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Assessment of the Contemporary Municipal Solid Waste Management in Urban Environment: The Case of Addis Ababa, Ethiopia

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ABSTRACT

Municipal Solid Waste (MSW) management is one of the most fundamental issues in the contemporary urban environments particularly in developing countries like Ethiopia. Huge generation of MSW coupled with unbalanced waste management services is the major challenges facing the City of Addis Ababa. The aim of this paper is to evaluate the current Municipal Solid Waste Management (MSWM) practices in Addis Ababa. Both quantitative and qualitative sampling methods were employed through primary and secondary sources. The result showed that the daily generation of solid waste is estimated to 0.5 kg per capita per day and the density of solid waste ranges from 205 to 370 kg m⁻³. The finding showed that there are some generic factors contributing to the poor management of solid waste in Addis Ababa. These derivers include: Lack of sufficient budget, inadequate and malfunctioning operation equipment, illegal dumping on undesignated sites, open disposals, poor condition of the final dump site, lack of effective public participation and in adequate governance in waste management system. Therefore, early involvement of representatives from all concerned stakeholders in the planning process and continuous awareness are critical elements of successful solid waste management programs.

Key words: Addis Ababa, Ethiopia, municipal, solid waste management, urban environment

INTRODUCTION

Solid waste management is becoming a big challenge for the cities' administrations in many developing countries mainly due to the magnitude of rapid urbanization and increasing population growth which in turn have greatly accelerated the municipal solid waste generation rate in the urban environment (Williams, 2000; Zhang *et al.*, 2010; Guerrero *et al.*, 2013). The burden of increased waste generation poses on the municipal budget as a result of the high costs associated to its management, the lack of understanding over a diversity of factors that affect the different stages of waste management and linkages necessary to enable the entire handling system functioning (Moghadam *et al.*, 2009).

In most urban centers of developing countries, municipal solid waste management (MSWM) is highly unsatisfactory (SKAT, 1996; Henry *et al.*, 2006) and beyond the capabilities of their economic setup for handling and disposal (WHO, 1996; Seik, 1997; Rakodi, 1997; World Bank, 1999). Hence, the issue of MSWM is major concern in many urban areas of

low-income developing countries (Moningka, 2000; Hardoy *et al.*, 2001; Zerbock, 2003), though their waste generation is low in comparison with middle income and industrialized countries (Cointreau, 1982).

Agunwamba (1998) strengthened the fact that low-income countries are characterized by poor methods and low capacities of MSWM. UNCHS (1996) also stated that between one-third and one-half of the solid wastes generated within most cities of low income countries are not collected and the waste generated is dumped at many undesignated sites (Haan *et al.*, 1998; Bartone, 2001). Therefore, their management is a complex task that requires appropriate organizational capacity and cooperation between numerous stakeholders both from the private and public sectors from collection to resource recovery and from treatment to disposal practices (Cointreau-Levine, 1994; SKAT, 1996); otherwise poor environmental quality in a city can deprive people of good quality of life (Gerlagh *et al.*, 1999).

Addis Ababa is established in 1879 as a capital of Ethiopia. Despite its early establishment, the city of Addis Ababa started its SWM 71 years later after its establishment with the aim of ensuring the health of its residents. Yet, the city is still faced with a number of waste management problems. Therefore, the present paper attempted to provide an assessment of different aspects of MSW management practices of Addis Ababa with the specific target to: (1) Identify MSW generation, composition and quantity in Addis Ababa, (2) Examine the different methods for MSW collection, storage, treatment, transportation and disposal, (3) Examine actors involved in the MSWM, (4) Examine how waste management and planning objectives and issues be addressed and (5) Suggest future SWM planing options.

METHODS

Study area: This study is conducted at Addis Ababa City which is the capital city of Ethiopia and it is a diplomatic capital for African Union, the United Nations Economic Commissions for Africa and regional head quarters for UNDP, UNICEF, UNHCR, FAO and ILO. The city is sub-divided into three layers for administrative purposes namely City Government, sub-cities administrations and Woreda (local name for District) (AACAA, 1998) (Fig. 1).

The city has currently a population of about 3.5 million with density of 5936.2 km² and an area of 540 km². The altitude in the city ranges from 2000-3100 meter above sea level. The months from June to September are the periods of heavy rain with 80% of the annual amount falls at these periods and the average annual rainfall of the city is 1200 mm (AACAA, 2002) while the small rain occurs between March and May. The temperature is mild and warm climate with annual average temperature between 10 to 20°C.

Data collection and analysis method: Both quantitative and qualitative data collection methods were employed from primary and secondary sources. Ten sub-city offices of Addis Ababa Solid Waste Management Agency were considered as a sample units and a range of data were collected through semi-structured interviews, observations and document reviews of the concerned institutions.

Physical surveys were carried out by visiting the various existing waste collection points and by examining the available equipments being used to manage the waste. Survey questionnaires were subject to pre-test as a modification task to identify and correct any sequencing, wording, or redundancy. The survey was intended to capture the overall solid waste management key issues in the city. Similar methods were used by other researchers through apply semi-structured

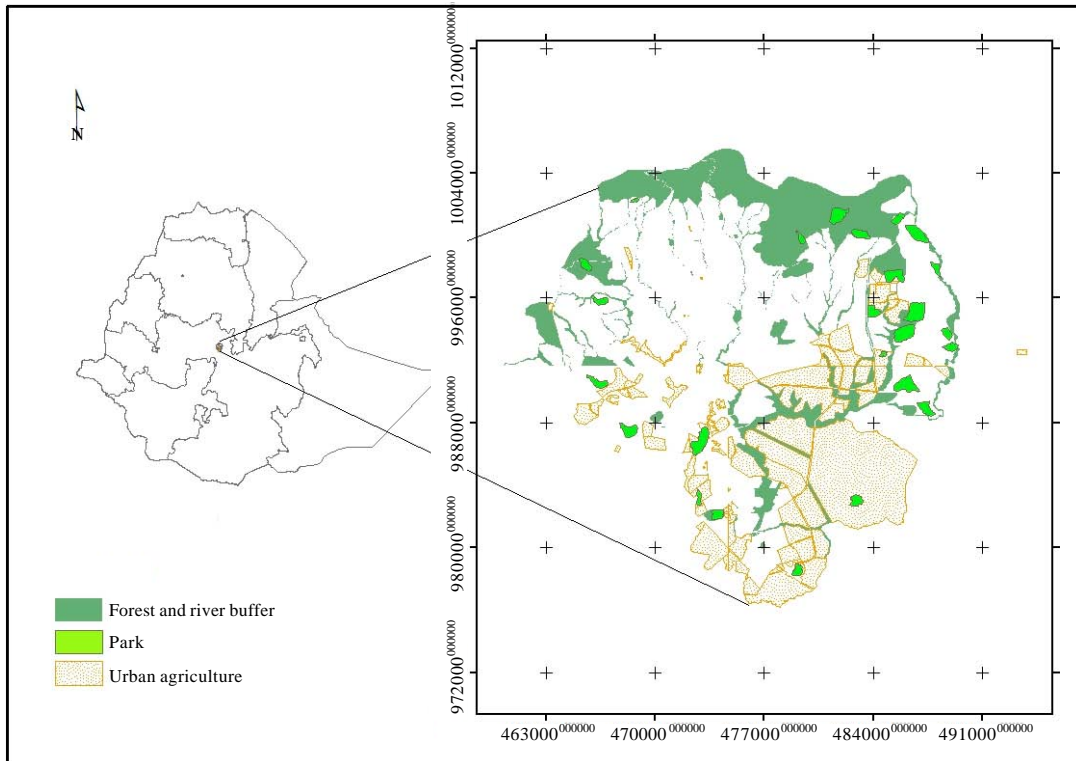


Fig. 1: Map of the study area

interviewing in order to capture the public opinions (Onwuegbuzie and Leech, 2005; Muskat *et al.*, 2012). Both open and closed ended questions were incorporated to identify and extract information. The sample comprised ten Solid Waste Management Offices in their respective sub-cities. Interviews and physical observations were completed in the office hours between 9-12 AM and 2-5 PM on weekdays in February-March 2012. Each office in the sub-cities was first explained about the purpose of the survey as focused only on the solid waste management of Addis Ababa. Average questionnaire survey completion times ranged from 20 to 30 minutes. Upon completion of the data collection and entry tasks, data were computed to display the data in counts and percentage. The data collected from each sub-cities were then analyzed using the Statistical Package for the Social Sciences (SPSS) software version 20.

RESULTS AND DISCUSSION

Solid waste generation: Currently the daily solid waste generation in the city of Addis Ababa is estimated to be 0.5 kg per capita per day, the density ranges from 205 to 370 kg m⁻³ and the daily waste generation has reached to 2,750 m³. Therefore, considering the city's population of 3.5 million people (CSA, 2007), it is estimated that approximately one million m³ of solid waste is generated per year.

With the existing level of urbanization, Palczynski (2002) estimated that there would be two fold increase of solid waste generation in few years time in developing countries. Just like the rest of African cities, most of the solid wastes generated in the city of Addis Ababa are organic in their natures (Table 1) with households, institutions, commercial centers, factories, hotels, health facilities and streets as the major sources of generation types.

Table 1: Types and composition disposed every day

Constituents of solid wastes	Percent
Vegetable	4.2
Paper	2.5
Rubber and plastics	2.9
Wood	2.3
Bone	1.1
Textiles	2.4
Metals	0.9
Glass	0.5
Combustible leaves	15.1
Non-combustible stone	2.5
Miscellaneous waste	65.0
Total	100.0

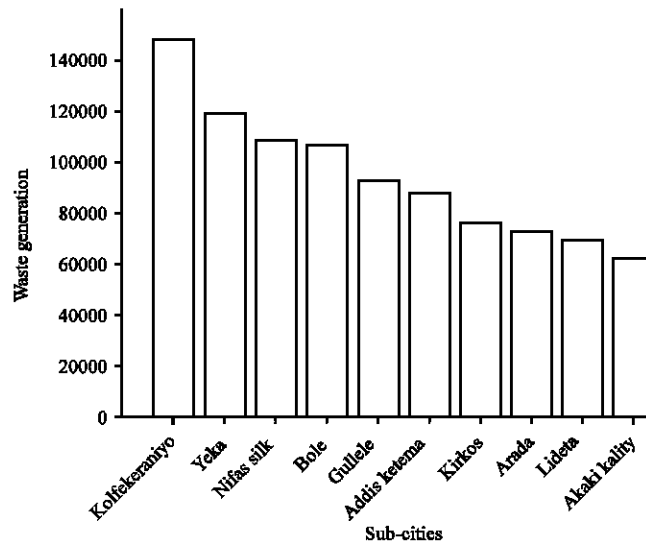


Fig. 2: The 2010 solid waste generation (m³) in ten sub-cities of Addis Ababa

Comparison in the amount of waste generation varies among the ten subcities of Addis Ababa which might mainly be due to the differences on their population sizes (Fig. 2). Streets are also one of the major areas of municipal waste generations in Addis Ababa and are affecting the aesthetic appearance of the city.

However, special attention has not yet been paid in the city’s development plan to address the street cleaning services. However, streets requiring cleaning in the city have been increasing specially since 2003 and yet, the current rates of streets being cleaned each day are only 41% (Fig. 3). Although there is an increase in the coverage of street cleaning to alleviate the street sanitation problems, the service delivery has not proportionally been stretched hand in hand with the construction of new roads that require regular cleaning in the city.

Solid waste collection: In urban centers throughout African regions, less than half of the solid waste produced is collected and 95 percent of that amount is indiscriminately thrown away at various dumping sites (Mohammed and Elsa, 2003). Within urban centers in developing countries,

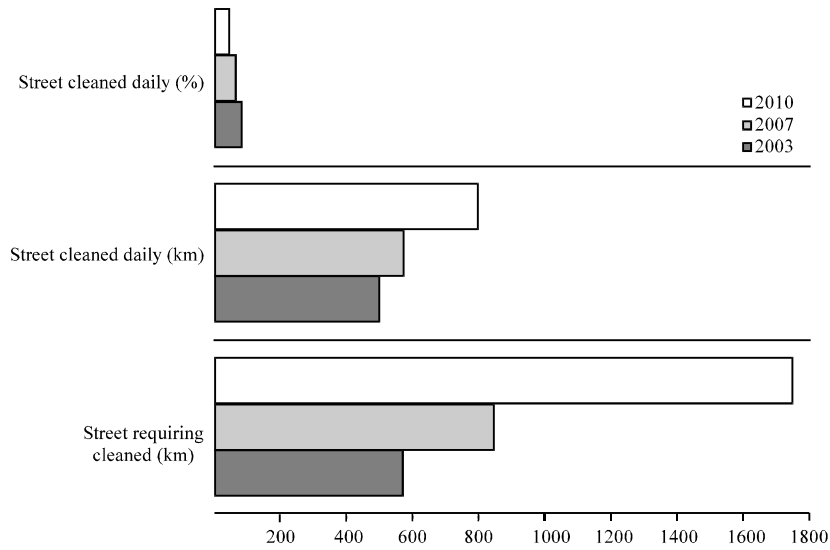


Fig. 3: Length of streets being cleaned each day in different years

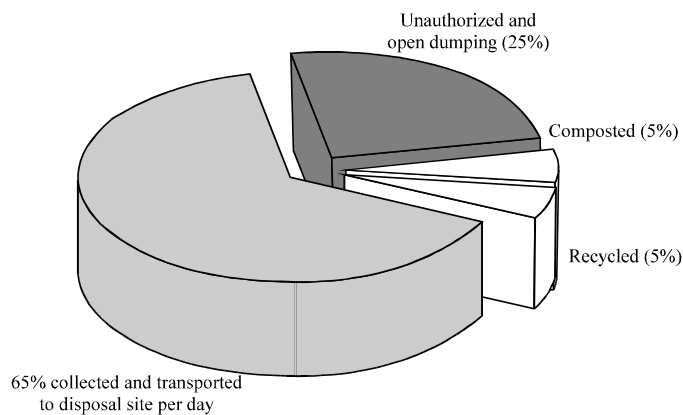


Fig. 4: Daily total waste collection and processing rate at Addis Ababa

30% to 60% of the generated solid wastes are left uncollected (Hardoy *et al.*, 1993; Serageldin *et al.*, 1995; Schubeler, 1996; Rushbrook and Pugh, 1999). This has been proved to be true in Addis Ababa as only 65% of generated wastes are collected and transported to the disposal site and the rest is disposed informally in a manner of polluting the environment (Fig. 4) and the remaining amount is left uncollected thereby disposed in sanitary drainage channels, rivers, open spaces, street sides among other improper places (Abdulwahid, 2003).

Solid waste collection policy: The solid waste collection policy in Addis Ababa has been decided by the city administration. According to the existing policy, solid wastes are collected by the government employees, private companies' based on contractual agreements and Micro and Small Enterprises (MSE). However, the principle stating that the waste producers are subject to put their wastes into different containers based on specific type of wastes is not practiced in the city.



Fig. 5(a-b): (a) Collection using push carts (Photo by WMA) and (b, c and d) Storage on street sides and pedestrian walkways

Solid waste collection methods: With the existing infrastructure facilities and manpower capacity, it is being attempted to collect and transport MSWs to a disposal site on daily basis. However, some distant parts of the city have very often less frequent collection than those in the center. In general, the collection is currently handled in different types of collection systems namely the door-to-door, curbside, set out, the block (container) collection systems and the street sweeping.

The door-to-door collection system is applied for households and is carried out by MSEs by walking the short distances from house to house. Each house owner put wastes in baskets, sacks, plastic bags or other suitable materials at the door side so that the collectors pick up and bring wastes using the pushcarts (Fig. 4a) to common temporary storage points for the trucks to pick up them to the disposal site. Some of the storage areas could be street sides and pedestrian walkways as shown in Fig. 5b and c. However, the regularity and frequencies of collection are not always maintained due to the less number of laborers with their low payment. But the method is not implemented in apartments and condominium houses.

Curbside collection system is the second most common practiced method where different sized containers are kept by the city administration near the street corners and street crossings so that householders deposit their wastes on them using baskets, plastic bags, sacks, or other suitable materials on regular frequencies. However, due to their low level of awareness some of the city dwellers end up throwing carelessly and littering the surrounding areas of the containers causing unclean and ugly view and attracting scavengers. However, setout collection system is not so popular in all parts of the city. It exists only in areas where there are no door-to-door collection systems especially in apartments and condominium houses. In this method, collectors are blowing horns as a signal indicating that they are there to collect wastes. After receiving the signal, the housing community members take out and deposit their wastes on pushcarts placed at convenient corner, which will later be taken to the transport trucks' site. The block (container) collection system is carried out by private companies from hotels, hospitals, schools and other service delivery and manufacturing organizations. Street sweeping is held by the Addis Ababa Solid Waste Management Agency.

Table 2: Beneficiaries and frequency of collection in Addis Ababa

Collection systems	Beneficiaries	Average frequency
Door-to-door	Households and community	Twice in a week
Private companies	Medium and large scale institutions	Once in a week
Street cleaning	Community	Daily

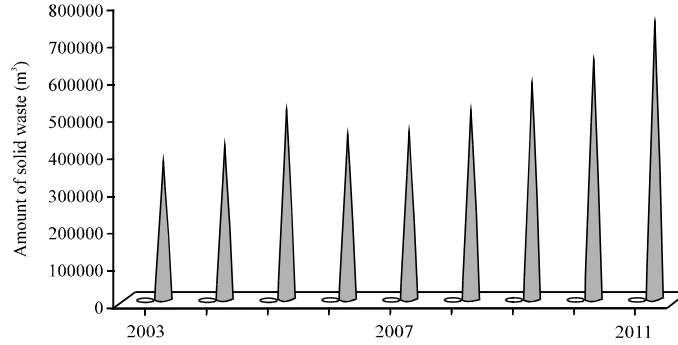


Fig. 6: Solid waste collected from the years 2003-2011 in Addis Ababa

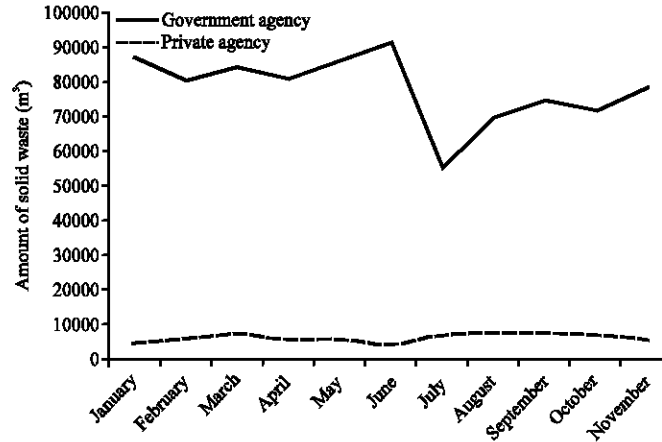


Fig. 7: Amount of solid wastes collected by private companies and city government in 2009

In general, enormous amount of solid waste is collected from three major sources namely households through door-to-door, institutions through private companies and street sweeping as shown in Fig. 6. Currently large proportion of wastes is collected by the micro and small enterprises and the remaining by private companies and employees from the city administration with different collection frequencies based on the types of sources (Table 2). However, the contribution of private companies is still low as compared to the government share as observed in 2009 (Fig. 7).

However, a shortage of waste containers in some parts of the city is also the problem Hence, collected wastes are improperly stored on open spaces and roadside as shown in Fig. 5 b and c until they are transported to the disposal site. UNDP (2004) also strengthened the existing fact that the waste collection service is unsatisfactory and observation of scattered waste is common in most part of Addis Ababa. Nonetheless, the collection system does not fully cover all residences, commercial centers and institutions specially those that are distant from the center.



Fig. 8: Platform for solid waste collection at each sub-woreda

Thus, the efficiency of the existing collection system is limited because of the low capacity of the city to allocate adequate budget for waste storage containers and waste transporting trucks.

Solid waste transfer stations: Transfer stations are intermediate places at which solid wastes are deposited and stored until transported to the final disposal site. However, they are not given due consideration to be incorporated as one of the components in the SWM scenarios of Addis Ababa development plan so that the city still lacks transfer stations. However, the collected wastes are stored on the roadsides and some other corners of the city until they are transported to the city's disposal site. Moreover, the collected wastes are totally kept open without cover and exposed to rain and sun making them to produce superfluous odor, cause hideous urban panorama, attract vectors and disturb human activities in the surrounding area.

Based on the road accessibility, population size, areas' slope, sensitive areas such as school, churches, mosques, the Addis Ababa Solid Waste Management Agency has designed setting up two platforms that consist of two containers (Fig. 8) per sub-woreda for the existing 841 sub-Woredas (Fig. 9).

However, the proximity of storage sites' to the community is not taken into consideration in most parts of the city especially in areas which are far from the city center. Some of the sites for communal containers are not below 100 m distance from living places. Thus, some households located away from this distance tend to dispose off their wastes in undesignated sites. Besides the collection capacity does not match with the growing rate of the city population. In general, solid waste disposal system is not integrated with the patterns of settlement development in the city.

However, this plan has not yet put in place on the ground for implementation to alleviate the existing problems. Although the objective is to provide service every 2-3 days, containers are actually emptied in more than a week period on average. The efficiency of this method is in general limited because of the capacity of the city government to deploy adequate number of waste containers, which in turn has direct relationship with revenue generation of the city.

Solid waste preliminary treatment: The integrated SWM principles state that the collected solid wastes need to be segregated into various types for the purpose of recycling, reuse or

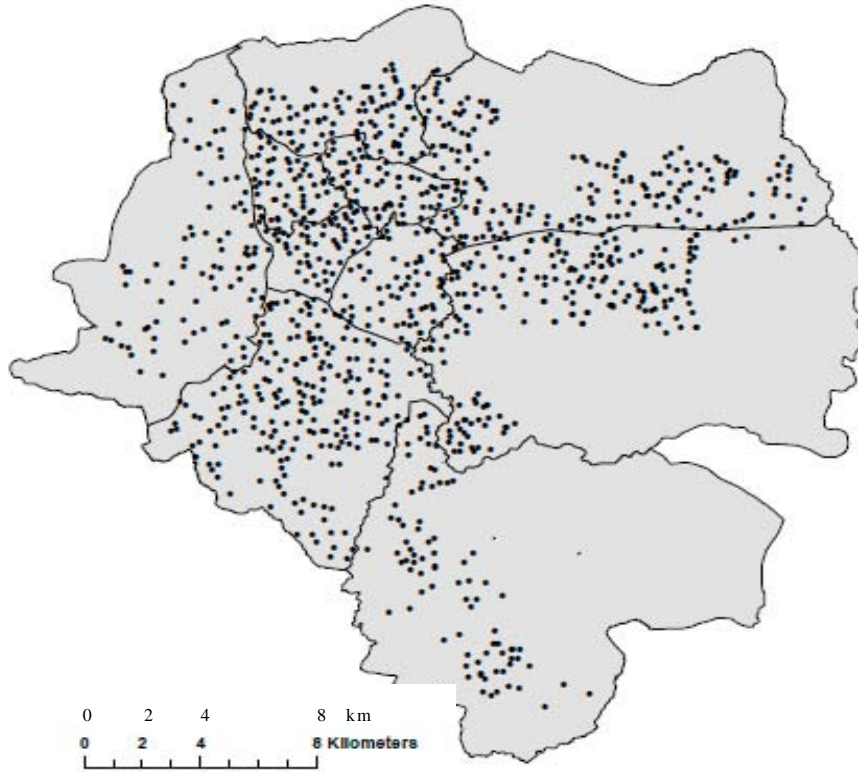


Fig. 9: Distribution of platforms throughout the city

transformation at various levels involving all stakeholders (Van De Klundert and Lardinois, 1995). Therefore, there must be treatment processes before disposal to separate the recyclable and reusable resources out of the wastes. However, consciousness among the residents in Addis Ababa is so little that almost all the collected wastes are transported to the open disposal site without segregation. It is not also binding at present to separate recyclable or reuse materials from the collected wastes at the city level. However, informal recyclers at small-scale level are accomplishing some form of sporadic recycling manually though it is insignificant. There are craftsmen who recycle metal, wood, rubber, clay to provide essential goods to great number of customers in the city of Addis Ababa (ENDA, 1999). However, facilities are not available to enhance their contribution for the purpose of waste treatments. Furthermore, the participation of the informal waste collectors and recyclers are not encouraged with the financial or technical support from the city government to make them formal.

Solid waste transportation: Cities in low-income countries often lack sufficient transportation and equipment to collect wastes (Segosebe and Vanderpost, 1991). This is the existing reality in Addis Ababa where waste collecting trucks are not available to the level demanded as indicated in Table 3 and even some of the available trucks do not all fully perform on daily basis attributable to long age, frequent accidents and maintenance problems.

But both private companies and the Addis Ababa Solid Waste Management Agency transport the collected wastes to the disposal site. All the trucks carry only a single container of maximum capacity of 8 m³ or 2160 kg at the time of disposal. Most of the trucks have no cover for waste containers so that they are dropping wastes in the city in their way to the disposal site.

Table 3: Current solid waste collection trucks in Addis Ababa

Sub-cities	Container lifter	Side loader	Hino compactor	Renault compactor	Total
Arada	3	2	2	1	8
Addis ketema	6	3	1	1	11
Lideta	2	2	1	1	6
Yeka	3	2	1	1	7
Kirkos	2	3	1	1	7
Bole	7	1	1	1	10
Akaki kality	3	1	1	0	5
Nefas-silk lafto	5	1	0	1	7
Kolfe	3	2	1	2	8
Gulele	6	2	1	0	10
Total	40	19	10	10	79

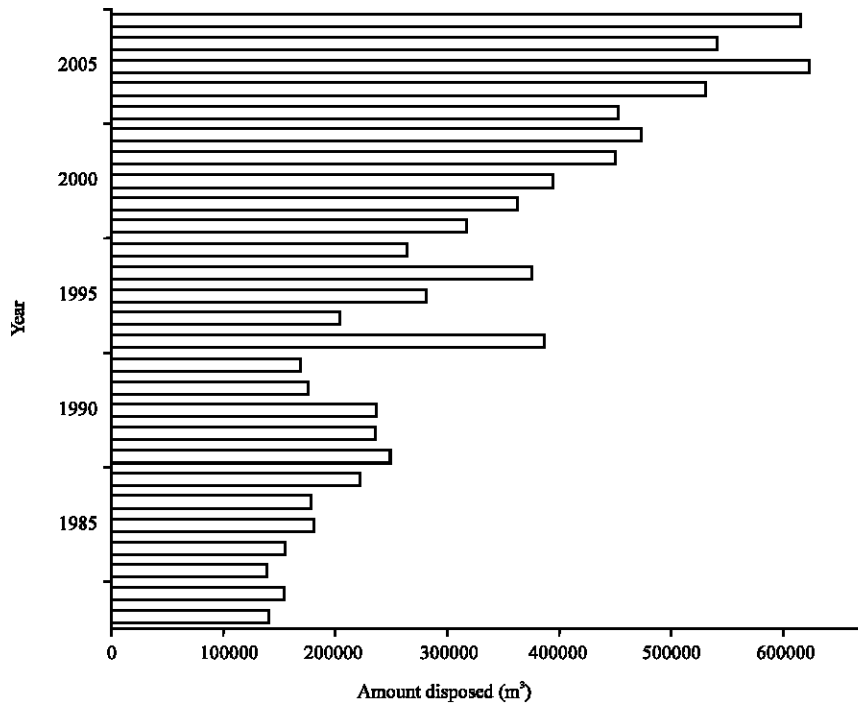


Fig. 10: Amount of solid waste disposed from 1981-2005

Solid waste disposal: Disposal is the ultimate stage in solid wastes management system for those wastes that have no further use to society (Tchobanoglous *et al.*, 1977). However, all the generated solid wastes in Addis Ababa have not been properly collected and disposed (Fig. 10). There are still some city dwellers disposing of their organic wastes in their respective premises. These people are being advised to dispose their wastes at least 10 meters away from houses and at least 30 m away from water wells if available.

Open dumping: Most low-income countries make use of open dumping as their form of land disposal. Similarly, Addis Ababa has also a single open dumping site located some 13km away from the city center named as 'Koshe' which was established in 1950s in the then outskirts of the city

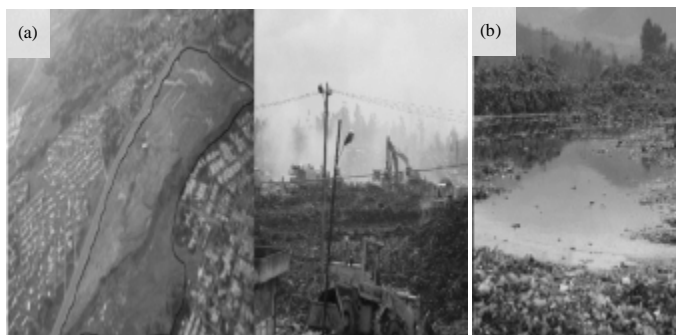


Fig. 11(a-b): Aerial view of Koshe disposal site surrounded by residents and (b) Internal conditions of Koshe open disposal site

with an area of 25 hectares. In fact this site is now becoming in the center of the city following the horizontal expansion of the city and greatly affecting the residents and institutions (Fig. 11a). It is also getting reached to its maximum full level just not to accommodate more wastes in time to come. Yet, the city still utilizes this site as the only open disposal location. The site has no daily cover with soil, any controls over leachates, gases and vectors (Fig. 11b).

Thus, such unhygienic disposal system has a negative impact on the health of surrounding neighborhoods and environment (World Bank, 2001). Hence, proper use of dumping requires certain standard including spreading refuse in the thin layers and compacting by bulldozer before next year spread. However, all the necessary measures are not put in place in the city to control contamination of surface and ground water as well as the air. Moreover, it is unprotected where children, destitute women and youngsters scavenging for survival. This needs integrated SWM decisions on how to handle wastes in a way that must take into account the environmental, economic and social dimensions (Gerlagh *et al.*, 1999). Therefore, the existing condition is now pushing the city government of Addis Ababa for the construction of engineered landfill.

Landfill sites: Addis Ababa has no landfill sites. With this context, the development plan of the city has proposed the establishment of four landfill sites in the eastern, northeastern, west and southwest part of the city. Though none of them has so far been established, the proposed plan to construct these landfill sites did not even properly take into account their subsequent impacts on the local environment and the inhabitants. It was simply planned to establish the sites without knowledge base and impact forecast viewpoint. That was why the city had latter recognized the problems and decided to cease this plan before implementation and set another new plan to construct the landfill site some 35 km away from the city center. Thus, the preparation for the establishment of landfill site has been ongoing since 2010. However, this still might have a problem on the efficiency of fleet management due to its long distance to have had as many trips as possible per day with the current number and conditions of the existing trucks. This might again increase various operating costs such as fuel, oils and grease. According to Chenje (2000), the problems of solid wastes are exacerbated in cities of developing countries caused by the growing population accompanied by poor or weak disposal systems. In line with the final disposal system, the MSW should not be disposed off along with hazardous wastes. However, some of the hazardous wastes in Addis Ababa are ending up with municipal wastes at the existing open disposal site. In this

regard, the current new plan might consider and propose the ways how hazardous wastes could be collected, transported and disposed off at a separate site away from the residential areas.

Remediation: In the city of Addis Ababa, open dumping is being operated without any processing. Access to the site is not controlled so that the presence of different types of scavengers is common. In addition, the land disposal site does not have leachate collection and treatment systems so that leachate generation and migration occurs through run-off of precipitation. Yet, the site is not located distantly from water sources so that communities located in surrounding areas receive precipitation that is polluting the soil and water resources. Therefore, rehabilitation of waste disposal sites is imperative with the aims for future expansion by preparing the area to receive additional wastes. Yet, the rehabilitation of waste disposal land site in Addis Ababa is not a common practice being operated taking into account the benefits of the public health and the environment as well as the benefit to reclaim the valuable spaces.

PLANNING SOLUTIONS

Existing planning ideas: Institutional aspect: Bartone (2001) suggested that involving the private sector could be a solution in the areas where there is very low service coverage and inefficiencies of SWM by creating job opportunities to a number of jobless especially women and youths. Recognizing the fact of Addis Ababa, as per its development plan proposal, has commenced encouraging private companies and Micro and Small Enterprise Unions to participate in SWM since 2004. During the time, there were only few private sectors and the service was being determined by a kind of bargaining with the household head with charging ranging from USD 0.60-1.75 per households per month for the service they were rendering. Yet, most of them were operating only in the middle and high income areas. However, at this moment in time, there are 6 private companies and 521 Micro and Small Enterprise Unions with more than 10,000 operators collecting from households, institutions and commercial areas. This has contributed to improve the collection system and has also created job opportunities for jobless youths and women in the city.

Legal aspect: Ethiopia has national solid waste proclamation dealing comprehensively with all aspects of SWM being used in all its federal states. The authorization in setting rules, laws, regulations and standards as well as imposing penalties for non-compliance regarding the management of solid waste is given to the Federal Environmental Protection Authority (EPA). At federal level Ministry of Health is also responsible to play a principal role in issues related to "Public Health and Sanitation" for which SWM is part and parcel of public health. In Addis Ababa, the responsibility to handle all aspects of SWM has been given to Addis Ababa Solid Waste Management Agency since January 2010. National environmental policy, National SWM proclamation, City Charter, city's SWM policy and City's solid waste Regulation are the existing policy and legal issues being used. With this, the agency is mandated to improve SWM policy and laws upon following up of their implementations; prepare directives and systems for effective implementations; prepare city-level SWM frameworks; review and monitor the implementation of sub-city waste management plans; encourage private sectors and micro enterprises, etc. However, various measures have not been taken to improve SWM in harmony with the existing policies and legal issues.

Financial aspect: Until recently, the only financial source for SWM was the city administration. However, the practice is now changed to make waste generators share the expenses. In this respect, the service charge for collection has been attached to the water bill with 20% and 40% of the monthly water consumption rate for households and institutions respectively. The city administration in turn pays to MSEs as per the amount they collected with the rate of USD 1.70 per m³ of solid wastes whereas the private companies receive their service charge directly from the institutions to which they have an agreement with the rate of USD 3.90 per m³ of solid wastes. Therefore, the service charges have been changed from willingness to compulsory pay across all income groups that use the water supply services. Though this mechanism has discouraged illegal dumping in open spaces, rivers and street sides, the plan has not been fully implemented across all waste generators as there are people especially in the commercial centers who do not use the water supply services but are among huge generators of solid wastes.

Awareness raising: Rathana (2009) stated the fact that a lack of public awareness and cooperation are the root causes of SWM problems. Likewise in Addis Ababa, lack of awareness in communities, private sectors and decision makers is one of the major problems regarding SWM. Managing waste materials at their sources requires the active participation of the waste generating households, commercial and industrial companies and their employees (Harrison, 1996). Therefore, awareness creation must be considered essential to help assist SWM problems. However, resource allocations for awareness creation programs have not been targeted well in Addis Ababa as one of the crucial issues to escalate the public awareness through continued training and sensitization to improve SWM practices.

Future planning options

Institutional aspect: The city of Addis Ababa needs to encourage both individuals and private institutions to provide proper SWM along with upgrading the required equipments to strengthen the service delivery systems. Therefore, public support and participation should be mobilized aiming at raising awareness and public perception to bring about necessary implementation for putting forward reasonable solutions. Institutional capacity building must also be considered to upgrade citywide technical and management capabilities to have the intended proper management of solid wastes. Therefore, there should be access to training and education for everyone involved in waste management. An increasing awareness of networking opportunities in the ten sub-cities must also be required to facilitate the information flows.

Legal aspect: The city should formulate and implement laws and regulations to establish integrated SWM systems, in accordance with the local conditions. The city should also gradually introduce a system of fees for the treatment of collected solid wastes. The legal frameworks must also be put in place along with effective enforcement mechanisms to implement the existing pertinent laws and policies to attain the goals set for further action. In this respect, the city should have efficient planning to strategically carry out the decisive interventions that can be implemented quickly and effectively to achieve most required services with the limited available funds.

Financial aspect: Fees must be considered in all areas of the city that generates wastes regardless of the presence of the current water supply connection systems. Enhancement of the participation and role of NGOs, private sector and communities must also be put in place to manage and

integrate partnership and cooperation along with provision of incentives for private waste collectors. The establishment of standard solid waste transfer stations in all directions at accessible sites; possession of additional trucks with large capacity to get faster transportation services; introduction of appropriate incentives to increase the qualified and trained personnel should also all be taken into consideration in order to scale up the existing SWM systems. Promotion of compost production and setting enabling systems and techniques is also necessary to be on ground to manage organic wastes.

CONCLUSION

The current condition of SWM in Addis Ababa lacks integrated waste management approach and the systems are not all so effective that wastes are often improperly disposed in undesignated sites. This is attributed to the rapid population growth coupled with unplanned urban expansion and financial scarcity to proper waste management. Some of the existing problems include: the poor socio-economic status, lack of properly designed root system, lack of time schedule to properly collect and empty containers, insufficiency of funds and lack of sufficient and good capacity tracks. Thus, the system is faced with numerous challenges due to the huge amount of waste generation beyond the collection capacity of the city. To improve these critical problems, the city has not yet set maximum efforts so as to incorporate modern techniques in the existing systems.

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