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Baseline Report – Bint Jbeil Caza

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TABLE OF CONTENTS

TABLE OF CONTENTS **2**

LIST OF FIGURES **4**

LIST OF TABLES **5**

LIST OF ANNEXES **6**

LIST OF ABBREVIATIONS **7**

1. BINT JBEIL PROFILE **10**

1.1. District Structure and Administrative Divisions 10
1.1.1. Union of Municipalities 12
1.1.2. Palestinian Camps Governance 12
1.1.3. Active NGOs in Bint Jbeil 12
1.2. Urbanization Dynamics & Existing Urban policies 13
1.3. Demography 16
1.3.1. Population Density 16
1.3.2. Expatriates in Nabatiyeh Governorate 17
1.3.3. Lebanese Citizens 18
1.3.4. Palestinian Refugees 22
1.3.5. Syrian Refugees 22
1.3.6. Total Population in Bint Jbeil District 23
1.3.7. Future Population Growth 23
1.4. Natural, Cultural and Archeological Characteristics of Bint Jbeil District 25
1.5. Economic activities 28
1.5.1. Agriculture 28
1.5.2. Industry 30
1.5.2.1. Summary of the Competitive Advantages in Nabatiyeh Governorate 30
1.6. Accessibility & Roads Network 31

2. MSWM PRACTICES IN BINT JBEIL DISTRICT **33**

2.1. Stakeholder Analysis & Institutional Arrangement 33
2.2. MSW Characterization 35
2.2.1. Sources, Types and quantities of MSW 35
2.2.1.1. Healthcare waste 36
2.2.1.2. Restaurants waste 37
2.2.1.3. E-Waste 37
2.2.1.4. Tires Waste 39
2.2.1.5. Industrial Waste 39
2.2.2. Composition 39
2.2.3. Waste generation trends 41
2.2.4. Waste Quantities 41
2.2.4.1. Approach 1 41

2.2.4.2. Approach 2 41
2.2.4.3. Waste Quantities – Summary 42
2.3. Storage, collection and street sweeping 42
2.3.1. Storage 42
2.3.2. Waste collection 44
2.3.3. Street sweeping 47
2.4. Waste Treatment 47
2.5. Ultimate Means of Disposal 51
2.5.1. Existing dumpsites 51

3. FINANCIAL ANALYSIS OF EXISTING MSWM SYSTEM 56

3.1. Sources of financing 56
3.2. Cost of Operation of existing system 57
3.3. External costs 59
3.3.1. Environmental damages 59
3.3.2. Health damages 61
3.4. Total costs 62

4. EXISTING PUBLIC AWARENESS & EDUCATION PROGRAMS ON MSWM 63

5. PUBLIC PRIVATE PARTNERSHIPS 63

6. THE BASELINE OF BINT JBEIL IN BRIEF 65

ANNEX 1 – HEALTH IMPACTS OF DUMPSITES 69

Introduction 69
Conceptual framework 69
Municipal waste 72
Hazardous waste 76
Health-care waste 79
E-waste 81
Open burning 85

ANNEX 2: PPP PROCEDURE 88

ANNEX 3: LIST OF DATABASE USED IN THE BASELINE REPORT 90

LIST OF FIGURES

FIGURE **PAGE**

1. Bint Jbeil District Location and Size (IDAL, 2017) 10
2. Municipalities within the District of Bint Jbeil 11
3. State of Urbanization in Lebanon 14
4. Ribbon sprawl in Nabatiyeh City 15
5. Ribbon sprawl in Bint Jbeil City 15
6 Percentage of Land Cover (UN Habitat, 2010) 16
7. Population density in Bint Jbeil District 16
8. Origin of Lebanese Emigrants (Information International, 2001) 17
9. Distribution of the number of household members in Nabatiyeh governorate 21
10. Syrian Refugees distribution in Lebanon (UNHCR 2017) 23
11. Estimation of Population in Bint Jbeil District 24
12. Map of Nabatiyeh Governorate Touristic Attractions (IDAL, 2017) 25
13. Thursday Market at Bint Jbeil 26
14. Maroun Ar Rass Valley 26
15. Public Garden in Bint Jbeil 27
16. Tebnine Castle in Bint Jbeil 28
17. Land use map of Nabatiyeh 29
18. Nabatiyeh cultivated land per produce (IDAL, 2017; MoA) 30
19. Roads leading to Bint Jbeil 32
20. A typical waste composition in a restaurant as per USEPA 37
21. Average household monthly income per capita at District Level (UNHCR et al. 2016) 40
22. The sorting table and the shredders at Kherbet Selem Facility 48
23. Aytaroun Municipal Solid Waste Sorting and Composting Plant Design Scheme (MORES, 2011) 50
24. MSW dumpsites in Bint Jbeil District and other areas of South Lebanon 55
25. Waste flow diagram in Bint Jbeil District 65

LIST OF TABLES

TABLE **PAGE**

1. Number of UN Agencies and NGOs that are active in Bint Jbeil District 13
2. Active NGOs in South of Lebanon 13
3. Lebanese Residents Population as reported by the Heads of the Municipalities of the Bint Jbeil Federation 18
4. Different approaches used to estimate the population of the Bint Jbeil District 19
5. Uncertainties associated with the population estimation approaches 21
6. Average family size calculations based on the data provided by the Municipalities of the Bint Jbeil Federation 22
7. Total Population in Bint Jbeil District 23
8. Attractions in Bint Jbeil District (Promenade, 2017) 25
9. Summary of Advantages in Nabatiyeh Governorate 31
10. Classification of the sources and types of solid wastes 35
11. Health care facilities in Bint Jbeil Districts (MoPH, 2018) 36
12. Types of E-waste accepted at Collection Points (Beeatoona, 2012) 38
13. E-waste collection points in Nabatiyeh managed by Beeatoona (Beeatoona, 2012) 38
14. Waste composition in Baabda & Shouf (Ramboll Study) 40
15. Approaches adopted to estimate the waste quantities 41
16. Daily Generated Waste Quantities 42
17. Average family size calculations 43
18. Summary of existing waste collection services 44
19. Labour in some Municipalities of the District 45
20. Sufficiency of the available bins for selected municipalities 46
21. Waste collected per worker 46
22. Waste sorting and disposal practices in Bint Jbeil 49
23 - Municipal composting plants in Bint Jbeil (Abbas et al. 2017) 51
24. Number and Volume Variation of Different Dumpsites in the District of Bint Jbeil 52
25. Lists of all MSW dumpsites identified in Bint Jbeil Caza 53
26. Lists of all CDW dumpsites identified in Bint Jbeil District 55
27. Indications for the operational cost of the current MSWM scheme 58
28. Cost of operation of the current MSWM scheme 59
29. Monetization of dumpsites environmental impacts 61
30. Total cost of waste management in the district of Bint Jbeil 62
31. Main provisions of Law No 48 64
32. Waste Management in the district of Bint Jbeil in brief 66

LIST OF ANNEXES

ANNEX	DESCRIPTION	PAGE
Annex 1	Health Impacts of Dumpsites	69
Annex 2	PPP Law Procedure	88
Annex 3	List of Documents Used	90

LIST OF ABBREVIATIONS

$	dollars
%	Percentage
AC	Air Conditioning
AUB	American University of Beirut
BDC	
BML	Beirut Mount Lebanon
BOT	Build–operate–transfer
C/N	Carbon-to-nitrogen ratio
cap	capita
CAPEX	Capital Cost Expenditures
CAS	Central Administration of Statistics
CBO	Community-based Organization
CDW	Construction and Demolition Waste
Cf.	confer/conferatur
CFU	Colony Forming Unit
Cr	Chromium
Cu	Copper
d	Day
dm	Dry mass
E. Coli	Escherichia Coli
e.g.	Example
ELARD	Earth Link and Advanced Resources Development S.A.L
Etc.	etcetera
EU	European Union
EU DG Environment	European Union Directorate General for the Environment
G	Grams
H	Height
ha	Hectare
HCW	Health Care Waste
HDPE	High Density Polyethylene
Hg	Mercury
HH	Household
IMFU	Independent Municipal Fund
IRS	Informal Recycling Sector
Kg	Kilograms
Km^2	Kilometer Square
LBP	Lebanese Pound
LDPE	Low Density Polyethylene
LMSEP	Lebanon Municipal Service Emergency
lt	liters
m	meter

m^2	Meter Square
m^3	Meter Cube
m^3/s	Meter cube per second
MBT	Mechanical Biological Treatment
MG	Milligrams
MoE	Ministry of Environment
MoIM	Ministry of Interior and Municipalities
MoSA	Ministry of Social Affairs
MPN	Most Probable Number
ms/cm	Millisecond per centimeters
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NGO	Non-Governmental Organization
Ni	Nickel
NIMBY	Not in My Back Yard
No/Nb.	Number
NPMPLT	National Physical Master Plan of the Lebanese Territory
O&M	Operation and Maintenance
OMEX	Operations and Maintenance Expenditures
OMSAR	Office of the Minister of State for Administration Reform
Pb	Lead
PDT	Prioritization Decision Tool
PET	Polyethylene terephthalate
pH	potential of hydrogen
PHC	Primary Health Care
PPE	Personal Protective Equipment
PPP	Public Private Partnership
rpm	Run per minutes
RSI	Risk Sensitivity Index
RTO	Regional Technical Office
SSRDP	Strategic Sustainable Regional Development Plan
Tons/u	Tons per Atomic Mass Unit
TV	Television
UN	United Nations
UNDP	United Nations Development Program
UNIFIL	United Nations Interim Force in Lebanon
UNRWA	United Nations Relief and Works Agency
UoM	Union of Municipalities
UoTM	Union of Tyr Municipalities
US	Unites States
Vs.	Versus

W	Width
WEEE	Waste Electrical and Electronic Equipment
WM	Waste Management
WWTP	Waste Water Treatment Plant
y	year
YMCA	Young Men's Christian Association
Zn	Zinc

1. Bint Jbeil Profile

Bint Jbeil District is one of the four Districts that constitute the Nabatieh Governorate in South Lebanon. It is composed of a total of 36 municipalities. The socio-economic activities of the district are of a similar nature to those prevailing in the Tyr District.

In terms of general characteristics, the District covers a surface area of the order of approximately 264 km^2. It located on the Southern international border of Lebanon and is bordered by Tyr district from the North and the West and the Marjeyoun district from the East (Localiban, 2017). Bint Jbeil, the Capital of Bint Jbeil District, is located at an altitude of 770m from sea level and is at 120 km away from Beirut the Capital (Bint Jbeil, 2017).

1.1. District Structure and Administrative Divisions

Bint Jbeil as a District is part of Nabatieh Governorate which comprises three other districts (Nabatieh, Hasbaya & Marjeyoun). Nabatieh District is the administrative center or capital of Nabatieh Governorate and the Bint Jbeil village is that of the capital of Bint Jbeil District which expands on an area of 264 km^2 out of the 1,058 km^2 which constitutes the Nabatieh Governorate (Figure below).

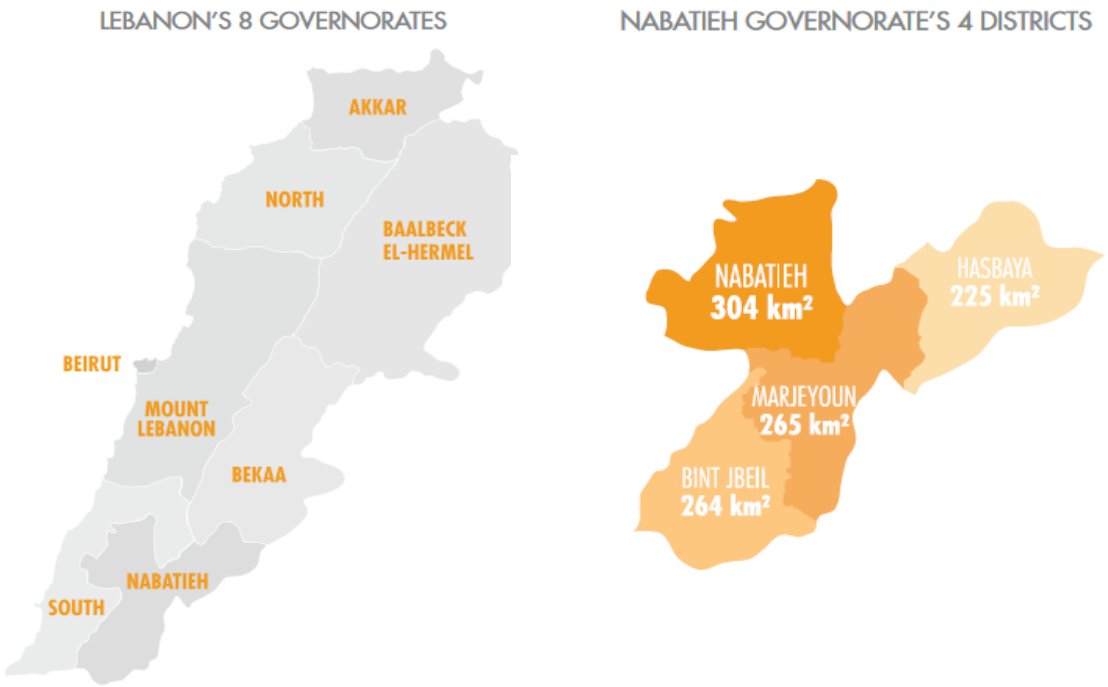


Figure 1. Bint Jbeil District Location and Size (IDAL, 2017)

There is some kind of discrepancy in relation to the number of municipalities within the Bint Jbeil District. On one hand, the data center on local development in Lebanon reports a total of 38 Municipalities (LocaLiban, 2017) (Figure below). On the other hand, a total of 36 Municipalities (excluding Deir Kifa and Niha villages) is reported by both the data center (also) and the Federation of Bint Jbeil District. Additionally, the Bint Jbeil Caza site reports a total number of 42 municipalities (Bint Jbeil, 2017). The reason behind such a divergence might be associated to some villages/localities which do not have a municipal council.

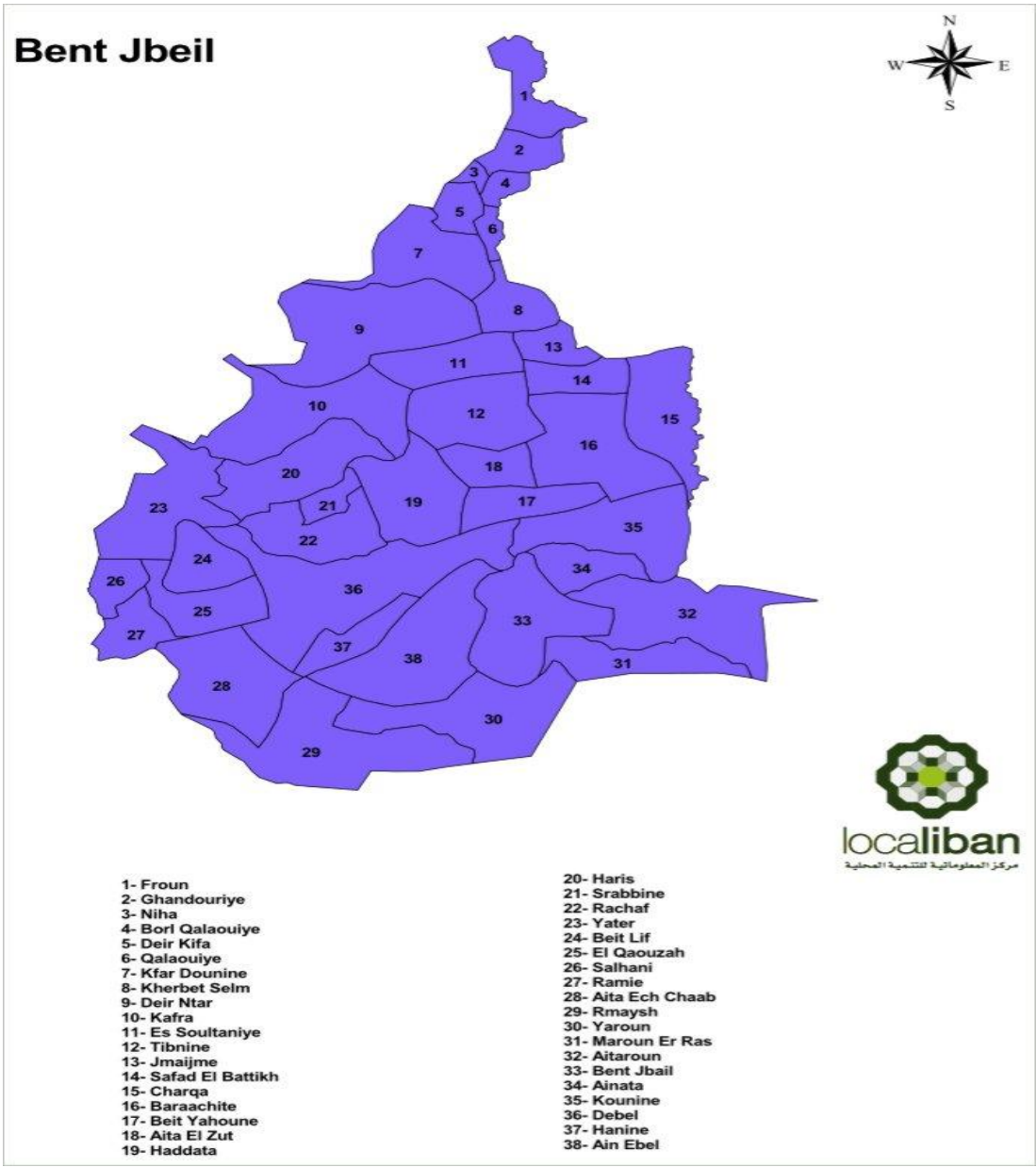


Figure 2. Municipalities within the District of Bint Jbeil

1.1.1. Union of Municipalities

The Lebanese law advocates adjoining municipalities to confederate into 'unions'. The legislative framework governing the establishment of unions of municipalities as well as the constraints impeding their proper operations are elaborated in the national baseline report.

In Bint Jbeil, a Federation of Municipalities was established on 04/01/2005, by the decree number 13941 as a local authority and having its administrative center within the district of Bint Jbeil. It originally encompassed 8 municipalities. Recently and as confirmed by the Head of the Federation of Municipalities of Bint Jbeil, the number of Municipalities constituting the Federation increased to 15.

The total number of municipalities that are members of Federation constitute 40% of the total number of municipalities in the District.

1.1.2. Palestinian Camps Governance

The Palestinian camps have their own governance systems mainly comprising popular committees, local committees and political factions. The camp management system involves local and international organizations which provide key services. UNWRA is the main provider of services in Lebanon's official camps. UNRWA is mandated under the United Nations General Assembly Resolution Nb. 302, to provide to all Palestinian Refugee Camps in Lebanon direct relief and work programs including upgrading of basic urban services e.g., water, sewage, electricity, and road networks; the delivery of social services e.g., education health, and social protection, that being exclusively delivered to Palestinians.

In the last decade, women's leagues known as 'al lajna an-sina'iyyah' have been formed in camps, which mainly contribute to health awareness and education (UN-Habitat & UNDP 2014).

1.1.3. Active NGOs in Bint Jbeil

According to the OCHA, the number of UN agencies and NGOs that are active in the area is as shown in the below table.

Table 1. Number of UN Agencies and NGOs that are active in Bint Jbeil District

Saida	-	4	4	3	5	5	3	8	9	7	5
Tyre	-	4	4	5	7	4	5	5	9	7	6
El Nabatieh	-	2	3	3	6	4	3	5	6	3	3
Bent Jbeil	-	3	1	3	5	2	3	2	6	3	2
Marjaayoun	-	2	3	2	4	1	2	2	6	5	1

The below table summarizes the NGOs that are active in the District of Bint Jbeil along with the sector of activities.

Table 2. Active NGOs in South of Lebanon

Sector of activities	Active NGOs & International Organizations
Child Protection	FHS-UOB; INTERSOS; MercyCorps; UNHCR;UNICEF
Energy and Water	FHS-UOB; INTERSOS; MercyCorps; NRC; UNHABITAT; UNHCR
Food Security	ACF; CLMC; DRC; IRW; SHEILD; UNHCR; WFP
Health	ACF; Amel; Beyond; Blue Mission; Caritas Lebanon; CCP JAPAN; Global Smile Foundation; ME; ICRC; IMC; IOCC; IOM; LAECD; LFPADE (as UNFPA IP); LRC; MAP; MoPH Lebanon; MoSA; MSSCF (as UNFPA IP); Orienthelfer; UNFPA; UNHCR; UNICEF; UNRWA; URDA Lebanon; WHO; YMCA
Livelihoods	FHS-UOB; ACF; UNHCR; IOM; UNDP
Shelter	CISP; NRC; SHEILD; Solidar Suisse; UNHCR
Social Stability	CRIC; UNDP; MOSA – UNDP; DPNA; SFCG; UN-Habitat

1.2. Urbanization Dynamics & Existing Urban policies

Lebanon has and still is witnessing a fast and unrestrained urban growth and sprawl. The uncontrolled urban expansion is due to limited enforcement of planning regulations. Figure 3 represents the state of urbanization in Lebanon where Beirut constitutes the biggest agglomeration.

Nabatiyeh Governorate is characterized by inland agglomerations, most of which are present in the Nabatiyeh District. These inland agglomerations constitute 8% of the total population in the Governorate. However, it is to be noted that the Nabatiyeh Governorate is the least population governorate in Lebanon, with Bint Jbeil District holding 24% of the governorate population.

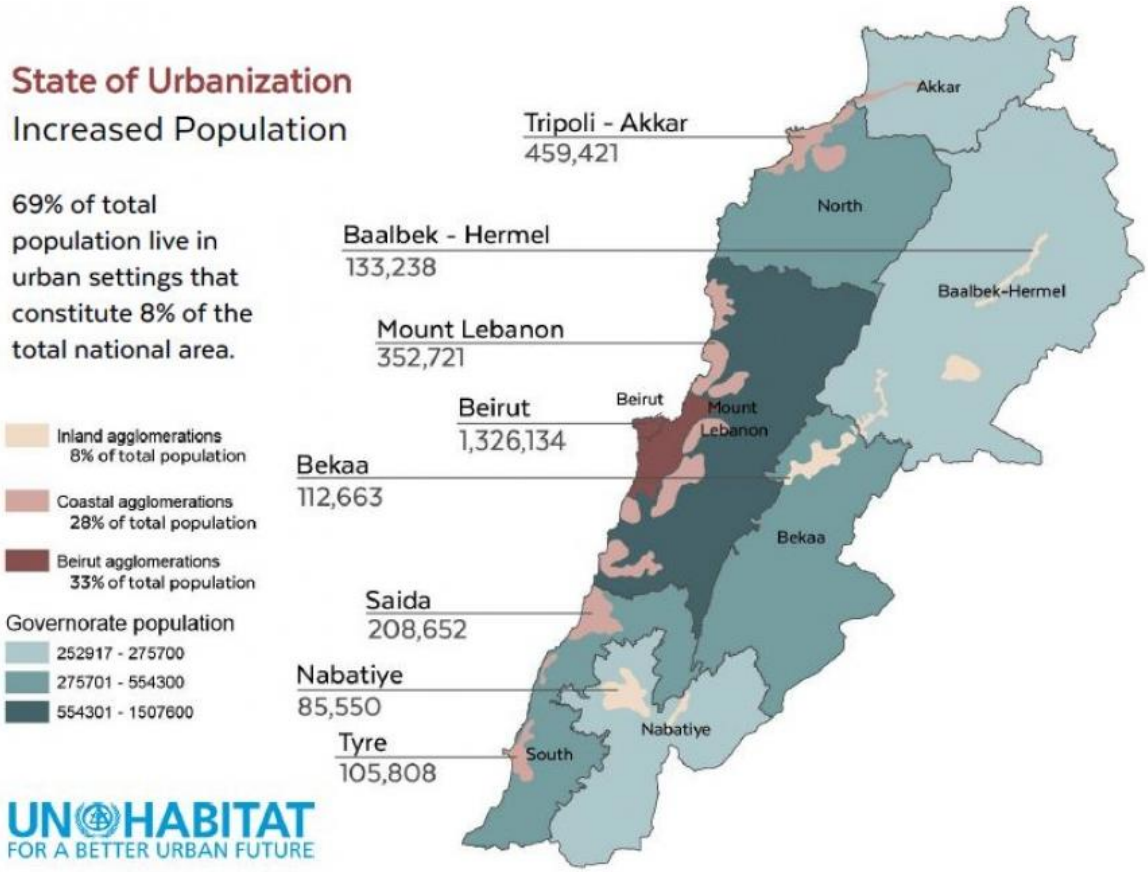


Figure 3. State of Urbanization in Lebanon

Urbanization in Nabatiyeh Governorate has taken place mostly along major transportation arteries, mainly roads. It shows a ribbon sprawl that arises on land that is adjacent to major roads (Faour, 2015). Ribbon sprawl – also known as linear expansion – is the expansion of towns and villages along major roads, therefore generating long roads of residential housing units and commercial centers on both sides of the road. This is the case of Nabatiyeh Governorate in general. However, as seen in the former figure, agglomerations have taken place in the Nabatiyeh District itself. Bint Jbeil District does not show any agglomerations. This can be seen from satellites image, representing Bint Jbeil city and Nabatiyeh city in order to highlight the extent of urbanization.

Figure 4. Ribbon sprawl in Nabatiyeh City

Figure 5. Ribbon sprawl in Bint Jbeil City

Based on a study done by the UN HABITAT (2010), "Towards Strategic Planning – Challenges and Assets Analysis for Seven Villages in the Caza of Bint Jbeil", the percent of built area of the villages' surface area is low – 14.7%. After the 2000 Liberation, and more specifically the 2006 war, buildings have been expanding on agricultural and green lands. In addition, most of these expansions take place along the main and primary roads. This is actually seen in Ainata, Aytaroun and Kounin whereby buildings have been constructed on the main roads that connect the villages and lead to the town of Bint Jbeil. It should be noted that the lack of zoning and strict regulations and lack of enforcement can and will jeopardize agriculture, shrubs and forest lands.

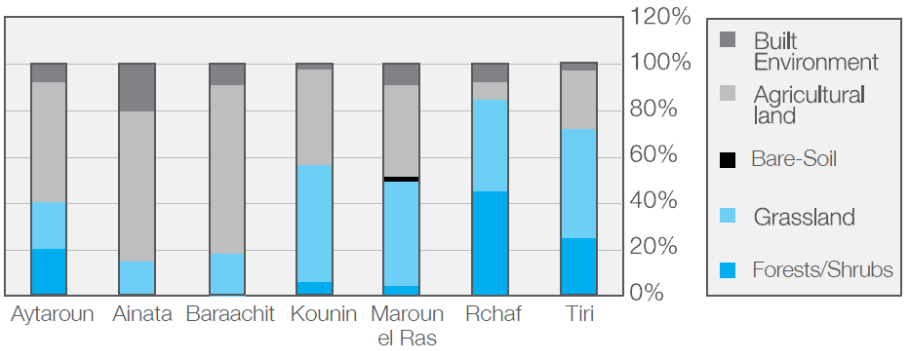


Figure 6 Percentage of Land Cover (UN Habitat, 2010)

1.3. Demography

1.3.1. Population Density

According to the National Physical Master Plan for the Lebanese territory, Bint Jbeil District is mainly composed of areas with a relatively low density that is around 250 capita per km^2, as shown in the following figure.

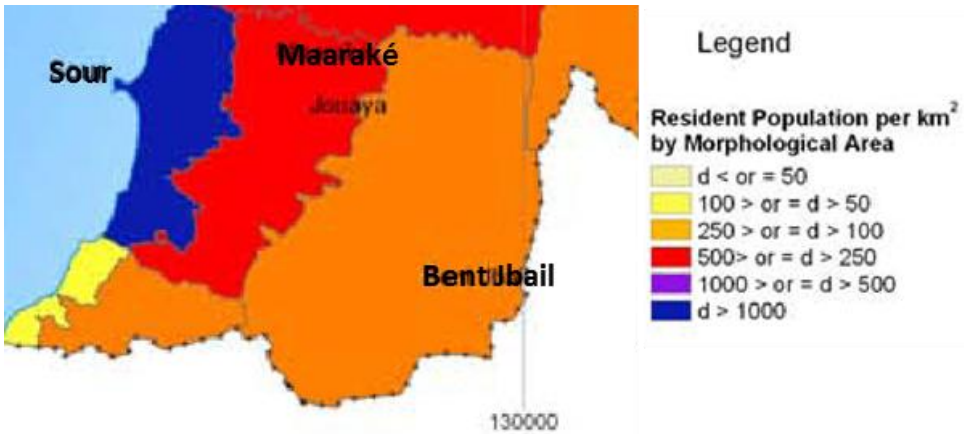


Figure 7. Population density in Bint Jbeil District

1.3.2. Expatriates in Nabatiyeh Governorate

The Lebanese diaspora is estimated at between 4 and 13 million emigrants because the actual holders of Lebanese nationality only make up a fraction of the descendants of the Lebanese migrants, who left the territory under Ottoman rule, before the creation of Lebanon in 1920 (European University Institute, 2017). In 2014, 885,000 Lebanese of the first-generation born in Lebanon were estimated to be migrants.

Lebanese who left the country between 1991 and early 2000s, seeking work abroad were mainly from South Lebanon – including Nabatiyeh Governorate – followed by Mount Lebanon and then by the Beqaa Valley. (European University Institute, 2017).

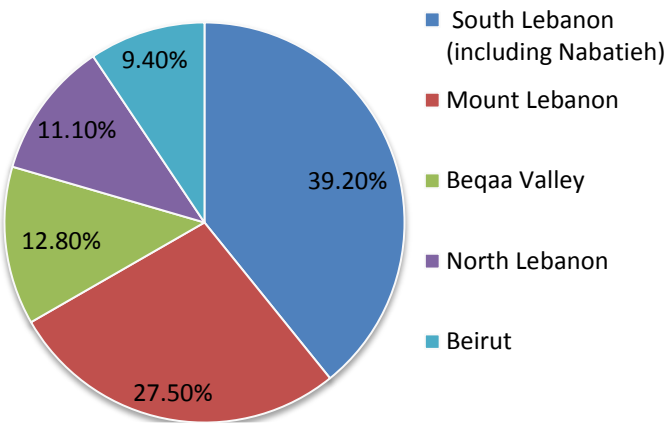


Figure 8. Origin of Lebanese Emigrants (Information International, 2001)

Indeed external migration is a phenomenon that affects most of the District where many of the villages and towns reported immigrants in Africa, Germany, the United States and the Gulf Region.

The reasons behind having this high emigration and especially in the South are due to the following demographic expansion in the region and political tensions (European University Institute, 2017):

- Economic recovery has been slow post the Israeli occupation of South Lebanon which lasted from 1982 to 2000;
- The Syrian military presence since 1990;
- Periods of political instability punctuated by several political assassinations and civil strife;
- Increased confrontations with Israel especially during the 2006 July war;

- The war in Syria and the presence of one million or more refugees intensified emigration pressure on all sectors of the Lebanese population.

The high emigration in the Nabatiyeh Governorate explains the low unemployment rate being below the national average of 6.04%. In addition, based on the Ministry of Interior and Municipalities, specifically the General Directorate of Personal Status, there are, 2,986 people living abroad who are aged above 21. According to CAS, 61.9% of the population residing in Nabatiyeh Governorate is aged above 20. Hence, 4,823 Lebanese people from Bint Jbeil District are expatriates. This is however a conservative approach because the CAS estimation is outdated and was done on a small sample of the population which might not be representative of the current situation.

Based on the "Bint Jbeil Village Profile", done by the Civil Society Center, 74.7% of the population migrated to America, Australia and Africa, 20.2% displaced to other cities in the country and 5.1% are still residing there. This can actually be extrapolated to the whole District since Bint Jbeil holds the largest portion of population within the District.

1.3.3. Lebanese Citizens

The most recent population database was published by OCHA on May 2016 in the form of "South and El Nabatieh Governorates Profile". In Bent Jbeil District, there are 24,964 Lebanese citizens that are living above poverty line, 41,079 are deprived citizens and 408 are returnees. So **in total, 66,451 Lebanese live in Bent Jbeil District**.

According to a meeting held with a committee representing the Federation of Bint Jbeil District on November 16, 2017, we were informed that the population of the 15 villages which joined the Bint Jbeil Federation (**including the Syrian Refugees**) is of the order of **40,150 capita during the winter** season, a number that increases to approximately **75,250 during the summer season** (Mid-June to Mid-September) (see below table). This 87% increase in the population during the summer season is mainly due to the high immigration rates amongst the citizens.

Table 3. Lebanese Residents Population as reported by the Heads of the Municipalities of the Bint Jbeil Federation

No	Municipality	Reported Population	
		Winter	Summer
1.	Al Tireh	700	3,000
2.	Barashit	3,500	5,000
3.	Bint Jbeil	4,000	7,000
4.	Beit Yahoun	500	1,500
5.	Hanin & Aytarout	500	1,000
6.	Hadetha	1,500	3,500

No	Municipality	Reported Population	
		Winter	Summer
7.	Rshaf	700	2,500
8.	Shakra – Doubiyeh	8,000	12,000
9.	Sarbin	250	750
10.	Aytaroun	6,500	11,000
11.	Aita Al Shaeb	8,000	10,000
12.	Ainata	2,000	7,500
13.	Kounin	1,500	4,000
14.	Maroun AL Rass	1,500	3,000
15.	Yaroun	1,000	3,500
	TOTAL	**40,150**	**75,250**

The above database was used to extrapolate the total population of the District. In addition we have adopted other approaches as described below:

Table 4. Different approaches used to estimate the population of the Bint Jbeil District

<table>
<tr><th>No</th><th>Approach</th><th>Basis of Population estimation</th><th>Bint Jbeil District Estimated Population</th></tr>
<tr><td>1.</td><td>Approach No 1</td><td>Population based on the interviews held with the heads of Municipalities</td><td>- According to a meeting held with a committee representing the Federation of Bint Jbeil District on November 16, 2017, we were informed that the population of the 15 villages which joined the Bint Jbeil Federation is of the order of <u>40,150 capita during the winter</u> season, a number that increases to approximately <u>75,250 during the summer season</u> (Mid-June to Mid-September). This 87% * increase in the population during the summer season is due to the high immigration rates amongst the citizens.
- In order to estimate the population of the remaining villages and since all the villages of the District are reported to have the same population density, we calculated the area of municipalities of the Federation with respect to the overall area of the District and extrapolated the total population of the District.
<table>
<tr><th>Municipalities</th><th>Area (km^2)</th></tr>
<tr><td>Taireh</td><td>7.62</td></tr>
<tr><td>Braachit</td><td>6.31</td></tr>
<tr><td>Bint Jbeil</td><td>8.02</td></tr>
<tr><td>Beit Yahoun</td><td>4.85</td></tr>
<tr><td>Hanin</td><td>6.18</td></tr>
<tr><td>Hadaatha</td><td>6.43</td></tr>
<tr><td>Rachaf</td><td>3.49</td></tr>
<tr><td>Chaqra - Doubay</td><td>0</td></tr>
<tr><td>Srobbine</td><td>3.95</td></tr>
<tr><td>Aaytaroun</td><td>13.6</td></tr>
</table></td></tr>
</table>

No	Approach	Basis of Population estimation	Bint Jbeil District Estimated Population
			Aayta Ech Chaab 10.04 Aaynata 4.37 Kounine 12.93 Maroun Al Ras 7.53 Yaroun 15.18 **Total (Km^2) 110.5** - This would lead to **a total population of 77,000 during the winter and 180,000 in summer**
2.	Approach No 2	CAS reported population for the Nabatiyeh Governorate in 2007	- According to CAS, the population of the Nabatiyeh Governorate is reported to be of 359,400 in 2007; - According to IDAL, 24% of the population of the Governorate are residents of Bint Jbeil, thus leading to a population of 86,500 in Bint Jbeil in 2007; - The annual population growth rate reported in NPMPLT is 1%. This would lead to a projected population of **96,500 as the total population residing in Bint Jbeil District in 2018**;
3.	Approach No 3	Using the MoIM official number of registered voters for the elections (i.e. the population above the age of 21) and extrapolating the total population on the basis of the recent statistics of CAS for the population age distribution for the Bint Jbeil District.	- The official number of Voters in the District of Bint Jbeil for the year 2018 as reported by the MoIM is 149,647 in total (between residents and emigrants); - According to the CAS, 59.4% of the population residing in Nabatiyeh Governorate is aged above 20 years. - The total population of Bint Jbeil District would then be of the order of **251,930 capita in 2018 (between residents and immigrants)** - If we apply the same Summer/Winter population ratio reported by the Municipalities, this scenario would lead to a population of **135,000 in winter and 252,000 in summer.**

It is to be noted though that each of the above approaches is associated with uncertainties that could not be avoided. The latter are summarized below for each of the adopted approaches:

Table 5. Uncertainties associated with the population estimation approaches

No	Approach	Uncertainties ,
1.	Approach No 1	- Given the fact that not all municipalities responded to the questionnaire, the extrapolation to the whole Governorate includes some level of uncertainties.
2.	Approach No 2	- The CAS reported population for the year 2007 is not based on a census and is by itself an estimation that is associated with some uncertainties; - The annual growth rate reported by NPMPLT might not representative of the real growth rate over the duration extending from 2005 till 2018
3.	Approach No 3	- CAS statistics for the population age distribution is based on a sample of the population in 2007 and might not be representative of the current status

Based on the various approaches presented above for the calculation of the Lebanese population, the results ranged between a minimum of 77,000 and a maximum of 135,000 for the winter season and 180,000-252,000 during the summer season.

Before deciding on the approach to be adopted, we have tested the accuracy of the population database provided by the Municipalities who also provided the project team with the number of residential units in the District. We calculated the average size of the family in each of the Municipalities of the Federation as shown in the below table. Then we calculated the population based on the distribution of the family size reported by CAS as per the below chart.

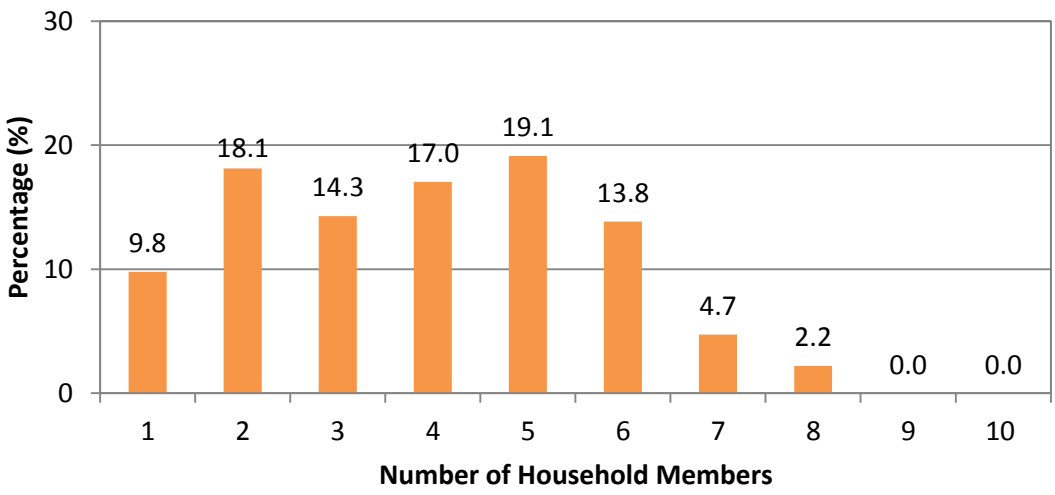


Figure 9. Distribution of the number of household members in Nabatiyeh governorate

Table 6. Average family size calculations based on the data provided by the Municipalities of the Bint Jbeil Federation

No	Municipality	Reported Population		No of residential units	Average family size as per Municpalities	Population count using CAS family size distribution
		Winter	Summer			
1.	Al Tireh	700	3,000	504	0.21-6	1,947.41
2.	Barashit	3,500	5,000	1200	0.7-4.2	4,636.69
3.	Bint Jbeil	4,000	7,000	4300	0.6-1.6	16,614.82
4.	Beit Yahoun	500	1,500	548	0.33-2.7	2,117.42
5.	Hanin & Aytarout	500	1,000	425	0.5-2.4	1,642.16
6.	Hadetha	1,500	3,500	400	0.4-8.7	1,545.56
7.	Rshaf	700	2,500	400	0.3-6.25	1,545.56
8.	Shakra – Doubiyeh	8,000	12,000	1600	0.7-7.5	6,182.26
9.	Sarbin	250	750	100	0.3-7.5	386.39
10.	Aytaroun	6,500	11,000	1100	0.6-10	4,250.30
11.	Aita Al Shaeb	8,000	10,000	1300	0.8-7.7	5,023.09
12.	Ainata	2,000	7,500	1450	0.27-5.17	5,602.67
13.	Kounin	1,500	4,000	600	0.4-6.7	2,318.35
14.	Maroun AL Rass	1,500	3,000	640	0.5-4.7	2,472.90
15.	Yaroun	1,000	3,500	500	0.28-7	1,931.96
-	**TOTAL**	**40,150**	**75,250**	**15,067**	**2.67-5**	**58,217.56**

The results of the exercise reveal inconsistency in the database. Accordingly, the Consultant opted for retaining the population count estimated based on the number of voters reported for the year 2018 by the MoIM, i.e. Approach No 3. Therefore, the total population in the study area is **135,000 during the winter season and 252,000 during the summer season**.

1.3.4. Palestinian Refugees

According to both the UNHCR (2016) as well as the OCHA Nabatiyeh Governorate Profile, there are no Palestinians residing in Bint Jbeil District. This was further confirmed during the meetings with the Federation of Bint Jbeil Municipalities.

1.3.5. Syrian Refugees

Based on the Nabatiyeh Governorate Profile conducted by OCHA (2016), the number of registered Syrian Refugees in Bint Jbeil District is 7,824 as of May 2016. According to the UNHCR data, a total of 7,605 Syrian refugees reside in Bint Jbeil District.

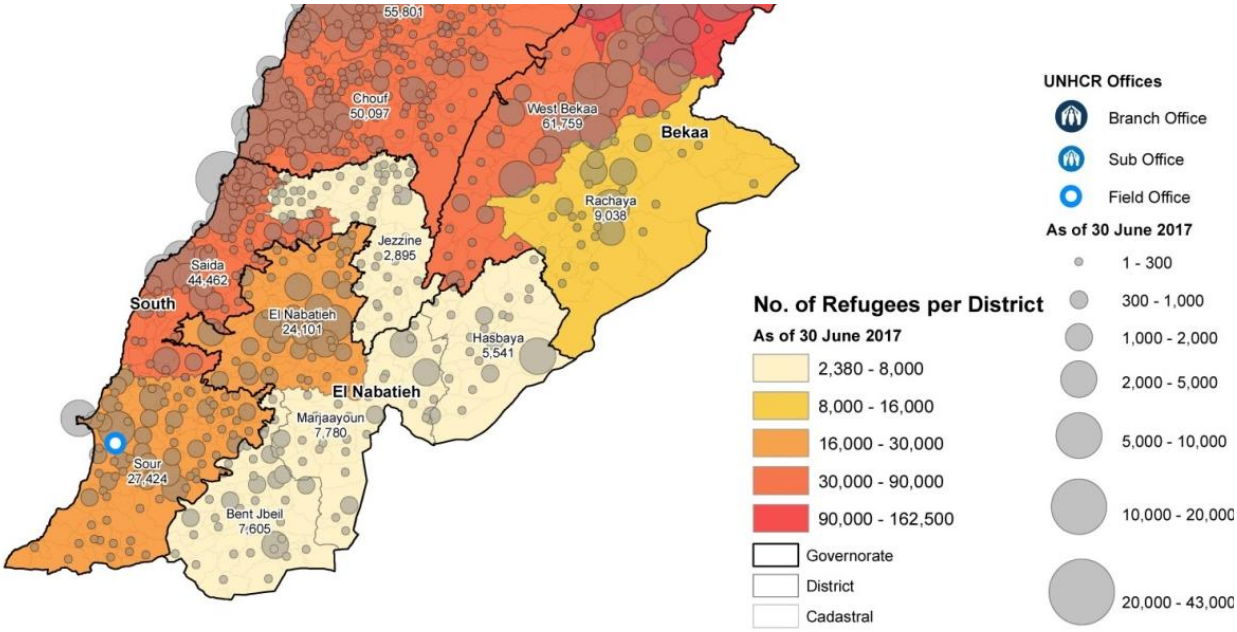


Figure 10. Syrian Refugees distribution in Lebanon (UNHCR 2017)

1.3.6. Total Population in Bint Jbeil District

Based on the analysis presented above, the total population of the study area is as summarized below:

Table 7. Total Population in Bint Jbeil District

No	Population Category	Number	Notes
1.	Lebanese Citizens	135,000	Winter Season
		252,000	Summer Season
2.	Syrian Refugees	7,800	-
3.	Palestinian Refugees	0	-
4.	**Total Population**	**143,000**	**Winter Season**
		260,000	**Summer Season**

1.3.7. Future Population Growth

Based on the CDR National Physical Master Plan for the Lebanese Territory, the population growth rate in Bint Jbeil District is around 1% similarly to the rest of the country. However, it should be noted that:

- There is a difference in fertility rate between Nabatiyeh Governorate and Beirut. This could be easily detected from the difference in the average family in Nabatiyeh Governorate in comparison to Beirut. According to data published by the CAS in the year

2009, 40% of the households in Nabatieh Governorate are constituted of more than 5 members in comparison to only 25% of Beirut's household.

- The Syrian refugee influx caused by the war in Syria has been notable in the South region
- The degrading situation in Beirut forces people to come back to their hometown

Based on the meetings held with the Union of Municipalities, a population growth rate of the order of 3 to 5% was reported. Taking the summer and winter Lebanese population on their own, and considering an average growth rate of 4% while keeping Syrian and Palestinian numbers stable, the following graph represents the estimation growth rate until 2027.

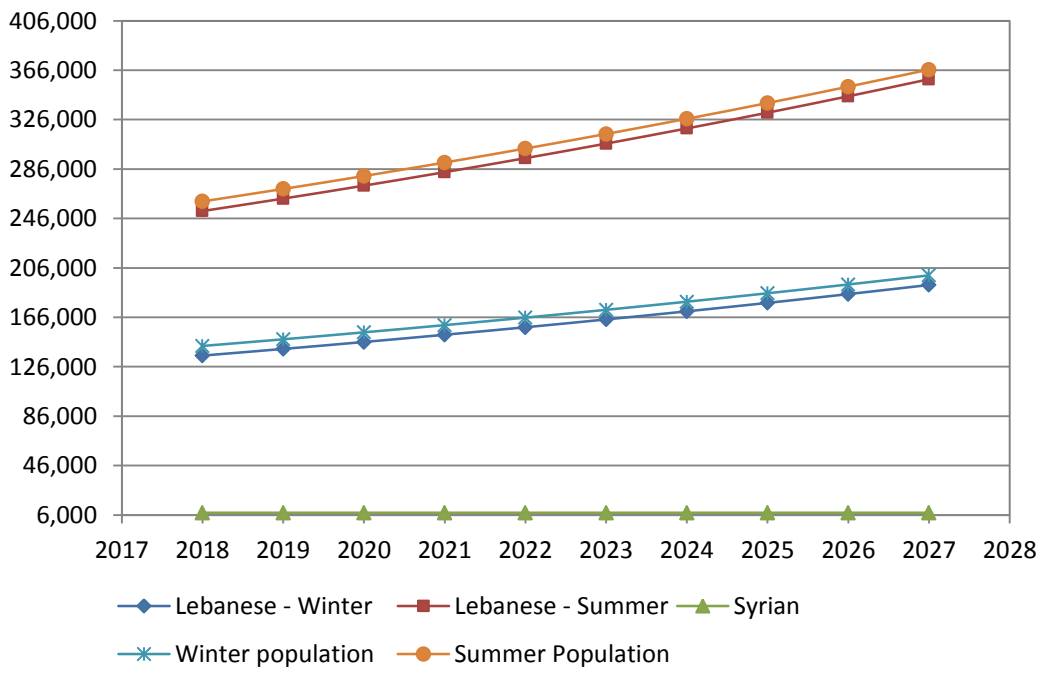


Figure 11. Estimation of Population in Bint Jbeil District

1.4. Natural, Cultural and Archeological Characteristics of Bint Jbeil District

The Governorate holds many touristic attractions as shown in the following figure.

Figure 12. Map of Nabatiyeh Governorate Touristic Attractions (IDAL, 2017)

In fact, the Governorate holds 138 natural and eco-touristic attractions, of which 46 are in Bint Jbeil District. The most prominent ones are summarized in the following table.

Table 8. Attractions in Bint Jbeil District (Promenade, 2017)

District	Monuments	Natural Attractions
BINT JBEIL	▪ Traditional Souk ▪ Byzantine Pillars and Stones ▪ Al-Kabir Ancient Mosque (The Great Mosque) ▪ Heritage Houses (oldest houses of Bint Jbeil) ▪ Saleh Bazzi Heritage House (one of the oldest residences of Bint Jbeil) ▪ Old Mill ▪ Old Site ▪ Heritage Houses	▪ Ain (Spring) Al-Kabira ▪ Garden ▪ Shala'aboun Pool ▪ Al-Wadi Wal Jazira Cave ▪ Hara Well ▪ Ain Hara

The name "Bint Jbeil" is of Phoenician origin, meaning limits or daughter of the mountain. In fact, a princess once lived in the area, hence the word Bint.

There many ancient remains that are visited by tourists, in Atlal square, like the temple dedicated to the goddess Annar, the old souq, where a market takes place every Thursday, Byzantine columns and capitals, mosques and old houses.

Figure 13. Thursday Market at Bint Jbeil

Figure 14. Maroun Ar Rass Valley

Ain El-Kabira, as its name means in Arabic, provides water for a big number of terraced gardens. There are also water pools, Well of Hara and the Valley Grotto.

A space in Bint Jbeil was transformed into a public garden in honor of the 108 individuals who died for their country. The space is in the center of Bint Jbeil town and is called Martyr's Square.

Figure 15. Public Garden in Bint Jbeil

It should also be noted that the town of Bint Jbeil is considered the capital of resistance and liberation, where the Israeli invaders have lost.

Figure 16. Tebnine Castle in Bint Jbeil

1.5. Economic activities

The Governorate is characterized by the different economic activities that are described below. The Consultant considered that the activities of the Governorate are the ones that also take place at the District level; the Governorate's characteristics usually are based on each District alone, to be able to extrapolate to the general situation.

1.5.1. Agriculture

Based on IDAL (2017), the agricultural sector is the third employer (14%) in South Lebanon and Nabatiyeh region given the abundant water resources – 3 rivers crossing the region. In fact, around 85% of the cultivated lands are used for the cultivation of olives.

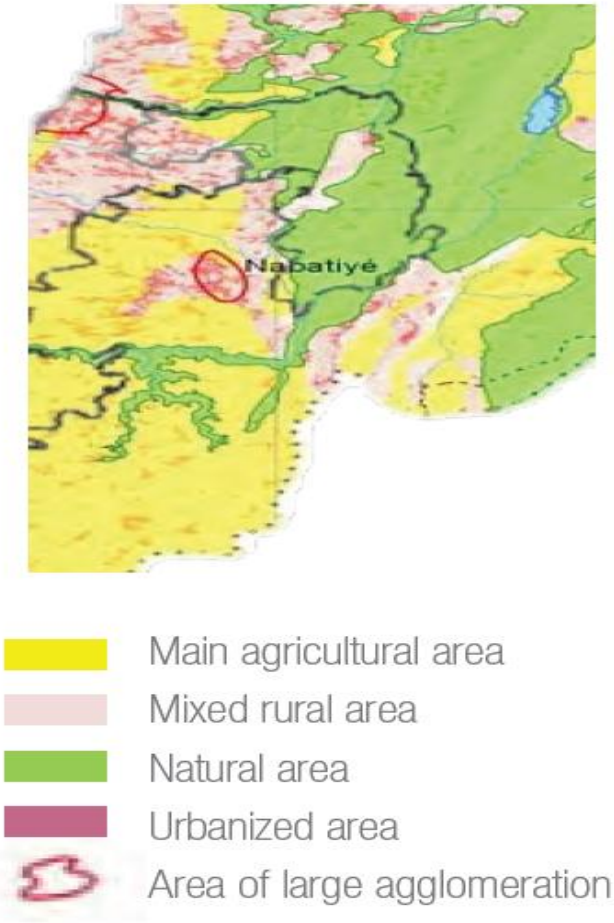


Figure 17. Land use map of Nabatiyeh

As it can be seen from the above figure, the majority of the Nabatiyeh Governorate including Bint Jbeil District is composed of agricultural land. In fact, the total permanent crop production area is of the order of 13,000 HA in the Governorate, which constitutes 10% of the total Lebanese permanent production. The distribution of the cultivated land per produced is represented in the following chart.

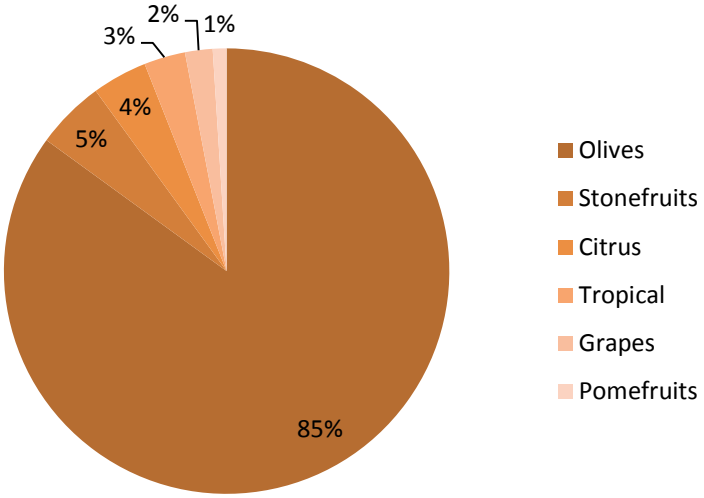


Figure 18. Nabatiyeh cultivated land per produce (IDAL, 2017; MoA)

The South region is known for its olive oil mills and olive oil production. As a matter of fact, the South and Nabatiyeh Governorates hold 25% of olive oil mills and produce 21% of the Lebanese olive oil.

L'Olio de Libano is a project whose goal is to develop the olive oil value chain in the Districts of Lebanon. In the South and Nabatiyeh Governorates, 26 cooperatives benefit from this project – of which 17 are single products producers and 9 are multi-products cooperatives.

1.5.2. Industry

According to the Ministry of Industry, Nabatiyeh Governorate comprises 108 industrial firms, of which 95 are in the Nabatiyeh District. This Governorate encompasses 3% of total Lebanese industrial firms. The majority operates in the food and beverages sector, constituting 34.26% of industrial firms in the governorate.

According to the information available in hands and based on the meetings held with the Federation of Municipalities of Bint Jbeil, Bint Jbeil District does not any industrial facilities or hospitals.

1.5.2.1. Summary of the Competitive Advantages in Nabatiyeh Governorate

The following table summarizes the competitive advantages of the Governorate as per the IDAL study (2017): "Investment Opportunities in Nabatiyeh".

Table 9. Summary of Advantages in Nabatiyeh Governorate

Access to Resources	Access to Human Capital	Access to Markets	Access to Finance
▪ **Natural Resources:** - 3 rivers and fertile land - 10% of Lebanese permanent crop production - 25% of total olive mills in the country ▪ **Economic Activities:** - 21 % of Lebanon's olive oil production - 29% of firms in Lebanon	▪ **Technical and Vocational Schools:** Holds 13% of the country's vocational schools and one business innovation center ▪ **Universities:** 10 universities with around 51,000 students, most of which graduate in business, law and engineering ▪ **Labor pool:** specialized in servies	▪ **Infrastructure:** access to Saida seaport (30mins) and proximity of Tebna industrial zone (20 mins)	▪ **Financing:** 3% of the country's commercial bank branches

1.6. Accessibility & Roads Network

Accessibility to Bint Jbeil District is ensured via Saida road, past Tyre to Tibnine or Kooseen – Ain Ebel – Bint Jbeil or Nabatiyeh – Deir Mimas – Kfar Kila – Markaba – Aitroun.

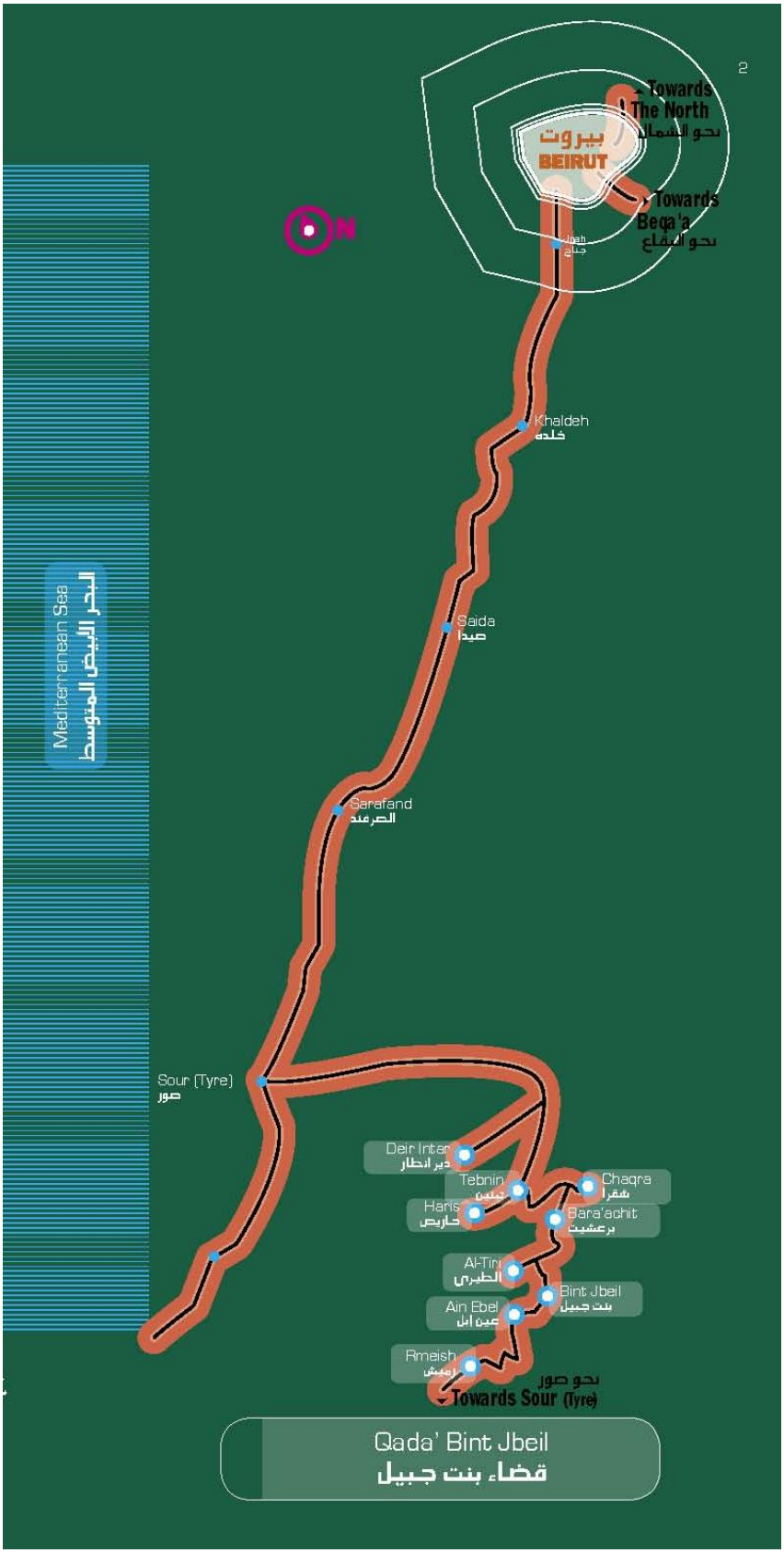


Figure19. Roads leading to Bint Jbeil

2.MSWM Practices in Bint Jbeil District

This section of the report provides a brief yet comprehensive overview of the different aspects of the current status of solid waste management in the district of Bint Jbeil. It addresses such features as waste sources, types, composition, quantities, collection & recycling schemes, current management practices and associated tariffs, etc. The data presented in this section is of fundamental concern for planning an ISWM plan.

The waste management practices addressed in this report include the whole lifecycle of the municipal solid waste from generation at the source until ultimate disposal. The analysis of the system will be included in a separate section.

2.1. Stakeholder Analysis & Institutional Arrangement

This analysis aims at identifying the key stakeholders involved in the solid waste management practices in the study area and who are expected to influence the implementation of the anticipated waste management plan.

The intention is to further involve these stakeholders during the planning and implementation stages of the proposed plan to maximize the chances of meeting the objectives of the master plan.

The District of Nabatiyeh has a number of key stakeholders, which are briefly described below.

No	Group	Stakeholder	Description
1.	Local Institutions	Existing Unions of Municipalities	The main stakeholder is the Union of Bint Jbeil Municipalities since a sorting facility is planned to serve them along with the Jabal Aamel Union of Municipalities and Al Kalaa Union of Municipalities that are present in Marjayoun District
		Municipality of Bint Jbeil	It plays a key role in the whole District. It is not only the main urban center of the district but it also attracts thousands of tourists during the summer thus influencing the economy of the entire area. For that reason, Bint Jbeil has a strong influence and interest in improving the SWM system.
		Remaining municipalities	Waste collection, transportation and street sweeping activities are under the responsibility of each municipality. Some municipalities pay contractors for the collection of waste and disposal of waste. Some municipalities hire a contractor for street sweeping. In general, the union of municipalities are each responsible for their own treatment and disposal.
2.	NGOs	NGOs	Several NGOs are active in the area as mentioned earlier in the report.
3.	National Institutions	MoE	Through the MoE does not really influence the process, it should be involved to increase the influence as the MoE keeps the control of the nation territory
		OMSAR	It acts as both a funding agency and a policy making ministry. It

No	Group	Stakeholder	Description
			develops regional plans and implements – supervises waste management projects outside BML area. They have influence and interest both at national level and a local level as they are trying to shape the proper level of regionalization and the technological solutions required in cooperation with the Union of Bint Jbeil Municipalities. In Bint Jbeil district, the waste treatment facility to be built is under the supervision of OMSAR, using an EU-fund
4.	Others	Informal Recycling Sector	These include workers and enterprises that are involved in the informal recovery of recyclables from waste, either to an intermediate processor, a broker, or a manufacturer. Their numbers increased with the Syrian crisis. Their activities are most of the time not formally organized and not recognized by the local authorities. They have very low influence but high interest.
		Political parties	One main political party is predominant in Bint Jbeil District. It is Amal Movement. They have high influence but relatively low interest in WM.
		Commercial, Industrial and Touristic Activities	Afraid of increase of taxation, if not properly consulted they can have a negative influence. They do not have real interest but are a Potential key stakeholder for waste source sorting initiative.
		Contractors	Contractors are hired to collect and dispose of the waste of different municipalities in Bint Jbeil district. They have high influence and high interest in WM.

2.2. MSW Characterization

The knowledge of the sources, types, composition and quantities of solid waste is basic to the design and subsequent operation of the functional elements associated with the management of the generated solid wastes.

2.2.1. Sources, Types and quantities of MSW

Sources of solid wastes in a community are in general directly linked and associated with the land use and zoning of the community. For the District of Bint Jbeil, the sources and types of waste that are generated are summarized below:

Table 10. Classification of the sources and types of solid wastes

Source	Description	Types of waste
Residential	Apartments, houses, etc.	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, tin cans, aluminum, other metals, diapers, ashes, street leaves, special wastes (bulky items, consumer electronics, white goods, batteries, oil, and tires), household hazardous wastes, bulky items
Commercial	Restaurants, malls, supermarkets, hotels, etc.	Paper, cardboard, plastics, wood, food waste, glass, metals, special waste (same as above), hazardous waste, bulky items, etc.
Touristic	Waste generated from touristic activities (resorts, hotels, rest houses, restaurants, etc.) mainly during the summer season	Food wastes, paper, cardboard, plastics, glass, tin cans, aluminum, other metals, etc.
Institutional	Schools, governmental centers, etc.	As in commercial waste
Construction & demolition	Construction sites, etc.	Wood, steel concrete, etc.
Municipal services	Streets sweeping, green waste from public landscaped areas, etc.	Street sweeping, landscape and tree trimmings, general waste from recreational public areas, etc.
Agricultural	Field and row crops, orchards, vineyards, dairies, feedlots, farms, etc.	Spoiled food wastes, agricultural wastes, rubbish, hazardous wastes

2.2.1.1. Healthcare waste

As far as health care waste is concerned, it is to be noted that a total of three hospitals and several health care centers are operational in the District (See below table). However the current study will only address non-hazardous fraction of waste generated within these facilities.

Table 11. Health care facilities in Bint Jbeil Districts (MoPH, 2018)

No	Type of Health Care Facility	Name
1.	Private Hospital	- Salah Ghandour Hospital
2.	Public Governmental Hospitals	- Bent Jbeil Governmental Hospital - Tebnin Governmental Hospital
3.	Health care centers	- The Martyr Francois Al Hajj center - Abbas Yater - Ain Ebel Medico Social Center - Ayta Al Chaab SDC Center - Bint Jbeil SDC Center - Borej Qalaway Health Center - Imam AlSadr Center - Nour Medical Center - Sayed Abdel Mohsen Fadlallah Health Center - Socio-Medical Center - Tebnin PHC
4.	Pharmacies	- 45 in total

For details about the classification of health care waste in Lebanon, please refer to the national baseline report.

The non-hazardous fraction of the HCW that is generated from the administration offices, the cafeteria, the kitchen of the hospital, the patient's rooms, etc. is already accounted for as part of the MSW quantities reported in other sections of this report. As for the remaining categories of HCW, the entire database related to their quantities and the treatment and disposal means are elaborated in the national baseline report.

2.2.1.2. Restaurants waste

Based on a brochure prepared and published by the Middle East Airlines (Promenade, South Lebanon), there are around 15 restaurants in Bint Jbeil District. Restaurants are known to generate big amounts of waste, especially organic/food waste. Indeed, according to the United States Environmental Protection Agency, a typical restaurant produces on average 68 tons of waste per year with the following composition:

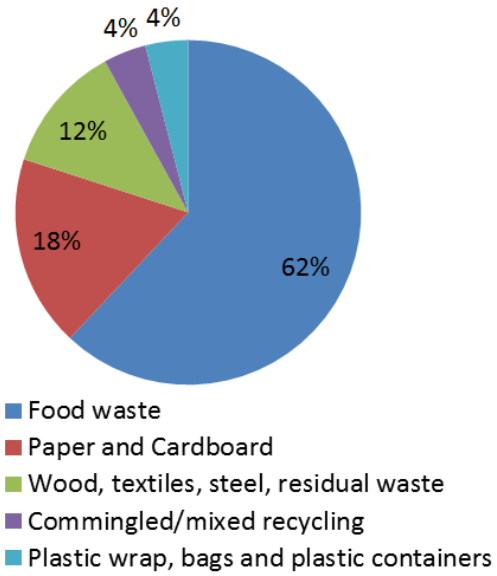


Figure 20. A typical waste composition in a restaurant as per USEPA

Considering each restaurant in the District produces 68 tons/year on average, this would sum up to a total of 1,020 tons/year of waste produced by restaurant, of which 632 tons are organic in nature. This is important to note since the waste composition in Lebanon also has a high percentage of organics, making the waste management of the country integrated more easily.

2.2.1.3. E-Waste

Legal and Institutional Framework, strategies and planning, financing, collection treatment and disposal, private sector involvement, case studies, best practices and lessons learned, and upcoming initiatives factors could not be developed for electronic waste or E-waste as it was done for other type of wastes (GIZ 2014 Country report on the solid waste management in Lebanon). However, a local non-governmental organization (NGO) called Beeatoona has been involved since 2009 in collecting E-waste from various private and public institutions (GIZ, 2014). Beeatoona works on raising awareness among local communities concerning the dangers of

hazardous disposal of E-waste. They classify the types of E-waste into 4 categories (see below Table).

Table 12. Types of E-waste accepted at Collection Points (Beeatoona, 2012)

No.	Category	Description
1.	Desktop Computers and Peripherals	- Computer Monitors - Desktop Computers - Computer Speakers - Mice and Keyboards - UPS Systems
2.	Portable Devices	- Laptop Computers - Cell Phones - PDAs - Digital Cameras
3.	Network Components	- Computer Cables - Servers - Networking - Equipment
4.	Office Apparatus	- Scanners - Printers - Fax Machines - Toner/Ink Cartridges

They have allocated drop-off points for the local communities to dispose of their E-waste (Table below). Only one center is allocated in Nabatiyeh Governorate (see below).

Table 13. E-waste collection points in Nabatiyeh managed by Beeatoona (Beeatoona, 2012)

District	Area	Collection Point
South	**Saida**	My PC, Best Buy Enterprise
	Tyr	Hilallal computer
	Nabatiyeh	Adco

The E-waste is later collected by trucks provided by Beeatoona, ensuring a safe disposal of the collected material in a special warehouse (Beeatoona, 2012). After segregation, this waste is shipped abroad for treatment (E-waste recycling) and/or disposal (GIZ, 2014). However this activity is becoming more difficult because of the complications and time associated with export procedures as they must comply with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

The Consultant could not get information about the quantity of E-waste generated in the study area. In the absence of a country estimate for the E-waste, it is very hard to make any estimation for the study area.

2.2.1.4. Tires Waste

Tire waste is considered as municipal solid waste (MSW) and is treated similarly. Different initiatives and approached are adopted in the country to handle tires. These are elaborated in the National Baseline Report.

According to an interview done by the Daily Star (2015) with Ahmad Hikmat Shamseddine, OLA 3R's owner, there's at least one tire damaged for every car.

Based on WHO (2011), the total number of registered cars in Lebanon is of the order of 1,530,000. In addition, the IPT group conducted a study on road transport and air pollution in 2012, and reported a total number of registered vehicles of the order of 1,580,000. A 3% increase is noticed from 2011 until 2012. Projecting these numbers till 2018, the total number of registered vehicles adds up to 1,880,000. Also based on the WHO, in Lebanon, for every 1,000 person there are 434 vehicles. Applying this to the District of Bint Jbeil, and taking into consideration that 135,000 are permanent residents, 58,590 are registered in the Bint Jbeil District. Since at least one tire is damaged for every vehicle per year, there is a minimum of 59,000 waste tires generated each year.

2.2.1.5. Industrial Waste

As elaborated in the National Baseline Report, the types of industries in Lebanon are mainly light manufacturing industries. Details about the types and quantity of industrial waste in the country are also elaborated in the National Baseline.

As far as the study area is concerned, industrial firms mainly operate in the services sector – retail, financial services, construction and health. These industries generate industrial waste of class III, that are insoluble and do not decompose (Lone Star College, 2018). Construction and medical wastes can cause serious threat to the environment and the ecosystem.

2.2.2. Composition

The consultants tried to organize a short local waste analysis campaign in selected points; however, the local authorities did not permit sampling and waste characterization for security purposes. OMSAR's Project Manager was informed about it and the consultants were requested to go on without local waste analysis campaigns and work with the available data.

In the current report, we will adopt the waste characterization campaign carried out by the Danish Consultant Ramboll for the waste generated from the Greater Beirut Area and part of Mount Lebanon and which was done as part of the feasibility study for the integration of waste to energy into the waste management schemes in Lebanon. Details about the sampling

campaign methodology, number of samples, time of sampling, parameters analyzed, source of waste, etc. as well as the results are elaborated in the National Baseline

In order to correlate the results of the above characterization study to the study area of Bint Jbeil, we have compared the average household monthly income reported for the District of Bent Jbeil to that of the districts covered in the above study (See below chart).

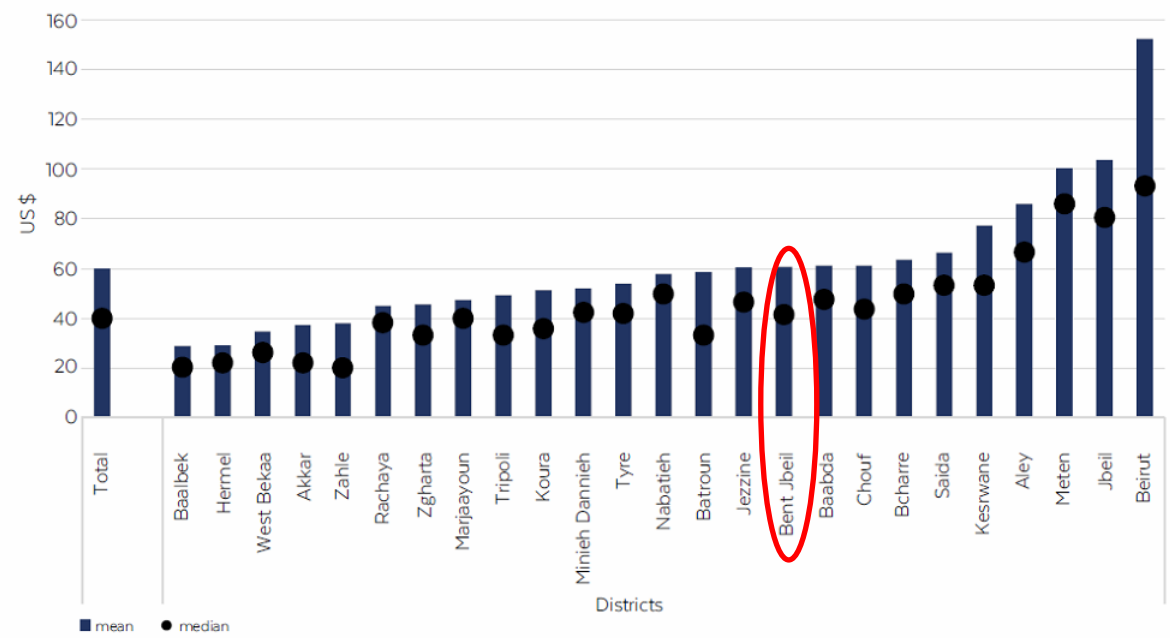


Figure 21. Average household monthly income per capita at District Level (UNHCR et al. 2016)

The above chart indicates that the District of Bint Jbeil is comparable to the Districts of Baabda and Chouf in terms of average household monthly income. Therefore, for the sake of the current study we will assume that the waste composition in the District of Bint Jbeil is similar to that measured in these two Districts (see below table).

Table 14. Waste composition in Baabda & Shouf (Ramboll Study)

Component	Composition (%)	
	Baabda	Chouf
Organic	55.13	56.86
Paper and Cardboard	11.97	11.11
Plastics	12.84	11.96
Metals	1.90	2.26
Textiles	3.52	2.67
Glass	2.77	3.08
Wood	1.03	0.95
Diapers	4.55	4.8
Others	2.16	1.72

However, once the facility of Bint Jbeil/Marjayoun is put into operation, the operator needs to conduct regular waste characterization analysis to have more accurate data about the waste composition.

2.2.3. Waste generation trends

For Bint Jbeil District, it would be very hard to assess the waste generation trend based on actual available database as the latter does not exist. However, it is anticipated that the seasonal variation in waste quantity will follow the trend of the seasonal variation in population which increases by a factor of 88% during the summer season.

2.2.4. Waste Quantities

In terms of waste quantities, the Consultant has adopted two main approaches to estimate the waste quantities generated from the various municipalities of the District:

Table 15. Approaches adopted to estimate the waste quantities

No	Approach	Description
1.	Approach No 1	This approach is based on the database reported by the Federation of Municipalities of Bint Jbeil and the extrapolation of the data to the whole District.
2.	Approach No 2	This approach is based on assuming a certain per capita waste generation rate and applying it to the population to come up with the estimated waste quantities generated in the District.

2.2.4.1. Approach 1

During the meetings held with the Federation of Municipalities of Bint Jbeil, the Consultant was informed that the District generates an average of 110tons of municipal solid waste per day.

2.2.4.2. Approach 2

As per the Sweep-net country report on the solid waste management in Lebanon, the MSW generation per capita varies in Lebanon from around 0.70 kg/capita/day in rural areas to around 0.85-1.1 kg/capita/day in urban areas. The District of Bint Jbeil is characterized by Significant rural and semi-rural areas.

Therefore, the per capita waste generation rate adopted to calculate the waste quantities generated within the District under Approach 2 is 0.7 kg/capita/day for the residing Lebanese. As for the Syrians, a waste generation rate of 0.5kg/capita/day will be used similarly to what has

been adopted in the baseline reports of other study areas under the current contract. This would lead to the following waste generation quantities:

Category	Population	Special Waste Generation (kg/cap/d)	Daily SW generated «winter» (tons/d)	Daily SW generated "summer" (tons/d)
Lebanese-Winter	135,000	0.85	95	-
Lebanese-Summer	252,000	0.85	-	177
Syrian Refugees	8,000	0.50	4	4
TOTAL	**-**	**-**	**100**	**180**

2.2.4.3. Waste Quantities – Summary

The outcome of the two approaches presented above for the calculation of the daily waste quantities generated in Bint Jbeil District is summarized in the below table:

Table 16. Daily Generated Waste Quantities

No	Approach	Waste generation rate (kg/capita/day)	Daily Generated Waste Quantities	
			Winter Time	Summer Time
1.	Approach 1	-	100 Tons/day	187 Tons/day
2.	Approach 2	0.7 kg/capita/day for Lebanese & 0.5 kg/capita/day for Syrians	100 Tons/day	180 Tons/day

The two approaches show very similar results of the order of **100tons/day during winter time (290days/yr) and 180 tons/day during summer time (75days/yr).** A total annual waste generation is of the order of **42,500 tons/year.**

2.3. Storage, collection and street sweeping

2.3.1. Storage

Municipal solid generated by households and commercial establishment is primarily collected through oil barrels (200L) and street containers of various sizes (50 – 1,100 L) without any cover and in non-optimal conditions.

Table 17. Average family size calculations based on the data provided by the Municipalities of the Bint Jbeil Federation

No	Municipality	Type of containers	Quantity
1.	Al Tireh	200L Metallic Barrels	-
2.	Barashit	200L Plastic Barrels	-
3.	Bint Jbeil	200L Metallic Barrels and 200 plastic containers	800
4.	Beit Yahoun	200L Metallic Barrels	200
5.	Hanin & Aytarout	200L Plastic Barrels	100
6.	Hadetha	200L Metallic Barrels	300
7.	Rshaf	200L Metallic Barrels	100
8.	Shakra – Doubiyeh	200L Metallic Barrels	300
9.	Sarbin	1,100L Plastic Containers	8
		200L Metallic Barrels	77
		50L Metallic Barrels	25
10.	Aytaroun	200L Metallic Barrels	150
11.	Aita Al Shaeb	200L Metallic Barrels	500-600
12.	Ainata	200L Metallic Barrels	500
		50L Containers	100
13.	Kounin	200L Metallic Barrels	500
14.	Maroun AL Rass	200L Metallic Barrels	120
15.	Yaroun	200L Metallic Barrels	-

Based on data collected from municipalities, most containers are in good condition. Most of them are of small size and are used for narrow streets while the few big containers are found on main roads.

The following table summarizes the current waste storage system in the municipalities of the District that responded to the questionnaire and provided the team with the required database.

In summary, there are:

No	Type of Container	Number
1.	4 wheel	8
2.	200 L Barrel	3,747
3.	50L Barrel	125
4.	**Total**	**3,880**

It can be noted that barrels are the most used for storage in the area.

2.3.2. Waste collection

According to the current institutional arrangements for the MSW management sector, collection is under the responsibility of each municipality or Union.

According to the different municipalities, the collection services (in most cases) are handled by the municipalities. Rare are the municipalities that have contracted the waste collection service to the private sector.

The below table summarizes the frequency of collection, the percent coverage, and the type of collection fleet as provided by the members of the Federation of Municipalities in the District of Bint Jbeil.

Table 18. Summary of existing waste collection services

No.	Municipality	Party in Charge of waste collection	Coverage (%)	Frequency of collection	Type of vehicle	Quantity
1.	Al Tireh	Municipality	100	-	Pickup	1
2.	Barashit	Municipality	100	2 times per day	Tractor	
3.	Bint Jbeil	Private contractor	100	Daily	Pickup	2
4.	Beit Yahoun	Municipality	100	3 times per week	Pickup	1
5.	Hanin & Aytarout	Municipality	100	2 times per week	Pickup	1
6.	Hadetha	Municipality	100	-	Truck	1
7.	Rshaf	Municipality	100	4 times per week	Pickup	1
8.	Shakra – Doubiyeh	Municipality	100	-	Compactor	1
9.	Sarbin	Municipality	100	-	Rented Tractor	1
10.	Aytaroun	Municipality	100	6 times per week	Tractor	1
11.	Aita Al Shaeb	Municipality	100	6 days per week	Truck + small compactor	2
12.	Ainata	Municipality	100	-	Trucks	2
13.	Kounin	Municipality	100	-	Small compactor	1
14.	Maroun AL Rass	Municipality	100	-	Pickup	1
15.	Yaroun	Private contractor	100	3 days per week	Pickup	1

All interviewed municipalities cover the whole municipal boundary. Given that the District is more of a rural character, the waste collection doesn't have to take place on a daily basis. This is actually seen in the table above, whereby the majority of the municipalities collect the waste 3 times weekly.

Regarding the labor, the following table presents the situation in the different municipalities.

Table 19. Labour in some Municipalities of the District

No	Municipality	No of workers
1.	Al Tireh	2
2.	Barashit	-
3.	Bint Jbeil	-
4.	Beit Yahoun	3
5.	Hanin & Aytarout	2
6.	Hadetha	2
7.	Rshaf	-
8.	Shakra – Doubiyeh	4
9.	Sarbin	-
10.	Aytaroun	6
11.	Aita Al Shaeb	3
12.	Ainata	-
13.	Kounin	3
14.	Maroun AL Rass	2
15	Yaroun	-

It should be noted that the municipalities represented in the table are the ones that handle their own waste collection. Municipalities that have contractors do not have any details about the labor force present during the collection.

From the figure above, most municipalities have 2 drivers while only 3 have 6 or more drivers.

For selected municipalities, it was possible to analyze the sufficiency of the waste containers, as it is demonstrated in the next table.

Table 20. Sufficiency of the available bins for selected municipalities

Municipality	Winter solid waste on Monday (m^3/d)	Volume of bins required in winter (m3)	Summer solid waste on Monday (m3/d)	Volume of bins required in summer (m3)	Volume of bins available (m3)	Winter sufficiency (%)	Summer sufficiency (%)
Bint Jbeil	100	125	175	220	160	128%	73%
Shakra – Doubiyeh	30	38	45	57	60	158%	105%

The table is based on data provided by the municipalities in terms of generated waste quantities. The tonnage was divided by the waste density (0.20 ton/m^3) in order to get the volume/day.

As it is shown, the bins are sufficient for the winter and summer period for Shakra – Doubiyeh, but insufficient for the summer season in Bint Jbeil (the calculations have been made for the Monday waste collection peak, i.e. 2 days storage). The sufficiency decrease during summer is logical given that the waste generated increases due to immigrant influx.

Next table presents the ratio of waste collected per worker in the municipalities.

Table 21. Waste collected per worker

Municipality	Summer solid waste on Monday (tons/day)	Number of workers	Average waste collected per worker (tons/d/worker)
Beit Yahoun	0.6	3	0.2
Aytaroun	12	6	2
Tireh	2	2	1
Kounin	4	3	1.3

To evaluate the results above, in well-organized systems the average collection rate is about 4-6 tons per worker per day. The results above show clearly that the level of productivity in waste collection is certainly low and this is due to two parameters:

- The rational allocation and the number of waste bins: the more the waste bins the more the stops to collect them and the less tons are collected per route.
- The lack of economies of scale as even very small communities organize their collection themselves, driving underutilization of both vehicles and personnel.

Based on the above analysis, the following key-points should be considered:

1. The level and the coverage of waste collection services are satisfactory, although most of the municipalities lack modern waste collection vehicles and a lot lack personnel. There is an urgent need to modernize the waste collection vehicles.
2. The sufficiency of the bins available is more than high but their distribution to municipalities is not reasonable as there is an excess of bins in small municipalities and a marginal sufficiency in big touristic ones.
3. There is a very serious potential to optimize the waste collection services, the vehicle utilization and the costs involved but this needs to overcome the fragmented way that the collection services are organized today and develop a regional collection plan that will achieve economies of scale.

2.3.3. Street sweeping

As far as street sweeping activities, they are carried out by the individual municipalities of the District with a variable frequency depending on need. Big municipalities clean the streets on a daily basis while other smaller ones have varying frequencies ranging from 1 to 2 times per week up to once yearly.

One to two workers are dedicated for this activity and most of the times these are the same workers handling the collection. In terms of infrastructure, street sweeping is taking place using basic manual tools. Mechanical street sweepers were requested by the Municipalities for use in the main streets.

2.4. Waste Treatment

In terms of municipal solid waste treatment in Bint Jbeil District, the system at the moment is composed of the following:

- An existing sorting and composting facility in Bint Jbeil with a capacity of 10 tons/day, serving only Bint Jbeil;
- An existing non-operational sorting facility in Shakra – Doubiyeh. This facility ceased operation since the Israeli attack on Lebanon in 2006;
- An existing operational sorting facility in Aytroun that receives the waste of two municipalities;
- An existing operational sorting facility in Kherbet Selem that receives the waste of the Municipality of Kherbet Selem.

Figure 22. The sorting table and the shredders at Kherbet Selem Facility

The remaining municipalities of the District of Bint Jbeil either dump their wastes or burn them.

According to the information made available by the Federation of Municipalities of the District, each municipality is handling the waste generated within its administrative territory. In some

cases, municipalities join their efforts. The below table summarizes the waste sorting and disposal means adopted at the moment by municipalities of the District:

Table 22. Waste sorting and disposal practices in Bint Jbeil

No	Village	Sorting	Ultimate disposal	Dump Site location and proximity to closest household
1.	Kounin	-	Dumping and/or open burning	The Eastern side of the village at El Wadi (at 2.5 km from the closest house)
2.	Aytaroun	Sorting & fermentation In Aytaroun Facility	Dumping	The Eastern side of Aytaroun (at 500m from the closest house)
3.	El Tiri	-	Dumping and/or open burning	The West side of Tiri, Baraket El Hajar Road (at 500 m from the closest house)
4.	Baraachite	-	Dumping and/or open burning	Haroun area between Baraachite and Aytaroun (at 1Km from the closest house)
5.	Bint Jbeil	Sorting & fermentation in Bint Jbeil Facility	Dumping + Rejects sent to Nabatiyeh	Ayn Ebel border, Yaroun, & the Southern side of Bent Jbeil
6.	Beit Yahoun	-	Dumping and/or open burning	The Eastern side of the village at Kaab El debsh (at 1 km from the closest house)
7.	Hanine	Sorting & fermentation at Aytaroun Facility	Dumping	Aytaroun
8.	Chakra-Doubiye	-	Dumping and/or open burning	The Southern Eastern side of the village (at 400m from the closest house)
9.	Ayta El Shaab	-	Dumping and/or open burning	The Southern side of the village, adjacent to the border (at more than 1Km from the closest house)
10.	Maroun El Rass	-	Dumping and/or open burning	Aytaroun
11.	Sarbine	-	Dumping	Ayn Ebel/Rshef (common dump site)
12.	Hadatha	-	Dumping and/or open burning	The Southern Western side of the village (at 500m from the closest house)
13.	Rshaf	-	Dumping and/or open burning	The Southern side, Debel side, (at 1,200m from the closest house)
14.	Aynata	-	Dumping	Outside the village
15.	Yaroun	-	Dumping and/or open burning	-

As far as the Facility of Bint Jbeil is concerned, it was financed by the Italian Development Cooperation and implemented by COSV (Comitato di Coordinamento delle Organizzazioni per il Servizio Volontario), an Italian NGO working in Lebanon, with an allocation of USD$538,685 to build a 50 tons per day (t/day) capacity waste-separating and composting plant in Bint Jbeil with

the support of the Italian Embassy (Melloni, 2010 and MORES, 2011). The initiative was also implemented through a contribution by the UNIFIL Civil Affairs through a Quick Impact Project for a total amount of $24,247 (The Daily Star, 2010). The project included the rehabilitation of the municipal waste treatment facility of Bint Jbeil through providing the necessary infrastructure and equipment (Melloni, 2010).

Aytaroun village has also its own plant which is designed to receive 15t/d of mixed MSW which receives the waste of Blida, Maroun El Rass and Hanine municipalities (Figure below). Aytaroun facility was rehabilitated post the July 2006 war and financed by the German Government through the German Agency for Technical Cooperation (GTZ) as part of the Environmental Fund Project for Lebanon (MORES, 2011).

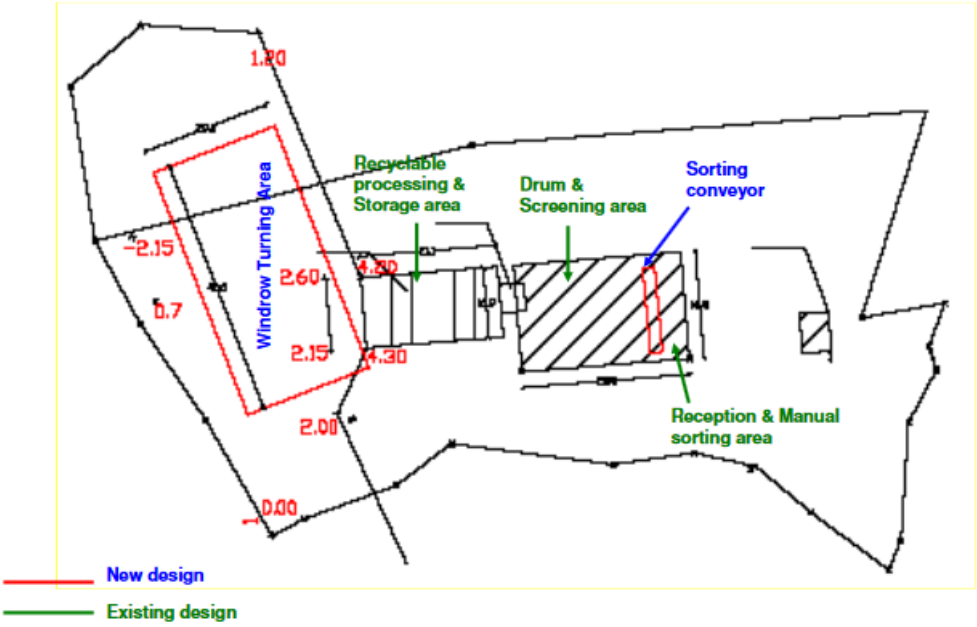


Figure 23. Aytaroun Municipal Solid Waste Sorting and Composting Plant Design Scheme (MORES, 2011)

A third facility exists in Chakra-Doubiye but is no longer operational since the Israeli attack on Lebanon in 2006 (GIZ GmbH, 2014 and Federation of Bint Jbeil District, 2017).

Two further facilities operate in the villages of Ain Ebel and Kherbet Selem which are not members of the Federation of Bint Jbeil District municipalities.

The following table presents the composting plants operating in Bint Jbeil along with their type of technologies used.

Table 23 - Municipal composting plants in Bint Jbeil (Abbas et al. 2017)

Name	District	Capacity (t/d)	Technology
Bint Jbeil	Bint Jbeil	20	Aerated Floor
Kherbet Selem	Bint Jbeil	15	Drums
Aytaroun	Bint Jbeil	15	Windrows
Ain Ebel	Bint Jbeil	10	Windrows

The Federation of Bint Jbeil Municipalities is at the moment planning MSW Plan that is structured as follows:

1- Initiating sorting at source;

2- Upgrading the existing facilities and increasing their capacities;

3- Constructing two transfer stations;

4- Constructing a waste to energy (WtE) facility

The Federation shared with the team a proposal they have received for the development of a WtE facility and which requires a capital investment of 529,000Euros for a 10 tons/day facility. According to the Federation, the operational cost is expected to be at around USD$30/ton in comparison to USD$60/ton for the existing current solid waste operational practices. The WtE technology is expected to get rid of slaughter house, leather wastes and the like.

2.5. Ultimate Means of Disposal

As mentioned earlier, the bulk of the waste of the Bint Jbeil District is dumped in uncontrolled dumpsites or burnet in open air. This section presents the status of dumpsites in Bint Jbeil.

2.5.1. Existing dumpsites

Recently a Master Plan for the closure and rehabilitation of open and uncontrolled dumps in Lebanon was prepared by the Ministry of Environment (MoE) and the United Nations Development Program (UNDP) with the technical assistance of Earth Link and Advanced Resources Development s.a.l. (ELARD). The study was originally prepared in 2011 and was then updated in 2016 due to the Syrian refugee influx and the solid waste crisis that started in July 2015 with the closure of the Naameh Landfill.

The study covered the whole country and more specifically the following four survey areas:

- Area 1: Akkar and North Lebanon
- Area 2: Beirut and Mount Lebanon
- Area 3: Nabatieh and South Lebanon
- Area 4: Beqaa and Baalbek

Dumpsites of highest priority were identified for closure and rehabilitation in light of potential impacts on the environment as based on a prioritization model developed for this purpose. The surveyed dumpsites, whether operational or non-operational, were divided into two types:

- Municipal Solid Waste (MSW) Dumpsite: contains over 85% of MSW in addition to hospital waste, CDW and industrial waste;
- Construction and Demolition Waste (CDW) Dumpsite: contains over 85% of CDW including rubble, green waste, and construction and demolition debris.

According to the above study, the Bint Jbeil district witnessed an increase of the order of 25.03% (18,159 m^3) in the volume of waste in both operational and non-operational MSW, and a decrease of 37.6% (84,700) in that of CDW waste(see Table below).

Table 24. Number and Volume Variation of Different Dumpsites in the District of Bint Jbeil

Year	Operational		Non-Operational		Inaccessible		Grand Total	
	Number	Volume (m^3)	Number	Volume (m^3)	Number	Volume (m^3)	Number	Volume (m^3)
Municipal Solid Waste (MSW) Dumpsites								
2011	31	78,828	6	2,808	-	-	37	81,636
2016	20	38,60	23	61,335	-	-	43	99,795
Construction and Demolition Waste (CDW) Dumpsites								
2011	6	11,810	3	9,038	-	-	9	20,848
2016	19	38,475	4	0	-	-	23	38,475

Out of the 20 operational MSW dumpsites identified in the 2016 Master Plan in Bint Jbeil Caza:

- 13 of these dumpsites existed and were operational in the 2011 Master Plan;
- 6 new operational dumpsites appeared in 2016.

23 of the operational MSW dumpsites identified in 2011 with a total volume of 61,335 m^3 became non-operational in 2016.

Out of the 23 non-operational MSW dumpsites identified in the 2016 Master Plan:

- 10 dumpsites with a volume of 12,595 m^3 were not rehabilitated;
- 5 dumpsites with a volume of 48,740 m^3 were rehabilitated and covered;
- 8 dumpsites with a volume of 0 m^3 were removed.

Out of the 19 operational CDW dumpsites identified in the 2016 Master Plan:

- 3 dumpsites existed in 2011 and remain operational;
- 2 dumpsites were non-operational in 2011 and became operational in 2016;
- 14 are new dumpsites identified in 2016

The total volume of waste in these dumpsites is 38,475 m^3 which represents a 22.6% increase from 2011 volume reported.

Four dumpsites in the 2016 survey were non-operational and removed. Three of these were operational in 2011, one was non-operational.

Mixed CDW dumpsites containing MSW could be classified as MSW Dumpsite since MSW has direct short-term impacts on the environment. The district of Bint Jbeil has 4 operational mixed dumpsites with a volume of 18,500 m^3 in total.

A Prioritization Decision Tool (PDT) was developed in order to prioritize dumpsites for rehabilitation based on a Risk Sensitivity Index (RSI). The RSI was calculated for each dumpsite by multiplying each sensitivity grade by its respective weight followed by an addition of all attributes. A site with a higher RSI indicates more risk to the environment, and thus requires a more urgent intervention. On the contrary, when the total RSI score of a dumpsite is low, its priority for rehabilitation decreases.

The below tables list all the MSW and CDW dumpsites that were identified in the District of Bint Jbeil in the 2016 survey along with their status, volume of waste, RSI score and priority rank.

Table 25. Lists of all MSW dumpsites identified in Bint Jbeil Caza

No.	Site ID	Status	Category	Volume (m^3)	MSWRSI	Priority Rank
1.	B3-Aintaroun-00	Non-operational	Not rehabilitated	30	23..662	124
2.	C3-Jmaijme-02	Non-operational	Not rehabilitated	360	23.110	145
3.	C3-Jmaijme-01	Non-operational	Not rehabilitated	75	22.491	171
4.	C3-Chaqra-00	Operational		1,500	21.762	214
5.	D3-Qalaouiye-03	Non-operational	Rehabilitated	0	20.880	266
6.	C3-Safad LBattikh-01	Non-operational	Rehabilitated	380	20.432	294
7.	B3-Ain Ibel-00	Non-Operational	Not Rehabilitated	2,400	20.423	295
8.	C3-Aaita Ej-Jabal-00	Operational		700	19.964	326
9.	D3-Froun-00	Operational		1,400	19.894	329
10.	C30Kfar Dounin-00	Non-operational	Rehabilitated	0	19.848	331
11.	B2-Hanine-01	Non-operational	Rehabilitated	0	19.495	347
12.	C3-Deir Ntar-00	Non-operational	Not Rehabilitated	200	19.191	367
13.	C3-Haris-01	Non-operational	Not Rehabilitated	500	18.970	379
14.	B2-Beit Lif-00	Operational		2,000	18.833	386
15.	B2-Qawzah-00n	Operational		360	18.382	409
16.	D3-Qalaouiye-01	Non-operational	Rehabilitated	0	18.380	410
17.	C3-Tibnine-00	Non-operational	Rehabilitated	270	18.244	419

No.	Site ID	Status	Category	Volume (m^3)	MSWRSI	Priority Rank
18.	B2-Ramyet Bent Jbayl-00	Operational		4,000	18.197	422
19.	D3-Qalaouiye-02	Non-operational	Rehabilitated	0	17.979	436
20.	B3-Kounine-01	Operational		1,000	17.794	441
21.	B3-Yaroun-02	Non-operational	Not Rehabilitated	150	17.629	448
22.	A2-Rmaich-00	Non-operational	Not Rehabilitated	80	17.167	472
23.	B2-Debl-00	Non-operational	Not Rehabilitated	4,800	17.110	477
24.	B3-Yaroun-01	Operational		900	17.082	478
25.	C3-Soultaniyet Bent Jbayl-01	Non-operational	Rehabilitated	0	16.777	498
26.	B3-Tiri-00	Operational		1,400	16.580	508
27.	D3-Borj Qalaouiye-00	Operational		50	16.572	510
28.	B3-Haddatha-00	Operational		6,000	16.369	521
29.	D3-Ghandouriyet Bent Jbayl-00	Operational		300	16.347	522
30.	B3-Rmaich-01n	Operational		4,000	16.223	526
31.	C2-Kafra Bent Jbayl-00	Non-operational	Rehabilitated	0	16.124	530
32.	B2-Rachaf-00	Operational		750	16.090	533
33.	C3-Baraachit-00	Operational		8,000	15.581	554
34.	B3-Beit Yahnoun-01	Operational		300	15.000	572
35.	A2-Aayta Ech-Chaab-02n	Operational		1,500	14.972	574
36.	B2-Debl-01n	Operational		700	13.305	603
37.	B3-Aaynata Bent Jbayl-02n	Operational		800	13.048	607
38.	B3-Maroun Er Ras-03n	Operational		2,800	12.324	614

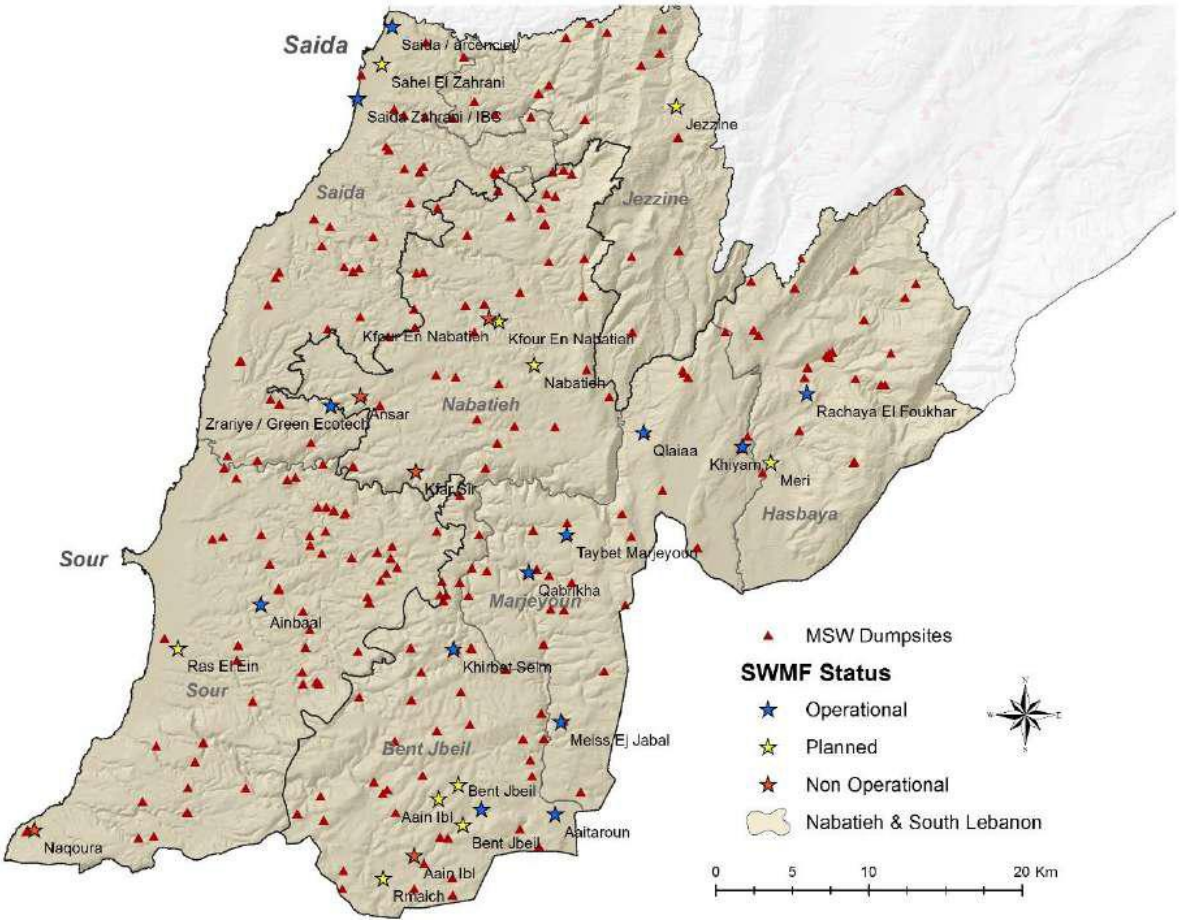


Figure 24. MSW dumpsites in Bint Jbeil District and other areas of South Lebanon

Table 26. Lists of all CDW dumpsites identified in Bint Jbeil District

No.	Site ID	Status	Category	Volume (m^3)	DRSI	Priority Rank
1.	B3-Aain Ibl-01n	Operational		3,000	20.315	29
2.	B3-Kounine-02	Operational		2,000	19.925	31
3.	C3-Kfar Dounine-01n	Operational		6,000	19.498	46
4.	B3-Beit Yahoun-02	Operational		6,000	19.056	55
5.	C3-Kfar Dounine-03n	Operational		800	18.792	68
6.	C3-Haris-02	Operational		200	18.716	71
7.	C3-Haris-03	Operational		300	17.743	107
8.	C3-Kfar Dounine-02n	Operational		400	17.138	127
9.	C3-Harris-04n	Operational		150	16.573	144
10.	C3-Maroun Er Ras-02	Non-operational	Rehabilitated	0	16.573	144
11.	C3-Safad El-Battikh-03n	Operational		2,500	16.494	147
12.	C3-Safad El Battikh-04n	Operational		100	16.315	155
13.	B3-Aain Ibl-02n	Operational		300	15.781	178
14.	B2-Beit Lif-01n	Operational		300	15.630	185
15.	B3-Aaynata Bent Jbayl-01n	Operational		6,000	14.465	226
16.	C3-Jmaijme-03	Non-operational	Rehabilitated	0	14.156	232

No.	Site ID	Status	Category	Volume (m^3)	DRSI	Priority Rank
17.	B2-Hanine-02	Non-operational	Rehabilitated	0	13.603	253
18.	C3-Safad El-Battikh-02	Non-operational	Rehabilitated	0	13.179	263
19.	B3-Haddatha-01n	Operational		25	12.415	280
20.	B3-Yaroun-03n	Operational		1,400	11.482	293

As shown in the table listing all MSW, no MSW dumpsites in Bint Jbeil district was identified as "priority".

3. Financial Analysis of Existing MSWM System

The Municipal Solid Waste (MSW) financial sustainability entails a cost stream being covered by a revenue stream over the management service lifetime:

On the cost side, the MSW cradle to grave costs vary according to the level and nature of collection (household vs. side-street; bulk vs. separation at source)/street sweeping, transformation (volume and quality of compostable and recyclables) and burial (dump, sanitary dump, landfill).

On the revenue side, a panoply of MSW fees, taxes and incentives and recovery options (linking the fee collection to the mobile bill collection) could be introduced while climbing up the compost and recycling supply chain (quality and quantity) with the aim to reduce the residual landfilling. This could help cover both the capital cost expenditures (CAPEX) and operations and maintenance expenditures (OMEX) of MSW or at least reduce the gap.

3.1. Sources of financing

At the local level, MSW revenues are covered through a direct tax levied at the Municipality level called Arsifa wa Majerir (street clean-up, waste collection as well as cleaning drains and septic tanks) which is equivalent to 30% of the annual rent or rent assessment if the household head is the owner. Municipal budgets were aggregated at the central level thanks to the USAID-University of Albany-supported municipal budget automation program, where it was possible to obtain the total municipal direct revenues by region from 2003 till 2007. Since the end of the program, municipal budget stopped being aggregated. Moreover, municipalities usually remain reluctant to release their budgets.

At the central level, the government and public entities collect numerous fees on behalf of municipalities. These fees are divided into two main categories: (i) Fees collected and directly redistributed to each municipality including arrears; and (ii) Fees collected and deposited into the Independent Municipal Fund (IMFU) including arrears. As for payments for solid waste

management, the IMFU bears the brunt of the cost of their respective services in the perimeter of some municipalities.

The IMFU payments, which constitute an important part of the municipal fiscal revenues, are usually backlogged putting some municipalities in precarious situations. The IMFU is distributed as follows:

- 75% to be distributed to municipalities of which 30 percent are earmarked for local development projects and 70 percent for budgetary support: 40 percent is proportional to the population, which is allocated on the basis of the registry office's civil status and not effective residence and remains a serious issue especially in larger municipalities; and 60 percent is based on the direct taxes/fees amount collected by the municipality over the preceding 2 previous years; and
- 25 % to be distributed to Federations of Municipalities, of which 75 percent are earmarked for local development projects with a priority to under developed areas and 25 percent for budgetary support.

This distribution is in theory but in practice the resulted allocation is not followed. Moreover, the share of MSW in total transfers has been increasing over the year except in 2015 where the solid waste crisis broke out. In 2013 and 2014, they accounted for almost half the transfers hence increasingly forgoing municipal development investments.

The cost recovery with regards to MSW in Lebanon is quite an impossible task and the most recent percentage of cost recovered to total cost of MSW services figures was calculated in the World Bank, 2011. Except for Beirut – Mount Lebanon area that the fee is estimated to cover almost 30% of the sweeping and collection cost, the other regions barely cover 10% of the sweeping and collection cost.

It is important to notice that in the area of Bint Jbeil, the operational cost of the waste treatment facility in Khirbet Selem is covered by OMSAR.

3.2. Cost of Operation of existing system

Information about the operation of the existing waste management system was obtained from the municipalities during the meetings held with the Consultant. In this context, it is to be noted that:

- The cost of operation of the street sweeping activities and waste collection is managed and handled independently by each municipality – most of the time;

- The cost of operation of the existing operational facilities is also handled by the Municipalities benefiting from them;
- The cost of the ultimate disposal of all the rejects resulting from the facilities as well as the untreated municipal solid waste is paid by the different municipalities;

The data obtained from the various municipalities is summarized in the below table:

Table 27. Indications for the operational cost of the current MSWM scheme

No	Municipality	Total Cost	Unit
Street Sweeping and Collection			
1.	Bint Jbeil	29	USD/ton
2.	Beit Yahoun	24	USD/ton
3.	Kounine	22	USD/ton
4.	Aaytroun	11.5	USD/ton
5.	Tiri	33	USD/ton
6.	Shakra – Doubiyeh	21	USD/ton
7.	Haddatha	34	USD/ton
8.	Aaynata	7.4	USD/ton
9.	Aita Al Shaeb	35.5	Million LL /Year
10.	Baraachite	3.0	Million LL/Month
11.	Maroun Al Ras	3.5	Million LL/Month
12.	Hadatha	1.8	Million LL/Month
13.	Rshaf	1.0	Million LL/Month
14.	Hanin	1.15	Million LL/Month
Treatment			
1.	Bint Jbeil	27	USD/Ton (
2.	Kherbet Selem	25	USD/Ton (By OMSAR)

Considering the whole picture of the study area, the following issues should be noted:

- The recent increases of the public-sector workers salaries are expected to increase the current collection costs by 15-25%. Most of the municipalities have inefficient waste collection systems with a current collection cost for the District ranging between 8 USD/Ton and 36 USD/ton

- Most of the waste is either dumped in open uncontrolled dumpsites or burnt in open air. The cost of such an operation is included within the collection cost

In the South, scavengers are very active. This should be taken into consideration in terms of waste quantities.

Based on the data collected, next table presents the costs of waste management in some municipalities of the study area.

Table 28. Cost of operation of the current MSWM scheme

Component	tons/year	US $/ton	Total (US $/y)
Collection	42,500	8-36	340,000-1,530,000
Treatment	16,425	27	443,475
Disposal	38,531	-	-
TOTAL	**-**	**-**	**783,475 - 1,973,475**

The bulk of the total cost is for waste collection which also includes the cost of dumping.

Considering the weighted Lebanese population (160,000 people), the average cost per capita and year is estimated at **4.9-12.3** ***US $/capita/year*** or about **0.41-*1.02 US $/capita/month*** which is very low.

Using as benchmarking the annual expenditures of individuals in South Lebanon Area (5,052 US $/y) as they are analyzed in the 2012 household survey, the cost of waste management is at maximum 0.24% of the individuals annual expenditures. For a quick comparison, they annual expenses for waste are less than 1/3 of the expenses for coffee, tea and cocoa (49.33 US $/y).

3.3. External costs

3.3.1. Environmental damages

The environmental cost of dumpsites is the cost due to environmental damages to atmosphere, CO2 emissions, water, soil, flora, fauna and of course of general environmental degradation. Since the polluters, under the current market and public policy conditions in Lebanon, do not pay for those damages, they are called externalities.

Dumpsites externalities split into fixed (independent of the quantity of waste) or variable (depending on the quantity of waste) costs. Most waste externalities such as emissions to air, water and soil are variable external costs. Disamenity effects of dumpsites mostly fixed external costs.

Regarding dumpsites most of the available information is on air emissions and less information exists on the emissions to soil and water. There is substantial literature and research on the quantification and valuation of the impacts of conventional air emissions and their resulting damage. The dispersion and impact patterns are relatively uniform once pollutants are emitted. Therefore, it is relatively easy to generalize the damage estimates and to apply such estimates widely. It can thus be concluded that valuation results in this field can be considered to be quite comprehensive and fairly robust although they are of course still subject to uncertainties. These uncertainties are reflected in relatively wide ranges of estimates. Other air emissions such as heavy metals and dioxins are, however, quantified relatively rarely.

Pollution pathways of emissions to soil and water are quite site-specific and difficult to measure. They depend largely on the quality of the soil, and on the specific location of the dumpsite with respect to for example groundwater reservoirs and receiving waters. Therefore, calculations on soil and water externalities must be considered as relatively uncertain.

Furthermore, the knowledge of the long-term effects from dumpsites in Lebanon is highly limited today due to the mere fact that such sites have not been studied in details, with appropriate methodologies. But it is more than sure, that damages may happen several decades after the emission has occurred. This raises the question of discounting and intergenerational distribution. How should a damage that occurs today be valued compared to a damage that happens in the future? Discounting is continuously subject of debate and the choice of the discount factor is very important for the results of our assessment.

For all those reasons, in our effort to assess the cost of environmental damages of dumpsites in Lebanon, it was decided to use the most conservative approach. This means that the results that are presented below are probably on the low side of the real damages, or in other words the cost of the environmental damages is probably underestimated. The methodology used is based on the EU study “Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste”, which was implemented by EU DG ENVIRONMENT in 2000. Justification of the valuation techniques have been made based on the more recent study on the cost of landfilling and dumpsites “The full cost of landfilling in Australia”, published at 2009 by the Department of the Environment, Water, Heritage and the Arts.

The table below summarizes the environmental cost components (externalities) that were identified as most suitable for the Lebanese conditions, in unit costs ($ per ton).

Table 29. Monetization of dumpsites environmental impacts

Component	Cost ($ / ton of waste disposed of)
Global warming	3.9 – 8.5
Air pollution	0.5 - 1
Leachate	3.5 - 8
Disamenity	3.5-7
TOTAL	**11.4 – 24.5**

Applying the previous to the specific area in which 31,002 tons are dumped annually, the following figures are provided.

Annual Cost of environmental damages: 0.44 – 0.94 USD million

Average Cost of environmental damage per ton of waste dumped: 18.00 USD/ton

Cost per capita: 2.75-5.9 USD/capita/year

The average cost of the environmental damage for the next 10 years, if the current uncontrolled disposal practice will not change, is going to be around 5.6 million USD.

3.3.2. Health damages

The health cost can be assessed through the benefits lost due to the health impacts, direct and indirect, that are caused by dumpsites - those benefits include the direct healthcare system costs, the losses of working time due to health problems as well as the psychological impacts of living nearby the dumpsites.

One of the most important challenges is to assess the economic burden posed to national and local health systems by dumpsites. Environmental pollutants can have direct and indirect effects on human health. Moreover, there are economic effects, e.g. on health care, productivity, recreation and intrinsic losses through disruption of ecosystems. National and international organizations increasingly request monetization of such effects for cost-effectiveness or cost-benefit evaluations. While some environmental health professionals regard the valuation of human health as unethical, it seems that the majority considers it a natural (though utilitarian) extension of burden of disease assessments.

Although the scientific and technical challenges involved in such an effort are high, the relevant concepts are under development and some key concepts should be taken into consideration. For the assessment of health costs related to dumpsites in Lebanon, we followed the methodology proposed by Carla Guerriero & John Cairns at “The potential monetary benefits of reclaiming hazardous waste sites in the Campania region: an economic evaluation”, Environmental Health 2009. The costs per disease were assessed using the data provided by

OECD at Environment Working Paper nr. 35 "Policy Interventions to Address Health Impacts Associated with Air Pollution, unsafe Water Supply and Sanitation, and Hazardous Chemicals", written by Prof. Alistair Hunt at 2011.

To apply this methodology, we made a rather conservative assumption that only 1% of the population of the Bint Jbeil District is affected by health impacts. Thus, the assumption means that the health impacts posed by dumpsites are affecting about 1,600 people, an approach which is also rather conservative. In practice, this could be anything between 1-5%, as we know from international experiences.

The benefits lost (or the health costs related to dumpsites) by each person affected have been assessed between 350 - 500$ per year.

Applying the previous, the results are as follows:

Annual cost of health damages: 0.56 – 0.80 USD million

Average health cost per ton of waste dumped: 22 USD/ton

Average health cost/cap/y: 4.25 USD/y

3.4. Total costs

The next table presents the total cost of waste management for the Bint Jbeil District per ton of waste managed and per capita.

Table 30. Total cost of waste management in the district of Bint Jbeil

COSTS PER TON		
Item	**MIN (USD/ton)**	**MAX (USD/ton)**
Direct cost	18.4	46.4
Environmental cost	10.35	22.1
Health cost	13.17	18.8
Total	**42.00**	**87.3**
COSTS PER CAPITA		
Item	**MIN (USD/cap/y)**	**MAX (USD/cap/y)**
Direct cost	4.9	12.3
Environmental cost	2.75	5.90
Health cost	3.5	5.0
Total	**11.15**	**23.2**

The main conclusion is that including the environmental and health costs involved from the current practice of uncontrolled dumpsites, the real cost of waste management goes much

higher (between 42 and 87.3 USD/ton) comparing to the direct cost which assessed at 18.4-46.4 USD/ton. The same is true for the cost per capita which is between 11.15 – 23.2 USD/cap/y.

The environmental and health cost of continuing the current business model, with the dominance of the uncontrolled dumpsites for the next 10 years, is between 10 – 17 million USD. Although this is not a direct cost, it is better understood through the costs for closing the dumpsites and rehabilitating them which is just a part of the total environmental and health damage.

4. Existing Public Awareness & Education Programs on MSWM

According to the meetings held with the members of the Federation of Bint Jbeil Municipalities, no attempts for Sorting at source were initiated at the federation level or at the Municipalities level.

5. Public Private Partnerships

The Lebanese Parliament ratified the Public Private Partnership (PPP) law in August 16, 2017. The Law was officially published under Law No 48 in the Lebanese gazette No 42 on the 14th of September 2017 and was effective since then.

This Law has been long awaited for despite the history of existing different types and forms of PPP contracts in Lebanon (management contracts, BOT contracts, Lease Contracts and Concession contracts). Examples include Electricity of Zahle (Concession, 1960), Liban Post (BoT, 1998), Beirut International Airport (Concession, 2000), Mobile Operators (Management Contract, 2004), Power Generation Ships (Lease, 2012), etc.

In the absence of this Law, a lot of planned investments for infrastructure development projects have been delayed and even cancelled. Indeed, there is a competition amongst countries to attract international developers and lenders who usually have preference for countries with a clear and supportive legal framework for such developments. Prior to the PPP Law enactment, the existing legal framework in Lebanon did not offer the customary guarantees that foreign investors and international financial institutions often seek in order to have visibility on the rules of the game and reduce the project risks. The absence of these parameters has impeded the success rate of PPP projects to date.

It is believed that the recent passing Law will put Lebanon in a more competitive position not only to attract investments (mainly from international financial institutions) but also to bring international expertise to the country, create thousands of job opportunities while eventually increasing revenues and stimulating the economic growth.

For the specific case of the solid waste management sector in Lebanon where the majority of the municipalities lack the financial resources as well as a qualified and motivated human resources base, the Public-private partnerships is a promising alternative to improve MSW management performance with privately owned enterprises.

This section of the baseline report presents a brief overview of the main provisions of Law No 48.

Table 31. Main provisions of Law No 48

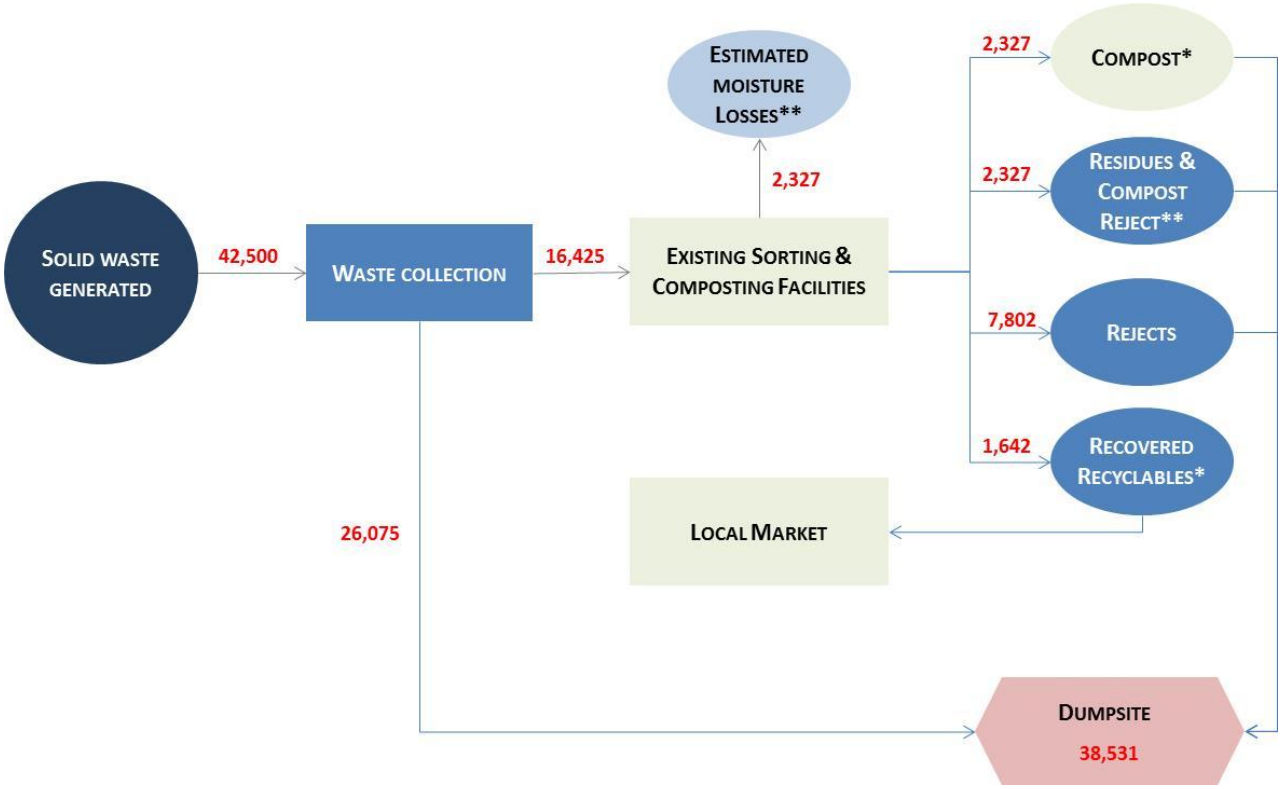
No	Provision	Description
1.	General	The Law defines a clear mechanism for tendering for PPP projects; It sets the general institutional framework; It calls for the creation of a project committee and supporting working groups for each project It defines the key elements of the PPP project agreement
2.	Definition	PPP projects are projects of public nature in which the private sector will finance, administer and provide at least one of the following services: design, build, construction, restoration, equipment, maintenance, rehabilitation and operation
3.	Beneficiaries	The PPP Law covers all projects carried out by the Government or state, the public institutions, and any public entity. It covers sectors such as telecommunications, electricity, civil aviation, etc. The scope of the Law could be expanded to cover PPP projects carried out by municipalities and /or union of municipalities
4.	Project agreement	The project agreement is the main contract that governs the contractual relationship between all stakeholders including the public authority, the project company, international financial institutions, foreign investors, others. The Law specifies the key provisions to be integrated and accounted for in the project agreement including without being limited to obligations and rights, financing basis, duration (cannot exceed 35 years), revenues, KPIs, reporting requirements, guarantees, transfer procedures, dispute settlement procedures, etc.
5.	Authorities	Based on the stipulations of the new Law, the "High Council for Privatization" instituted by virtue of the Privatization Law No.228 dated 31st of May 2000 is renamed as the "High Council for Privatization and PPP" and is granted the authority to: Assess and evaluate PPP proposals Establish a PPP Project Committee for every approved PPP project Decide on the outcome of Pre-qualification evaluations Approve the tender documents Confirm the winning of any tendering process
6.	PPP Project Committee	The project committee, having the Secretary General of the High Council for Privatization and PPP as a President, is in charge of the following: Preparing a comprehensive study of the PPP project Setting the pre-qualification criteria Assessing investors interest Management and administration of the application process Evaluation of prequalification applications Preparation of tender documents Review of bids Negotiation with retained bidder
7.	PPP Project	The winning bidder private partner is required to incorporate a Lebanese joint stock

No	Provision	Description
	Company	company, the PPP project Company, which will be in charge of executing the PPP project. The Company will benefit from exemptions from nationality related restrictions imposed by the Lebanese code of commerce. The Law further differentiates between the establishment phase of the company and the operation phase.

The procedure that every PPP project will undergo is illustrated in the form of a flowchart as shown in Annex 4.

6. The Baseline Of Bint Jbeil In Brief

This section describes the current waste management conditions in the district of Bint Jbeil using proper indicators that cover both the technical, environmental and financial aspects of the existing waste management system. The calculations are based on the waste flow diagram that describes the current waste management system in the area.



All quantities are in tons/year
**Calculations based on 10% recovery of recyclables*
***Calculations based on assuming that 50% of the waste are organic of which 85% is recovered, whereby 33% of the organic is lost as moisture and another 33% as rejects*

Figure 25. Waste flow diagram in Bint Jbeil District

The waste flow diagram shows that the biggest and most urgent problem of the District is to stop the disposal of waste without treatment in open dumps.

The next table presents the main indicators that describe the system in brief. In all first five indicators, the percentages are calculated with the total waste generated as the denominator. The final three indicators are qualitative ones and their ranking is based on the information that has been already presented in this baseline.

Table 32. Waste Management in the district of Bint Jbeil in brief

INDICATORS	MEANING	VALUE	COMMENTS
PUBLIC HEALTH PROTECTION		**LOW**	
Waste Collection Coverage %	The indicator shows how much of the population is served by regular collection services	100%	Collection covers all the population, but it is inefficient and not well organized
Uncontrolled disposal rate	The indicator shows how much of the waste is dumped in uncontrolled dumpsites	91%	This is an alarming signal that demonstrates serious public health and environmental risks. Closing the dumpsites and ensuring safe disposal to sanitary landfills is the number one priority.
ENVIRONMENTAL PROTECTION		**LOW**	
Diversion rate	The indicator shows how much of the waste generated is not dumped (recovered plus moisture losses)	9.3%	More than half of this diversion is due to the informal recyclers
RESOURCE MANAGEMENT		**LOW-MEDIUM**	
Recovery rate	The indicator shows how much materials are recovered	3.86%	The informal recyclers recover almost 83% of it.
Waste streams managed by the informal recyclers	The indicator shows what part of the waste generated is managed outside the formal waste management system	0%	This is a significant amount – the UoM and the municipalities should consider seriously ways to integrate the informal recyclers in the formal systems or to cooperate with them.
INSTITUTIONAL DEVELOPMENT	The indicator shows if there are sound institutions and pro-active policies in place	**LOW-MEDIUM**	The UoM is getting stronger but there are still problems with the overall cooperation of the municipalities and the planning efforts in place, while the technical and legal capacity is limited.
SOCIAL INCLUSION	The indicator shows if the current system is inclusive, providing transparent spaces for stakeholders to contribute as users, providers and enablers	**LOW**	There is a complain registration system in place but there is a complete lack of knowledge and cooperation with informal recyclers. There is a need for more specific and detailed procedures for stakeholders engagement as well as for detailed reporting on the results of the current waste management system.
FINANCIAL SUSTAINABILITY		**LOW**	The cost recovery rate is very low, waste treatment cost is covered by OMSAR and the financial stability of the system in place is questionable. There is a complete lack of

			accountability in financial issues. However, the overall cost is rather low and a serious upgrade of the system is possible within the affordability levels of the population.

SUB-ACTIVITY 1.1

ANNEXES

ANNEX 1 – HEALTH IMPACTS OF DUMPSITES

Introduction

Several population studies document (scientifically) that dumpsites can have serious effects on the health and well being of the population[1]. A wide range of toxic substances can be released into the environment from uncontrolled waste disposal, for example, methane, carbon dioxide, benzene and cadmium. Many of these pollutants have been shown to be toxic for human health. The International Agency for Research on Cancer[2] classifies exposure to cadmium and benzene as highly carcinogenic for humans. In addition, dumpsites are likely to contain highly hazardous compounds resulting from industrial production, for example asbestos and lead. Previous epidemiological studies have found that two main health outcomes – cancer and congenital malformations – are statistically associated with waste exposure in dumpsites.

But before going into the details, the conceptual framework that describes the heath risks and impacts associated with dumpsites will be outlined. Understanding this conceptual framework is necessary in order to put all the other elements in the right place. The health impacts related to dumpsites are directly linked with the types of the different waste streams that are disposed off. Different waste streams involve different health and safety risks. Besides the usual municipal waste, hazardous waste, health-care waste and e-waste are going to be discussed.

Dumpsites' on-site activities might increase or decrease the related health risks. Uncontrolled scavenging and open burning of waste, either for volume reduction or for metal recovery, are two of the most usual causes for increased health risks. Occupational health risks and impacts to dumpsites workers and informal sector recyclers (ISR) will be addressed, as this is a key-issue for a big part of the world and an important component of the on-going research.

Conceptual framework

The health risks and impacts by dumpsites are associated to some of the pollutants (or hazardous substances) that are found in waste streams or to pollutants that are created at the dumpsite environment through physic-chemical interactions.

In general terms, pollutants can move through air, soil, and water. They can also be on plants or animals, and can get into the air, the food chain and the water.
The different ways a person can come into contact with pollutants are called exposure pathways. There are three basic exposure pathways: inhalation, ingestion, and skin contact. Inhalation is breathing or inhaling into the lungs. Ingestion is taking something in by mouth. Skin contact occurs when something comes in direct contact with the skin. Ingestion can be a secondary exposure pathway after skin contact has occurred.

[1] Carla Guerriero and John Cairns, The potential monetary benefits of reclaiming hazardous waste sites in the Campania region: an economic evaluation, *Environmental Health* 2009, **8**:28 doi:10.1186/1476-069X-8-28
[2] IARC: Monographs on the Evaluation of Carcinogen Risks to 29. Humans. Beryllium, Cadmium, Mercury and the Glass Manufacturing Industry. Volume 58. Lyon: International Agency for 30. Research on Cancer; 1993.

Exposures can be either acute or chronic. An acute exposure is a single exposure to a hazardous substance (pollutant) for a short time. Health symptoms may appear immediately after exposure; for example, a burn when exposed to a strong acid such as from a leaking battery.

Chronic exposure occurs over a much longer period of time, usually with repeated exposures in smaller amounts. For example, people who lived near Love Canal[3], a leaking hazardous waste dump, did not notice the health effects of their chronic exposure for several years. Chronic health effects are typically illnesses or injuries that take a long time to develop, such as cancer, liver failure, or slowed growth and development. One reason chronic exposure to even tiny amounts of hazardous substances can lead to harm is bioaccumulation. Some substances are absorbed and stay in human bodies rather than being excreted. They accumulate and cause harm over time.

Adverse health effects are dependent on the factors of the exposure. Factors that play a part in whether or not adverse health effects may result from an exposure are:

- The type of pollutant;
- The amount or dose (the amount or level of a pollutant a person was exposed to);
- The duration (how long did exposure occur) and
- The frequency (how many times the person was exposed).

Consequently, any effort to associate dumpsites with health risk and impacts will certainly involve evaluation of the following parameters[4]:

- Mass rate of release of both waterborne and airborne pollutants.
- Areal extent of contamination, and persistence and transformation of the pollutants and their transformation products.
- Concentrations and gradients of those pollutants that adversely impact air, water and land resources.
- Number of people and especially sensitive populations that could be influenced by the release of pollutants from the site.
- Total period of time over which pollutant release will occur.
- Duration of exposure.
- Synergistic and antagonistic impacts of other pollutant releases or adverse health conditions that might cause an exposed population to be more susceptible to pollutants derived from the site.
- Characteristics of the site such as the depth of solid waste and degree of compaction.
- Characteristics of the wastes accepted by the site owner/operator during the dumpsites' active life.
- Size of the site as defined by the total amount of solid waste disposed of and the areal extent.

The whole process of assessing the health risks and impacts of a dumpsite is really difficult and requires high expertise, time and financial resources in order to be completed. Its successful

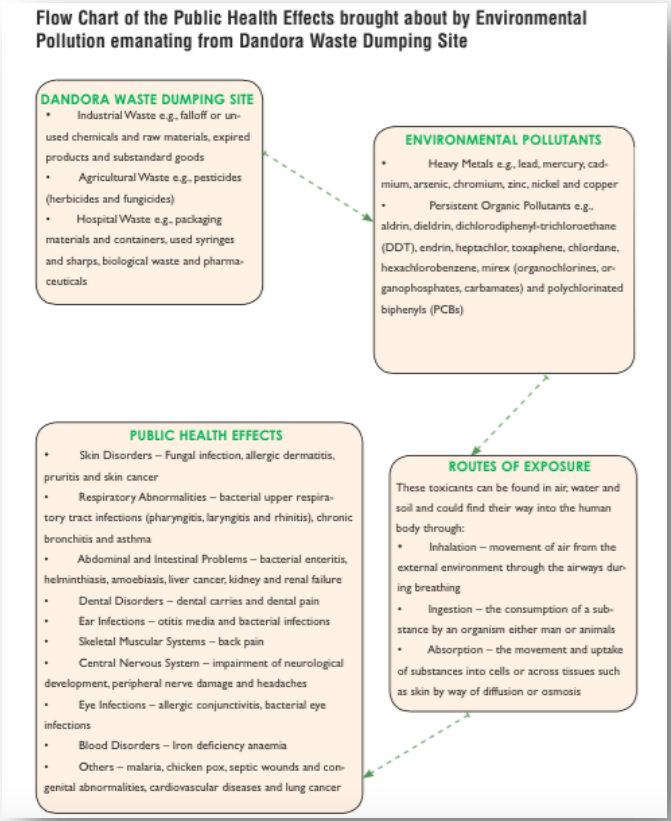
[3] Goldman LR et al. (1985). Low birth weight, prematurity and birth defects in children living near the hazardous waste site, Love Canal. *Hazardous Waste and Hazardous Materials*, 2:209-223.

[4] Kurian Joseph et al, A decision making tool for dumpsite rehabilitation in developing countries, Proc. Sardinia, Tenth International Waste Management and Landfill Symposium. Cagliari, Italty, October 2005

implementation requires to manage the non-availability of specific data on the dose response relationship for some of the chemicals of concern and to make a number of suitable assumptions and interpretations.

For a better understanding of what is more or less required, it is useful to outline the study that UNEP implemented regarding the public health impacts of the Dandora dumpsite in Nairobi, Kenya.[5]

For the implementation of the study, environmental samples (soil and water) were analyzed to determine the content and concentrations of various pollutants (heavy metals, polychlorinated biphenyls and pesticides) that are known to affect human health. Soil samples from the dumpsite were compared to samples taken from another site, which is a peri-urban residential area on the outskirts of Nairobi. A medical camp, located next to the dumpsite, was also set. A total of 328 children and adolescents living and schooling adjacent the dumpsite were examined and treated for various ailments. Of these, 40 were referred for further laboratory tests that entailed blood and urine sampling to assess the impact of exposure to environmental pollutants from the dumpsite on human health. Below, the flow chart of the study shows the link between the environmental pollutants from the dumpsite and public health impacts on the adjacent communities. This flow chart is characteristic for any similar effort and describes the conceptual framework between health and dumpsites.



[5] UNEP, Environmental Pollution and Impacts on Public Health: Implications of the Dandora Municipal Dumping Site in Nairobi, Kenya, 2007

Figure 1. The flow chart of the Dandora study[6] shows the conceptual framework for health & dumpsites

The waste streams disposed off at a dumpsite are one of the most important factors that determine its health risks. Besides municipal waste, healthcare waste, hazardous and e-waste are common streams found in dumpsites. The problem is that in most dumpsites all the previous waste streams are usually present in unknown quantities and with roughly unknown interactions.

Municipal waste

Organic wastes in dumpsites are biodegraded and thus they create conditions favorable for the survival and growth of microbial pathogens. These conditions can be further enhanced if the waste is disposed off with pathogens from human body fluids such as faeces, urine, blood and sputum. All are present in typical municipal waste through nappies, sanitary pads and the general discards from vomiting and human secretions. Organic wastes also provide a food source for carriers of enteric pathogens such as rodents, insects, birds and larger wild mammals. Subsequently, the diffuse airborne emissions from biologically and chemically decomposing municipal solid wastes at dumpsites are considered as a health risk. Decomposition of organic fraction in dumpsites results in the generation of gases and contributes to leachate formation. Thus the main sources of pollutant emissions from a dumpsite are as follows:

a. The wastes as they are brought onto site, normally in heavy vehicles,
b. Emissions from transport and bulldozers, compactors etc.
c. Waste blown by the wind as it is tipped or deposited at the dumpsite,
d. Dust generated from the surface of the dumpsite and when waste is tipped or unloaded,
e. Waste materials which have previously been deposited in the dumpsite,
f. Any gas generated as the waste breaks down (if not collected and treated),
g. Any leachate produced as the waste breaks down,
h. The discharges from any processes used to treat the leachate (if any at all).

While in modern sanitary landfills all those emissions are eliminated or under complete control (due to the use of advanced environmental protection measures like liners, top covers, biogas and leachate management system, continuous monitoring), in dumpsites those emissions are uncontrolled and they are actually associated with serious health hazards.

The main pollutants associated with health risks in dumpsites are the following ones.

Persistent Organic Pollutants

POPs, such as dioxins and furans (PCDDs and PCDFs) are persistent non-biodegradable organic compounds produced though uncontrolled burning waste, natural generation of methane gas and low temperature burning of waste to recover metals. POPs trigger a biological response to humans that results in neurological, immunologic and reproductive problems[7]. POPs have been also considered responsible for respiratory disorders[8], and elevated cancer risk[9].

[6] UNEP, Environmental Pollution and Impacts on Public Health: Implications of the Dandora Municipal Dumping Site in Nairobi, Kenya, Summary Report, 2007
[7] S.S. White and L.S. Birnbaum, An Overview of the Effects of Dioxins and Dioxin-Like Compounds on Vertebrates, as Documented in Human and Ecological Epidemiology, Journal of Environmental Science and Health, Part C.,2009, 27(4), 197-211p
[8] K.O. Boadi and M. Kuitunen, Environmental and health impacts of household solid waste handling and disposal practices in third world cities: the case of the Accra Metropolitan Area, Ghana,Journal of environmental health,2005. 68(4), 32-36p

Heavy Metals

Heavy metals can be found in dumpsites leachate, air and soil produced either from plastic burning or smelting of scrap metals and e-waste. Lead, mercury, cadmium and arsenic are the main heavy metals causing neurological impairments, anemia, kidney failure, immunosuppression, gastrointestinal and respiratory irritation, abnormalities of skeletal system, inflammation of liver, cancer of liver, cardiovascular diseases after chronic exposure[10].

Volatile organic compounds (VOCs)

Volatile organic compounds are harmful to humans and also contribute to ground-level ozone pollution, also known as smog. Inhaling certain VOCs can lead to eye, nose, and throat irritation, headache, loss of coordination, nausea, and damage to liver, kidney, and central nervous system[11].

Polynuclear Aromatic Hydrocarbons (PAHs)

The PAHs are a class of compounds composed of two or more aromatic rings and they are present in dumpsites[12]. Hundreds of them have been identified and found as complex mixtures. They are generated by incomplete combustion, forest fire and volcanic eruptions or by other anthropogenic sources such as industrial production, transportation and waste incineration. They are classified as environmentally hazardous organic compounds by European Community (EC) and United States Environmental Protection Agency (US EPA), and are included in the priority pollutant list[13]. Several PAHs are known to be potential human carcinogens, some examples include benz[a]anthracene, chrysene, benzo[b]flouranthene, benzo[a]pyrene and benzo[g,h,i]perylene [14].

Hydrogen Sulfide (H_2S)

Hydrogen sulphide is a colorless, flammable gas with a characteristic odor of rotten eggs. It is produced in dumpsites when high sulphate bearing materials (such as gypsum and plasterboard) are mixed with biodegradable waste. The composition of the waste material and the practices followed of the site will determine the amount of H2S produced. At low concentrations, H2S may result in irritation to the mucous membranes of the eye and respiratory tract. Exposure to high concentrations results in depression of the central nervous system, loss of consciousness and respiratory paralysis15. Other health effects have been reported, although data on the effects in humans following

[9] J. Krajcovicova and A.Q. Eschenroeder, Comparative Health Risks of Domestic Waste Combustion in Urban and Rural Slovakia. Environmental Science & Technology, 2007, 41(19), 6847-6853p

[10] United Nations Environment Programme, Environmental Pollution and Impacts on Public Health: Implications of the Dandora Municipal Dumping Site in Nairobi, Kenya, 2007

[11] EPA, Human Health,25 June 2014, Available at http://www.epa.gov/osw/nonhaz/municipal/backyard/health.htm, access on 22 January 2015

[12] J. K. Nduka et al, Polyaromatic Hydrocarbons (PAHs) and Inorganic Chemical Contaminants at Refuse Dumpsites in Awka, South Eastern Nigeria: A Public Health Implication, Journal of Scientific Research and Reports, ISSN: 2320–0227,Vol.: 2, Issue.: 1 (January-June). P. 173-189, 2013

[13] Guillen MD, Sopelana P, Partearroyo MA. Determination of polycyclic aromatic hydrocarbons in commercial liquid flavouring of different composition by gas chromatography-mass spectrometry. Journal of Agricultural and Food Chemistry. 2000;48:126-131.

[14] Nieva-Cano MJ, Rubio-Barroso S, Santos-Delgado MJ. Determination of PAH in food samples by HPLC with flourimetric detection following sonication extraction without sample clean-up. The Analyst. 2001;126:1326–1331.

[15] HPA (Health Protection Agency), Compendium of Chemical Hazards. Hydrogen Sulphide. Available at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1246260029655 , 2009

Particulates

Dumpsites activities produce both fine and coarse particulates, the make-up of which will depend on the activities undertaken on-site and the types of waste being handled[16]. Exposure to particles that can enter the respiratory system is known to be associated with a range of adverse effects on health. Particles of greater than 10 m in diameter (particulate matter, PM10) are unlikely to penetrate beyond the nose and larynx but, as the diameter of particles falls, the likelihood of their entering the lungs and being deposited in the airways increases. Particles of less than about 2.5 m diameter (PM2.5) are referred to as 'fine' particles and are deposited relatively efficiently in the deeper parts of the lung – for example, in the alveolar spaces. Particles between 2.5 and 10 m in diameter are referred as comprising the 'coarse' fraction of PM10. These particles may also have effects on health. Dust emitted from dumpsites will include particles, which fall into both the PM10 and PM2.5 categories. People with pre-existing lung and heart disease, the elderly and children are particularly sensitive to particulate air pollution.

Dusts from dumpsites can become airborne and move off site by a number of mechanisms. The amount of dust lifted from the surface of the dumpsite is dependent upon the speed of the wind, the condition of the surface and the size of the dust particles. The distance travelled by dust emissions will depend on the particle size and on the wind speed and turbulence. Smaller dust particles will stay airborne for longer and disperse over a wider area. Strong and turbulent winds will also keep larger particles airborne for longer.

Odors

Odors are frequently a key issue for dumpsites, especially those receiving biodegradable waste. Odors are typically associated with activities such as the handling of odorous wastes and the covering of biodegradable wastes or with the presence of trace components in gas or leachates. Odorous emissions are often accompanied by reports of ill-health from communities[17]. Individuals may report a wide range of non-specific health symptoms, attributing these to odor exposure, including nausea, headaches, drowsiness, fatigue and respiratory problems. Health symptoms reported in association with odorous emissions can arise at olfactory detectable concentrations well below the levels associated with toxic effects or thresholds for mucous membrane irritation. Individual responses to odors are highly variable and are influenced by many factors including sensitivity, age and prior exposure to the odor. Psychological and social factors, in addition to an individual's level of concern about the potential harm to their health, will also play an important role in an individual's response. There are published studies that show strong correlation between perceived odor annoyance and subjective symptoms[18].

Leachate

The nature of landfill leachate is a function of waste types, solubility, the state of decomposition and degradation. Rainfall input can serve to dilute and flush contaminants in addition to assisting in the degradation process by wetting the wastes. A wide range of substances may potentially be present in leachate, some of which are potentially harmful to human health. Table 2 shows the most important leachate substances that can be associated with health risks.

[16] HPA (Health Protection Agency), Impact on health of emissions of landfill sites, 2011

[17] Steinheider B, Environmental odours and somatic complaints. Zentralblatt für Hygiene und Umweltmedizin [International Journal of Hygiene and Environmental Medicine], **202,** 101–19, 1999

[18] Dalton P., Upper airway irritation, odour perception and health risk due to airborne chemicals. Toxicol Lett, 140–141, 239–48, 2003

Table 1: Leachate substances associated with health risks

TABLE 3 Priority substances in landfill leachate (taken from EA, 2010a)

Aniline	Fluoride	Organotin compounds
Arsenic	Mecoprop	Pentachlorophenol
Biphenyl	Methyl chlorophenoxy acetic acid	Phenols
Cyanide	Methyl tertiary butyl ether	Phosphorus
Di(2-ethyl hexyl) phthalate	Naphthalene	Polycyclic aromatic hydrocarbons
Dichloromethane	Nitrogen	Toluene
Ethylbenzene	Nonylphenol	Xylenes

In fact, the health risks posed by leachate demonstrate the huge difference between a dumpsite and a modern landfill. Any modern landfill is located through a proper site allocation and Environmental Impact Assessment procedure that takes into account environmental vulnerability. Leachate in a modern landfill is discharged following treatment in an on-site process, and/or at an off-site sewage works. Modern landfill liners are also very effective in containing leachate and a tiny amount of leachate will be released via the landfill lining system to land or groundwater. Modern landfills also impose continuous monitoring procedures, which identify leakages as soon as they happen. For all those reasons, it can be documented that leachate releases to surface or groundwater are unlikely to pose a significant risk of adverse effects on health[19].

In contrast, leachate releases by dumpsites are uncontrolled and surface and groundwater pollution should be considered as an almost certain consequence of the dumpsites operation. Taking into account that dumpsites are located without any proper procedures that take into consideration environmental vulnerability, it is not a surprise that serious surface and groundwater pollution is the rule in dumpsites[20],[21].

Biogas

Biogas formation to dumpsites can result in explosion risks and several similar accidents have been reported, some of them with lethal consequences (see relevant paragraph). Carbon dioxide and methane are the two major components of biogas. The health effects of exposure to methane and carbon dioxide are well known.

Both are colorless, odorless gases which act as asphyxiants. Carbon dioxide is non-flammable and, at low concentrations or low levels of exposure, it increases the depth and rate of respiration, blood pressure and pulse[22]. At increasing concentrations, a depressive phase develops which can culminate in cardiorespiratory failure. Concentrations above 6% by volume can give rise to headache, dizziness,

[19] EA (Environment Agency), Updating the Landfill Leachate Pollution Inventory Tool. R&D Technical Report No. PI-496/TR(2). Shrewsbury, Enviros Consulting Ltd. , 2003

[20] David, O. M., & Oluyege, A. O , Effect of Open Refuse Dumpsite on the Quality of Underground Water Used for Domestic Purposes in Ado-Ekiti, Nigeria - A Public Health Awareness Study, Journal of Environment and Ecology, Vol. 5, No. 2, ISSN 2157-6092 2014

[21] Glenn Sia Su, Water-borne illness from contaminated drinking water sources in close proximity to a dumpsite in Payatas, The Philippines, Journal of Rural and Tropical Public Health 4: 43-48, 2005

[22] HPA (Health Protection Agency), Carbon Dioxide. Incident Management. Available at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1279889001588 , 2010

mental confusion, palpitations, increased blood pressure, difficulty breathing and central nervous system depression. Humans cannot breathe air containing more than 10% carbon dioxide without losing consciousness.

In contrast to carbon dioxide, methane is a flammable gas, which is explosive in air at concentrations between 5 and 15% by volume. Inhalation can cause nausea, vomiting, headache and loss of coordination. At very high concentrations it may cause coma and death due to respiratory arrest[23].

In addition, municipal waste usually includes limited quantities of harmful substances like:

- Chemicals (pesticides, garden products, batteries, bleach, paint, varnishes, cleaning products)
- Biologicals (human waste, green waste, animal infestations, dead animal carcasses, animal waste, used needles/syringes, drugs etc.)

In a dumpsite, health risks from those harmful substances can occur via the following routes (for both workers and informal recyclers)[24]:

- Skin contact, especially through cuts and abrasions or contact with the eye's mucus membrane;
- Skin penetration through sharps injuries;
- Ingestion through hand-to-mouth contact (usually when eating, drinking or smoking);
- Breathing in infectious aerosols/droplets from the air.
- Sharp items, such as broken glass and tin cans, may increase the risk of exposure.

Hazardous waste

Hazardous wastes in dumpsites are a real threat for the lives of the workers and the nearby residents. WHO has estimated that environmental exposures contribute to 19% of cancer incidence worldwide.[25] Additionally, a WHO Global Health Risks report looked at five environmental exposures, (unsafe water, sanitation and hygiene, urban outdoor air pollution, indoor smoke from solid fuels, lead exposure and climate change), and estimated they account for nearly 10% of deaths and disease burden globally and around one quarter of deaths and disease burden in children under the age of five[26].

Hazardous wastes are by-products of human activities that could cause substantial harm to human health or the environment if improperly managed. As an example, the United States Environmental Protection Agency (EPA) classifies liquid, solid, and gaseous discarded materials and emissions as hazardous if they are poisonous (toxic), flammable, corrosive, or chemically reactive at levels above specified safety thresholds. The term hazardous waste generally refers to potentially dangerous or polluting chemical compounds, other potentially hazardous industrial, military, agricultural, and

[23] HPA (Health Protection Agency), Compendium of Chemical Hazards. Methane. Available at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1287147970726 , 2009
[24] HSE, Health and hazardous substances in waste and recycling, UK, 2014
[25] Vineis, P. and W. Xun. "The emerging epidemic of environmental cancers in developing countries." Annals of Oncology 20: 205–212, 2009.
[26] WHO, Global health risks: mortality and burden of disease attributable to selected major risks.", 2009.

municipal byproducts, including biological contaminants.

Chemical manufacturing, primary metal production, metal fabrication, and petroleum processing are some of the most usual industrial hazardous waste generators. However, businesses of all sizes generate dangerous chemicals; as an example, USA EPA currently lists more than 250,000 facilities as "small-quantity generators" of hazardous waste. These diverse, smaller producers account for about 10% of the potentially harmful substances produced each year.

Obsolete pesticides, stored in leaking drums or torn bags, can directly or indirectly affect the health of anyone who comes into contact with them. During heavy rains, leaked pesticides can seep into the ground and contaminate the groundwater. Poisoning can occur through direct contact with the product, inhalation of vapors, drinking of contaminated water, or eating of contaminated food. Other hazards may include the possibility of fire and contamination as a result of inadequate disposal such as burning or burying. Chemical residues discharged into the sewerage system may have adverse effects on the operation of biological sewage treatment plants or toxic effects on the natural ecosystems of receiving waters.

Asbestos is another usual hazardous waste, directly linked with serious health impacts. Asbestos refers to a family of fibrous minerals found all over world. When the fibers break off and become airborne, they can create a health risk if inhaled. Asbestos exposure is associated with certain types of lung cancer, and long time occupational exposure can also cause the lung disease asbestosis. In the past, asbestos was used in many household products and building materials because of its heat-resistant and structural properties. As a result, building remodeling and demolition projects produce much of the asbestos waste available today.

A recent report published by Blacksmith Institute[27] estimates that hazardous industrial / municipal waste dumpsites rank fifth in the Top-Ten Industrial Pollution sources, while the first and second are lead battery recycling and lead smelting. There are almost 150 industrial or municipal dumpsites in the Blacksmith Institute's database that are polluting local communities, potentially putting almost 3.5 million people at risk. The largest shares of these dumpsites are in Africa and in Eastern European and Northern Asian countries. Combined, these regions make up more than half of the total at risk population in the Blacksmith investigations of dumpsites. However, industrial and municipal dumpsites are prevalent throughout the developing world including in South and Central America and South and Southeast Asia.

At properly run municipal solid waste landfills, hazardous materials considered carcinogenic, corrosive, toxic, or flammable are not accepted and are directed to special treatment or disposal sites[28]. At informal or improperly run sites, all these items are disposed together, creating a toxic stew of waste exposed to heat, rain and air, causing the materials to break down and easily enter the environment. Industrial waste is one of the most toxic wastes at dumpsites and makes up a large portion of the pollution problem at the dumpsites investigated by Blacksmith.

[27] BLACKSMITH INSTITUTE, The World's Worst Pollution Problems: Assessing Health Risks at Hazardous Waste Sites, 2012

[28] Allen, A.R., Taylor, R. 'Waste disposal and landfill: Control and protection." Protecting Groundwater for Health: Managing the Quality of Drinking- water Sources, WHO Drinking Water Quality Series Monograph, IWA Publishing. 2006.

The main sources of pollutants from dumpsites are either leachate (contaminated liquids leaching into the groundwater), dust from poorly covered dumpsites and gases. Leachate can contain heavy metals, VOCs or hazardous organic compounds. These pollutants are carried into aquifers or surface waters. Dust from dumpsites may contain metals and human pathogens that come into contact with this pollution through contaminated groundwater and soil, or direct contact with the waste site.

Children often are seen playing in and around dumpsites, introducing direct exposure with hazardous waste through dermal contact, inhalation of dust or accidental ingestion. Informal neighborhoods are often built on top of previous dumpsites where the soil, groundwater and nearby surface waters are contaminated, indirectly exposing the local population to leached pollutants. A notable issue with dumpsites in the developing world is the presence of scavengers - workers and their families at dumpsites who make their living by recovering economically valuable materials in the waste. In such situations, people come into direct contact with the hazardous waste.
In the Blacksmith Institute's database of industrial or municipal dumpsites the most pervasive and harmful pollutants are lead and chromium. Combined they are the key pollutants in a third of the sites, potentially affecting almost 1.2 million people. The health impacts of these pollutants include lung cancer, neurological problems and cardiovascular disease. Other pollutants in the database of dumpsites include cadmium, multiple types of pesticides, and arsenic and VOCs.

Researchers analyzed 373 toxic waste sites in India, Indonesia and the Philippines, where an estimated 8.6 million people are at risk of exposure to lead, asbestos, hexavalent chromium and other hazardous materials. Among those people at risk, the exposures could cause a loss of around 829,000 years of good health as a result of disease, disability or early death[29]. In comparison, malaria in these countries, whose combined population is nearly 1.6 billion, causes the loss of 725,000 healthy years while outdoor air pollution claims almost 1.5 million healthy years, according to the World Health Organization. In fact this is a shocking finding: it seems that dumpsites are a more serious health risk than malaria at least for the 1.6 billion people of India, Indonesia and Philippines.

[29] K. Chatham-Stephens et al, Burden of Disease from Toxic Waste Sites in India, Indonesia, and the Philippines in 2010, http://dx.doi.org/10.1289/ehp.1206127, Environmental Health Perspectives, 2013

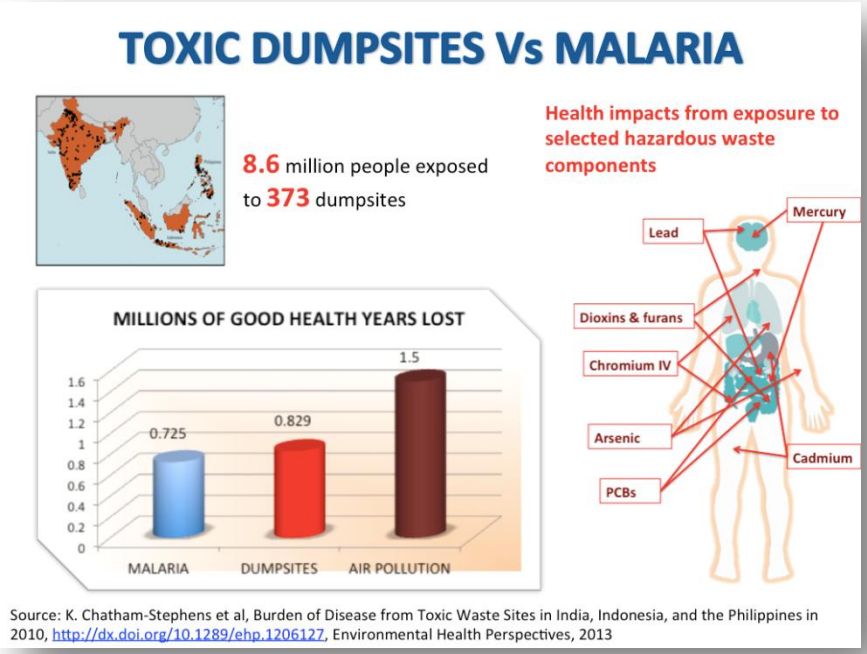


Figure 2: Dumpsites Vs Malaria as a health risk in India, Indonesia and Philippines[44]

Health-care waste

Health-care waste (HCW) are usually found in almost all the dumpsites in the developing world. Health-care facilities, microbiological research laboratories, diagnostic laboratories, pharmaceutical firms and funeral homes have always generated a wide variety of waste components that have the potential of transmitting infectious agents to humans. These include discarded materials or equipment from the diagnosis, treatment and prevention of disease, assessment of health status or identification purposes, that have been in contact with blood and its derivatives, tissues, tissue fluids or excreta, or wastes from infection wards.

Typical elements of the HCW are the following:

- Cultures and stocks of infectious agents and associated biologicals, including: cultures and stocks of infectious agents generated in research or clinical laboratories; wastes from the production of biologicals including vaccines, antigens and antitoxins, and sera.
- Pathological waste, including tissues, organs, and body parts; body fluids that are removed during surgery, autopsy, or other medical procedures; specimens of body fluids.
- Blood and blood products including discarded liquid human blood; discarded blood components (e.g., serum and plasma); containers with free flowing blood or blood components.
- Items or materials contaminated with blood or blood products.

- Sharps from health care, research, clinical laboratories and blood banks, including but not limited to: needles and syringes, scalpel blades, and broken or unbroken glassware, which were in contact with blood or blood derivatives.
- Animal waste including carcasses, body parts, body fluids, blood originating from animals from veterinary clinics or research institutes.

The hazardous components of HCW pose physical, chemical, radiological and/or microbiological risks to the public and those involved in their handling, treatment and disposal. In most cases, the concentration of hazardous chemicals present in HCW is generally too low to be considered an occupational problem or a danger to the public.

Physical injuries caused by discarded sharps are a more significant risk associated with HCW and may directly contribute to the transmission of microbial infectious agents. In addition, health risks may be generated through the release of toxic pollutants during dumpsite open burning or accidental fires[30].

The most common and most investigated cause of the microbiological risks associated with HCW are injuries due to needles. Other sharps wastes presenting similar risks include glass and plastic ware employed in clinical and anatomic laboratories, blood collection systems for obtaining specimens, and scalpel blades from surgical procedures. These sharps may all have been in contact with microbial pathogens. More importantly, sharps can cause percutaneous injuries and thereby create an opening for infectious agents to enter the body. The latter is one of the five essential elements in the acquisition of microbial infections.

Most exposures to biological hazards from health-care wastes occur when workers or informal recyclers are trying to recover useful elements like metals. Workers may be exposed to blood and body fluids from leaking containers as well as airborne pathogens as the waste enters the dumpsite.

Health-care waste components may also create microbiological risks as a source of infectious aerosols, i.e. droplets of less than 1- 3 microns in diameter, which contain etiologic agents of human and animal diseases. Cultures and stocks from the clinical laboratory contain high concentrations[31] of many infectious agents, e.g. Mycobacterium tuberculosis, which is naturally transmitted to their hosts through inhalation, although generally all infectious laboratory waste is treated at the source. Human and animal tissues, organs, and body parts have also been reported in scientific literature as sources of infectious aerosols. Finally, animal bedding materials, which have been saturated with body fluids, blood and excrement, can generate aerosols, which are a potential microbiological risk.

Blood and blood products, as well as various types of body fluids may be capable of transmitting pathogens[32] when brought into direct contact with the mucosal lining of the mouth and nose, the eyes, and areas of the skin containing cuts and abrasions.

It should be also noted that many of the chemicals and pharmaceuticals used in health-care establishments are hazardous[33] (e.g. toxic, genotoxic, corrosive, flammable, reactive, explosive,

[30] WHO, Review of Health Impacts from Microbiological Hazards in Health-Care Wastes, 2004
[31] Weber, AM, Boudereau, Y, Mortimer VD. Health hazard evaluation report 98-0027-2709, Stericycle, Inc, Morton, Washington. Cincinnati, National Institute for Occupational Safety and Health, 1999.
[32] Leese KE et al, Assessment of blood-splash exposures of medical-waste treatment workers. Enviro Health, January/February 1999, 8-11.
[33] WHO, Safe management of wastes from health-care activities, Chapter 3 - Health impacts of health-care waste

shock-sensitive). These substances are commonly present in small quantities in health-care waste; larger quantities may be found when unwanted or outdated chemicals and pharmaceuticals are disposed of. They may cause intoxication, either by acute or by chronic exposure, and injuries, including burns. Intoxication can result from absorption of a chemical or pharmaceutical through the skin or the mucous membranes, or from inhalation or ingestion. Injuries to the skin, the eyes, or the mucous membranes of the airways can be caused by contact with flammable, corrosive, or reactive chemicals (e.g. formaldehyde and other volatile substances). The most common injuries are burns.
Disinfectants are particularly important members of this group: they are used in large quantities and are often corrosive. It should also be noted that reactive chemicals might form highly toxic secondary compounds.

E-waste

E-waste describes waste electronic goods, such as computers, televisions and cell phones, while WEEE also includes traditionally non-electronic goods such as refrigerators and ovens. Computers and mobile telephones are disproportionately abundant because of their short lifespan. Components of electrical and electronic equipment such as batteries, circuit boards, plastic casings, cathode-ray tubes, activated glass, and lead capacitors are also classified as e-waste.

According the most recent statistics by STEP (Solving The E-waste Problem) initiative (http://www.step-initiative.org/overview-world.html), in 2014 roughly 42 million tones of e-waste were generated.

E-Waste is chemically and physically distinct from other forms of municipal or industrial waste; it contains both valuable and hazardous materials that require special handling and recycling methods to avoid environmental contamination and detrimental effects on human health. Recycling can recover reusable components and base materials, especially Cu and precious metals. However, due to lack of facilities, high labor costs, and tough environmental regulations, rich countries tend not to recycle E-waste. Instead, it is either landfilled, or exported from rich countries to poor countries, where it may be recycled using primitive techniques and little regard for worker safety of environmental protection.

The chemical composition of E-waste varies depending on the age and type of the discarded item. However, most E-waste is composed of a mixture of metals, particularly Cu, Al, and Fe, attached to, covered with, or mixed with various types of plastics and ceramics.

Heavy WEEE items, such as washing machines and refrigerators, which are mostly composed of steel, may contain fewer potential environmental contaminants than lighter E-waste items, such as laptop computers, which may contain high concentrations of flame-retardants and heavy metals.

Virtually all E-waste contains some valuable components or base materials, especially Cu. These are environmentally important, because they provide an incentive for recycling, which occurs predominantly in poor countries, and may result in a human health risk or environmental pollution. Platinum group metals are included in electrical contact materials due to their high chemical stability and conductance of electricity. The precious metal concentrations in printed circuit boards are more

than tenfold higher than commercially mined minerals[34].

The concentrations of environmental contaminants found in E-waste depend on the type of item that is discarded and the time when that item was produced. The potential environmental contaminants associated with E-waste and their typical concentrations are presented in Table 3[35]. Some contaminants, such as heavy metals, are used in the manufacture of electronic goods, while others, such as polycyclic aromatic hydrocarbons (PAHs) are generated by the low-temperature combustion of E-waste. The burning of insulated wire, which typically occurs in open iron barrels, generates 100 times more dioxins than burning domestic waste[36].

Table 2: Environmental contaminants and their typical concentrations in E-Waste[48]

Contaminant	Relationship with E-waste	Typical E-waste concentration (mg/kg)[a]
Polybrominated diphenyl ethers (PBDEs) polybrominated biphenyls (PBBs) tetrabromobisphenol-A (TBBPA)	Flame retardants	
Polychlorinated biphenyls (PCB)	Condensers, transformers	14
Chlorofluorocarbon (CFC)	Cooling units, insulation foam	
Polycyclic aromatic hydrocarbons (PAHs)	Product of combustion	
Polyhalogenated aromatic hydrocarbons (PHAHs)	Product of low-temperature combustion	
Polychlronated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs)	Product of low-temperature combustion of PVCs and other plastics	
Americium (Am)	Smoke detectors	
Antimony	Flame retardants, plastics (Ernst et al., (2003))	1700
Arsenic (As)	Doping material for Si	
Barium (Ba)	Getters in cathode ray tubes (CRTs)	
Beryllium (Be)	Silicon-controlled rectifiers	
Cadmium (Cd)	Batteries, toners, plastics	180
Chromium (Cr)	Data tapes and floppy disks	9900
Copper (Cu)	Wiring	41,000
Gallium (Ga)	Semiconductors	
Indium (In)	LCD displays	
Lead (Pb)	Solder (Kang and Schoenung, (2005)), CRTs, batteries	2900
Lithium (Li)	Batteries	
Mercury (Hg)	Fluorescent lamps, batteries, switches	0.68
Nickel (Ni)	Batteries	10,300
Selenium (Se)	Rectifiers	
Silver (Ag)	Wiring, switches	
Tin (Sn)	Solder (Kang and Schoenung, (2005)), LCD screens	2400
Zinc (Zn)		5100
Rare earth elements	CRT screens	

Although recycling may remove some contaminants, large amounts may still end up concentrated in landfills or E-waste recycling centers, where they may adversely affect human health or the environment.

Polybrominated diphenyl ethers (PBDEs) are flame-retardants that are mixed into plastics and components. There are no chemical bonds between the PBDEs and the plastics and therefore they may leach from the surface of E-waste components into the environment[37]. PBDEs are lipophilic, resulting in their bioaccumulation in organisms and biomagnification in food chains. PBDEs have endocrine disrupting properties[38].

[34] Betts K., Producing usable materials from e-waste. Environ Sci Technol 2008a; 42:6782–3.

[35] Brett H. Robinson, E-waste: An assessment of global production and environmental impacts, Science of the Total Environment 408 (2009) 183–191

[36] Gullett BK, Linak WP, Touati A, Wasson SJ, Gatica S, King CJ. Characterization of air emissions and residual ash from open burning of electronic wastes during simulated rudimentary recycling operations. J Mater Cycl Waste Manag 2007;9:69–79.

[37] Deng WJ, Zheng JS, Bi XH, Fu JM, Wong MH. Distribution of PBDEs in air particles from an electronic waste-recycling site compared with Guangzhou and Hong Kong, South China. Environ Int 2007;33:1063–9.

[38] Tseng LH, Li MH, Tsai SS, Lee CW, Pan MH, Yao WJ, et al. Developmental exposure to decabromodiphenyl ether (PBDE 209): Effects on thyroid hormone and hepatic enzyme activity in male mouse offspring. Chemosphere 2008;70:640–7.

Obsolete refrigerators, freezers and air conditioning units contain ozone-depleting Chlorofluorocarbons (CFCs). These gases may escape from items disposed in landfills.

Dust is a significant environmental media that can provide information about the level, distribution, and fate of contaminants present in the surface environment. As an example, recent studies have demonstrated elevated body loadings of heavy metals[39] and persistent toxic substances in children[40] and e-waste workers, respectively, at Guiyu, China.

E-waste pollutants are released as a mixture, and the effects of exposure to a specific compound or element cannot be considered in isolation. However, a more complex understanding of the interactions between the chemical components of e-waste is needed. Exposure to e-waste is a complex process in which many routes and sources of exposure, different lengths of exposure time, and possible inhibitory, synergistic, or additive effects of many chemical exposures are all important variables. Exposure to e-waste is a unique variable in itself and the exposures implicated should be considered as a whole. Sources of exposure to e-waste can be classified into three sectors: informal recycling, formal recycling, and exposure to hazardous e-waste compounds remaining in the environment (ie, environmental exposure).

Exposure routes can vary dependent on the substance and the informal recycling process. Table 3[41] provides the routes of exposure according the pollutants and the e-waste components. Generally, exposure to the hazardous components of e-waste is most likely to arise through inhalation, ingestion, and dermal contact. In addition to direct occupational (formal or informal) exposure, people can come into contact with e-waste materials, and associated pollutants, through contact with contaminated soil, dust, air, water, and through food sources, including meat.9–21 Children, fetuses, pregnant women, elderly people, people with dis- abilities, workers in the informal e-waste recycling sector, and other vulnerable populations face additional exposure risks. Children are a particularly sensitive group because of additional routes of exposure (eg, breastfeeding and placental exposures), high-risk behaviors (eg, hand-to-mouth activities in early years and high risk-taking behaviors in adolescence), and their changing physiology (e.g. high intakes of air, water, and food, and low rates of toxin elimination). The children of e-waste recycling workers also face take- home contamination from their parents' clothes and skin and direct high-level exposure if recycling is taking place in their homes.

In a recent study of health risks posed by e-waste, 23 published epidemiological studies were reviewed, all from southeast China[54]. The project recorded plausible outcomes associated with exposure to e-waste including change in thyroid function, changes in cellular expression and function, adverse neonatal outcomes, changes in temperament and behavior, and decreased lung function. Boys aged 8–9 years living in an e-waste recycling town had a lower forced vital capacity than did those living in a control town. Significant negative correlations between blood chromium concentrations and forced vital capacity in children aged 11 and 13 years were also reported. Findings from most studies showed increases in spontaneous abortions, stillbirths, and premature

39 Huo,X.;Peng,L.;Xu,X.J.;Zheng,L.K.;Qiu,B.;Qi,Z.L.;Zhang, B.; Han, D.; Piao, Z. X. Elevated blood lead levels of children in Guiyu, an electronic waste recycling town in China. Environ. Health Perspect. 2007, 15, 1113–1117.

40 Bi, X. H.; Thomas, G. O.; Jones, K. C.; Qu, W. Y.; Sheng, G. Y.; Martin, F. L.; Fu, J. M. Exposure of electronics dismantling workers to polybrominatetd diphenyl ethers, polychlorinated biphenyls, and organochlorine pesticides in South China. Environ. Sci. Technol. 2007, 41, 5647–5653

41 Kristen Grant, Fiona C Goldizen, Peter D Sly, Marie-Noel Brune, Maria Neira, Martin van den Berg, Rosana E Norman, Health consequences of exposure to e-waste: a systematic review , LancetGlobHealth 2013; 1: e350–61, Published Online October 30, 2013 http://dx.doi.org/10.1016/ S2214-109X(13)70101-3

births, and reduced birth weights and birth lengths associated with exposure to e-waste. People living in e-waste recycling towns or working in e-waste recycling had evidence of greater DNA damage than did those living in control towns.

Table 3: Routes of exposure for e-waste[54]

	Component of electrical and electronic equipment	Ecological source of exposure	Route of exposure
Persistent organic pollutants			
Brominated flame retardants Polybrominated diphenyl ethers	Fire retardants for electronic equipment	Air, dust, food, water, and soil	Ingestion, inhalation, and transplacental
Polychlorinated biphenyls	Dielectric fluids, lubricants and coolants in generators, capacitors and transformers, fluorescent lighting, ceiling fans, dishwashers, and electric motors	Air, dust, soil, and food (bio-accumulative in fish and seafood)	Ingestion, inhalation or dermal contact, and transplacental
Dioxins			
Polychlorinated dibenzodioxins and dibenzofurans	Released as combustion byproduct	Air, dust, soil, food, water, and vapour	Ingestion, inhalation, dermal contact, and transplacental
Dioxin-like polychlorinated biphenyls	Released as a combustion byproduct but also found in dielectric fluids, lubricants and coolants in generators, capacitors and transformers, fluorescent lighting, ceiling fans, dishwashers, and electric motors	Released as combustion byproduct, air, dust, soil, and food (bioaccumulative in fish and seafood)	Ingestion, inhalation, and dermal absorption
Perfluroalkyls	Fluoropolymers in electronics	Water, food, soil, dust, and air	Ingestion, dermal contact, inhalation, and transplacental
Polyaromatic hydrocarbons			
Acenaphthene, acenaphthylene, anthracene, benz[a] anthracene, benzo[a]pyrene, benzo[e]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[j] fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, fluorene, indeno[1,2,3-c,d]pyrene, phenanthrene, and pyrene	Released as combustion byproduct	Released as combustion byproduct, air, dust, soil, and food	Ingestion, inhalation, and dermal contact
Elements			
Lead	Printed circuit boards, cathode ray tubes, light bulbs, televisions (1·5–2·0 kg per monitor), and batteries	Air, dust, water, and soil	Inhalation, ingestion, and dermal contact
Chromium or hexavalent chromium	Anticorrosion coatings, data tapes, and floppy disks	Air, dust, water, and soil	Inhalation and ingestion
Cadmium	Switches, springs, connectors, printed circuit boards, batteries, infrared detectors, semi-conductor chips, ink or toner photocopying machines, cathode ray tubes, and mobile phones	Air, dust, soil, water, and food (especially rice and vegetables)	Ingestion and inhalation
Mercury	Thermostats, sensors, monitors, cells, printed circuit boards, and cold cathode fluorescent lamps (1–2 g per device)	Air, vapour, water, soil, and food (bioaccumulative in fish)	Inhalation, ingestion, and dermal contact
Zinc	Cathode ray tubes, and metal coatings	Air, water, and soil	Ingestion and inhalation
Nickel	Batteries	Air, soil, water, and food (plants)	Inhalation, ingestion, dermal contact, and transplacental
Lithium	Batteries	Air, soil, water, and food (plants)	Inhalation, ingestion, and dermal contact
Barium	Cathode ray tubes, and fluorescent lamps	Air, water, soil, and food	Ingestion, inhalation and dermal contact
Beryllium	Power supply boxes, computers, x-ray machines, ceramic components of electronics	Air, food, and water	Inhalation, ingestion, and transplacental

Table 1: Chemical classification of e-waste components and sources and routes of exposure

In other studies[42], researchers have linked e-waste to adverse effects on human health, such as inflammation and oxidative stress – precursors to cardiovascular disease, DNA damage and possibly cancer.

Although the toxicology of many e-waste components is well characterized, some newer materials, such as gallium and indium arsenides found in newer semiconductors, are less well understood. Their incorporation into nanomaterials may increase bioavailability in unanticipated ways. Developing children and fetuses may be particularly vulnerable to toxins found in e-waste, and early epidemiological studies near informal e-waste recycling sites indicate potential developmental neurotoxicity. Understanding the hazards of e-waste, the impacts of its disposal, and the dangers of informal or careless recycling will help reduce or prevent disease outcomes associated with exposure to e-waste components.

[42] Fangxing Yang et al, Comparisons of IL-8, ROS and p53 responses in human lung epithelial cells exposed to two extracts of PM2.5 collected from an e-waste recycling area, China 2011, Environ. Res. Lett. **6** 024013 doi:10.1088/1748-9326/6/2/024013

Open burning

"Open burning" of waste is a usual practice in many dumpsites, as a mean to reduce the waste volume. The practice of open burning results in many harmful public health and environmental effects.

Worldwide scientific research has conclusively demonstrated that burning of waste at dumpsites produces air toxins. Typically, burning occurs at low temperatures (250 ^{o}C to 700 ^{o}C) in oxygen-starved conditions. Hydrocarbons, chlorinated materials and pesticide compounds under these conditions produce a wide range of toxic gases harmful to the environment and public health. These gases contain dioxins / furans, volatile organic compounds, particulate matter (PM), hydrogen chloride (HCl), carbon monoxide (CO) and oxides of sulfur and nitrogen and liberate metals including antimony, arsenic, barium, beryllium, cadmium, chromium, lead, manganese, mercury, phosphorus and titanium[43].

The United States Environmental Protection Agency estimates[44] that mixed garbage burning is a larger source of dioxins than coal combustion, ferrous metal smelting, hazardous waste incineration or bleached pulp mill operations.

The burning of waste produces two types of ash, bottom and fly ash. Fly ash is made of light particles which is carried out by combustion gas and is laden with toxic metals, dioxin / furan and other products of incomplete combustion which can travel thousands of kilometers before they drop out where enter the human food chain. Open burning emissions are troubling from a public health perspective because of several reasons:

- Open burning emissions are typically released at or near ground level instead of through tall stacks, which aid dispersion;
- Open burning emissions are not spread evenly throughout the year; rather, they are typically episodic in time or season and localized/regionalized;
- Open burning sources are non-point sources and are spread out over large areas;
- Compliance to any bans on open burning are difficult to enforce.
- Open burning is a transient combustion phenomenon, frequently with heterogeneous fuels; it is difficult to attribute emissions to a single component of the fuel.

One of the most harmful pollutants released during open burning is dioxin. Dioxin is a known carcinogen and is associated with birth defects. Dioxin can be inhaled directly or deposited on soil, water and crops where it becomes part of the food chain.

Burning MSW can release hexchlorobenzene (HCB) to the environment. This compound is a highly persistent toxin that degrades slowly in the air. Therefore, it can travel long distances in the atmosphere. It bioaccumulates in fish, marine animals, birds, lichens, and animals that feed on fish and lichens. HCB is a probable human carcinogen, and based on animal studies, long-term, low-level exposures to HCB can damage a developing fetus, lead to kidney and liver damage, and cause fatigue

[43] Nammari, D.R., Hogland, W., Marques, M., Nimmermark, S. and Moutavtchi, V. (2004) Emissions from a Controlled Fire in Municipal Solid Waste Bales. Waste Management, 24, 9-18

[44] United States Fire Administration (USFA), "Landfill fires, their magnitude, characteristics and mitigation," TriData Corporation, Arlington, Virginia, USFA Tech. Rep. FA-225, 2002.

and skin irritation.

Formaldehyde is released when pressed wood products, paints, coatings, siding, urea-formaldehyde foam, and fiberglass insulation are burned. Exposure to formaldehyde can result in watery eyes, a burning sensation in the eyes and throat, nausea, difficulty in breathing (i.e., coughing, chest tightness, wheezing), and skin rashes. Prolonged exposure to formaldehyde may cause cancer.

Burning of plastics, or polyvinyl chloride (PVCs), can produce hydrogen chloride gas, or hydrochloric acid, which can cause fluid buildup in the lungs and possible ulceration of the respiratory tract.

The visible smoke from burning is composed of tiny particles (particulates), which contain toxic pollutants. If inhaled, these microscopic particles can reach deep into the lungs and remain there for months or even years. Breathing particulates increases the chances of respiratory infection, can trigger asthma attacks, and causes other problems such as coughing, wheezing, chest pain, and shortness of breath. Carbon monoxide is generated from the incomplete combustion of waste. Carbon monoxide is a colorless, odorless gas that prevents oxygen from being absorbed by the blood and lungs. It is especially dangerous when breathed by young children with immature lungs, the elderly, and people with chronic heart conditions or lung diseases.

Of particular health concern are the Tyr fires. Tyrs are composed of natural rubber from rubber trees, synthetic rubber made from petrochemical feedstock, carbon black, extender oils, steel wire, up to 17 heavy metals, other petrochemicals and chlorine. A coal and Tyr chlorine content comparison showed that Tyrs might contain as much as 2 to 5 times the chlorine level of western coal. Tyr fires burn for a long time allowing the build up of the by-products of combustion around surrounding areas. Burning Tyrs are known to emit dioxins and benzene derivatives, which have been linked with reproductive impairment and cancer in humans[45]. Tyr fires releases a dark, thick smoke that contains carbon monoxide, sulphur dioxide and products of butadiene and sTyrne. Further, Tyr fires can be extremely difficult to contain and extinguish and therefore burn and smolder for a long period of time. Even after they are extinguished, Tyr fires can flare up again weeks, even months later. This can cause a build up of the by-products of combustion in confined areas such as surrounding homes, which creates an additional health hazard. Table 4 presents typical open burning emissions of pollutants included in the plumes emitted.

[45] Adeolu O. Aderemi, Adebayo A. Otitoloju An Assessment of Landfill Fires and Their Potential Health Effects- A Case Study of a Municipal Solid Waste Landfill in Lagos, Nigeria # IJEP Vol. 2 No. 2 February 2012 PP.22-26 www.ij-ep.org

Table 4: Emissions from burning dumps and landfill fires (ng/m^3)[46]

Class	Compound	Controlled landfill fire	Uncontrolled landfill fire
PAHs	Acenaphthylene	90	60
	Acenaphthene	50	30
	Fluoranthene	100	50
	Phenanthrene	520	30
	Anthracene	160	85
	Fluorene	120	180
	Pyrene	120	170
	Benzo[*a*]anthracene	60	60
	Chrysene	80	70
	Benzo[*b*&*k*]fluoranthene	50	20
	Benzo[*a*]pyrene	20	15
	Indeno[1,2,3-*cd*]pyrene	10	10
	Dibenz[*a*,*h*]anthracene	10	10
	Benzo[*g*,*h*,*i*]perylene	10	10
	Total PAHs	1480	810
	Total PCBs	15.5	590

[46] Paul M. Lemieux, Christopher C. Lutes, Dawn A. Santoianni' Emissions of organic air toxics from open burning: a comprehensive review, Progress in Energy and Combustion Science 30 (2004) 1–32

ANNEX 2: PPP PROCEDURE

Step	Description	Party in Charge	Notes
1.	PPP Project Proposal initiated by the preparation of a Preliminary Study	- Minister or Head of Relevant Public Authority; - Mayor or Head of Union of Municipalities	-
2.	Review of the proposed PPP project preliminary study and issuance of recommendations to the High Council for privatization and PPP	- General Secretariat of the High Council for privatization and PPP	-
3.	**Rejection** / **Approval**	- The High Council for privatization and PPP	The rejection notification of the project is sent to the public authority submitting the proposal
4.	Establishment of a PPP Project Committee which will be headed by the General Secretary of the High Council for Privatization and PPP and will include as members the Minister of the relevant Authority, Representative from the Ministry of Finance, the Mayor or the head of the Union of Municipalities for Municipal projects	- The High Council for privatization and PPP	-
5.	Signing Contracts with consultants to advise in technical, financial, legal aspects / Establishment of a Project Team including a representative of all stakeholders	- The PPP project committee to propose specialized consultants contracts - The High Council for privatization and PPP for the signature of the contracts - General Secretary of the High Council for privatization and PPP for the Project Team establishment	-
6.	Preparation of a comprehensive study for the PPP project addressing all aspects (technical, legal, financial, financing sources, interested investors, prequalification criteria, etc.)	- The PPP project committee - The assigned Consultants - The Project Team	The Study is prepared by the PPP committee assisted by the Project Team and the assigned advisors (consultants)
7.	**Rejection** / **Approval**	- The High Council for privatization and PPP	The procedure stops here for rejected projects
8.	Approval of the Council of Ministers for non-municipal projects or Municipal Council for Municipal projects	- Council of Ministers - Mayor or the Head of the Union of Municipalities	The President of the High Council for privatization and PPP issues the study for the Council of Ministers approval
9.	Issuance of Prequalification Documents to select the Private enterprise	- The PPP project committee	This is done in accordance to a well detailed procedure specified in the Law
10.	Evaluation of the pre-qualification application and issuance of the results	- The PPP project committee - The Project Team	-
11.	**< 3 Qualified** / **≥ 3 Qualified**	- The High Council for privatization and PPP	If less than three bidders are pre-qualified, the prequalification process is repeated
12.	Preparation of a draft Tender Documents	- The PPP project committee	-
13.	**Rejected** / **Approved**	- The High Council for privatization and PPP	Rejected draft tender documents are returned to the PPP committee to redraft and resubmit
14.	Council of Ministers Approval of the Tender Docs	- Council of Ministers	-
15.	Launching the Tender Documents	- The High Council for privatization and PPP	-
16.	**< 3 Offers** / **≥ 3 Offers**	- The pre-qualified bidders	If less than three offers are submitted, the tendering process is repeated. If after repetition at least 2 offers are submitted, evaluation is initiated
17.	Evaluation of submitted technical proposals	- The PPP project committee - The project Team	-
18.	**< 2 technically acceptable** / **≥ 2 technically acceptable**	- The PPP project committee - The project Team	If less than 2 offers are technically compliant, the procedure is to be repeated
19.	Public Financial Bids Opening Session	- The PPP project committee - Bidders representatives	The session is headed by the PPP committee
20.	Evaluation of the financial offers & recommendations	- The PPP project committee - The Project Team	-
21.	Approval of the report and authorization of the PPP Project committee to negotiate with the winner	- The PPP project committee - The Project Team	-
22.	Contract signature & establishment of a Lebanese joint stock company (the PPP project Company)	- The PPP project committee - The Project Team	The PPP Company benefits from some exemptions

ANNEX 3: LIST OF DATABASE USED IN THE BASELINE REPORT

No	Document	Date
1.	A database to raise the waste situation in villages and towns in the Union of Municipalities of Bint Jbeil district	-
2.	Administrative Divisions of Lebanon (Localiban)	-
3.	Awareness Campaign on Waste Sorting Brochure in Arabic	-
4.	Green jobs assessment wcms (ILO UNDP)	-
5.	Lebanon PPP Law - English Translation	-
6.	Regional Technical Offices Improving Municipal Planning & Enhancing Local Governance Brochure (UNHABITAT)	-
7.	Assessment of Solid Waste Management Practices in Lebanon in 2015 (Sep) - EU (Support to Reforms – Environmental Governance, Beirut, Lebanon) GFA Consulting Group GmbH / Umweltbundesamt / Mott Mac Donald	2017
8.	Land Use and Environment (Some info) (CDR)	2017
9.	INVESTMENT OPPORTUNITIES IN NABATIYEH GOVERNORATE (IDAL)	2017
10.	Jobs for north lebanon (WB)	2017
11.	Migration Profile: Lebanon (EUI - Françoise De Bel-Air, Research Consultant)	2017
12.	MoE L to CoM August with annexes (SW)	2017
13.	MoE L to CoM SG July with annexes (SW)	2017
14.	MoE Memo 7-1 of 16 Nov (ISWM Guidelines)	2017
15.	MoEW decision regarding the next steps in the Waste management including the number of WTE sites CoM-2013-Reg.No.4293-28-12-2017	2017
16.	Open waste burning and health (human rights Watch)	2017
17.	Promotion of Green Entrepreneurship and Grassroots Ecological and Social Innovations in Lebanon (switchmed)	2017
18.	Solid Waste Management in Lebanon: Challenges and Recommendations (Journal of Environment and Waste Management)	2017
19.	SW-Draft Law Comparison-Table Jan 29 2014 - F Jan	2017
20.	swm in leb challenges and recommendations (journal of environment and waste management)	2017
21.	Trash Crisis and Solid Waste Management in Lebanon Analyzing Hotels' Commitment and Guests' Preferences (Journal of Tourism Research & Hospitality)	2017
22.	Nabatiyeh Governorate Profile - UN-HABITAT	2017
23.	Updated Master Plan for the closure and rehabilitation of uncontrolled dumpsites throughout the country of Lebanon (June) (Volume A - ELARD)	2017
24.	Waste Management Systems in Lebanon (Thesis: Elias Azzi)	2017
25.	Zgharta Solid Waste Management Plan- Final Report (Al Midan NGO - Coker Composting and Consulting - Keene Environmental Consulting LLC)	2017
26.	Economic instruments for Recycling (streg)	2016
27.	Lebanon Garbage Report (Global impact strat)	2016
28.	MoE Dec 189-1 13.04.2016 Audit Review Procedures	2016
29.	Ramboll pre-qualification for WtE	2016
30.	The National Renewable Energy Action Plan for the Republic of Lebanon 2016-2020 (LCEC)	2016

No	Document	Date
31.	Ramboll Solid Waste Composition Campaign 2012,2014,2015	2015
32.	Sustainable Consumption and Production Action Plan for the industrial sector in Lebanon (Switchmed)	2015
33.	wasteless lebanon 2022 (unhabitat)	2015
34.	COED BML (Sweepnet)	2014
35.	Cost of environmental degradation due to solid waste management practices in beirut and mount lebanon (BML) (GIZ-SWEEP-Net)	2014
36.	Country report on the solid waste management in Lebanon (Sweepnet)	2014
37.	e-watse practice in the MENA (Sweepnet)	2014
38.	ISWM Draft Law (Jan 10 - MoE in Arabic)	2014
39.	Lebanon Environmental Assessment of the Syrian Conflict & Priority Interventions (Sep) (MoE-UNDP-EU)	2014
40.	Millenium-Development-Goals-Lebanon-Report (2013-2014) (UNDP + CDR)	2014
41.	Population in Arabic (Dar El Handasah)	2014
42.	Proposed Master Plan Report (Dar El Handasah)	2014
43.	Nabatiyeh Governorate Profile (UNOCHA)	2014
44.	National Strategy for SWM in Lebanon (in Arabic Samir Moqbel Letter)	2013
45.	Ramboll feasibility study for the integration of WtE into the solid waste management sector in big cities in Lebanon	2013
46.	Decree 8003 (ISWM)	2012
47.	Land Tenure Planning and Managemnet in Oriental Near East Countries (FAO - RNE - SNO)	2012
48.	OMSAR - Policies, Programs and Procedures Towards a distinctive public service (2010-2012)	2012
49.	Strengthening Local Governance Through Effective Waste Management: The “Sustainable Environmental Practices and Policies” Program in South Lebanon and the Bekaa Valley (McCornack - The Journal of Sustainable Development)	2012
50.	Financing of Municipal Investment Projects in Solid Waste Management (OMSAR - Farouk El Merhebi)	2011
51.	Lebanon Urban Profile (UNHABITAT)	2011
52.	Management of Recyclable Material for Lebanese Municipalities - Manual (cooperation with OMSAR - MoE)	2011
53.	Public–Private Partnerships in Lebanon (Credit Libanais)	2011
54.	Republic of Lebanon Country Environmental Analysis (WB)	2011
55.	Roadmap for Modernizing Municipal Finance (ICMA)	2011
56.	Strategic Framework (ICMA)	2011
57.	Country report on the solid waste management in Lebanon (Sweepnet)	2010
58.	Scavenging in South Lebanon (COSV)	2010
59.	Solid Waste MoE (Excel Sheet)	2010
60.	Waste Pickers in South Lebanon A study on the territory of Seven Municipalities (www.ongrc.org)	2010
61.	treatment of liquid oil waste (mission rep - Karstensen, SINTEF, Norway)	2009
62.	Nahr el Bared Refugee Camp Crisis (Lebanon) Socioeconomic Impact Assessments and Recovery Plan For Areas Surrounding Nahr al-Bared Refugee Camp (Hanafi - AUB)	2008
63.	Integrated Management of East Mediterranean Coastlines: Northern Lebanon (SMAP & UoB - Fund:	2007

No	Document	Date
	EUROPEAN COMMISSION)	
64.	Tender Documents for the 2006 SWM National solid waste master Plan	2006
65.	CAS Demographic Characteristics of residents (National Survey of Household Living Conditions 2004-2005)	2005
66.	National Physical Master Plan of the Lebanese Territory (DAR - IAURIF)	2005
67.	Legal framework for solid waste management in Lebanon (ELARD - ENVIROTECH - TEBODIN)	2004
68.	Public–Private Partnerships for Solid Waste Management Services (M. MASSOUD and M. EL-FADEL - Journal Environmental Management)	2002
69.	South Lebanon & Nabatieh Governorates Profile, OCHA, May 2016	2016
70.	Investment opportunities in Nabatieh, IDAL, 2017	2017
71.	Bint Jbeil Village Profile	-