

# Horizon 2020 Mediterranean report

Annex 5: Palestine

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# Contents

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<b>Priority thematic areas.....</b>	<b>4</b>
Water resources .....	4
The state and impacts .....	5
The key drivers and pressures .....	10
Responses .....	10
2020 outlook.....	10
Industrial emissions .....	11
State and impact .....	11
Solid waste .....	14
State and impacts.....	14
Key drivers and pressures .....	17
Responses .....	17
2020 outlook.....	18
<b>Selected references.....</b>	<b>20</b>

## Priority thematic areas

### Water resources

The total actual renewable water resources in Palestine are 830 million cubic metres (mcm) per year, of which 750 mcm/year are in the West Bank and 80 mcm/year are in the Gaza Strip. Most of this flow from aquifers (underground layers of water-bearing rock). One large-scale seawater desalination plant with a total capacity of 100 mcm/year is planned to be fully operational by 2020. Although Palestinians have a 13 % share of the Jordan River catchment, they have no access to its annual flow — more than 1 300 mcm/year according to recent figures.

Groundwater resources in Palestine are distributed between the Mountain Aquifer, located underneath the West Bank, and the Coastal Aquifer, beneath the Gaza Strip, both of which are shared with Israel. The Mountain Aquifer has a surface area of about 4 000 km<sup>2</sup> and is by far the most important underground water reservoir in Palestine, with a potential annual replenishment estimated at 680 mcm. It lies almost entirely under the limestone hills of the West Bank, where 95 % of its feeding basin and 80 % of its stocking basin are located. This aquifer is divided into three sub-aquifers: the Western Aquifer, with a potential annual replenishment of 362 mcm, contains water of the highest quality; the Eastern Aquifer has a renewable volume of about 172 mcm/year, of which more than half is brackish water of very poor quality; and the North-Eastern Aquifer has a potential annual replenishment of 145 mcm of high-quality water. The Coastal Aquifer underneath the Gaza Strip is part of the coastal basin that extends from Mount Carmel to the north of the Sinai desert. It has an annual replenishment of 55 mcm, 41 % of which is assured by local rainfall, while irrigation, leakage from deficient distribution networks, and wastewater contribute almost 60 % of its replenishment.

Palestine's water supply per capita is among the scarcest in the world. The country's water scarcity is due to both natural and man-made constraints, mainly resulting from the specific Palestinian situation. Over time, water shortage in Palestine will

increase and become a greater problem as a result of population growth, higher standards of living and climate change.

In 1993, the Oslo Accords redefined water distribution rights between Israelis and Palestinians in accordance with a bilateral agreement. The agreement took into consideration the available renewable water volumes and was intended to guarantee the fulfilment of current and future Palestinian needs without hindering the economic development of Israel. In 1994, a Joint Water Committee (JWC) was established to oversee the implementation of the actions agreed on. The JWC is composed of an equal number of Palestinian and Israeli experts and works closely with the Palestinian Water Authority (PWA) — the legal representative of the Palestinian National Authority (PNA) for water affairs — and the equivalent Israeli representatives.

According to the Oslo agreement, Palestinians have the right to extract 118 mcm/year from the Mountain Aquifer, which represents about 20 % of its annual renewable volume. Israel has the right to withdraw the balance. Palestinians were given the right to extract water from the Coastal Aquifer according to their needs. A sustainable extraction level was estimated at 55 mcm/year, which corresponds to its annual replenishment rate. These two water resources would provide Palestine with a total volume of 193 mcm/year of renewable water, or about 115 litres per person per day.

Political unrest, restrictive Israeli measures and the institutional weakness of the PNA are the driving forces of the chronic water crisis in Palestine and seriously challenge its future improvement, according to a recent World Bank report. The asymmetrical power and capacity of the joint governance system of the water sector, best represented by the JWC, renders the rational planning and development of Palestinian water resources and infrastructure almost impossible. The movement restrictions and the regulatory measures by Israel on local and international investors in the water sector in Palestine render any operation

excessively costly and time-consuming, regardless of its size.

The structural and institutional weaknesses of the PNA and other water sector actors, undermined by the Israeli occupation and post-occupation practices, in addition to the chronic financial crisis of the Palestinian National Authority (NA), considerably reduce the Palestinians' capacity to plan and develop their water infrastructure, making only emergency rather than strategic water development plans operationally feasible. The current water crisis in Palestine is expected to worsen further as a result of demographic expansion, deficient water transportation and distribution systems and the continuous deterioration of water resources, partly caused by climate change.

Since the creation of the PNA in 1993, Palestinians have seen their water shares per capita almost halve as a result of population growth. Despite the trend towards a decline in the population growth rate observed recently, the annual growth rate of 3.7 % makes the Palestinian population one of the most rapidly growing populations of the world. The deficiency of the water transportation networks, most of them inherited before the establishment of the PNA, are responsible for an unaccounted-for water loss of about 30 % and 50 % of the overall extracted volume in the West Bank and the Gaza Strip, respectively. Further losses in water are caused by extremely inefficient irrigation wells, most of which were built in the 1950s and 1960s, inefficient irrigation water distribution networks and low water use efficiency at farmer level because of the small size of landholdings and poor water-sharing organisation. The degradation of water resources as a consequence of deliberate or uncontrollable contamination from untreated wastewater evacuation or leakage, unsupervised solid waste dumping and excessive use of chemicals in farms close to water resources makes it excessively costly to supply water meeting international quality standards in sufficient quantities.

### **Marine environment and resources**

The pollution of the Mediterranean Sea and the Dead Sea caused by the evacuation of untreated wastewater is a serious environmental problem which has severe consequences for the water bodies' ecological functioning and long-term sustainability.

### **The Mediterranean Sea**

The Oslo Accords divided the Mediterranean Sea off the shore of the Gaza Strip into three areas:

Area L: more than 40 km along the Gaza Strip and 20 nautical miles (nm) offshore. It is under full Palestinian control for all purposes.

Area K: a 1.5 nm wide slit inward of the Gaza coast that separates the north of the Gaza Strip from Israel.

Area M: 1 nm south of the Gaza Strip, on the borderline with Egypt.

Pollution is a serious problem directly threatening public health and the immediate and long-term sustainability of the Mediterranean marine environment. The main sources of pollution are untreated wastewater from domestic, agricultural and industrial sources and solid waste dumping. In 2010, the volume of partially or inadequately treated wastewater diverted on a daily basis from the urban centres of the Gaza Strip into the Mediterranean Sea was estimated at 80 000 m<sup>3</sup>. Reports on the high levels of contamination of Gaza beaches and shores with faecal bacteria and pathogenic microorganisms have been repeatedly documented. Other direct sources of pollution include untreated toxic solid waste dumped in landfills adjacent to the coastline and surface run-off of agricultural waste loaded with organophosphorus pesticides and nitrogen fertilisers, which passes through Wadi Gaza during heavy rain, causing occasional sea eutrophication and toxic algal blooms. Coastal erosion, atmospheric pollutant run-off and the potentially adverse effects of global climate change could also contribute to damage to the marine environment.

### *The state and impacts*

#### **Wastewater**

Wastewater management in Palestine is mostly limited to the collection of wastewater by sewage networks and cesspits. Furthermore, wastewater treatment facilities are restricted to a few localities in Palestine. The lack of sufficient and appropriate infrastructure for wastewater collection and treatment has been the limiting factor in the development of the wastewater sector.

#### **Raw wastewater generation**

Wastewater generation volumes in Palestine depend mostly on daily per capita water consumption and the availability of water resources. Table A5.1 illustrates the volume of wastewater generated in Palestine by region and year.

It should be noted that the amount of wastewater generated can be higher than the figures reported herein, as they were calculated based on the total volume of supplied municipal freshwater minus the total volume of unaccounted-for water, with the result multiplied by 85 % for both urban areas and refugee camps and by 70 % for rural areas (ARIJ, 2011).

A slightly increased upward trend in the generation of wastewater has been observed in recent years. This is consistent with the population increase as well as the slight improvement in social and economic life (see Figure A5.1).

**Connection to sewage systems**

Connection of households in Palestine to the sewage collection system increased from 39.3 % in 1999 to 55.0 % in 2011 (about a 40 % increase over 12 years; see Figure A5.2 and Table A5.2).

Most West Bank households rely on cesspits for wastewater disposal, whereas in the Gaza Strip sewage collection networks are the dominant wastewater disposal method adopted at household level (Figure A5.3).

The wastewater collection network is mostly limited to the major cities and refugee camps. Based on the local community survey conducted by the Palestinian Central Bureau of Statistics (PCBS) in 2010, 94 communities in the West Bank are connected to public sewage networks.

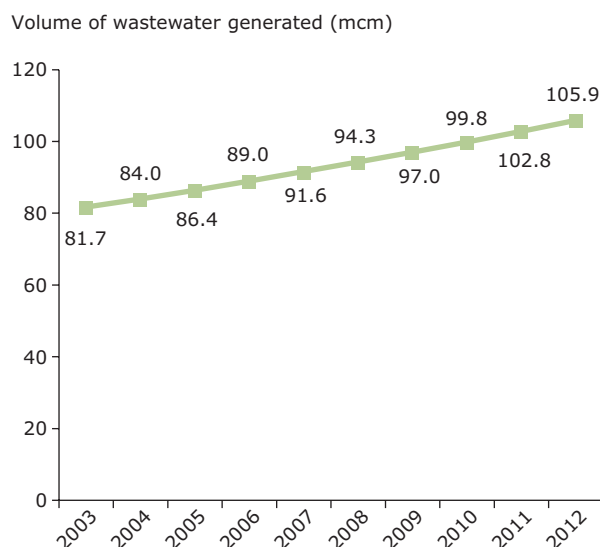
**Table A5.1 Volume of wastewater generated in Palestine by region and year (mcm/year)**

Year	Palestine	West Bank	Gaza Strip
2003	81.7	45.9	35.8
2004	84.0	47.0	37.0
2005	86.4	48.2	38.2
2006	89.0	49.5	39.5
2007	91.6	50.7	40.9
2008	94.3	52.1	42.2
2009	97.0	53.4	43.6
2010	99.8	54.8	45.0
2011	102.8	56.2	46.6
2012	105.9	57.7	48.2

**Note:** mcm = million cubic metres.

**Source:** Palestinian Central Bureau of Statistics, 2013a.

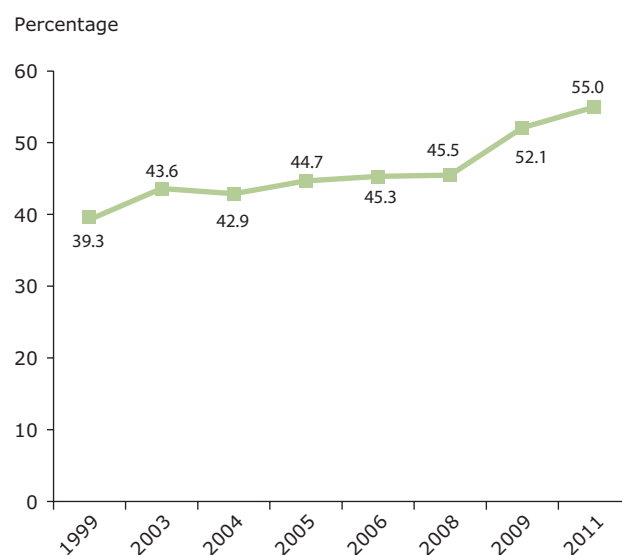
**Figure A5.1 Trends in wastewater generation in Palestine, 2003–2012**



**Note:** mcm = million cubic metres.

**Source:** Palestinian Central Bureau of Statistics, 2013a.

**Figure A5.2 Percentage of households that use wastewater network as a wastewater disposal method**



**Source:** Palestinian Central Bureau of Statistics, 2012.

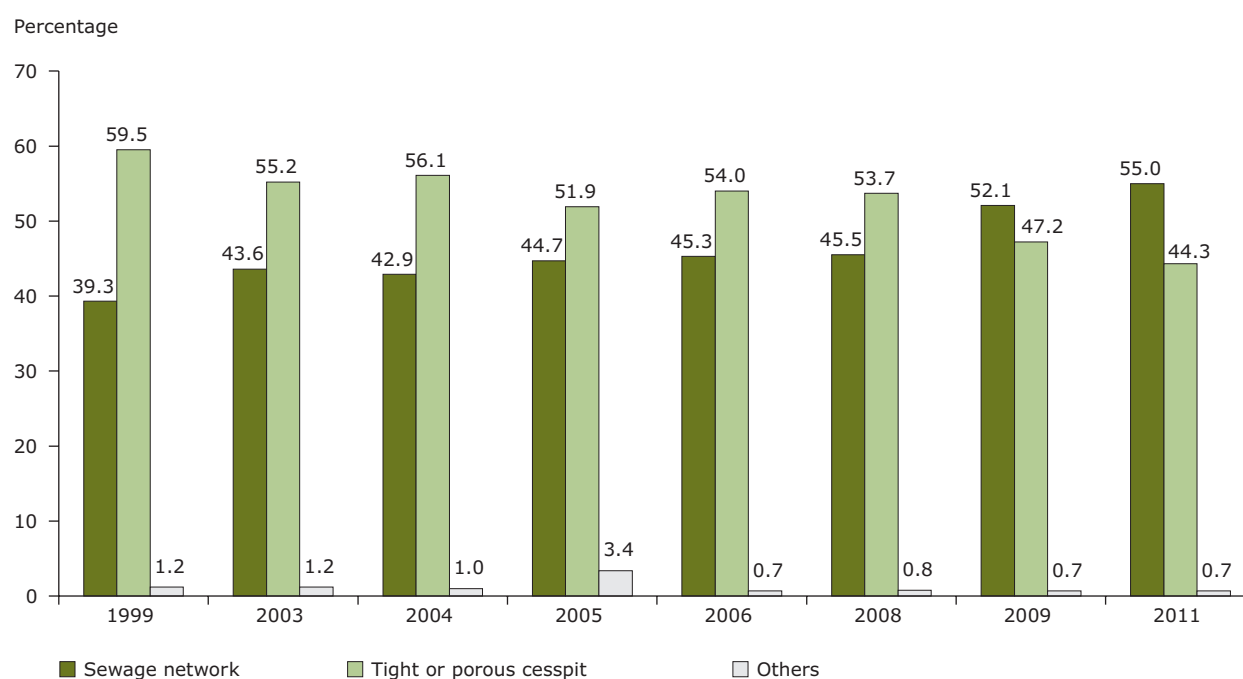
During 2011, data indicated that the wastewater network was used by 55.0 % of households in the Palestinian Territory to dispose of their wastewater, and porous cesspits were used by 39.0 % of households (see breakdown in Figure A5.4). The percentage of households in the Palestinian Territory using the wastewater network had increased from 39.3 % in 1999.

**Table A5.2 Percentage of households using improved sanitation system by region and locality type, 2005–2011**

Year	Palestine				West Bank				Gaza Strip			
	Total	Urban	Rural	Camps	Total	Urban	Rural	Camps	Total	Urban	Rural	Camps
2005	99.4	99.2	99.5	99.8	99.2	99.1	99.5	99.4	99.6	99.4	100.0	100.0
2006	99.3	99.2	99.2	100.0	99.2	99.1	99.1	100.0	99.7	99.5	100.0	100.0
2008 *	99.2	99.6	98.4	99.4	98.8	99.2	98.2	99.4	99.8	100.0	100.0	99.3
2009 *	99.3	..	..	..	99.0	..	..	..	99.8	..	..	..
2010 *	99.7	99.9	98.7	99.9	99.6	99.8	98.7	99.9	99.9	99.9	100.0	100.0
2011 *	99.3	99.4	98.8	99.9	98.8	98.9	98.7	99.7	100.0	100.0	100.0	100.0

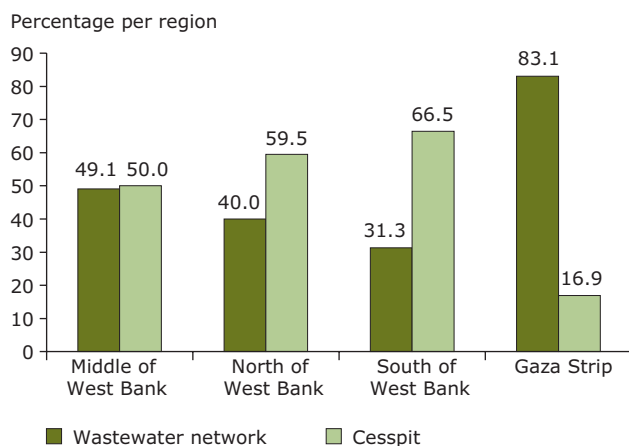
**Notes:** .. = data not available; \* = data represent the share of households, not the population.

**Source:** Palestinian Central Bureau of Statistics, 2013b.

**Figure A5.3 Percentage of households in Palestine by wastewater disposal method and year**

**Source:** Palestinian Central Bureau of Statistics, 2013b.

**Figure A5.4 Percentage of households in the Palestinian Territory by wastewater disposal method and region, 2011**



Source: Palestinian Central Bureau of Statistics, 2011.

### Wastewater final disposal

Collected wastewater is not treated; it is disposed into the environment. According to ARIJ's 2010 field survey, and consistent with 2009 data from the PCBS, the most common disposal method for wastewater in the West Bank (Table A5.3) remains cesspits. Only 6.33 % (2.836 mcm) of the wastewater generated in the West Bank is treated in centralised and collective wastewater treatment

**Table A5.3 Volume of treated wastewater in the West Bank governorates, 2010**

Governorate/region	Volume of treated wastewater in the West Bank governorates	
	(mcm/year)	Percentage
Jenin	0	–
Tubas	0	–
Tulkarm	0.07	1.56
Nablus	0	–
Qalqilya	0.02	0.66
Salfit	0.01	0.97
Ramallah and Al-Bireh	2.64	33.52
Jericho and Al-Aghwar	0	–
Jerusalem	0	–
Bethlehem	0.02	0.38
Hebron	0.08	0.8
West Bank	2.836	6.33

Source: ARIJ, 2010.

plants located in the West Bank, the remainder is discharged untreated into the environment, except for a part, which is treated by Israeli treatment plants located inside Israel. Cesspits are purposely designed and constructed without a concrete lining in order to allow seepage into the ground. With time, cesspits are filled with wastewater, which necessitates periodical emptying by vacuum tankers. The wastewater collected in the tankers is often released in the nearby wadis. However, septic tanks are environmentally preferable to cesspits, as their design prevents wastewater leakage to the ground. These tanks are rarely used in the West Bank. However, when using vacuum tankers, whether with sewage from septic tanks or cesspits, if there is not infrastructure available nearby to receive this sewage, those pollutants are discharged into the environment. Hiring of vacuum tankers, despite not being a real solution to the problem, is a costly service that in many cases citizens cannot afford. The major wastewater streams in the West Bank include Wadi Zeimar, Wadi el-Sajour (Nablus), Wadi Beitunia (Ramallah), Wadi as-Samen (Hebron) and Wadi en-Nar (Bethlehem). In the Gaza Strip, there are also discharges of untreated wastewater into the Mediterranean Sea.

The disposal methods for the wastewater generated in Palestine vary depending on available infrastructure. The variation in the quality of effluents disposed into the environment ranges from acceptable treated wastewater (as in Al-Bireh wastewater treatment plant, WWTP) to raw wastewater (in the case of Wadi en-Nar wastewater stream). In several instances, the wastewater that crosses the Green Line is treated in Israeli treatment plants and reused for irrigation purposes.

### Wastewater treatment

Sewage networks in the West Bank are rarely supported by wastewater treatment facilities. Appropriate treatment of wastewater has been neglected throughout Palestine. The restriction for implementation of projects due to Israeli occupation and the lack of investment in the sector have made the wastewater treatment sector incapable of providing this basic service to the majority of the Palestinian population.

To analyse the wastewater treatment infrastructure in Palestine, this infrastructure was divided according to size and treatment capacity into three main categories: (1) centralised wastewater treatment plants (often serving an entire locality, city, refugee camp, etc.), (2) collective wastewater treatment systems (often serving a neighbourhood, a cluster



of houses, several buildings, etc.) and (3) on-site small-scale wastewater treatment systems (often serving one house, one building). The wastewater infrastructure analysed covered all three categories for the West Bank but only the centralised wastewater treatment plants category for the Gaza Strip. In the West Bank, there are five centralised WWTPs, 13 collective wastewater treatment systems and 180 on-site wastewater treatments systems dispersed over the West Bank. The existing centralised WWTPs in Palestine are insufficient to provide the basic service to the population. Those centralised WWTPs,

if not constantly updated, modified and/or supported by additional wastewater treatment infrastructures, become obsolete and incapable of providing the expected ability to serve the population. The existing centralised WWTPs in the West Bank are Al-Bireh, Ramallah and Tulkarm. Jenin and Nablus are expected to start operating soon (Table A5.4).

In the Gaza Strip, there is another group of centralised wastewater treatment plants; Beit Lahya, Gaza and Rafah. Khan Younis currently utilises a temporary basin to achieve partial treatment (Table A5.5).

**Table A5.4 Existing centralised wastewater treatment plants in the West Bank**

Name of plant	Technology	Actual flow (m <sup>3</sup> /day)	Status of WWTP
Al-Bireh Wastewater Treatment Plant (Ramallah & Al-Bireh Governorate)	Extended aeration process	5 000	Operating well with high efficiency
Ramallah Wastewater Treatment Plant (Ramallah & Al-Bireh Governorate)	Extended aeration process	2 200	Not operating well (overloaded) and does not meet the requirements for effluent discharge
Tulkarm Wastewater Pre-Treatment Plant (Tulkarm Governorate)	Primary treatment (stabilisation ponds)	7 120	Operating well with high efficiency
Jenin Wastewater Treatment Plant (Jenin Governorate)	Aerated lagoons	9 000	Under rehabilitation
West Nablus Wastewater Treatment Plant (Nablus Governorate)	Activated sludge process	7 500	Expected to be in operation in December 2012

**Note:** Source of wastewater is domestic, commercial and industrial.

**Source:** ARIJ, 2011.

**Table A5.5 Existing centralised wastewater treatment plants in the Gaza Strip**

Name of plant	Technology	Actual flow (m <sup>3</sup> /day)	Status of WWTP
Beit Lahia Wastewater Treatment Plant (North Gaza Governorate)	Aerated facultative ponds	18 000	Overloaded; expected to be upgraded
Gaza Wastewater Treatment Plant (Gaza Governorate)	Two-ponds system (original design); upgraded in 1986, with two more ponds (aerobic and anaerobic); upgraded in 1999 with two trickling filters, aeration lagoon and drying beds	42 000	Overloaded; expected to be upgraded
Khan Younis (no wastewater treatment plant; only temporary basin)	Al Amal Storm Water Basin utilised temporarily to get partial treatment	n/a	Not enough treatment achieved
Rafah	Lagoon; upgrade will include trickling filter, aerobic pond, anaerobic pond and sludge-drying bed	8 000	Not enough treatment achieved

**Note:** Source of wastewater is domestic, commercial and industrial.

**Source:** ARIJ, 2011.

**Existing collective wastewater treatment systems**

In addition to the existing centralised WWTPs, some non-governmental organisations (NGOs) and academic institutions have established collective wastewater treatment systems in several localities that lack sewage collection networks and that depend on cesspits for wastewater disposal. Such wastewater treatment systems are composed of a sewage collection network or a vacuum truck collection system plus a collective WWTP.

**On-site small-scale wastewater treatment systems**

In addition to the existing centralised and collective WWTPs, on-site small-scale wastewater treatment plants have been established in several rural localities of the West Bank, where the dispersed pattern of houses in these rural localities makes it economically unfeasible to construct wastewater collection networks and centralised wastewater treatment plants. On-site small-scale wastewater treatment plants, which often serve a single house or building, respond to the needs and conditions in rural localities. They can solve the wastewater collection and disposal problems in such communities, along with the benefit of generating a water resource that can be utilised for irrigation purposes as land and agriculture are available.

Two types of on-site small-scale wastewater treatment systems were implemented in the West Bank, namely black and grey wastewater treatment.

**The key drivers and pressures**

- Lack of legal instruments and enforcement
- Wastewater management
- Political situation
- Bad practices that affect negatively the wastewater sector

**Responses**

## 1. Strategies

- Water Management Strategy of May 1998
- National Sector Strategy for Water and Wastewater in Palestine

## 2. Projects and achievements towards sustainable development

Ensuring sustainable development for the wastewater sector is one of the main challenges that currently face the PWA. In order to accomplish its mission, the PWA must be able to build a

sustainable wastewater sector in which the governmental and non-governmental sectors act jointly to achieve this goal. Coordination among all involved stakeholders is still needed to guarantee the implementation of projects in a satisfactory manner to achieve sustainable development. The international community is still promoting and financing a number of projects in Palestine. In many cases, the project-assigned budgets are limited and provide only partial solutions. The effect of political conditions on aid is another factor that does not contribute to achieving sustainable development in the wastewater collection and treatment sector.

All water and sanitation projects in Palestine must be approved by the Joint Water Committee. With the JWC frozen since 2010, this additional condition has considerably delayed the project planning and effective implementation.

The nature of wastewater collection and treatment projects is quite different from other projects. Such projects need to follow the topography, and the slope can mean that the best path goes through Area A, B or C. This fact limits the success and sustainability of wastewater collection and treatment projects.

**2020 outlook**

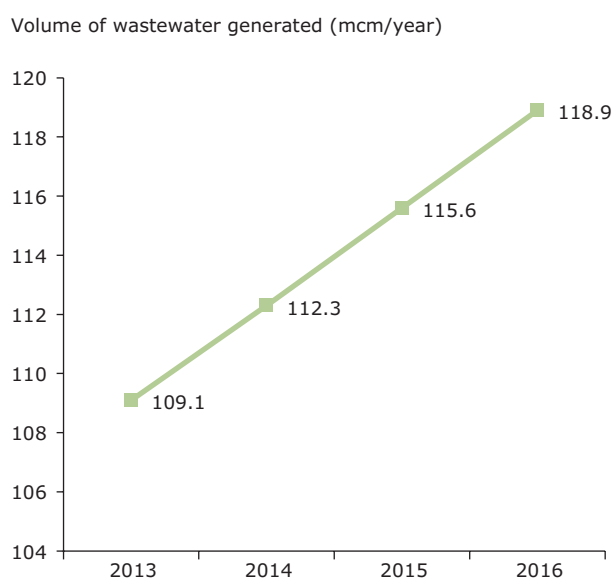
A slightly increased upward trend in the generation of wastewater is expected in the coming years (see Table A5.6 and Figure A5.5). This is consistent with population increase besides development in social and economic life.

**Table A5.6 Volume of wastewater generated in Palestine by region and year (mcm/year)**

Year	Palestine	West Bank	Gaza Strip
2013	109.1	59.2	49.9
2014	112.3	60.7	51.6
2015	115.6	62.2	53.3
2016	118.9	63.8	55.1

**Source:** Palestinian Central Bureau of Statistics, 2013a.

**Figure A5.5 Trends in wastewater generation in Palestine, 2013–2016**



**Note:** mcm = million cubic metres.

**Source:** Palestinian Central Bureau of Statistics, 2013a.

## Industrial emissions

The increased population in Palestine and the expanded human and industrial activities (especially in the absence of regulations and the specific political situation in the last 47 years) have increased the amount of smoke and hazardous gases, which include greenhouse gases, emitted into the air. Transport and the industrial sector are the major contributors to air pollution.

There are many industrial zones and industrial activities in Palestine. Certain industries emit smoke and hazardous and toxic gases in huge quantities. This has increased the level of greenhouse gases in the atmosphere. For example, some metal factories reuse motor oil as fuel, and the pottery industry uses tyres as a source of energy. In both cases, large quantities of toxic gases including CO, CO<sub>2</sub> and NO<sub>x</sub> are produced and emitted into the air. In addition, the charcoal industry produces large amounts of CO and CO<sub>2</sub>. Moreover, ozone (O<sub>3</sub>), which is a powerful greenhouse gas, is also produced from the photochemical reaction of the nitrogen and carbon molecules present in the atmosphere.

### State and impact

The Palestinian industrial sector (manufacturing and mining) plays a significant role in the economic

development of Palestine. The sector is represented by the Palestinian Federation of Industries (PFI), a private national institution. The industrial sector includes more than 17 090 registered enterprises, with more than 72 000 employed persons. The majority of the industrial enterprises are private, family-owned small enterprises employing fewer than 10 workers. The number of large industrial enterprises in Palestine is still very limited, with only about 100 of the manufacturing, mining and construction enterprises having a workforce of more than 100 employees (USAID & PFI, 2009).

The Palestinian industrial sector is categorised by a wide variety of products and services including textiles and garments, stone and marble, food processing and beverages, engineering and metal industries, chemical industries, pharmaceuticals, construction industries, handicrafts, paper and printing, furniture, footwear and leather products, and plastics. Tables A5.7 and A5.8 represent some indicators of the major industries in Palestine.

### The specific sector of the stone and marble industry

The stone and marble sector is a vital component of the Palestinian economy. Palestinian stone characteristics differ, but most Palestinian stone types meet international standards and safety specifications. The West Bank has a rich stock of good-quality stone, both soft and hard (marble), and represents the largest natural resource stock available to the Palestinian economy (USM Catalogue, 2004). There are more than 274 quarries in addition to approximately 1 000 factories and workshops in Palestine (USM, 2011). The vast majority of these quarries are located in the Hebron area, followed by the Bethlehem area. It is estimated that Palestine yields yearly more than 100 million tonnes of raw stone and about 25 million m<sup>3</sup> of stone, constituting around 4 % of the world's total production of stone and marble (USM, 2011). This industry has a yearly sales value of around USD 400 million, 60 % of which comes from exports to Israel and about 15 % from international markets, and generates approximately USD 60 million of exports. In addition, the industry supports 15 000 to 20 000 direct jobs and contributes approximately 5 % of gross domestic product (USM, 2011).

There are eight Israeli quarries in Area C of the West Bank, with an estimated annual gravel yield of 12 million tonnes (MNE & ARIJ, 2011).

From an environmental point of view, mining is considered a destructive developmental activity. The negative impacts of mining on the environment

**Table A5.7 Number of enterprises and employed persons and main economic indicators in Palestine for industrial activities, 2011**

Economic activity	Number of enterprises	Number of employed persons	Compensation of employees (USD 1 000)	Output (USD 1 000)	Intermediate consumption (USD 1 000)	Gross value added (USD 1 000)	G. F. C. F. (USD 1 000)
Industrial activities	17 090	72 022	311 978.5	2 819 352.8	1 530 266.8	1 289 086.0	66 632.1
Other mining and quarrying	247	1 766	9 044.7	101 725.3	33 536.3	68 189.0	2 243.3
Manufacture of food products	2 258	11 212	43 875.7	517 793.4	334 185.9	183 607.5	7 276.2
Manufacture of beverages	48	667	2 722.4	24 673.5	13 063.6	11 609.9	259.8
Manufacture of tobacco products	19	193	3 875.1	97 530.2	8 565.8	88 964.4	492.3
Manufacture of textiles	424	1 621	4 572.5	31 948.9	26 710.9	5 238.0	161.7
Manufacture of wearing apparel	2 058	10 853	40 433.0	89 719.6	45 782.6	43 937.0	2 681.3
Manufacture of leather and related products	466	1 985	7 173.6	46 348.9	23 304.0	23 044.9	364.0
Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	588	1 759	4 704.0	23 083.8	12 949.9	10 133.9	859.4
Manufacture of paper and paper products	93	883	5 450.3	53 166.8	33 683.3	19 483.5	822.9
Printing and reproduction of recorded media	244	1 186	5 991.6	39 042.3	21 178.2	17 864.1	1 224.7
Manufacture of coke and refined petroleum products	25	128	654.7	259.6	233.4	26.2	0.0
Manufacture of chemicals and chemical products	151	910	4 309.7	41 358.8	26 593.6	14 765.2	230.7
Manufacture of basic pharmaceutical products and pharmaceutical preparations	8	1 118	8 142.7	81 647.0	18 589.7	63 057.3	10 837.9
Manufacture of rubber and plastics products	192	2 008	8 943.1	107 988.9	74 239.6	33 749.3	1 619.6
Manufacture of other non-metallic mineral products	1 895	11 821	65 849.3	660 847.3	371 260.5	289 586.8	13 520.9
Manufacture of basic metals	32	244	888.2	4 436.4	3 050.4	1 386.0	17.7
Manufacture of fabricated metal products, except machinery and equipment	4 518	8 227	21 676.8	216 355.7	12 7039.3	89 316.4	1 970.8
Manufacture of motor vehicles, trailers	49	206	473.6	109.9	93.3	16.6	1.2
Manufacture of electrical equipment	62	482	1 557.2	16 634.5	6 278.1	10 356.4	282.0
Manufacture of machinery and equipment n.e.c.	44	586	2 984.7	31 036.3	9 462.3	21 574.0	61.0
Manufacture of motor vehicles, trailers and semi-trailers, Manufacture of other transport equipment	23	127	485.2	1 740.3	1 069.0	671.3	22.0
Manufacture of furniture	2 954	8 890	31 573.2	188 916.3	125 602.1	63 314.2	2 341.8
Other manufacturing	69	491	1 910.9	14 574.0	10 043.8	4 530.2	203.2
Repair and installation of machinery and equipment	185	330	539.0	1 962.0	487.9	1 474.1	0.0
Electricity, gas, steam and air conditioning supply	8	3 352	29 224.5	409 566.9	188 808.9	220 758.0	18 898.4
Water collection, treatment and supply	419	925	4597.7	11295.9	9479.9	1816.0	239.3
Sewerage, waste collection, treatment and disposal activities; materials recovery	11	52	325.1	5590.3	4974.5	615.8	0.0

Source: [http://www.pcbs.gov.ps/Portals/\\_Rainbow/Documents/ind\\_annual1\\_2011e.htm](http://www.pcbs.gov.ps/Portals/_Rainbow/Documents/ind_annual1_2011e.htm).

**Table A5.8 Selected indicators in Palestine for industrial activities, 2011**

Economic activity	Compensation per wage employee (USD)	Output per employed person (USD)	Output per wage employee (USD)	Value added per employed person (USD)	Value added per wage employee (USD)	Value added to output (%)	Compensation of employees to value added (%)	Depreciation to output (%)
Industrial activities	4 800.7	39 145.7	43 384.0	17 898.5	19 836.4	45.7	24.2	3.7
Other mining and quarrying	6 268.0	57 602.1	70 495.7	38 612.1	47 255.0	67.0	13.3	3.2
Manufacture of food products	4 352.3	46 182.1	51 363.3	16 376.0	18 213.2	35.5	23.9	4.8
Manufacture of beverages	4 294.0	36 991.8	38 917.2	17 406.1	18 312.1	47.1	23.4	3.1
Manufacture of tobacco products	20 078.2	505 337.8	505 337.8	460 955.4	460 955.4	91.2	4.4	1.5
Manufacture of textiles	3 199.8	19 709.4	22 357.5	3 231.3	3 665.5	16.4	87.3	2.2
Manufacture of wearing apparel	4 024.0	8 266.8	8 929.1	4 048.4	4 372.7	49.0	92.0	2.1
Manufacture of leather and related products	4 227.2	23 349.6	27 312.3	11 609.5	13 579.8	49.7	31.1	1.6
Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	3 215.3	13 123.3	15 778.4	5 761.2	6 926.8	43.9	46.4	2.8
Manufacture of paper and paper products	6 480.7	60 211.6	63 218.5	22 065.1	23 167.1	36.6	28.0	8.2
Printing and reproduction of recorded media	5 269.7	32 919.3	34 338.0	15 062.5	15 711.6	45.8	33.5	6.6
Manufacture of coke and refined petroleum products	7 702.4	2 028.1	3 054.1	204.7	308.2	10.1	2 498.9	0.0
Manufacture of chemicals and chemical products	5 023.0	45 449.2	48 203.7	16 225.5	17 208.9	35.7	29.2	1.0
Manufacture of basic pharmaceutical products and pharmaceutical preparations	7 389.0	73 029.5	74 089.8	56 401.9	57 220.8	77.2	12.9	3.1
Manufacture of rubber and plastics products	4 946.4	53 779.3	59 728.4	16 807.4	18 666.6	31.3	26.5	2.6
Manufacture of other non-metallic mineral products	6 287.5	55 904.5	63 100.1	24 497.7	27 650.8	43.8	22.7	2.5
Manufacture of basic metals	3 763.6	18 182.0	18 798.3	5 680.3	5 872.9	31.2	64.1	11.7
Manufacture of fabricated metal products, except machinery and equipment	2 994.9	26 298.2	29 891.6	10 856.5	12 339.9	41.3	24.3	3.3
Manufacture of motor vehicles, trailers	2 299.0	533.5	533.5	80.6	80.6	15.1	2 853.0	1.3
Manufacture of electrical equipment	3 672.6	34 511.4	39 232.3	21 486.3	24 425.5	62.3	15.0	3.1
Manufacture of machinery and equipment n.e.c.	5 589.3	52 963.0	58 120.4	36 815.7	40 400.7	69.5	13.8	4.7
Manufacture of motor vehicles, trailers and semi-trailers, Manufacture of other transport equipment	5 331.9	13 703.1	19 124.2	5 285.8	7 376.9	38.6	72.3	2.4
Manufacture of furniture	3 900.8	21 250.4	23 340.3	7 122.0	7 822.4	33.5	49.9	2.1
Other manufacturing	4 615.7	29 682.3	35 202.9	9 226.5	10 942.5	31.1	42.2	2.8
Repair and installation of machinery and equipment	2 929.3	5 945.5	10 663.0	4 467.0	8 011.4	75.1	36.6	11.7
Electricity, gas, steam and air conditioning supply	8 718.5	122 185.8	122 185.8	65 858.6	65 858.6	53.9	13.2	6.4
Water collection, treatment and supply	5 230.6	12 211.8	12 850.9	1 963.2	2 066.0	16.1	253.2	5.7
Sewerage, waste collection, treatment and disposal activities; materials recovery	7 740.5	107 505.8	133 102.4	11 842.3	14 661.9	11.0	52.8	0.5

Source: [http://www.pcbs.gov.ps/Portals/\\_Rainbow/Documents/ind\\_annual1\\_2011e.htm](http://www.pcbs.gov.ps/Portals/_Rainbow/Documents/ind_annual1_2011e.htm).

are generally large. They can involve deforestation and other damage to or destruction of the natural vegetation, in addition to significant disturbance to wildlife. Leakage from the disturbed stone-cutting facilities into groundwater could contaminate surface water as well as groundwater. Moreover, when the used water runs into the soil, it could affect soil stability and cause erosion. Other considerations include dust, noise and air pollution. Large amounts of particulate materials and dust are produced from quarries and stone-cutting facilities, and many of them are located near residential areas. Particulate materials cause health problems, especially in the respiratory system.

### Air pollution in Palestine

Palestine suffers from substantial air pollution, especially in urban areas and their vicinities. In Palestine, transboundary air pollutants, industrial activities, population growth and the increase in the number of vehicles are the key reasons for deteriorating air quality. However, data about the concentration of the air pollutants or their types are not available because Palestine lacks air quality monitoring stations.

Recently, the Palestinian Central Bureau of Statistics published data about emissions into the air (Palestinian Central Bureau of Statistics, 2012) based on 2006 calculations by the Intergovernmental Panel on Climate Change. The calculations deal with the energy, solid waste and agriculture sectors, but, due to a lack of the requisite data, not the industrial sector.

### Solid waste

Solid wastes refer to a variety of discarded solid and semisolid materials, not liquid or gases, which are deemed useless or worthless (Weiner and Matthewa, 2003). The discarded materials in question include waste from homes, shops, public places, hospitals and other community services. Municipal solid waste (MSW), which consists of all materials discarded by the community, represents the major part of the solid waste produced, whereas 'refuse', which is the fraction of MSW produced in domestic households, is mostly food waste (Weiner and Matthewa, 2003).

As a result of rapid global urbanisation and industrialisation, the amount and variety of waste generated is continuously increasing, and the handling and disposal of these wastes is regarded as an urgent task for societies, especially given that providing an attainable standard of life is recognised as a human right.

### State and impacts

The Palestinian National Authority (PNA) has worked to develop the sector in an attempt to compensate for the lack of infrastructure, services and equipment in several localities. Different projects in cooperation with external donors have been conducted throughout Palestine. Equipment has been supplied to several local authorities, and projects such as sanitary landfills have also been undertaken. However, this sector still needs further funding and projects to achieve sustainable development.

### Waste generation

According to the Palestinian Central Bureau of Statistics (PCBS), the total population of Palestine in mid-2012 was estimated at 4.293 million, and approximately 1.512 million tonnes of solid waste were generated in the same year (2012).

The average per capita solid waste generation rate in Palestine is approximately 0.91 kg/day. Table A5.9 and Figure A5.6 show the total amount of solid waste generated in Palestine for the years 2003 to 2012.

A slight upward trend in the generation of solid waste can be observed in the later years, which reflects the population increase and the slight development in the quality of social and economic life.

It should be noted that waste generation and waste management are influenced by political, legal,

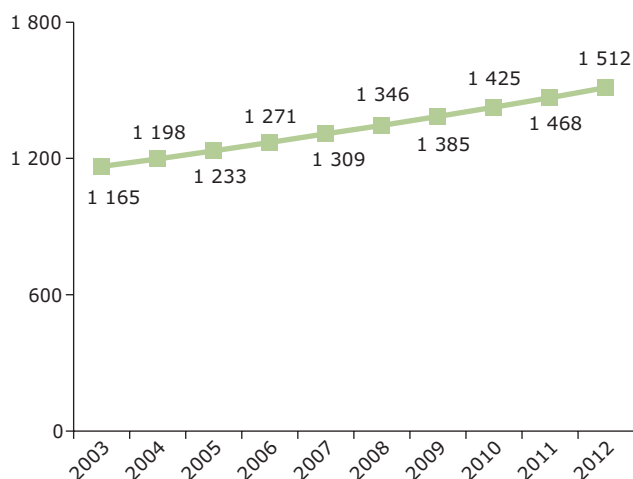
**Table A5.9 Quantity of solid waste generation in Palestine by region and year (1 000 tonnes/year)**

Year	Palestine	West Bank	Gaza Strip
2003	1 165	716	449
2004	1 198	735	463
2005	1 233	754	479
2006	1 271	775	496
2007	1 309	796	513
2008	1 346	817	529
2009	1 385	839	546
2010	1 425	861	564
2011	1 468	884	584
2012	1 512	908	604

**Source:** Palestinian Central Bureau of Statistics, 2013. Solid waste database, unpublished data. Ramallah, Palestine.

**Figure A5.6 Trends in solid waste generation during the period 2003-2012 in Palestine**

Quantity of solid waste generation (1 000 tonnes/year)



**Source:** Palestinian Central Bureau of Statistics, 2013. Solid waste database, unpublished data. Ramallah, Palestine.

sociocultural, environmental and economic factors, as well as available resources. These factors have interrelationships that are usually complex in waste management systems (Abu Qdais, 2007; Kum et al., 2005). Obviously, the current situation in Palestine has greatly influenced the waste generation rate, as the aforementioned judgment would suggest. In this regard, waste generation in Palestine varies according to the community's classification (Table A5.10), i.e. urban or rural (1.05 kg/capita/day or 0.7 kg/capita/day respectively). The higher rate was found in urban communities and the main cities, which can be attributed to higher living standards and greater economic activity than in rural communities.

Family size and income level also have a major effect on the rate of solid waste generation, so that a large family with a low income produces less waste than

**Table A5.10 Quantity of solid waste generation in Palestine by type of locality (1 000 tonnes/year)**

Region/locality type	Quantity of solid waste
<b>Palestine</b>	<b>1 512.0</b>
Urban	1 214.3
Rural	297.7

**Source:** Palestinian Central Bureau of Statistics, 2013. Solid waste database, unpublished data. Ramallah, Palestine.

a smaller family with a higher income (Al-Khatib and Arafat, 2010). It is estimated that the average Palestinian household produces almost 3.0 kg/day of solid waste (PCBS, 2011).

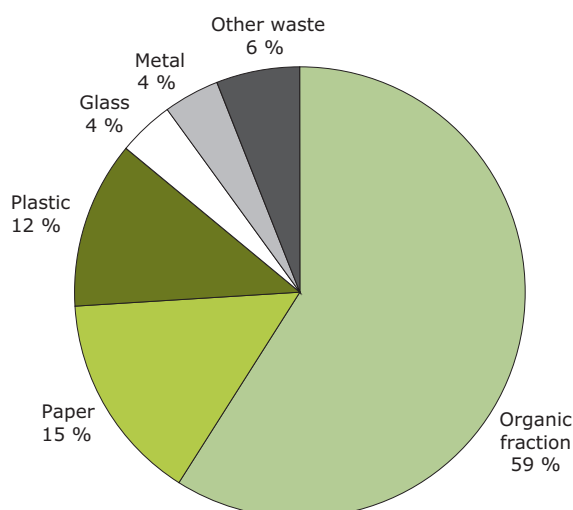
#### Physical composition of solid waste

The physical composition of solid waste plays a major role in the management of such materials, since the characteristics and components of the waste determine the best way to handle it. However, solid waste composition varies from one community to another (see Figure A5.7), as well as over time within any given community. As Palestine is still under Israeli occupation, Israel controls Palestinian activities, and this control hampers the development of various industries and commercial activities.

Accordingly, the waste generated mostly represents municipal waste, about half of which comes from households (about 50 %). Food waste, or organic fractions, represents the major part of the waste generated, accounting for almost 59 % of solid waste, although other studies have indicated a higher percentage for this fraction (Al-Khatib and Arafat, 2010). The remaining waste consists of paper, carton and cardboard, plastic, glass, metals, wood and other materials. The percentages of these components are illustrated in Figure A5.7.

As has already been pointed out, the gross composition of solid waste may be the most important characteristic affecting its disposal or the recovery from it of materials and energy.

**Figure A5.7 Physical composition of solid waste in Palestine**



**Source:** ARIJ (Applied Research Institute, Jerusalem), 2009.

### Waste collection

In Palestine, the number of non-served communities was 166 according to the PCBS in 2005; however, the number had dropped to 79 in 2010, which shows an improvement in the services provided (Table A5.11 and Figure A5.8). Currently, around 95.0 % and 86.2 % of households receive a solid waste collection service in the West Bank and the Gaza Strip respectively (PCBS, 2011), and about 54.4 % of households receive this service three times or fewer per week (PCBS, 2011).

The local authorities collected solid waste for 74.5 % of households in Palestine in 2011, compared with 71.8 % in 2009. The United Nations Relief and Works Agency for Palestine Refugees in the Near East

(UNRWA) collected for 8.5 % of households in 2011 compared with 8.2 % in 2009 (PCBS, 2011).

Solid waste from homes, institutions, shops, etc. is usually collected manually in plastic bags and transported to steel containers (ranging in capacity between 800 and 1 000 litres) or large bins (with capacities ranging between 5 and 6 cubic metres). These are distributed in the cities and towns to be transported later by compactors or trucks to the dumping sites or transfer stations which form part of the collection system.

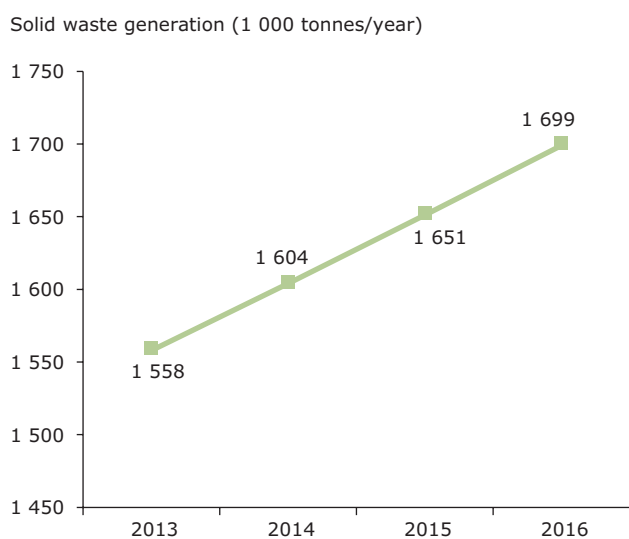
This is the case for major towns and cities. For small villages, the service is different, as there are neither containers nor compactors for waste collection. People in these communities use door-to-door manual collection and tractors to collect waste, usually once a week.

**Table A5.11 Projected quantities of solid waste generation in Palestine by region and year (1 000 tonnes/year)**

Year	Palestine	West Bank	Gaza Strip
2013	1 558	932	626
2014	1 604	957	647
2015	1 651	982	669
2016	1 699	1 007	692

**Source:** Palestinian Central Bureau of Statistics, 2013. Solid waste database, unpublished data. Ramallah, Palestine.

**Figure A5.8 Trends in solid waste generation during the period 2013–2016 in Palestine**



**Source:** Palestinian Central Bureau of Statistics, 2013. Solid waste database, unpublished data. Ramallah, Palestine.

### Solid waste disposal

In Palestine, lack of proper management and enforcement regarding solid waste, along with Israeli measures, pose a threat to the environment and public health. The relationship between the improper management of solid waste and human disease is intuitively clear.

Dumping of solid waste in open, uncontrolled, unmonitored sites is the dominant method of waste management in the majority of local authorities in Palestine. It is estimated that there are more than 160 random dumping sites scattered throughout Palestine, and none of them was constructed with regard to environmental considerations (Al-Khatib and Arafat, 2010; PCBS, 2009). Normally, burning is the standard method to reduce the volume of waste at these dumping sites, regardless of the negative effects which result. The burning of solid waste is the biggest source of exposure to smoke in Palestine, where the proportion of households exposed to smoke is 26.3 % (PCBS, 2011).

The number of dumping sites increased after the Second Intifada due to the restrictions imposed on movement. For example in 2001, there were 137 dumping sites in Palestine (PCBS, 2001), and more than 183 by 2006. However, the construction of new, central waste management projects such as Zahrat Al-Finjan has reduced the number of these random dumping sites.

Improper disposal of waste causes numerous problems for the ecosystem, including damage to soil, water, air, etc., through leachate infiltration. In this regard, Friends of the Earth Middle East (FoEME)



released an investigative report several years ago called 'A Seeping Time Bomb: Pollution of the Mountain Aquifer by Solid Waste'.

The unsustainable disposal of solid waste has resulted in the percolation of toxic substances, including chloride, arsenic and heavy metals such as cadmium, mercury and lead, into the groundwater. Furthermore, the results obtained by Alslaibi et al. (2011) for Deir Al-Balah and Gaza landfills demonstrated that most of the wells investigated were contaminated by leachate, and the concentrations of contaminants were above the acceptable standard levels. In this context, it is worth highlighting that the projected cost of diseases arising from the improper management of solid waste in the West Bank over the course of the next 20 years is estimated at USD 909 million (ARIJ (Applied Research Institute, Jerusalem), 2005).

### *Key drivers and pressures*

In Palestine, population growth, which is approximately 2.96 % (PCBS, 2012), and rising living standards have resulted in an increase in the amount of solid waste being generated. Fortunately, a comprehensively integrated strategy for solid waste management has recently been developed and is currently being implemented in an attempt to reduce the adverse effects resulting from mismanagement of this waste. The political situation (separation wall, restrictions in movement of goods and persons) exert also some constraints in the development of a proper solid waste management system in Palestine.

### *Responses*

As mentioned before, solid waste management within Palestine has seldom been given the attention it deserves. On the contrary, throughout the occupation period Israeli actions have resulted in various environmental problems.

The Palestinian environment has been neglected, with scant regulation and insufficient investment in the infrastructure needed to develop this sector. This behaviour on the part of Israel ignores Palestinian rights, since promoting and protecting the environment is directly linked to the promotion and protection of human rights within the context of sustainable human development, as established in the Stockholm Declaration (1972): 'Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being.'

Since the establishment of the PNA, various efforts have been directed towards addressing issues concerning the environment in an attempt to redress their past neglect, with the introduction of proper planning and adequate laws and policies regarding the waste management sector. Palestinian Environmental Law No 7 was approved by the Palestinian Legislative Council in 1999 (MEnA, 1999). The first chapter of the second section of this law deals with issues relating to solid waste in several articles, specifically Articles 7 to 10. Furthermore, the PNA, in spite of Israeli restrictions, has worked to develop the environmental sector, so that the approval of laws was followed by several steps designed to create a sustainable solid waste management system and carry out the most pressing improvements. In fact, the JCs created for solid waste management have developed the services provided; however, achieving optimal results in this field will require further efforts and funding (MoLG, 2004).

Presently, JCs for solid waste management in the West Bank are responsible for the main sanitary landfills, Zahrat Al-Finjan (in operation), Ramoun (planned) and Al-Minya (under construction). Information about the situation in the Gaza Strip is not fully available owing to the current political discord and discontinuity; however, three main sanitary landfills are in operation to serve the area. These landfills are Jaher Al-Dik, Deir Al-Balah and Rafah. Jaher Al-Dik has a liner and leachate collection system, but Deir Al-Balah and Rafah landfills were built on impermeable ground without liners (Al-Najar, 2004).

The PNA also developed the Palestinian Environmental Strategy (2000–2003) in cooperation with the Netherlands Development Agency, whereby solid waste management was recognised as one of the most urgent environmental priorities needing to be improved to reduce the environmental impacts resulting from waste mismanagement. Subsequently, the National Environmental Action Plan (NEAP) was developed, based on the previous strategy and setting out action and projects necessary to solve or alleviate environmental problems in Palestine. The implementation of the environmental projects proposed in the NEAP faced several obstacles associated with the practices of the Israeli occupation authorities, which intensified following the outbreak of the Second Intifada in September 2000. In this regard, the geographical discontinuity created between communities under Palestinian control through the implementation of Israeli segregation plans and the construction of the segregation wall has hampered

the implementation of several centralised projects relating to the management of solid waste (ARIJ, 2007).

Ultimately, and in accordance with Palestinian Ministerial Cabinet Decision No 53 (2008), a National Strategy for Solid Waste Management (NSSWM) was issued. The document was produced and endorsed by the Ministerial Cabinet on 16 May 2010. The project was supported by the German Federal Government, through the German Technical Cooperation (GTZ) solid waste management programme. This new strategy aims to define the development path for Palestinian solid waste management by 2014. The vision, strategic objectives and sectoral policies set out in the strategy are aligned with the national development goals and common vision for establishing a Palestinian State seen in the 2009 plan 'Palestine: Ending the Occupation and Establishing the State'.

This national strategy is considered to be the first cross-sectoral strategy for solid waste management in Palestine. It constitutes the reference point and strategic framework for all decisions, programmes, activities and medium-term investment plans, aiming to develop the solid waste sector in the years to come (PNA, 2010b).

Unfortunately, the political situation and illegal Israeli measures in Palestine generally impede the planning and implementation of several projects (especially in Area C) and hinder the promotion of sustainable development in the foreseeable future. The PNA is trying to improve the situation and some progress has been made, with more efforts being directed at developing the services provided. However, the PNA still suffers from limited sovereignty over the land. For instance, it does not have the right to plan or implement any project on land in Area C, as this is beyond its control (both civilian and military). Even in Area B, where the PNA has civilian control, permits must be obtained from the Israeli authorities for these projects.

### *2020 outlook*

A slight upward trend in the generation of solid waste is expected in the next few years, in accordance with the population increase and the development in quality of social and economic life.

Proper solid waste management is an important issue because of its impact on the environment. Until now, the integrated and optimised solid

waste management plan has been only partially implemented in Palestine. Waste management practices in Palestine are limited to the collection of the gross solid waste generated, the transportation of the waste collected and finally its disposal in dumping sites which are largely unsanitary, with the exception of the newly established ones such as Zahrat Al-Finjan, which serves the northern West Bank Governorates and the city of Ramallah.

In recent years, the solid waste sector has been one of the main priority sectors supported by the Palestinian government. Some good steps have been taken, such as preparing and publishing the National Strategy for Solid Waste Management (NSSWM) for 2010–2014 and issuing the medical waste by-law, in addition to preparing a national plan for hazardous waste management. It is hoped that the new strategy (NSSWM 2010–2014) will improve the situation and result in the provision of better services. The assessment of the current practices concerning solid waste management in Palestine pointed out several areas which need to be improved, as described in the 2010–2014 NSSWM.

For instance, the institutional framework still lacks effective and updated legislation governing the SWM sector, in addition to the insufficient financial, human and organisational capacities of institutions involved in management of this sector. The absence of a comprehensive system for authentication and analysis of data is a weak point in the management process. Furthermore, the currently insufficient monitoring and evaluation systems must be improved upon.

Regarding technical issues, in spite of the financial assistance provided by several donors, which has made an important contribution to waste management in Palestine, this sector still requires further investment in both infrastructure and management practices.

The open dumping of solid waste is still a widespread practice in Palestine, and this problem necessitates the closure and/or rehabilitation of these random dumping sites to eliminate their negative environmental, health and aesthetic effects. Furthermore, there is a strong need for initiatives and expertise in waste minimisation, reuse and recycling, and recovery. One of the main problems of the random dumping sites is the presence of hazardous waste, particularly in industrial areas, as there is no separation at source.

Options for reuse and recovery have to be put on the table to minimise the growing amount of waste.

Sanitary landfills should be viewed as the ultimate means of disposal of all types of residual, residential, commercial and institutional waste, as well as unutilised MSW from waste-processing facilities and other types of inorganic waste and inert matter that cannot be reused or recycled in the foreseeable future. Sanitary landfills are a known method of waste disposal in Palestine: one sanitary landfill has been in operation since 2008 (Zahrat Al-Finjan); one is about to commence operation (Al-Minya, which is in the south of the West Bank and will serve Bethlehem and Hebron Governorates); one is under preparation, and two in Gaza are under proposal.

During Horizon 2020 activities, the stakeholders in these landfill sites are being exposed to the experience of EU countries inside and outside the Mediterranean area in a way that gives them the opportunity to learn about the best practices in those countries. In addition, small steps are to be taken and projects conducted in relation to recovery and composting. For instance, the Palestinian Agricultural Relief Committees (PARC) signed an agreement with Marj Bin Amer municipality to construct a composting plant. The project falls within the framework of the twinning of Jenin Governorate and Modena in Italy through the Nixsos Organisation.

In the case of some localities, the inability of local authorities to recover management costs is the main constraint against the development of solid waste management services, which threatens their sustainability.

Unfortunately, only limited cost estimates have been developed regarding efforts to mitigate environmental and health effects. Cost estimates were carried out by Palestinian NGO ARIJ (Applied Research Institute, Jerusalem) and the EU. ARIJ predicted the cost of diseases arising from mismanagement of solid waste for the next 20 years as USD 909 million (ARIJ, 2005), while the EU report OPT-ENPI Benefit Assessment estimated the annual benefits from improving waste management at between EUR 41.7 million and EUR 166.6 million.

Solid waste as a pollution source will continue to be a major cause for concern in the near future, encompassing all aspects of solid waste: domestic, industrial, medical and hazardous.

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