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Main Problems and Issues of Municipal Solid Waste Management in Developing Countries with Emphasis on Problems Related to Disposal by Landfill

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Abstract

In Municipal Solid Waste Management (MSWM) of developing countries five typical problem areas can be identified: 1) inadequate service coverage, 2) operational inefficiencies of services, 3) limited utilization of recycling activities, 4) inadequate management of non industrial hazardous waste, and 5) inadequate landfill disposal. This paper discusses some of these problem areas and suggests possible approaches for improving the situation. Emphasis will be on the problem of inadequate landfill disposal.

Open uncontrolled dumping is still the most common method of solid waste disposal in developing countries. Although the environmental consequences are often quite evident, the problem is seldom dealt with. Reasons for not dealing with the problem are low political priority, inadequate resources allocated, and/or missing know-how regarding alternative solutions for operating and managing a landfill/dump. To improve the current situation, alternative institutional and financial models for disposal activities must be developed and applied. Knowing the costs of waste disposal activities are a prerequisite that enables municipalities to make decisions about their programs with regard to cost minimizing and better planning for the future. For the design and operation of landfills, appropriate guidelines for developing countries have to be developed. These guidelines should not be based primarily on the existing requirements of sanitary landfills in industrialized countries, but should mainly take into account the basically different physical and economic situations prevailing in developing countries. In that respect efforts should also be undertaken to upgrade existing dumpsites and so "aiming" in the long run in the direction of a sanitary landfill.

Keywords: Solid Waste Management, Developing Countries, Landfill, Waste Disposal, Waste Collection, Upgrading Landfills

1 Introduction

Human activities create waste, and it is the way these wastes are handled, stored, collected and disposed of, which can pose risks to the environment and to public health. In urban areas, especially in the rapid urbanizing cities of the developing world, problems and issues of Solid Waste Management (SWM) are of immediate importance. This has been acknowledged by most governments, however rapid population growth overwhelms the capacity of most municipal authorities to provide even the most basic services. Typically one to two thirds of the solid waste generated is not collected. As a result, the uncollected waste, which is often also mixed with human and animal excreta, is dumped indiscriminately in the streets and in drains, so contributing to flooding, breeding of insect and rodent vectors and the spread of diseases. Furthermore, even collected waste is often disposed of in uncontrolled dumpsites and/or burnt, polluting water resources and air.

Throughout the developing world it is the urban poor, often in the peri-urban areas, that suffer most from the life-threatening conditions deriving from deficient SWM, as municipal authorities tend to allocate their limited financial resources to the richer areas of higher tax yields where citizens with more political pressure reside. Usually as income of the residents increases, part of the wealth is used to avoid exposure to the environmental problems close to home, but as waste generation also increases with increasing wealth, the problems are simply shifted elsewhere. Thus even as environmental problems at the household or neighborhood level may recede in higher income areas, citywide and regional environmental degradation due to a deficient SWM remains or increases.

Rapid urbanization is taking place especially in low-income countries. In 1985, 41% of the world population lived in urban areas, and by 2015 the proportion is projected to rise to 60 % (Schertenleib & Meyer, 1992), whereby 68 % of this urban population will be living in the cities of low-income and lower middle-income countries[1]. (Figure 1).

An important feature often cited when dealing with the urbanization of the developing world is the rapid growth of "large" cities and metropolitan areas. By the year 2000, 17 of 22 large urban agglomerations with a population of over 10 million people will be located in the developing world (Schertenleib & Meyer, 1992). However not only these large urban agglomerations represent an enormous challenge for environmental services. The urban data for the year 1995 (table 1) shows that approximately 65% of the urban population in the developing world still live in cities with populations smaller than 750'000.

[1] Income groups are divided according to 1996 GNP per capita: low income < 785 US$; low middle income 786-3115 US$; upper middle income 3116-9635 US$, and high income > 9636 US$ (World Bank, 1998).

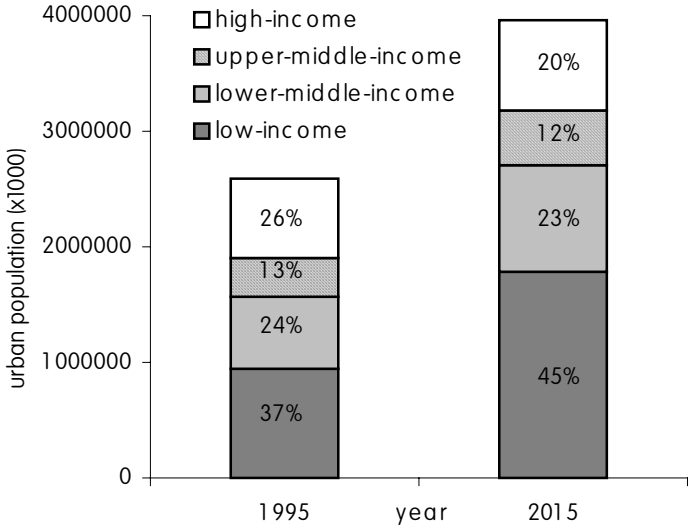

Fig. 1: Distribution of total urban population in 4 groups of country average GNP per capita [1], source: World Resources Institute (1998).

Classification based on GNP and regions	% of urban pop.
low-income countries	62
low middle-income countries	67
upper middle-income countries	58
high income countries	54
Classification based on regions	**% of urban pop**
Central and South America	55
North America	45
Africa	64
Asia and Oceania	60
Europe	69

Tab.1: Percentage of urban population living in cities < 750'000, classified by region and GNP (World Resources Institute, 1998).

Based on extensive literature reviews, observations and discussions in a number of developing countries Schertenleib & Meyer (1992) identified five typical problems of SWM.

- inadequate coverage of the population to be served
- operational inefficiencies of municipal SW services and management
- limited utilization of the formal and informal private sector in recycling activities
- problems concerning the management of (non-industrial) hazardous waste, and
- specific problems related to final disposal of solid waste.

Research focus and improvement efforts from all around the world have focused on many of these problems during the last few years. The following chapters will try to give a brief overview on the issues involved, highlight some of the paths chosen to solve the problems, and also offer some suggestions for future activities.

2. Coverage of the population to be served

2.1 The challenge

Municipal solid waste collection schemes of cities in the developing world generally serve only a limited part of the urban population. The people remaining without a waste collection service are usually the low-income population living in peri-urban areas.

One of the main reasons, is the lack of financial resources to cope with the increasing amount of generated waste produced by the rapid growing cities. Often inadequate fees charged and insufficient funds from a central municipal budget can not finance adequate levels of service. Furthermore the available resources are often allocated to the high-income areas with higher tax yields where residents have more political influence, so leaving the poor in peri-urban areas unserved.

However not only financial problems affect the availability or sustainability of a waste collection service. In very many cases it is also technical issues that hinder an efficient service and higher population coverage. Often the "conventional" collection approach as developed and used in the industrialized countries is applied in developing countries. The used vehicles are sophisticated, expensive and difficult to operate and maintain, thereby often inadequate for the conditions in developing countries. After a short time of operation usually only a small part of the vehicle fleet remains in operation.

2.2 Solutions

The most realistic and promising approach seen to improve the situation of low-income areas is for the population to assume the responsibilities of the municipal authorities and to set up an appropriate institutional and technological waste collection scheme while taking their economic situation into account. Such non-governmental, alternative schemes where initiated and tested during the past few years by several organizations in countries all over the developing world. SANDEC has reviewed a number of selected cases and has published a synthesis of the most important lessons learnt (Pfammatter & Schertenleib, 1996). These can be summarised as follows and were further discussed in the UMP/SDC Collaborative Programme Workshop, Cairo (1996):

- An essential prerequisite for a successful non-governmental primary collection scheme is the collaboration between the municipal authorities and the community groups and/or the private sector involved with the waste management. A lack of cooperation can result in serious deficiencies, especially at the interface between the non-governmental primary collection and the municipal secondary collection. Emphasis must be laid on the establishment of a service-oriented collaboration between the public and non-governmental actors.
- Alternative approaches for primary collection schemes require considerable participation of the households. It is therefore important to assess their willingness to contribute and to involve the future users on all levels of decision making while setting up the scheme. Willingness to contribute is related to the felt need of the population for waste collection and this again is related to their awareness with regard to the problems related to inappropriate waste handling. Enhancing awareness through information and education can enhance motivation and participation.
- Low-cost technical solutions are prerequisites for successful schemes. Poor people may not be able to afford cash contributions however they may contribute in kind, e.g. by carrying their waste to the next communal bin. If collection vehicles are needed, muscle powered (person or animal) carts or small vehicles proved to be appropriate for areas with difficult access.
- Costs of the collection scheme must be recovered from the beneficiaries through a simple fee collection system to ensure a certain sustainability of the system.
- Out of the evaluated cases, small private enterprise systems proved to be most efficient as they operate according to business management principles. Management of community-based schemes however, sometimes a voluntary involvement of only one motivated individual, are vulnerable and may collapse if the person in charge withdraws from the responsibilities. Voluntary management also often lacks of formal control, which may lead to corruption and mismanagement of funds. Total transparency of the organizational and financial set-up can be the solution to this problem.

3. Operational efficiency of SW services and limited use of the informal and formal private sector activities in SWM

3.1 The challenge

Municipal authorities in developing countries usually spend from 20 to 50 percent of the total municipal expenditure for the solid waste service. However even at such a level of expenditure the level of service is low (Cointreau-Levine, 1995). Only 50 to 70 % of the solid waste is collected serving less than 50 % of the population, and once collected, it is mostly disposed of inadequately in uncontrolled open dumps. Operational inefficiencies of SW services operated by municipalities are mainly due to inefficient institutional structures, inefficient organizational procedures, deficient capacity of the institutions involved and use of inappropriate technologies. On the other hand, the informal sector has traditionally been playing a important role in SWM, especially in resource recovery. However, as their activities can disrupt the operation of landfills and transfer stations they are an eyesore and therfore opposed by the authorities.

3.2 Solutions

One way to improve the situation would be to increase the efficiency of governmental institutions. To make better use of the comparative advantage of the private sector to provide solid waste collection services seems to be an other important step for improving the situation. The potential role of the private sector in SWM is widely recognized and is often recommended as the solution to the "high expenditure and low level of service" situation in municipalities. However, the overall responsibility has to stay with the government. With promotional tools and documents dedicated to the operational aspects of private sector involvement, pri-

vate/public sector partnerships should be promoted (UMP/SDC Collaborative Working Group, 1996). Private sector involvement however does not in itself guarantee higher efficiency. Certain preconditions must be fulfilled so that an efficient private sector service can develop (Schübeler et al., 1996).

- An environment of competition and competitive bidding is necessary to ensure that private firms must perform efficiently to make a profit and to maintain their position on the market. Private monopoly with no opposing competitive forces will not achieve optimum efficiency.
- When deciding for the option of private sector participation it is necessary to assess, if enterprises with an adequate technical and organizational capacity exist, to fulfill the goals specified.
- The public authorities need to determine clear specifications on the outputs to be delivered. With private sector involvement government institutions shift from service provision to regulation. They therefore need to establish a legal and regulatory framework (by-laws, and regulations) and appropriate systems of performance control and monitoring to ensure appropriate service.

The experience of the past years has shown that informal or formal Micro and Small Enterprises can not only play an important role in improving service delivery particularly to low-income urban areas, they also generate employment and facilitate upgrading the status, earnings and working conditions of waste pickers and recyclers (UMP/SDC Collaborative Programme, 1996).

4. Management of (non-industrial) hazardous waste

4.1 The challenge

Pathogenic waste, generated by hospitals and clinics can be regarded the most important waste product from the category of non-industrial hazardous waste. Approximately 85 percent of the total waste generated by hospitals and clinics can be classified as regular domestic wastes, whereas 10 percent can be regarded as infectious and 5 percent as non-infectious but hazardous wastes (Coad, 1994). Therefore it is essential that the generated waste be separated, as the non-infectious and non-hazardous waste can be managed like ordinary domestic waste. Hazardous and infectious waste should be collected in different categories according to the way they should be processed at later steps. This classification can be sharps (needles, scalpels etc., all assumed to be infectious), non-sharp infectious wastes, pharmaceutical and chemical residues and other hazardous wastes. Although most hospitals require separation of their waste and the burning of their pathogenic waste, most of the their incinerators are usually out of order and these wastes often enter the municipal waste stream. This poses serious health risks to the public, especially children, to scavengers, collection crews and to workers at the landfill.

4.2 Solutions

The key to adequate medical waste management is the handling. It needs discipline and care from a number of people, starting with the nurse or doctor, continuing with the porter or laborer who provides the bags and carries away the waste and ending with the person responsible that the waste is disposed of in the correct way. Training and motivation on all these levels is very important but till now is still given little care (Pescod & Saw, 1998). Legislation or guidelines exist in many places however are seldom implemented or enforced. Another issue is the storage of hospital waste. For each of the categories of hospital wastes mentioned above, appropriate containers must be available. Different colored bags for different waste types and puncture safe containers for sharps are recommended. The different waste in different bags or containers can then be handled, treated and disposed in an appropriate way according to their content. Treating infectious waste by incineration can be very effective if the incinerators operate properly (Ogawa, 1993). Often however combustion temperatures are too low and there are problems of odor and smoke. Other treatment options like chemical disinfection give a false sense of security, as they are not always reliable (WHO, 1995).

5. Final disposal of solid waste

5.1 The challenge

Most of the municipal solid waste (MSW) in developing countries is dumped on land in a more or less uncontrolled manner. Such inadequate waste disposal creates serious environmental problems that may impair health of humans and animals and cause economic and other welfare losses.

The environmental degradation caused by inadequate disposal of waste can be expressed by the contamination of surface and ground water through leachate, soil contamination through direct waste contact or leachate, air pollution by burning of wastes, and the

spreading of diseases by different vectors like birds, insects and rodents.

Due to urban growth, in the past few decades uncontrolled dumping sites have often been encircled by settlements and housing estates and today are often centrally located. Such uncontrolled dumps with missing site management directly endanger the health of the people living near to, or on the site. It is however naïve to think that the other citizens will not be affected as the chemical and biological contaminants from inadequate disposal will inevitably find their way to them. The public may be affected by the contamination of their drinking water, by soil contamination passed on to the aquatic and terrestrial food chain and through the spreading of diseases by different vectors. People living near or on the site are often subject to direct transfer of contamination from hand to mouth and through inhalation of dangerous volatile compounds and aerosols. There is also a direct physical danger involved, deriving from possible waste landslides, collapsing landfills, explosions, fires and waste related transport accidents.

Financial and institutional constraints are the main reasons for inadequate disposal of waste especially were local governments are weak or underfinanced and rapid population growth continues. Financing of safe disposal of solid waste poses a difficult problem as most people are willing to pay for the removal of the refuse from their immediate environment but then “out of sight – out of mind” are generally not concerned with its ultimate disposal.

The present disposal situation is expected to deteriorate even more in the near future because till now the relative central location of the dumping sites, i.e. close to the collection area, and the often missing management efforts, has enabled governments to dispose of the municipal solid waste at little cost. This will change soon as with rapid urbanization, settlements and housing estates now increasingly encircle the existing dumps and the environmental degradation associated with these dumps directly affect the population. Waste disposal sites are therefore also subject to growing opposition and it is becoming increasingly difficult to find new sites which find public approval and which are located at a reasonable distance from the collection area. Siting landfills at greater distances to the central collection areas implies higher transfer costs as well as additional investments in the infrastructure of roads hence intensifying the financial problems of the responsible authorities. In addition to all this, an increase in service coverage will even aggravate the disposal problem if the amount of waste cannot be reduced by waste recovery.

Other reasons for inadequate disposal are the mostly inappropriate guidelines for siting, design and operation of new landfills as well as missing recommendations for possible upgrading options of existing open dumps. Many of the municipal officials think that uncontrolled waste disposal is the best that is possible. Often the only guidelines for landfills available are those from high-income countries. These are based on technological standards and practices suited to the conditions and regulations of high-income countries and do not take into account for the different technical, economical, social and institutional aspects of developing countries.

5.2 Solutions

One of the key issues when tackling the problems of inadequate waste disposal is, trying to solve the deficient financial situation of municipalities in respect to SWM. An important factor is trying to determine the actual costs of SWM and especially the costs of waste disposal. Many cities do not know the total costs of their solid waste collection and disposal services, and therefore can not set cost recovery targets. As many local governments tend to focus only on covering labor costs and purchase of consumables, equipment is often old and badly worn and facilities for safe disposal do not exist (Cointreau-Levine, 1997). Finance for SWM needs to cover for planning, capital, operating and monitoring costs and needs to account for safe disposal of wastes. Estimated capital and recurrent landfill costs are shown in table 2. They vary depending on landfill size and engineered environmental protection measures (e.g. liner, drainage, leachate treatment) between 5.6 and 11.3 US$ per ton of capacity over landfill life (10 years).

	total capital and recurrent cost US$ per ton of capacity over landfill life (10years)		
	large landfill 1000 t/day	medium landfill 500 t/day	small landfill 250 t/day
landfill without engineered liner or leachate system	5.6	6.5	11.3
landfill with off-site clay liner and leachate system, excluding geomembrane	7.0	8.0	9.6

Tab. 2: Estimated landfill costs for different landfill sizes (Cointreau-Levine, 1997).

For a city of 1 million the cost for the development of a modern sanitary landfill is estimated to be between 3-10 million US$ depending on length of access roads and engineered measures of environmental protection (Cointreau-Levine, 1997).

5.2.1 Upgrading existing sites

As mentioned above, the estimate capital and recurrent costs for the development of a modern sanitary landfill for a city of 1 million are between 3-10 million US$. Taking these costs into account, an important issue is trying to prolong the life of an existing dump while upgrading it, so as to minimize environmental pollution and health risks to the public. Upgrading does not mean converting a dump to a sanitary landfill in one step. It must be regarded as a step to step process depending on the financial situation of the authorities. The process of upgrading is not necessarily difficult or expensive. Even simply using the available finances, staff and/or equipment in a different way may already achieve improvements.

As an example of step to step improvement, the government of Malaysia formulated an action plan in 1988 on the improvement of their disposal sites. When they considered the limited financial and technical know-how that was available, the strategy adopted was to convert open dumping to sanitary landfills in stages (Huri bin Zulkifli, 1993). The improvement target levels were given as follows: Target 1: controlled tipping, Target 2: landfill with embankments and daily cover, Target 3: landfill with leachate recirculation and, Target 4: landfill with leachate treatment.

The key to upgrading a waste disposal site is, first of all to acknowledge the deficient present landfill operational and/or design methods and then start looking for ways to improve them. In this, it is important that the authorities be assisted either with site specific consulting or by guidelines and manuals on the technical possibilities available for improvement. Literature is very sparse especially when it comes to taking into account for the different technical, economical, social and institutional aspects of developing countries. Oeltzschner & Mutz (1994) concentrate mostly on the issues of siting new landfills however also attempts to close the existing gap by providing some good information on low-cost gas collection systems. Matsufuji (1990) provided technical guidelines for landfill design and operation for the improvement strategy of the government of Malaysia as mentioned above. Part two of the guide covers detailed technical aspects such as the construction of embankments, drainage systems and liners for the engineer, but also covers operational procedures for the manager. This guide is widely used in Malaysia (Ogawa, 1998). The "Guidance for Landfilling Waste in Economically Developing Countries" (Savage et al., 1998) covers all aspects of landfills like siting, design and operation and also describes measures for remediation, corrective action and resource recovery. Finally a new guide for decision-makers (Rushbrook & Pugh, 1998) allows the waste managers of low and middle-income countries to identify the main issues and problems of inadequate disposal and decide on the key decisions to be taken. It recommends a minimum standard to be achieved and also expresses desirable improvements to these minimum standards. More information is however needed on viable technologies adapted to the economic and technical aspects of the situation in order to achieve these standards.

A possible measure to upgrade open dumps and poorly designed or improperly operated landfills is the reuse of decomposed waste (landfill mining). This practice can be observed in Deonar, the waste disposal site of Mumbai, India (Coad, 1997) where laborers extract decomposed materials manually from a part of the site. The waste is dried, screened and the fine material bagged and sold. Landfill mining has potential not only as a method of resource recovery but also allows upgrading the excavated area to a better standard for then reusing it as disposal space. Recovered fine soil material may be suitable as cover material and coarse inert materials might be used as for the maintenance of access roads. In our view the potentials of landfill mining should be further pursued.

Last but not least a continiuos technical training of personnel is needed to ensure a satisfactory operation of a upgraded or new landfill disposal site.

5.2.2 Siting and designing new landfills

Upgrading dumps may longer their life span, however, due to the rapidly growing cities, the municipalities will inevitably have to plan for new landfill sites. Of main importance when opting for a new landfill site is determining the ideal site location. A poorly chosen site may require high costs of waste transport (e.g. the site is far from the collection area) or site construction. Finding a site where no additional lining is necessary can save up to 30% of the total capital and recurrent costs (Cointreau-Levine, 1997). To identify an appropriate site a systematic process of selection needs to be followed, whereby the selection criteria need to be prioritized according to local climatic, political and cultural circumstances (Rushbrook & Pugh, 1998). The goal of a careful site design is to minimize environmental impacts and operational problems. A good control of

water, traffic, soil and waste movement is an essential prerequisite for a well designed landfill.

7. Conclusions and Recommendations

The five major problems identified by Schertenleib & Meyer (1992) in SWM in developing countries (inadequate coverage of the population to be served, operational inefficiencies of municipal SW services and management, limited utilization of the formal and informal private sector in recycling activities, problems concerning the management of (non-industrial) hazardous waste and specific problems related to final disposal of solid waste) still exist to a large extent and need increased attention.

The main lessons learned from research over the last few years can be summarized as follows:

1. In order to be able to improve and properly manage the solid waste services, it is important that the municipalities know the actual costs of the different components of the SWM system including waste disposal. Knowing the complete costs of SWM services enables the authorities to make decisions, identify opportunities and plan for the future ("What is measured can be managed"). The current situation is still far from satisfactory.
2. To increase coverage and efficiency of solid waste services, community-based and private sector involvement can be a solution. However there are certain preconditions for a successful operation of such models which must be taken into consideration.
3. Final waste disposal has till now received little interest by municipalities as well as the public (out of sight-out of mind) and uncontrolled dumping is still the most common way of waste disposal in cities of the developing world. However contamination of water resources and air pollution of such disposal sites and increased health risks of people living nearby are of growing concern. A few important goals should be targeted in future to improve the current waste disposal activities:
    - Stop uncontrolled waste dumping by considering upgrading of existing dumpsites as a first step
    - Develop appropriate landfill standards to allow for a step-to-step approach towards long term standards
    - Develop landfill guidelines to suggest appropriate low-cost solutions for upgrading, designing and operating a landfill
    - Pay attention to siting of new landfills using a systematic and transparent process.
    - Develop sustainable markets for products recovered or produced from Municipal Solid Waste so to encourage small-scale organic waste recycling and the existing informal recycling system

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