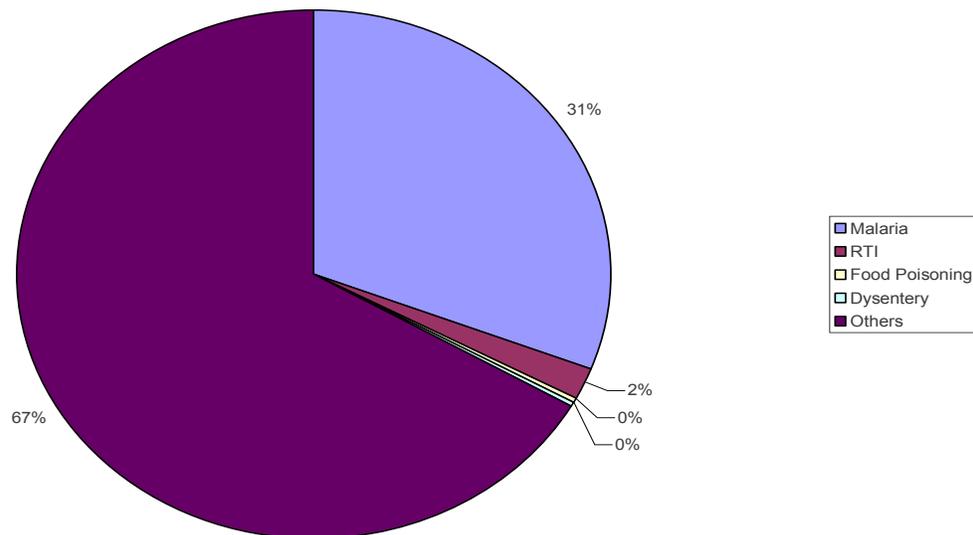
reported at the students' clinic of the UG between 11<sup>th</sup> of October, 2007 and 18<sup>th</sup> of April 2008 – a period of about 6 months.

The records indicated that for the period of 6 months covered between 11<sup>th</sup> October, 2007 and 18<sup>th</sup> April, 2008, 5,800 cases of various diseases were reported at the Students' Clinic. Out of the total of 5,800 cases of diseases reported 1,792 were malaria, 109 were respiratory tract infection diseases, 12 were cases of food poisoning, and 23 were cases of dysentery. The total of rubbish dump related diseases reported

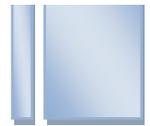
within the period was 1936 constituting 33.38% of the total of all the diseases reported to the clinic. The total of non-rubbish dump related diseases was 4008. The figures showed that out of the total figure of 1,936 of the rubbish dump related diseases reported in the university clinic Mensah Sarbah Hall reported 489, Akuafu Hall reported 440 cases, Legon Hall reported 419 cases, Commonwealth Hall reported 352 cases, Volta Hall reported 143, Graduate Hostels and the Ghana Hostels reported 45 cases each and the International Students' Hostels reported 3 cases.

**Table 1 Composite Variable and Score Creation for Dietary, Physical Activity and Sedentary**

Halls	Malaria	RTI	Food poisoning	Dysentery	Total
Legon hall	387	27	0	5	419
Akuafu hall	406	24	4	6	440
Volta hall	137	0	2	4	143
Mensah sarbah hall	446	32	5	6	489
Commonwealth hall	325	26	1	0	352
Int. Students' Hostel	3	0	0	0	3
Graduate Hostels	43	0	0	2	45
Ghana hostels	45	0	0	0	45
<b>Total</b>	<b>1792</b>	<b>109</b>	<b>12</b>	<b>23</b>	<b>1936</b>



**Fig 4 Pie Chart Showing Proportions of Diseases Recorded**



## Interviews

The questions asked in the personal interviews with the head of the sanitation management office of the University of Ghana were: "would you describe what you do in this department?"; "what type of sanitation management work do you do?"; "in what area or department do you work?"; "what are the factors that determine where rubbish dump sites are located?"; "do you consider that the closeness of the dumps to HACs pose health risks?"; "is there anything that can be done to avoid the breeding of houseflies, mosquitoes, mice, rats and insects at the dumps?"; "do you recognize that burning at the dump sites poses risks to human health and the environment?"; "what are the difficulties for acquiring an incinerator, sanitation tricycles which can carry the rubbish directly from the halls and residencies directly to the permanent dump site at Mempeasem?" and "in your opinion what can we do to improve the situation?".

Analysis of this interview transcript pointed to the fact that

- 1) the choice of the dump locations were based on our judgment of where rubbish were more likely to be generated and how convenient it was for trucks to move to the sites and cart the rubbish away
- 2) The 100 meters distance could not be kept away from the HACs because the university community was so enclosed that it was not possible to get 100 meters away from one human activity center without locating within 100 meters of another. The plan was to evacuate rubbish and spray the sites daily with insecticides to avoid the breeding of flies, rodents, and insects etc., but they were not operating according to those plans because of unavailability of adequate logistics and resources
- 3) Conveying rubbish from the halls of residence to the permanent rubbish disposal sites directly would have been the ideal thing to do but that would require the regular use of a number of trucks which they did not have and which they may not be able to acquire in the immediate future. The use of the tricycles to cart rubbish directly to the permanent dump site at Mempeasem will require that many

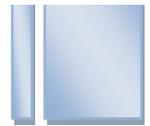
tricycles be bought and the university may not have the financial resources to buy them now. Also the tricycles might obstruct free flow of traffic on campus

- 4) they recognized that the insects, flies and rodents generated at the dumps posed grave health risks, but the problem could not be solved without the provision of adequate trucks for carting the rubbish as often as required and insecticides for spraying the dump sites and
- 5) they recognized that the burning of rubbish at the sites posed health and environmental risks and therefore warned the university community against burning of refuse anywhere on campus and the burnings that took place at the dump sites were done by workers mainly cleaners from the halls of residence against the regulations.

The questions asked in the personal interview with Medical Personnel of the University of Ghana Clinic were: "What is your work in this clinic?"; "What diseases do students often report at the hospital?"; and "Do you think some of these diseases are related to the closeness of rubbish dump sites to human activity centers in the university?".

Analysis of this interview transcript with the Medical Personnel of the University Clinic showed that

- 1) most of the diseases reported at the university clinic were malaria and influenza and occasionally they had occurrence of diarrhea and dysentery in epidemic proportion;
- 2) most of the diseases like malaria, respiratory tract diseases, diarrhea and dysentery reported could be the result of poor sanitation and he would not rule out poor sanitation management at the rubbish dumps as the sources of these diseases;
- 3) the situation may lead to some serious outbreak of epidemic of a disease which may have devastating effect on lives in the University;
- 4) the only solution was to keep the dump sites away from the HACs; and



- 5) the situation became so serious that on some occasions the nurses themselves picked shovels and brooms to collect rubbish scattered on the floor of the dumps close to the clinic to safer places to avoid health hazards.

The questions asked in the personal interview with residents of the HACs close to the rubbish dump sites were: "For how long have you been working/residing here?"; "Do you experience any hazards arising from the closeness of the rubbish dump sites to where you live/work?"; "Do you see any of these hazards posing any threat to your health?"; and "Why then do you continue living/working here?".

Analysis of this interview transcript with some residents/workers of the close HACs showed that:

- 1) they have either worked or resided in the area for the past year or more;
- 2) they face hazards such as the strong stench they will have to endure on daily basis, the presence of houseflies, mosquitoes, insects and rodents like mice in their rooms, including the kitchens of the restaurants near the dumps;
- 3) the workers and the residents report cases of malaria regularly and these cases they easily identify as being the result of the mosquito bites they receive at the place;
- 4) when the smoke from rubbish burnt entered their rooms they sometimes experienced the attacks of cold and catarrh;
- 5) even though they occasionally experienced diarrhea and dysentery, they hardly attributed them to the presence of the dumps since so many other things could have resulted in the diseases; and
- 6) The only solution they could envisage was to have the dumps removed to places outside the HACs.

### Disease Epidemiology

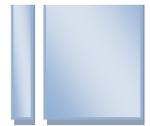
The records indicated that for the period of 6 months covered between 11 October, 2007 and 18<sup>th</sup> April, 2008, 5,800 cases of various diseases were reported at the Students' Clinic. Out of the total of the 5,800 cases reported 1,792 were malaria, 109 were

respiratory tract infection diseases, 12 were cases of food poisoning, and 23 were cases of dysentery. In effect the rubbish dump related sicknesses reported at the clinic totaled 1,936 forming about 33.38% of the total number of cases of all diseases reported. This represents a high percentage of the total number of all cases of diseases reported. It is noteworthy that malaria alone accounts for about 30.90%. Even though many other factors may account for the high rate of malaria reported, one could not rule out the huge number of mosquitoes generated at the dump sites as a major factor.

One hundred and nine (109) cases of respiratory tract infection diseases reported in a period of 6 months in the university clinic was a huge figure considering the fact that the disease was rare under normal circumstances - the burning that took place at the rubbish dump sites and the strong stench that was felt at the dump sites could be the cause of the high figure. There was no significant difference in the figures as far as the traditional halls of residence like Mensah Sarbah, Akuafu, Legon, Commonwealth and Volta Halls were concerned. Any differences noticed could be partly due to differences in the populations of students in the halls and partly due to the level of interest, of individual students in each hall, in using the university clinic when they fell sick. Many students either used self-medication or used clinics or hospitals other than the university clinic when they fell sick.

The current student populations of the traditional halls were as follows; Mensah Sarbah Hall – 5987, Legon Hall – 5879, Akuafu Hall – 5,690, Commonwealth Hall – 4,388 and Volta Hall 3,907. With the non-traditional halls of residence like the International Students' Hostels, the Jubilee Halls, the Valco flats and the SSNIT hostels, the low figures reported could be due to low patronage of the university clinic by occupants of those hostels. The occupants of those hostels were considered more affluent section of the students' population and were likely to have the means to access other health facilities than the university clinic.

The residents and workers of the HACs reported the presence of hazards such as smokes, houseflies,



mosquitoes, mice, rats, cockroaches etc. in their rooms, kitchens and offices. The Medical Officer indicated that even though other factors could be the cause of high incidence of malaria and occasional outbreaks of diarrhea and dysentery reported at the clinic, the closeness of the dumps to the HACs could not be ruled out since it constituted strong risk factor for causing those diseases.

The Acting Director of the Municipal Services indicated that if their plans of carting the rubbish daily and spraying the dumps regularly were followed, the threats to human health would have been reduced by far. He attributed the inadequacies of both the selection of the dump sites and the poor maintenance of cleanliness at the dumps to inadequate logistics and working facilities.

All the respondents agreed that the ideal thing would have been to send the rubbish from the halls and residences directly to the permanent dumps at Mempeasem without dumping them first on dump sites on the campuses.

#### DISCUSSION AND CONCLUSION

If solid waste are just dumped or used as fill, they can become a breeding place for flies, insects and rodents. Since some of the waste may be contaminated with poisons or diseases, it is dangerous to allow people to live by the dump sites. In some countries people have died after eating food found at the dump. Waste can also be a source of significant water pollution, either in water running off the dump site or in ground water contaminated by seepage from the waste.<sup>14</sup> If the wastes are burned, the smoke can be a significant source of local air pollution, and may contain toxic gases.

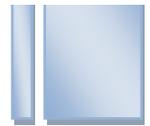
If the findings of this study are anything to go by then the danger signals must be clear. The conventional acceptable minimum disposable point from HAC is put at 100 meters by authorities like the Ghana Environmental Protection Agency.<sup>15</sup> In a country like the United States of America from where the regulations were adapted, their treatment of waste is believed to be more sanitized than what is seen in Ghana. If their dump sites are more sanitized and yet they insist on keeping the distance of 100 meters

away from human activity centers, to avoid outbreak of diseases, then we can imagine what we Ghanaians do to ourselves when we send our so poorly sanitized dumps so close to our HACs – less than 50 meters – with some less than 30 meters away. Only a few are more than 50 meters away and none of the human activity centers met the 100-meters distance required, away from the dumps.

It is believed that the huge amount of money used in subsidizing the treatment of students and the high number of students' hour spent on visits to Legon hospital and clinics for treatment of diseases like dysentery, cholera, respiratory track diseases and malaria would be greatly reduced if the university authorities would pay attention to sanitation at the dump sites. There seems to be a culture which makes it acceptable for people to live with rubbish without seeing anything wrong with it – this is an attitude that needs to be changed if we want to avoid outbreak of diseases through indiscriminate dumping.

The explanation by the Acting Director of the Municipal Services that sanitation tricycles might cause inconvenience to traffic flow is not convincing. Traffic on the university's campus is not very heavy and with good planning the tricycles can be used with very little or no inconvenience to other road users to cart the rubbish directly from the halls and residences to Mempeasem. Even if it is true that traffic is heavy on the campus in the day the rubbish could be carted very early in the morning, using the tricycles.

The argument about scarcity of resources did not hold since cost analysis would show that the purchase of tricycles would be more cost efficient than the expenses made on hiring Zoom-lion trucks to cart the rubbish from the dump sites to the permanent site at Mempeasem. Besides, because of its relatively smaller size it has the added advantage of being able to go round the halls and residences easily to cart the waste from there directly to the permanent site to avoid the process of having to dump them at the dump sites first and so doing preventing all the dangers that were found associated with dump locations to close HACs in the University. The use of the tricycles would also save



expenditure on hiring trucks regularly, labor cost, acquiring bins and containers, purchasing chemicals and insecticides for spraying the sites etc.

The findings showed that the location of rubbish dump sites were too close to human activity centers and posed serious threats to the health of the human community in the university. The findings indicate that there was great risk of an outbreak of epidemic of disease – a disease which the university clinic and the hospital may not find immediate treatment or cure for and which may result in devastating outcomes to human lives.

### RECOMMENDATIONS

The findings of this project work should be used by the UG authorities to make evidence-based decisions about possible relocation of rubbish dump sites; the university authorities should consider the use of sanitation tricycles which are more convenient and more cost efficient than the big trucks that the UG is relying on now; garbage should be drained before being placed in storage containers. If liquids are strained away, garbage may be stored for a longer period of time without developing an unpleasant odor. After straining, the garbage should be wrapped in several thicknesses of old newspapers to absorb remaining moisture before putting it into the containers; a tight-fitting lid must be provided for all the containers – this is important to keep out houseflies, mosquitoes, rodents and insects; there are sophisticated techniques for destroying solid wastes like high temperature incinerators, the university authorities may consider that, but if that is beyond the means of the university then they may consider the most widely used disposal method, which is the sanitary land fill. A site should be chosen on the UG campus where there is no risk of contaminating important water supplies. With this method the wastes should be dumped, compacted, and immediately covered with a layer of dirt or other fill. The method is simple and relatively cheaper. Availability of fill material may be a constraint but with determination the authorities can find ways out; all poisonous or potentially poisonous materials should be handled with care to avoid eventual disastrous effects when they are thrown away; since some of the waste may be contaminated with poisons or diseases, people should not be allowed to

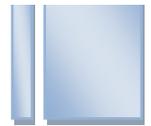
sort through and remove things from the dump. Such people may spread poisons or diseases in the community; wastes can also be a source of significant water pollution, either in water running off from the dump site or in ground water contaminated by seepage from the waste – all pipe lines near the dump sites should be removed or appropriately protected; the environmental protection groups on the university campus should design an educational program to combat the low level of consciousness on the consequences of poor rubbish disposal management practices; the student-body, workers and teachers associations should make it their responsibility to ensure that the waste management authorities of the university do not dump rubbish near their residences, offices and food joints; the funding available for waste disposal should be looked at again and the logistics and funding that the Municipal Services Unit require should be provided them to move the rubbish directly from the halls and residences to the permanent dump site; and the impact of poor rubbish disposal practices on health at the UG should be looked at again more extensively, in the context of general sanitation management practices.

### LIMITATIONS OF THE STUDY

The data available at the clinic on attendance of the clinic by members of the halls of residence did not include the room numbers of the students. It was therefore difficult to establish any correlation between closeness of the human activity centers to the dumpsites and the diseases reported using inferential statistical methods such as hypothesis testing, correlation or regression methods. The development of the thematic map, the use of GIS tools for analysis, the meticulous choice of respondents used, the clearness of the answers provided to some extent compensated for the absence of any such inferential statistical methods for analysis.

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