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Original Research

Municipal solid waste management in El-Beheira Governorate, Egypt: a case study in Damanhour City

Magda Magdy Abd El-Salam

[1] *Environmental Chemistry and Biology, Environmental Health Department, High Institute of Public Health, Alexandria University, Egypt*

[2] *Public Health Sciences, Biology Department, College of Science and Humanity Studies, Salman bin Abdulaziz University, Kingdom of Saudi Arabia*

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Corresponding Author:
Magda Magdy Abd El-Salam,
High Institute of Public Health,
Alexandria University, Egypt
mmagdy_hiph@yahoo.com

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Abstract

Aim: This study is aimed to evaluating the generation, characterization and the current management practices of municipal solid waste (MSW) in Damanhour City, El-Beheira Governorate, Egypt.

Methods: Environmental and public health impacts of MSW management were also investigated. Sampling was selected by stratified random method, and the assessment was conducted using questionnaires, interviews with municipal officials and field observation. Physico-chemical characteristics of MSW were determined according to standard methods.

Results: This study indicated that the quantity of MSW generated by households was with an average of 0.92 kg/capita/day. The survey results revealed that the management of the waste remains inefficient and inadequate for the amount generated daily. Wastes are dumped in open non-controlled dumpsites which are not accepted at the current time. It is also found that residents near a dump site affected by various diseases. It was concluded that the insufficiency in the current MSW management practices were mainly related to performance of municipality and citizens behavior. Integrated MSW management programs require cooperation between governorate and citizens.

Conclusion: These results support the need for increasing public awareness and citizens' participation in waste sorting at generation source and implementation of integrated MSW management programs as part of the environmental action plan for the governorate.

INTRODUCTION

Solid waste management (SWM) in the world is a problem that continues to increase with the rapid growth of population, urbanization, industrialization and economic development [1].

Globally; municipal solid waste (MSW) generation is exceeded 2 billion tons per year [2]. The annual growth rate of MSW is 2–3% in developing countries while 3.2–4.5% in developed countries [3]. The rate of MSW generation in Egypt fluctuates between 1.0-1.3 kg/capita/day in big cities, 0.5-0.8 kg/capita/day in medium cities and about 0.25 kg/capita/day in small cities and rural areas [4].

Solid waste is one of the major causes of environmental pollution in Egypt. SWM continues to be a challenge, particularly prevention, collection, transport, treatment, recycling, recovery and final disposal. A waste management hierarchy based on the most environmentally sound criteria favours waste prevention/ minimization; waste re-use, recycling, and composting [5].

In Egypt, household waste and construction/demolition debris are being got rid into the streets by residents. The rapidly advancing random building movement after 25 January revolution is adding complexity to the situation. Previously such debris was carried to dumpsites to avoid penalties imposed by municipality supervisors. After this revolution, people chose an easy way for throwing such debris regardless of the

environment, hygiene or personal responsibility due to the absence of inspection and control [6].

In developing countries, final disposal of MSW was carried out through transporting the collected waste to open dumping site then burnt it to reduce its volume and to minimize the attraction of animals and vermin and also to retrieve recyclable items. Despite the degradation of valuable land resources and the creation of long-term environmental and public health problems, uncontrolled, open dumping is still prevalent in most developing countries [7].

Egypt has adopted a national strategy for integrated MSW management (2000) through which to develop and implement enhanced SWM systems. However, it doesn't have discrete legal framework for SWM. Despite decree No. 38/1967 on general public cleaning and Law No. 4/1994 for the protection of the environment and their amendments as well as their update within 2005-2010 [6], the current system of SWM remains inefficient and inadequate for managing the amount generated daily. Also, authorities are failing to regulate segregation, collection, transfer or treatment due to weakness of legislative enforcement. In addition, lack of modern and practical SWM policy is one of the weakest points in the system. Despite of the considerable efforts undertaken by El-Beheira Governorate, various obstructions are being faced in El-Beheira Governorate such as inadequate provision of budget allocation, lack of public participation and awareness and lack of skilled staff and training about integrated SWM system. Lack of the governmental records and studies regarding MSW quantities, characteristics and composition in El-Beheira Governorate are also limiting factors to identify the existing management shortcomings [8]. More than 80% of MSW is disposed of in open-pit dumps or uncontrolled open-air burning that are the most common practices applied in many areas of the governorate, creating problems to public health and the environment. The accumulation of solid wastes is a major pollution source in most local and rural units inside the governorate, due to lack of public dumping sites, equipment, human resources [9]. Therefore, the objective of the present study is to assess the situation of MSW management in the capital and biggest city of El-Beheira Governorate (Damanhour City) and to identify the major problems in the current system. This was achieved through determining the quantity of waste generated in Damanhour City. Characteristics of MSW have also been investigated in order to suggest the appropriate solutions solving of the identified problems.

BACKGROUND INFORMATION

El-Beheira Governorate is the second biggest Governorate in Egypt which covers an area of 9826 km^2, representing 1% of the Egypt's total area, and encompasses 15 Markaz, 15 cities, 84 rural local units, 497 villages and 5737 hamlets. According to 2012 census, the total population reached 5.327 million comprising 19.2% urban and 80.8% rural. The population natural growth rate has reached 19.1 per thousand [10]. Damanhour is the capital city of El-Beheira Governorate in Egypt with a population of 743,450 and containing 14.8% of El-Beheira inhabitants [11].

Waste quantities

According to Egyptian Environmental Affairs Agency (EEAA) records in 2010, 77 million tons of solid waste generated annually in Egypt as presented in Table 1 [6, 12]. MSW currently constitutes about 27% of the generated waste, which is equivalent to 21 million tons annually [12]. It is evident from this table that, industry generates 8.4 million tons/annum of solid waste of which around 0.20 million tons are classified as being hazardous.

Table 1. Different quantities of solid waste varieties in Egypt according to 2010 EEAA's estimates

Type of waste	Annual estimated quantity (million tons)
Municipal solid waste generation	21.0
Medical waste generation	0.40
Industrial waste generation	8.20
Hazardous industrial waste generation	0.20
Agricultural waste generation	25.0
Construction and demolition waste generation	6.0
Others	16.2

Source: SWEEP-Net (2010, 2012) [6, 12]

In El-Beheira Governorate, the demographical development and the intensification of the economical activities are accompanied by an increase of the annual waste generated with 1.1 million tons representing 3000 tons/day in accordance with 2010 EEAA's estimates [6]. Only 60% of MSW generated in El-Beheira Governorate is managed by a public sector collection, disposal, or recycling operation, and near 40% remains untouched and uncollected [13]. The estimated amount of waste accumulated in the governorate in 2004 is 600,000 m^3 [14].

MATERIAL AND METHODS

Study setting and design

The study was performed as case study in Damanhour's municipality. Damanhour City was selected from El-Beheira Governorate centres for the following reasons:

- It is the capital city.

- It has the highest generated quantity of waste as presented in Table 2.
- The main dumpsite and composting plant are located there.

Table 2. Urban and rural municipal solid waste generation in El-Beheira Governorate, Egypt

Centres	Location	The inhabitants number	Waste generation (tons/day)
	Urban	262125	324
Damanhour	Rural	481325	230
	Total	743450	554
	Urban	45003	50.0
Abu Almtamir	Rural	320636	140
	Total	365639	190
	Urban	36339	40.0
Abu Homs	Rural	400386	180
	Total	436725	220
	Urban	43950	35.0
El-Dillingat	Rural	276470	133
	Total	320420	168
	Urban	27349	30.0
El-Mahmoudia	Rural	216352	110
	Total	243701	140
	Urban	44421	40.0
Etay El-Baroad	Rural	378902	160
	Total	423323	200
	Urban	86222	100
Hushe Issa	Rural	143283	60.0
	Total	229505	160
	Urban	89756	90.0
Rosetta	Rural	113132	50.0
	Total	202888	140
	Urban	30485	30.0
Shbrakhitt	Rural	222085	100
	Total	252570	130
	Urban	281215	289
Kafr-Eldoar	Rural	571913	209
	Total	853128	498
	Urban	39043	50.0
Kom-Hamada	Rural	397580	170
	Total	436623	220
	Urban	18754	30.0
Wadei El-Natron	Rural	13344	20.0
	Total	32098	50.0
	Urban	31840	40.0
El-Rahmanih	Rural	108127	70.0
	Total	139967	110
	Urban	109954	90.0
Edko	Rural	55649	30.0
	Total	165603	120
	Urban	17972	20.0
Bader	Rural	135850	80.0
	Total	153822	100
Total		4999462	3000

Source: SWEEP-Net (2010) and HAD (2007) [6, 11]

Data collection

An environmental survey was conducted in 2012 based upon reviewing records of Ministry of State for Environmental Affairs (MSEA) and EEAA, interviewing with municipal officials and field observations to collect information about the municipality and the current MSW management system. A household's survey was conducted using questionnaires distributed to the selected 650 households based on stratified random sampling technique in order to estimate waste generation rate, composition and to assess waste disposal methods and satisfaction with municipal services. Moreover, survey of 50 residents near a dump site using a questionnaire to assess environmental and public health impacts from the waste disposal practices.

Sampling

The wastes generated by these households were gathered and investigated twice a week for a period of six weeks giving a total of 12 samples to determine the average waste generation rate in kg/capita/day. The householders were requested to separate their waste as organic biodegradable kitchen waste, paper, plastic, glass, metal and other waste. All generated waste categories were weighed twice every week. The same households were interviewed as to their waste disposal practices and satisfaction with municipal services.

Analytical methods

Samples were taken from each physical component of wastes in order to determine moisture content and volatile substances. The analytical methods of the generated waste were carried out according to Methods of Analysis of Sewage Sludge, Solid Wastes, and Compost [15]. Temperature and pH were measured from the waste extracts using a glass electrode. Total carbon content of the waste sample was estimated using C% = % total volatile solids/1.8 [16].

Statistical analysis

Data were tabulated and analyzed using Statistical Package for Social Sciences (SPSS) version 11.0 computer software package [17].

RESULTS AND DISCUSSION

Municipal solid waste quantities and characteristics

Municipal solid waste generation rates

In developing countries including Egypt, there are a wide difference between the amounts of solid waste generated and that reaching final disposal sites. Moreover, there are no either weighing facilities at disposal sites or waste analysis, except at composting plants. However, in developed countries, the two

figures are much close since most waste arising must be disposed of formally [18].

The contribution of the different sources of MSW is shown in Table 3. Damanhour City generates 554 tons/day of solid waste in accordance with 2010 EEAA's estimates [6]. MSW comprises 96% of Damanhour's solid waste while the rest types including agricultural waste comprise 4% of it. The majority (70%) of MSW derived from household while the other types are hospital waste (0.7%), commercial and industrial waste (14%) and construction and demolition waste (0.9%) as shown in Table 3. This finding is approximately in accordance with results obtained by Damghani et al. who found that the solid waste produced in Tehran classified into four groups where MSW constitutes > 97%, hospital waste, 1.0%; industrial waste, 0.6%; and construction waste, 0.5% [3]. It is found that the generation of MSW in Damanhour City varies from 0.75 to 1.0 kg/capita/day with an average of 0.92 kg/capita/day. According to World Bank study in 1999, MSW generation in Sri Lanka is 0.8 kg/capita/day and expected to be 1.0 kg/capita/day by the year 2025 [19]. According to the National Environmental Action Plan (1992), it is estimated that the generation rate of MSW in Egypt ranges from 0.03 kg/capita/day in rural areas to 0.8 kg/capita/day in Cairo, but it reaches 1.5 kg/capita/day for hotels and tourist resorts [18]. Similar result obtained by Bai and Sutanto in Singapore who found that the amount of solid waste produced was 0.96 kg/capita/day [20]. Lower average generation rate (0.88, 0.5-0.8, 0.2-0.5 and 0.66 kg/capita/day) than the present study is obtained by Damghani et al. in Tehran, Manaf et al. in Malaysia, Sharholy et al. in India and Dangi et al. in Nepal respectively [3, 21-23]. However, higher average generation rate (1.21 kg/capita/day, 1.32 kg/capita/day and 1.52 kg/capita/day) of MSW than the present study is obtained by Suocheng et al. in China, Magrinho et al. in Portugal and Jin et al. in Macao respectively [1,24,25]. This difference might be due to different standards of living and cultural habits [24]. Less developed countries are relatively generated small quantities of MSW compared to the production in most Organization for Economic Co-operation and Development (OECD) countries e.g., up to 2.1 kg/day/capita in the USA [5].

Waste composition is of vital importance for the choice of waste treatment and disposal methods [5].

The composition of MSW generated from households selected from located in Damanhour City is presented in Table 4 and Fig. 1. From these table and fig., it is evident that the average composition of MSW was found to be 54% food waste, 14% paper and cardboard, 10% plastic, 3% glass, 1% metal and 18% other materials. It is noticed that food residues constituted the main bulk of wastes generated with a wide range extending from 49% to 58%. This finding is in contrast with results obtained by Magrinho et al. study in Portugal where the physical composition of MSW in an urban region are 35.5% organics, 25.90% paper and cardboard, 3.40% textile wastes, 11.50% plastics, 2.60% metal, 5.40% glass and wood wastes around 0.75% [24]. The present study is in agreement with Sharholy et al., Dangi et al., Norbu et al., Hui et al. and Zhuang et al. studies in India, Nepal, Thailand, Chongqing and China which found that organic fractions (40-60%, 71%, 68.5%, 59% and 64.48% respectively) of the waste were very high compared to the general MSW stream [22, 23, 26-28]. In Singapore, food waste accounts for about 39% of the total waste streams and paper makes up 20.60% [20] while in Japan, 40% comes from foodstuff and 25% from containers and packaging material [29]. Another waste characterization study found that the main components of Malaysian waste were food, paper, and plastic which comprise 80% of overall weight [21]. Bandara and Hettiaratchi showed that the total residential waste generation in Sri Lanka is estimated to be 80 tons/day while the total quantity of MSW disposed of by the municipality has been estimated to be 135 tons/day [19]. The difference is attributed to the presence of commercial waste in MSW stream while household waste consists primarily of organic waste with higher percentage (90%) than the present study (54%) [19]. However, the paper (5%, <1% and 4.87%) and plastic (3%, 3-6% and 6.13%) percentages in Sri Lanka, India and Vietnam respectively were lower than paper and plastic (14% and 10% respectively) in the present study [19, 22, 30].

Table 3. Sources of municipal solid waste in Damanhour City, El-Beheira Governorate, Egypt

Municipal solid waste sources	Percentage
Household	70
Localities' services (e.g. street sweeping)	6.4
Commercial	12.0
Industrial	2.0
Hospitals	0.7
Institutions	5.0
Construction and demolition	0.9
Others	3.0

Composition of municipal solid waste

There are several factors affecting the composition of household solid waste including dietary habits, cultural traditions, lifestyle, climate and income [22, 25]. In addition, the composition of MSW depends on the affluence of the population contributing to the waste stream. Quantitative analysis carried out by EEAA indicated that the composition of MSW in Egyptian

cities differs considerably from that of cities in developed countries. One reason for this is that there is a wide range from poverty to affluence in Egypt urban population and much of the waste is reclaimed for recycling at various stages from arising to final disposal. On the other hand, organic content of MSW in Egypt are much less in rural areas where waste materials are used traditionally and beneficially (e.g. for feeding animals, as soil conditioner, and as fuel for ovens). While rural areas comprise about 60% of the total population in Egypt, they only dispose of around 30% of the total amount of solid waste. This reduction is due to the reclamation of reusable constituents in the waste [18]. This finding is in contrast with the results obtained by Sharholy et al. (2008) study of MSW in India where organic waste percentage is increasing with the decreasing socio-economic status and consequently for that rural households generate more organic waste than urban households [22].

Table 5 shows the characteristics of MSW generated from households selected from located in Damanhour City, Egypt. It is clear from table 5 that the temperature recorded for the whole generated wastes ranged between 30˚C and 45˚C. Low pH values ranged between 5.0 and 6.5 could be due to the reduction of organic matter to mineral acids or due to the reduction of the volatile acids [26]. Moisture percentage of the whole generated waste samples found to be ranged from 43 to 62% with a mean of 58%. Moisture content plays a crucial role in the waste sorting process. Although high moisture content value decreases waste sorting into different fractions, it increases biological activities of microorganisms during composting [26, 28]. Similar results obtained by Manaf et al. (2009) in Malaysia and Zhuang et al. (2008) in China who found that solid waste contains a high moisture content of 55.01% and 56.50% respectively [21, 28]. Higher values (64.1%) of moisture content than found in the present study (58%) were obtained by Hui et al. (2006) in Chongqing [27] while lower values of 48.6% obtained by Bai and Sutanto (2002) in Singapore [20]. The mean values of volatile solids, carbon and nitrogen content for the whole generated wastes were 75%, 42% and 1.05%, respectively. High volatile solids content can be attributed to organic fractions dominated the waste composition. This was in agreement with another study in Thailand which recorded that the mean values of moisture, volatile solids, carbon and nitrogen content for MSW were 68%, 80%, 45.5% and 1.025 respectively [26]. C/N ratio in the present study is within the range of 35–42. This finding is in contrast with the results obtained by Sharholy et al. (2008) study in India where the C/N ratio ranges between 20 and 30 [22]. Rapid degradation of organic matter in composting process reduce C/N ratio where microorganisms consume carbon for energy/growth and nitrogen for their protein production/reproduction [26].

Table 4. Composition of municipal solid waste generated from households selected from located in Damanhour City, El-Beheira Governorate, Egypt

Ingredients	Range (%)	Average (%)
Food waste	49-58	54.00
Paper and cardboard	9-23	14.00
Plastic	4-11	10.00
Glass	1-5	3.00
Metal	1-1.5	1.00
Other materials	10-26	18.00

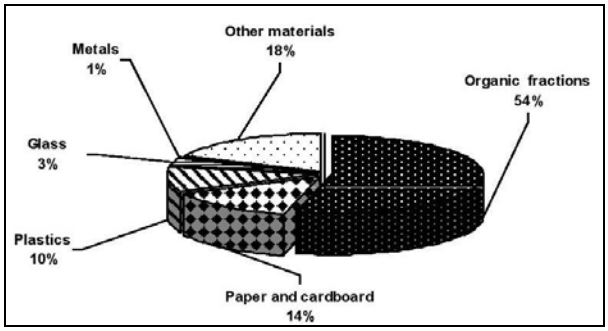

Fig.1 Urban municipal solid waste composition generated from households selected from located in Damanhour City, El-Beheira Governorate, Egypt

Table 5. Characteristics of municipal solid waste generated from households selected from located in Damanhour City, El-Beheira Governorate, Egypt

Parameters	Unit	Minimum	Maximum	Mean
Temperature	˚C	30	45	40
pH	-	5.0	6.5	6.0
Moisture	%	43	62	58
Volatile solids	%	65	80	75
Carbon	%	39	44	42
Nitrogen	%	1.0	1.1	1.05
C/N Ratio	-	35	42	40

Current practices of municipal solid waste management

Waste collection and transportation

MSW collection efficiency is a function of manpower availability and transport capacity [22]. Solid waste collection, transportation and disposal are currently handled by municipality of Damanhour City (Local Unit). Only household waste, commercial waste and street sweepings are collected as MSW (Table 3).

Survey of SWM in Damanhour City showed that household waste collection varies from urban to rural areas. In rural areas, waste collection is neglected where accessibility is limited. These wastes either throw on water stream banks or open-dump onto roadsides/neighborhood bare lands or burn in open areas. In urban areas, MSW is collected at temporary collection points or containers then transported waste is collected from them using flat-or open-bed trucks. This study was in accordance to findings of a survey conducted in Sri Lanka (2010) which found that wastes along the roads are cleaned by the sweepers operating push carts that clean the roads, collect waste and keep them in small heaps in temporary transfer sites [19]. Also, this survey indicated that there are no permanent transfer stations prepared for storing waste collection but public areas close to bus stands which are accessible by the trailers are used for this purpose [19]. This finding is in conformance with confirmed the results of the present survey. Also, it is found that scavengers or informal waste pickers are active in collecting recyclable materials from solid waste. A survey carried out in 1992 by the National Environmental Action Plan in Egypt reported that only 68% of MSW is collected in Cairo. Half percentage of MSW is collected by garbage collectors using pick-up trucks. Waste collection efficiency range from 0% in low-income rural areas to 90% in high-income areas of large cities. In poorer areas, waste collection is much less where solid waste disposal depends on informal scavengers, natural biodegradation and dispersion, burning at source of disposal, and local dumping sites [18]. Another survey carried out in Qena-Egypt showed that households store their waste in plastic bags inside their staircases behind their entrance doors from where the waste collectors can pick up the bagged wastes. The waste is loaded directly onto small size pick-up vehicles. Waste collection is organized on a house-to-house basis and not a single communal container is used in town [31].

The present study is in contrast with a survey done by Jin et al. (2006) who studied solid waste management in Macao and reported that there are two waste collection methods for MSW. The first collection system is used in high-rise apartment blocks where waste is stored in bulk containers in the basement of the apartments. These containers transferred to the bin compounds then transported to the refuse disposal sites. The second is a centralized refuse-chute system. This system allows residential refuse to be discharged directly from individual flats through a common discharge chute to the central refuse container. It also allows a small vehicle to go directly up to the central refuse chute of each apartment block and transfer the central refuse container mechanically from the central refuse chute to the waste collection truck [25]. Another survey in India showed that there is no MSW storage at source in urban areas. For both decomposable and non-decomposable waste, communal bins (movable or fixed) are used to collect the waste without any segregation and disposed off at a community disposal centre. House-to-house collection is just starting in many megacities [32].

The present survey revealed that waste collection period also varies. Over the Governorate Road and market areas, waste, which represents 30%, is collected daily. Half percentage of the surveyed household areas, waste is collected every other day and in 20% of them waste is collected only about twice a week as shown in Table 6. Refuse collection is mostly arranged at morning. It is also found that the collection manner of waste fee is along with estate fee by the municipality.

According to the household survey conducted by Bandara and Hettiaratchi (2010) in Sri Lanka, MSW collection is available to only 56% of the households. About 20% of the households dump their waste on the roadside and 8% dump the waste into pits in their own backyards. In addition, 7% of the households use their waste as a compost while 7% others recycle it [19]. This finding supported the households' survey in Damanhour City (Table 6).

Waste treatment and disposal

MSW disposal has become an increasing problem faced by the municipality due to increase of land scarcity [19]. It is also a vital problem in El-Beheira Governorate towns especially in Damanhour City due to rapid urbanization. Despite this growth, there is no parallel effort to properly manage the MSW generated by the urban dwellers. The quantities of MSW are doubled to be 3000 tons/day in the last ten decades [6].

Treatment and disposal technologies such as sanitary landfilling, composting and incineration are recently applied in Egypt. Open dumping is the most common practice and open-air burning is used to reduce the volume of accumulating waste which indeed creating air pollution. At present, there are no landfill regulations or standards that provide a basis for compliance and monitoring, but national guidelines for these standards are being prepared by the EEAA [18].

Table 6. Municipal solid waste collection and final disposal in Damanhour City, El-Beheira Governorate, Egypt

Collection and disposal	Percentage
Municipal solid waste collection coverage	
Rural areas	0-27%
Urban areas	40-60%
Collection period/frequency:	
Daily	30%
Every other day	50%
Twice a week	20%
Times of collection per day:	
Once	100%
Twice	0%
Thrice	0%
Municipal solid waste final destination	
Open-dumped	86%
Composted	8%
Recycled	2%
Landfilled	4%
Number of sanitary landfills in El-Beheira Governorate (MSEA/EEAA, 2008) [14]	
Under study	0%
Under construction	0%
Built	2
Operational	2
Number of recycling factories in El-Beheira Governorate (MSEA/EEAA, 2008) [14]	
Under study	0
Under construction	0
Built	3
Operational	1

In El-Beheira Governorate, flat-or open-bed trucks are used to collect the waste heaped on temporary dump sites along the roadsides and transport to the final thirteen public dumping sites [14]. In addition, there are three solid waste recycling factories and production of organic compost (composting) at Damanhour, Kafr-Eldoar, and Edko in El-Beheira Governorate in accordance with 2007 MSEA's records [10]. Nowadays, the two Damanhour and Kafr-Eldoar plants are suspended. Edko factory is functional with capacity of 10 tons/hour and run by the government sector [14, 33]. Moreover, there are two sanitary landfills for solid wastes disposal in El-Beheira Governorate according to MSEA in 2007 [10] as represented in Table 6.

Survey of SWM in Damanhour City showed that the municipality is responsible for the SWM of the city. A percentage of 86% of MSW is mainly open dumped. The remaining part is recycled (2%), processed as compost (8%), and landfilled (4%) as presented in Table 6. This finding study was in accordance to findings of a survey conducted in Sri Lanka which revealed that all of the collected MSW is disposed of at temporary, un-engineered and uncontrolled open dump site. Also, this survey indicated that the municipality collects roadside wastes include even industrial waste [19]. Results from a survey conducted in Portugal showed that 96% of MSW was collected mixed and only 4% was separately collected. A percentage of 68% was disposed of in landfill, 21% was incinerated, 8% was composted and 3% was recycled [24]. In USA (2009), 54% of MSW was landfilled, 12% was incinerated, and the remaining 34% was recovered, recycled or composted [34]. The percentage of MSW disposed at landfills accounted for 3% in Japan (2003), 18% in Germany (2004), 36% in France (2005), 54% in Italy (2005), and 64% in the UK [5]. Another survey in India showed that waste dumps or open burning continues to be the principal method of waste disposal. These methods are continuous source of emission of harmful gases and highly toxic liquid leachate [32].

Municipal solid waste management problems encountered in the Damanhour City, El-Beheira Governorate

The major solid waste problems in Damanhour City, El-Beheira Governorate, Egypt were:

1. Sorting of MSW randomly by scavengers either in streets or at collection points.

2. Lack of MSW containers lead to waste accumulation and generation of an appropriate environment for pests and insects.

3. Lack of modern equipment and trucks used to collect MSW.

4. Variations in cleanliness service levels among Damanhour City areas according to income level.

5. The behavior of citizens dealing with the waste such as incineration in street.

6. Waste accumulation in open dumps led to outbreak of fires.

Environmental and public health impacts near dumping site

As for the majority of the El-Beheira cities, Damanhour has uncontrolled waste dumping site that is located within 3km of the city center in the middle of residential areas. It is worth mentioning that MSW are dumped into the El Manshua dumping site without any

treatment and the site receives all types of solid wastes from the municipality. The results obtained by Mato study in Tanzania revealed that sanitary landfills are used for disposing of heterogeneous solid wastes from the municipality and crude dumping is being practiced [35]. The urban location of the dump site can constitute a risk for the neighboring population such as unpleasant odor, smoke generation from spontaneous fires, contamination of water, soil and atmosphere, and array of environmental impacts and potential health implications [19, 35].

Table 7. Public health impacts among affected people living near dumping site in Damanhour City, El-Beheira Governorate, Egypt

Public health impacts	Percentage
Presence of low birth weight infants	5.2
Presence of baby with congenital abnormality	2.6
Presence of mortality in the last two years	7.1
Presence of hospital admissions in the last two years	10.8
Presence of bad odours	58.9
Presences of pests/domestic insects (e.g. cockroaches, house flies, lizards, spiders, mosquitoes, etc)	70.9
Presence of vector (e.g. rodents, rates, etc)	82.4
Presence of respiratory diseases (e.g. bronchitis, chronic obstructive pulmonary disease, asthma-like symptoms, etc)	75.8
Presence of skin diseases (e.g. skin irritation, etc)	20.5
Presence of eye diseases (e.g. eye irritation, etc)	48.7
Presence of gastrointestinal tract diseases (e.g. parasites, diarrhea, etc)	62.4

Interview with fifty affected people who lived near a dump site using a questionnaire revealed that the worst impacts of present solid waste disposal practices are related to public health implications as presented in Table 7. The major environmental and public health hazards associated with MSW management are:

- Bad smell emanating from refuse heaps, waste transportation and dump site.
- Breeding of pests, insects, stray pets and rats due to accumulation of waste.
- Traffic hindrance caused by garbage collection vehicles.
- Falling of garbage bags from garbage trucks on either side of the main road.
- Dust created by garbage collection vehicles.
- Residents near a dump site affected by various diseases such as respiratory, skin, eye, and abdominal diseases.

CONCLUSION AND RECOMMENDATIONS

It is concluded that inefficient collection is the most significant solid waste problem in Damanhour City. Only a fraction of the MSW generated is properly collected. Often times waste is burned once large volumes accumulate on the streets or in vacant lots. Wastes are dumped in open non-controlled dumpsites. Residents should be encouraged and given incentives to participate in an integrated MSW management program where waste is sorted at the point of generation.

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