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Change of Solid Waste Management System in Addis Ababa City for Best Practice and Nice Indication

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Abstract— *Introduce innovative approaches for waste management that are cost effective and efficient. These include door-to-door collection system in Addis Ababa, plastic collection and recycling systems with community and private sector participation. Effective solid waste management was more than just cleaning the streets or collecting waste and dumping of the collected waste, as practiced by most municipalities or the city part. It required efficient combination of various components of solid waste management in an integrated manner. Integrated solid waste management was therefore a process of optimizing the waste management system as a whole with application of a variety of suitable technologies. Waste collection was generally considered to be the most important component of any waste management system because it was the most expensive and visible part of the system. Therefore, properly designed and executed waste collection systems can be resulted in significant savings and reduction in environmental and public health risks. The following issues generally need to be considered in designing a waste collection system: Containerization and on-site storage of waste, Source separation, Collection mechanism (roadside collection, door-to-door collection, communal containers, on-time collection etc.), Cleansing of streets and other public places, Time of collection, Type of vehicles used for collection, Frequency of collection, Route planning, No. of staff used for collection, Special collection for bulk waste generators, Separate collection for special waste such as medical waste and household hazardous waste. These best practices demonstrate that local initiatives with extensive participation of local communities and private sector can go a long way in addressing the problem of solid waste management in urban areas.*

Keywords— *Waste generators, waste, effective and efficient waste management*.

I. INTRODUCTION

Addis Ababa, whose population grew from about 2.1 million in the year 1994 to 2.7 million in 2007, is one of the fastest growing cities in Africa. Its current population is estimated to be exceeding 3 million and, apart from its sheer population size, the city is playing significant economic, social and cultural roles both at the national and international levels. Accordingly, the City has significant contribution to the national GDP owing to the concentration of various urban-based service orientated and manufacturing activities. The city, which is the Federal Capital, accounts for almost a quarter of the national urban population that is a mosaic of Ethiopia's multi ethnic and multicultural identities. On the other hand, being the home of the African Union, the Economic Commission for Africa, several specialized UN agencies and other international organizations and more than one hundred diplomatic missions, it is among the few most culturally and ethnically diverse cities in the world.

Everyone produces waste. Some people produce more waste than others, but everyone produces some waste as leftover food, dirty water or garbage, just to mention a few. So, what is it that we call waste?

One of the answers is that waste is simply something unwanted, something left-over which has lost its value for the initial user. It is something you do not want any more and want to throw away. Solid waste is a byproduct of human activities which tends to increase with rapid urbanization, improved living standards and changing consumption patterns. Management of increasing amounts of solid waste has become a major challenge in many cities in developing countries. If solid waste is properly used, it can be a valuable resource, but if it is not effectively managed, it can result in serious adverse impacts on environment and public health. Solid waste management is therefore a critical component within urban sanitation and it is also one of the most important and resource intensive services provided by municipalities. According to most urban residents consider solid waste management as the most important environmental problem in urban areas of Addis Ababa.

Management of solid waste is a growing concern in Addis Ababa as urban population densities increase and flat usable land is in short supply. Although small urban centres were declared to be municipalities, they suffer from a lack of infrastructural, technical and financial resources to tackle the problems of waste management. With increasing public awareness about good health and a clean environmental sanitation, solid waste management has now become the priorities of the municipalities in Addis Ababa. Municipalities, for managing the waste, are expressing their desire to develop final disposal system even though collections systems are still not in place. They are also promoting waste reduction, reuse, and recycling among the communities.

Introduce innovative approaches for waste management that are cost effective and efficient. These include door-to-door collection system in Addis Ababa, plastic collection and recycling systems with community and private sector participation

II. METHODOLOGY

2.1 Description of Study Area

Addis Ababa was a capital city of Ethiopia with great geographical diversity endowed with rich natural and human resource base, and yet it was one of the cities in the world with the seat of many higher international communities and diplomat like UNDP, UNHCR, UNICEF and USAID etc and the head quarter of AU, ECA.The city has an area of 540 square kilometers, of which 18 square kilometers is rural. It

lied between 2,000 and 3,000 meters above sea level. Despite its proximity to the equator, Addis Ababa enjoys a mild, Afro-Alpine temperate and warm temperate climate. The lowest and the highest annual average temperature are about 10^0C and 25^0C. Annual rainfall is around 1200 mm.

The population of Addis Ababa grew from about 2.1 million in the year 1994 to 2.7 million in 2007 and the annual growth rate of 2.1%, is one of the fastest growing cities in Africa. Its current population is estimated to exceeding 3 million. Due to certain reasons like other developing countries, the city has experienced highly accelerated population growth. The rapid population increase of the city has been mainly attributable to natural urban population increase and internal migration. According to the country's 1994 population and housing census, out of the total population of the city, 46.7% were migrants from rural and other urban areas in Ethiopia (CSA, 1999:161). Currently, CSA notifies that birth rate of Addis Ababa city administration is 2.1% with average family size 4.1 persons. At the start 2011; the city has a population of 2,979,206 and if no exaggerated rural urban migration faces, at 2020, it will expected to have a total population of 3,599,003. The projection of population is described in Table I below.

TABLE I. Population Projection of Addis Ababa City.

Year	Number of household	Total population
2010	711535	2917295
2015	790309	3240270
2016	807081	3309036
2017	824209	3379260
2018	841701	3450975
2019	859563	3524212
2020	877847	3599003

The projection is calculated from initial population of 2010 CSA data with rate equal to 2.1% and statistical projection formula [$P_n=P_oe^{(R/100)\ xt}$], where R is rate of population growth, t is time in years, p_o is initial population, p_n is final population and e is common logarithm.

However, there is no formal economic classification of urban duelers in Addis; we stratified the city into three city socioeconomic classes according to their housing structure. The poorest people lives where in the slummy area of the city like Cherkos, lideta/kereyu areas, Addis Ketema/Atobis Tera and other slum part of the city are categorized under the lower socio-economic classes. The second stratum is those people living in condominium houses which are considered to be middle level income population. The third class of the city dwellers is highest economic class; for which the income of the people is comparatively highest and those living in the well-constructed and furnished villa and multistory buildings in majority at Bole areas.

III. Results and Discussion

3.1 Waste Management System

Effective solid waste management was more than just cleaning the streets or collecting waste and dumping of the collected waste, as practiced by most municipalities or the city part. It required efficient combination of various components of solid waste management in an integrated manner. Integrated solid waste management was therefore a process of optimizing the waste management system as a whole with application of a variety of suitable technologies. This includes the following activities: Reduction of the amount of waste generated, proper segregation and storage of waste at source, efficient waste collection, Street sweeping Waste transfer from preliminary collection vehicles to haulage vehicles, Transportation of waste, Waste composting and recycling, Landfilling, Hazardous waste management, Public education and participation, Formulation and enforcement of policies and regulations, Organizational management, Financial management. In order to ensure that all aspects of integrated solid waste management are addressed and the system as a whole functions effectively and efficiently, municipalities need a proper strategy as well as sufficient human and financial resources to implement the strategy. SWM strategy which aimed to establish a cost-effective, environmentally sound and efficient integrated solid waste management system with active community as well as private sector participation. The strategy was clear and comprehensive and it provided a direction for future activities. However, the strategy has not been fully implemented because of the absences of proper plans, adequate resources and effective monitoring. Therefore, municipalities need to formulate effective strategies for integrated solid waste management and back it up with annual plans and programmers as well as effective monitoring systems.

3.2. Waste Collection System

Primary Collection of Waste: Domestic, trade and institutional food/bio degradable waste are to be collected on a daily basis. Recyclable waste and non-biodegradable waste other than toxic and hazardous waste were to be collected at regular intervals from the source of waste generation. Hazardous and toxic waste were be deposited by the waste producer at specified places and not elsewhere.

Waste collection was generally considered to be the most important component of any waste management system because it was the most expensive and visible part of the system. Therefore, properly designed and executed waste collection systems can be resulted in significant savings and reduction in environmental and public health risks. The following issues generally need to be considered in designing a waste collection system: Containerization and on-site storage of waste, Source separation, Collection mechanism (roadside collection, door-to-door collection, communal containers, on-time collection etc.), Cleansing of streets and other public places, Time of collection, Type of vehicles used for collection, Frequency of collection, Route planning, No. of staff used for collection, Special collection for bulk waste generators, Separate collection for special waste such as medical waste and household hazardous waste, Transfer of waste from primary collection vehicles to larger vehicle for secondary transport different types of waste have to be collected separately, but the savings due to increased recycling will be made the system as a whole more efficient. Consumer surveys have indicated that most people were willing to separate their waste at source, provided that the waste was also collected separately. Similarly, waste collectors were also

willing to collect waste separately because of the income they can be made from selling recyclable materials. In fact most waste collectors from private operators sort the waste as soon as they receive it and put recyclable scrap in separate bag, which is an informal system of source separation. Therefore, it would be wise for municipalities to introduce a system in which waste has to be sorted at the source by the generators themselves into at least two components- organic and inorganic. As the inorganic component was generally less in volume and did not degrade it can be collected only once a week. This will be made the collection system more efficient and cost effective. Once waste was collected in primary collection vehicles such as handcarts, rickshaws or tractors.

Secondary collection of waste: Transportation system often needs to be transferred from temporary storage to larger vehicles for transportation to treatment or disposal sites. This transfer process is usually inefficient and ineffective because the waste from the primary collection vehicle is normally dumped on the ground and then loaded on to the haulage vehicle manually or using a loader. A more effective method is to transfer the waste from the primary vehicle directly on to the secondary transport vehicle by collecting the waste in detachable containers, such as sacks or bins within the primary vehicle which can be lifted manually and emptied into the secondary vehicle without having to put the waste on the ground during the transfer process. Another method is to use a split-level transfer process, where the primary collection vehicle is tipped to allow waste to fall in to the secondary vehicle that is placed at a lower level. Such transfer operations are practiced in a few locations in Addis Ababa

3.3. Segregation of Recyclable/Non-Biodegradable Waste

The BMC has directed households, shops, establishments not to mix recyclable waste with domestic waste. These two categories of waste are to be kept in a separate bin or bag at the source of waste generation and collection itself.

3.4. Storage System

3.4.1. Temporary Storage: Temporary holding of MWS pending collection, transportation, treatment or disposal as in containers, tanks, waste piles (see storage).A storage location for health-care waste should be designated inside the health-care establishment or research facility. The waste, in bags or containers, should be stored in a separate area, room, or building of a size appropriate to the quantities of waste produced and the frequency of collection. Recommendations for the storage area

Storage of Waste at Source **k**eeps the street and public places clean are the responsibility of all. This motive can be achieved only with people's participation and co-operation. No Waste Shall be thrown on the Streets, Footpaths, and Open spaces, Drains or Water Bodies. Waste shall be stored at sources of waste generation designated bins. Hazardous household waste should be kept separately from the above two streams of waste.

3.4.2. Temporary SW Dumping Locations

Existing collection system consists of temporary SW dumping locations, collection vehicles and crew.50–80 households use common temporary dumping locations. Residents throw waste into those, Places. Collection vehicles collect waste from those dumping locations. Scattering of waste around, Temporary dumping locations were observed. This mainly happen due to cows, monkeys, dogs, cats, and crows who search for food from those dumping locations. The food waste (short term, Biodegradable component) attracts the scavengers. Hence the reduction of food waste at the pint of, Generation would give a solution for this also. During rain periods the runoff water takes solid waste from those dumping locations, which adds, Pollutants to natural water bodies including the Kandy Lake and River Mahaweli. The rotting waste, Produces leachate which pollutes the ground water and surface water bodies. In some places where the Scattering occurred, all the waste was not collected by the collectors. Odor is another problem at those dumping locations which diminishes the quality of fresh air in the surrounding area. The odor causes residents to through SW from far distance to the SW collection bin, which possibly cause Scattering SW around the bin. Scattered waste beside streets causes environmental and aesthetic. This paper introduces the Temporary Storage concept, starting with *A brief history of waste management*, in which disposal of waste in landfills and the concept of Sustainable Landfilling is described. In the next section, *Earlier concepts of Temporary Storage*, preliminary waste storage initiatives and some conceptual ideas of temporary storage are explained which, together with the concept of Sustainable Landfilling, support the achievability of the Temporary Storage concept. Also the present day practice of waste management and legal aspects of waste storage are discussed. The newly proposed Temporary Storage concept is described in more detail in the next section, *Temporary Storage: A revolutionary concept built on state of-the-art technology*. Preceding the *Conclusions*, the Temporary Storage is applied to landfills (*Transforming landfills into Temporary Storages*) and the advantages of integration with Enhanced LandFill Mining (ELFM) are explained (*Temporary storage in combination with ELFM*).

3.4.2.1. Preliminary storage

Preliminary storage sites exist for Municipal Solid Waste (MSW) and industrial waste and they can be divided into seasonal storage and non-seasonal storage sites. The storage can be in the form of (1) hard compacted storages, (2) loose compacted storages, and (3) bales. Preliminary storage sites may be sub-classified as: (a) Seasonal storages: where waste is stored (up to 8 months) and stored materials to be combusted at incineration plants, which face variation in demand loads of district heating and electricity between summer and winter; (b) Non-seasonal-storages: where storage time varies between two to eight weeks and materials are sorted and prepared before transportation for recovery or disposal elsewhere such as; storage at seasonal storage sites, processing at composting plants digesters and/or disposal at landfills;(c) Collection centers: small storage centers, located close to residential and commercial areas. Storage time is not more than one week from where waste is transported to preliminary storage sites.

3.4.2.2. Innovative storage concepts

Several conceptual ideas related to longer term temporary storage of materials where communicated in the past like the Dutch Temporary Storage pyramid idea "megastratem".

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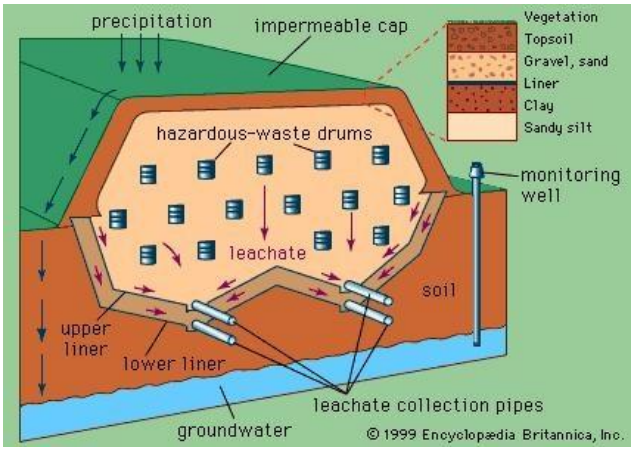
Megastratem, presented by consultant DHV was a price winning concept in the contest 'landfilling beyond 2000'.5 the suggestion was to create large spheres (pyramid shaped "megastratem") in which waste could be stored until collection and recycling would be feasible. This all started from the awareness that today's waste might be tomorrow's resource basis. Examples of wastes to be stored in the megastratem given in 1998 are tires and demolition wastes; wastes that are nowadays already to a large extent being recycled. Special attention was paid to the visual presence of the megastratem. No attempts were made to functionally. Integrate the megastratem into the existing landscape, as is an essential part of our new Temporary Storage scheme. Instead, megastratem were meant to be monuments of our time, a concept that is actually followed by the Leppe landfill (Metabolon) in Germany During storage, the quality of the waste is conserved and improved by in-situ technology (*e.g.* the pollution potential is reduced by biological stabilization, aeration or flushing, resources are extracted by extraction, heap-leaching or (an)aerobic digestion. Separation options are improved, by biodegradation of organic materials, which increases differences in particle size of materials. By combining safe storage of waste with smart use of extensive processes, the quality of mixed (organic and inorganic) can be improved in view of future reuse. This could imply removing and degrading contaminants and concentrating valuable residuals, while in the meantime harvesting precious compounds already. Temporary Storages along these lines could take the form of a lively industrial process area with different functionalities, offering different storage conditions, *e.g.*: An area for unconditioned storage in about 1 m3 bales and another one for stockpiles; Passively or actively aerated windrows (see Figure) for removal of trace organic pollutants from inorganic wastes; Flushing bioreactor cells for extensive treatment of larger amounts of wastes, Extraction ponds for heap-leaching of sludge (see below).



IV. Conclusion

Although proper management of solid waste is essential for urban sanitation, many municipalities are struggling with this problem. Municipalities are spending significant resources to address this problem, but the overall situation is far from satisfactory and rapid and haphazard urban growth is making the problem worse. However, several municipalities have demonstrated ways to effectively manage waste using simple measures such as door to-door waste collection, promotion of household composting, distribution of "*suiro*" for plastic collection, separate management systems for hazardous waste and operation of an effective landfill with community participation. Almost all these successful efforts have been initiated locally without much external donor support but with plenty of support from local communities and private sector. These best practices demonstrate that local initiatives with extensive participation of local communities and private sector can go a long way in addressing the problem of solid waste management in urban areas.

V. Recommendations

The storage area should have an impermeable, hard-standing floor with good drainage; it should be easy to clean and disinfect, there should be a water supply for cleaning purposes. The storage area should afford easy access for staff in charge of handling the waste. It should be possible to lock the store to prevent access by unauthorized persons.

1. Easy access for waste-collection vehicles is essential. There should be protection from the sun. The storage area should be inaccessible for animals, insects, and birds. There should be good lighting and at least passive ventilation.
2. The storage area should not be situated in the proximity of fresh food stores or food preparation areas. A supply of cleaning equipment, protective clothing, and waste bags or containers should be located conveniently close to the storage area.

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