

## **PhD Proposal Plan**

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MSc. Geophysics, BSc. Geology and Physics

**2. TITLE:** Environmental Impact Assessment of Solid Waste Dumpsites in the Kumasi Metropolis Using Integrated Geophysical Methods

### **3. Abstract**

Integrated geophysical methods namely Electrical Resistivity, Electromagnetic (EM) Method, Self-potential, Magnetic susceptibility and some chemical analysis namely atomic absorption spectroscopy and X-ray fluorescence measurements will be carried out on soil and underground water sample from the catchment area of some waste dumpsites in the Kumasi Metropolis. This is to help determine the level of pollution caused by the deposition of the solid wastes in the communities in which the dumps are located. The data collected will be modeled to assess the short and long term impact on the quality of the environment. It is hoped that the outcome of this research will go a long way to affect the policy formulation in the area of solid waste disposal in the Kumasi Metropolis and Ghana at large.

### **4. PROBLEM STATEMENT**

The environment has over the years faced adverse natural and anthropogenic challenges including overpopulation, rapid loss of biodiversity, global warming and waste management. Urban managers in developing countries, in particular, face an enormous array of problems. Some of the most important ones are poor housing, unemployment, land degradation, and waste management with the range of problems requiring immediate attention constantly increasing. In the midst of new initiatives and uncertain solutions to all of these and several other demanding situations, the quality of the environment is deteriorating.

Environmental pollution from solid waste landfilling (SWL) is of major concern to both environmental scientists and individual citizens. SWL inevitably generates chemicals or pollutants that reach their surroundings, such as soil, groundwater resources, and even the ambient air, because of environmentally unacceptable disposal of solid waste, or failure of lining system in the dumpsites. This can cause adverse impacts on the environment and to public health and property (Wildung and Zachara, 1981). Human activities pollute fragile systems by modifying their quality to such an extent that subsequent use becomes restricted (Beatriz et al., 1998).

Increasing amount of MSW emanating from residential, commercial and industrial areas, together with changing nature of waste over time, have led to the degradation of the quality of the environment. Municipal Solid Waste (MSW) disposal in Ghana is particularly a growing problem in urban areas such as Accra, Kumasi, Tamale and Takoradi. Environmentally sound management and increasing difficulty in treating organic waste is of major concern in these cities. Available statistics indicated that the Kumasi Metropolis generates about 1200 ton of solid waste a day with Kumasi Metropolitan Assembly, the agency responsible for waste management, only able to

collect about 70% of the solid waste generated in the metropolis (Ghana EPA, 2010). The rest of the waste are therefore left uncollected for days or end up in drains and rivers in the communities. Consequently, what were once peri-urban settlements are now surrounded by heaps and mountains of garbage.

Waste management planning, operation and maintenance strategies and systems for the management of materials for which there is no further use for a particular purpose at a specific time, can be approached in four ways namely; source reduction, recycling and composting, waste to energy conversion facilities and landfills. Landfills, most of which are open and uncontrolled dumpsites, are the most common waste disposal systems in Ghana. Most of these waste landfills are improperly designed due to their low capital investment, thus allowing for environmental pollution in those areas.

The health risk and the effect on the quality of livelihood cause by this practice calls for comprehensive approach to the assessment of the impact of waste dumpsites on the environment. Most researchers in Ghana depend on the hydrochemical and geochemical analysis (Khanal, 2007; Denutsui et al., 2012) in determining the level of environmental impact caused by this practice. These analyses depends on samples which are picked from selected location from the sites hence may not give true picture of the overall level of pollution in the areas. This study therefore seeks to determine the environmental impact caused to communities around solid waste dumpsite in the Kumasi Metropolis using integrated geophysical methods.

## **5. OBJECTIVES:**

The research seeks to determine the impact of environmental pollution on some communities located around solid waste dumpsites in the Kumasi Metropolis. The project will involve two stage processes using geophysical techniques:

1. Determination of the level of soil pollution around the waste dumpsite and the community where they are sited.
2. Determination of the level and extent of groundwater pollution in the catchment area of the dumpsite.

## **6. Project Description**

The research work will be conducted on seven selected dumpsites (un-engineered landfill site) and one engineered landfill site in the metropolis. The research will be started after full consultation with the community during the reconnaissance stage of the survey.

Reconnaissance survey will be carried out to help prepare the ground for the work. This will involve preliminary surveys of the sites to:

- Study the topography; topographic maps of the area
- Carry out a study of the geology of the area. If possible structure and geological mapping from airborne magnetic data over the area will be carried out. Geosoft and MapInfo-Discover software packages will be used for this purpose.
- Determine locations of profiles
- Get consent of communities and their support (community relation)

In this work electromagnetic (EM) and resistivity survey profiles will be laid radially from the site into the community. The survey will be conducted using Geonics EM34 instrument and Terrament with the Lund imaging system. A total of eight (8) profiles will be created per dumpsite with the length of the profile depending on the proximity of the dumpsite to the community. The profile lengths are estimated to range between 500 to 1200 m. The site for the magnetic susceptibility and self potential measurements will be selected based on the results from the resistivity and EM surveys.

## **7. METHODOLOGY**

The following geophysical methods will be employed in this research work:

- 3D Electrical Resistivity tomography

3D resistivity survey using a 3D interpretation model should delineate the area of high contaminant plume as this will greatly affect the conductivity of the underground. The data from the survey will be modeled using the Res3Dinv software. The Res3Dinv program uses the smoothness-constrained least-square inversion technique to produce a 3D model of the subsurface from the apparent resistivity data (Loke and Dahlin, 2002; Loke and Barker, 1996). The program will automatically choose the optimum inversion parameters for a data set. However, the parameters which affect the inversion process can be modified by the user.

- EM Method (Geonics EM34 Instrument)
  - Electrical resistivity tomography (ERT) technique and EM method would provide clear images of the underground structure and delineate the extent of dumpsite contaminant plum (Zume, 2006).
- Self-potential measurement

This survey will measure the electrofiltration potential and liquid-junction potential created due to the movement and infiltration of the leachate from the dumpsite into the soil and the difference in concentration between the leachate and the water in the pores of the rocks. The self-potential measurement will help in the monitoring of the contaminant plume movement around the dumpsite.
- Magnetic susceptibility measurement.
  - This will provide insight into the level and source of heavy metal (Pb, Cu, Zn, Co, Cd and Ni) pollution in the area (Canbay, 2010).
- AAS and XRF measurements will be carried out to determine composition of the leachate soil in the catchment area of the dumpsite.

Finally, impact assessment model will be developed to model the level of pollution to see its long time effect on the environment. The discharge from the dumpsite into the water bodies will be modeled using Water Quality Analysis Simulation Program (WASP) and Discharge Monitoring Report (DMR).

## 8. WORK PLAN

Research	First Year			Second Year			Third Year		
	First Quarter	Second Quarter	Third Quarter	First Quarter	Second Quarter	Third Quarter	First Quarter	Second Quarter	Third Quarter
Month	A M J J	A S O N	D J F M	A M J J	A S O N	D J F M	A M J J	A S O N	D J F M
Course work	-----▶			-----▶					
Literature Search	=====▶								
Synopsis Approval and Selection of Co-supervisor	=====▶								
Research Proposal Presentation 1	=====▶			=====▶					
Reconnaissance and community relation			=====▶						
Site preparation			=====▶						
Proposed Stay Abroad				=====▶			=====▶		
Progress Report 1 Presentation 2				=====▶					
Sample preparation and data collection Phases 1				=====▶					
Progress Report 2 Presentation 3									
Data analysis and interpretation							=====▶		
Sample preparation and data collection Phases 2							=====▶		
These writing							=====▶		
Publishing of results							=====▶		
Research Assigment									=====▶
Final Report Presentation									=====▶
These submission									=====▶

## 9. REFERENCES

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- Loke, M. H. and Barker R. D., 1996. Practical techniques for 3D resistivity surveys and data inversion, *Geophysical Prospecting*, 44, pp. 499-523.
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- Zume, J. T., Tarhule, and Christenson, S. 2006. Subsurface Imaging of an Abandoned Solid Waste Landfill Site in Norman, Oklahoma. *Ground Water Monitoring & Remediation* 26, No. 2, pp. 62–69.

### 10. Proposed PhD Courses

Course title	Institution	Suggested ECTS-points
Research Methodology in environmental science	KNUST	
Climate change processes, mitigation and adaptation	KNUST	
Multivariate Data Analysis in Environmental Sciences	??	
Climate Modeling & Data Assimilation	??	

### 11. SCIENTIFIC COMPETENCES THAT THE STUDENT WILL GET FROM THE PROJECT:

This work will expose me to field work using various geophysical techniques. The students will also have the opportunity to interact and work with other researchers from other part of the world there by improving upon research skill. Finally, this project will give the background to the student to understand the dynamics and impact of pollution on the environment.

<b>13. DATE AND SIGNATURES</b>			
	Date	Name	Signature
Principal Supervisor		Prof. Aboagye Menyeh	
Project Supervisor		Prof. Sylvester Kojo Danuor	