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SOLID WASTE MANAGEMENT IN JORDAN: IMPACTS AND ANALYSIS

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ABSTRACT

The inefficient solid waste management (SWM) affects negatively the environment and the community health. That is why the SWM sector should take serious precautions and measures to address the growing rate of solid waste (SW) generation noting its characteristics (composition), proper collection and disposing methods in a manner aiming its impact decrease. The current situation of Municipal Solid Waste (MSW) is assessed in this paper. It reveals that the existing gaps in the legislations, the funding mechanisms, the capacities (or lack thereof) of the trained staff, the minimal public awareness, and the deficiencies in the equipment are determined to contribute to the overall inefficiencies of the SWM sector and its corresponding services. This paper highlights the SWM problem in Jordan and this problem amplification by the presence of large numbers of Syrian refugees reaching 600,000 individuals, 80 % of which settled in municipal jurisdictions. The improved management practices having the potential to mitigate the negative consequences of the large, improperly managed quantities of SW on health and environment are discussed in this paper. The improved management practices can positively affect Jordan's and municipal economies.

Keywords: solid waste management (SWM), refugees, waste, Jordan.

INTRODUCTION

As a result of the conflict in Syria, Jordan hosts about 1.4 million Syrians, of whom 646,700 are refugees [1 - 5]. Eighty-five per cent of the latter live outside the camps (i.e. reside in municipal areas) and a significant number of them are classified as extremely vulnerable. Providing municipal and livelihood services to this community has impaired Jordan's public finances causing increased government spending on subsidies, public services and security [1].

The municipal services, particularly in the northern

governorates, have been stretched by over-populated host communities leading to increased societal tensions and additional pressure on livelihoods - the main current threat to social cohesion [2, 6]. The impact of Syrian refugees has strained different sectors including the livelihood, the labor market, the education and the health services, the houses prices, the water shortage process and the municipal services and infrastructure [6, 7].

The Syrian refugees registered in Jordan are located in various governorates. The highest percentage is found in Irbid, Mafraq, Zarqa, and Amman [6, 7]. The United Nations High Commission for Refugees records that

as many as 661,000 Syrian refugees are registered in Jordan [6]; however, the number of the unregistered one is currently unknown. The largest concentration of Syrian refugees is in the governorates of Amman, Mar-fraq and Irbid referring to 28.7 %, 24.4 % and 21.0.4 %, respectively [6].

These numbers of Syrian refugees residing outside the camps add additional pressure on the municipalities that are already struggling to provide essential services to their constituents [6, 7].

The influx of refugees has resulted in an increase of 340 tons of SW daily across Jordan, averaging a 3% annual increase [1, 2, 7 - 15].

Studies show that in 2012, of the total SW generated in Jordan ca 50 % are organic, 16 % plastic, 15 % paper and cardboard, while the remainder includes glass, metal and other miscellaneous types of waste [2, 16].

In this paper, the SWM sector is assessed along a baseline scenario and compared with a second scenario that accounts for Syrian refugees aiming to evaluate the resulting impact. The study considers those who crossed the borders and registered as refugees with the United Nations High Commission for Refugees (UNHCR). The population projection (including the Syrian refugees) in the next 5 years and the corresponding waste generated are estimated to evaluate the momentary impact of the population number increase.

SWM prospects in Jordan

Millions of metric tons of solid wastes are generated in Jordan from agricultural, municipal and industrial sources every year. The growing industrialization and the high population growth rate, in part due to the recent forced migration, has led to a rapid increase of the solid waste generation in the country which has, in turn, put increasing pressure on the existing waste management infrastructure.

SWM services in Jordan are no longer of the same standard as prior to the refugees' influx in the northern governorates of Jordan. The overall situation of the waste management systems in these areas is characterised by a massively littered environment, deteriorated collection systems with damaged equipment and vehicles, a total absence of any recycling and inappropriate and dangerous waste disposal activities in the landfills of Al Ekaider and Huseyneyat. The municipalities who are responsible for the day-to-day solid waste collection within its municipal boundaries face big challenges

while handling the significantly increased solid waste amounts. This continues to fuel a sense of dissatisfaction among the civil society toward the municipal waste collection services as well as conflicts between the local inhabitants and the Syrian refugees.

The average daily municipal waste in Jordan is about 3700 ton/day. Most of this SW ends up in any of Jordan's 24 dump sites. Seven sites (in the northern parts of Jordan) receive a daily average of about 680 ton of SW. In the central and southern parts of Jordan, the daily average of SW received is 2620 and 400 ton, respectively. These quantities are transported to any one of 17 dump sites in the central part of Jordan. The total MSW generation in Jordan has increased from 1.5 million tons per year in 2000 to about 2.0 million tons per year in 2010. In 2015, the total MSW generation by the residential population has reached the amount of 2.6 million tons of MSW, and is expected to reach up to 6.0 million tons by 2039. The current average rate of SW generation for the baseline year used in this study (2015) is 0.99 kg/cap/day in the urban areas and 0.87 kg/cap/day in the rural areas [1, 2, 7]. The existing MSW collection coverage is estimated at about 90% and 70% for urban and rural areas, respectively [7].

The classification of MSW on the ground of its generation is estimated to be 80 % from domestic and commercial sources, and 20 % from industrial activities. The final destination of wastes refers to the following: 6 % - 10% are recycled, 50 % are landfilled in engineered landfills, 35 % are landfilled in controlled dumps, while the rest 5 % are open dumped [17].

The SW recycling industry in Jordan remains untapped. Most of the existing SW recycling and waste picking activities are informal and limited to private corporations, CBOs and NGOs as well as individuals. As an estimate, 6 % - 10 % of Jordan's SW are being recycled at the moment, as there is no large-scale and effective government-run MSW sorting practices or recycling system yet in place. Meanwhile, the public awareness and the willingness of the local communities in Jordan for waste recycling and separation practices are also lacking [18, 19].

The participation of the Jordanian private sector in SWM is still limited and very modestly explored. The development of Private-Public Partnership (PPP) concepts and models for waste recycling and segregation in Jordan is a recent concept. Almost all MSW recycling

activities in Jordan nowadays are considered pilot projects and small-scale interventions. The vast majority of the running recycling pilot projects in Jordan are initiated and supported by NGOs and other international organizations. The Corporate Social Responsibility (CSR) initiatives should be highlighted for the local community to ensure long-lasting and sustainable waste recycling and sorting practices in terms of investments, performances and outcomes.

In the absence of national recycling systems or structures and due to the ever-present socio-economic needs, especially in the poorer regions, an informal waste recycling sector consisting of local waste-pickers and scavengers has developed over the last twenty years. Several thousand individual scavengers usually collect waste fractions of a marketing value directly from the MSW collection containers dispatched over the urban cities, or MSW is delivered to official landfill sites where they are then sorted through by individual contractors. In general, MSW recyclables are collected by:

- Informal waste-pickers at the dumpsite level who usually sell them to middlemen.
- Informal waste-pickers at the city level who usually sell them to middlemen.
- Formal waste-pickers at the dumpsite level who are hired by contractors and/or “small enterprises”.

The formal waste-picking activities are only carried out at the dumpsite level. The people involved are hired by qualified private contractors, who have been involved in the business for a long time. These private contractors have a high potential for classifying various recyclable materials according to their marketing prices.

There is limitation in respect of receiving accurate figures from the official authorities which refer to the exact numbers of the waste pickers and the scale of the formal and informal waste picking activities being implemented in Jordan. The available studies show descriptive and questionnaire approaches that are recently conducted for socio-economic assessments of the waste picking activities.

The current legal and policy SWM frameworks and other MSWM related legislations report several gaps and deficiencies in the sector. The ability to establish sustainable materials recovery is one of them. The frameworks of recyclable materials recovery need to be evaluated and adjusted to the context of reaching Jordan goals outlined in the “National MSWM Strategy 2015”.

The National SWM strategy in Jordan will govern the current and upcoming relevant regulatory frameworks toward better organized, regulated and cost-effective waste management services promoting the involvement of the private sector in the development of an integrated SWM industry.

The short-term planning of the National SWM strategy in Jordan (2015 - 2024) promotes recycling and reuse activities through the establishment of pilot separate collection systems for recyclables (at least paper, metal, plastic and glass), formulating relevant technical regulations and addressing the legislative frameworks required for proper recycling practices, public awareness and educational programs. The expansion of MSW recycling and separation schemes is to be achieved within the mid-term agenda by the year 2024. The construction of mechanical and/or biological treatment facilities, and other sophisticated material recovery systems are to be achieved by 2034 according to the long-term strategy.

Methods

The methodology implemented in the present study is based on semi-structured interviews with a wide range of stakeholders involved in ongoing projects that target the host communities of Syrian refugees. It includes also sites visits, data collection, desk research concerning the current waste generation and consumption as well as existing material recovery activities in the municipalities. It includes as well participatory observations regarding the SWM situation in the local municipalities and its surroundings aiming to understand the overall SWM system setup. The information obtained through the interviews is crosschecked with the objective to reassess gaps and information divergences. Follow-up questions are formulated and submitted to the corresponding persons based on the issues of divergences that are found in research and/or prior interviews.

RESULTS AND DISCUSSION

Status assessment and analysis

The lack of a comprehensive waste management plan in Jordan and the humble capabilities of the municipalities that provide the waste collection and disposal are aggravated by the influx of Syrian refugees. The latter distribution at and outside of camps affects critically and increases the burden on this sector. The resulting demand for SWM is outpacing (and continues to outpace) the

existing capacities. The concern in respect of natural resources contamination and health hazards is growing.

The total estimated solid waste generated in 2011 is ca 2,024,832 ton with an average generation rate of 0.95 kg/cap/day in urban areas and 0.85 kg/cap/day in rural one. Hosting 569,003 Syrian refugees has increased the total population to 6,957,003 in 2012. Of those 82.6% are distributed in urban areas, while 17.4 % in rural one. This leads to estimated daily waste generated of 6,609 ton in 2012, while the total annual waste generated is estimated to be 2,412,341 ton constituting 19.1 % growth.

A projection of waste generated between 2012 to 2017 in the highly impacted cities and a baseline scenario comparison are used in the following sections to assess the impact of the increased population attributing to Syrian refugees influx.

Mafraq city: SW is collected twice a day. The fleet capacity used in the waste collection comprises seven compressors, two rollers and 115 staff and wheel barrows most of which are outdated and needing maintenance. Eighteen percent of the municipal budget is dedicated to the waste management, excluding the salaries. The municipality’s inability to cope with the additional wastes leads to individuals carrying out illegal SW disposal practices, such as open dumping and burning. These activities contribute to the risk of polluting the soil, the water and the air. The daily waste management is conducted by 126 employees using 16 types of vehicles and 400 rubbish containers. The cost of management and disposal for each ton of wastes reaches 16.6 JD [20].

Mafraq city hosts the highest number of Syrian

Table 1. Solid waste composition.

Composition	%
Kitchen garbage	63
Paper	11
Ceramics	0.3
Garden	0.4
Plastics	16
Glass	2.1
Fabrics	4.3
Metals	2.1
Others	0.6

refugees as pointed out in Table 1. Fig. 1 shows the increase of the cost of MSW due to Syrian refugees’ influx when compared to that of the baseline population. The two scenarios are compared to estimate the impact, which is depicted in Fig. 1. The latter illustrates that Mafraq city could face an increase of SWM costs by 60 %. Fig. 1 shows the development of the population, the waste collected and the cost of the waste collected and disposed in the city.

Amman city: One-thousand nine hundred tons of wastes are collected daily from 20,000 bins by 231 trucks. All waste collected is transported and disposed at Al Ghabawi landfill, which is the largest and the only engineered sanitary and controlled landfill in Jordan. Approximately, 73% of the solid waste received at the landfill is delivered through one transfer station. Al Ghabawi landfill receives also about 550 tons of waste

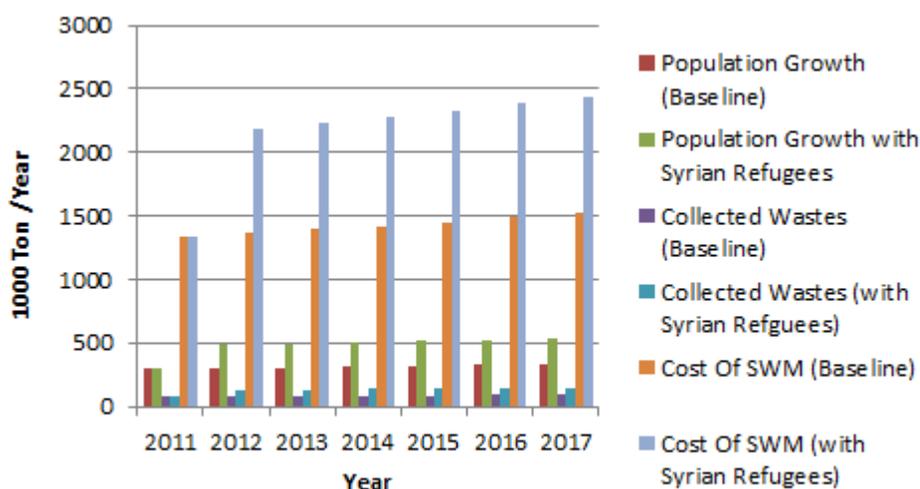


Fig. 1. Syrian refugees impact on Mafraq City SWM sector in the period of 2011 - 2017.

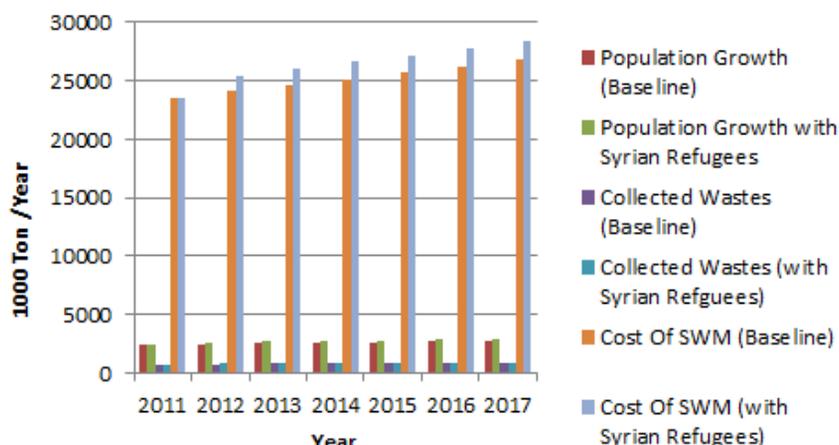


Fig. 2. Syrian refugees impact on Amman City SWM sector in the period of 2011 - 2017.

from other cities [21]. Fig. 2 shows the development of the population, the waste collected and the cost of waste collected and disposed in the city.

Irbid city: The waste is collected twice a day by compressors and/or vans with a capacity of 1tons -3 tons each prior to its transfer to compressors of 9 tons - 12 tons ton capacity and transport to one of the three landfills (Al Sari, Toqbol and Alakeeder). The increase of the waste generated does not correspond to that of the labor and the equipment. Additionally, no recycling and separation processes are conducted. Fig. 3 shows the development of the population, the waste collected and the cost of the waste collected and disposed in the city.

Zarqa city: The collection activities in Zarqa city require additional staff, vehicles, bins, maintained solid waste containers and improved capability of the SW workers [22]. The working vehicles amount to 31, while

the staff - to 557. Fig. 4 shows the development of the population, the waste collected and the cost of waste collected and disposed in the city.

The impact in terms of wastes collected and MSW services cost in the cities that have the highest numbers of Syrian refugees are depicted in Figs. 5 and 6.

Fig. 5 shows the monetary impact on the cities of Mafraq, Amman, Irbid and Zarqa due to hosting Syrian refugees. Fig. 6 shows the estimated additional amounts of collected wastes due to the registered Syrian refugee population.

The deficit of labor, equipment and funds contributes to the inefficient collection and disposal of SW. This research estimates that these four municipalities will require about 176.4 million USD in order to procure the necessary SWM equipment and fiscal funds to avoid an environmental disaster. In the meantime, as the Ministry of Planning and International Cooperation (MOPIC)

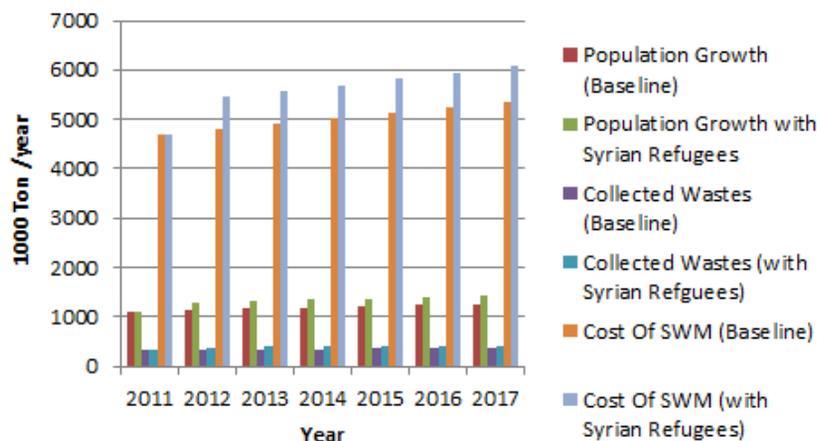


Fig. 3. Syrian refugees impact on Irbid City SWM sector in the period of 2011 - 2017.

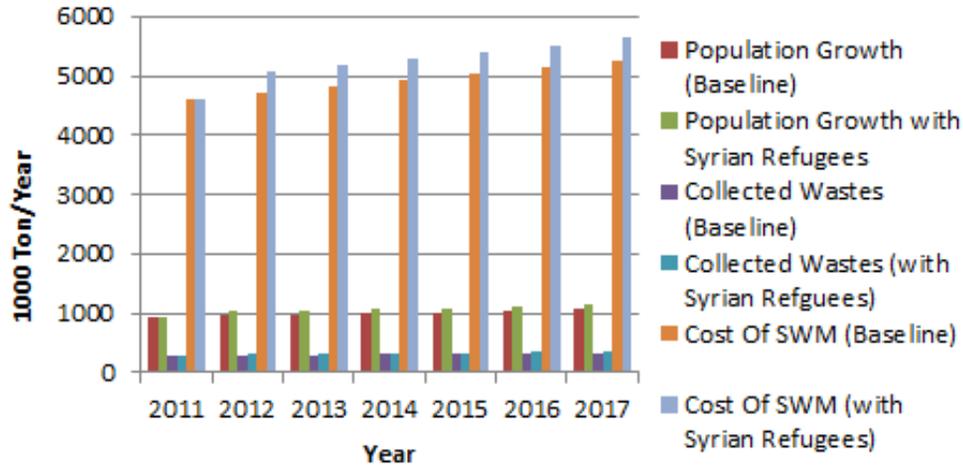


Fig. 4. Syrian refugees impact on Zarqa City SWM sector in the period of 2011 - 2017.

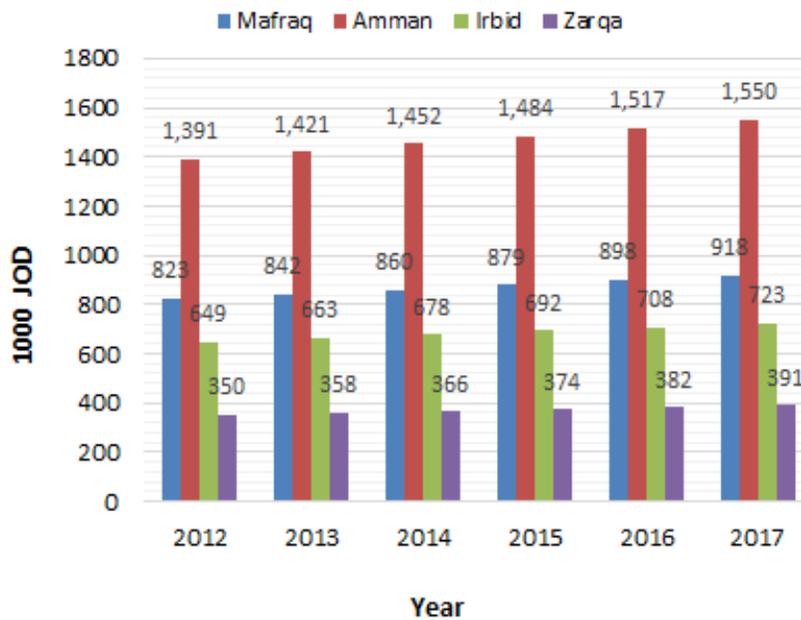


Fig. 5. Estimated costs required to cover MSW expenditure.

reports, the per capita cost of SWM services amounts to 115.8 USD annually. This stresses additionally the municipal funds and impacts the delivery of other necessary services.

Problem mitigation

To reduce the adverse impacts of SW many measures can be taken:

a) Segregation of solid waste (Composition, Recycling, Gas and Heat):

SW is a material which could be used for industry as a raw material with the application of the right tech-

nology. The composition of the wastes received has to be considered in view of output (recyclables, gas, electricity, etc.) choice. Table 1 shows the composition of SW in Jordan. It appears that methane has the highest concentration. About 40 % of it can be utilized for electricity generation [23]. Jordan is not rich in natural energy resources with about 96 % of the country's energy demand being met by imported energy [23]. Thus, obtaining energy from a renewable energy resource could address both environmental and economic aspects [24 - 28]. Table 2 shows the typical landfill gas composition.

Table 2. Typical landfill gas composition.

Component	Concentration Range	
	Lower	Upper
Methane	40	70
Carbone	30	60
Carbon	0	3
Oxygen	0	5
Nitrogen	0	3
Hydrogen	0	5
Hydrogen	0	2
Trace	0	1

b) Private sector cooperation: The private sector can play a significant role in the recycling operations and the biomass conversions. Most of the landfills in Jordan are rented by the private sector and are dependent on the market price of the raw materials: Al- Ekaider landfill – 60,000 JD /year, Al-Shinyat landfill - 40,000 JD/ year, and Al-Hamra landfill - 20,000 JD/year. The role of the private sector in SWM is limited at present to the collection. The private participation is encouraged to extend to all areas SWM areas from collection to recycling, disposal and treatment aiming the sector performance improvement.

c) Awareness: The government has the responsibility

to educate the public about how to handle and manage properly SW. The traditional approach to an increased awareness refers to the publication of newspaper article or broadcasting information on the topic. However, this has rendered little affect as fewer people are watching TV and those reading newspapers are unlikely to change their behavior based on a newspaper article on SWM.

d) Fees Mechanisms: SWM has high operational and capital costs. The operational costs consist mainly of employees' salaries and those for fuel for the vehicles. The capital costs are incurred from the transport vehicles and the container prices. SWM fees are incorporated into the household electric bills and are collected as such with an average cost of 1 JD - 2 JD per month, which is not proportional to the true cost of SW collection and dumping. These fees typically cover less than 50 % of the true cost. So, efforts should be made on the regulatory side to increase gradually the service delivery fees. The latter have to be in line with the actual costs of the service provision and to provide a better reflection of the social equity (e.g. differential rates of residential, commercial and industrial users).

The entire MSW management sector and its activities aim at organising the logistic of services, but they do not address the lack of public awareness and residents' sensitivity in respect to a clean and healthy environment and appropriate habits. MSW infrastructure suffers severely from the rapid inhabitants increase. Ramtha and Mafraq are extraordinarily affected and the MSW

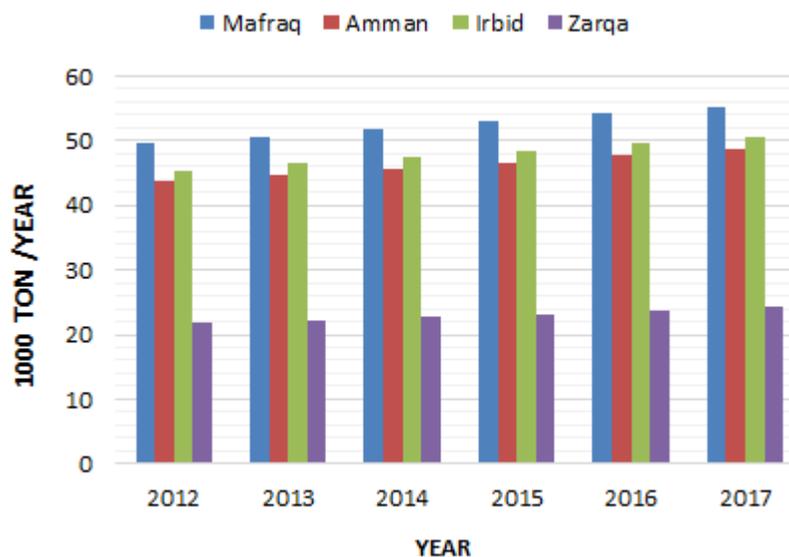


Fig. 6. Estimated additional amounts of collected wastes due to hosting of Syrian refugees in the period of 2012 - 2017.

collection systems are close to collapse. Severe gaps in the equipment and the facilities and endemic constraints of the managerial capacity are observed.

Despite the legislation enforcing the decentralization the municipalities remain dependent on the central Government for funds and decision making. The overall organizational level with respect to SWM is considered poor due to lack of written standard procedures, of task descriptions and staff performance evaluations, of non-availability of mapped waste collection routings and container locations, of electronic data processing which provides monitoring and evaluation.

The insufficient maintenance of MSW compactor trucks is largely attributed to the deficit of funds at the municipal level. The collection equipment is also in poor condition. Some of this equipment is improperly used and/or not used at all.

The material recovery of valuable recyclables is carried out on a very small, simple scale, mostly by informal activities at the curb side or by simple manual sorting at the disposal sites. The collection and treatment of the organic fractions is also non-existent. The municipalities strongly need treatment facilities to make the recycling activities reasonable.

The relevant disposal sites are on a simple and modest technical level without barrier systems and common landfill features such as gas extraction and leachate collection systems. The Al-Ekaidar lifespan is extended to 2019 even though it has recently received funding for upscaling and expansion operations in the course of two planned phases. There is a framework for continued improvement of the dumpsite extending until the year of 2034. Al-Hussainiyat disposal site in Mafraq is managed properly, but it urgently needs technical rehabilitation.

As the dumpsites decompose and degrade, and the rainfall penetrates the exposed waste and the leachate obtained represents a significant threat to the environment. Therefore, it is necessary to install a barrier system to prevent further negative impacts on the environment.

The most practical solution refers to the incorporation of the following three methods: (i) development of legal and institutional framework to manage properly and operate comprehensive SWM services; (ii) provision of public awareness and communication management programs to introduce the proper ways of dealing with wastes, the advantages of recycling and disposal which will enhance the cost effectiveness of SWM; (iii)

organization of technical support and capacity building activities required by Jordan to build technical expertise and resources; (iv) provision of infrastructure and support for the fleet development for proper operation; and (v) design and construction of sanitary landfills and rehabilitation of closed landfills.

CONCLUSIONS

The Jordanian National Agenda of the 10-year action plan for 2005 - 2015 emphasizes the need for an integrated SWM sector. Jordan has no comprehensive system for the collection, recycling, disposal and treatment and/or legal framework for this sector. This research finds that there are numerous challenges brought on by the recent rate of population growth and regional migration that have (and continue) to burden the SWM sector.

The scale of the impact on SWM sector varies between the top Syrian refugee-hosting cities. Mafraq city has experienced the greatest impacts among the four cities analyzed in this paper. SWM of Mafraq city was insufficient even prior to the refugees' arrival. Now the sector is further exhausted and requires immediate actions.

There are different measures that can help to reduce the adverse impacts of the people from Syria. An action plan can be worked out on a consumer, private and governmental level. At the consumer level, the legalization and the awareness activates can play a key role in the refugee camp sites. The private sector can play a principal role in redirecting the current SWM status in Jordan and the economic crisis.

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