Waste Generation and Disposal Methods in Emerging Countries

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Solid waste is an environmental problem in both developed and developing countries. The typical problem in Municipal Solid Waste Management (MSWM) of developing countries can be identified as inadequate service coverage and operational inefficiencies of services, limited utilization of recycling activities, inadequate landfill capacity, and inadequate management of hazardous and healthcare waste. In recent years, most developing countries have started to improve their municipal solid waste management practices. Different countries have adopted different strategies for reaching their goals, be it by applying advanced environmental technologies and extending recycling and reuse. Sustainable waste management will have to consider all possible options for the reduction of the negative impact of consumption.

The technological solutions and treatment alternatives to deal with the municipal waste must satisfy the sanitary and environmental reqirements. The traditional approach of *collect and dispose* is hard to be considered as an environmentally sustainable solution to the waste problem. In many countries MSW management systems are becoming more complex with the move from landfill-based to resource recovery-based concept following the setting of international and national targets to divert waste from landfill and to increase recycling and recovery rates.

1. Solid waste management in developing and emerging countries

The vast majority of solid waste management (SWM) projects implemented in developing and emerging countries (DEC) visualize the disposal of residual waste on a sanitary landfill. This approach leads in most cases to an increase of greenhouse gas (GHG) emissions. By implementing advanced SWM systems DEC could lower their national greenhouse gas balance by 10 to 15 percent.

The GHG emissions of the solid waste sector are of high relevance in developing and emerging countries (DEC), especially due to the high proportion of degradable organic material contained in the waste. Intensifying recycling activities offers further reduction potentials even if the amount of recyclable material in the waste stream of DEC is lower than in industrialised countries. By the implementation of advanced SWM concepts, DEC could lower their national GHG balances by 10 to 15 percent, as model calculations conducted by the German Federal Environment Agency (Umweltbundesamt – UBA) shows for the countries Mexico, Turkey and Tunisia.

Till now the vast majority of SWM projects supported by international development cooperation envisage, besides enhancement of recycling activities, the implementation of sanitary landfills as core element. Whereas, in terms of health and environmental protection these facilities represent huge improvements in relation to the given situation (mostly uncontrolled dumping), they are counterproductive in terms of GHG mitigation.

SWM cost consist predominantly of running cost, around sixty to seventy percent of the total costs are operating cost. Capital cost play even in technically advanced systems a more or less secondary role. Hence the provision of low-interest credits or even grants alone can not ensure financial sustainability of advanced SWM systems, ensuring proper SWM requires steady and reliable revenues. Full cost covering user fees, as they are common in industrialised countries, face serious restrictions in DEC due to the user's limited ability to pay. Revenues for recyclable materials or energy-from-waste could cover between twenty to thirty percent of the total system cost, depending on waste composition and recycling market conditions.

However, the provision of financial means and technology transfer alone will not be sufficient to develop the SWM systems in DETC. The framework conditions (*enabling environment*) are presently very weak in these countries. The situation of the solid waste management in most DETC is characterised by

- lack of competent project executing agencies,
- not or inadequately qualified personnel,
- missing or inadequate legal framework,

- lack of appropriate technical standards and environmental requirements,
- lack of professional regulatory and supervisory institutions,
- lacking or inadequate financing instruments/cost coverage,
- missing professional education, no research and development,
- insufficient participation of the civil society.

2. Case study: current situation of MSW management in the Arab region

With the rising of environmental awareness in the Arab region, environmental protection and waste management has been given high priority in the political agenda. Most of Arab countries made some efforts to deal with the problems of solid waste management such as issuance of several Laws and regulations aimed to organize work in waste management. Foreign rules and regulation were enacted but without any customization to suite the characteristics of every countries.

3. Framework and responsibility

Solid waste management in the region is a major responsibility of local government and there is no significant participation by the private sector has been identified. In some countries local private companies are involved in the collection and transport of solid waste and some various recycling activities. Organizational frameworks are defined by some countries but they still lack managing capacity as to the implementation and the effective commitment. The function of the organizational structure is disrupted by the centralization of authorities at the national level, inaction from the governmental institutions, lack of investment by the private sector in solid waste management and the absence of public participation in decision making.

4. Generation and composition

Recyclable materials such as plastic, glass, paper, metal, textile, etc. is not separately collected, and the household waste in some cases is collected mixed with other types of waste which make the amount of municipal waste generated increase. Municipal waste also contains hazardous substances such as drug residues, expired medicines, chemicals, paints, barratries and other materials. The physical composition of municipal solid waste in some countries in the Arab region is shown in Figure 1. The percentage of decomposable material in municipal solid waste is very high in the region and varies from thirty to seventy percent.

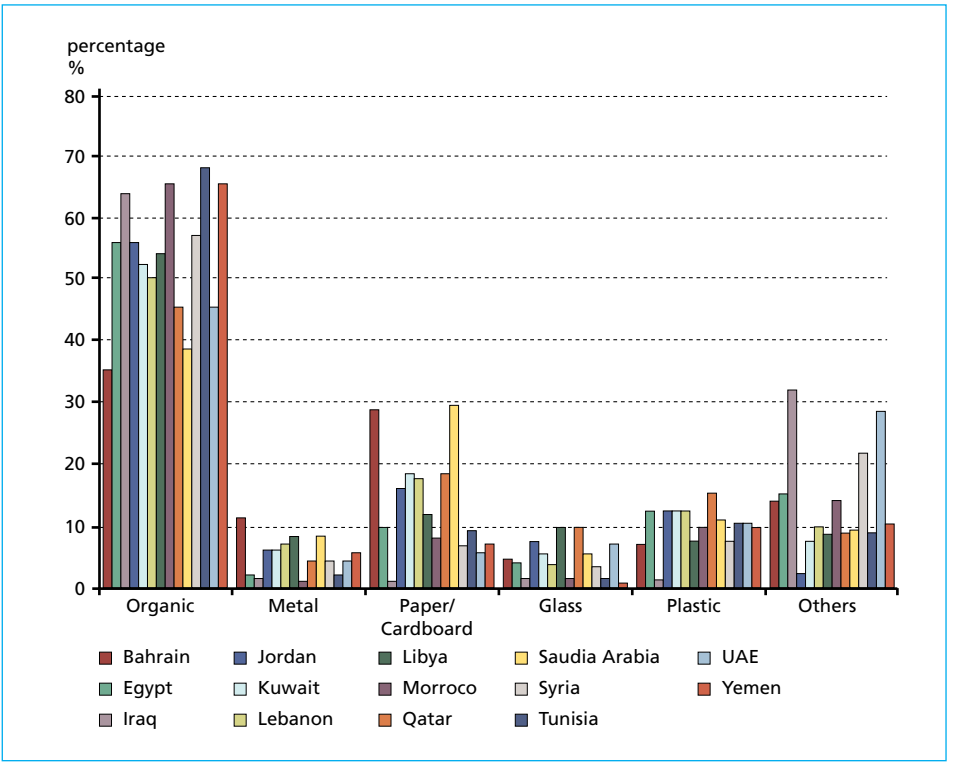

Figure 1: The physical composition of municipal solid waste in some countries in the Arab region

5. Solid waste treatment and disposal

Landfill and open dumps are still the common disposal method in the region, as shown in Figure 2, the common issues for practicing waste management are choosing the suitable treatment method of waste and the optimization of disposal logistics – e.g. introduction of separate waste collection, cost reduction and minimizing collection intervals.

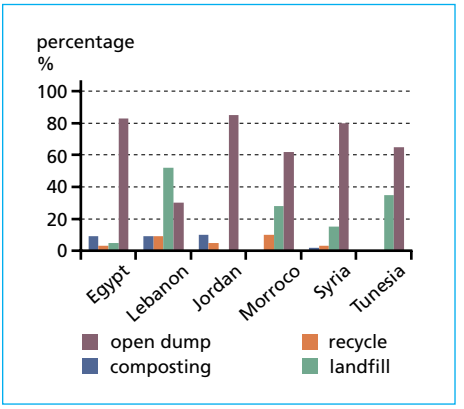

Figure 2: Municipal solid waste practices in some countries in the Arab region

The region is living a bad experience with sorting of recyclable materials from municipal waste and processing of the separated organic matter. About one to three percent of the total generated waste are recovered as recyclable materials, such as PET, other plastics, metals and paper. These materials are sorted from the waste

containers and disposal sites by scavengers and the sorted paper, metals and some plastic materials are marketed and recovered in local recycling facilities, while the PET are marketed internationally. In the region, many composting plants closed due to their mismanagement, some of them are even closed before they start to operate because of the inappropriate technology resulting in high operating costs and frequent mechanical breakdowns through poor maintenance, lack of understanding of the composting process and training in operational procedures.

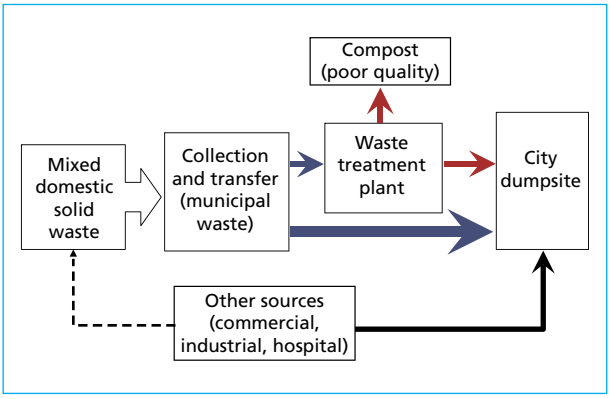

Figure 3:

The dominant concept of MSW management in the region

The production of compost from municipal solid waste is an important means of recovering organic matter and an essential method of disposal. It seems to be a possible strategy for the region, but there are however, many constraints such as:

- plants close due to mismanagement; some even close before they start operation,
- high operating costs,
- frequent mechanical breakdowns,
- poor maintenance,
- lack of understanding of the composting process,
- lack of training in operational procedures,
- compost quality.

A study conducted at the University in Rostock analyzed the compost quality of five compost facilities from five different countries (Egypt, Sirya, Iraq, Turkey and UAE). The results show that only 15 percent of the samples fulfill the German requirements (BioAbfV) regarding heavy metal concentration in compost and can be considered as stable compost. All other samples had higher heavy metal concentrations. In general, the samples had poor quality and are not recommended as soil fertilizers.

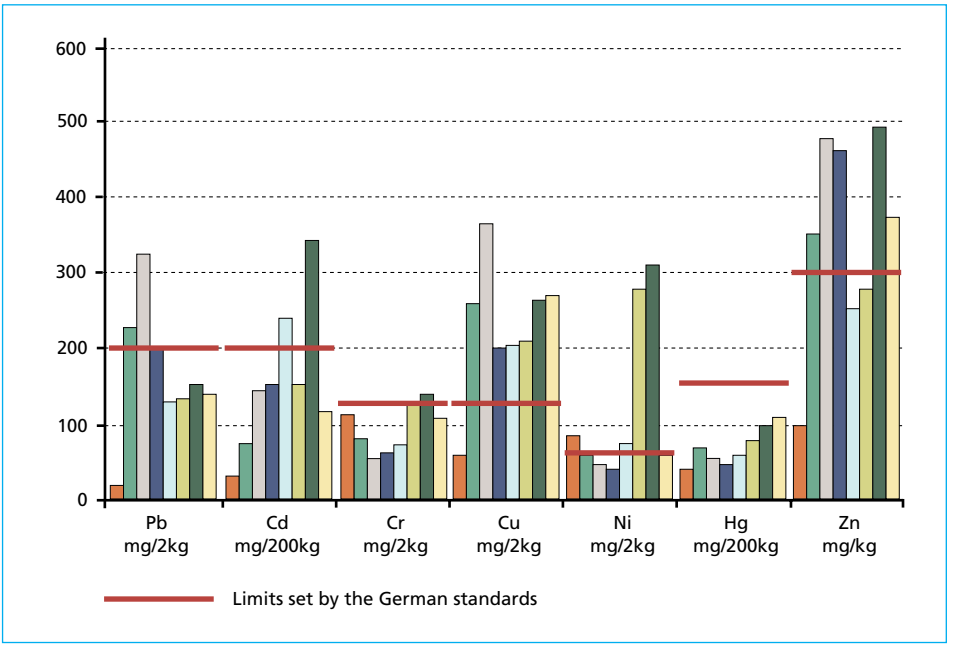

Figure 4: Heavy metal concentration in compost samples from 5 different facilities in the region compared to the German requirements (BioAbfV)

Considering the poor compost quality and the unfeasibility of a segregated collection, other practical alternatives for the management of mixed municipal solid waste should be evaluated and considered for the region. Waste-to-Energy strategies could be considered. Aside from the *established* waste incineration also the pre-treatment of waste to a RDF (refuse derived fuel) and its co processing in the industry will be presented. Currently, there are some activities to construct and operate a mechanical biological waste treatment (MB) plants to produce high calorific value fraction (RDF), which can be utilize in the future as secondary fuel in cement industry.

6. Possible solutions for MSW treatment in MENA Region

Nowadays, one of the priorities for municipalities are to collect, recycles, treat and dispose of the increasing quantities of MSW. The potential impacts caused by wastes on the environment, the use of valuable space by landfills and poor waste management that causes risks to public health are the absticles to handle the problem.

Waste generated in the MENA Region is deposited in landfill/dumpsites with different technical standards without separation of materials for recycling and treatment. Landfilling without treatment is now forbidden in Europe for environmental reasons

and sustainable resource management. Incineration is considered a good solution for Western European countries, but it is not suitable in the MENA Region for technical (calorific value) and economic (investment) reasons. Municipalities in the MENA Region face therefore the problem of identifying cost-efficient SWM strategies meeting their local goals and needs.

With proper MSW management and the right control of its polluting effects on the environment and climate change, municipal solid waste has the opportunity to become a precious resource and fuel for the future sustainable energy. Alternatives should be examined so that waste is put to the use which is most beneficial in resource and environmental terms, rather than accepting a simple hierarchy, thus pursuing integrative strategies.

The main objectives of the alternatives are:

- production of recycled materials,
- separation of the high calorific fractions larger than one hundred to 150 millimetres for combustion,
- separation of the organic fractions smaller than one hundred to 150 millimetres,
- physical drying of the organic fractions by the waste heat and
- combustion of the dried organic fractions with the separated high calorific material groups.

7. Municipal solid waste treatment to produce energy or RDF

The practical experience in Western European countries have shown that the following groups of substances can be produced and utilized by the mechanical-biological/physical treatment processes:

- approximately five to ten percent recyclable materials for marketing in the local and international markets,
- forty to sixty percent alternative fuels for thermal utilization in the cement industry and power plants. The price of the fuels is dependent on energy prices in the country;
- twenty to thirty percent inert/stable for landfill material for landfill. Where no leachate and no landfill gas are produced.

The following figure illustrates the possibilities of the treatment and recovery of the individual fractions of household waste and commercial waste in the MENA Region.

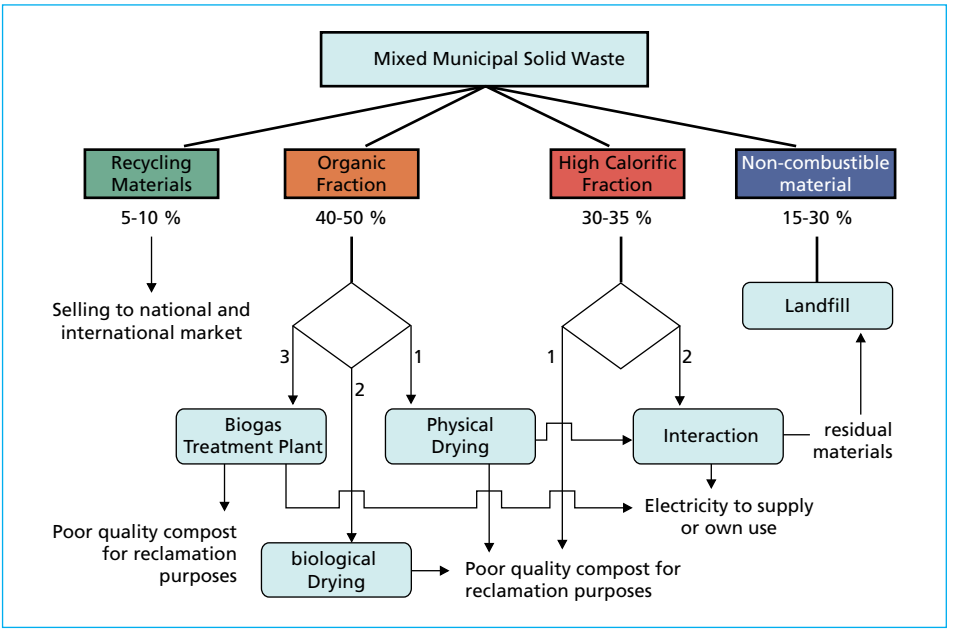

Figure 5: Possible treatment and recovery of the individual fractions of household waste and commercial waste in the MENA Region

Such solutions are suitable for the MENA Region. The challange for such solution proposed is to ensure the thermal utilization of the produced fuels. The ecological and economic assessment represents the utilization of alternative fuels in the cement industry. In most countries of the region there are already existing cement plants, which could use the RDF from municipal and industrial waste.

8. Utilization of RDF

In the industrial co-incineration process RDF is utilized as secondary fuel to generate energy and heat in an industrial combustion facility. RDF is mechanical-biological/physical pre-treated waste material of defined composition and properties. The amount of RDF needed depends on the type of RDF, the technology and the essential requirements of the end product. The energetic content of MSW and industrial waste can also be recovered in industrial facilities, where waste acts as a substitute fuel, or in some cases as raw material. Not all types of waste are appropriate for co-incineration. Depending on the process, demands must be made on the calorific value, the homogeneity of the waste, content of heavy metals (Mercury), size, etc.

In MENA Region Energy prices varies by countries and cities. There are initial concepts for projects in the region for energy production from organic waste. Countries and cities, which have no cement industry, can also adopt the concept of *waste to energy* by waste thermal treatment. The calorific value of municipal solid waste in Arab cities

is between 4,000 to 6,000 kJ per kilogram. In comparison, the calorific value is 8,000 to 10,000 kJ per kilogram in Germany. For a effective waste combustion, the water content must be reduced by treatment processes.

Based on the availability of land for disposal, market for recyclable material and the need for energy production, and taking into account economic and social aspects, with particular attention to environmental issues this assessment could increasing awareness of managers and planners in the region to follow a sustainable approach to waste management and to integrate strategies that will produce the best practical option.

Depending on the quality of the waste and the market situation, both material recycling or energy recovery are possible. The processing of waste with the aim to produce secondary raw material from mixed waste requires the solution of numerous problems.

9. Conclusions

In developing countries municipal solid waste is mainly mixed with construction and demolition debris, drain silt, and hospital and other hazardous waste. Mixed waste composting facilities have high operating and machinery costs and the final compost can contain a high level of contaminants. One of the primary concerns is the presence of heavy metals and toxic organic compounds in the MSW compost product. It is difficult to separate out the main sources of heavy metals before the refuse is composted.

The input material for the compost process is a mixture of organic and recyclable materials (plastic, glass, paper, metal, textile, etc.) together with other domestic waste (diapers, dust, ceramics, bones, etc.) and in some cases even hazardous domestic waste (drug residues, expired medicines, chemicals, paints, batteries and other materials). Separating contaminants from the raw material at the compost site is inefficient since it requires additional effort, space, and time, and it is likely that much of the contamination has already affected the organic fraction. The selection of the suitable municipal solid waste (MSW) treatment alternativi is a complex task in which a widespread set of criteria must be taken into account. Additionally to economic or social aspects, the decision process should consider the environmental perspective. Alternatives should be examined so that waste is put to the use which is most beneficial in resource and environmental terms. Depending on the quality of the waste and the market situation, both material recycling and energy recovery are possible. The processing of waste with the aim to produce secondary raw material from mixed waste considered a solution of numerous waste problems in the region.

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