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SOLID WASTE MANAGEMENT

IN THE OCCUPIED PALESTINIAN TERRITORY

West Bank including East Jerusalem & Gaza Strip

OVERVIEW REPORT

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THE AUTHORS

Valérie Thöni holds a double Master in International Law and Environmental Studies from Geneva and Tel Aviv Universities. She has worked for the United Nations (UNHCR, UNDP, UNHCHR), the Swiss non-governmental organisation CIMERA and international federation UIAA and has 16 years' experience in project management, public relations and fund raising. She has been working on environmental projects for the past 6 years, related to waste collection and environment protection awareness.

Samir Matar is a researcher and practitioner in the field of Environmental Engineering. He holds a bachelor degree of Environmental Engineering from the Islamic University of Gaza and a Master degree in Environmental Engineering (Solid and Hazardous Waste Management) from University Sains Malaysia. Samir works as Environmental Specialist at Municipal Development and Lending Fund (MDLF) and has 7 years of experience in the Environmental Safeguards and Environmental Management; he has been working on Waste Management Projects since 2014.

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Cover: Al Fukhary Sanitary Landfill, June 2019, Gaza Strip

ACRONYMS USED

EQA	Environment Quality Authority
FTFP	Fixed time fixed pay
GS	Gaza Strip
HCW	Healthcare waste
HtH	Home to home
HW	Hazardous Waste
IEE	Initial Environmental Evaluation
JICA	Japan International Cooperation Agency
JSC	Joint Service Council
LF	Landfill
LGU	Local Government Unit
M	Million
MDLF	Municipal Development and Lending Fund
MoLG	Ministry of Local Government
MoH	Ministry of Health
MSW	Municipal Solid Waste
OPT	Occupied Palestinian Territory
PA/PNA	Palestinian Authority/Palestinian National Authority
PCBS	Palestinian Central Bureau of Statistics
PPE	Personal Protective Equipment
SW	Solid waste
SWM	Solid waste management
TS	Transfer Station
UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East
WB	West Bank
WHO	World Health Organisation

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EXECUTIVE SUMMARY

This report aims to give an overview about the current situation of solid waste management in the West Bank (WB), the Gaza Strip (GS) and, as much as possible, in East Jerusalem, at the legislative, technical, financial and environmental levels. It updates the data of former reports, which date back from 2015. The report examines first municipal solid waste, i.e. the waste collected by or on behalf of municipalities, that is generated by households, and by commercial, industrial and institutional activities, similar in nature and composition of household's waste[1]. In addition, the management of some of the hazardous and infectious waste, which can be present mainly in industrial, commercial and health care activities, is described and takes into account the fact that, in the Occupied Palestinian Territory (OPT), this type of waste is not systematically collected and treated separately.

A pragmatic approach was followed to prepare the report, depending on a diverse range of tools and approaches to achieve its objectives. The methodology comprises data collection through desk review of many of previous related studies and reports, conducting interviews with stakeholders, and carrying out field visits to the associated Solid Waste Management (SWM) sites in the West Bank and Gaza Strip.

In the first part, we review the context and legal framework covering solid waste management and the stakeholders involved. The main developments since 2016 are the adoption of a new National Strategy for Solid Waste Management 2017-2022, the new Joint Service Council (JSC) Bylaw (2016), the Solid Waste Management Bylaw (2018), and the Construction and Demolition Waste Bylaw (2019). These laws and regulations help clarify the different roles of the SWM stakeholders; however, the enforcement of these laws and some specific guidance about standards of management, are still in need.

Palestinians from West Bank and Gaza generated about 1.59 Million tons or nearly 4,356 tons/day in 2018. Average production per capita is about 0.9 kg/day[2]. Most of municipal waste (94%) is collected by municipalities, the UNRWA (in refugee camps especially) and JSCs. The JSCs collect about 65% of the municipal waste; the remaining waste is taken care off by the previously mentioned service providers and the private sector.

Disposal methods are mainly landfilling and dumping (random or controlled). It is estimated that about 30-35% of municipal waste is illegally dumped and 65-70% is disposed in one of the six operational landfills existing in Palestine. These landfills face the risk of over-capacity in the short term, due to land restrictions, low primary separation and an increase trend in waste quantities. The use of solid waste transfer stations (TS – a place where solid waste is temporarily deposited and often separated to be later transferred to the final disposal site) is a relatively new approach in the OPT. There are currently 12 operational Palestinian TS (11 in West Bank; 1 in Gaza Strip) and 3 newly constructed (in WB and GS). These TS have a good potential for waste segregation and recycling activities, thus helping to reduce the amount of waste finally disposed in landfills; however, their use is still underdeveloped.

1 https://www.gov.uk/guidance/local-authority-collected-waste-definition-of-terms, accessed 31.05.2019

2 Based on the authors' estimations. See Table (3) page 19 for details.

In addition, Israeli settlements in the West Bank generated about 1,200 tons/day in 2017, with a 1.9 kg/capita/day generated, due to their lifestyle and access to resources[3]. In general, settlers use the Tovlan landfill in the North and Al Minya landfill in the South, as well as other dumpsites. Several Israeli industrial parks/zones (19 in 2015) are located in the West Bank and produce solid waste. There are as well three Israeli transfer stations: Al Abdaly for municipal waste, as well as RA Ofek and Green Danlop for construction and demolition waste[4].

Cost recovery is a real issue for the municipalities in the OPT. Despite the fact that there are national guidelines for tariff, cost, and fee collection, there is no unified application in the fee collection system and this has consequences on the long-term capacities of municipalities and JSCs to maintain a satisfying service to the Palestinians. Another characteristic of the solid waste management in the OPT is that most of the large projects, like landfill rehabilitation or composting pilot projects for example, are dependent on external funding for capital cost investment.

The main composition of municipal waste is organic (about 50%), followed by plastic (17% in average) in progression and paper/cardboard (11%)[5]. Despite this large portion of biodegradables and recyclables, only a small fraction is collected for reuse (about 3%), among which about 1% is recycled. Moreover, the only materials currently recycled in the OPT (i.e. processed waste into secondary raw material to be reused) are organic waste, some plastics and some cardboard. The others, like metals, are collected and sent abroad. The Palestinian market in materials' reuse/recycling is characterised by its small size, informality and fluctuation. The great majority of pilot projects implemented in the last 10 years focused on composting mainly, as well as some plastic and paper/carboard recycling. There is a recent growing interest for E-waste, due to the negative ecological consequences and health problems its treatment and disposal provoke in the areas concerned.

Special waste (industrial, construction and demolition, health-care waste, e-waste…), is difficult to estimate in its totality. Some of it is mixed with municipal waste and some is collected and treated separately, like health-care waste. Construction and demolition waste and tires for example are disposed in separated places; E-waste refuse is either recycled, illegally burnt or disposed in landfills; health-care waste treated or non-treated ends up in landfills usually. There are, for the moment, no clear instructions, data and information about most types of hazardous wastes.

Solid waste management (SWM) in Palestine, despite its crucial importance, is not sufficiently recognised, valued and supported and is confronted with several challenges: the need for a legislation well adapted to the realities on the ground and including all aspects in SWM; effective means for its implementation; the lack of an efficient data collection and management system and reporting about different waste types; the need for a certain financial autonomy; the need for technical expertise, equipment and modern infrastructure; performant human resources; the need for innovative solutions in waste segregation and treatment; as well as the poor involvement of the civil society and low public awareness. The persistent improper behaviour of residents and the increasing generation of waste exacerbate these challenges.

3 This figure is an estimation by the authors from the available data about the number of settlers in the WB and the average solid waste generation in kg/pers/day. See Table (3) page 19.

4 B'Tselem, 2017, page 19.

5 Based on the information provided by the JSCs.

A/ THE CONTEXT

Solid waste (SW) has become over the past decades one of the most pressing issues, as the world population is growing at a fast pace (11 million tons per day in 2100). According to The World Bank's specialists, from more than 3.5 million tons per day in 2010, global waste generation will reach 6 million tons per day by 2025 and probably about 11 million tons per day in 2100[6]. All countries will have to tackle an increased pollution of soils and water and potentials for health crisis, but it is most probable that developing countries will suffer the most from unsustainable waste management policies. In the case of Israel and the Occupied Palestinian Territory (OPT), solid waste management is also a crucial issue: the rapid growth of the population and consumption, the scarcity of land and water resources and the climate conditions are important factors to be taken in consideration for any future sustainable solid waste management.

The OPT, as per the Oslo Agreements[7], include the West Bank (including East-Jerusalem) and Gaza Strip, which is about 6,220 km^2 (5,860 km^2 for the WB and 360 km^2 for Gaza) with a total population of about 4.68 million people in 2017 (with about 2,9 and 1,8 million in the West Bank and the Gaza Strip respectively). In the OPT, per capita GDP (PPP) amounted to 5,560 USD in 2017. As a comparison, per capita GDP (PPP) in Israel was 37,910 USD for a population of 8.71 million[8].

Among the challenges that sustainable solid waste management faces in the OPT, one of the most important and pressing is the land issue. It is important to bear in mind that, following the Oslo Accords, the Palestinian Authority (PA) administers areas A and to some extent area B, but area B is mainly inhabited and not suitable for many more SW constructions. Area C is under the entirely managed by the Israeli civil administration (the COGAT) and construction permits are very difficult to obtain[9]. In addition, with the presence of Israeli settlements, solid waste management is further complicated by two different types of management, source and rhetoric existing in parallel.

6 http://www.worldbank.org/en/news/feature/2013/10/30/global-waste-on-pace-to-triple, accessed 22.05.2018.

7 The Oslo Accords consist in several agreements, signed between 1993 and 1995, between the Israeli Government and the Palestine Liberation Organization (PLO). The most important are the Declaration of Principles on Interim Self-Government Arrangements (Oslo I) and the Interim Agreement on the West Bank and the Gaza Strip (Oslo II). The aim of these agreements was to start a peace process and to reach, through several rounds of negotiations during the following 5 years, a peace treaty, based on the UN Resolutions 242 and 338. Both parties agreed on mutual recognition and the Palestinian Authority was created as an interim government in the Palestinian territories. In Oslo II, Areas A, B and C in the West Bank were defined. Key issues on borders, refugees and Jerusalem were to be negotiated until 1999. https://en.wikipedia.org/wiki/Oslo_Accords, accessed 19.02.2019.

8 https://databank.worldbank.org/data/views/reports/reportwidget.aspx?Report Name=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=ISR and https://databank.worldbank.org/data/embed-int/CountryProfile/id/b450fd57, accessed 19.02.2019.

9 Area A is under full civil and security control by the Palestinian Authority (about 18% of the WB); Area B is under Palestinian civil control and joint Israeli-Palestinian security control /22%) and Area C is under full Israeli civil and security control (60%). https://en.wikipedia.org/wiki/West_Bank_Areas_in_the_Oslo_II_Accord , accessed 19.02.2019.

B/ THE POLICY AND LEGAL FRAMEWORK

Solid waste management (SWM) in the West Bank (WB) and Gaza Strip (GS) is regulated by several laws, reflecting the national strategy and waste management policy of the Palestinian Authority. In 2019, the most important policy documents and laws are as follows:

1. At the strategic level

The National Strategy for Solid Waste Management in Palestine (2017-22): The NSSWM was adopted in August 2017, following the first National Strategy for SWM 2010-2014. The first strategy was set up in 2004 by the Ministry of Local Government (MoLG). It is considered as the global framework of all "decisions, programs, activities and medium-term investment plans, aiming at developing the SW sector in Palestine" (PNA 2010, page 5).

Updating what was done in the first NSSWM, the National Strategy (2017-2022) includes also the willingness to align the Palestinian SW policy on the Sustainable Development Goals of 2030, especially Goal 3 (Health and Well-being), as well as Goal 11 (Sustainable cities and human settlements). The strategic objectives of the current NSSWM are:

1. A modern and effective legislative and organisational framework for SWM;
2. Strong implementing institutions;
3. Effective and environmentally safe management of SW services;
4. Financial sustainability and efficient SWM services and activities;
5. Appropriate treatment and inventory of medical, hazardous and special waste;
6. A growing participation of the private sector in SWM;
7. A more participating and aware public;
8. Effective information and monitoring systems (PNA 2017, page 9-11).

Table 1. NSSWM 2017-2022 Achievements by 2022 [10]

Achievement	Status in 2017	Status in 2022
Percentage of recycled materials	< 1%	30%
Percentage of transferring organic materials into low quality compost for the purpose of coverage	2.5%	15%
Coverage of residential areas	95%	100%
Service coverage by JSCs	76%	100%
House separation of SW	0%	20%
Coverage of sanitary landfills	53%	100%

10 PNA 2017, page 42.

Among the strategic indicators chosen in this National Strategy to be reached in 2022, are also:

- 20% current random sites are rehabilitated in the WB and Gaza Strip;
- 50% sanitary landfills have gas treatment systems;
- 80% of special waste in urban areas is removed;
- 15% reduction of hazardous waste disposal;
- At least 6 recycling projects are implemented;
- At least 3 public awareness projects involve the civil society
- 100% municipalities/JSCs provide accurate information on SW (PNA 2017, pages 43-70).

The Environment Sector Strategy 2017-2022

In its strategy 2010-2013, the EQA planned to focus on 4 interventions: the upgrade of SW collection and landfill disposal services, the closure/rehabilitation of random dumpsites, the implementation of the NSSWM and the development of an initiative promoting separation and 3Rs principles (GIZ-SWEEPNET, 2014). In reference to the last adopted strategy (Sectoral Environment Strategy 2017-22 (EQA, 2017), EQA focuses on the same previous four interventions generally, but the EQA Director General for Projects and International relations, Mr. Abu Thaher, mentioned the 4 directions taken by the Agency related to SWM: reduction of the pollution (reduction of solid waste included); encouraging reuse, recycling and recovery; investing into the legal framework and institutional capacities; developing waste awareness and education through campaigns and various activities[11].

The National Development Plan 2014-2016

The National Development plan (NDP) is a tri-annual plan presenting the Palestinian Authority's strategy in Economic Development and Employment; Good Governance and Institutions Building; Social Protection and Development and Infrastructure. The priority objectives in the SWM sector are to "improve solid, liquid and hazardous waste management system, including collection, transportation and safe disposal" and "where possible to encourage recycling" (PNA, 2014, p.78).

11 Interview from 8.11.2018.

Table 2. SWM targets planned for 2016 [12]

Indicators	Baseline 2013	2016 Target
Households currently connected to SW collection services in %	95%	100%
Total SW disposed in sanitary landfills out of produced waste in %	40%	60%
Total SW recycled in %	12%	25%
Number of private SWM companies	3	9
Average daily SW generation per capita	0.80 kg	0.75 kg
Number of installations treating hazardous and medical waste	30	50
SW fee collection in %	85%	90%

2. At the legislative level

The Municipal and Local government Law or Local Authorities Law No. 1 (1997) defines the roles and responsibilities of the local authorities (Local Government Units and Joint Service Councils – LGU and JSC), supervised by the MoLG. According to its Article 15, local authorities are responsible for the waste management in their own jurisdiction: the collection of SW in public spaces, its transportation and disposal, the management of a landfill facility, as well as the option to provide services through a private contractor, or to join with other municipalities through a JSC (GIZ-SWEEPNET, 2014). Article 15 mentions furthermore the need to take precautionary measures in public health in order to prevent any future pollution or epidemic outbreaks (Soufan, 2012).

The Environmental Law No. 7 (1999, revised in 2003) establishes the general legal framework for SWM in Palestine, including also hazardous waste management. It aims to reduce the negative effects of waste, to protect the environment and public health, to promote sustainable development, to develop inter-ministerial cooperation and standards, and to increase information and awareness. The most important provisions of this law related to SW are:

- Article 1: definition of the notions of solid waste and hazardous waste;
- Articles 7 and 9: the national role of the Environment Quality Authority (former Ministry of Environmental Affairs-MEnA) as the responsible entity to set up a strategic plan and to technically specify disposal sites;
- Article 8: Relating to the 3Rs (reduce, reuse and recycle), this article asks for the reduction of SW generation at the lowest level possible, as well as implementing re-use and recycling measures where possible;

12 PNA, 2014, p.158.

- Article 10: asks the relevant actors for precautionary measures in storage and transportation of construction and demolition waste;
- Regarding hazardous waste: Article 11 proposes a listing of hazardous waste; article 12 forbids the use, treatment, storage and disposal of any type of hazardous waste, except under certain conditions and article 13 forbids any importation and limits crossing of hazardous waste on the OPT;
- Article 23: forbids dumping waste in non-designated sites;
- Articles 74 and 76 refer to the « polluter pays » principle (Soufan, 2012; GIZ-SWEEPNET, 2014).

The Palestinian Environmental Impact Assessment Policy (2000) describes the conditions, through standards and guidelines, under which any private or public development activity, in terms of environment protection, shall be implemented. Its aims are to protect Palestine environment's sustainability, as well as to prevent any irreversible or to mitigate any reversible damage from development activities. It gives a list of activities needing to conduct an Environmental Impact Assessment (EIA) or an Initial Environmental Evaluation (IEE).

The Palestinian Law (2003) asserts the right, in its article 33, to a "clean and a balanced environment as a basic right of every Palestinian" and the national duty for "preservation of the Palestinian environment for the sake of both present and future generations" (Soufan 2012, page 70).

The Public Health Law No. 20 (2004) defines the Ministry of Health (MoH) as the institution responsible for licensing SWM facilities (article 2.12). The MoH is also in charge of taking all the "necessary and precautionary measures" to confiscate and destroy all contaminated or potentially contaminating materials (article 10). In cooperation with other competent bodies, it is responsible for the determination of the work conditions for people in craft and industries that might affect their health (article 34). Finally, the MoH is in charge of regulating, in coordination with other institutions, the collection, storage, transport and disposal of hazardous wastes (article 42) (PNA, 2004; GIZ-SWEEPNET, 2014).

The Medical Waste Management Bylaw (2012) gives a definition of medical waste and a classification of its different types (articles 9 and 10), as well as instructions for its identification (art.12). The Bylaw also describes the procedures related to medical waste's separation and collection (by waste types in chapter 3); the conditions for storage inside the health institution and for transportation outside (chapters 4 and 5). In its chapters 6 and 7, the Bylaw presents the treatment measures to be applied and specifies the locations' requirements for treatment within and outside the institution, as well as the conditions for disposal of solid medical waste and waste water. The document furthermore describes the responsibilities of the Ministry of Health, the EQA, the local authorities and the licensee (chapter 8) and mentions the duties to exchange information between the stakeholders, and to prepare an emergency/contingency plan (PNA, Bylaw 2012; GIZ-SWEEPNET, 2014; ARIJ, 2015).

The Law on the Encouragement of Investment in Palestine Law No. (1) of 1998, amended in 2004, 2011 and in 2014 (decree No. (7) Of 2014)[13] aims to provide guarantees and incentives to private investment, through the Palestinian Investment Promotion Agency. Investment is protected from expropriation or nationalisation in general (art. 7) and free transfer of all financial sources is guaranteed (articles 10-11). Income taxation exemption is provided to agricultural projects while tax reduction incentives for at least 5 years, through an incentive package contract, is allowed to any investment (articles 23-25)[14].

The basic regulation on the Joint Service Councils of year 1996 (updated in 2006): defines the role and responsibilities of Joint Service councils. According to the (JSCs) official Statute, it is in charge of the followings:

- Planning for and supervising the sound implementation of solid waste collection and disposal;
- Founding and operating a sanitary landfill with provision of the necessary facilitations to ensure smooth daily operations;
- Provision of waste containers in the served governorates and maintaining regular maintenance;
- Organizing and implementing public awareness activities to raise the environmental sense of the public community;
- Organizing cleaning campaigns regularly;
- Guidance of the member local government units in whatever related to solid waste management in the fields of technical, legal, public health, environmental or social issues;
- Representation the member local government units in any events related to solid wastes;
- Planning for and implementing the methodologies of solid waste pollution reduction, proactive prevention, and waste recovery and recycling (GIZ-SWEEPNET, 2014).

In 2016, a new JSC Bylaw was adopted, which describes the conditions for forming/ending a JSC, the roles of the different members and representatives of the JSC, as well as the tasks and activities of the JSC (PNA 2016c; JSC Today, March 2018). A national Guideline on SW Tariffs was also produced the same year.

The Solid Waste Management Bylaw was drafted in 2018 and adopted in March 2019. This regulation describes the rights and obligations of the following actors:

- the "competent authorities" are responsible for developing a comprehensive plan for SWM, standards, procedures and strategies (art 3), for supervising SWM (art.25), for control/inspection (art. 31);
- waste producers' obligations (art.6) and polluter pays principle (art.36);

13 https://investmentpolicyhub.unctad.org/InvestmentLaws/laws/201/download/3

14 Solid waste management was mentioned in the Law of 1998, requiring the approval of the Council of Ministers (art.4). In the amended Law of 2014, the sector is not explicitly mentioned.

- service providers take safety and health measures (art.7), collection and transportation processes (art. 8,9), build/operate transfer stations (art.10), treat and dispose the waste (art.11, 30), and keep records (art.30);
- the landfill owner (art. 13,14);
- the MoH, in monitoring the separation, collection and transportation of medical waste (art. 25)
- the EQA, in terms of hazardous waste treatment approval (art.26);
- the MoLG, regarding the establishment of a national waste registry compiling all information about waste management (art.29).
- Special conditions are required for landfills regarding operation, closing and rehabilitation (art. 12, 15, 16, 17) and for automated burning (articles 19,20,21), whereas random burning is forbidden (art. 18). Reuse and recycling shall be encouraged (art. 27). Waste management fees shall be proposed by service providers and approved by the MoLG (art. 35).
- Hazardous waste should not be mixed (art. 33) and its import submitted to the approval of competent authorities (art. 34);
- Municipalities and Joint Service Councils submit waste management fees to the Minister for approval (art. 35);
- The Ministry of Local Government is entitled to give fines (art. 36) (PNA, 2018).

In the matter of Construction and Demolition waste, the MoLG, with the support of JICA, finalized the draft of a new Bylaw in 2018, which should be adopted in spring 2019, as well as a Guideline Manual on Construction and Demolition Waste (C&D) in the West Bank. The purpose is to ensure the proper regulation and reduction of any new C&D waste. The Bylaw and the Manual describe the conditions for a C&D permit, the requirements for a waste disposal and recycling services plan, a hazardous material report about monitoring, collection, transportation and disposal, as well as the obligation to keep record and to report during and after any construction and demolition activities (MoLG-JICA, 2017b).

Lately, the Palestinian Environment Quality Authority has prepared a list about hazardous waste and drafted a hazardous bylaw[15], which shall be adopted in 2019 also. The EQA is also in the process to update the status of random dumpsites, landfills as well as transfer stations (PNA, 2017).

In reference to data about solid waste management, MoLG with JICA has published a new SWM Databook in the summer 2019, with updated figures from both JSCs and local municipalities.

15 Mentioned by EQA representative on 8.11.2018. The documents are not yet officially published.

C/ THE ACTORS (AT THE NATIONAL AND LOCAL LEVELS)

SWM in the OPT is characterized by its diversity of actors and the complexity of different roles assigned to the different groups. In addition to public institutions like ministries, local municipalities, private sector or civil society, there are other actors, such as the UNRWA (who is managing the solid waste in the 27 refugee camps of West Bank and Gaza), external donors (who support the PNA in the implementation of some SW projects) and Israeli settlements (who produce also waste and have an impact on the environment of the West Bank).

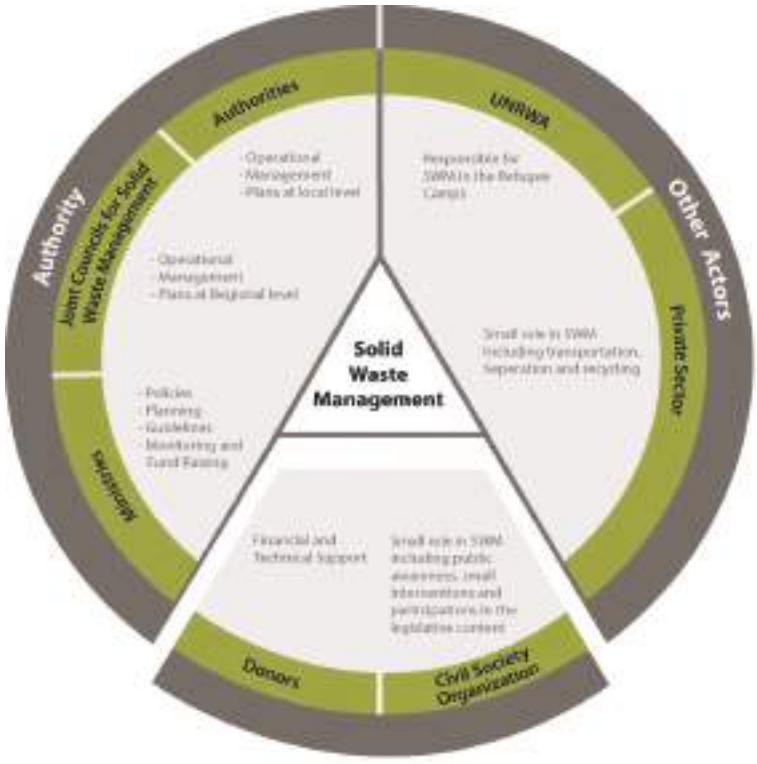

Figure 1. ARIJ, 2015, page 93.

1. At the national level

- The Ministry of Local Government (MoLG) sets general policies about solid waste management and coordinates the activities of the Local Government Units (LGUs) and Joint Service Councils (JSCs). It provides them with the financial and technical support, it is involved in several awareness projects with other ministries, and it monitors the execution of infrastructure projects including solid waste projects (GIZ-SWEEPNET, 2014). It is currently chairing the National Team responsible for the implementation of the adopted NSSWM[16].

16 Following the Cabinet Resolution, no 05/49/13 of May 2010, the National Team replaces the Steering Committee in charge of the implementation of the Solid waste national strategies.

- The Environment Quality Authority (EQA) elaborates SWM at the strategic level; it develops the standards, procedures and guidelines for sustainable SWM (including hazardous waste management), determines the SW sites specificities, and promotes the reduction, recycling and reuse of solid waste. It has also a monitoring and inspection role in the application of adopted laws and standards. It is responsible for the approval of Environmental Assessment Impacts and for promoting environmental awareness among the Palestinian public. It furthermore provides expertise and ensures the implementation of the environmental protection (ARIJ, 2015; GIZ-SWEEPNET, 2014). Finally, the EQA has also an international role, as the institution responsible for the application of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal in the OPT (Palestine is a member since 2015).
- The Ministry of Health (MoH) is responsible for licensing and monitoring health institutions in general, and facilities responsible for medical waste management (article 2; Public Health Law-PHL, 2004). In addition, its Environmental Health department carries out research and data collection on water, air, hazardous waste and pollution. As mentioned above, the MoH has the role of issuing the conditions related to "transport, store, treatment, and dispose of the hazardous waste" (article 42, PHL, 2004), a role which is in conflict with the EQA's responsibility (GIZ-SWEEPNET, 2014). The Medical Waste Bylaw adopted in 2012 attempts to clarify the responsibilities of each stakeholder.
- The Palestinian Standards Institute (PSI): establishes and adopts the national standards, as well as implements adopted international standards, among which the ones related to SWM. It chairs also a national committee which is responsible for developing the directives or the technical regulations (GIZ-SWEEPNET, 2014).
- The Palestinian Central Bureau of Statistics (PCBS) collects and disseminates the national data about SWM, through its website and regular surveys like the household, environmental, economic and medical environmental surveys.
- The Municipal Development and Lending Fund (MDLF) ensures the provision of funds for different projects (among which SW activities) to the local authorities and occasionally to the joint service councils (GIZ-SWEEPNET, 2014). MDLF is managing the Southern component of the Gaza Solid Waste Management project (GSWMP) since 2012 covering 3 of 5 governorates in Gaza Strip, namely the Middle Area, Khan Younis, and Rafah Governorates comprising approximately 64% of Gaza Strip's total geographic area inhabited by 46% of the total Gaza Strip's population, or approximately 800,000 people according the 2014 Palestinian Central Bureau of Statistics (PCBS) projections[17]. As well, MDLF is managing a grant for enhancing the primary solid waste collection and transport (secondary collection) through Municipal Development Program (MDP) since 2008.

17 MDLF Website: www.mdlf.org.ps

2. At the operational level

- The Local Government Units (LGU): they include the municipalities, village councils and project committees. LGUs are the main responsible local authorities for the collection, transportation and disposal of municipal waste. In 2018 there were 427 LGUs in the WB and 20 in GS[18].
- Joint Service Councils (JSC): an association of several LGUs to provide one or more services to all member municipalities with the aim to reduce costs and to efficiently coordinate services. There are currently 13 JSCs responsible for SWM in the West Bank (including one Higher Council): 12 are in charge of SW collection, 9 are responsible also for transferring SW. JSC Jenin, JSC Jericho and the Higher Council of Bethlehem and Hebron supervise the management of the three main landfills. Two JSCs operate in the Gaza Strip.
- The United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) supervises the waste management of the 19 refugee camps in the West Bank and the 8 camps in Gaza, in coordination with municipalities and JSCs. Under its area of jurisdiction, the UNRWA support's role is to provide services and manage the camps. The organisation is responsible for collecting waste from the refugee camps, which will be disposed of at sites run by municipalities against monthly payment to the dumpsite operating organization. UNRWA has also given assistance to municipalities in the Gaza Strip by being the channel through which equipment, provided by bilateral donors, has been provided to the municipalities.
- The private sector: some companies can be contracted by municipalities/JSCs for the collection, transportation or/and disposal of waste or the management of certain facilities (like transfer stations) and private companies own and directly manage recycling/recovering activities.
- Informal sector: unlicensed individuals, family-run businesses, industries and public institutions dealing in general with the reuse and recycling of specific waste (including E-waste for example), although the Palestinian legal and policy framework doesn't provide any specific regulations regarding it (Di Maria et al., 2017).

Waste pickers: Waste pickers are people who illegally collect some types of wastes such as plastics and sell it to sub-contractors/waste recovery factories. They don't have any right, are not vaccinated against disease, nor use any Personal Protective Equipment (PPE). They are usually very organized, but persons are always changing, so that no studies defined their numbers and conditions. They can be noticed in dumpsites and near street waste containers.

There are two types of waste pickers:

Waste pickers in landfills/random dump sites: Mostly they are prevented to access to the landfill sites as ordered in Al-Minya, Deir Al-Balah, and Al-Fukhary landfills, but it is difficult to prevent them to access to random dumpsites as they are open areas. Their presence in

18 MoLG-JICA, 2019. JSC Ramallah informed that 2 of their LGUs split in two, thus there are now 70 LGUS and not 68 in Ramallah Governorate (interview on 6.2.2019).

landfill sites is considered not safe, not only due to collecting waste without protective tools, but also due to the heavy machinery activities in landfill sites.

Waste pickers in streets: they are found in Gaza Governorates and in the West Bank, they are noticed collecting some materials such as plastics, and sometimes food waste. Mostly they are found in rich neighbourhoods. Some of them are children and women.

As a case study, 17 of waste pickers who worked permanently in the past in Al-Fukhary

Figures 2-3. Waste pickers in Gaza Strip: right picture in Deir Al-Balah, 2014, the left image for a 6 years kid picking waste in one of Gaza Streets

existing dumpsite were prevented to access to Al-Fukhary new landfill site due to the heavy machinery activities, but they were merged in one of UNDP programs which provided a small business for each of them as an alternative livelihood source[19].

The Palestinian SWM system is furthermore supported by external donors, like government agencies, international organisations and NGOs, who provide the financial and technical resources and experts, in order to build facilities, upgrade the collection and disposal equipment, rehabilitate dumpsites, support recycling and composting activities and pilot projects, develop the institutional capacities and raise public awareness about waste management.

19 MDLF Annual Report, 2017b.

D/ SOLID WASTE MANAGEMENT

1. Waste Generation

In 2018, the estimation of the total solid waste generated in Palestine is still challenging, due to the lack of available or consistent data. For 2012, GIZ-SWEEPNET (2014) estimated that 1.387 million tons of municipal solid waste were generated in a year by the Palestinians (population of 4.29 Million in 2012[20]), with a per capita generation of 0.94 kg/day and a municipal solid waste growth of 4 % per year[21]. Based on this calculation, SW total amount would be in 2017 and 2018, respectively 1.687 and 1.755 million tons in 2018. MoLG-JICA Databook report estimates that 4,333 tons/day or 1.58 M tons/year are generated in the OPT (2,622 in the WB and 1,330 in the GS), with a daily SW generation per capita of 0.9 for the WB and 0.7 for the GS kg/day in 2019 (MoLG-JICA, 2019)[22].

Solid waste generation usually differs between urban and rural areas. In the OPT, it is estimated that rural areas generate less waste (about 0.75 kg/day/capita), compared to urban areas like Ramallah or East Jerusalem, which produce about 1-2 kg/day/capita (GIZ-SWEEPNET, 2014; ARIJ, 2015). In the Gaza strip, on average, the generation rate in urban areas is double than in rural areas (which generate less than 0.5 kg/capita).

In Table (3) below, waste generation figures remain an estimation: some waste management activities are not systematically tracked and recorded and most of the figures from Gaza date from 2012. In order to estimate the total SW amount generated by Palestinians in 2017 and 2018, we propose to add the solid waste generated by the population of East Jerusalem[23], which is usually not covered by the West Bank SW data available in literature. We chose a MSW generation rate of 1.9 kg per capita per day[24], as East Jerusalem is an urban area. In 2017, the result is 1.62 million tons for the whole OPT.

PCBS data for 2018 was respectively: 4.91 Million total population, with 2,953,943 for WB (including East Jerusalem) and 1,961,406 for GS[25]. About 1.59 M was generated in the West Bank and Gaza Strip in 2018 (4,348 tons/day). If we include the solid waste generated by the 284,926 population in East Jerusalem, keeping a unit rate of 1.9 kg/capita/day[26], we estimate the total solid waste generation in 2018 in the OPT to 1.78 Million tons/year for all Palestinians or 4,889 tons/day[27].

20 https://www.pcbs.gov.ps/Portals/_Rainbow/Documents/gover_e.htm accessed 11.10.2018.

21 GIZ-SWEEPNET, 2014, page 15-16.

22 MoLG-JICA Databook 2019, page 1.

23 East Jerusalem (J1) includes: Jerusalem (J1) localities are: Kafr Aíqab, Beit Hanina, Shuífat Camp, Shuífat, Al ŕlsawiya, Sheikh Jarrah, Wadi al Joz, Bab as Sahira, As Suwwana, At Tur, Jerusalem (Al Quds), Ash Shayyah, Ras al Aímud, Silwan, Ath Thuri, Jabal al Mukabbir, As Sawahira al Gharbiya, Beit Safafa, harafat, Sur Bahir, Umm Tuba. PCBS Census 2017 final summary. http://pcbs.gov.ps/Downloads/book2383.pdf , accessed 06.02.2019, page 130.

24 This choice is arbitrary, as there is no exact figure for this part of Jerusalem. GIZ-SWEEPNET (2014) gave a range of 0.9-2.05 Kg/capita/day. GIZ-SWEEPNET,2014, page 16.

25 PCBS Report 2400 (2018c).Palestinians at the end of 2018. Estimated figures. http://pcbs.gov.ps/pcbs_2012/Publications.aspx , accessed 06.02.2019.

26 https://www.pcbs.gov.ps/Portals/_Rainbow/Documents/JerusalemE.html accessed 06.02.2019.

27 See Table (3) for details.

Table 3. The estimated amount of municipal solid waste generated in the OPT in 2017-2018.

	West Bank		Gaza Strip [28]		OPT (excl. settlements)		Israeli Settlements
	2017	2018	2017	2018	2017	2018	2017
Total Population *(E.J. included)*	2,881,957[29]	2,953,946[30]	1,899,291[31]	1,961,406	4.78 M[32]	4.91 M[33]	653,621[34]
Population WB *(E.J. excluded)*	2,600,794	2,669,020					
SW Generation in t/day *(excluding E.J)*	2,190[35]	2,622[36]	1,709	1,726[37]	3,891	4,356	1,242
SW Generation in t/year *(excluding E.J)*	799,350[38]	957,030[39]	623,917[40]	630,000	1,42 M	1,59 M	453,286
Average generation in kg/day/capita	0.84[41]	0.98[42]	0.9	0.88	0.86[43] 0.92[44]	0.94 0.99	1.9[45]
East Jerusalem population	281,163[46]	284,926[47]					
Generation in E.J. in tons/day	534	541					
Average generation in kg/day/capita in E.J	1.9[48]	1.9					
Total SW Generation in t/year including E.J	994,336	1.15 M			1,62 M	1,78 M	

28 UNDP, 2012. Feasibility Study for Gaza Solid Waste Management Program. Most of data are projected.

29 PCBS Census 2017 final summary. http://pcbs.gov.ps/Downloads/book2383.pdf , accessed 06.02.2019.

30 PCBS Report 2400 (2018c).Palestinians at the end of 2018. Estimated figures, page 36. http://pcbs.gov.ps/pcbs_2012/Publications.aspx , accessed 06.02.2019.

31 PCBS Census 2017 final summary. http://pcbs.gov.ps/Downloads/book2383.pdf , accessed 06.02.2019.

32 PCBS Report 2400 (2018). Palestinians at the End of 2018. Estimated figures. http://pcbs.gov.ps/pcbs_2012/Publications.aspx accessed 06.02.2019.

33 PCBS Report 2400 (2018). Palestinians at the End of 2018. Estimated figures. http://pcbs.gov.ps/pcbs_2012/Publications.aspx accessed 06.02.2019.

34 PCBS Report 2395 (2018). Israeli Settlements in Palestine Annual Statistical Report, 2017. http://pcbs.gov.ps/pcbs_2012/Publications.aspx accessed 06.02.2019. Another source estimates 834,000 settlers in 2017 (This week Palestine, issue 248). According also to Yesha Council, 421,000 settlers live in WB excluding East Jerusalem, https://www.timesofisrael.com/settler-group-says-421000-israelis-now-living-in-west-bank/ accessed 29.05.2018.

35 MoLG-JICA 2017a, p.11.

36 MoLG-JICA 2019, p.1

37 Estimations based on landfills records and the estimation of waste quantities dumped illegally.

38 MoLG-JICA 2017a, p.11.

39 MoLG-JICA 2019, p.1. 2,622 x 365 =957,030 tons/year.

40 UNDP, 2012. Feasibility Study for Gaza Solid Waste Management Program. Most of data are projected.

41 Result of 799,350:365, divided by 2,600,794 (estimated population excluding East Jerusalem.

42 MoLG-JICA Data Book 2019 gave 0.91 as kg/capita/day generation average.

43 Division of the total yearly production by 365 and the total population excluding East Jerusalem.

44 Result from division of the total yearly production including East Jerusalem by 365 and the total population.

45 According to Daskal et al. 2018, the SW production/day/capita in Israel was about 1.9 kgs in 2017. This can be applied most probably to settlers.

46 PCBS Census 2017 final summary. http://pcbs.gov.ps/Downloads/book2383.pdf , accessed 06.02.2019. page 124.

47 PCBS, Projected Mid -Year Population for Jerusalem Governorate by Locality 2017-2021, http://pcbs.gov.ps/Portals/_Rainbow/Documents/JerusalemE.html, accessed 06.02.2019.

48 This average of the SW generated is from East Jerusalem only.

In 2019, SW daily per capita generation estimation is close to 0.9 kg/day/capita average in the whole OPT as, in principle, the total waste generated constantly increases, each year, following the increase of the population and the evolution of life style and livelihood conditions. However, although the increase of population, the waste generation rate in Gaza Strip was decreased in the last two years. Table (4) shows the decline rate of waste generation in Khan Younis city (2017-2019). The decrease of the waste generation could be associated to the unstable economic conditions in Gaza Strip in the same period.

Table 4. Waste Generation in Khan Younis City (2017 - 2019)

Item	Jan-17	Jan-18	Jan-19	Mar-17	Mar-18	Mar-19	Jun-17	Jun-18
Generation (Ton/ Month)	4,255	3,955	3,951	3,948	3,722	3,392	4,558	3,825
Decline rate	-	7%	16%	-	6%	14%	-	16%

A recent assessment of SWM in the refugee camps of the WB (CESVI, 2017) estimated the average daily municipal SW generation of 0.75 kg/capita/day in 2016, based on UNRWA total collected waste 49,189 tons and population served of 178,829 people[49]. This result faces two main challenges however: the lack of accurate estimation of the population actually living in the camps and the difficulty of obtaining accurate and reliable waste generation data. First, PCBS census is not always available in some refugee camps and the UNRWA figures do not reflect the actual population located there: some camps' residents are not refugees as per UNRWA status (and therefore not registered) and some refugees do not live in refugee camps. Second, some types of waste (bulky, wood, metal for example) generated are not collected (they are either burnt or informally traded by informal companies), and weighing systems and daily data recording are also lacking in some camps (CESVI, 2017).

In the OPT, solid waste is generated from the following sources:

- Residential waste (households, parks, etc);
- Commercial waste (hotels, shops, restaurants, slaughterhouses, etc);
- Industrial waste (manufacturing, trades and crafts);
- Medical waste (hospitals, medical clinics or health centres);
- Institutional waste (schools, universities, governmental or private offices);
- Agricultural waste (animal farms, plant nurseries, olive mills). (Al-Batnij, 2013).

In 2015, out of the total generated waste:

- 45-50% came from households;
- 20-25% from construction and industrial sectors;
- 25-30% from commercial / institutional sectors (ARIJ, 2015).

49 In 2017, 43,025 tons were generated in the 19 West Bank refugee camps (population of 129,536) and 67,369 tons in 8 Gaza camps (252,841 people). MoLG-JICA Data Book 2019, page 10.

We suppose that this repartition is still accurate in 2018 for the WB, whereas in Gaza Strip, some changes have occurred on this repartition due to the unstable political and economic situation. For example, the construction sector was almost inactive from 2007 to 2014 due to the siege on Gaza, but after the war on Gaza in 2014, the construction sector grew up substantially, so that the generated waste from this sector is expected to be increased significantly, as well as 2 million of demolition waste have been resulted due to the 2014 war. There are no recent studies estimating the per capita generation; generally based on landfill records, it decreased in Gaza Strip in the last 4 years (2015 – 2019), due to the troubled economic situation, as well the industrial, agricultural and commercial waste generation.

According to official statistics, about 16,900 tons/month were also produced by economic establishments in 2017, i.e. industrial, agricultural and commercial sectors (13.4 thousand tons in West Bank and 3.4 in Gaza) (PCBS, 2017a). This figure may be under-evaluated, as a recent report about construction and demolition waste estimated to 208,996 tons of construction waste only generated in the WB in 2016. It is not clear if the waste quantity generated by these economic establishments should be included in the figures from Table 3. As its majority seems to be collected by municipalities or transferred by the establishment to the nearest container[50], we should consider that this amount is included.

For information, PCBS in 2017 estimated to 158,590 the number of operating establishments in the whole OPT (including East Jerusalem) (PCBS, 2018a), with 49 dealing with SW (PCBS, 2018b), as well as indicated 135,888 enterprises in private and non-governmental sectors (PCBS, 2018b). Economic establishments in Israeli settlements are not considered in these figures.

2. Waste Collection and Transportation

In the OPT, waste collection and transportation is organised mainly by municipalities, JSCs and the UNRWA (for refugee camps). Depending on the area, either the member municipalities or the UNRWA ensure primary collection (from houses to containers) or people throw the waste into fixed placed containers; then LGU/JSC/UNRWA's vehicles collect the containers' wastes and transfer them to the landfill in which disposal occurs (from containers to landfill – secondary collection).

In the Gaza Strip, this process is clearly applied in the Southern governorates (i.e. Deir al-Balah, Khan Yunis and Rafah governorates), whereas some complications were found in the Northern governorates (i.e. Gaza and North Gaza governorates). The JSCs keep continuous contact with the health and environment departments in member municipalities to ensure harmony between the secondary and primary collection. It is worth to mention that the council's vehicles serve the governorates daily under specific and organized working shifts and pay special attention to the peak periods.

50 PCBS, Environmental Economic Survey, 2017, page 40.

Figure 4. Solid Waste Management Cycle (JSC-KRM Annual Report, 2015).

In the refugee camps, solid waste is disposed into plastic bags or in plastic bins/containers and is collected mainly through manual carts and tractors in some camps. Collection is done every working days (as a comparison, collection by JSCs and municipalities for about 50% of the waste takes place 1-3 times in a week in the WB – Al Khatib et al., 2010a; PCBS, 2015). The UNRWA service is free of charge for the camp residents; thus, the waste collected often contains also waste from neighbouring areas.

Figure 5. Type of manual cart and hand barrow in Al Arroub camp (CESVI, 2017).

Figure 6. Tractors in use in Shu'fat camp (CESVI, 2017).

In general, there are no estimates of percentage of the un-collected waste in urban, rural, and camps areas. In 2015 in the West Bank and Gaza strip, about 94.5% average of households had access to solid waste collection services: either from a local authority (78.8%), from the UNRWA (9.4%), from a private contractor (0.3%) or by other means (4.6%) (PCBS, 2015). A survey conducted within the Environmental and Social Impact Assessment (ESIA) Study for Gaza Solid Waste Management Project in 2012, showed that 80% of the surveyed areas receive their services from the municipalities, whereas about 17% of people receive UNRWA services. The rest of the respondents receive the services from other institutions. The informal sector is not active in solid waste collection in the Gaza Strip. In the main Gaza urban centres (main cities), collection coverage is close to 100%, while the middle size towns classified as urban areas, have lower rates of solid waste collection than those in the urban centres.

In the West Bank

In the West Bank in 2018, 65% of the total generated waste was collected by JSCs (1'711 tons/day), the remaining quantity being managed by LGUs (about 911 tons/day) (MoLG-JICA, 2019). In terms of service, the JSCs provide about 87% of the collection and transportation service for the LGUs and 85% of the total population in the WB in 2018 (MoLG-JICA, 2019). Out of 13, twelve JSCs are responsible for collection and transportation (Hebron and Bethlehem Higher Council is not responsible for collection) and four JSCs (Jericho, Jenin, Hebron and Bethlehem Higher Council and North & North-West Jerusalem) are responsible for the landfill management (MoLG-JICA, 2017a).

Table (5) below shows the main characteristics of the JSCs' collection system. Salfit drops 100% of the waste collected into random or controlled dumpsites and Ramallah about 50% in controlled dumpsites. Except for Jericho and Bethlehem governorates, the average transportation distance to landfills is 25 km minimum and in some cases exceeding 80 kms (cf. Ramallah and Qalqilya for example), which has a non-negligible impact on JSCs' operational costs.

Table 5. Main characteristics of the collection system run by the JSCs in 2018 in the West Bank

JSCs	Population district in 2018[51]	Collection system type	Number LGU served out of total LGU	% population covered	Number of vehicles	Vehicle's condition status	Transportation of collected SW to
Jenin	321,950	FTFP[52] 70% HtH 30%	75 of the 77 LGU	93.4%	32 (30 compactors)	11 good/ 22 bad	21% sent to TS then ZAF LF (35km) 79% to ZAF LF
Tubas	62,430	FTFP 95%	12 of the 12 LGU	100%	4 compactors	3 bad /1 good	100% sent to TS Tubas then to ZAF LF (28km)
Nablus	396,210	FTFP 85%	32 of the 57 LGU	47%	5 compactors	3 bad / 2 good	88% to Al Sarayfi TS then ZAF LF (40 km) 8.4% to dumpsites 3.6% recycled
Tulkarem	190,169	FTFP 40%	27 of the 31 LGU	87%	10 compactors	8 bad/ 2 good	98% sent to Tulkarem TS; then to ZAF LF (35km) 1% recycled.
Qalqilya	115,184	FTFP 96%	25 of the 24 LGUs	97%	12 compactors	7 bad/ 5 good	100% sent to Qalqilya TS then to ZAF LF (80km); 1% organic separated; 1% recycled.
Salfit	77,473	FTFP 90%	19 of the 19 LGUs	100%	8 compactors	2 bad/ 6 good-v.good	100% to random dumpsites No transfer station
Jericho	50,946	FTFP 99%	14 of the 17 LGUs	87.4%	16 (13 compactors)	4 bad/ 12 good-v.good	94.3% sent to Jericho LF; 5.7% to ZAF LF through Al Sarayfi TS
Ramallah & Al Bireh	336,835	n.a.	60 of the 70 LGUs[53]	79%	13 (11 compactors) In some areas tractors used	good 43 LGUs use them	50% to ZAF LF and 50% to dumpsites
N-E & S-E Jerusalem	118,000	FTFP 100%	12 of the 12 LGUs	100%	16 compactors	12 bad/ 4 good	100% sent to Al Abdaly TS (25 kms) then Al Minya LF; Al Ram TS to rehabilitate From 2019, Al Sawareh TS to replace Al Abdaly.

51 Except from the two Jerusalem Governorates (figures given by the JSCs), estimated population numbers from PCBS Report 2400 (2018). Palestinians at the End of 2018. http://pcbs.gov.ps/pcbs_2012/Publications.aspx accessed 06.02.2019.

52 FTFP is "fixed time fixed place", referring to container disposal and HtH means "house-to-house" or door to door collection.

53 JSC Ramallah provides full service to 17 LGUs. It also provides the equipment and monitors the maintenance of the collection vehicles, while municipalities provide the human resources in 43 LGUs. A private contractor is responsible for the long distance transfer to ZAF landfill (MoLG - JICA Databook 2019 and interview with JSC).

JSCs	Population district in 2018[51]	Collection system type	Number LGU served out of total LGU	% population covered	Number of vehicles	Vehicle's condition status	Transportation of collected SW to
North & N-W Jerusalem	49,459	FTFP 75% HtH 25%	16 of the 16 LGUs And 5 LGUs from RABJSC	100%	10 compactors	2 good, rest bad	Since October 2018, 80% to LF, rest in 2 dumpsites. Before 100% to dumpsites
Bethlehem	222,624	FTFP 90%; 9% HtH; 1% containers	28 of the 36 LGUS	80%	25 (18 compactors)	all good	100% to Al Minya LF
Hebron	733,537	FTFP 75%	32 of the 55 LGUS	53%	27 (25 compactors)	12 bad/ 15 good	50% to Al Minya LF directly; 50% through TS (Tarqumia 39 kms, Al Fahs 33kms and Yatta)

(Sources: MoLG-JICA, 2017a & 2019; PCBS; JSC Today newsletters and JSC information)

A wide range of collection systems is found within the OPT. In the West Bank, the door-to door collection is done by street sweepers with wheelbarrows or/and the street container are the most commonly applied waste collection systems. The types of street containers used are mainly 1.1m^3 (32, 24, 10, 4 m^3 also) and small size bins (360-240L), and the door to door system has diverse containers (from 240-120L bins to plastic bags) (MoLG-JICA, 2017b). Commercial/industrial waste is gathered in 32/25/10 m^3 containers. Trucks and compactors are taking the waste to transfer stations or directly to dumping sites. In WB villages, collection is done through wheelbarrows and tractors. City areas can get a 7 times/week service, while SW is generally collected twice a week in villages (MoLG-JICA, 2019).

In East Jerusalem (about 284,926 people in 2018[54]), both door-to-door and street container systems apply and all the waste collected goes to GreenNet transfer and recycling station in Atarot industrial zone[55], where it is sorted. About 35% of the organic and 12-15% of non-organic is recycled. The rest of the waste goes to the south of Israel for landfilling. In addition, there is a primary separation of plastic containers and bottles, cardboard/paper and of glass with dedicated containers located in few neighbourhoods[56].

54 PCBS estimates at the end of 2018 a total of 446,585 persons in East Jerusalem (i.e the Palestinian side, according to international law), which includes the zones currently covered by JSC NE-SE Jerusalem and JSC NW-W Jerusalem, which are behind the Separation Wall. What we call East Jerusalem in this paper comprises only the territory under the Israeli Jerusalem municipality's rule since 1967.

55 http://www.greennet.co.il/ and http://www.tecogroup.co.il/%D7%92%D7%A8%D7%99%D7%9F-%D7%A0%D7%98-%D7%94%D7%97%D7%91%D7%A8%D7%94-%D7%9C%D7%A0%D7%99%D7%94%D7%95%D7%9C-%D7%A4%D7%A1%D7%95%D7%9C%D7%AA-%D7%91%D7%A2%D7%9E/ , accessed on 20.10.2018.

56 See webgis page in Hebrew, https://jergisng.jerusalem.muni.il/baseWab/?config=../gisviewerngsupport/api/InjectingConfig&locale=he accessed on 11.04.2019.

In the Gaza Strip

Currently, there are three solid waste management service providers in the Gaza Strip: Joint Service Councils for Solid Waste Management; and 25 municipalities. In addition to the above, UNRWA provides solid waste management services free of charge in the 8 refugee camps located throughout the Gaza Strip.

Primary collection is applied with street sweepers with wheelbarrows or donkey carts in Gaza; and rear-loading compactors and tipper crane trucks which empty wheeled waste containers of capacity about 1 m^3, are most commonly used. Hook-lift (also called Roll-on Roll-off – RoRo) containers are also found in most cities. Crane-tippers/skip loaders were mostly designed as part of the GTZ/SWMC project; each truck has a hydraulically-operated truck-mounted crane which lifts and empties containers into a large body which can be closed at the top by pivoted flaps, and is emptied by tipping. The bodies of these trucks, like the containers they use, were fabricated in Gaza. A crew of two - one driver and one assistant operate the trucks. A new system, which is used in conjunction with crane tipper trucks, is house-to-house collection using a small agricultural tractor, which has a trailer at the rear to enable it to carry 1 m^3 container. When full, the container can be left at the roadside for a crane tipper to pick up and empty. In addition to the previous collection tools, collection by donkey carts is used for primary collection which started since the fuel crisis in 2008, and it continued and grew up for more than 10 years. This tool collects waste from households to large street bins (roll on/off containers). Donkey carts collects more than a third of primary collection in Gaza Strip, and about half of Gaza City waste[57].

Table 6. Assessment of donkey carts in Gaza (MDLF, 2017b).

Municipality	Gaza	Khan Younis	Rafah	Jabalya	Biet Lahya	Beit Hanon	Dier Al-Balah	Total
No. of Donkey carts	215	62	59	45	6	5	7	506
Capacity ton/ day	322	93	86	65	10	7	11	594
Capacity %	48%	62%	57%	46%	10%	14%	14%	

57 Ecoconserve & Universal Group. (2017). Studies for optimizing waste collection (Consultancy service to MDLF).

Figure 7. Donkey Cart removing waste to Roll on/off container, Gaza Strip

For inner areas of the municipalities with relatively narrow streets: Residents place their wastes in reused plastic bags in front of the buildings, donkey carts (Municipality) transfer the waste to transfer stations, if relatively close, or else to sub-transfer stations (large container bins of 6, 8, 20, 24, 28, 30 m^3 capacity) or to the more commonly available 1 m^3 bins.

For areas with relatively wide streets: Residents place their wastes in plastic bags or small bins in front of the buildings, Workers accompanying compactors collect the piled plastic bags (containing waste) from building to building, compactors transport the collected waste to the landfill directly.

For areas with relatively wide streets and for main roads: In districts where roads are wide enough, bins, usually of 1 m^3 capacity, are placed every 100 – 200 meters and within short distances from residential units. Tipper cranes and/or compactors collect waste from the bins and transfer it to landfill.

For semi-urban areas and areas with unpaved roads: In this case, tractors-trailers are more commonly used to collect the waste. The tractors collect waste in reused plastic bags from building to building and transport it to transfer station or directly to landfill[58].

58 Ecoconserve & UG, Assessment report of Studies for optimizing waste collection, 2017.

Table 7. Main characteristics of the collection system in Gaza in 2017-2018.

JSCs in Gaza	Population district	Collection system type	% LGU served	% population covered	Number of vehicles	Vehicle's condition status	Transportation of collected SW to
Khan Younes/ Rafah/ Middle Area (Secondary Collection)	850,000	Primary Collection (from house to container): conducted by municipalities and UNRWA Secondary Collection from container/ TS to landfill): Conducted by JSC-KRM, Municipalities and UNRWA	100% of the 17 LGU	JSC covers 48%[59], whereas municipalities and UNRWA cover 97% of primary collection[60] and 52% of secondary collection.	20 (7 compactors, 10 tipper cranes, and 3 roll on/off)	50% good/ 50% bad	Until July 2019: 78% sent to Dier Al-Balah LF[61], 22% sent to Al-Fukhary existing dumpsite[62]9. July 2019: 100% sent to Al-Fukhary Sanitary Landfill. Part of waste dumped in random sites e.g. in Absan Al-Kabeera and Khuzaa. Two transfer stations in Rafah and Khan Younis are expected to be operated in 2020 with a distance 16 km and 14 km consequently.
Gaza Governorate and North (not operational)	1,150,000	Municipalities do all the collection	100% of the 8 LGU	JSC covers 0%[63] of waste collection, but municipalities and UNRWA covers 97%	5 (2 compactors, tractor, loader, and tipper crane)	Bad conditions	31% sent to Al-Yarmouk TS then to Johr Al-Diek LF (10km) 36% sent to open illegal dumpsites at the north of Gaza governorates 33% sent directly to Johr Al-Diek Landfill

59 JSC-KRM annual report, 2017.

60 Environmental and Social Impact Assessment of GSWMP, 2012

61 Dier Al-Balah landfill was closed in the July 2019, the alternative landfill was AL-Fukhary new sanitary landfill.

62 Al-Fukhary existing dumpsite will be closed once the start of operation the new AL-Fukhary sanitary landfill at the middle of 2019.

63 The JSC in Gaza and North Gaza was established in 2017, but it is still non-operational.

3. Waste Disposal: Landfills, Transfer Stations and Dumpsites

One challenge with SWM in the OPT is the disposal process. The principal methods of disposal are landfilling and random dumping. In addition, illegal and spontaneous fires take place in dumpsites or in containers. In 2018, regarding how much municipal waste goes to landfills, figures reported vary from 50% (Di Maria et al., 2017) to 80% (MoLG-JICA, 2019, concerning only JSCs). Taking into account the information available and tables and data mentioned before, one estimates that in 2018 about 65% is disposed in controlled landfills, 3% is recovered/recycled and about 32% is illegally dumped[64].

In 2019, there are in the West Bank (including East Jerusalem) and Gaza strip:

Sanitary landfills

7 Palestinian and 1 Israeli sanitary landfills:

- West Bank: Zahrat Al Finjan (ZAF), Al Minya (AM), Jericho and a very small one in North-West Jerusalem (Beit Anan). In addition, 1 Israeli (Tovlan in Jericho – currently takes the waste from Israeli settlements);
- Gaza: Al-Fukhary (Sofa) existing dumpsite and new sanitary landfill, and Johr Al-Diek landfill. Deir El Balah landfill was closed in july 2019.

In the West Bank:

Zahrat al-Finjan sanitary landfill (ZAF) was established in 2007 in Jenin governorate and its total area is 240,000 m^2 with a total cell capacity of 2.25 M tons of waste. It is located in area B and managed by JSC Jenin. Originally, it was designed to take the municipal solid waste of Jenin and Tubas, for about 30-35 years. The landfill is managed by JSC Jenin.

It has reached almost its full capacity in 2018, due to the fact that the landfill receives SW also from all Northern governorates (Tulkarem, Qalqilya, and Nablus), as well as from Ramallah and Al Bireh cities (El Kelani et al., 2017; Abu Jahal, 2018)[65].

One thousand two hundred tons is the daily currently waste[66] disposed in the landfill's 4 cells (90,000 m^2). The landfill's old cells above ground level is about 36m high. Excavation of one of the eldest cell has apparently started[67], and a feasibility study about a possible future waste-to-energy pilot project is currently under process. Some parts of the landfill need to be reinforced, in order to avoid collapse.

64 In its report in 2014, GIZ-SWEEPNET estimated about 33% of waste landfilled and 67% dumped. The construction of landfills and rehabilitation of dumping sites improved the situation since then.

65 In 2019, ZAF may be unable to further accept Ramallah SW. Source: JSC Ramallah.

66 JSC Jenin representative confirmed 1,100 tons/day on 19.11.2018.

67 Interview with MoLG in November 2018.

Cells 3 and 4 are currently operated. There is a possible extension of the landfill surface of 140,000 m^2 (MDLF, 2017a; Abu Jahal, 2018) but there seems to be local resistance.

Figures 8-9. Cell in operation in Zahrat-Al-Finjan landfill and old cells 1-2 (V. Thöni)

Figures 10-11. Aerial view of the Zahrat-Al-Finjan landfill (MDLF, 2014); one leachate pond (V. Thöni)

The landfill is sealed (using geosynthetic clay liner, HDPE liner, fabric and clay rocks) and equipped with a leachate collection system. The two leachate lagoons have a capacity of 4,000 and 17,000 m^3 liquid respectively. Fluid reduction is achieved with natural evaporation through 4 pumps spraying over the waste. The amount of leachate produced (60-100 m^3/day) has serious potential environmental negative consequences, in terms of soil and groundwater pollution and odours (MDLF, 2017a; El Kelani et al., 2017). Currently, the aeration tank is not functioning (MDLF, 2017a) and there is no gas collection system on the cells for the moment.

The main composition of the SW coming in ZAF in 2017 is mainly organic (55%); paper and cardboard (12%); plastic and rubber (14%), glass (1.5%) and metals (2%).

In terms of reuse and recycling, there is a separation unit on the site, which is not working any more; however some paper/cardboard is stored next to it. Some tires are reused as soil barriers or plant containers, paper and cardboard are separated already at primary collection level in Jenin and sold to an Israel firm from waste, whereas plastic (only HDPE

and PP) is sold to local companies (Al Batnij, 2013). In addition, hazardous waste is usually restricted but some medical waste is finally disposed with other normal municipal waste.

Located in area C, Al Minya sanitary landfill was opened in 2014, designed originally for 630 tons/day but actually it receives 1,100 tons/day in November 2018: all the waste from the southern governorates, Bethlehem (220t/day) and Hebron (700 t/day)[68], as well as from East-Jerusalem (115 t/day) and settlements (65t/day)[69]. It is operated by the Higher Council for Solid Waste Management – Bethlehem and Hebron. All the waste collected from these districts go either directly or through the transfer stations of the South governorate. The total landfill area is 250,000 m^2, with a design capacity of 4.9M m^3 and an expected lifespan of about 20 years.

Figure 12. Al-Minya landfill, cell 5 in preparation forward and in the back cell 4 in operation. (V. Thöni)

On the landfill, the first three cells have been already closed (50m above GL) and cell 4 is in operation, to be full in 2019; cell 5 is being prepared (3 others should be ready in about 3 years). The cells are sealed with HDPE, PVC and clay liners, and equipped with a leachate collection system (main lagoon of 16,000 m^3 capacity and another next to it of 12,000 m^3, a third pond is in the building process at the time of writing). In 2018, the average leachate production is 80-100 m^3 in summer and 200 m^3 in winter [70].

68 In 2016, Al-Minya was providing service 33 municipalities and 830,000 people. World Bank, http://www.worldbank.org/en/news/feature/2016/02/17/working-amid-fragility-delivering-results-in-essential-services-in-palestine, accessed on 14.01.2019.

69 Currently, waste from settlements coming to Al Minya is not charged (settlements being considered illegal). The settlements include Gush Etzion Bloc, Har Hebron and Qiryat Arba (Al-Sari', 2015). This was confirmed by several JSC representatives.

70 From HCHB representative estimation on 4.11.2018; there is no daily measurement of the leachate production.

Figure 13. Al Minya's two leachate ponds. (V. Thöni)

Leachate management is an issue, as the only method to reduce it is evaporation. There is a treatment unit with an aeration tank, which is out of order; an odour repellent is sprayed regularly on the leachate ponds and over the landfill itself, in order to limit the inconvenience to nearby residents. The ponds face the risk of overflow during certian seasons and the reduction of the leachate is very low. There is also a passive gas collection/venting system on the three cells (no gas flaring system at the moment) (MDLF, 2017a).

About 45-50% of waste arriving on the landfill is organic/ biodegradable; 11% is paper/ cardboard; 14-18% is plastic; 3-5% is glass; 1-2% is metals; 15-20% is other waste, which includes sludges from slaughter houses, tanneries or dairy plants [71].

Figures 14-15. Sorting line in Al-Minya (V. Thöni)

There is a sorting plant with a separation line mainly for plastic, metals, cardboard and organic, with a capacity of 60 t/day[72]. The final 9 tons daily recycled consist in carboard/

71 Information from JSC

72 Technically, this facility works as a mechanical biological treatment system, combining some material recovery and stabilization of organic component. This type of waste processing enables to reduce the waste to landfill and thus save its lifetime (as well as costs); it uses also the stabilized matter for covering and filling purposes. https://zerowasteeurope.eu/2011/09/mechanical-biological-treatment-mbt-zero-waste/ accessed 30.6.2019.

paper, plastic, organic waste, metal, glass, wood and tires. A new sorting trommel shall be installed and used in 2019 for organic waste. There is also a plan in the future to sort out and treat tires in a new facility built on the landfill. With regard to special waste, separated medical waste is buried each day in a special place of the operating cell. The landfill has also a training centre for all JSCs and is engaged in several projects with the nearby localities.

The third sanitary landfill is located in Jericho since 2007 in Area A and receives the waste from all Jericho governorate, plus some from Nablus governorate (about 40-50 tons / day in 2018), with a designed total capacity of 0.0685 million m^3 and an annual waste capacity of 11'500 ton/year (GIZ-SWEEPNET, 2014). It is managed by JSC Jericho. The landfill operation is semi-aerobic. Small amount of leachate is generated (about 7 m^3/day depending on season) and reaches two leachate ponds (one for each cell) with a capacity of 1,400 m^3 each.



Figures 16-18. Jericho landfill in 2018: medical waste cell, gas pipes and old cell (V. Thöni)

In February 2017, the landfill was expanded to enable further reception (current cell capacity of 44,000 m^3) but it shall be full by mid-2019 and there are currently no possibilities for further expansion (the site being adjacent directly to Area C). One option will be to reclaim old cells while separating waste for recycling (a waste separation facility is already built; future equipment is awaited[73]). The gas collected in the landfill is released through vertical pipes in the atmosphere without flaring.

There is also a special cell for hazardous and medical waste, where 85% of the medical waste of Jericho governorate was disposed until 2015[74]. The JSC is currently undertaking an experimental biogas station and feasibility study, whose results are available in 2019.

73 Darwish D., 2017, http://www.ps.undp.org accessed on 20.10.2018 and information given by JSC Jericho in November 2018.

74 JSC Jericho reported that since this date, 85% of the medical waste produced ends up with the rest in the landfill, following a governmental decision requiring to treat the medical waste directly in the medical institutions before disposal.

Figures 19-20. Beit Anan controlled landfill in December 2018; concrete culvert in the river bed (V. Thöni)

Since September 2018, North & North West Jerusalem JSC opened an engineered landfill[75] cell (an area of about 3,000 m^2) with special lining and leachate collection systems (but no proper leachate pond for the moment). Its location is near to a former dumping site (Beit Anan) which was closed (all in area C). The landfill receives about 60 tons/day from the 16 LGUs situated in the JSC service area, plus 20 tons from 5 additional LGUs from Ramallah and Al Bireh JSC (RABJSC). Due to the special topography of this site (in a depression), a stream had to be covered with a concrete culvert to ensure rainfall stream discharge. The landfill allowed the closure of 6 random dumpsites in the district. The further expansion (LF phase 2) of this site (approx. 10,000 m^2 area) with a lifespan of 3-4 additional years is pending for future financial support [76].

Another sanitary landfill in the Rammun area is planned in area C. It would serve all the communities (68 localities) from Ramallah and Al-Bireh governorates, with a total area of 208'000 m^2 and a total capacity is 2.75 Mm^3, divided into 4 cells, and a possible lifespan of 20 years (MoLG-JICA, 2013). More importantly, it would allow the closure of about 50 random dumpsites and would relieve the burden currently put on ZAF and Al Minya. This controversial project is put on hold for the moment: after several years it received the Israeli's construction permission (which seems conditioned by the possibility for Israeli settlers to dump their waste there[77]), but it faces a strong opposition from the Palestinians living in the area, as well as from some settlers' communities[78] who put the case to the Supreme Court. In the next months of 2019, the decision of the Court should be announced.

75 https://www.uni-due.de/imperia/md/content/abfall/landfilldesignss2006_1.pdf accessed on 30.06.2019.

76 Interview with JSC North & North-West Jerusalem, December 2018.

77 The Times of Israel, 13 August 2018, Israel said to nix German plan for garbage dump to be used only by Palestinians. https://www.timesofisrael.com/israel-nixes-german-plan-for-dump-to-be-used-only-by-palestinians-report/ accessed on 20.11.2018

78 Ben Hatem, 23 July 2014, Controversial Landfill Prompts West Bank Showdown https://www.thedailybeast.com/controversial-landfill-prompts-west-bank-showdown; Dina Omar, June 4, 2013,Trashing Four Generations of Palestinian Inheritance, https://al-shabaka.org/commentaries/trashing-four-generations-of-palestinian-inheritance/ ; all accessed on 25.11.2018.


Figures 21-22. Yatta former dumpsite with gas flaring system (V. Thöni).

In the Hebron governorate, the uncontrolled dumpsite in Yatta, which had run for decades, was closed in 2013, with the opening of Al Minya landfill. The whole surface (about 160,000 m^2) was covered and a gas collection system was installed with a flaring system (gas is burnt for about 6 hours every day). The system could allow for electricity generation. The leachate is directed through concrete gutters but there is no proper leachate pond collecting it.

In addition, some landfills managed by Israeli are located in the OPT:

- the El 'Eizariya non-sanitary landfill of 430,000 m^2 surface, located between El 'Eizariya and Abu Dis Palestinian localities in area C in Jerusalem governorate. This landfill is apparently closed now after many years of operation, but according to ARIJ, the landfill was still used in 2015 and some expansion projects were on the way (ARIJ, 2015). Al Abdaly (also called El Eizariya) transfer station managed by Israelis is close to the site.

- In the Jericho valley, the Tovlan landfill, run by Israelis[79], receives the waste from settlements (among which Ariel and Ma'ale Efrayim), as well as from the Barkan Industrial Park. It is equipped with leachate lagoons and an electrical plant using the extracted methane gas. There is also a composting plant nearby. There is no data nor contact publicly available regarding the treatment of waste done there.

In Gaza Strip:

Al-Fukhary (Sofa) disposal site is located within the administrative jurisdictions of Khan Younis Governorate; Khan Younis Governorate is located in the southern part of Gaza Strip. The site is situated approximately 5 km northeast of the former Gaza Airport, 6 km north-east of Rafah City, and 800m from the Israeli border (the 1950 armistice line); it is bounded by Khan Yunis Waste Water Treatment Plant (WWTP) from the East, access road from the South, and agriculture lands from other sides. The closest residential areas to the site are Al-Fukhary and Al Buyuk areas which are at a distance of around 1,600 m and 1,700 m respectively. Al-Fukhary (Sofa) disposal site is divided into two parts as the following:

79 About Tovlan: https://www.slideserve.com/hans/tovlan-landfill-site; https://ejatlas.org/conflict/tovlan-landóll-serves-illegal-israeli-settlements-at-the-expense-of-palestinian-communities; https://www.jica.go.jp/english/our_work/social_environmental/archive/pro_asia/pdf/pale_04.pdf; all accessed on 25.11.2018.

Figure 23. Al-Fukhary Sanitary Landfill and Existing Dumpsite (June, 2019). Source: Facebook - Masoud and Ali Contracting Company

- The existing dumpsite: It was operated since 1996 by Municipality of Rafah, and it received the municipal solid waste from Rafah governorate only. The dump site was created over an area 26,000 m^2, given that the height of waste reached up to 30 m in 2017 with a very steep side slope (1V:1H). The dumpsite doesn't utilize a liner system but only leachate collection pipe dissecting the 6-8m deep bottom over a silty clay layer; the leachate collection system was out of action few years after the operation of the dumpsite. The existing dumpsite was extended over adjacent 11,000 m^2 land in 2018 as a short-term solution to gentle the side slopes to be more stable and safer. Leachate collection system was created in the extension part in order to be connected with the leachate lagoon in the near future. The existing dumpsite continued receiving the daily coming waste (about 170 ton/day) until July 2019.
- Al-Fukhary (Sofa) Sanitary Landfill: this new landfill has a surface of over 140,000 m^2. It was financed mainly by the France Development Agency (AFD), the European Union (EU), and the World Bank. The Kingdom of Sweden by Municipal Development and Lending Fund (MDLF), through the Gaza Solid Waste Management Project (GSWMP) since 2014, supported the construction. The new sanitary landfill is located adjacent to the existing dumpsite; the new landfill is lined and has a leachate collection system. Furthermore, it includes administration building, maintenance warehouse, stormwater lagoon, and surrounding ring roads. It is operated by JSC-KRM since July 2019 by receiving waste from Middle Area, Khan Younis, and Rafah Governorates (17 municipalities which constitute JSC-KRM).

Deir Al-Balah Central Landfill was built in 1995 and extended in 2002 by the support of the Federal Republic of Germany. The landfill is located on the eastern part of Deir Al-Balah City directly near the border line (the 1950 armistice line) with Israel. The total dumping area of the landfill in the first phase was 34,900 m^2. The landfill was extended in 2002 bringing the total dumping area (footprint of the landfill) to 59,900 m^2 and reached nearly 26 m of waste height in 2018. This landfill has a gravity leachate collection system in two ponds where the leachate is recirculated again onto the landfill surface according the original design, given that the estimated annual leachate production is about 45,000 m^3.

Figure 24. Deir Al-Balah landfill (S. Matar)

The first leachate pond was constructed in 1997 on an area of 1,000 m^2 with volume 2,400 m^3, whereas the second pond was constructed in 2002 and has 1,500 m^2 with 3,600 m^3 volume. The landfill utilized asphalt liner system with leachate collection pipe dissecting the 5-7m deep landfill bottom.

Deir Al-Balah Landfill was operated by JSC-KRM and received an average of 450 ton/day from Middle area and Khan Younis governorates, knowing that the landfill was exceeded its design capacity since 2008. Deir Al-Balah landfill was closed in July 2019, instead the new Al-Fukhary (Sofa) sanitary landfill starts receiving the waste of Middle area and Khan Younis Governorates.

Johr Al-Diek Landfill (JAD) was built in 1986 and extended in 1990, 2000, and 2013. The landfill is located in the south-eastern part of Gaza Governorate near the border line (the 1950 armistice line) with Israel. The total dumping area of the landfill in the first phase was 30,000 m^2, the landfill was expanded with new liner, leachate collection system, and leachate lagoon bringing the total dumping area (footprint of the landfill) to 140,000 m^2. Additional adjacent 120,000 m^2 has been acquired in 2018 to be use in the near future, knowing that the existing landfill is almost full. In this landfill, there was also a hazardous waste disposal cell, with encapsulation in concrete boxes. It is the only hazardous waste disposal site in Palestine.

Figure 25. Johr Al-Diek Landfill just after short time of rehabilitation (S. Matar)

The landfill is operated by Gaza Municipality and receives an average of 700 ton/day from Gaza city and North Gaza governorates, knowing that the generated waste quantities are estimated at 1,100 ton per/day; but the generated waste in North Gaza Governorate (Jabalia, Bet Lahya, Bet Hanoun, and Um Al-Nasr), which is about 400 tons/day, is transferred instead to one of the three random dumpsites in Jabalia, Bet Lahya, and Bet Hanon. The accumulated quantity of waste in dumpsites in North Gaza estimated at 250,000 tons. Municipalities in North Gaza use part of external financial supports for transferring these quantities to Johr Al-Diek landfill.

The new activated council JSC-GN is finally in place late of 2017; consultation is carried out in order to transfer the responsibility of the landfill operation from the municipality of Gaza to JSC-GN, but no agreement was signed yet.

According to the UNDP 2012 Feasibility Study of the Gaza Solid Waste Management Project which was agreed by all parties and stakeholders, the following points were agreed:

- The short-term upgrade of the landfills (Johr Al-Diek and Al-Fukhary) would be effective from 2013 onwards, followed by a 5-year operation period for construction and completion of the long-term sanitary landfills;
- Two landfills up to 2040; would be the preferred scenario, with the exception that the JAD landfill shall be located not closer than 500 m from the border with Israel. This puts certain constraints on the available land for this landfill, also taking into account the minimum distance of 200 m from adjacent houses. This implies that the JAD landfill will remain in operation until 2032, and might be closed in that year.
- Both landfills shall be realized at a depth of 20 m below surface. The soil profiles obtained from drillings at both landfills show that the soil conditions, including existing clay layers and depth to groundwater, permit environmentally safe landfilling under these

conditions. Both landfills will be filled until 30 m above surface, as such realizing a total height of 50 m for the waste bodies. Although this will increase the overall investment cost, this will have a clear advantage in terms of visual aspects of the landfill, and will enable more realistic closure and landscaping plans.

- After 2032, there will be two options: (1) all municipal waste, expect the waste streams that will be recycled or composted, will be disposed of at one central landfill located in Rafah (Al-Fukhary); (2) if agreement can be reached with the Israeli's to expand the landfill towards the 300 m border line, Johr Al-Deek landfill will remain in operation after 2032.
- Option 1 implies that from 2033 onwards a bulk transfer station shall be established at Johr Al-Deek on the waste reception area. Meanwhile bulk waste vehicles will transport all waste from Johr Al-Deek to the Rafah central landfill.
- Starting from the operation of the long term sanitary landfills at Johr Al-Deek and Rafah, two Joint Service Councils will be established in the Gaza Strip: (1) one for Northern Gaza (including Gaza City and the existing JSC for Northern Gaza), responsible for waste collection, transportation and operation of the Johr Al-Deek Sanitary Landfill; (2) the second one for Southern Gaza (including Beir al Balah JSC and Rafah City), responsible for waste collection, transportation and operation of the Rafah Landfill. This situation will remain in place at least until the year 2032. UNRWA, which is responsible for collection of waste from the refugee camps can decide either to outsource their waste collection services to these two JSC's, or to continue waste collection by themselves.
- This feasibility has a final time frame until 2040, and foresees in major landfilling activities up until that year. Nevertheless, it may be expected that during the next 30 years alternative waste treatment technologies requiring less space will also become feasible for the Gaza Strip, including digestion and incineration. However, much will depend on the economic developments within Gaza in the next 30 years, as well as further improvement of waste management services and related enforcement of operational and financial regulations.

Solid Waste Transfer stations

15 Palestinian and 3 Israeli transfer stations:

- West Bank and East-Jerusalem: Western Jenin, Tubas, Tulkarem, Al Sayrafi, Qalqilya, Al Bireh, Ramallah, Al Ram, Al Sawareh, Tarqumia, Al Fahs Hebron Industrial Zone and Yatta[80]. Managed by Israelis: Al Abdaly, RA Ofek and Green Danlop Atarot[81].
- Gaza Strip: Al-Yarmouk TS in Gaza, Khan Younis TS, and Rafah TS.

80 Yatta transfer station is managed by the HCBH. The newly built TS Al Sawareh in NE-SE Jerusalem shall replace the use of Al Abdaly from 2019.

81 B'Tselem 2017.

Table 8. Summary of the transfer stations in the OPT in 2018 (MoLG-JICA Databook, 2019)

	Transfer Station	Location area	Managed by	Transferred Quantity	Transferring Distance	Final Disposal	Additional Information[82]
1	Western Jenin	Jenin	Jenin JSC	50 tons/day	35 km	ZAF	cardboard, metal and plastic separation and treatment
2	Tubas	Tubas	Tubas JSC	43 tons/day	28 km	ZAF	Cardboard and plastic separation and treatment raised platform
3	Al Sayrafi	Nablus	Nablus Municipality	180 tons/day	40 km	ZAF	cardboard, metal and plastic separation no weighing bridge no pavement
4	Tulkarem	Tulkarem	Tulkarem JSC	132 tons/ day	30 km	ZAF	Pavement and concrete ramps; paper/cardboard separation; weighing bridge
5	Qalqilya	Qalqilya	Qalqilya JSC	123 tons/day	60 km	ZAF	Pavement; weighing bridge; cardboard separation
6	Ramallah	Ramallah	Ramallah Municipality	100 tons/day	120 km	ZAF	weighing bridge, raised platform; no pavement
7	Al Bireh	Ramallah	Al Bireh Municipality	100	80 km	ZAF	no pavement; no weighing bridge
8	Al Ram	N-E & S-E Jerusalem	Al Ram Municipality	60 tons/day	55 km	Al-Minya	covered surface area
9	Al Fahs	Hebron	Hebron & Bethlehem Higher Council	400 tons/day	33 km	Al-Minya	HCW treatment unit; weighing bridge
10	Yatta	Hebron	Hebron & Bethlehem Higher Council	140 tons/day	35 km	Al-Minya	weighing bridge; no pavement
11	Tarqumia	Hebron	Hebron & Bethlehem Higher Council	100 tons/day	39 km	Al-Minya	
12	Wadi El Nar (Sawareh)	N-E & S-E Jerusalem	SE Jerusalem JSC	Not operational yet	30 km	Al-Minya	
13	Al Abdaly (Ezzariye)	N-E & S-E Jerusalem	Israel	60 tons/day	35 km	Al-Minya	weighing bridge
14	RA Ofek	Atarot industrial zone	Israel	n.a	n.a	n.a	n.a
15	Green Danlop	Atarot	Israel	n.a	n.a	n.a	n.a
In the Gaza Strip							
13	El Yarmouk	Gaza	Gaza municipality	350 tons/day	10 km	Johr Al-Diek (JAD)	
14	Khan Younis	Khan Younis	Khan Younis JSC	0	14 km	Al-Fukhary (Sofa)	Newly constructed, expected to transfer 40 ton/day. The facility includes a treatment unit for HCW.
15	Rafah	Rafah	Khan Younis JSC	0	16 km	Al-Fukhary (Sofa)	Under construction, expected to transfer 60 ton/day.

(Sources: MoLG-JICA, 2019; CESVI 2017; JSCs and CESVI) [82]

82 It is worth keeping in mind that although there is some separation going on in some transfer stations, the quantities segregated remain very small.

Transfer Stations in the West Bank:

Seven of them are managed by JSCs, 4 by municipalities (MoLG-JICA, 2017a). Almost half of waste collected by JSCs is transferred through them.

In the majority of the TS visited, the collected waste is disposed directly on the soil (no pavement), some of it is separated and stored (plastics and metals for example), then the rest is loaded by wheel loader on trucks which will transport it to the nearest disposal site. Some have no weighing bridge (like in Al Sayrafi TS), some have an upper level allowing for easier discharge (like in Tubas TS).

Some of these transfer stations above mentioned are the place for sorting recyclable waste (paper/carboard or plastics for example), or are dedicated to special waste (hazardous or industrial).

Figure 26. Tubas new TS (JSC Today, March 2018).

Figure 27. Ramallah TS (CESVI, 2017).

In Al Sayrafi TS in Nablus, separation of paper/cardboard, plastic and metal is done. A material separation facility is in place but not used for the moment; however, there is a plastic shredding facility functioning (CESVI, 2017). Qalqilia TS has the project, with the Netherlands support, to build a factory for recycling cardboards[83].

83 Information from CESVI team, 2019.

In the Hebron governorate, Al Fahs-Industrial zone transfer station for example has the only healthcare waste treatment facility in the south OPT. In operation since 2013, it aims to collect in the future the health-care waste from all hospitals, clinics and laboratories of the Hebron and Bethlehem governorates. It currently collects 750 kg from Hebron and 250 kg from Bethlehem, so 1 ton /day in total[84]. This TS is also equipped with a used tire recycling facility, a cardboard bailing facility, as well as a compaction system for bulky waste, but neither of them do work anymore. Al Fahs TS has recently stopped for maintenance.



Figures 28-30. Al Fahs TS medical treatment unit and tire sorting line (V.Thöni)

Yatta transfer station was opened in November 2017 next to the former dumpsite and serves as a transfer station for the waste from the surrounding municipalities, going to Al Minya. There is some sorting of waste (mainly plastic and metals) there, about 1% of the total waste received. The High Council of Bethlehem and Hebron would like to upgrade this station, with more containers and additional trucks, in order to make it the main transfer station of the south.

Figure 31. Yatta TS (V.Thöni)

Al Abdaly transfer station in N-E & S-E Jerusalem, near El 'Eizariya is managed by the Israelis but Palestinians use it and pay for the transfer of the waste to Al Minya. The 3-years agreement signed with the Palestinian authorities finishes in March 2019 and the station should be

84 Information from JSC Bethlehem, June 2019.

closed (or not accessible anymore for Palestinians). Al Abdaly receives also waste from settlements. A new transfer station, Wadi El Nar (Al Sawareh), shall open in 2019 (electricity and water access, equipment and vehicles were missing at the moment of writing), to cover the 6 municipalities currently using Al Abdaly. The plan is also to develop a sorting/recycling facility in Al Sawareh, in order to reduce the waste disposed in Al Minya.

In addition to Al-Abdaly, there are also the Israeli RA Ofek and Green Dunlop sorting plants and transfer stations in the Atarot industrial zone, which also recycle construction and demolition waste. The quantities of recycled material there are unknown.

Transfer Stations in Gaza Strip:

- South of Gaza Strip: three transfer stations were planned to be constructed under Gaza Solid Waste Management Project (GSWMP) in Rafah, Khan Younis and Middle Area governorates. Khan Younis transfer station has been constructed by UNRWA through IDB funding in 2017, whereas Rafah transfer station is under construction by MDLF, and it is expected to be operated in 2020. Middle Area transfer station was designed, and a land was allocated for it, but it was not financed through GSWMP. Khan Younis and Rafah transfer stations are expected to start receiving 40 and 60 ton/day consequently in 2020, knowing that their capacities can reach up to 200 ton/day. Both transfer stations are closed sites, they have leachate collection systems, they are fully tilted by concrete slab to prevent leakage of leachate to the soil and groundwater aquifer, and they are covered by steel shed.

Figure 32. Khan Younis TS, January 2018 (Municipality of Khan Younis Facebook Page)

- North of Gaza Strip: one existing transfer station (Al-Yarmouk Transfer station) was used by Gaza Municipality. It is located in the Gaza city, it is not tilted by any material and not covered by a shed, but the waste is transferred from the transfer station to Johr Al-Diek Landfill on the daily basis.

Figure 33. Al-Yarmouk TS – Gaza city

Dumpsites

Random dumping is still a practice in the OPT, especially for special waste, such as construction and demolition debris, used tires or agricultural waste for example, are disposed along roads or in empty plots, with burning in some places. It is difficult to have an up-to date list of all the uncontrolled dumpsites. In the last few years, thanks to the opening of sanitary landfills and several rehabilitation efforts, many illegal dumpsites could be closed. In 2019, it is estimated that about 343 tons/day in the WB and 443 tons/day in the GS are disposed in dumpsites (MoLG-JICA, 2019).

In 2013, there were about 160 uncontrolled and 3 controlled dumpsites in the West Bank, half of it not in use (GIZ-SWEEPNET, 2014). In 2018, according to the EQA, there are no more uncontrolled dumpsites in the southern governorates, nor in Tulkarem, Jenin and Tubas governorates. This would mean that there are still about 57 uncontrolled dumpsites in the West Bank. In 2018, MoLG estimates that there are about 83 dumpsites in the West Bank[85].

Sensitive areas like Ramallah, Al Bireh, Salfit, Qalqilya, and Nablus, because of the lack of sanitary disposal areas and long distance to the existing ones, accommodate the most non-sanitary dumping sites, whereas southern governorates have a better situation. JSC Ramallah confirmed in 2019 the use of still 53 random dumpsites in the governorate. MoLG-JICA listed also the number of dumpsites in operation in 2017 in Nablus, Qalqilya, Tubas, North and North West Jerusalem and North East and South East Jerusalem reported in Table (9) (JSC Today, August 2017).

85 Meeting with MoLG representative on October 2018, mentioned also in JSC Today Issue 11; March 2018.

Table 9. List of dumpsites in operation in some WB Northern governorates.

Governorate	Dumpsites in operation
Nablus	Beita; Beit Fureek; Jamma'in; Doma; Al Lubban Al Sharquyah; Al Sawyah; Qusra; Talfit; Aqraba; Aseera; Al Shamaliyah
North/North West Jerusalem	Biddu; Beit Duqqo; Beit Sureek; Bir Nabala
North East/South East Jerusalem	Alsheikh Sa'ad
Qalqilya	None
Tubas	None
Salfit[86]	Nine sites
Ramallah & Al Bireh	Fifty sites

In addition to the above-mentioned figures, it is important to mention that there are also dumpsites for special purposes, for example for C&D waste. At least 21 of them were identified in a recent report[87].

In the Gaza strip's northern part, Beit Lahya, Beit Hanoun, and Jabalia dumpsites stored more than 250,000 m^3 of waste illegally up to now. On the other hand, many of collection points are distributed over all the Gaza Strip area; the waste is not stored in collection points, but transferred within short time, and mostly roll on/off containers are located in these points.

Figures 34-35. Random Dumpsite in Bet Lahya (about 85,000 tons) in Gaza (S. Matar)

Waste burning is also a problematic issue all over the West Bank, even in East Jerusalem, and especially near refugee camps' collection points, where all the waste not collected by the UNRWA (some municipal waste, bulky waste or old vehicles for example) is regularly burnt.

86 Salfit and Ramallah-Al Bireh information from MoLG-JICA, 2019, page 12.

87 MoLG-JICA, Study on Construction and Demolition Waste in West Bank, Palestine, 2017.

Figures 36-37. Examples of random dumping and waste burning in the WB (V. Thöni)

4. Solid Waste Cost and Cost recovery

Reaching financial sustainability and service efficiency is an important topic in SWM. In the OPT, it refers to the Strategic Objective 4 in the NSSSWM 2017-22, with two directions: decrease the collection and transportation costs, and achieve full cost recovery and self-financing[88].

Tariff systems and Cost Recovery in the West Bank

Solid waste management has a cost and is a real burden in the OPT. There is a big gap between the cost of waste collection, transportation, and disposal (144 NIS/ton in average in 2017 in the WB, with a big proportion for collection - 92 NIS/ton) and the amount of fees collected from the inhabitants (about 27 NIS/ton in average) (MoLG-JICA, 2017a). Also, the fee collection rate effectively collected is far from satisfactory in some areas.

The tariff and fee collection system applied to residents and institutions differs from one place to another; it is usually based on the population, the number of households and institutions served and the quantity of waste gathered. It can be a fixed tariff (in Jericho for example) or a fee based on the weight of collected waste. Depending on the system chosen, it will have an impact on long term planning and waste reduction strategies (MoLG-JICA, 2017a).

For Iyad Aburdeineh (Executive director of the Bethlehem Joint Service Council for Solid Waste Management), except in the Northern governorates (where the waste tariff is included in the electric/water bill), fee collection rate collection by municipalities was about 40% on average in 2014, obliging municipalities and village councils to cumulate debts and to find subsidies or coverage from other financial sources for the 60% remaining[89]. In Ramallah municipality for example in 2014, collected revenues covered only 19% of the incurred costs, due to the fact that only half of the service recipients paid the charged fee and to the high transportation cost to the Zahrat al-Finjan landfill (about 1 million USD per year in 2018[90]).

88 PNA, 2017. Page 10.

89 This Week Palestine, http://thisweekinpalestine.com/wp-content/uploads/2014/09/Habitat-and-Solid-Waste-Management.pdf, accessed 14.01.2019.

90 Data from MoLG interview, October 2018.

Since then, efforts in the collection rate have been made and the situation has improved, yet remains challenging.

Table 10. Examples of cost recovery rates of Solid Waste Management in the WB for 2018[91]

JSCs[92]	Annual O&M costs (NIS)	Annual billed amount (NIS)	Collected amount (NIS)	Collection rate (%)	Cost recovery rate (%)
NE & SE Jerusalem	5,316,200	4,539,290	3,800,000	80%	38%
NW & W Jerusalem	1,151,660	1,098,394	868,269	79.05 %	95.37%
Jericho	2,304,068	2,375,929	2,287,150	96.3%	99.3%
Bethlehem	7,015,530	6,987,670	5,605,842	80.2%	79.9%

As a growing service provider in SW, the JSCs depend on municipalities for cost recovery, as these are the ones who collect the fees. The collection rate is variable and most of the JSCs interviewed confirmed that, in general, the costs covered the operational costs but not any of the long-term costs and investment needs, including among others:

- The replacement of old vehicles or collection material;
- The creation or rehabilitation of transfer stations;
- The creation of new cells in landfills;
- The installation of leachate management systems in landfills;
- The installation/replacement of the equipment like aeration tanks, sorting lines or trommels.

Cost Recovery in the Gaza Strip

The waste management tariff structures are different in all the 25 municipalities in Gaza Strip. The waste service tariffs are between 5 NIS to 13 NIS for apartments in residential buildings and between 10 NIS and 25 NIS for offices. All municipalities in the Gaza Strip prepare standardized monthly financial reports. The report format and content are usually matching the requirements of Ministry of Local Government. The municipalities are required to prepare monthly reports that include the following:

- The budgeted amounts for each type of expense and revenue;
- The actual amounts expended or collected/accrued;
- The variation between budgeted and actual amounts;
- The percentage of execution.

The financial collected data show that the cost recovery rate of the solid waste management service is less than 30% in 22 municipalities, whereas only three municipalities has a waste recovery rate more than 30%. Table (11) presents the cost recovery rates in some municipalities in Gaza Strip, it is noted that the billed amounts are not covering even the actual O&M costs

91 Data gathered from JSCs, January 2019.

92 Data given by the concerned JSCs between December 2018 and March 2019.

in most of municipalities e.g the actual O&M costs in Gaza is 40,774,992 NIS in 2017, but it billed only 22,591,944 NIS in the same year. Hence, Municipalities depend on external financial supports to fill their financial gaps.

Table 11. Cost recovery rate of solid waste management for Gaza municipalities in 2017

Municipality	Annual O&M costs (NIS)	Annual billed amount (NIS)	Collected amount (NIS)	Collection rate (%)	Cost recovery rate (%)
Gaza	40,774,992	22,591,944	5,647,986	25	13.9
Khan Younis	3,677,234	3,776,856	1,435,203	38	39
Rafah	5,522,790	2,799,888	839,967	30	15.2
Dier Al-Balah	1,474,200	1,123,620	100,002	8.9	6.8
Jabalia	9,845,573	4,214,400	1,685,761	40	17.1
Nusierat	1,847,520	1,027,992	229,242	22.3	12.4
Bani Suhaila	1,280,160	1,143,324	227,522	19.9	17.8

In another hand, JSC-KRM Fee collection rate was oscillating in the last three years due to the unstable economic situation in Gaza Strip. Table (11) shows the fee collection rate from JSC-KRM members (17 municipalities) during 2015, 2016, 2017, 2018, and February 2019 with presenting the cumulative debts during the same years.

Table 12. JSC-KRM fee collection rates

Year	Cumulative debts (NIS)	Percent of fee collection[93]
2015	11,162,477	64%
2016	11,092,641	100%
2017	12,212,028	68%
2018	12,375,099	94%
February 2019	12,632,445	39%

5. Waste Awareness Policies and Campaigns

Developing a sustainable solid waste management system is essential but doesn't solve the long-term issue about the quantity of waste put in a landfill (which is also a temporary solution over time). The key question is how to reduce the amount of waste thrown away and try to re-use/recover/recycle as much as possible. With this objective in mind, the participation of all stakeholders and the civil society and the awareness of any person is critical. In the OPT, the question of awareness of people is not new but suffers from small participation and interest from institutions, as well from the residents.

Diverse media and documentation have been published, as well as pilot projects have been conducted, with variable results. JSC Jericho for example has distributed leaflets and posters, and organised several activities like meetings and trainings. JSC Ramallah started

93 The presented fee collection is for the same year itself, it is not taking into consideration the cumulative debts.

recently a campaign to encourage people to pay their waste service fees and collaborates with JICA in a school program to raise environmental awareness and prevent burning the waste. In 2019, the JSC is launching an advertisement campaign through the distribution of new collection material. JSC Bethlehem has taken part in 2018 to the international network "World Clean Up Day" organised by the Let's do it Foundation[94]. JSC in Zahrat-el-Finjan landfill regularly presents landfill activities and waste management to schools. MoLG intends to develop in the future, with the Ministry of Education, a pilot project, involving adults and children about waste separation[95]. Incentives to encourage the private sector, guidelines about participation, waste sustainable practices' information included in the educational curricula, as well as joint projects and awareness campaigns among institutions and the civil society are part of the NSSWM 2017-22.

Figure 38. Example of poster distributed for the JSCs. "We have rights and we have also some duties», (Source: JSC Jericho)

Figures 39-40. Example of leaflet distributed for the JSCs (recto-verso) (JSC Jericho)

94 https://www.letsdoitworld.org/ , accessed 28.2.2019.

95 From interview with MoLG, October 2018.

A Public Awareness campaign, coordinated by MoLG with the support of JICA, was realised and broadcasted on Palestine TV and social media from May to August 2017[96]. It consisted in five television, as well as five video and radio spots and covered the following issues:

- In the TV episodes: the SWM investments mechanisms, the NSSWM 2017-22, the Japanese experience, the environmental and health effects from, as well as recycling options and composting industry;
- In the videos and radio spots: the importance and utility of home composting; the importance for citizens to pay the waste collection fees, the need to refrain from throwing waste from car windows and in random places.

The average views for the TV episodes was 74,200 and 27,250 for the video spots. From the persons interviewed in a follow-up questionnaire, 73% has seen the TV episodes or radio broadcasts, 95% found them interesting or very interesting.

In Gaza: JSC_KRM Public awareness team was formed since the establishment of the JSC in 1995, and it consists of 8 educators and serves 17 municipalities (JSC-KRM member municipalities). All of them are women and they implement different awareness campaigns and events every year targeting households, mosques, schools, etc. The team use different awareness means in their campaigns such as printing educative materials (brochures, leaflets, fact sheets, booklets …etc), awareness presentations, presenting plays in schools, as well producing documentary films and radio messages. The Public awareness team depends in their work on the wide relations who made with ministries (especially Ministry of Education), local municipalities, and local NGOs. They are also considered as a channel who receive complaints from residents and transfer them to the in-charge person in the JSC-KRM.

In general, municipalities in the Gaza Strip don't have fixed specific staff for environmental awareness, but they use social media to send messages to residents, except Gaza Municipality which has a full team of educators. They do not only conduct awareness campaigns, but also organize some events about recycling from time to time.

In another hand, EQA conducted also some awareness activities related to environmental issues including the solid waste field. EQA has limited staff for awareness activities, so they depend widely on volunteers. Most of the EQA awareness campaigns are conducted by volunteers in schools.

96 JSC Today, vol. 9, October 2017, page 5.

Figures 41-42. Awareness event conducted by JSC-KRM in one of Al-Fukhary Schools (JSC-KRM FB)

Figure 43. Example of brochure distributed for the JSCs (recto-verso) (JSC-KRM).

Figure 44. Awareness Message posted on Municipality Facebook Page, December, 2018

It is worth to mention that JICA launched a National Awareness Campaign in 2019 under the title "2019…The year of cleaning and waste reduction" in line with the Palestinian National Strategy for Solid Waste Management (2018-2022). The campaign is targeting all JSCs in West Bank and Gaza Strip. The campaign aims to increase the awareness about some of solid waste issues e.g. minimization of waste generation.

Figure 45. Launching the campaign "2019…The year of cleaning and waste reduction" in Ramallah

Figure 46. Launching the campaign "2019…The year of cleaning and waste reduction" in Khan Younis

Despite all these efforts, there is still a lack of knowledge from the Palestinians about the real costs of solid waste management and the need to support municipalities' activities, as well as a general lack of real interest about the consequences of waste littering on the environment and ultimately on people's health.

E/ TYPES OF WASTE AND REUSE/ RECYCLING ACTIVITIES

Composition of Municipal Solid Waste

There are various ways to classify solid waste but we can say that there are four main categories:

- compostable or biodegradable (food waste, animal dung, plants, yard and trees' waste);
- recyclable (plastic, metals, glass, paper and cardboard, clothes, certain tires and batteries);
- inert (from construction and demolition, debris and stones);
- hazardous (paints, chemicals, pesticides, aerosols, batteries, some medical waste – including infectious, like medical waste and animal carcasses - components of waste from electrical and electronic equipment).

In general, municipal solid waste focuses on the following waste fractions:

- Organic (organic scrap and wood)
- Paper
- Plastic
- Glass
- Metal
- Others (like textile)

Waste composition proportions can be discussed: some organic waste can be burnt on site by households and hence be not collected, and some recyclables may also be taken away before collection.

In a case study in Nablus in 2010, Al Khatib et al. found out that organic waste is about 65.1% of MSW collected, the recyclables being about 25,5% (Al Khatib et al., 2010b).

Table 13. Solid waste composition in Nablus Area in 2010[97]

Organic	65.1%
Plastic	7.6%
Paper/ Cardboard	9.1%
Glass	2.9%
Metal	2.8%
Textile	3.1%
Other and ≤10mm	9.3%

Table 14. Analysis in all WB landfills 2017-2018 and Gaza in 2012 [98]

	Al Minya LF (2017)	Zahrat Al Finjan LF (2017)	Jericho LF (2018)	Gaza Strip (2012)
Organic	46.0 %	55%	45.9 %	56.6 %
Plastic	18.3 %	12 %	26.4 %	13.9%
Paper/ Carboard	10.9 %	14 %	11.1 %	7.6 %
Glass	2.3 %	1.5 %	1.3 %	1.96 %
Metal	1.8 %	2 %	4.9 %	2.27 %
Others	20.7 %	15.5 %	10.6 %	17.67 %

97 Al Khatib et al., 2010b.

98 All data for WB provided by JSC Jericho on 19.3.2019 and by JSC Gaza for GS information.

The low figures of metal in AM and ZAF landfills in Table (14), compared to Jericho data, may suggest that metal separation is done before reaching the disposal place. The high percentage of plastic in Jericho landfill may be linked with the tourism activities of the area.

Based on the data from Table (14), we can see that the waste repartition [99] in the OPT in 2018 is about half organic, and the proportion of plastics and paper seems to have raised (nearly 30% for the two; 17% and 11.2% average respectively). This is maybe explained by the general trend of the increased use of packaging. Figure (47), showing MoLG-JICA data, also illustrates a similar SW composition.

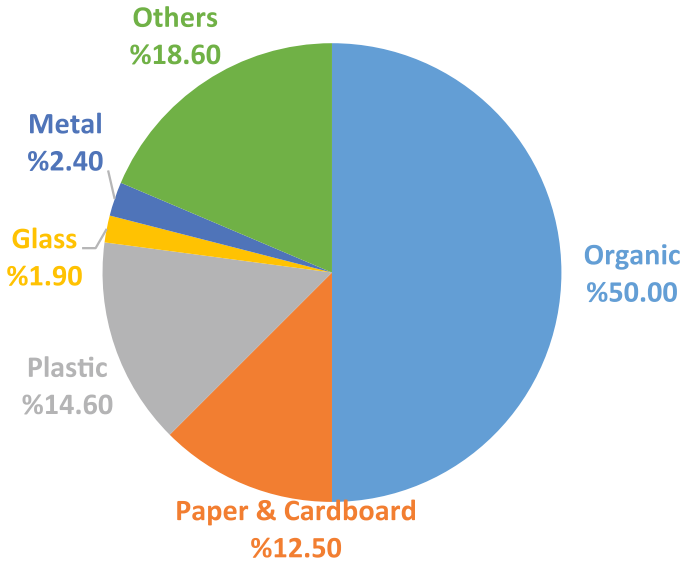

Figure 47. SW composition in 2016 (MoLG-JICA, 2017a)

Most of the municipal solid waste (coming from houses, commercial and public institutions, and some industries) is mixed and not recycled when collected. Medical waste and some special waste can be collected separately (16% establishments separate their chemical waste, 14.2% and 12.3% separate their sharp and infectious waste respectively – PCBS 2017a) but, at the final destination level, there is currently no separated special cell dedicated for them and it ends up mixed in the landfill. Construction and demolition debris are usually dumped in special sites; hazardous waste is not allowed in the existing landfills in general and it is not clear where it is effectively treated and disposed.

Recycling policy and introduction of the 3 Rs (reduce, recycle, re-use) have been mentioned over the past years in several official documents (in the Environmental Law of 1999 for example, as well as in the two National Strategies above mentioned) and are officially supported, through various awareness events and publications. But separation at source is in general not implemented (except in some cases and at a very small level like in Jenin with cardboard/paper) and waste minimization is absent. Officially, it is about 4 % of the total waste and about 30 private companies in the West Bank (out of 19,367 in 2016) are

99 Data from MoLG-JICA 2017a.

involved in this sector[100]. There is however no comprehensive data about the total quantities of waste separated and recycled in the WB.

The waste reuse and recycling market for paper, glass, metal and plastics remains very small and informal. It is done through mainly itinerant collection (for example door to door, in refugee camps or in transfer stations and landfills) and often goes through many traders (from the waste pickers to private facilities). In addition, the workshops/enterprises involved are of small scale, not always officially registered and dependent on the fluctuating market (international and local prices, variable demand and offer) and operational costs.

1. Biodegradables: Green waste, agricultural waste, food/kitchen waste and composting

In general, green waste is defined by "waste that decays naturally and in a way that is not harmful to the environment"[101]. It comes from trees, plants, seeds, fruits, vegetables and food process residues and is mainly produced by agricultural, municipal/economical activities and households. It is important to bear in mind that, although we speak about biodegradables, pollutants like pesticides can be mixed/included at some point in this green waste process, thus having a negative impact on the environment at the end.

To this date, it is difficult to estimate the total quantity of agricultural waste produced per year nor the proportion or amount of green waste generated from agricultural activities in the OPT. In general, agricultural waste is not collected by municipalities. In the Jericho valley for example, agricultural waste exceeds 1,000 tons/year and it is burnt on site or randomly discarded[102]. A study also estimated the animal manure produced in the OPT in 2012 to 767,743 tons/year (Al Sari et al., 2018).

Few regulations clearly mention agricultural waste and its potential hazards: some articles in the Environmental Law NΓ7 (1999) and the Agricultural Law NΓ2 (2003) refer to pesticides and insecticides' impacts on the environment and the necessity of special procedures and permits in some cases[103]. The Ministry of Agriculture is responsible for the update of pesticides and the handling of chemicals. Additional regulations about animal diseases define also certain procedures about disinfection and disposal for example[104]. As agricultural waste is included in the solid waste definition of the Environmental Law, all laws related to solid waste should in fact apply (GIZ-SWEEPNET, 2014).

At the strategic level, agricultural waste and organic waste are included in the NSSWM 2017-2022, through the development of pilot projects aiming to reduce, recycle and reuse

100 Figure from 2011 is 15 (GIZ-SWEEPNET, 2014). The 2018 estimation is based on a list of recycling companies whose sources come from JSCs and partners. There is actually no available official comprehensive list of private actors dealing with recycling /composting.

101 In Cambridge Dictionary, https://dictionary.cambridge.org/dictionary/english/green-waste, accessed 28.2.2019.

102 Information from JSC Jericho.

103 Articles 14 and 15 Environmental Law 1999 (GIZ-SWEEPNET, 2014, page 68).

104 Agricultural Law n°2 (2003), Law n°43 (1945) and n°39 (1954) about animal disease control and procedures (GIZ-SWEEPNET, 2014).

the waste. As part of this strategy, composting should be encouraged as a key element to reduce the volume of waste landfilled or dumped. Moreover, composting has a positive impact on soil fertility and water retention capacity and can be an asset in terms of household's revenue. Feasibility studies conducted in several places of the WB concluded that composting is a realistic option on the long run (Mafarjeh, 2011; HydroplanIngenieur-GesellschaftmbH, 2013). In addition, the demand for organic fertilizers increases, due to the shortage of chemical fertilizers (Al Sari et al., 2018).

Composting includes in general agricultural organic waste and animal manure, as well as household and commercial organic waste. In the OPT however, there is no household or commercial composting. Compost is sold as a product and in some areas composting activities are seasonal (GIZ-SWEEPNET, 2014). A recent study about food loss and waste in the WB concluded that the proportion is about 11% of the total vegetable production (a percentage quite common in developing countries), for post-harvest handling, storage and distribution. The causes identified are the disease, the lack of knowledge and new technologies, the lack of cold storage and transportation, as well as of a proper marketing system of products cultivated (Bencivenni, 2017).

Furthermore, composting can be usually done at home level and central level. Regarding home composting, several studies were conducted under the supervision of the MoLG and JICA between 2015 and 2018, to experiment different types of composting barrels, of mixture (sawdust, dry leaves and ready compost), in various rural regions (Jericho, Hebron then Ramallah, Bethlehem and NE/SE Jerusalem areas), with volunteering families. If most of the participants know the value of composting as an agricultural product, the main issues are to raise the awareness about the advantage of home composting as an important mean to waste reduction and to encourage more people to engage themselves (JSC Today, October 2017). Home composting is furthermore quite difficult in urban areas compared to rural ones, so it remains currently at a micro level.

Centralized composting is another option for the OPT, but faces several challenges:

- the need to maintain a low percentage of non-organic material in the total waste mass (2%), which requires an efficient primary separation and the use of biodegradable bags/packaging for collection like bio plastics;
- the need to cover the higher costs of the organic waste treatment, separation and specific collection;
- the need to have a sufficient internal market to absorb the quantity of compost produced, to be able to market the product at a good price.
- The availability of other fertilizers (chemical or organic manure) and of Israeli compost (variable in quality but often more competitive);
- The absence of complementary material (needed for starting any composting facility) in the OPT;
- The lack of land, most of the suitable land available being in the area C, currently under Israeli total control (JSC Today, August 2017).

Currently, there are several agricultural waste composting plants in the West Bank and in Gaza, most of them supported by external funding and with variable results. In the West Bank for example, they benefit farmer cooperatives under the umbrella of the Agricultural Development Association PARC (Di Maria et al., 2017), which has one composting plant in Jericho. In Jenin Governorate, agriculture composting projects were conducted with the Al Jalameh and Western Jenin cooperatives. Although the first finally failed due to high costs and low participation of the local population, the second still works during summer time and its trade still profitable, although not enough competitive with Israeli products (CESVI, 2017).

In Jericho and Baytillu (Ramallah district), two brand new composting plants started in 2017 with the aim to collect agricultural waste, as well as organic waste from hotels and shops. They were part of the SCOW program framework and supervised by the Palestinian NGO House of Water and Environment, with the two municipalities managing. The compost of these two sites was produced from animal manure, food waste and shredded wood/palm. Unfortunately, the Jericho composting plant stopped at the beginning of 2018 and the new municipality council is discussing an agreement with a private contractor, to resume the activities in 2019. Baytillu also stopped, having not found a proper contractor to operate it[105]. The same fate apparently occurred for the pilot composting project in Al Sarayfi TS Nablus in 2009, involving Nablus Municipality, which never started (CESVI, 2017).

Figure 48. SCOW composting plant in Jericho in March 2019 (V.Thöni)

In Hebron governorate, Dura composting plant is still recovering animal manure and agricultural organic waste, with the support of PARC and international organisations. The site has been equipped with a warehouse, as well as shredding and packaging machines. In Al Minya landfill, the composting unit has stopped. Al Minya direction however finalised in 2018 a concept proposal for potential donors about a biological treatment plant, using aerated static pile composting[106].

Al Sari et al. (2018) evaluated the quality of compost produced by Israelis and Palestinians in the Palestinian market and concluded that it has a medium quality, due to the non/partial compliance of the local testing parameters with international or Jordanian standards (Al Sari et al., 2018). In addition to this result, the study found out also that the general attitude of farmers to compost is positive in general.

105 Information from JSC Ramallah, HWE and JSC Jericho.

106 HC Hebron & Bethlehem, Technical description paper "Household Waste Al Menya Mechanical and Biological Treatment Plant".

In Gaza several attempts for composting have been performed in the last few years. Two of them were conducted by Gaza and Beit Lahia Municipality in the north of the Gaza Strip and another two by NGOs in Rafah city, one was in cooperation with Rafah Municipality, but both are no longer in operation. Further, some NGOs tried to produce compost but their attempts were terminated at early stages. Ministry of Agriculture conducted a composting plant which worked for a short period of time. It is estimated that less than 1 – 2 % of the total solid waste flow is actually being composted in Gaza. The major amount of compost is imported from Israel. In Gaza, they use windrows active pile systems for composting. Size, shape and spacing of piles are determined based on waste composition, aeration equipment and size of the site. For turning the windrows, they use shovels, rakes, or with equipment such as a bulldozer and tractor.

In Rafah, Palestinian Environmental Friend (NGO) was awarded a large-scale project from the World Bank through NDC in 2010 in two stages with a total donation of 250,000 USD. PEF rented 4,000 m^2 land at the east of Rafah city and installed the composting unit for the agriculture waste by applying the windrow system. The unit capacity reached 25 tons per week and PEF sold the compost to several international organizations such as FAO and NPA. These organizations provided these quantities to farmers on a free basis. The compost produced by PEF was solid for 100-120 USD per ton, whereas it cost around 70USD/ton based on PEF estimations.

After four years of operation and at the end of donor support; PEF mentioned that they were not able to market the product as the farmers were not motivated to buy it due to its quality and shape as compared with the imported compost. Further, and according to PEF staff, one of the obstacles faced the locally produced compost is that the governmental organizations (such as MoNE and MOA) did not provide enough support for the marketing of such newly produced local product.

In 2011, PEF through cooperation with Rafah municipality obtained a new fund from UNDP through JICA for installation of a sorting unit of domestic solid waste. Rafah municipality allocated 18 dunums in Tal Al sultan area. PEF installed this new separation unit and constructed a new composting unit in the same location. The separating unit was completed and commenced the operation in September 2012 with overall capital cost of 800,000 USD.

The unit separated the waste into steel, aluminium, plastic, paper & cardboard, glass, organic, nylon and residual material. PEF agreed with Egyptian contractors to buy the recyclable waste, but due to the political constrains, this agreement was not implemented, and it is not yet valid. The capacity of the unit is 120 tons/day and the monthly running cost is about 10,000 USD.

The existing composting unit applied windrow system and the cycle requires 8 weeks in summer and 10-12 weeks in winter. The unit tried to compost the domestic waste collected from the separation unit. The produced compost was non-marketable, and therefore PEF kept it in the site. The unit is stopped since 2013 as PEF could not market the produced compost due to that fact that its quality is not good and the farmers were not willing to use it regardless the price.

PARC signed an agreement with PEF in 2017 to rehabilitate the facility to enhance the operational sustainability and technical performance of the current model in Rafah by

constructing tunnelling compost system for compost production from the organic solid waste separated at the semi-automated sorting, separation, and processing model in order to sustainably manage the MSW stream in Rafah City. The project also includes supply of wheel loader, trucks, and electric generator, as well a maintenance workshop for daily maintenance.

To conclude, due to the above mentioned reasons, the composting market in the OPT is still weak, the quantities produced remain small and the compost's quality has difficulties to compete with the imported Israeli one.

2. Recyclables

Plastic

There are 7 categories in which plastic waste is usually classified: Polyethylene (PETE 1), High Density Polyethlyene (HDPE 2), Polyvinyl Chloride (PVC 3), Low Density Polyethylene (LDPE 4), Polypropylene (PP 5), Polystirene (PS 6) and others (category 7)[107]. The two problems with plastic are that it can contain contaminants and that mixed categories of plastics recycled lose their quality (in terms of strength and flexibility)[108] .

In the OPT, the recycled plastic market is still very small and suffers from a lack of investment both from the JSCs and the private sector, due to the low revenues it currently generates and the poor quality of the final products. This sector is basically all informal, waste pickers/ waste buyers go to the landfills or transfer stations to get the material and the recycled plastic retailing companies are of small size.

Figure 49. Proposed products in Ettihad plastic recycling factory in Hebron Industrial Zone (V.Thöni)

High-Density Polyethylene (HDPE), Polyvinyl Chloride (PVC) and Polypropylene (PP) are the types of plastics collected from dumpsites, landfills or transfer stations by second-hand dealers, not segregated by colour nor type and are sold to the private sector who will do the sorting, then crush it and shred it. PET plastic is traded with Israeli industries with special requirements (only items produced in Israel) and is imported also from Israeli settlements (Di

107 http://polystarusa.com/plastic-recycling-numbers/ accessed on 15.01.2019.

108 https://www.nouvelobs.com/planete/20180202.OBS1657/dechets-plastiques-la-dangereuse-illusion-du-tout-recyclage.html , http://eco3e.eu/base/plastiques/ , accessed on 15.01.2019.

Maria et al., 2017). A few plastic recycling facilities are located in the Nablus and Hebron region, as well as in Gaza[109]. Several pilot projects have been also conducted/launched with the aim to separate plastic at primary or secondary collection[110]. In transfer stations like in Yatta or at Al Minya landfill for example, a certain amount of plastic is sorted. However, all these projects and factories have a very small scale, and are often discontinued on the long term.

Gaza Strip produces plastic waste with a percentage of 16% from the total waste generation in Gaza strip. There are around 15 grinding plastic workshops and around 74 factories in Gaza Strip. It is estimated that 10 tons are being recycled daily and 250 tons monthly[111]. This means that, currently, not exceed of 3% of the daily generated plastic wastes are being recycled in Gaza Strip. The main problems that the plastic recycling industry faces in Gaza strip are the shortage of energy and fluctuating prices due to closure, as well as the limited availability of required machines, equipment or spare parts due to current political situation.

Paper & Cardboard

In OPT, this waste is usually not separated from other municipal waste containers but there are some initiatives to collect it since several years. Like organic and plastic waste, this type of waste has a potential for recycling. However its market remains under-developed and to date most of the paper is collected and then sent to Israel for recycling. In the West Bank, Jenin, Nablus, Ramallah, Hebron and Bethlehem municipalities are engaged in cardboard collection with private partners or local organisations. Paper and cardboard material can be also separated and stored at transfer stations and landfills and sold to private buyers. Among the private actors involved in recycled paper or cardboard, one can mention Ommar Al Ard Recycling in Ramallah, as well as Ostry (egg trays from recycled paper[112] and Paper Pal (paper from recycled tree leaves[113]) in Jericho. Di Maria et al. also identified in 2017 the following paper/cardboard sorting facilities:

- in Al Minya landfill, a trommel and a manual sorting line which apparently works at half of its treatment capacity (150 t/day against the 300 t/day capacity). This shall be replaced by a new trommel in 2019.

109 Factories in Dura produce low quality flakes and in Nablus fruit cages. For example: SAB Plastic company in Nablus uses polyethylene to produce plastic bags (https://www.facebook.com/SAB-factory-for-plastic-recycling-1090758814392240/, accessed on 18.10.2018). In Al Sarayfi TS, PP and HDPE is shredded and PET is sold to exportation (CESVI, 2017). In Hebron Ettihad Recycling factory receives 1t /day from the landfill and 600-700 kgs from other sources. In Gaza, the Ramlawi Plastic Factory collects plastic for re-use.

110 The example of the plastic recycling system in Gaza in 2010; http://www.oecd.org/derec/italy/Emergency-programmes-Palestine.pdf , accessed on 16.10.2018. Or the pilot project from Ramallah municipality in 2016; https://www.bankofpalestine.com/en/media-centre/newsroom/details/566 , accessed on 18.10.2018.

111 MDLF, (2017). Studies for optimizing waste recovery (Conducted by ENFRA Consultant)

112 https://eeas.europa.eu/delegations/palestine-occupied-palestinian-territory-west-bank-and-gaza-strip_zh-hans/52943/Japan%20provides%20new%20contribution%20to%20the%20Jericho%20Agro%20Industrial%20Park%20incentives%20programme%20implemented%20by%20the%20EU , accessed on 25.09.2019

113 https://eeas.europa.eu/delegations/palestine-occupied-palestinian-territory-west-bank-and-gaza-strip/48873/japan-provides-new-contribution-jericho-agro-industrial-park-incentives-programme-implemented_en , accessed on 25.09.2019

- one at Zahrat Al Finjan landfill created in 2012 but stopped since 2014, due to political issues. It is equipped with a trommel, manual sorting lines, as well as shredders and balers. It is an also a private-public partnership.
- one in Nablus area near the Al Sayrafi TS, created by a private industry (PADICO), also through a public-private partnership arrangement but which never started (CESVI, 2017; Di Maria et al., 2017).

In Tulkarem, there is a direct paper/cardboard waste recycling program going on, with a dedicated storage place and regular collection by a private trader contracted by JSC Tulkarem. This system covers Tulkarem municipality (CESVI, 2017).

Figure 50. Carboard/paper separation area at the ZAF landfill. The sorting line in the background does not function. (V.Thöni)

Gaza strip produces around 145 ton per day of paper wastes with a percent of 8.4% from total the waste generation in Gaza. There are only 3 paper recycling factories in Gaza Strip. It is estimated that 4 tons of paper wastes are being recycled daily with 100 tons monthly. This represents around 2.2% of the daily paper waste generation is recycled in Gaza Strip. The main challenges facing the paper recycling industry in Gaza strip are the shortage of electricity and its high cost, competition with the imported products and the high cost of establishing such factories.

Metal

Although being a very small portion of the total waste produced (about 2.5%), this type of waste is widely collected in the West Bank by itinerant small-size buyers and sorted manually in most cases (usually with negative impact on the environment and health of the workers). It can be collected from primary collection points and in transfer stations, landfills and dumpsites. In Al Sarayfi TS for example, metal parts are dissembled or openly burnt (CESVI, 2017), like in Idhna. It is then sent to Ramallah, Anata, Eizaryia in the North or to Idhna in

the South mainly (to Jericho also). From there, metal parts compacted are transported by larger industries to the Israeli towns of Haifa and Akka or to Jordan, where it is traded for exportation (Di Maria et al., 2017).

In the Gaza Strip, there is no recycling factories for the scraps and waste metals, but factories exported in the past the waste metals into Israel and Egypt once it was allowed to be exported.

Glass

In the West Bank, glass is mostly non-recovered, only a small portion is sorted in Hebron for the glass industry (it is about 3-5% of total waste in Al Minya landfill). There are glass collection points in East Jerusalem managed by Jerusalem municipality. In the Gaza Strip, there is no real glass recycling. Most of the waste glass is disposed to landfills. A very small portion is recycled for simple decoration and floor tiles purposes.

Special Types of Waste

3. Industrial and Hazardous Waste

In 2017, PCBS reported 19,118 industries in the OPT (excluding East Jerusalem) and 640 construction activities related institutions; this representing respectively 14.1% and 0.5% in total distribution of economic enterprises (PCBS, 2018b). The industrial sectors include mainly food and beverage, mining and quarrying, textile, paper and printing, furniture, paper and printing, chemical, metal, pharmaceutical and construction industries. According to the National Development Plan 2014-2016, there were 30 facilities treating hazardous and health-care waste in the OPT (PNA, 2014) and as mentioned before 49 entities dealing with waste collection, disposal, treatment and recovery (PCBS, 2018b).

The major features of Palestinian factories are medium-size, family or single ownership and more than half of them depend solely on Israeli companies for imports/exports (Al Khatib et al., 2015a+b). The location of these industries is diverse but in general industries and industrial zones are close to residential or commercial areas, thus making the pollution and health risks greater (ARIJ, 2015). Some industrial parks have been developed in the recent years: Jericho Agro-Industrial Park, Bethlehem Industrial Estate, Jenin Industrial Free Zone and Gaza Industrial, under the supervision of the Palestinian Industrial Estates & Free Zones Authority (PIEFZA)[114]. Projects of the Tarqumia Industrial Park and Bonded Area[115], the industrial estate in Hebron[116], as well the Information Technology Park in Tulkarem are under development.

According to PCBS in 2017, 82.5% of economic establishments in the OPT used local authority disposal services, while 12% disposed of their solid waste by themselves (PCBS, 2017a). Another report stated that 77.5% of economic establishments disposed their solid waste in nearest container, 16.3% have their waste collected directly from the municipality, the remaining 3.8% in dumpsites and 0.8% in random sites (PCBS, 2017a). The great majority of establishments generates paper/cardboard (89.8%), plastic (76.6%); 45.6% generate soil

114 PIEZA, www.piefza.ps/pfs/en/, accessed 6.02.2019.

115 Palestinian Investment Fund, http://www.pif.ps/en/article/94/Industrial-Parks , accessed 6.02.2019.

116 Hebron Chamber of Commerce and Industry, http://www.hebroncci.org/en/index.php?option=com_content&view=article&id=1608&Itemid=99, accessed 6.02.2019.

and stones[117], 39.2% generate organic waste. Out of all the economic establishments in the OPT, 8.3% declared generating infectious and sharp and 1.4% chemical (PCBS, 2017b). Moreover, 16.7% of economic establishments, which generated chemical waste, as well as 26.5% of those generating sharp and infectious waste, reported that they separated it; (PCBS, 2017b).

Al Khatib et al. (2015a) surveyed the industrial solid waste of 277 companies in Nablus, Ramallah and Al Bireh governorates. About 34% of these companies were related to food and beverage; 26% working in textile and apparel; 18% in oil, petroleum, basic chemical sectors. The majority of waste producers belonged to the chemical sector (2,044 tons/year); food and beverage (1,973.5 tons/year) and pulp and paper (1,807 tons/year). The study also showed that 47.7% of the waste was paper/cardboard, 20% metals and 7.3% plastic (Al Khatib et al., 2015a).

The problem with solid industrial waste from Palestinian industries is that it is often mixed, i.e. containing also hazardous components. Most of the industries don't separate; some waste is burned on-site (cf. packaging and textile) or in dumpsites. There are attempts though of re-using some material, such as solid waste from olive mills or from stone factories (ARIJ, 2015).

In addition, the Applied Research Institute - Jerusalem (ARIJ) estimated in 2015 about 19 Israeli industrial zones in the West Bank (Barqan industrial park, Ariel industrial zone or Nitsanei Shalom industrial zone for example) with about 252 industrial facilities (ARIJ, 2015). In 2017, Israeli facilities treated about 38% of waste generated in Israel and in the settlements in the WB and East Jerusalem and the trend is increasing (B'Tselem, 2017).

The crucial issues with these industries are that environmental monitoring, control and supervision, according to Israeli strict standards, is reportedly not fully implemented in the Palestinian territory and that transparency and accessibility of information is lacking. Considering that the West Bank is an occupied territory, this contravenes with International Law (International Covenant for Economic, Social and Cultural Rights, Art 12; Hague Regulations respecting the Laws and Customs of War on Land, Art. 43 and 55, among others) (B'Tselem, 2017).

Used Tires

Old tires belong to the types of industrial waste. The amount generated of this material was about 5,550 tons/year in 2011 in the OPT (GIZ-SWEEPNET, 2014); no actual figure could be found but based on the available PCBS data for WB and GIZ-SWEEPNET methodology, one calculated that the 228,324 registered vehicles in West Bank in 2017 produced at least 4,940.28 tons of waste per year[118]. For Gaza, no data was available.

117 In Gaza, 90.3% generate this type of waste.

118 PCBS data, http://pcbs.gov.ps/Portals/_Rainbow/Documents/Trans_annual2_2017e.html, accessed 10 February 2019. Estimates are: Private Cars 181,012; Taxis, 9,486; Motorcycles and Moped, 1,378; Private Buses, 1,110; Public Buses, 973; Trailers and Semi-Trailers, 2,971; Agricultural Tractors, 752; Road Tractors, 37; Trucks and Commercial Cars, 30,252; Other Vehicles, 353.
The GIZ-SWEEPNET methodology and figures for waste for each type of vehicle in table 39, page 78. GIZ-SWEEPNET, 2014.

There are no specific disposal or treatment procedures for tires after use nor provision on tire waste management in licensing workshop procedures (GIZ-SWEEPNET, 2014). Tires are either stored/dumped in some places or disposed next to/in a special place in the landfills. They can be used for soil stabilisation (in ZAF for example) or eventually by municipalities for playgrounds or as flower beds.

Although mentioned in the NSSWM 2010-2014, the recycling of tires did not come up with any long-term results. The EU financed pilot project in Hebron to shred tires and separate metal with a capacity of 3t/day, which was operating in 2014 (GIZ-SWEEPNET, 2014), finally stopped. In the Hebron governorate, United Steel Company is currently involved in the production of iron and aluminium and is ready to start a waste-to-energy system, using tires and non-recyclable material for 10 tons/day (Arcobaleno, 2018).

As defined by US Environmental Protection Agency, hazardous waste (HZW) is the waste improperly managed and posing "a serious threat to human health and the environment"[119]. In the OPT, this waste is regulated through the Environmental Law of 1999 (article 11, 12 and 13) and the Public Health Law of 2014 (article 14 - coordination with other relevant bodies on transfer, storage and disposal conditions). It is also mentioned in Bylaws, like in the Medical Waste Bylaw (2012) and the SWM Bylaw (2019).

Furthermore, the PA has ratified the Basel Convention on Hazardous Waste on the Control of Trans Boundary Movement of Hazardous Waste and Disposal, the Stockholm Convention on Persistent Organic Pollutants (POPs), as well as the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, thus rendering all hazardous waste importation illegal[120].

Hazardous waste shall be treated according to the approval of the EQA or according to the MoH requirements, if it is of medical origin; systematically separated and banned from any municipal solid waste landfill (unless under certain conditions).

According to the EQA National Hazardous Waste Master Plan 2010-2013 proposal in 2010, respectively 421,422 liquid, 58,660 solid and 24,795 tons gaseous HZW were generated in the year in WB, whereas in Gaza the annual liquid and solid hazardous waste was 2,649 tons and 3,961 tons respectively (EQA, 2011).

Hazardous waste come mainly from industrial activities. In his study about the establishment of a Palestinian Hazardous waste list, Al-Jabari (2015) proposed to include:

- Industrial waste (pharmaceutical, chemical, ceramics, wood, glass, paint, metal processing, textile, food…);
- Construction and demolition waste;
- Agricultural waste;
- Wastes from oils, fuels, solvents and related materials;

119 EPA definition, accessed on 5.06.2018 from https://www.epa.gov/hw/learn-basics-hazardous-waste

120 According to the Oslo Agreement, special hazardous waste is agreed to be transported and treated at the Ramat Hovav industrial zone in Israel. But transport from Israel to the OPT is forbidden.

- Municipal Waste;
- Wastes resulting from handling and treatment of wastes and wastewater
- Wastes from other sources (packaging, electrical and electronic equipment, maintenance) (Al-Jabari, 2015).

At the time of writing, the EQA is in the process of issuing a list of hazardous waste in the OPT.

B'Tselem report in 2017 counted at least 15 Israeli facilities treating industrial waste in the WB. Among these, 5 Israeli hazardous waste management facilities:

- Green Oil Energy Ltd (oil waste)
- MTA recycling technologies (solvent waste)
- Polcom (hazardous waste packaging)
- All recycling (electronic waste)
- EMS Refiners of Precious Metals Inc. (electronic waste and batteries)
- Talus (oil waste)

Some others, like Compost Or (sewage sludge) or Eco Medical Plant (medical waste), although not considered as only treating hazardous waste, can include hazardous components.

Several studies showed the pollution potential of the Israeli industries and consequences on the health of local residents and the environment (ARIJ, 2015). A report about Green House Gases from the EQA mentioned that the estimated overall emissions is 0.8 tons of CO^2 equivalent per capita, which is low compared to Israel (10.7) (ARIJ, 2015).

Oils and lubricants

In 2018, there is no data about this type of hazardous waste. In GIZ-SWEEPNET (2014), it was estimated to 29,400 ton per year in 2010. This figure has certainly increased. Used oil is apparently sold to the private sector but its final destination is unknown. Part of this waste is illegally burned, without proper regulation, thus creating an additional air pollution (GIZ-SWEEPNET,2014).

Construction and Demolition waste

In 2017, the construction sector in the OPT had the fourth place with Information and Communication (0.5%) in terms of number of enterprises, after Internal trade (55.6%), Services (28.5%) and Industry (14.1%); also, fourth in terms of economic output (5.6%) (PCBS, 2018b). Construction and Demolition waste (CDW) has negative impacts, such as degrading the landscapes, obstructing roads or river beds like wadis, as well as polluting soils.

CDW is usually not accepted in municipal landfills, and is randomly disposed along roads, in wadis or on private lands. A recent study conducted by the Universal Group for Engineering and Consulting of Nablus, Palestine for MoLG and JICA noted that "factors such as construction-related education among employees, contractor experience in construction works, source-reduction measures, and reuse of materials, waste disposal behaviours and attitudes toward waste management are the most significant factors affecting contractor behaviour on waste management" (MoLG-JICA, 2017b).

Taking 14 samples of CDW in different locations in WB, the study further determined that the composition of CDW is about 41.4% concrete, 22.1% bricks, 14.2%, wood 4.3%, plastic 4%, metals 3.5% stones, asphalt 3.1%, paper/cardboard 2.6%, gypsum 2,1%, tiles 1.2% and others 1.6%[121]. About 21 dumpsites receiving CDW were listed in this study, present in all governorates of the WB, with Ramallah/Al Bireh being the most CDW producers. Estimations of the accumulated waste in the dumpsites sampled gave 25,333,016 tons based on licensed area, and 23,520,270 tons based on population[122]. In 2016, it was estimated that about 208'996 tons of CDW was produced in the WB (MoLG-JICA, 2017b).

in 2019, a new Bylaw was adopted on CDW as well as Guidelines. This new legislation should help in the preparation and implementation of any future planning about CDW management, especially in the improvement in recycling/re-using practices. Currently, there is no information about the percentage of CDW recycled. Waste pickers take metal parts (steel bars and non-ferrous metals); wood can be sold to bakeries, glass to some industries and paper/cardboard seems to be reused for example in the Eastern Industrial Area of Nablus (MoLG-JICA, 2017b).

In the Gaza Strip, two million tons of demolition waste were resulted due to the war on Gaza in 2014, 1.8 million ton of residential buildings and 0.2 ton of commercial buildings (UNDP, 2015). 60% of the demolition waste was found in Gaza and North Gaza Governorates (25% in North Gaza and 35% in Gaza), whereas 40% of the demolition waste were found in Khan Younis, Rafah and Middle area governorates (18% in Khan Younis, 12% in Rafah, and 10% in Middle area). Asbestos wastes were very limited, but other poisoning or unexploded ordnances (UXO) materials are expected to be found in the demolition (UNMASS workshop, 2014). Thirty donums land was allocated for demolition wastes, it is located adjacent to Johr Al-Diek Landfill and used by the Gaza and North Gaza Governorates, whereas 70 donums land was allocated in Tal Al-Sultan – Rafah to receive the demolition wastes from the southern governorates.

Figure 51. Demolition wastes in Shujaya – Gaza, 2014

121 MoLG-JICA, 2017b. Page 46.

122 MoLG-JICA, 2017b. Page 41.

United States and Japan governments allocated a 20 Million USD fund for removal of the demolition wastes within two years after the war on Gaza; during the first year aimed to remove the whole quantities of demolition wastes, and during the second year aimed to grind and break the demolition waste to be reused in road constructions.

E-waste

This type of waste is one example of the complexity of solid waste management in the OPT. Waste from Electronic and Electrical Equipment (WEEE or E-waste) includes all electronic and electrical devices like computers, cell phones, TVs, radios, printers and calculators, motors, etc. and any device containing electrical or mechanical boards, such as air conditioning (ENFRA, 2018). In general, E-waste includes items containing hazardous compounds (such as refrigerators, air conditioning systems or TV with cathode ray tube) and exclusively non-hazardous ones (washing machines, computers, tablets, and hair dryers for example).

However, in the Palestinian legislation, E-waste is considered entirely hazardous and its importation in the Palestinian territory illegal (cf. Basel Convention adopted by the PA). Although mentioned in the Environmental Law of 1999 as a component of hazardous waste, there is no strategy, no specific law or article, nor technical specification for E-waste. In Israel, the principle of Extended Producer Responsibility applies, and E-waste should be treated by Accredited Compliance Bodies; in practice however, it is not the case and most of it is controlled by unauthorized entities and sent to illegal sites (both in Israel and Palestine) (ENFRA, 2018).

In the OPT, the E-waste sector is characterised by its informality and efficiency, social tribe ties among big families, as well as by the lack of proper regulation to ensure public health and environment protection.

The main locations where E-waste is traded and treated are Beit Awwa, Idhna, Deir Samit, Al Kum and Beit Maqdum in the Hebron governorate (Area A, about 42,000 inhabitants). Every year, about 70-80,000 tons of E-material is sent to these villages (90% coming from Israel) (Arcobaleno, 2018). The items collected are first sold to recyclers and workshops in the Beit Awwa bazar market, then treated in other places. Some appliances are repaired and sold as second-hand products, others are dismantled to recover spare parts, and the remaining is smashed to recover material.

It is estimated that the treatment of E-waste involves about 150-200 workshops, 1,000-2,000 permanent workers, as well as more than 5,000 non-permanent workers and 100 workers under the age of 18, contributing to one third of the whole local economy (ARIJ, 2015; Arcobaleno, 2018).

Secondary materials are mainly metals (like nickel, copper and lead) and plastics, which are either sold locally or transported to Israel, through Israeli brokers (based in settlements) or Palestinian traders with official authorization, where they are sold to recycling factories or sent abroad (India, China). Metal selling prices follow international market prices. (ENFRA, 2018; Arcobaleno, 2018).

The treatment of the E-material consists in dismantling, cable processing and clean metal

assembly, through a primitive process with negative impacts on the environment and human health. By-products are either sent to Tarqumya TS and/or the Al Minya Landfill, or burnt or illegally dumped. However, the Green Police created by EQA managed to reduce the illegal burning and dumping by 70%-80% (Arcobaleno, 2018).

Figures 52-53. Extracting the metal parts; metal sorted and compressed, ready for exportation, Idhna, June 2018 (V.Thöni)

A recent study[123] described the main characteristics of the E-waste treatment:

- There is about 6,535 tons/month entering in the three localities (from Israel and the OPT);
- The composition of the waste received is in average:
  - Car motors 50%
  - Air conditioner 25%
  - Cables 10%
  - TVs 2.5%
  - Refrigerators 10%
  - Cell Phones 2.5%
  - Computers 25% in Beit Awwa, 2.5% in Idhna
  - Batteries 25% in Deir Sumit

The majority of the waste collected is recycled/treated (90%, rest goes to landfill or dumping sites);

The vast majority of workshops says it does not burn the e-waste to extract metal (more than 90%);

- The majority of workshops has no periodic records of the waste coming in and out;

123 ENFRA Consultants. 2018. In Depth Study of the Waste from Electrical and Electronic Equipment Recycling Market-Final Report. Pp123.

- Most of the workshops are not aware of e-waste regulations;
- Most of them say there is no monitoring by Palestinian agencies;
- The majority of workers are doing these activities for job opportunities;
- About 80% know about the health issues related to such activities;
- The majority of the workers implement manual treatment activities (ENFRA, 2018).

The study also showed the priorities of workers interviewed:

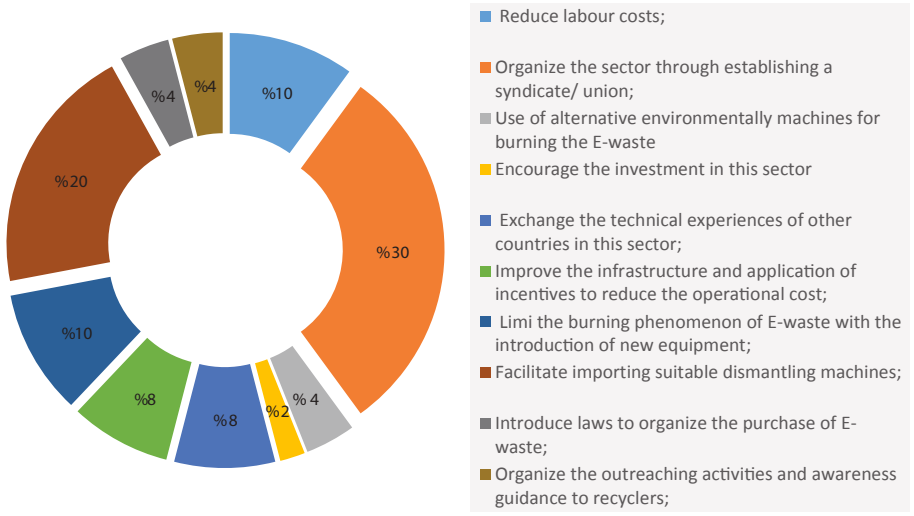

Figure 54. Recommendations from people interviewed (ENFRA, 2018, page 36).

In the E-waste sector in Palestine, there are two officially registered plants (but not yet operational) with appropriate and modern equipment, the Safa Recycling Plant (treating 6 tons of cables/day and separating plastic), near Idhna, and the recently created private company Ecotech Recycling (based in Bethlehem Industrial Zone), which will focus not only on WEEE but also on paper/cardboard recycling[124].

The main challenges that these E-waste facilities face are:

- the high operational costs;
- the insufficient and inappropriate infrastructure;
- the lack of governmental support;
- and the limited technical capacity available.

On the one hand, there is evidence that the improper treatment of this waste has a negative impact on the environment and the public health of both the workers exposed and population living nearby. Different types of E-waste bring different degrees of damages. For example, the treatment of electric cables, that does not have an intrinsic hazardous character (except for cables containing heavy metals), has a primary damage on human health (due to the dioxins released during the uncontrolled combustion of the coating rubber) and a secondary damage on the environment (Arcobaleno, 2018). In most of the workshops visited, workers

124 www.ecotech-recycling.com, accessed 6.4.2019. Interview on 4.4.2019.

do not wear PPE and have poor working practices, increasing their vulnerability on the long term. The impacts on the human health consist for example in high incidences of birth defects, infant mortality, blood diseases, malfunctioning of organs and immune system anomalies (ILO report, 2012). Several studies carried out in the Hebron Governorate where E-waste is treated, confirmed the negative health consequences on the local population[125]. Davis et al. (2018) research, which analysed the Palestinian cancer registry data from 1998 to 2007, found out a strong incidence of cancers in these villages of South Palestine and showed a strong correlation between children lymphoma and E-waste dismantling activities.

Regarding the impacts on the environment, E-waste treatment produces leachates, particle matters, ashes and effluents that contribute to the loss of agriculture land fertility, the pollution of soils, of surface waters, of the air and, on the long term, of ground waters. Refrigeration appliances for example have a primary damage on the environment, from the different ozone-depleting gases used in the refrigerant circuits.

Considering that the sector brings a non-negligible financial resource to local residents, there is an urgent need to adopt flexible methods to ensure, as much as possible, the separation between the hazardous and non-hazardous components and to apply modern and safe treatment processes (Arcobaleno, 2018). Another issue is the gap of knowledge about the source, the amount, the processing and end points, which makes the tracking and the quality/quantity/type monitoring of this type of waste difficult to achieve (ENFRA, 2018).

125 Cf. Study report of Green Land Society for Health Development, AJEEC – NISPED; ENFRA 2018, page 58 and 66.

Medical waste

The United States Environmental Protection Agency (USEPA) defines medical (also called health-care waste -HCW- by WHO[126]) as a type of waste generated by health care centres (hospitals, physicians' offices, dental practices, blood banks, and veterinary hospitals/clinics, as well as medical research facilities and laboratories). This type of waste has a hazardous component: contaminated blood, body fluids, anatomic waste, pharmaceutical waste and infectious/sharp materials[127].

Regarding the proportion of hazardous waste in generated HCW, World Health Organization (WHO) statistics estimate in general that about 20% is considered hazardous (i.e. infectious, toxic and/or radioactive)[128]. Infectious waste is the major type of hazardous waste found in medical centres (up to 15%), whereas chemicals and pharmaceuticals is about 3%, and sharp objects, genotoxic waste, heavy metals are about 1% each (JICA, 2016). Regarding the situation in the OPT, it is interesting to note that Al Khatib et al. estimated it to 35% (Al-Khatib et al, 2016) and another study in Jenin to 43.2% (Al Khatib, 2014).

In the case of West Bank and Gaza Strip, despite the adoption of the Medical Waste Bylaw in 2012, health-care waste management faces several challenges:

- no regulations in several aspects;
- existing laws either lacking clear information about procedures or not well-known;
- lack of trained staff and course opportunities about safety, collection and disposal procedures;
- lack of financial resources and modern or appropriate material;
- random compliance to the existing regulations;
- lack of appropriate segregated transportation and disposal once the hazardous waste is collected;
- lack of reliable/recent and systematic collection/records of data (Sarsour et al. 2014; Caniato, Vaccari, 2014).

Primary, secondary and tertiary health care[129] services are delivered mainly by MoH facilities (63%), then by nongovernmental organizations (NGOs), the UNRWA, military medical services and the Palestinian Red Crescent (PNA, MoH Annual Health Report, 2016).

In the OPT, there were 739 Primary health care Centres (PHC) in 2016, with respectively 587 PHC in the WB and 152 in the GS.

126 https://www.who.int/topics/medical_waste/en/ accessed 30.6.2019.

127 https://www.epa.gov/rcra/medical-waste accessed 12.6.2018.

128 WHO's Blue Book, https://www.who.int/news-room/fact-sheets/detail/health-care-waste, accessed 30.6.2019.

129 Primary health care is a whole-of-society approach to health and well-being centred on the needs and preferences of individuals, families and communities. It addresses the broader determinants of health and focuses on the comprehensive and interrelated aspects of physical, mental and social health and wellbeing. https://www.who.int/news-room/fact-sheets/detail/primary-health-care , accessed 11.03.2019. Secondary health care refers to general hospitals and tertiary to specialized hospitals, like psychiatric and neurological hospitals.

In addition, in the WB, 203 laboratories belong to the Ministry of Health, including 14 central laboratories in hospitals and 188 laboratories in PHC (PNA, MoH Annual Health Report, 2016).

With regard to secondary and tertiary healthcare, there were 81 hospitals in the OPT in 2016 (including East Jerusalem), with 51 in WB and 30 in GS (PNA, MoH Annual Health Report, 2016).

Table 15. Number of hospitals, beds in the OPT in 2016 (PNA, 2016; JICA, 2016).

Number of Hospitals	OPT	WB[130]	GS	Number of beds' capacity	OPT		WB	GS
	81	**51**	**30**		**6'146**	**100%**	**3'702**	**2'444**
# MoH hospitals	27	14	13	In MoH hospitals	3'325	54.1%	1'661	1'664
Total for governmental health hospitals					**3'325**		**1'661**	**1'664**
# Private hospitals	16	16	0	In Private hospitals	536	8.7%	536	0
# Civil soc. hospitals	34	20	14	In Civil society hospitals	2'061	33.5%	1'442	619
# UNRWA hospital	1	1	0	In UNRWA hospital	63	1%	63	0
# Military hospitals	3	0	3	In military hospitals	161	2.6%	0	138/161[131]
Total for non-governmental health hospitals					**2'821**		**2'041**	**780**

Table 16. Number of PHC centres and patients in WB and GS in 2016 (PNA, 2016; JICA, 2016).

Other health centres	OPT	WB	GS	Number of patients in Gaza
	739[132]	587	152[133]	
Governmental Clinics	466	412	54	4'558
UNRWA Clinics	64	43	21	13'679
Civil society Clinics	189	112	77	5'576

GIZ-SWEEPNET (2014) estimated the annual generation of hazardous waste from hospitals at 1,968 tons in 2011 in the OPT. In 2014, PCBS estimated the waste generated from health facilities to 381 tons/month (277 in WB and 104 tons/month in GS) for a total number of beds of 5,939 (3,502 in WB and 2,437 in GS)[134], thus reaching 4,572 tons in the year. In 2018, it is very difficult to have a realistic estimate of the total annual medical waste and its hazardous component. There have been no PCBS surveys about health care centres (governmental and non-governmental) since 2014 and there is in general no data record by health institutions of their medical waste, as figures are mostly based on survey respondents' estimations.

130 Including East-Jerusalem.

131 138 is the figure given in JICA (2016) report; 161 is the figure given by the PA in its report in 2016 (PNA, MoH Annual Health Report, 2016, p.69).

132 PNA, MoH Annual Health Report, 2016, p.37.

133 JICA report (2016), p.60.

134 http://pcbs.gov.ps/Portals/_Rainbow/Documents/HHC%20E%205%202014.htm and http://pcbs.gov.ps/Portals/_Rainbow/Documents/hospitals-2014-01E.htm , accessed 11.03.2019. This would make about 2kg/bed/day (=381,000: 5,939 :30) in average.

In the West Bank, Al Khatib et al. (2016), evaluating three kind of hospitals in Nablus city (governmental, charitable and private) and two type of patients (inpatient/outpatients) in 2013, found a mean generation of 1.34, 3.32 and 5.45 kg/patient/day respectively cf. table (17). Another study in some hospitals of Jenin district (Al Khatib, 2014) showed an average generation rate of 4.66 kg/ in-patient/day (1.96 kg/bed/day), while the average hazardous waste generated was 2.014 kg/ in-patient/day (0.85 kg/bed/day).

Table 17. Estimation of waste generation rates in Nablus hospitals (Al Khatib et al., 2016).

		General Waste	Hazardous Waste
Government hospital	Kg/total patient/day	1.34	0.275
	Kg/inpatient/day	2.03	0.293
	Kg/outpatient/day	0.65	0.088
Charity hospital	Kg/total patient/day	3.32	0.68
	Kg/inpatient/day	4.45	0.87
	Kg/outpatient/day	2.18	0.51
Private hospital	Kg/total patient/day	5.45	1.10
	Kg/inpatient/day	7.57	1.64
	Kg/outpatient/day	3.35	0.56

In the Gaza Strip, several studies estimated the average production of medical centres. Caniato et al. (2016) gave an estimation of MW production in Gaza: 0.9-2.7Kg/occ. bed/day or 3,357 kg/day, with about 805 kg/day, including 173 kg/day of hazardous waste generated in clinics, and 2,552 kg/day, including 683 kg/day hazardous waste generated in hospitals.

Table 1
Hospitals and clinics in the Gaza Strip.

HCFs	Reference				
	WHO et al. (2011)		WHO and EMRO (2010)		
	# of facilities	# of beds	# of facilities	# of beds	# of patients[a]
Hospitals	**27**	**2697**	**28**	**2697**	1,685,265
MoH	13	2009	13	2040	1,325,658
PMMS	–	–	1	45	56,720
NGOs	14	688	11	549	302,887
Private			3	63	N.A.
	# of facilities	Facilities with buildings in bad conditions	# of facilities	# of visits[b]	
Clinics	**131**	**9**	**110**	6,493,704	
MoH	54	9	56	2,735,716	
UNRWA	20	N.A.	20	3,449,316[c]	
NGOs	57	N.A.	34	308,672[d]	

N.A.: not available.
[a] # of patients includes admissions, outpatient and ER visits.
[b] # of visits includes general practitioner and specialized visits.
[c] Data from 3 clinics are missing.
[d] Data from 8 clinics are missing.

Figure 55. Estimation of medical waste coefficients and production in Gaza in 2016 (Caniato et al., 2016, page 387).

Also, in 2016, Japan International Cooperation Agency (JICA) commissioned an assessment study to evaluate the current situation of medical waste in Gaza area. The study also included recommendations for the feasible options for medical waste management in Gaza area. The study revealed that Gaza Strip medical centres produce 7,199 kg/day of medical waste; 1,071 kg/day of which is infectious (14.8%). MoH hospitals consist in the main producer, with 4,701 kg/day of medical waste; 715 kg/day of which being infectious (JICA, 2016).

Table 18. Estimation of HCW based on data available in 2016 (PNA, 2016; JICA, 2016).

Item	OPT	MoH hospitals	Non-governmental
Total number of beds	6,146	3,325	2,821
Total bed occupancy rate		92.2%	na
Total bed occupied		3,065	2,601
Average generation in kg/bed/day		1.8-2[135]	
Average medical waste generation (kg/day) in GS	7,199	4,701	2,498
Average medical waste generation (kg/day) in WB	6,826	3,063[136]	3,763[137]
Total medical waste generation (ton/day)	**14**		
Estimation waste PHC centres (739) (ton/day)	5.46[138]		
Estimated medical waste generated (ton/year)	**7,103**		
Estimated hazardous waste generated (ton/year)	1,420[139]		

Research results differ about which kind of hospitals (either private or public) produces the most hazardous waste (Caniato et al, 2016; Al Khatib et al. 2016), but most of the studies (Sarsour et al., 2015; Caniato et al., 2016; Al Khatib et al., 2016; JICA, 2016), highlight the fact that an important fraction of infectious medical waste is not separated. According to Al Khatib et al. (2016), 83.1% of the general waste and 16.9% of the medical hazardous waste are disposed of, while 20% of the medical hazardous waste is treated. PCBS further recorded in 2017, 12.3% of establishments which generated infectious waste and separated it, and 14.2% of establishments producing sharp waste and separating it (PCBS, 2017a).

According to the Medical Waste Bylaw (2012), the medical institution is responsible for the internal separation, treatment and collection of the generated medical waste; while the local authorities are in charge of the outside transportation and final disposal of the medical waste (PNA, 2012).

In general, there is a lack of systematic separation of the infectious and sharp waste, as well as pharmaceutical waste in the health centres/hospitals. This includes the lack of colour coding, of container labelling, of availability of separation material (like yellow bags or safety boxes), onsite storage containers or special separate storage room, special cart and route. There is also a lack of internal procedures, written information and appropriate training available to medical and non-medical staff working in health facilities (Al Khatib, 2014; Caniato et al., 2016). In Jenin for example, 34% of the medical personnel was aware of medical waste treatment instructions in 2014 (Al Khatib, 2014). Figure (56) gives an idea about the main HCW producers and the disposal locations of this waste in 2010. it mau be possible also in 2019. In general, sharps are the medical waste mainly separated, the majority of the other wastes being usually thrown into municipal containers.

135 Average generation found in Study from Islamic university of Gaza in 2013 (JICA 2016, p.21). Average found in 2014 was 2 kg/bed/day (see footnote 126). As no data was available for 2016, we kept the same figure.

136 1,661* 92.2%*2

137 2,041* 92.2%*2

138 14*39%. PHCs are estimated to generate 39% of the total medical waste.

139 7'103 *20%

Some pharmaceutical products can be discharged into the sewage water, others don't follow the encapsulation procedures when sent to special hazardous sites, or others can be simply disposed into municipal waste (Tabash et al. 2016; Caniato et al. 2016).

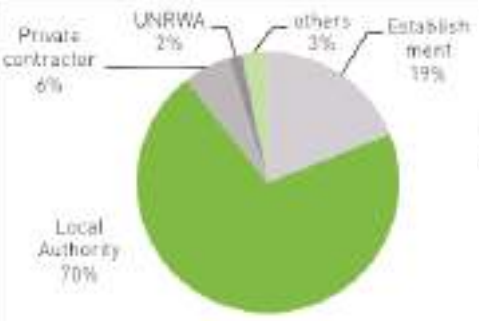

Figure 16: Doer of medical solid waste collection (PCBS, 2010)

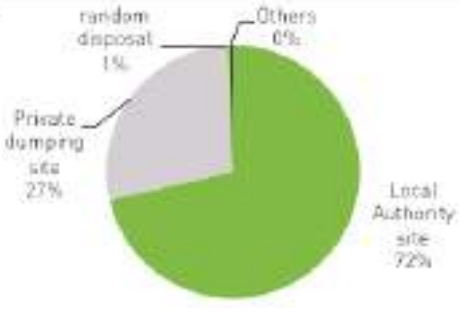

Figure 17: Location of medical solid waste disposal (PCBS, 2010)

Figure 56. Sources of medical waste and disposal methods in 2010 (GIZ-SWEEPNET, 2014, page 65).

Figure 57. Medical waste sorted in Jenin hospital (Hijawi, 2015).

Collection vehicles are also in general not specially designed for medical waste, hence there are no special procedures about the maintenance (cf. cleaning vehicles and staff equipment) and proper waste handling. This practice can expose unfortunately waste management staff to dangers of contamination.

In general, the different ways of treating hazardous medical waste inside health facilities are incineration (for pathologic, pharmaceutic waste); thermal (with autoclave) or irradiative (microwave) for sharps, infectious but never pathological waste; chemical or eventually

biological[140]. In the OPT, the majority of hospitals don't have any waste treatment facilities (GIZ-SWEEPNET, 2014) and the separated waste is either treated outside or ends up untreated in the landfills.

Table 19. Summary of treatment methods available in the WB and GS in 2018[141]

Governorate	Medical centre	Method/ Technology used	Estimated quantities treated	Capacity
Ramallah	4 hospitals complex	**Autoclave** (central)	500 kg/day	600L 50-75 kg/cycle 3-5 cycles/day
Bethlehem	2 private hospitals	**Autoclave** (in each)	n.a	n.a
	MoH PHCs	**Autoclave**	n.a	n.a
Beth. & Hebron	Other medical centres	**Microwave** (In TS)	110 kg/hour 700 kg-1 ton/day	100kg/hour
Nablus	1 hospital	**Incinerator** (in hospital) Not operational	n.a	n.a
Jericho	1 hospital 12 PHC	**Incinerator** [142] (in hospital) Separate disposal until 2014. Then, no separation.	40-50 kg/week (only sharp+ pathology) 743 kg/month	25 kg/hour twice a week 3 trenches (3 years each). 1.5 already used.
Gaza Strip[143]	2 hospitals (Nasser, Shifa) 2 others out of service	**Incinerator** (in each hospital)	400-800 kg/week	80-100 kg capacity/ cycle 1-2 cycles/day 5 days operation
		Autoclave Installed in 2015, not functioning		8,800 kg/month (50kg/cycle; 8 cycle/ day; 22 working days/ month)

In the West Bank, some health establishments are equipped with an autoclave; two hospitals (in Nablus and Jericho) were using problematic incinerators, that have no filters and generate toxins. It seems that these incinerators are not operational anymore. In Jericho, there was until 2014 a dedicated space in the Jericho landfill. In Hebron, as above mentioned, the medical waste treatment facility in Al Fahs industrial zone serves Hebron and Bethlehem governorates. The project was implemented through the Palestinian Municipal Support Program (PMSP), funded by Italy. The PMSP program included the supply of a microwave equipment to be used for waste treatment, a mini truck for transferring the health care waste from health centres to the treatment facility, small machinery for cleaning, and consumables such as containers; UNDP and YMCA also contributed constructing the facility steel structure over

140 http://www.biomedicalwastesolutions.com/medical-waste-disposal/ , accessed 11.03.2019.

141 GIZ-SWEEPNET, 2014; JSC information from interviews in 2018 and 2019 and JICA, 2016.

142 It is not sure if these 2 incinerators are operational in 2019

143 JICA, 2016

250 m^2 in Hebron transfer station. In addition, the project included training for different users such as JSC workers, EQA and MoH staff, hospitals and clinics, and producing awareness materials.

The capacity of TS Hebron medical treatment facility is 110 kg/hour, it receives HCW from governmental, private and UNRWA clinics and hospitals and 80% of private labs in Hebron and Bethlehem, but it does not receive HCW from dental clinics and private general doctors clinics. The facility treats about 1,000 kg/day, covering 150 medical institutions. Once treated, the HCW is sent to Al Minya landfill where it is disposed. For the moment, there is no dedicated space for treated medical waste there.

In East Jerusalem, there are 6 hospitals (about 613 beds) serving Palestinians from the Gaza Strip and the West Bank (Augusta Victoria Hospital, St. Joseph Hospital, St. John Eye Hospital, Palestinian Red Crescent Maternity Hospital, Princess Amira Basma Rehabilitation Centre and Makassed Hospital)[144]. The medical hazardous waste is separated inside the hospitals, stored in special rooms/places and treated outside (private companies like Tabib come several times per week to collect it) and the normal waste is collected from hospital containers by the Jerusalem Municipality[145].

In Gaza, there are a few hospitals being able to manage their hazardous waste. Either the MSW services providers are collecting it or the hazardous waste is treated with incinerators or autoclaves. The 4 incinerators in Gaza are in Al Shifa Hospital, Nasser hospital and European Hospital; two of them are not working (JICA, 2017c). Gaza also has 1 hazardous landfill (constructed in 2012, about 250 m^3 out of 6,500 m^3 capacity was filled). All of these facilities unfortunately do not meet the international standards (Caniato et al., 2016).

Referring to the Feasibility Study of the Gaza Solid Waste Management Project which was conducted in 2012 by UNDP, it was agreed by all stakeholders to create and operate three autoclave treatment facilities in Gaza Strip (for instance Gaza city, Khan Younis, and Rafah). The study stated that the old used treatment technique (incineration) is not recommended to be introduced in the short-term plan. The cost of construction the three facilities was estimated at US$ 2.11 million including provision of the three autoclaves.

The Assessment Study from JICA in 2016, concluded that most of governmental and NGOs hospitals and clinics conduct separation process only for sharps and dispose all other infectious HCW with normal waste in municipal containers and then dispose them to municipal landfill. Most of medical centres do not have adequate stores for medical waste. The majority of centres store safety boxes inside the centre or in open areas in the backyards. The HCW from the majority of medical centres is disposed to street municipal containers. This creates health problems to public. Thus, the study recommended the following urgent actions:

- Intra management in all medical institutions have to segregate based on the three-bin system with colour coding (safety boxes for sharps, yellow bags for all infectious waste and black bags for normal waste) similar to UNRWA and NGO clinics.

144 http://archive.thisweekinpalestine.com/details.php?id=3235&ed=187&edid=187 accessed 15.03.2019.

145 Interview in Makassed hospital in April 2019.

- Existing JSC might possibly be licensed and then contracted to handle the outside management. They will be responsible for secondary collection, transportation, treatment and disposal of medical waste[146].

JICA allocated part of its financial fund to the Palestinian people in establishing the Health-care Waste Treatment Facility as a pilot project. Whereas UNRWA showed willingness to provide vehicles to be used for safe transport of HCW. JSC-KRM is the delegated implementation agency for this project; its responsibilities are (i) transporting the HCW from the healthcare facilities to the Medical Waste Treatment Facility (only the infectious wastes); (ii) treating the received HCW by using the Autoclave (provided by MoH) and; (iii) transporting the treated waste to the final disposal site. The Ministry of Health role is to segregate and store the HCW into three categories (Sharps, Infectious, Non-infectious), the pathogenic wastes has a separate treatment technique used by MoH. The Ministry of Local Government, Environment Quality Authority and the Ministry of Finance are responsible for supervising the whole process to be in line with local Palestinian regulations.

JSC-KRM produced a Medical Waste Manual in September 2017. The Manual explains the roles of each stakeholders (JSC-KRM, MoH, MoLG, EQA …etc). The Manual categories the medical waste into types mentioning the colour of containers to be used for each type and specification for the container itself, as well it details in steps how to transfer the medical waste from the health care centre until reaching to the treatment facility. Finally, the manual listed the required capacity building for employees in MoH and JSC-KRM.

146 Two Joint Service Councils are in Gaza Strip with a view of providing efficient waste management services for the member municipalities. South Joint Service Council serves the municipalities of Khan Younis, Rafah and Middle Area (17 in total). While, North Joint Service Council is newly established to serve the municipalities of North Gaza and Gaza Governorate (8 in total).

F/ ROLE OF THE PRIVATE SECTOR

In the census 2017, PCBS estimated 49 establishments involved in waste collection, treatment and disposal activities, employing about 268 persons, which is about 0.03 % of the whole establishments. Nothing was mentioned about remediation activities (PCBS, 2018b). In another document, PCBS mentioned 244 establishments, private, NGO and governmental, involved in waste collection, treatment and supply, 26 in collection of non-hazardous waste, 25 in material recovery and 2 in remediation activities and other waste management services (PCBS, 2018a).

In the landscape of SWM in Palestine, the municipalities and JSCs remain the main service provider for solid waste collection, process and disposal. There are however some agreements with private companies to run transfer stations, composting plants or landfills. The private-public-partnership (PPP) established in 2013 between JSC-H&B and the Greek consortium W.A.T.T. S.A.-MESOGEOS S.A. & EPEM S.A., covering the operation and maintenance of the Al-Minya Landfill, the Hebron and Tarqumiya transfer stations, as well as the transportation services, was a good example of possible arrangements between public service providers and private institutions (PPIAF, 2013). The MoLG-JICA survey conducted in 2015 in 12 JSCs to assess the situation of PPP in the solid waste sector concluded:

- 100% JSCs were dependent on waste collection fees as only income source; only 50% of the JSCs covered their operational costs from utility provision;
- 80% LGUs were lacking the financial resources to promote PPPs;
- 54% JSCs had already experience some agreements with private providers, regarding waste collection and transportation, landfill operation and recycling.

The survey further mentioned the possible causes for this low result: the lack of updated laws promoting PPP; the need for improvement of the financial situation of JSCs/LGUs; the limited possibility for foreign investment; the limitation of movement of goods, persons and financial transfers due to Israeli controls; the lack of trained people in latest technologies; and finally the lack of strategies to implement a sustainable local economic environment (JSC Today, vol.2, 2015).

The private sector participation is much more important in the technical aspects of SWM, in the construction of landfills and transfer stations for example, or in the rehabilitation of dumpsites, in conducting feasibility studies and researches (GIZ-SWEEPNET, 2014).

As above mentioned, there is no significant private facility dealing with recycling: the market is informal and risky and the legislation still does not provide the incentives for the private sector to take a long-term interest in this sector.

There are however some examples of companies dealing with solid waste as shown in Table (19) below.

Table 19. Examples of private companies related to solid waste treatment or recycling in the WB.

Green Palestine Investment Company	www.greenpalestine.ps/	solid waste and waste water, promoting the use of alternative and renewable energy
Tafkeek (E-waste)	www.facebook.com/Tafkeek.co/	founded by Tasneem Abuhijleh
Ecotech Recycling	www.ecotech-recycling.com	E-waste and carboard. Founded by Anton and Hanna Hallak. In Bethlehem Industrial Zone. Should start at the end of 2019-beginning of January 2020.
The Portland Trust	https://portlandtrust.org/	implement initiatives to help develop the Palestinian private sector and relieve poverty through entrepreneurship and social investment. Office in Ramallah.
Manufacture egg trays out of recycled paper	www.linkedin.com/in/wael-bader-72162851/	Bader Brothers in Beit Duqqu
Ommar Al-Ard Recycling - Revivers of the land of Palestine Papers and Cardboards	www.ommar.ps	Paper and cardboard

Individual initiatives in solid waste recycling however rise among the young generation: Engineers Ghadeer Arafeh with a Biodiesel project, Anton Hallak with EcoTech Recycling, Citizens of the World from Basel Jarayseh and Nicola Abu Amsha[147] or Green Cake (brick from ashes and rubles) from Majd Mashharawi and Rawn Addullatif[148] are examples of high potential projects, provided they receive long term attention and support.

Across the Gaza Strip, municipalities are delivering the primary collection services with no involvement from the private sector. Municipalities have not been encouraged to involve the private sector in primary collection services for the following reasons (Eco-Conserve & Universal Group, 2017):

- There is a common perception that involving the private sector will lead to a cost increase of the service.
- The majority of the citizens do not pay waste management fees and the municipalities have no regular or predictable financial resources to pay the private sector.
- Ambiguity in terms of the possible contractual agreement with the private sector for primary collection services.

Currently the Private Sector is mainly involved in:

- Manufacturing of metal container bins of different sizes for waste collection purposes as well as in their maintenance.
- Manufacturing the metal cages for the donkey carts involved in primary collection.
- Transfer of municipal solid waste from the transfer stations, dumpsites and the larger container bins to the landfills.
- Collection and disposal of construction and demolition waste.

147 https://www.buildpalestine.com/blog/meet-palestines-five-latest-green-start-ups accessed 15.03.2019.

148 http://www.ideassonline.org/public/pdf/GreenCakeGaza-ENG.pdf accessed 15.03.2019.

G/ CHALLENGES AND NEEDS

The implementation of an effective and integrated SWM in Palestine is confronted with several challenges at the legislative, organizational, technical, environmental and financial levels. This situation is further complicated by the lack of statistical data needed for decision making, planning and monitoring operations. The complications of the current political situation add its own challenges, such as the limited Palestinian control over land and resources.

1. Institutional and Organizational Challenges

Incomplete legislative framework

Although there is a progress in the current legislation governing the SWM sector, they are still limited in several aspects. Currently, solid waste management is governed by a number of standalone articles in more than one law. Essential solid waste management requirements are not addressed adequately in any of the existing legislations. These articles are incomplete and at a relatively high level of generality. There is a global feeling of top-down decisions without really knowing what are the real legislative needs and constraints at the operational level. In the case of e-waste for example, the actual legislation would need more flexibility, as mentioned above. There is a need for a comprehensive and more inclusive waste management legislation, that would regulate, in an integrated manner, the management of all waste categories.

As for waste collection, the two pieces of legislation mostly known to, and applied by, the municipalities are the "Waste Collection Legislation (city ordinance)" and the "Public Health Offenses legislation". In the case of a limited number of municipalities, the former is relatively detailed and inclusive and accordingly, it is recommended, as a first step, to adopt it for all other municipalities. This is not expected to be a time-consuming process, as it only requires the endorsement of the Minister of Local Government.

Weak legislation enforcement

There is an obvious substantial deficiency in the law enforcement in general, especially in waste service fee collection and in the remedy of any waste pollution. Regarding fee collection, this could be partially attributed to inadequate institutional capacity for enforcement and fee collection. It is however not clear to the authors if this is compounded by insufficient political will for enforcement. In this respect, there is consensus among the waste management officials that:

- Enforcement of legislation is inadequate;
- A significant percentage of the population is unemployed and/or cannot afford to pay the fees as they have more pressing priorities.

Regarding waste pollution, although the "polluter pays" principle apply, this is hardly controlled and repressed on the ground and it requires more investment.

Need for SWM standards and specifications

There are currently no Palestinian standards for many aspects of SWM. For example, there are no Palestinian standards for the siting, design, or operation of sanitary landfills. Consequently, these landfills follow the standards of the donor agency that funds them. Similarly, there are no Palestinian standards for dealing with special and hazardous waste, or for transfer stations, recycling operations, etc. Making these standards available is vital for achieving effectiveness and safety in dealing with SW and for protecting the environment.

Poor capacities of the SW institutions and lack of Capacity Building Programs

The current status shows lack of SW capacity and training (human, financial, and organizational) at the national and institutional levels, and to a less extent at the level of Joint Service Councils. As such, the mid-career and junior staff that will replace the current experienced senior staff might not be qualified nor equipped enough to carry out their responsibilities efficiently. There is a need to build these capacities to achieve effective and updated management of SW, especially in systems for which there is limited previous exposure, such as medical wastes and transfer stations. There is also a need to develop capacity for other systems, such as recycling processes, hazardous waste management, as well as landfill operation including leachate management, filling sequence, and social and environmental management. This lack of capacity may cripple future efforts to build effective SWM, if not remediated.

There is also no national program including a Separation/recycling Fund for the JSCs and municipalities or even the private sector.

Non-systematic planning operational management, monitoring and reporting activities

Documented operational plans for a large percentage of the municipalities and JSCs exist. These operational plans are not necessarily comprehensive or detailed, but are in general relatively adequate. The planning exercise should however be further developed and improved.

Although supervision activities for waste collection and disposal services are performed as a routine daily work, yet there are limited monitoring, evaluation and reporting activities. Data collection is also missing regarding special waste like medical and other hazardous materials. There are a few exceptions, where JSCs/municipalities or establishments produce periodic reports reflecting important solid waste management data and information. In general, there is a deficiency in systematic solid waste data gathering activities, waste information system(s) and performance indicators for primary collection activities. As well, most of waste management reports are usually not publicly disclosed.

2. Technical Challenges

Shortage of Number and Efficiency of Running Solid Waste Equipment

There is a shortage of efficiently running waste collection vehicles in most, if not all, municipalities. Existing waste collection fleets are in deteriorating condition, not optimally

used or inefficient. In Gaza Strip for example, shortage of spare parts further exacerbates the problems of operating the primary collection fleet. In addition, municipalities currently operate vehicles of diverse origin, manufactures (brands) and auxiliary mechanisms. This wide diversity in collection fleet vehicles within the same municipality makes operating and maintaining the fleet is less than optimum.

There is also shortage in the number of waste containers in most of municipalities, knowing that it is the responsibility of JSCs to provide the containers for municipalities in most of Palestinian areas. Moreover, most of the existing containers are old and they are not well maintained.

Challenging SW collection and transport operations

About 94% of the Palestinian localities are covered with SW collection and transport services. The success of these services varies by localities. The poor financial and human resources of local authorities (especially when they are of small size), coupled with the low collection rate of SW service fees, has forced many local authorities to cover the cost of the SWM services using the budget allocations of other vital services. As a result, it became difficult for these local authorities to provide high-quality SWM services to its citizens. In some cases, SW collection takes place in absence of appropriate standards or using inappropriate collection vehicles or donkey carts (in Gaza Strip), not compatible with the waste collection containers used. In most local authorities, including major cities, the distribution of waste collection containers and the routing of collection vehicles is determined neither according to known scientific methods, nor as a result of a careful analysis of viable alternatives. Other technical problems facing the local authorities include the use of obsolete equipment and vehicles, poor preventive maintenance, and weak monitoring and control systems. All of these issues aggravated the price tag of SWM for these authorities and depleted their budgets.

On the other hand, some JSCs have managed, using the "economy of scale" principle, to provide similar services to those provided by local authorities at a higher effectiveness and efficiency. Despite the success of JSCs, transportation of waste is an issue in the operational budget and the example of JSC Ramallah's huge costs for transportation to ZAF landfill highlights the lack of available landfill sites in a relatively near vicinity.

The use of donkey carts in Gaza Strip started since 2008, i.e Gaza Municipality collected more than 50% of their wastes by donkey carts in 2017. The use of donkey carts started when there was a fuel shortage in Gaza Strip, and it continued even after the end of the fuel problem; it grows year by year and mostly it is funded by external donors. The collection of waste by donkey carts is the cheapest solution, but it is barely compatible with a modern type of solid waste management.

In another hand, many of transfer stations were constructed in Palestine in order to facilitate the transfer of waste, but their use is still new for many of JSCs and municipalities and more time and capacity building are required to enhance using them.

The need for appropriate mechanisms to collect and treat special wastes

Special wastes in the OPT include construction and demolition (C&D), tires, E-waste,

slaughterhouse waste, scrap metal from cars and some medical waste. There are still limited available statistics for the quantities of these wastes. The recent adoption of the C&D Waste Bylaw and Guidance Manual is a big progress, but other materials would need also to be covered in the near future. As mentioned earlier, a high proportion of these wastes can be recycled, and additional efforts to apply segregation and re-use/recycling more systematically in order to limit contamination with normal waste and final disposal in landfill, would have a positive impact.

The poor working conditions of solid waste workers and the issue of waste pickers

As we have seen, solid waste comes from a lot of activities, including municipal to hazardous types. In each stage of SWM, workers face risk of contamination and accidents due to improper knowledge, training and equipment. The use of personal protective equipment (PPEs) by the workers is less than satisfactory. The PPE is either primitive, lacking or not properly wore; transportation vehicles and other equipment in treatment facilities are in poor conditions and can be polluted. There is also a lack of knowledge and professional training about how to handle special waste and to apply safety procedures after having handled the waste. As well, vaccination of workers against tetanus and hepatitis are not provided in most of JSCs and municipalities. There is a need for a relevant investment in the situation of workers, both in equipment and capacities.

Furthermore, the number of street waste pickers have been significantly increasing in the previous three years (2016-2019), especially in the Gaza Strip. Most of them are men, but also some of children and women were noticed picking the waste from street containers. More studies are required to search their livelihood conditions, and there is a need to find alternative livelihood sources for them to end this phenomenon.

The fragility in terms of waste management costs' recovery and dependence on external funding

The waste management tariff structures are different in all municipalities. It is noted that the billed amounts are not covering at least the O&M costs in most of municipalities. Hence, municipalities depend on external financial supports to fill their financial gap, which creates a very fragile situation on the long-term. For example, all the waste collection by donkey carts in Gaza Strip is financed through MDLF. On the one hand, some of the main strategic projects dealing with SWM infrastructure (including construction of landfills, transfer stations and their access roads, in addition to the supply of waste vehicles) conducted by JSCs are financed by external partners, with a financial contribution from the Palestinian Authority. On the other hand, some of JSCs are still non-operational due to the shortage of external funding; for example, JSC-GN was recently re-established in 2017, but it is still non-operational due to the absence of fund.

The capacity limits of the existing landfills and the issue of dumpsites

As mentioned above, landfills have a limited capacity: ZAF is almost full, Jericho and AM could handle the waste for 2-3 years more only. As the availability of land is very limited, there is an urgent need to find ways to reduce the final disposal to the landfills and/or to find innovative treatment solutions to reuse the waste. In addition, existing random dumpsites

need to be closed over time or rehabilitated and controlled at least.

Ideas like incineration, waste to energy, landfill mining, anaerobic digestion have each positive and negative impacts and need to be clearly reviewed and discussed between all stakeholders, taking into account the local conditions and constraints.

Limited professional knowledge and initiatives about separation operations and recycling programs

There is an evident absence of the concept of waste minimization at the source, and the Palestinian expertise in this field is still limited. This expertise is confined to individual initiatives at homes, which is linked to the environmental awareness of some Palestinian families, in addition to some institutions which follow the policies of waste minimization and segregation in order to obtain the IS0-14001 certification. On the other hand, there are some models and experiments for waste recycle, which have not been publicized enough to extract lessons from them. As a result, achieving significant waste minimization and recycling goals requires additional national policies aiming at elevating public awareness in this area and encouraging the private sector to invest in SW separation and recycle operations.

Insufficient Complaining Systems

Most of large municipalities and JSCs have a clear Grievance Redress Mechanism (GRM) and clear channels for submitting a complaint/initiative from residents. The GRM system is including all the municipality services including the SWM departments. Usually, people are not aware of the GRM especially regarding to waste issues, they prefer not to submit a complaint, but just to talk with workers during daily operation. In small municipalities, there is an absence of complaining systems. The follow-up with complaints differs from municipality to another based on its organizational structure and operational procedures.

Insufficient public awareness and poor involvement of the civil society

Awareness and communication activities are still insufficient and need to be significantly improved. The current human and financial resources are unavailable to carry out the needed awareness activities. In general, there is a need to raise the awareness of people about the real costs of solid waste, the need for them to systematically pay their waste service bills and to ensure their commitment to properly dispose their waste. This commitment comes not only with the provision by municipalities of waste disposal facilities like bins and containers and clear communication about collection conditions, but also with a national message to keep Palestine clean, a generalized education program focused on waste disposal and recycling, an effective communication strategy and an efficient policy of systematically fining those who degrade the environment.

There is a lack of support by the government for PPP involvement in the solid waste sector and providing incentives.

There is a need finally to establish a national consortium including all stakeholders on the issue of SWM.

3. Greenhouse gas emissions from waste management (GHG)

Another challenge on the long term is about the emissions produced from solid waste related activities. In 2011, emissions in the waste sector (waste and wastewater) in Palestine were 751.7Gg of CO_2 eq., emissions of CH_4 dominated followed by N_2O. Emissions of CH_4 arose from waste decomposition and wastewater treatment, whereas N_2O emissions arose during biological nitrogen removal in wastewater treatment plants.

A small amount of CO_2 was also emitted, which arose from the burning of waste. Within the waste sector, the categories that contributed to GHG emissions were:

1.) wastewater treatment and discharge emits 496.3 Gg CO_2 eq. (66%);

2.) solid waste disposal emits 232.6 Gg CO_2 eq. (31%);

3.) incineration and open burning of waste emits 22.9 Gg CO_2 eq. (3%)[149].

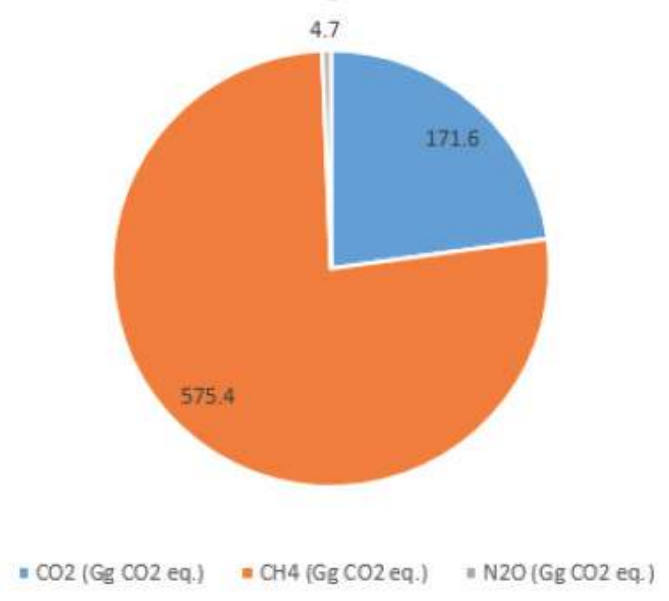

Figure 58. Waste sub-sector emissions (Gg CO2 eq.), 2011

The work is still modest in dealing with the GHG emissions associated to solid waste. There is a need for concerting more efforts for adaptation or mitigation e.g. installation of gas collection systems in the operational landfills, using the daily covers in landfills, and restricting the open burning of waste.

149 Reference: EQA & UNDP, report to UNFCCC, 2017

GLOSSSARY

Agricultural solid waste: wastes produced from the raising of plants and animals for food, including manure, plant stalks, and leaves.

Biodegradable Material: a compound that can be degraded or converted to simpler compounds by microorganic.

Bulky waste: items whose large size or weight precludes or complicates their handling by normal collection, such as refrigerators, ovens, microwave ovens, washing machines, cooling appliances.

Collection waste: the act of picking up wastes at homes, businesses, commercial and industrial plants, and other locations; loading them into a collection vehicle; and hauling them to a facility for further processing or transfer to a disposal site.

Commercial solid wastes: wastes that originate in wholesale, retail, or service establishments, such as office buildings, stores, markets, theaters, hotels, and warehouses.

Compost: a mixture of organic wastes partially decomposed by aerobic and/or anaerobic bacteria to an intermediate state. Compost can be used as a soil conditioner.

Construction wastes: wastes produced in the course of construction of homes, office buildings, schools, and other structures. The material usually includes used lumber, miscellaneous metal parts, packaging materials, cans, boxes, wire, and other materials. Construction and demolition wastes are usually groped together.

Disposal: The activities associated with the long-term handling of (1) solid wastes that are collected and of no further use and (2) the residual matter after solid wastes have been processed and the recovery of conversion products has been accomplished. Normally, disposal is accomplished by means of sanitary landfilling.

Domestic waste: waste produced by households includes organic waste, paper, cardboard, plastic, glass or any non-hazardous waste produced by daily household activities as well as garden and tree waste.

Energy Recovery: the process of recovering energy from the conversion products derived from solid wastes, such as the heat produced from the burning of solid wastes.

Hazardous waste: Waste from various activities and processes or their ashes that retain the properties that pose a serious threat to the environment and human health, such as nuclear waste, medical waste, and waste from the manufacture of any pharmaceutical, organic solvents, pigments, paints, pesticides or other hazardous substances.

Industrial wastes: wastes generally discarded from industrial operations or derived from manufacturing processes. A distinction should be made between scrap (those materials that can be recycled at a profit) and solid wastes (those that are beyond the reach of economical reclamation).

Leachate: liquid that has percolated through solid waste or another medium. Leachate from

landfills usually contains extracted, dissolved, and suspended materials, some of which may be harmful.

Municipal waste: domestic waste and waste from schools, places of worship, public and private institutions, small workshops, shops, dead stray animals or other wastes of a similar nature to domestic waste.

Recycling: The process of converting waste into raw materials for reprocessing or for other purposes.

Resource recovery: general term used to describe the extraction of economically usable materials or energy from wastes. The concept may involve recycling or conversion into different and sometimes unrelated uses.

Reuse: All processes aimed at recovering and renewing waste, for economic and health use.

Sanitary Landfill: an engineered method of disposing of solid wastes on land in a manner that protects human health and the environment. Waste is spread in thin layers, compacted to the smallest practical volume, and covered with soil or other suitable material at the end of each working day.

Separation or sorting of waste: All processes aimed at separating the different components of waste according to their nature or type, either from the source or in the different waste management facility. Separation may be done manually or mechanically with specialized equipment,

Transfer station: a place or facility where wastes are transferred from smaller collection vehicles into larger transport vehicles for movement to disposal areas, usually landfills. In some transfer operations, compaction or separation may be done at the station.

Treatment: The process of changing the properties of waste in order to reduce its size or change its nature in order to reduce its impact on the environment and public health, or facilitate recycling, reuse or final disposal.

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