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MANAGEMENT PRACTICES AT THE MUCHEKE MUNICIPAL SOLID WASTE DISPOSAL SITE IN MASVINGO CITY, IN ZIMBABWE

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Abstract
The management of solid waste dumpsites in Zimbabwe presents a number of challenges. This study examines the management practices at Mucheke dumpsite in Masvingo City in Zimbabwe. In looks at the criteria used to locate the dumpsite, the waste streams at the dumpsite, and the environmental impacts resulting from the practices. It was observed that the council did not adhere to the stipulated location criteria of dumpsites. The management practices are weak. The dumpsite is not protected and can be accessed any time of the day. Wastes are not inspected before they are dumped at the site. Wastes of various types reach the site and it remains uncovered for long periods. The study recommends that more stringent measures should be put in place to mitigate a possibility of an environmental disaster. These include restricting access to the site, covering waste promptly and inspecting waste before it is dumped.

Background to the study

Most urban areas in the developing world use the crude dumping system to dispose of their solid waste. This is whereby waste is tipped into a dump, which has very little on-site management. In Zimbabwe, at least 60% of municipal solid wastes generated in large cities are dumped at crude also known as open disposal sites that do not meet basic environmental standards (Masocha 2002). Mukuka and Masiye (2002) observe that disposal sites in Zambia use the open dumping method, and there is no control over the type of waste dumped at these sites. Wastes remain uncovered making them a potential health hazard. The selection of tipping sites (dumpsites) is done

arbitrarily (Tevera, 1995). In most cases these are borrow pits, which need reclaiming. In support Mukuka and Masiye (2002) propound that most dumpsites are abandoned quarries, rather than properly designed disposal sites, hence they are of a reclamation type. Tevera (1995) also argues that most dumpsites are located close to the built-up areas. This compromises the health of the residents. Chenje (2000) argues that due to the absence of appropriate technologies most dumps fill up within a few years because waste is not compacted. Current compacting machines are capable of reducing 30 cubic meter of loose solid waste to 1 cubic meter of dense waste. This study was based on the following objectives.

Main objective:

To establish the management practices at the Mucheke municipal solid waste disposal site.

General objectives:

i. To establish the different waste streams that reach the disposal site.
ii. To examine whether location criteria were followed.
iii. To identify possible environmental impacts of poor management at the site.
iv. To suggest better ways of managing the disposal site

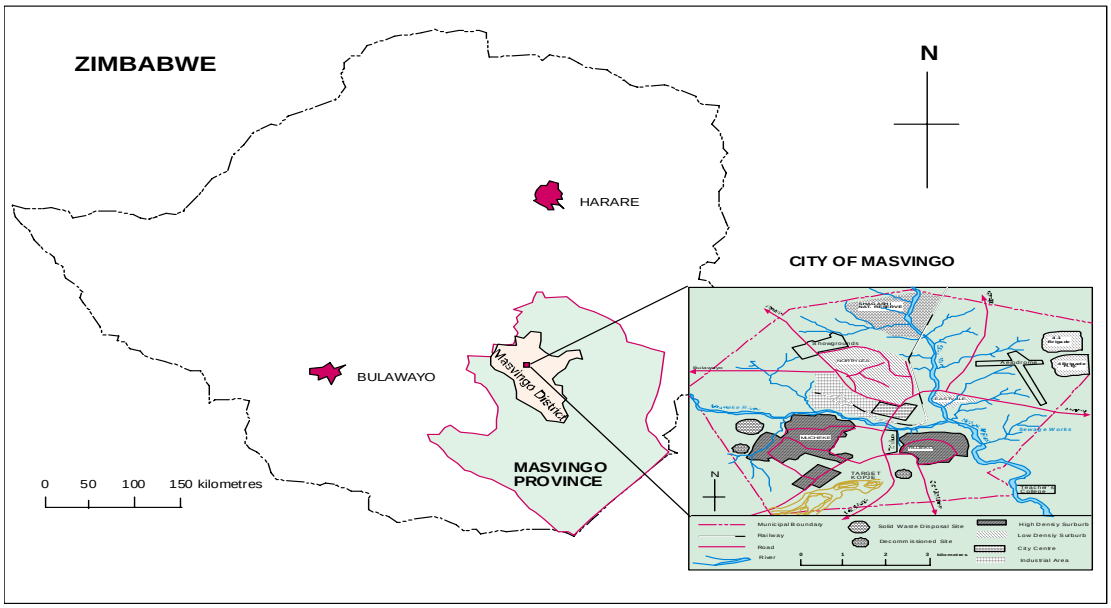
Study Area

The study was carried out in the City of Masvingo (Fig 1) between May and August 2003. Masvingo city is located in the southern part of Zimbabwe. The study is based on the city's solid waste disposal site. The disposal site is on the margins of Mucheke high-density suburb in the western direction of the city. The dump received

waste from the high-density suburbs of Mucheke and Rujeko, low-density suburbs of Rhodene, Northlea, Eastvale and Clipsham Park. It also gets waste from the industrial areas, academic institutions such as Masvingo Teachers College and Masvingo Polytechnic College, and several schools as well as the army barracks. It was observed special wastes such as hospital waste and industrial wastes were illegally dumped at the site.

The dumpsite, which was commissioned in September of 1997, is located 8 km from the city centre, and it is about 1.2 km from Runyararo West, a section of Mucheke high-density suburb. The pit covered an area of approximately 2.5 hectares. Its depth varied in places with the deepest section being 4m deep. The pit was divided into 4 cells. Each cell was 100m long and was between 15 and 20m wide, while it was 1.5m thick. Each cell had 4 layers. During the time of the study, three cells were already full while the fourth, which was the last, was already filling up. This reflected on poor planning on the part of the council. At commissioning it was projected to have a lifespan of 15 to 25 years. The Municipality of Masvingo excavated this pit following an Environmental Impact Assessment. During that time it was 3 km from Runyararo West (Mangizvo, 2003).

Figure 1: Location of Masvingo City in Zimbabwe



Source: Research data

Methodology

A case study was used to establish the management practices at the disposal site. The study also employed the use of questionnaires, which were distributed to residents of Runyararo West specifically to establish the impacts of the disposal site on the suburb. The suburb has 250 households and 50 were randomly selected. House numbers were written on small pieces of paper then put in a hat. Fifty were randomly picked. Interviews were conducted with key informants such as the city council's Cleansing Superintendent, officials from Zimbabwe National Water Authority (ZINWA), Environmental Management Authority (EMA) and the residents of Runyararo West suburb. This was in a bid to find out whether any planning was done before the pit was excavated, as well as getting the views of the main stakeholders on the management practices and environmental impacts from the site. Waste pickers were also interviewed. Observations were made on several visits that were made to the site to identify the practices in place at the dump, and the environmental impacts resulting from the dump. Measurements of both chemical and biological contaminants were done on

leachate and soil samples drawn from the dump. This was to ascertain the impacts of the disposal site on water and soils.

Findings and discussions

Location criteria

The council did not strictly adhere to the location criteria for dumps when creating the Mucheke Dump. The dump was less than 1 km from the nearby Mucheke River. It was located upslope of the river. It was therefore and still remains a potential source of physico-chemical and micro-biological contaminants, which, could be transported by overland flow and seepage to surface and groundwater sources respectively.

The site at the time of excavation was 3 km from the built up area. This was not desirable as flies, rodents and other disease vectors could easily affect the residents of Runyararo West suburb. According to Pickford (1983) houseflies, which are effective carriers of sanitation-related diseases such as cholera and diarrhea, can fly for up to 5 kilometers. This meant that the dumpsite was too close to the residential area.

The dump is located in an area with rich clay soils. It is also rocky in some places and these two factors help to reduce pollution of underground water by leachate. However this is not adequate as lining and compaction are essential in arresting infiltration. The dump did not have any lining at its basements. No compaction was done on the basement to reduce infiltration of leachate into the underground. According to the Cleansing Superintendent it was assumed during the creation of the dumpsite that compaction and lining were not necessary since the basement consisted of hard ground, which was rocky and contained a little bit of clay soils. This would therefore reduce infiltration of leachate

to join groundwater. Coincidentally the council took this as a cost saving measure since its financial resources were limited. However the absence of lining and compaction meant that groundwater was prone to contamination by leachate.

It would appear the issue about the capacity of the dump was not given adequate attention. At it excavation it was projected to have a lifespan of 15 to 20 years yet it was filling up after being in use for about 10 years. It was apparent that factors that contributed to increase in waste generation were not given adequate consideration. The capacity of the dump was not established, hence like its predecessors it will fill up quickly. This will present problems of acquiring another site to the council; as such type of land is hard to come by. It will also be costly to excavate a new dump, whilst giving post-decommissioning attention to this dump.

The composition of the waste at the site

The study established that since the co-disposal method was used at this disposal site, a variety of solid domestic waste reached the site. This study revealed that waste at the site comprised of plastic papers and containers, newsprint paper, glass, putrecibles, metals and ceramics. Some hazardous waste such as discarded car batteries, aerosol cans and hospital wastes, which included blood stained bandages and X-ray negatives were also identified at the dump. According to Hardoy et al (1993) in many cities hazardous wastes become mixed with household wastes and this exposes individuals who pick waste at dumps to many health risks. Similarly waste pickers at Mucheke dump were exposed to serious health hazards. The composition of the waste is summarized in Table 1 below.

Table 1: Types of wastes at disposal site

Type of Waste	**Percentage**
Plastics	40

Paper	30
Petrucibles	15
Glass	5
Metal	4
Other	6

Source: Research Data, 2007

Management of waste dump

a) Fence: At the time the study was carried out the dump was not fenced as council (responsible authority) actually removed it. This was because the fence was being vandalized, and several lengths had been stolen. From the interview the Cleansing Superintendent revealed that the municipality had no option but to remove the fence. However the absence of the security fence led to a number of problems. Firstly wind blown debris such as plastics and paper were observed about 3 km away from the pit. This was because there was no fence to hold them back. This compromised the aesthetic value of the environment around the pit. Seventy five percent (75%) of respondents from Runyararo West Suburb confirmed that they experienced problems of litter from the pit on their yards. They argued the litter originated from the dump. They further expressed that the litter was both a nuisance and a health hazard to their children who could pick it oblivious of its dangers.

Secondly the absence of the fence made the site accessible from any direction. Dumping of materials was therefore difficult to regulate. All waste was supposed to be checked before it was allowed in. This was not possible as some waste was allegedly brought to the site during the night, or during weekends when attendants were not at the site. Special wastes such as medical waste and industrial waste were supposed to have their own dumping place. This put the health of waste pickers at risk as they could pick some of the hazardous waste. Due to the absence of a fence some prohibited waste were

dumped at the Mucheke Dump. For example, during the time of the study two dog carcasses were observed at the dump. Under normal circumstances these are not supposed to be dumped together with domestic waste. Some waste pickers even alluded that condemned beef from private abattoirs were dumped here. This was being recovered and being sold to unsuspecting residents of Mucheke high-density suburb. The Cleansing Superintendent revealed that some abattoirs did not want to pay disposal fees at the incinerator for condemned carcasses hence they dumped these at night when the dump was not guarded.

Thirdly, the absence of a fence resulted in waste being dumped in wrong cells. Individuals could access the dump from any direction at any time of the day. As a result this led them to deposit their waste in any cell without consideration of the cell that was in use. Several heaps of wastes were observed on top of cells that the council had declared full and had been covered with soil. This tended to compromise the management practices at the dump.

b) Weighbridge: It was observed that there was no weighbridge at the dump. Trucks drove into the dump willy-nilly. Some damp waste was being allowed in and this tended to quicken the rotting of waste at the dump. Weighbridges are very important in that all wastes that enter the landfills or dumps must be weighed and checked for moisture content. These weights are used when estimating the lifespan of a landfill or dump. Again most prohibited waste is detected at the weighbridge. They therefore have a multipurpose. The Cleansing Superintendent explained that the municipality could not erect a weighbridge since these were very expensive and had to be imported. Over the years (Table 2) weights were based on approximations. In such a situation it is very difficult to estimate the lifespan of a site.

c) Use of fire: Fires were observed to be a common phenomenon at Mucheke dumpsite. Fires were either started by attendants to reduce the amount of waste paper and plastics at the site, or it started spontaneously from heated glass. Waste pickers also used fire to recover wire from old tyres. Fires also started as a result of hot ashes that were dumped at the site. Fires have been a big problem at the site as they can burn for long periods because fire went deeper into thick layers of waste. A smoldering fire was observed during the time of the study. Though it was not extensive it had the potential of injuring the waste pickers or young children who often visited the dump to salvage materials for use or resale. Ninety-two percent of the respondents from Runyararo High density suburb complained that the dump was a source of offensive smoke. The toxic fumes posed health problems to people inhaling the polluted air especially those suffering from asthma. The fumes, which contribute to the problem of Greenhouse Gases concentrations in the atmosphere, have long-term effects on climate change. They produce substances that deplete the ozone layer. This could result in increased temperatures

d) Soil Cover: The Cleansing Superintendent revealed that the waste remained uncovered for up to 3 months. This was due to lack of suitable equipments. The health Department depended on hired equipment from the Engineering Department. The machinery was experiencing continuous breakdown and Council lacked foreign currency to procure spare parts. Both the fronted invader and the dozer, which could be used to cover the soil, had mechanical faults. Only one tipper was functional. The municipality experimented with the use of manual labor to cover the waste. During the time the study was conducted 20 casual workers were contracted to cover the soil. They used wheelbarrows and shovels. The soil used to cover the waste was recovered from the heap that was created when the pit was dug. The process was tedious and slow. The waste, which remained uncovered for long periods, provided a conducive environment for the breeding of diseases vectors such as flies. Maggots were observed at the dump and flies posed a potential health threat to Runyararo West suburb. Sixty five percent (65%) of the respondents were of the view that cases of stomach ailments reported in Runyararo West suburb were linked to the dump. The sampled residents revealed that flies were a nuisance during the summer season. They argued these came from the dump. While on the one hand this situation was bad for solid waste management, on the other hand, waste pickers were happy that they had more time to recover items from the waste.

e) Leachate pond: As a way of reducing the leachate problem at the dump a leachate pond was created about 130m down slope from the dump. Excess leachate was drained from the dump by gravitational pull, and then collected in the leachate pond. While it helped to reduce the problem at the dump, it created a number of environmental problems such as pollution of underground water, as well as water in Mucheke River if the pond

gets flooded. Wild animals, which drank water from the pond, were likely to be poisoned.

Products of the dump

a) Leachate: It was observed that a lot of leachate was being produced at Mucheke dumpsite. From observations made by Mangizvo (2003) waste entering a disposal site has some moisture since most of it is domestic. Pressure of successive layers of waste being placed, squeezes water out of the waste at the lower layers. This moisture contributes to the total amount of leachate that collects at the bed of the dump. The leachate percolated into the ground as the dump was neither lined nor compacted. This could possibly lead to the pollution of the underground water. Hardoy et al (1993) concur with the view that rubbish dumps contaminate underground water. A sample of leachate was collected from the dumpsite and tested for a number of parameters. Table 1 shows these.

Table 2: Sample of leachate from the solid waste disposal site:

Parameter	**Units**	**Method /Instrument**	**Analysis Result**	**Maximum Permissible Limit**
pH		pH Meter	6.6	6.0-9.0
Conductivity	S/m	Conductive Meter	0.976	0.1
Arsenic (As)	mg/L	AAS	ND	0.5
Cadmium (Cd)	mg/L	AAS	ND	0-5
Iron (Fe)	mg/	AAS	16.36	Less than 0.1
Copper (Cu)	mg/L	AAS	0.03	Less than 1
Lead (Pb)	mg/L	AAS	0.14	0.5
Phosphorus (P)	mg/L	Colourimetry	62.75	1.0
Hardness	mgCaCO3/L	Titrimetry	12.4	50-100
Sulphate (SO4)	mg/L	Gravimetry	94.74	50
Faecal coliform	Most probable number per100ml		1500	0 counts per 100ml
Total bacterial	Count per 100ml		>3000	0 counts per 100ml

***AAS = Atomic Absorption Spectrometry**

Source: Research Data

The following elements were detected in the leachate; lead, iron, copper, phosphorus, sulphates bacteria and faecal coliforms (E-Coli). The following impacts may occur to fauna and flora in Mucheke River:

- Lead could have come from lead containing ceramics, pesticides, cans, solder used in food cans and some industrial products dumped at the site. Lead is toxic to aquatic organisms. It is a carcinogen, which can accumulate in fish and cause cancer in individuals who consume the fish. Lead may cause nervous system disorders and kidney damage. Since it accumulates in body tissues, it is especially hazardous to the fetus or to children under three years of age.
- Iron could have been coming from metal tins and objects that were strewn all over in the disposal site. Iron was identified to be in high levels at the disposal site. Iron oxidizing bacteria that oxidizes ferrous to ferric iron produces a slimy coating that can harbor pathogenic micro-organisms. As a result it may be difficult to control the breeding of mosquitoes as the slimy material prevents chemicals from getting to the lava. Tissue damage can result from prolonged eating of food stuffs cooked in iron water. There is a possibility that contaminated water could get to Mucheke River. Waste pickers and squatters used water from Mucheke River for cooking, as there was no piped water at the site. This meant that they could end up being affected by this water.
- Copper coming from industrial deposits metal products dumped at the site could cause gastro-intestinal disturbances, liver, kidney and red cell

damages if consumed in high quantities. It is also toxic to plants and fish at certain concentrations.

- Nitrates, phosphorus, and sulphates were observed in levels higher than the desired ranges. These tended to promote weed growth and eutrophication of water in Mucheke River, especially at the point water from the dump joined the river. The heavy presence of hyacinth in Mucheke River could be partly attributed to this. Excessive weed growth does not allow enough light to reach photosynthetic aquatic life forms. The presence of nitrates, phosphates and sulphates tends to promote the proliferation of decomposing bacteria, using up the available oxygen and increasing the concentration of toxic compounds such as ammonia. Fish and other animals that require clean, well-oxygenated water perish and their dead bodies increase the activities of the decomposing bacteria. Photosynthesis that occurs in water bodies is also essential in maintaining oxygen. Excessive weed growth also accelerates water loss from a water body by increased evapo-transpiration. This partly explained why water levels in Mucheke River quickly dropped as the river was heavily infested with the water hyacinth.
- Faecal coliforms (E-Coli) in the collected leachate water sample were innumerable. For drinking water the count should be zero. This water was never supposed to get into contact with drinking water for humans and animals since it was highly contaminated. This water could cause diarrhea, cholera and dysentery. Furthermore E-coli is an enteric

pathogen, which can survive in water up to 117 km from the point of discharge. Its effects are not therefore localized (Mason, 1991).

- Bacteria count should be zero but in this case it exceeded 3000 per 100ml. This water was never supposed join drinking water as it was highly contaminated. The water could cause diarrhea, cholera and dysentery.

b) Odors: Mucheke disposal site produced some offensive smell. The organic matter was putrescent. The problem was made worse by lack of soil cover over the waste. This attracted flies, rats and other vermin, which later on visited the Runyararo West Suburb. There was lack of technology to spread the waste evenly, thereby creating depressions within the waste. Ponds of water collected in the depressions and this encouraged decomposition.

Conclusions and Recommendations

The following conclusions were drawn:

Conclusions

It was established that waste management at the solid waste disposal site was not being done sustainably. It was concluded that the planning process was poor on the part of council. The council did not project the lifespan of dumps correctly on commissioning the new sites. The sites filled up before the projected time. Some of the sites were decommissioned because the new suburbs of Hillside and Runyararo West were encroaching onto them. Between 1980 and 2003 four disposal sites were decommissioned. The current disposal site was likely to be engulfed by the expanding Runyararo West Suburb. It was also filling up fast at a rate that was never anticipated

before. It was apparent that the council was running out of suitable land for disposal sites, as that type of land was difficult to come by.

The council did not have enough revenue to efficiently manage the solid waste disposal site. The council depended on monthly rentals and refuse fees to maintain the site. These were very inadequate as amounts paid by tenants were set at unrealistically low levels. As a result the council was unable to procure suitable equipment such as the dozer, front-end loader and the weighbridge as they were very expensive. These were very important in the management of the site. The council was unable to import spare parts for broken down machinery, as it did not have foreign currency.

Recommendations

The following recommendations could help improve the management of disposal sites.

- It is imperative at the planning stage, for the council to follow the location criteria when citing a new dumpsite. This will reduce negative impacts of the dumpsite on the environment and people.
- Access to the site should be controlled, either by fencing or by having people manning it. This means that only suitable solid waste material is dumped at the dump. It is easier to deal with special wastes such as hospital and industrial waste if the dump is protected.
- Fast growing species of trees should be grown, for example the eucalyptus as these have a multi-purpose. These have a high affinity for water so they help reduce water contamination. They also act as an effective screen from built-up area while holding back litter from flying out of the dumpsite.

- A detachable weighbridge, which is less expensive, could be installed on the access road instead of a computerized office with a weighbridge. This enables the effective monitoring of waste flows and to charge for disposal by private companies.
- A well or borehole should be drilled to enable monitoring the presence of leachate in the underground water. Contamination levels are therefore regularly checked.
- Use of fire should be avoided as this causes air pollution as well as emergence of greenhouse gases.
- Waste should be covered promptly with well spread out soil to reduce the incidence of odor, flies, rodents and vermin. The soil cover should be well spread out so that water does not to settle in form of small ponds on top of the waste as this aids decomposition.
- Waste should be compacted to increase life span of the site. The council does not decommission old sites and look for new sites as ground for such use is limited, and urban centers are growing exponentially.
- The basement should be either lined or compacted to stop leachate water from contaminating groundwater.
- The central government should assist the municipal council to acquire foreign currency to enable it to buy appropriate machinery and spares to enable smooth running of the disposal site.

It is hoped that the above discussion will help to improve the management at the disposal site.

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