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The Impact of Oblogo Landfill Site in Accra-Ghana on the Surrounding Environment

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Abstract: Oblogo landfill is the main recipient of waste from the city of Accra-Ghana. It is situated near an ecologically important wetland where the Densu River which supplies water to most part of the city runs through. The study was carried out to assess and evaluate the appropriateness of the location and operation of this landfill, to determine the composition of the solid waste dumped at the landfill and the extent of contamination of the landfill leachate to the surrounding environment (water and soil). Field measurements were carried out to determine the concentration of nutrients and metals in the landfill leachate, water and soil using UV spectrometer and Atomic Absorption Spectrometer. The landfill is not well located as it is close to a residential area, school and cattle farms.It is also located on a slope which ends in an ecologically important wetland, the Densu wetland. The landfill generates nuisances such as bad odour, scattering of waste by scavenger birds, flies and noise from vehicles carrying waste. Industrial and hospital waste are not pre-treated before disposal into the landfill. The concentration of most of the variables (nutrients, heavy metals) recorded especially for the metals were low. Nutrient values recorded in the leachate taken from the leachate canal were relatively high. The leachate has a high organic strength as the BOD/COD ratio was greater than 0.7 and this shows the higher biodegradability and acidic phase of decomposition of the landfill. Although there is accumulation of metals in the sediments and water, the concentration has not reached toxic levels to humans.

Key words: Contamination, heavy metals, leachate, nutrients, solid waste, water

INTRODUCTION

Accra, the capital town of Ghana has a population of 3 million people with a floating population of 300,000 (Ghana Statistical Services, 2002). This population growth has not been accompanied by increase in housing and basic sanitation facilities. The implications of these are increases in population density with low income settlements, large waste generation and increased pressure on waste management facilities.The population of Accra generates 500-1800 tonnes of waste per day and this amount is expected to increase by 3.7% annually in the metropolis. An average of 1,250 tonnes of solid waste is collected daily and hauled to a landfill site (Oblogo landfill site), 17 km West of Accra. This facility is an abandoned stone quarry and it began to be used in early 2002. Before its use, there was an installation of clay lining. The site has no engineered containment of leachate. Accra metropolitan assembly (AMA), the body responsible for the collection and disposal of waste in the municipality, is only able to compact the waste to guarantee some level of proper dumping and hence "this site is considered a controlled dump rather than a properly engineered landfill" (Anomanyo, 2004). Improperly managed landfills can pollute surface and underground water. Appropriately, landfills should have plastic linings along the base to collect and treat leachate.

Leachate from landfills with high organic matter, when discharged into a river, increases its biochemical oxygen demand leading to low oxygen available to the existing living organisms. Organic matter from landfills also contains essential nutrients such as phosphorus and nitrogen which are relevant for plant growth. However, the release of these nutrients into water may cause eutrophication. Disposal of metalliferous waste on land can lead to these areas getting completely devoid of vegetation (Mwiganga and Kansiime, 2005).

This study seeks to report on a study that was done to assess the appropriateness of the location of Oblogo landfill, to determine the composition of waste dumped at the landfill and determine the extent of contamination by the landfill leachate on the environment (water and soil).

METHODS

Study area: The surveys were carried at Oblogo landfill site which is situated in the community of Oblogo, on the Western periurban fringe of Greater Accra Region. It is about twelve meters in depths from the valley floor in which it is located to surface ground, and is expected to

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be closed down leaving two meters covered with laterite soil. The landfill is located on a slope which ends in a wetland through which the Densu River passes. It is used for the abstraction of water for domestic use by the local community at both upstream and downstream points of the landfill. The Weija dam which is located upstream of the landfill supplies water to most parts of Greater Accra Region. Near to the landfill site are residential buildings and schools. There are also cattle farms sited close to it. The study was carried from October 2007 to March 2008.

Field measurement and observations: Visits were made to the site to check the suitability of the landfill site for human settlement and water resources. Residents close to the landfill site complained bitterly of their painful plight as a result of the noise and accompanying mosquitoes and flies that are associated with the activities at the landfill (personal communication). The site serves as a reception point for solid waste in the whole of Accra Metropolitan Area. When the trucks transporting the waste arrive, they are weighed at the entry point before going onto the site, and also on the way out empty. Sample collection and analyses were conducted between October, 2007 and March, 2008. Temperature, pH and conductivity were determined in situ using WTW microprocessors. Samples for laboratory analyses were collected in clean 500 mL plastic bottles. Samples for metal analyses were acidified with nitric acid and kept on ice before transporting them to the laboratory of the Ghana Atomic Energy Commission for analyses.

Laboratory analyses: Nitrate-nitrogen, sulphate and phosphate were determined by spectrophotometric methods. Dissolved oxygen was determined by titrimetric method. Heavy metals in water samples were measured by the use of Atomic Absorption Spectrometer (AAS). Sample preparation and analysis followed standard methods (APHA, 1995).

Soil samples were analysed for soil pH and electrical conductivity. Atomic Absorption Spectrometer was used to determine heavy metals in soil.

The study area was divided into three zones. Zone 1 is site 1, which is located upstream of the landfill site. Zone 2 comprises sites (2 and 3). These sites are located on the canal, which carries leachate from the landfill into the Densu delta wetland. Zone 3 includes sites (4, 5, 6 and 7) located in the Densu delta wetland.

RESULTS

Suitability of the landfill site: The extent of contamination of surface water due to leachate flow from the landfill may depend on a number of factors including leachate composition, distance of the water body from the pollution source (the Oblogo landfill site in this case) and other factors. In the present situation, Oblogo landfill site is situated north of the wetland and the leachate flows down slope directly south to enter the Densu River which flows through the wetland.

Communities around the Densu River abstract water from the river for human and animal consumption. There are two cattle ranches, a school and residential buildings within some few meters of the landfill. Nuisances such as noise from vehicles carrying waste, unhealthy odour emanating from decaying garbage, vermin infestation, mosquitoes, houseflies and scattering of garbage by bird affect residents. Residential sewage flows into the landfill. This leads to wash out of leachate with its pollutants into the Densu River. According to the waste management department of AMA (1999), the main characteristics of most of our waste in Accra, Ghana includes food and garden waste(65%), paper (6%), textiles (1.7%), plastic (93.5%), glass (3%), metal (2.5%), inert (17.1%) and others (1.2%). This high percentage of food and plant waste could be attributed to the fact that Ghana is an agricultural country. Apart from food for consumption

Table 1: Values of concentrations of given parameters in the water upstream (site 1), downstream (sites 4, 5, 6 and 7) and leachate from the landfill site (sites 2 and 3)

Parameter	site						
	1	2	3	4	5	6	7
pH of water	9.5	7.5	8.5	7.8	8.3	7.9	6.3
Conductivity (µS/cm)	244	1044	1534	238	732.5	50200	52900
Turbidity (NTU)	50	750	1490	22.5	13.5	126.5	18.5
Nitrate (mg/L)	0.046	0.418	0.392	0.166	0.039	0.217	0.047
Phosphate (mg/L)	0.009	0.112	0.388	0.13	0.26	0.1	0.15
Sulfate (mg/L)	0.28	0.35	1.17	5.2	12.4	22.8	25
BOD (mg/L)	63.33	100	66.7	1.25	6.67	1.67	5.835
Cobalt (mg/L)	0.0049	0.005	0.012	0.0049	0.0049	0.0049	0.0049
Copper (mg/L)	0.0029	0.006	0.003	0.059	0.0029	0.072	0.007
Lead (mg/L)	0.009	0.009	0.009	0.05	0.009	0.02	0.013
Chromium (mg/L)	0.006	0.004	0.022	0.005	0.005	0.001	0.008
Cadmium (mg/L)	0.019	0.019	0.019	0.019	0.019	0.019	0.019
Iron (mg/L)	0.028	0.042	0.478	0.036	0.04	0.043	0.098

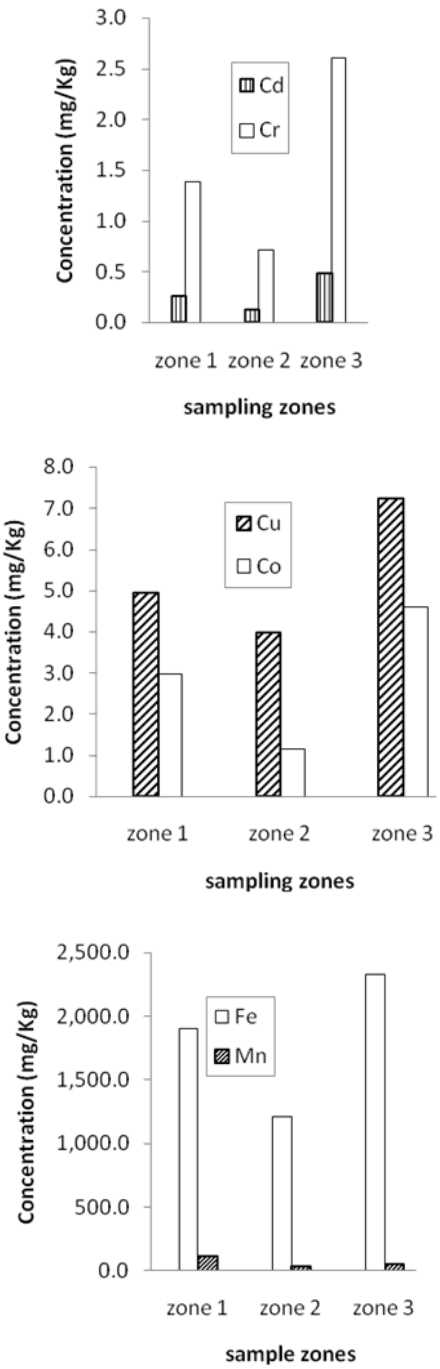

Fig. 1: Variation of heavy metals in soil at 3 sampling zones

and food processing factories, post-harvest losses due to inadequate storage facilities and ready market for the farm produce contributes to the greater percentage in the waste composition. Hazardous solid waste generally occur in small quantities except in the case of specific industrial operations for which the industry concerned takes responsibility and is assisted to put in place management plans guided by standards on effluent and discharges set by the Environmental Protection Agency (EPA).

Generally, some of the variables measured were high in the leachate canal (sites 2 and 3) and the lowest values were recorded at site 1 (Table 1). The conductivity value was lowest at site 1 (244 μS/cm) but it increased at sites 2 and 3 to 1044 and 1534 μS/cm, respectively. The value of conductivity decreased through sites 4 and 5 and increased again at sites 6 and 7 (Table 1).

The concentration of nitrate was low at site 1 (0.046 mg/L) but increased sharply at site 2 (0.418 mg/L) which is the start of the leachate canal, which carries the leachate from the landfill to the wetland. It then decreased gradually from sites 3 to 7 (Table 1).

The concentration of phosphate was the lowest at site 1 (0.009 mg/L) but it increased at sites 2 and 3 and then decreased more gradually from site 4. The trend of decrease from site 4 to site 7 was not uniform, though. BOD concentration was highest in the leachate canal (sites 2 and 3) but then decreased from sites 4 to 7 (Table 1).

The concentration of copper in soil was high at zone 1, i.e. site (4.93mg/kg) but it decreased at zone 2, i.e. sites 2 and 3 (3.98 mg/kg) then increased sharply at zone 3, i.e. sites 4, 5, 6 and 7(7.22mg/kg). The variation of the concentration of cadmium, cobalt, chromium, iron and manganese in soil showed the same trend as that of copper in the soil (Fig. 1).

DISCUSSION

The pH of leachate from Oblogo landfill is between 7.5 and 8.5. This shows that the leachate is alkaline and this is typical of samples from aged wastes (Aluko *et al*., 2003). Such wastewater requires high coagulant dosage to ensure sweep coagulation of pollutants if chemical treatment is desired. Relatively high pH values were contributed to by high alkalinity values which was as a result of high organic strength of the waste. High organic material facilitates algal bloom (Stoker and Seager, 1976). Algae, however, can reduce the free CO_2 concentration below its equilibrium concentration with air and consequently can cause an even greater increase in pH. As the pH increases, the alkalinity forms change, with the result that CO_2 can also be extracted for algal growth both for HCO_3^- and from CO_3^{2-} in accordance with the following equilibrium equations (Stoker and Seager, 1976).

$$2HCO_3^- \leftrightarrow CO_3^{2-} + H_2O + CO_2$$
$$CO_3^{2-} + H_2O \leftrightarrow 2OH^- + CO_2$$

BOD concentrations ranged between 1.25-100 mg/L. For the leachate samples (i.e., sites 2 and 3), the BOD_5/COD

ratio was higher than 0.7. This indicates the higher biodegradability and acidic phase of decomposition of the landfill (Inanc *et al*., 2000).

Relatively, the concentration of phosphate for the leachate was highest in zone 2 (i.e., sites 2 and 3). Nitrate concentration was also high in zone 2. This could be accounted for by the composition of waste dumped at Oblogo. About 65% of waste deposited at Oblogo consists of food and garden waste and this may imply that there is high usage of fertilizers which are major sources of phosphate and nitrate.

In general, the concentration of heavy metals was low. However, zone 2 (i.e., sites 2 and 3) recorded relatively higher values of most of the heavy metals as compared to zones 1 and 3. As depicted in Fig. 1, the concentration of heavy metals in soil was high in zone 1, then reduced in zone 2 and then increased again in zone 3.This could suggest that the release of leachate on the soil led to loss of the metals from the soil.

CONCLUSION

The Oblogo landfill is not well located. It is near an ecologically important wetland. It is also in an area with conflicting land-uses. The wetland is negatively impacting on the environment. It produces nuisances such as such as noise from vehicles carrying waste, unhealthy odour emanating from decaying garbage, vermin infestation, mosquitoes, houseflies and scattering of garbage by bird which are not properly mitigated. The landfill also produces large volumes of leachate that are released into the Densu wetland. BOD/COD ratio of leachate was above 0.7 which shows the high biodegradability and acidic phase of decomposition of the landfill. Although heavy metal concentration was generally low, the landfill leachate recorded relatively high values which were attenuated by the sediments in the wetland to an extent that their concentrations in zone 3 (i.e., sites 4, 5, 6 and 7) were very low.

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