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INTEGRATED WASTE MANAGEMENT POLICY PAPER

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We at the UN-Habitat and the Muhanna Foundation hope that this Policy Paper serves as the foundation of a bridge to support the nation in its transition from "2015 Waste Crisis Management" into "Sustainable Integrated Waste Management".

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ABSTRACT

In the absence of a clear national plan for Integrated Waste Management (IWM), and due to various political and governmental issues, Lebanon has had to face a serious waste crisis in 2015. The paper scrutinizes events leading up to the 17th of July 2015, and the impact of its aftermath on Lebanon's environment, infrastructure, health and landscape. Parallels are drawn throughout the paper to a similar crisis faced by residents of Campania, Italy.

This paper thoroughly analyzes Lebanon's "waste profile" and benchmarks it against a spectrum of countries to further understand global trends in waste management and treatment in comparison with Lebanon's capacity, capability and potential in the field.

The Task Team evaluated the Technical Committee's plan and highlighted major points such as: 1)the lack of procedural clarity; 2)the need for the implementation of a thorough capacity and capability building plan in parallel; and 3)the pressing need to replace the concepts of "comprehensive solid waste management" with "Integrated Waste Management".

Taking crisis mitigation measures implemented locally, the role of CSOs and the feasibility of mandating Unions of Municipalities to undertake waste treatment, the paper considers three focal policy questions:

1. *What is the most feasible course of action in order to solve the 2015 Waste Crisis?*
2. *What are the most strategically sustainable IWM models to adopt?*
3. *Can these practices be replicated nationwide and integrated at policy level?*

Basing the study on a holistic policy analysis, the paper looks at the governance, health, social, financial and technical aspects of what is available and what is required; not just to resolve the 2015 Waste Crisis, but to transition authorities from a "reactive crisis mode" into "proactively implementing a Zero-Waste Integrated Waste Management Plan" or "Wasteless Lebanon 2022".

The Task Team builds on Chehayeb's plan to suggest a timeline for the mitigation of the 2015 Waste Crisis amalgamating the Technical Committee's plan with other suggestions of export and local treatment modalities. Meanwhile, the capacity building mode needs to run in parallel to achieve a sustainable IWM and to grow the much needed Green Economy.

PREFACE

On November 30th,2015, and under the patronage of the Minister of Agriculture, Mr. Akram Chehayeb, who is chairing the ministerial committee in charge of Solid Waste Management, the UN-Habitat Lebanon Program and the Muhanna Foundation organized a press conference at the Economic and Social Council, to launch the "Integrated Waste Management' Policy Paper and discuss its main recommendations.

The paper analyses reasons leading up to the events of 17th July, 2015, when the waste "Time Bomb" exploded causing administrative dead-lock and unrest in the central administration, as well as the negative impact of its aftermath on Lebanon's environment, health, infrastructure and landscape.

Three policy focal points were taken into consideration:

1. *What is the most feasible course of action in order to solve the 2015 Waste Crisis?*
2. *What are the most strategically sustainable IWM models to adopt?*
3. *Can these practices be replicated nationwide and integrated at policy level?*

This study represents independent insights and recommendations that aim to optimize all the available factors within the Lebanese context and envisages formulating a National Strategic IWM plan at the soonest possible time, in order to leverage this crisis and transform the 2015 Waste Crisis calamity into an opportunity for a better economy and provide hope for the Lebanese youth in this critical time of the Levantine history.

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ACRONYMS

BML	Beirut and Mount Lebanon
CBL	Central Bank of Lebanon
CDR	Council for Development and Reconstruction
CNRS	National Council for Scientific Research
CSO	Civil Society Organization
DPSIR	Driving Forces, Pressures, State, Impacts & Responses
GAC	Ghareb Al-Aala wal Chahar
GBSA	Greater Beirut Service Area
GDP	Gross Domestic Product
GoL	Government of Lebanon
IKC	Ikleem al Kharoub al Chamali
IMuF	Independent Municipal Fund
ISWM	Integrated Sustainable Waste Management
ITS	Informal Tent Settlement
IWM	Integrated Waste Management
JV	Joint Venture
LA	Local Authority
M&E	Monitoring and Evaluation
MDF	Municipal Development Fund
MoE	Ministry of Environment
MoIM	Ministry of Interior and Municipalities
MoPH	Ministry of Public Health
NCIWM	National Committee on Integrated Waste Management
NGO	Non-Governmental Organization
NOWM	National Observatory for Waste Management
OECD	Organization for Economic Co-operation & Development
PPP	Public-Private Partnership
PSP	Private Sector Participation
RoA	Return on Assets
RTO	Regional Technical Office
SMFP	Strategic Municipal Financial Planning
TOR	Terms of Reference
TPD	Tons per Day
UoM	Union of Municipalities
WtE	Waste-to-Energy
WWTP	Waste Water Treatment Plant

EXECUTIVE SUMMARY

In the absence of a clear national plan for integrated waste management (IWM), and due to various political and governmental issues, Lebanon is facing an unprecedented waste crisis in 2015.

As garbage piled up in the posh streets of Beirut, and the end results of a crisis - rooted in webs of administration, politics and mismanagement - materialized, leading to civil unrest.

In response to the 2015 Waste Crisis: the UN Habitat and the Muhanna Foundation assembled a Task Team pooling both institutions' expertise in the fields of economics, municipal development and actuarial science with the aim of producing a holistic study that looks into the 2015 Waste Crisis and its underlying dynamics in order to propose applicable policy recommendations to support central authorities in mitigating the crisis and seizing the opportunity it provides.

The paper analyses reasons and events leading up to the 17th of July 2015, when the waste "Time Bomb" exploded causing administrative dead-lock and unrest in the central administration, as well as the negative impact of its aftermath on Lebanon's environment, health, infrastructure and landscape.

Throughout the paper, parallels are drawn to a similar crisis faced by residents of Campania, Italy: Based on the Italian experience – and up to 2008 – the total estimated cost of the crisis could top two billion Euros if not mitigated appropriately and timely. Furthermore the Task Team thoroughly analyzed Lebanon's "waste profile" before and after the turning point of the crisis, and benchmarked it against a spectrum of representative countries to help further understand global trends in waste management & treatment in comparison with Lebanon's capacity, capability and potential in the field.

The Task Team also evaluated the Technical Committee's plan – headed by Minister Chehayeb – and highlighted major points such as: 1)the lack of procedural clarity; 2)the need for a thorough capacity and capability building plan to be implemented in parallel; and 3)the pressing need to replace the concepts of "Comprehensive Household Solid Waste Management" with "Integrated Waste Management".

Taking crisis mitigation measures implemented locally (Roumieh Municipality), the role of CSOs (Sayyidat Baysour) and the feasibility of mandating Unions of Municipalities to undertake waste treatment (the Ain Baal Facility), the following three policy focal points are taken into consideration:

- What is the most feasible course of action in order to solve the 2015 Waste Crisis?
- What are the most strategically sustainable IWM models to adopt?
- Can these practices be replicated nationwide and integrated at policy level?

Basing the study on a holistic policy analysis, the paper looked at the governance, health, social, financial and technical aspects of what is available and what is required; not just to resolve the 2015 Waste Crisis, but to support the central authorities' transition from a "reactive crisis mode" into "proactively implementing a Zero-Waste Integrated Waste Management Plan" or "Wasteless Lebanon 2022".

From a governance perspective, there is a pressing need to pass and promulgate a national IWM law, while local authorities should be allowed to undertake their rightfully endowed responsibilities of waste management as per governmental decrees. It should be noted that, if open dumping/Backyard Burning practices are carried on, they will ultimately lead to catastrophic impacts on the infrastructure (bridges, roads & urban structures) and water networks (sewers, storm & potable water) as well as the Environment and the Public's Health.

One upside to the 2015 Waste Crisis is the "collective paradigm shift" leading to an exponential increase in social awareness on the topic. CSOs have seized the opportunity to provide solutions (Sayyidat Baysour) or reject what was deemed as unhealthy ones (The Siblin case). Moreover, the massive refugee contingency could prove to be key in solving the 2015 Waste Crisis.

Financially, the affordability of the pre-crisis waste management system is seriously questioned as it levies high costs on Municipalities, already hampered by poor collection rates. The average estimated cost of the current WM system averages at 320 million USD (33% of the Total Municipal Budget) and could reach $670 Million USD in ten years' time. Technically, Lebanon's waste composition is a strong foundation to build a "Green Economy" and create employment opportunities for young Lebanese.

The Task Team builds on Chehayeb's plan to suggest a timeline for the mitigation of the 2015 Waste Crisis amalgamating the Technical Committee's plan with other suggestions of export and local treatment modalities. Over-reliance on export could lead to costs as high as 250 USD/ton, foregoing more affordable internal solutions whereby cost recovery would be possible (up to 100 USD/ ton).

The Task Team's proposal is to first and foremost declare a "National State of Emergency" to treat the accumulated waste, as well as the newly generated waste, which has increased due to rainfalls. Thereafter, an interim plan should be put in place to export part of the pilling trash over the coming few months while slowly transitioning to the internal treatment of all waste. The cost of such a process, estimated over 18 months, would average 240 USD/ton with the potential to recover 33% of costs by the end of the crisis mitigation period.

The Task Team's Policy Recommendations illustrate the steps to undertake, on all levels, for the formulation of a viable and sustainable national IWM policy and subsequent strategic plan.

Administration & Community: Who should be doing what

The Task Team – inspired by the constitutional concepts of decentralization and deconcentration – suggests the segregation of powers in the IWM process, with central authorities contributing in policy setting, plan formulation and the necessary legislations; and Governors & Caza directors assuming oversight, monitoring and evaluating (M&E) the implementation of all IWM processes. Municipalities and Unions, with the support of CSOs, are expected to execute a national Strategic IWM plan, with CSOs also providing additional oversight as Watch-dogs of the implementation process.

The task team also encourages the establishment of the National Committee on Integrated Waste Management (NCIWM) formed of members of the public sector, civil society and WM experts from the private sector. The NCIWM's mandate would include the establishment and operation of the National Observatory for Waste Management (NOWM), regulation, oversight and reporting on IWM, as well as providing solution recommendations.

The paper also includes the Task Team's suggestions on municipal recruitment, establishing Technical Bureaus and Offices nationwide, and defining the roles of all key stakeholders to ensure sustainable capacity building on all levels of administration.

Governance: Decrees and Laws

Within the framework of constitutional decentralization and deconcentration, the Task Team envisions the following key implementation processes:

- Liberation of the IWM market with the support of the CBL through financial stimuli;
- Enforcing regulations on the import of recyclables, composts and fertilizers in to protect the Lebanese Green Industry;
- Establishing the Municipal Development Fund to support IWM projects nationwide;
- Enabling an "already existing" holistic legal framework for IWM;
- Revitalizing the IWM related Municipal Decrees;

Among other recommendations related to municipal funding and additional measures to ensure the proper implementation of the anticipated strategic IWM plan to be formulated;

At Source: Where it starts

The Task Team has developed a holistic waste collection framework and timetable to aid the first stage of WM: sorting at source. This framework was developed with the help of WM experts as well as international best practices, and would allow for the distribution of bins and collection of different categories of waste (Organic, Non-Organic and other) according to a pre-determined schedule.

Furthermore the Task Team highlights the importance of raising awareness on the different categories of waste and subsequent treatment techniques, and provides a general framework of the different campaigns and initiatives that can and must be carried out.

Process: After pick up

The Task Team stresses on the appropriate and most

suitable IWM techniques for Lebanon:

- Forbid & penalize open-dumping;
- Discourage & heavily penalize incinerations in case of violation;
- Compressing waste should be discouraged and monitored at all stages;
- Landfilling practices, as they have been carried out in the past, should be abandoned;
- All inert material should be recycled and/or sold;
- Hazardous waste, on the short run, should be exported in lieu of the development of treatment sites;
- Electronic waste should be disassembled (for recoverable) and sold;
- Organic waste should be treated at a ratio of 40% for soil rejuvenation, 50% composting and 10% landfilled with the aim of developing Waste-to-energy Facilities.

This study represent independent insights and recommendations that aim to optimize all the available factors within the Lebanese context and envisages formulating a National Strategic IWM plan at the soonest possible time, in order to leverage this crisis and transform the 2015 Waste Crisis calamity into an opportunity for a better economy and provide hope for the Lebanese youth in this critical time of the Levantine history.

INTRODUCTION

In the absence of a clear national plan for integrated waste management in Lebanon, and due to various political and governmental issues, Lebanon has had to face a serious waste crisis in 2015. Images of the posh and busy streets of Beirut covered with piles of garbage suddenly surfaced, and the end results of a crisis - rooted in intertwined webs of administration, politics and mismanagement - were eventually materialized, leading to civil unrest. The civil society marched to protest primarily against the failure of the government to address the crisis, and eventually other issues were brought up such as the lack basic services and corruption, among others.

I. OBJECTIVE

This paper aims to provide an overview of the development of the waste crisis in Lebanon to date, analyzing it from the governmental, financial, infrastructural/urban, social, health and technical perspectives in order to provide solid recommendations to guide decision makers, local authorities and all other related stakeholders on the way forward.

II. METHODOLOGY

This paper is based on a desk review of available data related to the waste crisis in Lebanon. Additionally, informal interviews were conducted with local authorities to highlight three initiatives to address waste management led by municipalities or Unions of Municipalities in order to derive local successful approaches that could be replicated elsewhere. Moreover, interviews were conducted with environmental and waste management experts to validate the information.

The analysis and projections presented in this paper rely upon the data produced as a result of the research and interview processes. The methodology adopted was developed based on methods used in previous environmental studies of the World Bank and Sweep-Net, as well as the Task Team's expertise in the fields of economics, municipal development and actuarial sciences.

As is the case with all projection models, certain assumptions were relied upon in order to carry out future forecasts. These assumptions introduce an element of uncertainty to the results; consequently the outputs have been presented in ranges rather than point estimates, and various stress testing and "what if" scenario settings were carried out in order to validate all results and figures.

Long gone are the days when the term Solid Waste Management is put to use. Nowadays, Waste Management is segregated into seven categories:

- Household
- Slaughterhouses
- Industrial waste
- Medical waste
- Wastewater
- Electronic waste
- Construction waste

An Integrated Waste Management Policy looks at all seven categories.

SITUATIONAL ANALYSIS

I. BACKGROUND CONTEXT

This section provides a brief overview of events leading up to the 17th of July, 2015 and its aftermath: a historical contextualization of the Waste Management "issue" in addition to the political conditions that lead to the deadlock and civil unrests as well as the crisis in numbers and the proposal of the Technical Committee.

Region	Waste Manager	Mandate	Contracted by
BML	Averda: Sukleen & Sukomi	- Sweeping - Collection - Treatment - Landfilling	GoL
Saida	New Trading & Contracting Company (NTCC)	- Collection - Dumping	Municipality of Saida
Tripoli	Lavajette	- Collection - Landfilling - Dumping	Union of Municipalities of Al Fayhaa

Table 1: Waste Managers in Major Lebanese Cities

1. Historical Context

The Government of Lebanon (GoL) has yet to adopt a clear national plan for waste management. With the exception of BML[1], Saida and Tripoli this task became the responsibility of municipalities which mostly collect and dump the waste into valleys or open areas at the boundaries of their localities, without any treatment.

Due to a solid waste crisis in Beirut in 1997, a "temporary" emergency plan – Decree No. 18 – was prepared by the Ministry of Environment (MoE) and adopted by the GoL aiming at:

- Upgrading the plant in Amrousieh to sort and incinerate 600 TPD of domestic waste;
- Rehabilitating and upgrading the Quarantina plant to process 1,100 TPD, with waste to be sorted, treated, incinerated and composted;
- Establishing a new composting facility (850 TPD) near the Beirut River;
- Compressing all inert material and the remaining quantities from the previously mentioned facilities and landfilling with an estimated volume of 200 T in a sanitary landfill.

Nevertheless, the planned new composting facility never materialized, thus leaving one facility with the capacity for 300 TPD and transporting the rest to the Naameh landfill. In addition, the exponential population growth[2], both local and refugee, led to an increase in waste volumes. Regardless of the state of implementation in major cities or in other areas of the country, the waste crisis became inevitable due to a plethora of factors that will be thoroughly discussed throughout this paper.

2. Political Conditions

The political roots of the current waste crisis can be traced back to the mid 1990's when private companies were contracted to collect garbage for double the cost proposed by municipalities at that time. The value of the BML contract increased exponentially from 3.6 Million USD/year in 1994 to 150 Million USD/year in 2015, without any evolution in services. Moreover, the waste management bill is settled on behalf of Municipalities – and prior to funds distribution – directly through the "Independent Municipal Fund" (IMuF), thus exploiting their rightfully allocated resources and the possibility of finding other alternatives. The Waste Management "issue" was a time bomb that exploded on July 17th, 2015. Annex A features a detailed timeline.

2.1 Status Quo

According to a study by the Council of Development and Reconstruction (CDR) in 2010 the costs incurred by the Lebanese taxpayer for waste management service providers are as follows:

Area	Waste Management	Collection Cost (USD/ Ton)	Landfill Cost (USD/ Ton)
Saida & surroundings	NTCC	24	-
Tripoli	Lavajette	22	29.30
Zahle	Municipality	18	22
BML (Excl. Jbeil)	Sukleen	34.55	38-54

Table 2: Waste Treatment Costs in Major Lebanese Cities

[1] BML is Beirut and 225 local authorities (out of 307) within Mount Lebanon – excluding the Jbeil Caza
[2] Arab crises spillover effects

In addition, the cost of sweeping reached 2.26 USD/ sqm, since it was estimated that the roads' and streets' area in Greater Beirut is 70 sqkm. Accordingly, the estimated waste volume in Lebanon (2014) is 5,600 TPD, i.e. 2.04 Million tons/year, almost half of which are organic (52.5%). The other half is constituted of paper/ cardboard, plastic, glass and others. The graph below indicates the distribution of waste generation per governorates of Lebanon. More than half of the generated wastes is estimated to originate from BML (SweepNet 2014).

"Sukleen operators used to collect stones while sweeping the streets to increase the weight of the collected garbage"

Ziad AbiChaker, *Industrial/ environmental engineer, founder of CEDAR Environmental*

As mentioned in Annex A, Sukleen benefitted from several extensions of the BML contract with cost adjustments, the last being for a final six months – as of the 17th of January 2015 – to allow the CDR to start a fair and legal bidding process. However, the process failed with no contractor applying to BML due to very complicated specifications. On the 17th of July 2015, Sukleen's contract expired with no appointed service provider taking over. Since then, the government – which was expected to declare a state of emergency – showed little, unclear and no serious mitigation initiatives; exporting the waste is currently being considered the only viable solution since adopting landfills, despite being unfavorable, as the main waste management option is being facing immense popular objections for a plethora of reasons. On the other hand, civil society organizations (CSO's) and municipalities have endeavored to either sort at source or collect and dump waste into valleys and open lands, such as in the proximity of Beirut International Airport or the historic Lamartine Valley – a UNESCO World Heritage site.

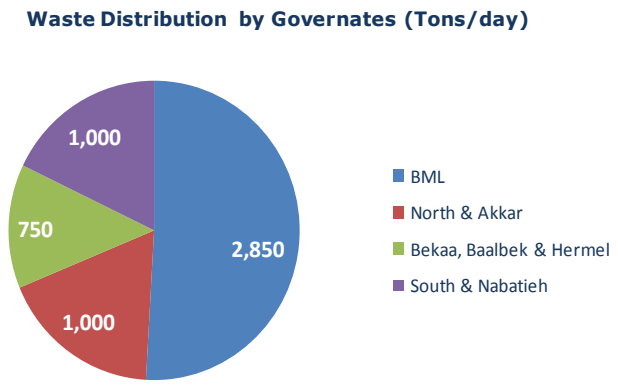


Figure 1. Daily Waste Generation Rate per Governorate

2.2 Causalities: A 20th Century Bidding Process

The 2015 bidding process aiming to contracting a waste management company raised concerns; with no service provider applying to the Greater Beirut Service Area (GBSA) in the first round, due to very strict specifications and criteria, suspicions of privileges granted to Sukleen were raised which brought to light the importance of identifying inherent loopholes.

According to several bidders, the terms regarding waste recovery revenues were unclear, which would ultimately lead to a return to the status-quo prior to July 17, 2015. Additionally, other criteria were out-dated; for instance, applicants are required to buy an estate and build waste management facilities under contract duration of 7 years. This short period is not feasible to depreciate the investment in land, facilities, machinery and equipment, thus leading to a drastic increase in the proposed prices. Nevertheless, the winning contractors, charged with sweeping, collecting, sorting and treating the generated waste were able to bid at a price considerably lower than Sukleen – which was only responsible for sweeping, collecting and landfilling – and with a healthy profit margin. Moreover, after announcing the winning bidders in the second round, contractors were astonished that their quoted prices were inexplicably increased by a margin, which this paper analyses in later parts.

Impact of the Waste Crisis in Campania

1. Environmental: The territory of Campania has been invaded and poisoned by waste for about 20 years. 17 wild fires occur daily; and the crisis also affected the quality of the soil and other environmental components like watercourses and underground water reservoirs: 13% are caves used as illegal landfills, 12% are water reserves and 75% are landfills

2. Economic: The waste policies of Campania are seen to create a "*Culture of Death*" as they are causing the disappearance of rural and traditional food production, which has negative economic and cultural implications.

3. Health: The exposure to waste contaminants was directly linked to causing youth fatalities by tumors (30% of men, 21% of women) and cardiovascular diseases (40% of men, 50% of women) in addition to an increase in respiratory illnesses such as bronchitis and asthma.

3. Deadlock & Civil Unrest

No official has been held accountable for the ongoing waste crisis, which exemplifies the fundamental problem of the political system in Lebanon. With the absence of practical solutions, the situation heightened leading to civil unrest and protests. Thus, instead of seizing the opportunity to transform waste management into a holistic industry, the topic grabbed the headlines for the wrong reasons.

On many occasions, civic movements had to confront security forces and demonstrations started to get out of hand raising a major security concern in an already volatile country. Meanwhile the solution proposed by the Technical Committee, assigned to resolve the waste crisis, was met with opposition from the civic movements stating their preference for a holistic strategy rather than simply a landfilling one.

At the same time, piles of rubbish accumulated in the streets; as the mounds got higher, the smell of rotting garbage became intense. People resorted to "backyard burning" (burning trash in the open) in crowded residential areas, while garbage trucks illegally dumped the collected wastes in rivers and valleys.

Many observers have likened the current Lebanese Waste Crisis to that of Campania in Italy. Be it coincidence or irony, Lavajette – the company formerly in charge of Tripoli's waste management and part of the consortium that won the cancelled bidding for GBSA – was in charge of waste management in Naples, Campania when the crisis started in 1989, and led to a total breakdown of Waste Management Services in 2008. Due to the lack of transparency and the mafia's role, the crisis has had a deep impact on the Campania and Italian landscapes.

4. Impact on the Environment & Landscape

With the 2015 Waste Crisis being almost analogous to the Neapolitan crisis, close comparisons can be drawn: unless the waste crisis is resolved promptly and properly – through a valid, methodical and environmentally sound system – people will suffer from dire consequences on their health, the environment, as well as their economic levels. For an economy that is mainly reliant on services, namely tourism and banking, having a "wretched" landscape is detrimental to the growth potential. Meanwhile, inhabitants and visitors alike suffer from odors, contaminated vectors and waters as well as a decrease in the quality of living. The table below highlights the impact of the crisis and the probable outcomes. A further elaboration of "backyard burning" by-products is found in Annex B.

It is clear how allowing the trash to pile-up, resorting to "backyard burning" and providing an ecosystem that breeds vector-borne disease carriers is harmful to the people, and their trust in their country's administration. Moreover, this crisis can prove to be catastrophic for the nation's healthcare bill and economy.

PROBLEM	IMPACTS
Poor waste management	• *Open decomposition leading to unpleasant odor* • *Breeding of vectors (flies & rats) and diseases carried by mosquitos* • *Contamination of streams, rivers, lakes, drinking and underground water* • *Contamination of soil and damage to plant and wildlife habitats* • *Decrease in the quality of life for nearby residents* • *Water pollution due to sewage and domestic waste, causing typhoid, cholera, jaundice, dysentery, diarrhea, etc. This can lead to the outbreak of epidemics;*
Backyard Burning	• *Upper airway irritation* • *Neurological symptoms (headache, fatigue)* • *Acute respiratory symptoms (shortness of breath)* • *Asthma and chronic lung disease exacerbations.* • *Acute cardiac events* • *Cancers (long term exposures)* • *High organic waste content can lead to Salmonella, Shigella…etc.*
Vector-borne diseases transmitted by mosquitoes, ticks & rodents	• *Skin & blood infections from direct contact with waste and infected wounds* • *Eye & respiratory infections from exposure to infected dust & fumes* • *Various diseases caused by the bites of animals feeding on waste* • *Skin abrasions due to scratching of scabies or mosquito bites, thereby providing an opening for the infestation of bacteria and viruses* • *Transmission of "Rickettsia prowazekii", "Yesinia pestis" …etc.* • *Cats can be carriers of the viruses causing toxoplasmosis, which results in hundreds of miscarriages and birth defects (e.g. blindness)*

Table 3. Effect of Backyard Burning on Health of Humans and Livestock

II. EVOLUTION OF THE CRISIS IN NUMBERS

1. The "Peoples" of Lebanon

In total the population residing within Lebanon accounts for almost 7.7 million inhabitants: 1) 5.85 million Lebanese, Palestinians and all other expatriated persons; and 2) 1.85 million Refugees from the Syrian Conflict and distributed among urban, rural and Informal Tented Settlements (ITS). Based on the UNDP's "Lebanon Environmental Assessment of the Syrian conflict" report (2014) the total inhabitants in Lebanon are segregated as per the chart to the right: only 184,615 refugees live within ITS.

This distribution implies that there are three patterns of living conditions within the Lebanese territory: Urban (6.21 million people), Rural (1.31 million people) and Refugees (around 0.18 millions). These different patterns yield three different waste generation patterns, highlighted in the section below.

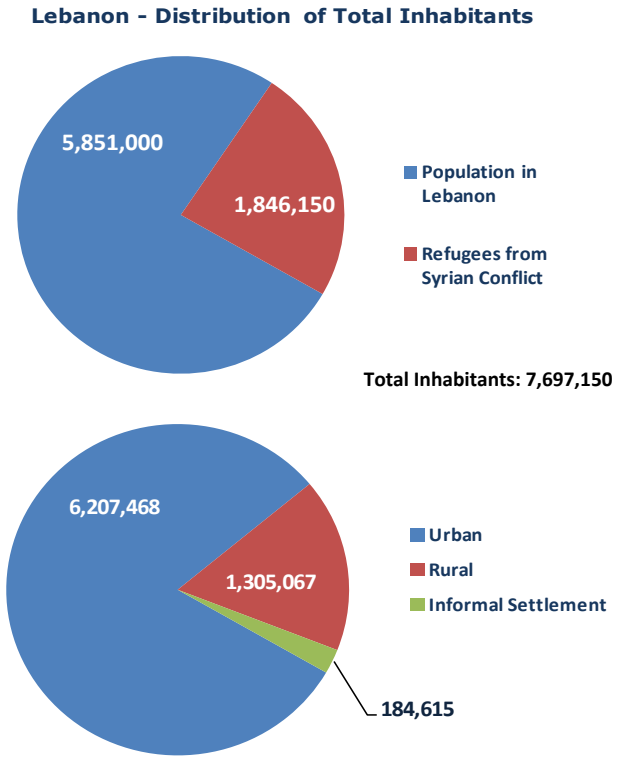


Figure 2: Distribution of Inhabitants of Lebanon

2. The Waste Composition

Grouping the Urban and Rural populations together, and adopting the national averages of waste composition, 52.5% is organic whereas, under the same category, the Refugee population produce around 70%. Around 8% of the Refugees' waste is made up of paper and a similar amount is in plastic, whereas for the Urban and Rural Populations it is 16% and 12%, respectively. The metal component is almost double among the Urban and Rural population (6%) versus that generated by Refugees, while the latter produce 6% of their waste in glass in comparison to just 4% for the Urban and Rural population. The 'other' category (which includes medical & construction waste, diapers and toxic materials among others) constitutes 10% of Urban-Rural, versus half of that for the Refugee population.

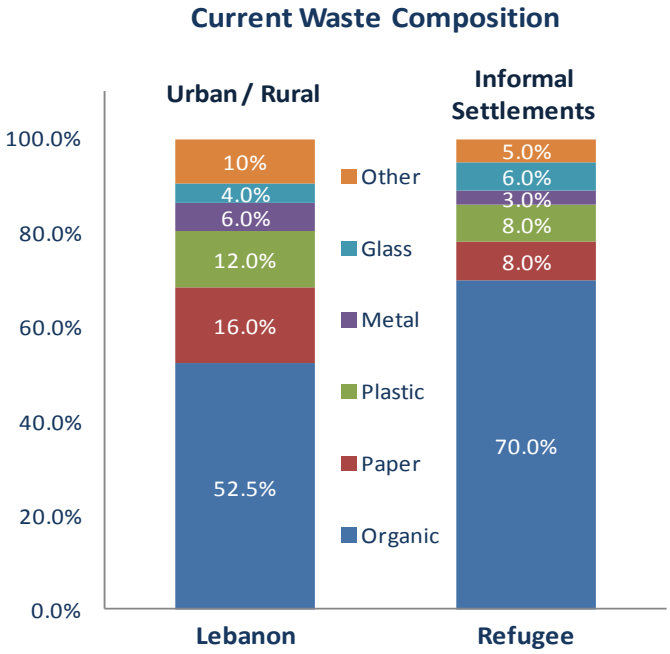


Figure 3: Waste Composition of Different Lebanese Population groups

After July 17th 2015, the waste generated in BML was almost entirely disposed of in open dumps and burning piles, thereby altering the distribution of waste treatment as depicted below (assuming that the proportions recovered remain the same):

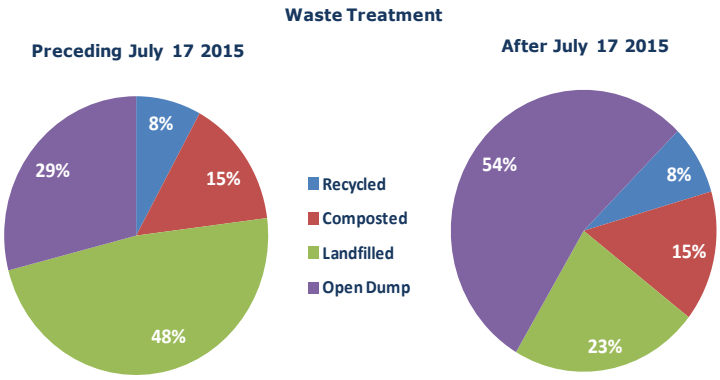


Figure 4: Waste Treatment Modalities before and after the 17th of July 2015

It is clear that 25% of the waste that was previously landfilled is currently being open dumped, thus raising the proportion for this method of 'treatment' from 29% to 54%. This is a major concern of the 2015 Waste Crisis, and according to the MoE, there are currently more than 760 open dumps spread all across the Lebanese territory. Based on SWEEP-NET figures for 2014 (adjusted to reflect waste generation in 2015), the per capita rate of waste generated, recovered (i.e. recycled and composted) and finally disposed (i.e. open dumps and landfills) is detailed as follows:

(Kg/p/day)	URBAN	RURAL	REFUFEE
Waste Generation Rate	1.10	0.89	0.50
Waste Recovery Rate	- 0.25	- 0.20	- 0.08
Waste Disposal Rate	0.08	0.68	0.43

Nevertheless, after triangulating the sources and finding out that household wastes are generated at a daily rate closer to 0.65 kg/capita, the task team was able to re-state the average figures of TOTAL Waste Generation rates as per the diagram below. The average urban citizen produces around 0.97 kg on a daily basis, out of which 0.22 kg is recovered and 0.75 kg is disposed of. In rural areas, the rate falls to 0.79 kg/capita on a daily basis out of which 0.18 kg is recovered and 0.61 kg is disposed of. For refugees, and given their affinity to reuse inert material, the per capita daily generation estimate is at 0.50kg, out of which 0.08kg is recovered and 0.43kg is disposed of.

(Kg/p/day)	URBAN	RURAL	REFUFEE
Waste Generation Rate	0.97	0.79	0.50
Waste Recovery Rate	- 0.22	- 0.18	- 0.08
Waste Disposal Rate	0.75	0.61	0.43

3. Benchmark Comparison

A benchmarking comparison of different countries and regions was carried out to help better understand the waste generation patterns in Lebanon. These patterns are closely related to Gross Domestic Product (GDP) and cultural factors. In the table below, Lebanon's "waste profile" is compared against countries and regions with different IWM characteristics.

In OECD[3] countries, with a population almost 100 times larger than Lebanon, the waste generation rate per capita is only double the local rate; at the same time none of this waste is unsoundly disposed of (compared to 54% in Lebanon) and over half of the waste generated is converted to energy or recovered through composting and recycling (compared to 23% recovery in Lebanon). Though part of the OECD group, Greece and Iceland exhibit different patterns. In comparison to Lebanon, Greece has twice as much GDP/capita whereas Iceland has almost 3.5 times. Greece and Iceland produce 1.41 and 1.56 kg/capita daily, while recovering 0.24 kg and 0.95 kg respectively. In terms of IWM Greece has similar recovery proportions to Lebanon, but only 2% of Greece's waste is disposed of unsoundly. Singapore represents the higher industrial spectrum, with a GDP/capita 4.5 times larger than the Lebanese counterpart, and the Singaporean inhabitant producing 3.74 kg of wastes on a daily basis (0.97 kg in Lebanon), yet recovering 60% with 0% unsound disposal.

Country/ Region	Lebanon[1]	Tunisia	Greece	Singapore	Iceland	OECD
Ref. Year	**2015**	**2013**	**2012**	**2014**	**2009**	**2015**
Pop. (Millions)	7.70	10.80	11.10	5.50	0.33	711.90
GDP per Capita (USD)	12,006	4,317	24,446	56,319	41,750	69,318
Av. Waste Generation (Kg/p/d)	0.97	0.60	1.41	3.74	1.56	2.15
Waste Disposed	77%	91%	83%	2%	36%	42%
Waste Unsoundly Disposed[2]	54%	45%	2%	0%	0%	0%
Waste Recovered[2]	23%	9%	17%	60%	61%	33%
Waste to Energy[2]	0%	0%	0%	38%	3%	21%

[1] The Population in Lebanon includes the Syrian and Palestinian Refugees

[2] The Unsound Disposal percentages are for the Year 2015 for all countries and regions

Table 4: Benchmark Comparison of Lebanon's Waste Generation and Treatment Patterns with relevant countries and regions

If the Greeks and Lebanese have similar Mediterranean cultural factors, so do Tunisians whose GDP/capita is three times less than Lebanon's, with its waste generation rate per capita of 0.60 kg out of which 10% is recovered and almost 45% is disposed of unsoundly.

These benchmark elements exhibit different waste generation and management patterns. In developed countries (Singapore, OECD and Iceland) there is no open dumping, in Greece only 2% is openly dumped whereas this percentage rises to 21% in Tunisia and is currently at 54% in Lebanon. Recycling is another characteristic of IWM in developed economies, as is

[3] Organization of Economic Cooperation and Development

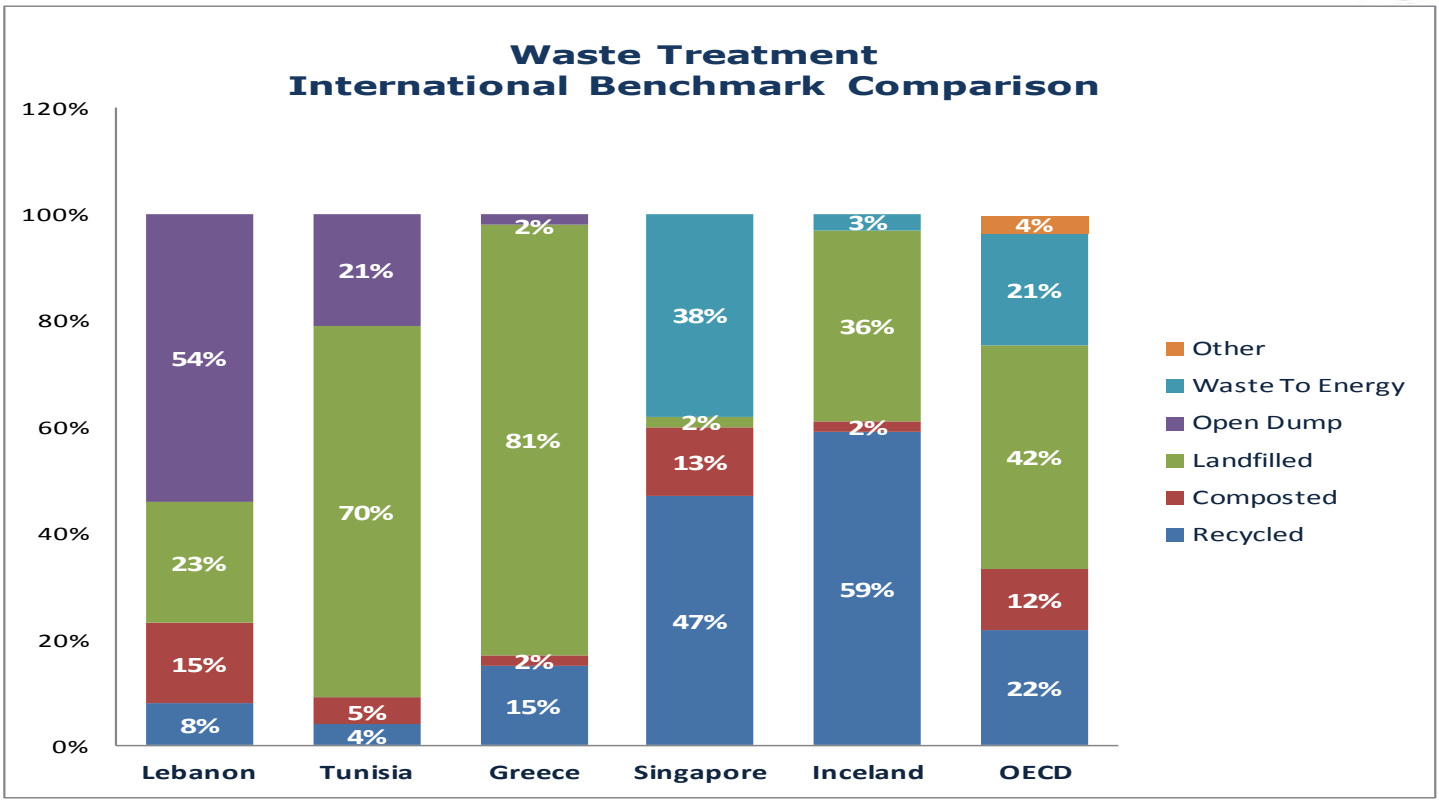


Figure 5: Waste Treatment Modalities International Benchmark Comparisons

Waste to Energy (WtE), whereas in less developed and developing economies landfilling tends to be the main solution.

Composting also seems to be discouraged in advanced economies. OECD countries have figured out other IWM protocols to deal with their waste (mainly incineration) which, given the industrial and environmental cultures in lesser developed and developing economies, might result in detrimental environmental effects and increase the healthcare bill – especially since most of these countries lack regulators for environmental and air pollution. It is also noted that most countries adopting incineration as part of their IWM plan are also countries that have put in place a zero emission policy.

III. PROPOSAL OF THE WASTE CRISIS TECHNICAL COMMITTEE

In response to the 2015 Waste Crisis, and in September 2015, the Technical committee, headed by the Minister of Agriculture Akram Chehayeb, devised a three section crisis management plan: the operational phase, the transitional phase and treatment sites.

1. The Plan

1.1 The Operational Phase

The operational phase is designed for a period of 18 months. During which, procedures will be divided into two parts: one part is related to general guidelines' implementation preparations, and the second for procedural implementation in BML. These guidelines aim to prepare municipalities and service areas for the operational phase which kicks off following GoL's approval, considering that service areas may start implementations anytime during this period.

- Two months post approval, municipalities should be trained and service areas identified;
- Three months post approval, contractual conditions must be drafted and the bidding process initiated;
- The bidding process should be concluded within a month and solicited providers should subsequently be commissioned to operate existing and/or newly established waste management facilities.

1.2 The Transitional Phase

It involves the immediate removal of waste accumulated on the streets and the temporary dumps used by municipalities and UoM's. During this period, CDR will be commissioned to prepare and activate the suggested sites in the shortest period possible.

1.3 Treatment Sites

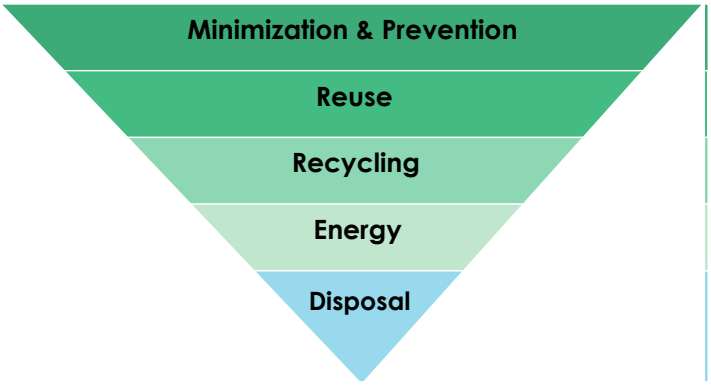
Once GoL approves the plan, the following waste treatment sites are suggested to be put to use:

- Saida treatment plant, to receive 250 TPD;
- Establishing a sanitary landfill near the Lebano-Syrian

borders in the Masna'a area, with the first cell receiving 1500 TPD for 6 months, and 1000 TPD in later stages;
- Rehabilitating the Bourj Hammoud dump through creating a nautical barrier, creating an additional cell to receive 1000 TPD for a year and turning it into a green space;
- Re-opening the Naameh Landfill and transferring the waste accumulated on the streets since 17th July 2015 over a span of 7 days; the waste will be moved for packaging, arrangement and greening.

2. General Overview

On the technical level: During the operational phase, the plan stipulates a hierarchical holistic management of solid waste which includes waste reduction, sorting at source, re-use, generation of energy, and reclamation of distorted sites with the use of inert material. Local authorities – municipalities and/or UoMs – would sweep, collect, transport, encourage and supervise sorting at source. Meanwhile, related ministries (MoE and MoIM) should oversee these processes.



Treatment is the responsibility of the identified service areas (municipalities, UoMs or conglomeration of local authorities) with a minimum waste generation volume of 200 TPD for efficiency and economic feasibility. These areas would be assigned to sort, recycle, generate energy and find potential sites for treatment.

On the economic level: the sustainable management of solid waste is funded by local authorities through municipal resources, IMuF, revenues from the mobile communication network and donations. It should be noted that municipalities hosting waste treatment facilities are entitled to bigger shares of revenues from the IMuF.

On the legal level, drafting a comprehensive national solid waste management law should be prioritized, as well as legislative and procedural texts tackling environmental reforms, especially those necessary for the reduction at source of waste production.

3. Comments on the Plan

- The plan discusses comprehensive solid waste management whereas it should be focusing on Integrated Waste Management;
- The treatment of the accumulated and already dumped waste, planned to be done during a week, lacks procedural clarity;
- The plan doesn't include treatment techniques for the accumulated waste in BML;
- The period of 18 months for capacity and capability building requires further elaboration.

IV. MITIGATION MEASURES

The waste management crisis was faced with heavy protests from the civil society and even though the GoL proposed an interim solution, other initiatives were already ongoing. In this section, three local endeavors are highlighted: the Municipality of Roumieh, Sayyidat Baysour Association (The Ladies of Baysour – NGO) and the work at the Ain Baal waste management facility in Sour.

In Roumieh, Mayor Louis Abi Habib called for a municipal council meeting and invited experts on board to draw up a plan to mitigate the waste crisis. The municipality focused on engaging civil society components to ensure proper waste management practices. Youth groups, scouts and religious communities actively participated in raising awareness while municipal contractors undertook waste collection under the supervision of local staff. The noticeable aspect of this initiative is the reward/penalty scheme. Citizens that do not sort their waste receive a "yellow card" on their first default, before being fined on the second; a mechanism similar to a football match. To highlight the effect of local CSO's in Roumieh, the Sayyidat Bayssour Association needs to be brought forward. In 2014, a year prior to the crisis, the member ladies started sorting from source in coordination with the Baysour Municipality and other local CSOs. In a model civic engagement application, the Municipality of Baysour provided a piece of land and sorting bins for every neighborhood, allowing the ladies to manage a project they call "Colorful Gold". Currently this initiative is being endorsed by the Ghareb Al-Aala wal Chahar (GAC) UoM and a compactor is being prioritized – with the support of international agencies – to enhance the

efficiency and feasibility of this project. The importance of raising awareness for sorting at source can be further stressed when considering the case of the Ain Baal sorting facility in the caza of Sour. Established in 2011, the facility has a capacity of 160 tons/day and can serve 30 out of 64 member municipalities in the UoM of Sour. The plant receives "unsorted" domestic waste in a collection yard and "treatment" endeavors are undertaken where inert materials are sold and organic materials are composted. According to the facilities' management, the plant could perform better if sorting is done at source, and the conveyor belts are made longer and wider. Based on the above, there is an immense need to integrate waste management practices for all active players: the municipalities, the local CSOs and the UoMs. In an ideal scenario, the Municipality engages local civil societies at the levels of awareness building and waste collection, while the UoM could manage secondary sorting and treatment facilities for optimized IWM.

"We didn't fine those who were violating, but instead we used a booking system similar to a football game where a yellow card is placed on the violating bag and if the household doesn't comply, it will receive a red card which means that garbage will no longer be collected".

Louis Abi Habib, *Mayor of Roumieh*

V. POLICY FOCAL POINTS

Admittedly, a typical waste management process is depicted as per the process illustrated in figure 6 below.

The first stage consists of raising awareness and distribution of waste reduction kits and sorting bins. The second phase includes sweeping and collecting; in the third stage, the collected waste is sorted again, bailed, wrapped and readied for treatment in stage four.

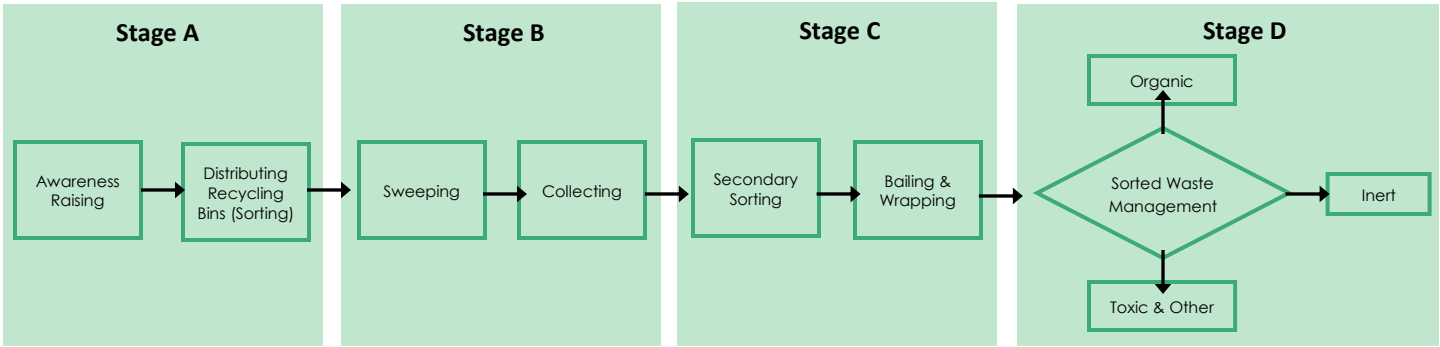
Regardless of the current capacities of municipalities, each local authority is capable of handling the first two stages with minimal support from central authorities. The three local case studies elaborated above are further proof that if municipalities engage their local communities, they will be able to implement the first two stages of the process with ease.

Nevertheless, it takes a Union of Municipalities to make a sorting facility, such as the one in Ain Baal, feasibly relevant. In addition, the Municipality of Roumieh is looking into partnering with "similar" municipalities to expand their involvement in the management of their citizens' waste. On the other hand, the Municipality of Zahle is taking charge of the entire solid waste management process – although ending in landfills rather than being sorted and treated. The presented case studies lead us to the following questions:

- *What is the most feasible course of action in order to solve the 2015 Waste Crisis?*
- *What are the most strategically sustainable IWM models to adopt?*
- *Can these practices be replicated nationwide and integrated at policy level?*

These questions could be answered following a holistic analysis of the underlying factors that affect the adoption of such a policy. These factors can be grouped along the following:

- Governance;
- Environmental and Health;
- Infrastructure and Urban Design;
- Social;
- Financial; and
- Technical.

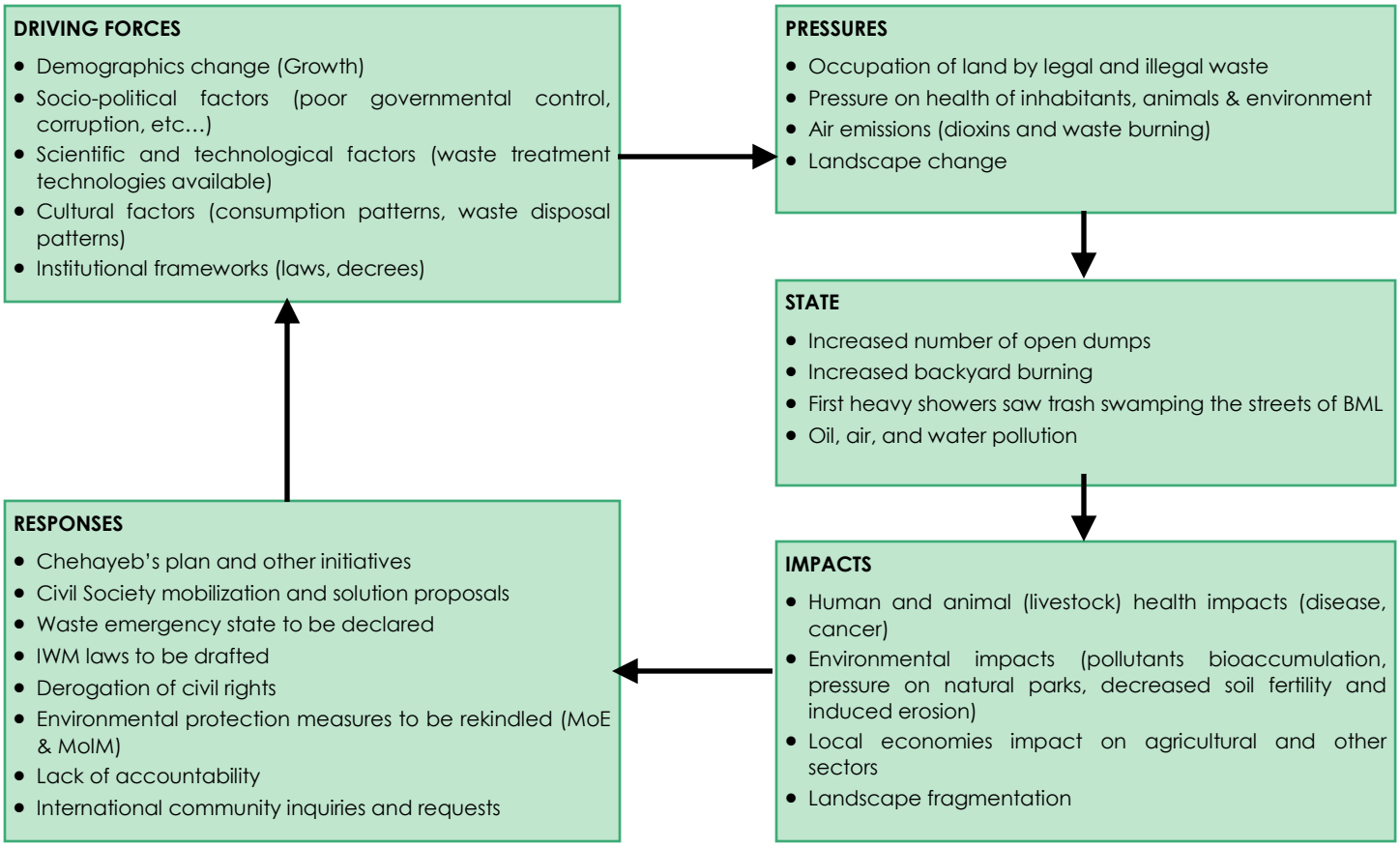


POLICY ANALYSIS

As elaborated under the situational analysis, the waste management issue was a time bomb, which exploded on the 17th of July, 2015. The Driving Forces, Pressures, State, Impacts, and Responses (DPSIR) chart below in figure 7 summarizes the current dynamics related to the 2015 Waste Crisis.

To be able to provide cutting-edge policy recommendations, it is necessary to look at the governance, environmental, health, social, financial and technical aspects of what is available and what is required; not just to resolve the inherent waste crisis, but to transition the GoL and LAs from being in a "reactive crisis mode" into "proactively implementing a Zero-Waste Integrated Waste Management Plan".

This is currently possible as the population has experienced a collective increase of awareness and has become conscientious about what happens to their waste. The demonstrators successfully highlighted the issues of transparency and accountability. Although the movement faces a political uphill battle to remain focused on the waste issue, it is currently perceived that the civil society is engaged with authorities on working towards a modern IWM policy implementation.



I. GOVERNANCE

In its 2010 report "Solid Waste Management in the World's Cities", the UN-Habitat elaborates on the methodology of drawing an "Integrated Sustainable Waste Management" (ISWM) plan. The first triangle of the ISWM consists of collecting, treating and reducing waste. The second triangle is related to governance and elaborates on: 1) Inclusivity through engaging all stakeholders; 2) Financial sustainability; and 3) Sound, proactive and institutional and policies.

According to the UN Habitat (2010) "while national authorities create the boundary conditions, it is the municipal authorities who are responsible for solid waste management in a city". Yet it is not the sole responsibility of municipalities; all stakeholders need to actively participate in waste management efforts, in one or more of the following categories:

- Consultation, communication and involvement of users at all stages;
- Participatory planning & system design;
- Institutionalizing inclusivity and active civic engagement.

In this regard, it is highly encouraged to have Private-Sector Participation (PSP), Public-Private-Partnerships (PPP) and Joint Ventures (JV) to allow LAs to leverage on the expertise, know-how and agility of non-public sector entities for service provision.

LEGAL FRAMEWORK FOR WM IN LEBANON

There is no legislative framework directly related to WM, however there is a draft law on WM that was sent to parliament for approval under decree number 8003/2012 and is still under discussion. Another draft law incentivizing municipalities hosting WM facilities was prepared in 2013 and is also still under discussion.

DECREES DIRECTLY RELATED TO WM

- 8735/1974 assigns WM to municipalities;
- 9093/2002 incentivizing municipalities to host facilities;
- 1117/2008 incentivizing municipalities hosting sanitary landfills and still under revision prior to implementation.

OTHER RELATED LAWS & DECREES

- Law 444/1988 regulating hazardous wastes;
- Decree 8471/2012 related to industrial environmental compliance;
- Decree 8006/2002 amended through 13389/2004 classifying the different categories of healthcare waste

Source: Country Profile on Waste Management situation in Lebanon, SweepNet, 2014

Table 5. Legal Framework for Waste Management in Lebanon

In the Lebanese context, one major weakness is in providing a solid legal framework. There is no law – albeit a draft still resides in the drawers of the parliament – that regulates waste management nationwide, and thus it is essential to pass such a law and all related operational decrees.

Municipalities have the right – and duty – to claim their role as Waste Managers as per decree 8735/1974. Although there is a huge need to build the capacity and capability of these LA's and invite related stakeholders to collaborate, the cases of Roumieh's Municipality and Sayyidat Baysour are a clear example of active civic engagement that can reap tangible and effective results in waste management.

In this light, NGOs and CSOs have a major role to play in spreading awareness, building society's capacity and actively participating in WM efforts. These organizations are present throughout the Lebanese territory (Annex D) and are major partners in WM and the cleanliness of their communities. They have also played a watch-dog role by tracking any misconduct of parties involved in WM activities. The civil-unrest witnessed during 2015 presents a lively example of how events can escalate if WM is not undertaken properly.

II. ENVIRONMENT & HEALTH

Although the main driver for this study is the 2015 Waste Crisis, it is of utmost importance to point out that prior to the July 17, 2015 the WM environmental repercussions were not close to ideal.

While an acceptable level of waste recovery is maintained, the waste treatment modalities are still in question. "Open Dumping" and "Backyard Burning" have proven to be detrimental; but in Lebanon, adopting landfilling and incineration as a means for waste disposal could lead to results that are equally as noxious.

The case of the Naameh Landfill is considered a model indication of how landfilling in Lebanon could have negative impacts on the host and surrounding areas. The Naameh landfill, which qualifies as a sanitary landfill, has been used as a dump rather than a landfill for 'mistreated' waste.

Moreover, incineration could be the core of a "National Strategic Action Plan" for waste treatment, yet given the state of infrastructure, the inherent – or lack of – industrial culture and the parallels drawn from the "Trash Crisis in Campania", incineration could have extremely

IMPACT OF NAAMEH LANDFILL

The Naameh landfill has been a cause of serious health risks to the people in its surrounding areas. A large number of reported cases were associated with the deterioration of air quality due to methane gas produced by the landfill; yet no accurate figures are present – for the time being – to precisely determine the impact on the healthcare bill due to waste "mis-management".

Among these are cases of dyspnea, suffocation, unconsciousness, allergies and lung diseases. In addition, reports of wild fires were linked to the landfill gases, where it caused green trees to burn, and in one case, small explosions were heard. The landfill is thought to produce 20,000 cubic meters of methane gas per hour.

Affected residents have also stated that they do not open their windows or use their balconies since the air has become too heavy for breathing.

devastating effects on the environment, the healthcare bill and the livelihood of Lebanese communities.

If we are to draw from the case of Naples and Campania, the emergency funds allocated by the Italian central authorities – until the end of 2008 – have exceeded 1.8 billion Euros, 20% of which being allocated as salaries for the people who failed to mitigate the crisis. And with Lebanon's economic struggles, this could prove to be a back-breaking straw.

III. INFRASTRUCTURE & URBAN DESIGN

The wide spread phenomenon of open dumps and "Backyard Burning" inflicts disastrous effects on the environment and healthcare. Yet, a critical aspect is often neglected: the effect on infrastructure, namely sewage & water drainage networks as well as bridges.

1. Sewage & Water Networks

In Lebanon, sewage networks are either old and mismanaged or haphazardly newly constructed. Today, two main constraints come into play: 1) the exponential increase of pressure on the networks with the sudden increase in population, as a direct result of the Syrian refugee crisis; and 2) the Waste Crisis which exposed weaknesses and aggravated related problems. The sewage and storm-water networks are inter-connected in the majority of cases throughout the Lebanese territory, mostly ending in river naps.

"Operators are now working 24/7 to make sure that screens won't be plugged; "if any problem occurs the coast will be flooded! We were collecting garbage bags, shoes, clothes, diapers, etc…"

Mr Riad Doumiaty, Supervisor of wastewater treatment facilities in BML

Open Dumping of waste, as is the case with the Beirut River at its terminus near the Port, has direct implications on the networks and water tables which are extremely dangerous. A related example is Al Ghadir Waste Water Treatment Plant (WWTP) in Ouzai on the southern coast of Beirut. Officials admitted that the plant was able to filter and screen 3 times the quantities of solid waste normally generated by sewers.

2. Concrete Structures

Open dumping near bridges and other urban infrastructures, and the subsequent open burning, leads to extreme pressures on the state of concrete structures since most of them were designed to resist up to a couple of hours of direct fire (2 hours if designed according to the French Code, 4-5 hours if additives are added to the concrete mix according to the American Codes). On the short run, fire can cause significant disruption to the operation of a bridge and the travelling public. On the long run, if the concrete structure is placed in a humid environment (i.e rain), carbon emissions from underlying waste will lead to accelerated concrete carbonation and subsequent hasted spalling.

IV. SOCIAL

Despite the catastrophic outcomes and impacts of the 2015 Waste Crisis, there is one upside: the media coverage and gravity of the situation have drastically reduced the cost of raising awareness regarding waste generation, sorting at source and management.

Individuals are now being cautious about sorting from source and households are being cooperative with municipal initiatives, e.g. the previously elaborated case of Roumieh's Municipality. We can clearly see a "collective paradigm shift" when it comes to practices on these levels. Yet, the unavailability of waste disposal outlets is forcing municipalities to open dump, open burn etc.

An explicative case of civic engagement and social integration would be the Ghareb El Aala wal Chahar (GAC) UoM, which endorsed the Sayyidat Baysour Colourful Gold project and decided to establish a sorting facility that serves all municipalities on a previously allocated land (See Annex C).

Meanwhile, in the Ikleem al Kharoub al Chamali (IKC) UoM, the Waste Crisis has led to an intriguing issue: the central authorities suggested the use of Sibline cement factory incinerators as one of the means to deal with the crisis and the UoM declared its approval. However, the local CSOs openly refused the suggestion and civil unrest ensued. Subsequent initiatives were undertaken priming civic engagement (see Annex C).

On the other hand, one cannot discount the effect of the refugees influx on the overall landscape: while Afghan refugees in Lahore–Pakistan have proven to be a key component in the WM solution, Syrian refugees on Lebanese soil – commissioned to do a similar exercise in Sarafand – led to an increase in theft of recyclable materials and an aggravation of the already sensitive security situation.

Hence, the previously elaborated role of local CSOs provides much needed stability, initiative and civic engagement in keeping related stakeholders actively participating in the "cleanliness" of their community.

"We are deploying all our efforts in order to make our project more complete and efficient, starting by the allocation of a specific land for composting operations. Compost will be distributed to farmers."

Mr Walid Abou Harb, Mayor of Baysour and President of the GAC UoM

V. FINANCIAL STATUS QUO

This section presents an overview of the existing WM systems in place and their associated costs. The costs have been projected over the short, medium and long terms – using available data and certain basic assumptions – and compared against the total budget and revenues "available" to municipalities and the UoMs in order to assess the *affordability* of the system.

Estimating that the total waste generated in 2015 will culminate to over 2.6 million tons, the table below highlights the pertaining costs of WM (from sweeping to disposal & recovery) and their minimum, maximum and average proportions of the total available budgets of municipalities and UoMs.

The Average Estimated Cost of WM (USD 320 million) is in line with the actual bid prices resulting from the second bidding process while the Maximum Estimated Cost of WM (USD 470 million) is in line with the bid prices published by the MoE.

The current WM system has levied high costs on municipal budgets, already hampered by poor collection rates, thus questioning the affordability of the current system. Furthermore, assuming that the current situation remains as is – while keeping the environmental and disaster impact out of the equation – and that waste generation rates and costs will increase with economic growth, inflation, population growth and urbanization, the average cost of WM is expected to top $673 million in ten years' time, which is equivalent to an estimated 35% of the total municipal budget at that time. In addition, with a waste recovery rate of 23% (i.e. waste that is recycled or composted), recovered costs range from 6% to 13% of the total WM. Given the composition of the waste generated in Lebanon – and the fact that it is recyclable or compostable in its majority - the capability, capacity and aptitude of the current WM system is seriously questioned. Upon utilizing all available facilities and implementing sorting practices on all generated waste, the recovered costs can go up to 50% of the actual cost.

2015 Estimates	Minimum	Average	Maximum
Estimated Total Waste Generated		2.61 Million Tons*	
Estimated Cost of WM (Million USD)	210	320	470
Proportion of WM Cost from Total Municipal Budget	22%	33%	48%
**Waste generated by total Lebanese inhabitants as well as Refugees of the Syrian conflict*			

Table 7: Cost of WM in Lebanon

VI. TECHNICAL

In case an IWM policy is implemented, and given the composition of waste generated, Lebanese authorities are assumed to adopt a plan to reach the Zero-Waste milestone within the foreseeable future; the Task Team foresees a Wasteless Lebanon by 2022.

1. Organic Waste

With most of the waste made up of organic material (around 52%), composting is a vital waste recovery technique. Whether done for commercial purposes or for soil decomposition reversal (namely through the Green Project) after several years of "dumping" nitrogen-rich chemical fertilizers, organic composts are a necessity for the next 10 to 15 years.

It should also be noted that Lebanon annually imports fertilizers and low grade composts worth in excess of 30 Million USD; this further augments the argument that composting should be encouraged and protected through governmental regulations and customs. Other treatment methods should also be taken into consideration like transforming landfills into Waste to Energy facilities in rural areas, which can help in providing part of the electricity requirements for these regions and contribute to the creation of employment opportunities.

Landfilling – the way it is has been until the 17th of the July 2015 – is ***highly discouraged*** given the effects it has on its surroundings and underlying water tables. Moreover, incineration of organic waste is also discouraged given the cost and low calorific value as well as the Lebanese industrial culture.

2. Inert Material

Taking into consideration that 42.5% of the total waste generated are inert material, most of which are recyclable and up-cyclable, inert material could become a revenue stream for LAs. Landfilling is considered non-feasible given the foregone revenue potential, whereas incineration is highly discouraged for reasons already stated. Other material deemed un-treatable and un-qualified could be landfilled and used to treat areas such as quarries.

3. Others, Hazardous & Toxic Wastes

As the Lebanese WM culture is still in its early days, the industry lacks the necessary facilities; in light of the overall lack of industrial culture, exporting toxic and untreatable waste is highly recommended to avoid Campania-like toxic waste contamination. It should be noted that previous experiences with toxic waste have gone un-treated, such as those in the Faqra and Normandie Dump in the late 1980s and early 1990s. Export partners such as Germany, Denmark or even the United Kingdom could represent potential solutions.

VII. SYNTHESIS

With all the above taken into consideration, WM solutions are being narrowed down especially for the GBSA, given the current "urban mis-planning". Hence the need to provide an adequate holistic solution nationwide, especially since citizens of the North, Bekaa and Southern Governorates heavily protested the prospects of landfilling BML waste in their backyards.

Moreover, the cost of establishing and operating waste treatment facilities (sorting, bailing, wrapping as well as recovery techniques) is currently beyond the budgets of municipalities and unions, especially since their funding from the IMuF is being held up; and when released and transferred they are lacking the needed transparency for efficient budgeting and strategic financial planning. Nonetheless, if partnerships with the private sector become an option and there is access to capital markets through a clear and defined legal framework, LAs and UoMs will be empowered to carry on the establishment and operation of waste treatment facilities.

1. Time Line

As per the diagram below, and factoring in Chehayeb's plan, the timeline for treating this crisis and implementing a sustainable solution can be elaborated around T0, the time when the IWM plan and processes are put to action.

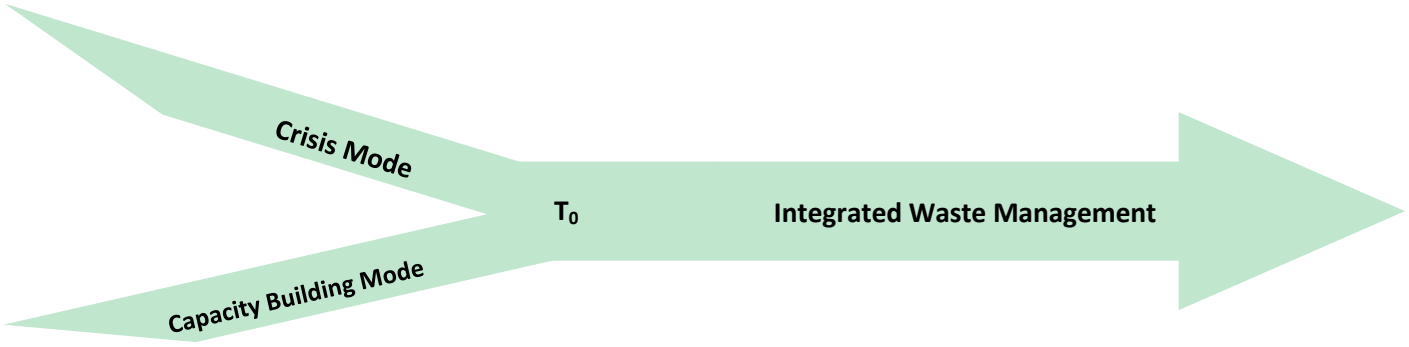


Figure 7: Suggested Timeline

1.1 Pre T_0 Period

Prior to T_0, two different modes need to be considered: Crisis Mode (which aims at mitigating the effects of the 2015 Waste Crisis) & Capacity Building Mode with the objective of preparing LAs to assume their rightful and legal duties.

A. Crisis Mode

Whereby the LAs should work on the "now" and resolve the waste crisis that is threatening the country on all levels; this is equivalent to declaring a "State of Emergency" where the pending issue needs to be *resolved at all costs*.

As previously elaborated, Chehayeb's plan extends for a period of 18 months, and was based on adopting nationwide sanitary landfills in rural areas to resolve the crisis. The plan and its implementation are faced with ferocious opposition from political and social components alike, and solutions such as waste exporting are now seriously being considered.

Since the start of the crisis on the 17th of July, 2015 and up until mid-December, the waste generation total is estimated to have exceeded 500,000 tons – taking into consideration the effect of rain – in BML alone. Three options could be considered to tackle the problem appropriately.

i) Adopting Chehayeb's Plan

Despite the tepid reception of the Technical Committee's interim plan, the availability of additional land in the Naameh Landfill could prove to be a viable crisis mitigation measure. Regardless of protest, civil unrest and quasi-unanimous rejection to re-open the Naameh Landfill, the Task Team perceives that a limited, fully supervised and specifically assigned mandate could be an integral factor in the formulation of a solution for the 2015 Waste Crisis. Adopting Chehayeb's plan could be considered the first milestone, among many additional steps, for appropriate crisis mitigation measures.

ii) Central Authorities Assume Responsibility of IWM

The current crisis has put LAs and municipalities face-to-face with their legally acknowledged responsibilities of WM. The population is starting to sort at home, but penetration rates remain low given the lack of enforcement mechanisms. The quantities of waste lying in the streets, openly dumped, are strongly assumed to be unsorted. Central authorities can contract a WM service provider to operate the existing sorting and treatment facilities in Quarantina and Amrousieh to sort (primary and secondary), treat and bail the openly dumped and newly generated waste.

The costs, as per Sukleen's contracts, are estimated to average around 63 USD/ton for these steps, whereas other private sector entities – who have their own facilities – are charging an average of 59 USD/ton. This process might have high operation costs since capacities are limited, with operations running on multiple shifts.

In addition, central authorities – in collaboration with UoMs – would establish sorting facilities in central geographic zones around BML for a start (in tandem with the capacity building phase discussed below). These facilities need to be contracted to private sector entities to ensure competitiveness and efficiency. The costs of infrastructure might be high, but the resolve of the international community to support Lebanon in IWM could be called-upon in this situation. The revenues of the resulting sorted material, once sold, should be directly deposited into the IMuF.

iii) Exporting the Waste

This is a more expensive alternative if OECD countries are to be considered as the final destination; on the other hand if neighboring export partners are taken into consideration, the exporting costs could render the whole IWM process "less expensive" than if treated locally.

> The principal purpose of the strict control system operated under Basel Convention is to ensure that the transboundary movements of Hazardous and other waste is reduced to the minimum consistent with the environmentally sound and efficient management of such waste, for the purpose of protecting human health and the environment against the adverse effects which may result from this movement. In addition, the Convention prevents the import of hazardous and other waste if it has reason to believe that the waste will not be managed in an environmentally sound matter. Under the same reasons, the Convention states that the hazardous and other waste subject to the movements should be packaged, labeled and transported in conformity with international rules and standards.
>
> *The Basel Convention - 1992*

Yet, regardless of the costs, the Basel convention for waste export needs to be considered as a framework, potentially leading to higher than previously envisioned costs on the Lebanese taxpayer. Moreover, under the technical guidelines of the convention, if Lebanon is unable to meet the standards for environmental soundness of the waste to be exported, then it "has the duty to ensure the re-importation of the wastes for

disposal", leading back to square one. A detailed summary of the Basel Convention and the European Commission for Waste Movement Regulation can be found in Annex F.

Furthermore, the cost of exporting is high (with some sources quoting unit costs in excess of 250 USD/ton) yet it remains negligible if we consider the repercussions on the economy, public health, longevity and environment of the population; for an example of these repercussions one need look no further than the Campania Crisis.

WHICH OPTION TO ADOPT?

As the 2015 Waste Crisis is culminating into a crescendo with the first rains falling on open dumps, thus increasing the weight of the already hefty piles of waste and escalating the environmental effects, it is imperative that the crisis be resolved the soonest.

Though empowering LAs to assume their rightful responsibilities of WM is ideal, it is not feasible in the short run due to deficiencies in infrastructure and capacities for sorting and treatment. On the other hand, as noted in the Basel Convention, the export of waste is not compliant since it needs to be appropriately sorted and packaged beforehand. Meanwhile, the Technical Committee's plan lacks procedural clarity and a general framework.

One solution may be to amalgamate all three options: collect, sort and treat part of the waste over the next six months using existing WM facilities, while carrying out the necessary procedures to export a larger proportion of the openly dumped waste. In parallel, LAs can develop the appropriate WM systems and facilities in order to manage the remainder internally, thus reaping the benefits of the sorted waste and respective revenues.

Based on current negotiations between GoL and different export partners, it is apparent that any contract the GoL may enter for the exportation of waste would need to be set for a minimum period of 12 months, with a pre-defined amount of waste to be exported throughout the contract period.

Furthermore, with the additive effects of rain, the status on the ground and the export companies' condition of not handling waste that is older than 2 months, the Task Team estimates that only about 200,000 tons of the openly dumped waste could be considered for export.

Building on the above, the Task Team's estimates for the costs of internally treating the waste and exporting over the coming period (taking into consideration the opportunity loss of foregone revenues from recovered waste), is USD 291.46 million in year one and an additional USD 210.54 million in the following year. For a transitional period of two years, the average treatment cost per ton would top 222.95 USD/ton. Additional details can be found in Annex G.

From a financial perspective, exporting waste may not be the best option, yet, in spite of the "inflated" costs, a solution has to be put in place as quickly as possible to limit the damages and repercussions of the crisis, and to avoid jeopardizing the populations' health and livelihood.

B. Capacity Building Mode

During which the capacities of all WM stakeholders should be built according to the adopted policies. This mode should ultimately start with the adoption of a national policy and the formulation of a Strategic IWM National Plan.

Municipalities that have already taken the initiative to implement an IWM practice in response to the 2015 Waste Crisis could benefit from funds mobilization to support their ongoing work, whereas other municipalities who have yet to implement an IWM process should undergo further capacity building steps before their allocated funds are mobilized.

1.2 At T_0

At T_0 several scenarios need to be taken into consideration and one needs to be adopted as a National Policy, the vision of the Lebanese Republic for IWM. In the section below, we explore the most probable scenarios**.**

The following table depicts the most likely WM scenarios (in descending order of likelihood) based on current and potential capabilities/capacities of municipalities and the private sector. The Task Team is very aware that the decision making process regarding IWM should be brought as close as possible to the people it directly affects, since a LA that lives among its community can be held to much better accountability than central authorities, where other factors enter into consideration in the decision making process. In the following table, based on the process previously elaborated in Section E, we explore the most probable permutations:

Stage A (awareness and distribution) should be kept at the helm of the LAs as they are the closest administration to the people. Stage B is mostly associated with the LAs as well, as it involves sweeping and collection. The private sector would only be interested to assume responsibility at this stage (whether through contracting or PPPs) if they will also be involved until the last phases of Stage D – which leads to a scenario similar to the recent Sukleen situation.

Secondary sorting, bailing and wrapping can only be assumed by either a large municipality or a UoM to be economically relevant (valid for scenario 1 &3). The private sector could enter into play at this stage and will ultimately lead to a scenario similar to the current market dynamics (i.e. Cedars Environmental).

At the end of this stage, waste is properly sorted, treated and stocked by category and will ultimately turn into "green industrial raw material".

[4] Taking into consideration that 66% of the waste will be exported in year 1 and 54% in year 2

Big municipalities and UoMs can undertake enterprises at this stage, yet the private sector – if properly incentivized – should be seeing this stage lucrative enough to endeavor. *(Refer to Annex E for more details on the results of the above scenarios and permutations.)*

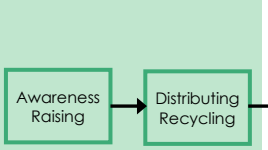
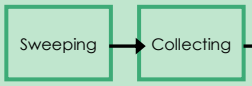
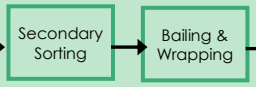
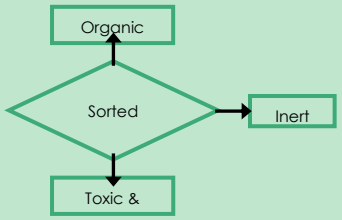
Probable Scenarios	Stage A	Stage B	Stage C	Stage D
				
Scenario 1	Municipality/UoMs	Municipality/UoMs	Municipality/UoMs	Private Sector/PPP
Scenario 2	Municipality/UoMs	Municipality/UoMs	Private Sector/PPP	Private Sector/PPP
Scenario 3	Municipality/UoMs	Municipality/UoMs	Municipality/UoMs	Municipality/UoMs
Scenario 4	Municipality/UoMs	Private Sector/PPP	Private Sector/PPP	Private Sector/PPP

Table 8: Probable Scenarios - Sort by most to least likely - of IWM

POLICY RECOMMENDATIONS

Based on the aforementioned analysis, the Task Team is adamant that the GoL should adopt a policy under the title of "Wasteless Lebanon 2022". This policy statement should represent the platform to draw, adopt and implement a National Strategic IWM Plan, for which the recommendations discussed below could be taken into consideration. These recommendations fall under the following axes:

- Administration & Community: Who should be doing what
- Governance: Decrees & Laws
- At Source: Where it starts
- Process: After pick up
- IWM Techniques

I. ADMINISTRATION & COMMUNITY: WHO SHOULD BE DOING WHAT

1. The Segregation of Powers in IWM

The segregation of tasks and responsibilities is proposed, inspired by the Lebanese constitution's aim for decentralization, as follows:

Party	Mandate
Ministries & Cabinet	Policy setting and National Strategic Plan formulation
Governors & Cazas' Dir.	Overseeing Implementation, Monitoring and Evaluation
Municipalities & UoMs	Execution of National Strategic IWM Plan
Civil Society	Implementation partner and Watch-dog

2. The National Committee on Integrated Waste Management (NCIWM)

The Task Team encourages establishing the National Committee on Integrated Waste Management, constituted of the following stakeholders:

Party	Constituents
Public Sector	Ministries, Governors, Cazas' directors, UoMs, Municipalities, National
Civil Society	Council for Scientific Research (CNRS), CDR;
Private Sector	WM experts (firms or individuals).

The NCIWM's mandate would include but is not limited to the following:

- Establishing and managing the National Observatory for Waste Management (NOWM): a data center that collects analyses and publishes WM and other environmental related studies;
- Regulating, observing and reporting on IWM;
- Recommending solutions (draft laws, plans to be endorsed by GoL among others);
- Meeting on a quarterly basis.

3. Putting the Right person in the Right Place

Technically, staffing the proposed IWM executive structure is very challenging given the lack of qualified experts and WM professionals, the need for capacity building and the sustainability of any of these endeavors. The Task Team proposes commissioning civil servants in Ministries, Governorates, Cazas and UoMs:

- The Council of Civil Service will undertake recruitment with the support of experts commissioned by the international community to develop TORs and manage competitive examinations, within a maximum period of 4 months;
- The process should be expedited through the appointment of a UN-led committee to avoid the impasses of the Council of Civil Service;
- Provide competitive salary packages and benefits to encourage Lebanese nationals to apply;
- Recruited staff are set to undergo an intensive capacity building program on IWM led by international experts.

4. The IWM Police: Governors and Caza Directors' Technical Bureaus

Establishing a technical bureau as an "IWM regulator" in each caza to Monitor and Evaluate (MandE) and report to the Governor's office, this in turn is overseen by the Ministries' technical arms. Their role would be to reward or penalize municipalities and waste wrong-doers, with penalties set to feed the IMuF (using the experience of the Municipality of Roumieh as well as that of the MoPH). Rewards could be in the form of incentives for citizens to report anomalies, while all the IWM hierarchy could be penalized for the pertaining anomalies.

5. UoMs: Key IWM Implementers

- Technical offices in UoMs should be set up to enhance the municipal executive capacity (UN-Habitat Regional Technical Offices (RTOs) being exemplary);
- Municipalities should be encouraged to join UoMs/ form UoMs[5] for sustainable development initiatives.

6. Civil Society as a Major Stakeholder in IWM

- CSOs are emboldened to keep a close eye on the execution and monitoring processes;
- CSOs are integral members of and report directly to the NCIWM.

7. Sustainability of Capacity Building Initiatives

- Establish the National Institute for IWM Technical Training (similar to the Bassel Flaihan Financial Studies Center) under the supervision of international experts;
- Encourage the Lebanese University to develop a curriculum on IWM in the form of a Bachelor's Degree, while higher studies could be in in Waste Recovery or in Waste to Energy techniques.

II. GOVERNANCE: DECREES & LAWS

1. Liberate the IWM Market

The Central Bank of Lebanon (CBL) should incentivize private sector entities to establish, construct and operate WM facilities through commercial bank WM loans. WM loans should be similar to housing loans and not guaranteed by the CBL, in order to avoid increasing the national debt (Kafalat loan type).

2. Protect the Lebanese Green Industry

Regulations on customs should be put in place to protect recovery industries and incentivize private sector entities to focus on locally manufactured recyclable and compostable materials. On an annual basis, around 30 Million USD worth of composts is imported from a prominent export partner – yet this compost is extremely low grade as it contains oil refinery byproducts and sludge.

3. Establish the Municipal Development Fund (MDF)

- This fund, previously proposed by ministers and most of the Municipal Development Experts, could be used to support IWM projects in UoMs and Municipalities nationwide;
- Strategic Municipal Financial Planning (SMFP) has to take into account inhabitants of each municipality rather than registered voters. A person occupying two estates in two different regions has to pay Municipal taxes twice.

4. Enable a Holistic Legal Framework for IWM

Pass the following draft laws:

- Public Private Partnership Law;
- The IWM management law sent to parliament under decree 8003/2012;
- The Municipal Incentive Law for hosting waste management facilities (drafted in 2013).

5. Revitalize the IWM-related Municipal Decrees

Municipalities need to be empowered to undertake their responsibilities; as stipulated under decree 8735/1974. Empowerment means providing the capacity, the capability and the decision authority. However, prior steps need to be taken into consideration:

- Each municipality's ability should be assessed according to the 7 Pillars of Municipal Good Governance, with a proposition of the way forward to enable municipalities and UoMs;
- Each municipality's ability to manage waste should be assessed and a capacity/capability plan should be put in place;
- Municipalities' and UoMs' Creditworthiness should be assessed prior to allowing access to capital markets.

6. IWM Municipal Funding

Municipalities need to have their legal financial allotments to be able to respond to their communities' WM needs. Municipal funding from mobile revenues is being held up for long periods of time, though this could have a positive outlook.

- Short-term measures: revenues for the period extending to the end of 2013 are to be distributed;
- Mid-to-long term measures: the MDF needs to be established to facilitate IWM initiatives;
- Municipalities and UoMs need to be given access to capital markets after creditworthiness exercises, with the MDF used as leverage to secure financing for such initiatives.

7. Additional Measures to be Put in Place

- Upgrade building codes to include IWM specifications

[5] 760 municipalities, out of the 1108 municipalities in Lebanon, form 53 UoMs

(bio-shredder next to the sink, pre-waste water treatment machine etc…);
- Implement the National Waste Water Treatment plant and ensure regional stations to be topologically and ecologically feasible with the goal of establishing composting and organic waste treatment facilities in their proximity.
- For towns, boroughs and areas that do not have municipalities, undertake the necessary measures to rally them together with other neighboring towns/ boroughs to form municipalities that cover all areas.
- The same should also be considerated for municipalities with small council sizes leading to better efficiency and efficacy.

III. AT SOURCE: WHERE IT STARTS

1. Sorting at Source

Based on the above case studies, feedback from experts in the field as well as international best practices, sorting at source is verifiably the cornerstone of IWM. Waste is to be sorted and collected from sources as indicated in the table below.

Period	Waste Category	Frequency of Collection
Short Term	Organic	4 times/week
	Non-Organic	2 times/week
	Other	1 time/week
Medium to Long Term	Organic	3 times/week
	Paper	1 time/week
	Plastics	1 time/week
	Metals	1 time/week
	Others	1 time/week

- Bins should be provided by municipalities upon request and mapped using GIS for operation and monitoring purposes;
- Old street bins to be removed and replaced with narrow opening sorting bins;
- Inhabitants are encouraged to dispose of non-organic waste in distributed bins without bags and after cleaning/rinsing;
- Municipal supervisors monitor collected garbage & report (more than one fouled bag/week to be subjected to penalties);
- Diapers: Municipalities to distribute diaper bins to be collected daily versus a deposit to be returned after returning the bins.

2. Awareness Raising

Holistic national campaigns to promote sorting at source and to encourage waste reduction:
- Billboards, media (classic and social media platforms), workshops, seminars, pamphlets and field visits among other possible activities;
- Enforce anti-littering through the provision of small bins by municipalities and putting a reward/penalty scheme in place;
- Provide cigarette clops ballots (i.e. units to vote for municipal initiatives);
- People should be provided with templates and kits to report any anomaly and earn rewards.

IV. PROCESS: AFTER PICK UP

1. Collected garbage should never be compressed after pick up

2. The Role of Municipalities and Unions

Municipality: gathers garbage and sends it to agreed sorting and/or treatment facility specified by UoM/ municipality itself.

Municipality &/or UoM: 1) Secondary sorting facility to be operated by UoMs and/or municipalities' staff; 2) sorting and/or treatment facility could be an estate that the UoM/Municipality could leverage to increase its Return On Assets and create new revenue streams; 3)at the end of this stage (Stage C), "products" of sorted waste belong to UoMs/municipalities; 4) from this point onwards two different options present themselves as UoMs/municipalities could process "products" whether through proper enterprises, outsourcing, PPP or sell products to private Waste Management Firms.

V. IWM TECHNIQUES

- Forbid and penalize open dumping.
- Discourage and penalize incineration
- Compressing should be discouraged (and reported) at all phases of the process; except for paper and cardboard products which could be compressed at the collection point.
- No landfilling (the way it has been done in the past).
- Recycling inert material: Plastics (16%), metals (6%), glass (4%), textiles (3%), wood (1%) and diapers (3%): 1) for green glass and other silica based material that cannot be recycled, the Blue project can adopt a shredding technique for the purpose of beach sand

recovery; 2) other products that can't be recycled should enter into the production of alternative products such as Ecoboards, furniture and up-cycled items.

- Shipping and exporting: Hazardous waste (0.4%), medical waste (0.2%) and others (0.3%). This can be done by UoMs/ municipalities or by private sector entities that collect, treat and sell.
- Construction waste to be recycled and used to refurbish deteriorated sites.
- Electronic wastes: Should be disassembled for recycling: Plastic, Metals, Glass and others (Gold).
- Organic waste: To adopt a 4:5:1 ratio (Distribute: Sell: WtE); 40% to be used for soil rejuvenation and distributed by the Green Project, especially with the wide spread use of NPK products throughout the past two decades. Composts need to be used for a long period to offset the detrimental effects of soil nitrogenation; 50% to be composted by IWM firms and traded on the market;10% to be landfilled with the aim to establish WtE facilities in rural areas, thus providing both power and employment opportunities.

IWM ALTERNATIVE TECHNIQUES

In spite of the sizeable initial investment, the Plasma Arc Gasification technique needs to be considered as an IWM solution for the mid to long term periods. Additional details can be found in Annex H.

VI. CRISIS MODE

- Declare a National State of Emergency and mobilize all stakeholders;
- Operators are paid by municipalities for Stage B processes (i.e: collection and transportation);
- Export process to be funded from municipalities budget;
- Operators to undertake secondary sorting and selling of recyclable & recoverable waste;
- Hazardous and medical waste should be exported;
- The ratio of locally treated waste to exported waste should be at 1:2 with proportions reversed over the course of the following 24 months and ideally reaching 4:1 (locally treated : exported).

[6] Unless municipalities pay for the export of waste directly, exporting tends to be a foregone adopted solution; the Task Team fears that it will not be revisited later on and will be adopted as a "feasible and functional" WM solution. Municipalities need to incur this cost themselves in order to be incentivized to find strategically less expensive local treatment solutions.

ANNEX A
WASTE MANAGEMENT TIMELINE

1. THE SUKLEEN TIME BOMB

In 1994, CDR contracted Sukleen Company[7] to sweep the streets and collect garbage in Beirut, along with a few surrounding areas, with GoL covering the cost of equipment and bins. The contract was amended in 1997, expanding the collection area to cover Beirut and Mount Lebanon (BML) excluding Caza Jbeil. This contract, signed based on a "negotiable agreement", set a low initial cost that amounted to 3.6 million USD p.a., and rose to reach 102 million USD; these funds were transferred from the CDR budget to the IMuF from 1/1/1996 till 31/12/2000.

Under Decree No. 3038/2000, the GoL was allowed to allocate the necessary funds to the benefit of designated municipalities, in order to contract waste collection and management companies; accordingly these private entities' services did not cover all the Lebanese territories. Furthermore, as per budget law No. 326/2001, the GoL deducted 40% of the allocated IMuF funds for each municipality benefitting from private WM services.

In November 2007, the cabinet extended Sukleen's contract for an additional 3 years (until January 17, 2011); a decision favored by the CDR since administrating a fair and legal bidding process would have been impossible due to time constraints.

In 2009, the cost of Sukleen's BML contract reached 43.5 Million USD covering collection and sweeping. This contract was broken down as follows:

- 17.5 million USD for collection – 26.65 USD/ton for a quantity of 653,501 tons/year;
- 15.8 million USD for sweeping the streets in the GBSA (70sqkm);
- 34.55 USD for each collected ton in Mount Lebanon;
- 17.59 USD for each heavy weighted ton in Sukleen service areas;
- 601,000 USD with LACECO, the consultant supervising collection and sweeping works.

As for the rehabilitation and maintenance of sorting and recycling facilities:

- 33 million USD for upgrading and rehabilitating all available facilities – exceeded 42.3 million USD due to the waste influx from June 1st, 2009 until May 31st,2010;
- 1.9 million USD for the consultant LACECO;
- 39.3 million USD for the sanitary landfill in Naameh from 19/1/2009 till 18/1/2010.

For similar reasons, Sukleen benefited from another 4 year extension in April 2010; which was further extended on the 17th of January 2015 – the expected termination date – for another 6 months to allow the CDR to start a fair and legal bidding process. However, the process failed with no other contractor applying to BML, due to very complicated specifications, and on the 17th of July 2015, Sukleen's contract was terminated with no other assigned service provider.

[7] Contract no. 1348

2. TIMELINE

PHASE 1

1990s

- Early 1990's: GoL contracted private companies to collect garbage for double the cost proposed by municipalities
- 1994: CDR contracted Sukleen through contract no. 1348[7]. Before that no service providers were assigned. CDR constructed all solid waste management facilities (Quarantina, Amrousieh, Bsalim...) with funding from the World Bank.
- 1997: Sukleen's contract was amended, expanding the collection area to cover BML, excluding Jbeil Caza. Under the "temporary" emergnecy plan - Decree No. 10 by MoE - Sukleen was contracted to expand the existing facilities.

2000 - 2009

- 2000: Decree No. 3038/2000 was issued by GoL which allowed it to allocate the necessary funds to the benefit of selected municipalities, in order to contract waste collection and management companies
- 2001: Based on budget law No. 326/2001, the government deducted 40% of the allocated IMuF funds for each municipality benefitting from private WM services
- November 2007: GoL extended the contract with Sukleen for an additional 3 years (Until January 17,2011)

2010 - 2015

- April 2010: Sukleen's contract was granted another 4 year extension, along with another 6 months extension in 2015
- January 17th 2015: Sukleen's contract was extended an additional 6 months
- July 17th 2015: Sukleen's contract was terminated with no other assigned contractors

PHASE 2

2015 (July 17 till Sep. 9)

- Firt phase of the bidding process failed as no service providers applied to BML
- Crisis was met with civil unrest and protests, sometimes resulting in clashes with security forces
- Collection of the bidding process by GoL itself
- GoL established a committee chaired by the Minister of Environment, which was protested by the civil society
- The minister of Environment resigned from the committee and let his place to Mr. Akram Chehayeb, the Minister of Agriculture
- Sep. 9th 2015: Chehayeb's committee provided technical solution to GoL which faced civil rejection, again leading to protests
- Meanwhile piles of rubbish accumulated in open dumps with several areas resorting to burning waste

PHASE 3

Post Sep. 9

- Some municipalities adopted solutions to the crisis (Roumieh) while others are burning or dumping trash under bridges/ valleys/ private lands
- More free rider actions were taken, with NGOs and stakeholders, began raising awareness

[1] The value of the BML contract increased exponentially from 3.6 Million USD/year in 1994 to 150 Million USD/year before the 17th of July

ANNEX B
BACKYARD BURNING BYPRODUCTS

Backyard Burning is one of the worst WM solutions to resort to. Its effects, very similar to toxic waste contamination and other dangerous materials, will negatively impact the health and quality of living of inhabitants and tourists alike.

Chemical Component	Transmittal Route	Effects
Dioxins	Plants and animal fat	• Highly Toxic and long lasting • Alter the growth of cells • Cancer • Disruption of immune & hormonal systems
Particle Pollution	Air	• Aggravates respiratory conditions • Associated with cardiac arrhythmia & heart attacks • People with lung/ heart diseases, elderly & children at highest risk
Polycyclic Aromatic Hydrocarbons (PAHs)	Smoke & soot	• Carcinogenic
Volatile Organic Compounds (VOCs)	Air	• Ground-level ozone pollution (smog) • Worsens respiratory conditions • Inhalation can lead to eye, nose & throat irritation, headaches, loss of coordination, nausea and damage to the liver, kidney and central nervous system
Carbon Monoxide (CO)	Air	• Neurological symptoms including headaches, fatigue, nausea and vomiting
Hexachloro-benzene (HCB)	Degrades in air and bio-accumulates in marine animals, birds & lichens	• Long term low level exposures may damage a developing fetus, cause cancer and/or lead to kidney and liver damage • Causes fatigue and skin irritation
Ash	Food & vegetables when buried	• Contains toxic metals (mercury, lead, chromium & arsenic) • Leads to high blood pressure, cardiovascular problems, kidney damage and brain damage

ANNEX C
THE ROLE OF CSO - GAC & IKC CASES

Baysour's mayor and president of the GAC UoM, Mr. Walid Abou Harb endorsed the decision to sort waste from the source, and sell the resulting "stocks" in cooperation with all CSOs working within the region. The sorting initiative, elaborated under the case study of Sayyidat Baysour, is being spread throughout the union, by distributing colored garbage bags (different colors for each type), taking full advantage of the awareness that was raised as a result of the crisis.

Abou Harb also emphasized on the importance of solving the waste crisis in a rational and organized manner, for the good of all (by closing all unsanitary-disease spreading open dumping zones).

A meeting was held on July 21st 2015, in the presence of Mr.Walid Harb and representatives of various ecological associations. The meeting discussed a realistic plan which was divided into two stages: The first stage included awareness campaigns, and the second technical operations. Lack of funding was pinpointed as the main weakness of these efforts.

The example of Ikleem el Kharroub El Chamali (IKC) UoM reveals how this crisis has affected local politics on a community level, leading to an increase in tension and overall exasperation.

Given the collective social shift of awareness that sprung from the 2015 Waste Crisis, and upon transferring waste to the Sibline factory for incineration in accordance with international standards for RDF synthesis incinerations, residents of IKC decided to engage in a three day long protest, by blocking the highway leading to Sibline's cement factory. Protestors accused the UoM of endorsing the decision, so they surrounded the UoM building in Mazboud and detained all personnel inside the building for hours. The movement led to the cancellation of this decision, although this is one of the very few facilities in the country that abides by environmental and industrial regulations.

However, local volunteer groups emerged, trying to find primary solutions to the crisis by spreading awareness on sorting from source. The Regional Technical Office (RTO), established by UN-Habitat in 2013, was among the first initiators of the movement. Awareness campaigns were launched with volunteers visiting every house, distributing brochures and explaining sorting techniques: A leading example was implemented in Mazboud during the first 4 weeks of the crisis.

ANNEX D
MAPPING OF CSO IN LEBANON

Mapping of CSOs in Lebanon specializing in the Environmental Sector

Governorate	Caza	Number of National CSOs*	Distribution
North	Akkar	3	33%
	Tripoli	4	44%
	Koura	1	11%
	Bchirreh	1	11%
Total North		**9**	**18%**
Beqaa	Hemel	1	25%
	Baalbeck	1	25%
	Zahleh	2	50%
	Hasbaya	1	100%
Total Nabatieh		**1**	**2%**
South	Saida	1	25%
	Sour	3	75%
Total South		**4**	**8%**
Mount Lebanon	Jbeil	1	7%
	Kesrouan	3	21%
	Metn	4	29%
	Baabda	4	29%
	Aley	1	7%
	Chouf	1	7%
Total Mount Lebanon		**14**	**28%**
Beirut	Beirut	18	100%
Total Beirut		**18**	**36%**
Total Lebanon		**50**	**100%**

** These national CSOs are specialized in the Environmental sector*

Sample list of CSOs in Lebanon specializing in the Environmental Sector

Organization:	Major Contributions:	Region	Source
Indy Act	Established in July 2006, this organization works on both waste and environmental issues. Some campaigns include: - *Zero Waste Campaign* - *Out to sea? The Plastic Garbage Project* - *Arab Climate Campaign* - *Save our Seas*	Beirut	*www.indyact.org*
Zero Waste Coalition	A national coalition between Indy Act and other NGOs and municipalities in Lebanon, aiming at urging the government to develop an environmentally suitable national policy for the management of solid waste in Lebanon	Beirut	*www.beirut.com/l/17101*
The Lebanese Development Network (LDN)	A national non-profit organization dedicated to helping individuals, groups and organizations develop their capacities by raising awareness and enhancing technical skills so they can improve their potential, advance their progress, and ensure their growth	Beirut	*www.ldn-lb.org*
Arcenciel (aec)	A non-profit, apolitical and non-confessional association that was established during the civil war, in 1984/1985. Among several programs, it is committed to the environmental program with its pilot project "tumbling caps"	Beirut	*www.arcenciel-en.org*
Green Line	Founded in 1991, it is a proactive, non-aligned, secular NGO. It promotes environmental awareness and documents environmental threats in order to better confront them	Beirut	*greenline.me.uk*
Society for The Protection of Nature in Lebanon (SPNL)	A national civil society organization founded in 1986, it is concerned with advocacy and awareness on environmental issues	Beirut	*daleel-madani.org*
Green Hand	An environmental, social and cultural NGO founded in 2001. It was highly active on different levels, mainly: Forestation, advocacy campaigns, cleaning campaigns, ecotourism activities, artistic recycling workshops and lectures	Mount Lebanon –Aley	*www.greenhand.org.lb*
Cenacle Libanais pour la Protection de l'Environnement (CELPE)	A national organization without any external affiliation, it is concerned with all kinds of activities aiming at strengthening pollution control and environmental protection in Lebanon	Jounieh	*undp.org.lb/ngo*
Association for Forests Development & Conservation (AFDC)	Established in 1993 to achieve sustainable conservation of natural resources, raise awareness and build capacities, so as to contribute to the national efforts for better environmental management	Beirut	*www.afdc.org.lb*
Green Orient (GO)	An environmental & development NGO that aims to protect natural heritage, through partnerships, towards a cleaner environment; was founded in 2007	Mount Lebanon	*daleel-madani.org*
Lebanese Environmental Forum (LEF)	Established in 1992, it now comprises 46 local environmental NGOs. A non-profit organization aiming to protect the environment and to encourage the establishment of new environmental organizations in Lebanon	Beirut	*www.lbeforum.org*
G Association	Operating since 2009, it is a Green living NGO committed to providing solutions for businesses and organizations to promote a healthier environment, a cleaner earth and a more sustainable future	Beirut	*www.g11.me*
Operation Big Blue Association (OBBA)	An educational campaign launched since 1997 to clean up waste on the coastline and underwater	Beirut	*operationbigblue.org*

ANNEX E
SCENARIO ANALYSIS ON IWM

Implementing an IWM plan on a national level can lead to a reduction of total WM costs over the medium and long term horizons.

In the short term, operational costs may increase to a tune of 20% on average in order to carry out awareness campaigns for the reduction of waste and to distribute the necessary bins, pamphlets and kits for sorting at source. Furthermore, the development of new facilities for sorting, composting etc. will most certainly levy additional costs in the short term.

Over the medium and long term however, annual operational costs (on a national level) can reduce by 15% and 40% on average, respectively, which amounts to a total annual decrease of around 70 million USD p.a. in the medium term, reaching 200 million USD p.a. in the long term.

Global Picture – Potential Operational Costs & Potential Revenue or Municipal Budgetary Offsets

Proportion of Costs from Municipal Budgets	Short Term	Medium Term	Long Term
Minimum	25%	16%	11%
Average	*40%*	*30%*	*20%*
Maximum	60%	42%	30%

Scenario 1 – Municipalities/UoMs (A, B, C); Private Sector/PPP (D)

Proportion of Costs from Municipal Budgets	Short Term	Medium Term	Long Term
Minimum	25%	16%	11%
Average	*40%*	*30%*	*20%*
Maximum	60%	42%	30%
Potential Cost Recovery from Stage D	**Short Term**	**Medium & Long Term**	
Minimum	50%	85%	
Average	65%	100%	
Maximum	100%	200%	

Scenario 2 – Municipalities/UoMs (Stages: A, B); Private Sector/PPP (Stages: C, D)

Proportion of Costs from Municipal Budgets	Short Term	Medium Term	Long Term
Minimum	7%	4%	3%
Average	*14%*	*10%*	*6%*
Maximum	21%	15%	10%
Potential Cost Recovery for Private Sector	**Short Term**	**Medium & Long Term**	
Minimum	40%	60%	
Average	55%	80%	
Maximum	100%	140%	

Scenario 3 – Municipalities/UoMs (Stages: A, B, C, D);

Proportion of Costs from Municipal Budgets	Short Term	Medium Term	Long Term
Minimum	11%	8%	6%
Average	*21%*	*16%*	*11%*
Maximum	30%	23%	16%
Potential Cost Recovery for Municipality/UoM	**Short Term**	**Medium & Long Term**	
Minimum	75%	200%	
Average	100%	250%	
Maximum	150%	400%	

Scenario 4 – Municipalities/UoMs (Stages: A); Private Sector/PPP (Stages: B,C,D)

Proportion of Costs from Municipal Budgets	Short Term	Medium Term	Long Term
Minimum	3%	2%	1%
Average	*9%*	*6%*	*3%*
Maximum	14%	9%	5%
Potential Cost Recovery for Private Sector	**Short Term**	**Medium & Long Term**	
Minimum	20%	50%	
Average	25%	70%	
Maximum	45%	100%	

ANNEX F
THE BASEL CONVENTION & EUROPEAN COMMISSION FOR WASTE MOVEMENT REGULATION

Since 1992, the Basel Convention aims to protect human health and the environment against adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and "other" waste (includes the wastes collected from households and the residues arising from the incineration of household wastes).

The Basel Convention is first and foremost a global environmental treaty that strictly regulates the transboundary movements of hazardous wastes and obligates concerned parties to ensure their environmentally sound management (ESM) and disposal. It is worth noting that the technical guidelines are principally meant to provide guidance to countries who are building their capacity to manage waste.

The principal purpose of the strict control system operated under the Basel Convention is to ensure that transboundary movements of hazardous and "other" waste is reduced to a minimum, consistent with the environmentally sound and efficient management of such waste, for the purpose of protecting human health and the environment against any adverse effects which may result from this movement. In addition, the Convention prevents the import of hazardous and "other" waste if it has reason to believe that the waste will not be managed in an environmentally sound matter. For the same reasons, the Convention states that hazardous and "other" waste subject to movements should be packaged, labeled and transported in conformity with international rules and standards (United Nations Economic Commission for Europe (UNECE) (2007).

The Basel Convention has proven to be effective, strict and therefore reliable in times of waste crises and for the management of waste movement around the world. In fact when a transboundary movement of hazardous and "other" waste is carried out, and if in accordance with the convention it cannot be completed in an environmentally sound manner, the state of export has the duty to ensure the re-importation of the waste for disposal if alternative arrangements cannot be made for their disposal in an ESM manner.

Due to the belief that there was a high risk of hazardous waste being disposed of in non-OECD countries, in a manner that would not be environmentally sound, an amendment to the Convention was made which imposed a total ban on all exports of hazardous wastes destined for final disposal in non-OECD countries. For the protection of the environment, the European Union Law implemented restrictions on the import of hazardous and "other" waste for final disposal under the "EC Waste Movement Regulation". The EU states that in case of imports into the community, the competent authority of destination in the community shall:

- Take the necessary steps to ensure that any waste shipped into its area of jurisdiction is managed without endangering human health and without using processes or methods which could harm the environment, in accordance with Article 4 of Directive 2006/12/EC and other community legislation on waste throughout the period of shipment, including recovery or disposal in the country of destination;
- Prohibit an import of waste from third countries if it has reason to believe that the waste will not be managed in accordance with the requirements under point (a).

Article 4

1. Member States shall take the necessary measures to ensure that waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment, and in particular:
- Without risk to water, air or soil, or to plants or animals;
- Without causing a nuisance through noise or odors;
- Without adversely affecting the countryside or places of special interest.

2. Member States shall take the necessary measures to prohibit the abandonment, dumping or uncontrolled .

ANNEX G
COST OF CRISIS MANAGEMENT

The following table presents the estimated costs of exporting BML's waste during the Crisis Management phase.

Under the first and best case scenario, the estimates are based on the GoL entering two 12-month contracts whereby under the first year, 66% of the total waste accumulated during the crisis, as well as the new waste generated in BML, is exported at an average cost of 235 USD/ton. The remaining 34% is then treated internally at an average cost of 120 USD/ton based on current capacities. The exporting process will result in an opportunity loss of approximately USD 80 million; nominally generated from internal treatment and sale of recoverable and recyclable materials. Furthermore, the internal treatment of 34% of BML waste in the first year can generate revenues of approximately USD 26.5 million from the sale of recyclable materials. The total cumulative cost over 2 years of exporting is estimated to be around USD 502 million, or an average of 222.95 USD/ton of waste exported and treated. This is what the Task Team considers as the likely – realistic – scenario that will take place, if the required funds are to be deducted from the funds allocated to LAs.

	Year 1	**Year2**
	Internally Treat 34%	**Internally Treat 47%**
	Export 66%	**Export 53%**
Open dumped waste in the past 2 months Total new waste generated over 12 months	171,000 tons 1,040,250 tons	 1,040,250 tons
Annual waste export requirement Annual waste to be treated internally	803,000 tons 408,250 tons	547,500 tons 492,750 tons
TOTAL WASTE TO BE CONSIDERED	***1,211,250 tons***	***1,040,250 tons***
Cost of exporting waste (avg of 235 USD/Ton) Cost of internally treating waste (avg of 120 USD/Ton)	188,705,000 $ 48,990,000 $	128,662,500 $ 59,130,000 $
TOTAL COST	***237,695,000 $***	***187,792,500 $***
Opportunity loss due to export Cost recovered from internal treatment	80,300,000 $ 26,536,250 $	54,750,000 $ 32,028,750 $
TOTAL NOMINAL COST ***(incl opportunity loss and cost recovery)***	***291,458,750 $***	***210,513,750 $***
TOTAL CUMULATIVE COST OVER 2 YEARS (USD)		***501,972,500 $***
AVERAGE COST PER TON OVER 2 YEARS (USD)		***222.95 $***

Under the second scenario, the estimates are based on the GoL entering three 12-month contracts whereby under the first year, 66% of the total waste accumulated during the crisis, as well as the new waste generated in BML, is exported at an average cost of 235 USD/ton. Under the second and third years, 53% the new waste generated in BML will be contracted under an average cost of 235 USD/ton, though it should be noted that the actual cost of exporting in years 2 and 3 would likely be higher, as the cost increases inversely with the total amount of waste being exported. (the Task Team perceives that the minimum amount to be considered in year one is equivalent to 2200 Tons/day, while in the following years, the daily rate to be considered could fall to 1500 tons/day).

The remaining 34% in year 1 and 47% in years 2 and 3 is then treated internally at an average cost of 120 USD/ton based on current capacities. It should be noted that this cost is expected to decrease with the increase in capacity

and capabilities. The exporting process will result in an opportunity cost of approximately USD 80 million in the first year and 54.75 million over the course of the following 2 years; this represents the opportunity lost from internal treatment and sale of recoverable & recyclable materials. Furthermore, the internal treatment of 34% of BML waste in the first year and 47% in the subsequent two years can generate revenues of approximately USD 26.5 million in year one and 32 million in each of the following two years from the sale of recoverable materials. The total cumulative cost over 3 years of exporting is estimated to be around USD 712.48 million, or an average of 216 USD/ton of waste exported and treated.

	Year 1	**Year2**	**Year 3**
	Internally Treat 34%	**Internally Treat 47%**	**Internally Treat 47%**
	Export 66%	**Export 53%**	**Export 53%**
Open dumped waste in the past 2 months Total new waste generated over 12 months	171,000 tons 1,040,250 tons	 1,040,250 tons	 1,040,250 tons
Annual waste export requirement Annual waste to be treated internally	803,000 tons 408,250 tons	547,500 tons 492,750 tons	547,500 tons 492,750 tons
TOTAL WASTE TO BE CONSIDERED	***1,211,250 tons***	***1,040,250 tons***	***1,040,250 tons***
Cost of exporting waste (avg of 235 USD/Ton) Cost of internally treating waste (avg of 120 USD/Ton)	188,705,000 $ 48,990,000 $	128,662,500 $ 59,130,000 $	128,662,500 $ 59,130,000 $
TOTAL COST	***237,695,000 $***	***187,792,500 $***	***187,792,500 $***
Opportunity loss due to export Cost recovered from internal treatment	80,300,000 $ 26,536,250 $	54,750,000 $ 32,028,750 $	54,750,000 $ 32,028,750 $
TOTAL NOMINAL COST ***(incl opportunity loss and cost recovery)***	***291,458,750 $***	***210,513,750 $***	***210,513,750 $***
TOTAL CUMULATIVE COST OVER 3 YEARS (USD)			***712,486,250$***
AVERAGE COST PER TON OVER 3 YEARS (USD)			***216$***

ANNEX H
THERMAL PLASMA GASIFICATION OF WASTE

Over the past decade, the thermal plasma process has been regarded as a viable alternative for treating highly toxic wastes, such as air pollutant control (APC) residues, radioactive, and medical wastes; It's also been demonstrated that the process is environmentally friendly, producing only inert slag and minimal air pollutants that are well within regional regulations.

More recently, pilot thermal plasma programs for the gasification of waste[8] have been developed in commercial plants, employing extremely high temperatures in the absence or near-absence of O_2 to treat waste containing organic and other materials. The waste is dissociated into its constituent elements and transformed into other materials, some of which are valuable products - organic components are transformed into syngas (which is mainly composed of H_2 and CO) and inorganic components are vitrified into inert glass-like slag.

Plasma is defined as a quasi-neutral gas of charged & neutral particles that exhibits collective behavior; it can be classified into thermal & non-thermal plasmas according to the degree of ionization and the difference of temperature between heavy particles and electrons.

Thermal Plasma is characterized by approximately equal temperatures between heavy particles and electrons, and has numerous advantages including high temperature and high energy density. Electrically generated thermal plasma can reach temperatures of ≈10,000°C or more (well above the 2,000°C limit achieved by burning fossil fuels).

Compared with commonly used combustion techniques, thermal plasma is considered an ideal alternative to conventional waste treatment methods, including:

- Potential for large throughput with a small furnace given the high energy density, temperatures, and fast reaction times;
- Fast attainment of steady state conditions due to high heat flux densities at the furnace boundaries, allowing for rapid start-up and shutdown compared with other thermal treatments
- Easier and less expensive to manage due to the small amount of oxidant needed to generate syngas, as the gas volume produced is much smaller than conventional combustion processes.

Within the thermal plasma furnace, three kinds of processes tackle waste treatment:

- *Pyrolysis* (without O_2) of gaseous, liquid and solid waste with the use of plasma torches
- *Gasification* (O_2-starved) of waste containing organic compounds to produce syngas (H_2 + CO)
- *Vitrification* of waste by transferred, non-transferred, or hybrid arc plasma torch according to electric conductivity of substrate

The latter two are the main processes being considered for the treatment of waste due to the potential energy recovery and waste volume reduction.

Gasification uses an O_2-starved environment to break down carbon-based materials into fuel gases; it is closely related to combustion and pyrolysis, albeit with key distinctions: feedstock is not allowed to be completely burned as heat is applied (i.e. NOx and SOx are not emitted). Hence, raw materials go through the pyrolysis process, producing char and tar which are in turn broken down into syngas that can be used as a fuel source (mainly H_2 and CO). As such, the plasma gasification process has been combined with other technologies to recover energy from syngas, e.g. a combination with the integrated gasification combined cycle (IGCC), fuel cells, and the production of high purity H2.

DESIGN PARAMETERS FOR A 100 TON PER DAY SCALE THERMAL PLASMA GASIFICATION PLANT

- Waste storage unit and feeding system
- Integrated furnace with 2 non-transferred thermal plasma torches
- Effluent gas treatment systems, including water quencher & scrubber
- Syngas combustion chamber
- Air preheater/gas cooler
- Steam turbine[9]

[8] *INTECH (Open science - open minds) Youngchul Byun, Moohyun Cho, Soon-Mo Hwang and Jaewoo Chung*
[9] *This was not included in the 10 TPD plant*

The specific different characteristics between the 10 & 100 TPD scales are tabulated below:

Items	10 TPD Scale	100 TPD Scale
Thermal Plasma Consumption Power	0.817 MWh/ton	0.447 MWh/ton
Heat loss from effluent gases of stack	16%	10%
Heat loss through system walls	14%	7%
Energy Recovery	Not Used	Used through steam turbine

At 10 TPD, the power consumption of the plasma torch used for the treatment of a single ton of waste was 0.817 MWh/ton while at 100 TPD the consumption falls to 0.447 MWh/ton. At 10 TPD, the heat loss of the overall process through the wall was 14% and the energy contained in the effluent gases of the stack was 16%; however, at 100 TPD, the heat loss would be 7% and 10% respectively. In addition, at a 10 TPD scale, syngas and the heat generated from the heat exchanger have not been reused; however, at 100 TPD, the energy generated from syngas and heat exchanger through steam generators would be used. The energy reused by the two steam generators would be 73% of the input energy [a ratio of 12 plus 13 (16,679 Mcal/hr) to 1 plus 2 (22,858 Mcal/hr)].

ECONOMIC EVALUATION OF THE THERMAL PLASMA GASIFICATION PLANT

The economics of this process has many variable parameters including regional characteristics, types of waste to be processed, capacity, etc… In the USA, the average landfill and incineration cost are approximately 30-80 US$/ton and 69 US$/ton, respectively. However, the average cost of landfills and incinerators in smaller countries such as Japan and European countries is approximately 200-300 US$/ton since land is scarce, making thermal plasma gasification for waste treatment more viable. Presently, the average construction cost of thermal plasma plants is estimated to around 0.13-0.39 million US$/TPD.

Dodge estimated construction costs for a 750 TPD plant at 150 million US$, or 0.2 million US$/TPD

The construction cost of the 300 TPD plant in Utashinai, Japan was approximately 0.17 million US$/TPD

Although the costs in each country differ, and given the insufficient data, the trend of construction cost according to capacity could be identified as follows:

- 0.39 million US$/TPD applies to the 10 TPD plant constructed by GS Platech in Korea.
- For capacities between 250 and 750 TPD, around 0.17-0.22 million US$/TPD is applicable.
- Above 2,000 TPD, 0.13 million US$/TPD is applicable.

Therefore, plasma gasification processes are more economical once their capacities are increased. Presently, detailed operational costs are not available for each case with the exception of *GS Platech in Korea*. In addition, there are many methods to utilize byproducts generated during waste gasification. For example, syngas, which could be used for the generation of high value products such as fuel, chemical compounds and high purity hydrogen.

This means that, although thermal plasma technology is well-established, there is still room for enhancing its economic viability. Based on this information, the total construction cost for the GS Platech 100 TPD plant in Korea was 24.8 million USD, or or 0.25 million USD/TPD. Operational costs consist of fixed costs (2.39 million USD/ year), variable costs (0.82 million USD/year), and insurance (0.12 million USD/year).

Tipping Point	Facility Cost (100TPD)	Electricity Cost
40USD/ Ton	**Capex**: 40MUSD/30years **Opex**: 4MUSD/year	200 LL/kWh

On the other hand, revenues could be earned by selling electricity generated from steam turbines. The recovery heat values from two steam generators are 16,679 Mcal/hr. Considering the total efficiency of a steam supply & power generation using a steam turbine at 26%, 4,286 Mcal/hr of electricity could be generated, which is equivalent to 5,000 kW of electricity:

- 2,000 kW of electricity is necessary to generate thermal plasma torches;
- 3,000 kW of electricity could be sold to the grid (equivalent to 23.8 million kWh/year).

Given the selling price of electricity (10.9 cent/kWh[10]), total profits could amount to *2.6 million USD p.a.*; In addition, profit could be generated from treating waste: 110 USD/ton is paid by the local government for treating MSW in Cheongsong, Korea; therefore with 100TPD of MSW, revenues for treating MSW would be *3.6 million USD/year*. This results in TOTAL profits of 6.2 million USD/ year.

Given the operation cost (3.34 million USD/year), the total profit margin for a 100 TPD MSW treatment plant using thermal plasma gasification would be about 2.86 million USD/year which is equivalent to 86 USD/ton. Based on these design parameters, energy balance, and economic evaluation, a 100 TPD thermal plasma plant for RPF (refused plastic fuel) gasification is now under construction in Yeoncheon, Korea, with results to be reported once fully operational.

Thermal plasma technology is a mature, reliable and proven method for generating high temperatures at atmospheric pressure, which is not achievable by burning fuels[11]. In addition to converting organic waste into syngas and dissociating, collecting and vitrifying other materials to produce an inert glass-like slag, NOx and SOx are not emitted; furthermore concentrations of dioxins are very low compared to conventional incinerators. Therefore, thermal plasma processes are an environmentally friendly alternative for the gasification of waste.

Although the technical feasibility of thermal plasma gasification of waste has been well demonstrated, it is not presently clear that the process is economically viable on the global market due to regional variations in waste treatment costs. However, it is clear that the reuse of vitrified slag and energy production from syngas will improve the commercial viability of this process, and therefore have continued advances towards further development.

Items				Costs
Construction cost				24.8 million UD$
Operation cost per year	Fixed costs	Labor costs	14 labors	0.57 million US$/year
		Overhead charges	Fring benefits Safe maintenance cost Train expense Per diem and travel expenses etc...	0.17 million US$/year
		Depreciation cost	Depreciation period = 15 years	1.65 million US$/year
		Sub total		2.39 million US$/year
	Variable costs		Maintenance cost Electricity cost Chemical cost Wetted cost Etc...	0.82 million US$/year
	Insurance		0.5% of construction cost	0.12 million US$/year
	Total			3.34 million US$/year
	Operation cost per ton if MSW		Total operation cost /330 day x 0.01 day/ton	111 US$/ton (with VAT)
				101 US$/ton (without VAT)

Table 9: Economic evaluations of a 100TPD thermal plasma gasification plant for MSW treatment. These data are obtained based on experiences obtained from a 10 TFD thermal plasma gasification plant. All costs are based on Korean price. Exchange rate between USA and Korea 1,130 won/US$

[10] *The selling price of electricity recovered from waste is relatively high compared to other electricity prices due to the government's renewable portfolio standards (RPS) policy promoting the use of renewable energy in Korea*

[11] *Recently, thermal plasma technology has been applied for the treatment of waste directly from trucks in pilot and commercial plants*

Endnotes

http://www.newsweek.com/italy-naples-still-trash-city-87463
The effect of fire on concrete structure can be summarized into the following:
•Reduction in compressive strength;
•Micro-cracking within the concrete microstructure;
•Color changes consistent with strength reductions;
•Reduction in the modulus of elasticity;
•Various degrees of spalling;
•Loss of bond between concrete and steel;
•Possible loss of residual strength of steel
•Reinforcement and possible loss of tension in prestressing tendons

The more severe fire damage would also involve the total exposure of main bars, significant exposure of prestressing tendons, significant cracking and spalling, buckling of steel reinforcement and even significant fracture and deflection of concrete components.

To avoid a case similar to the "Ecoballs" issue in Campania

Cover Photo Credit Fadi BouKaram/Facebook

- منع المكبات العشوائية وفرض العقوبات عليها
- عدم تشجيع المحارق وفرض عقوبات شديدة عليها في حالات المخالفة
- مراقبة ومنع كبس النفايات في جميع مراحل المعالجة
- وجوب التخلّي عن سياسة الطمر بحسب الطرق المتّبعة سابقاً
- وجوب إعادة تدوير/بيع كافة المواد غير العضويّة وغير السامّة
- وجوب ترحيل المواد الخطرة/السامة بدل إنشاء مرافق متخصصة لمعالجتها
- وجوب تفكيك النفايات الإلكترونية وبيع مكوّناتها بهدف زيادة المستردات
- وجوب معالجة النفايات العضويّة بحسب النسب التّالية:
- ٤٠% لإعادة تجديد التربة، ٥٠% للتسبيخ بهدف البيع و ١٠% للطمر بهدف بناء منشآت لتحويل النفايات إلى طاقة.

تمثل هذه الدراسة رأياً محترفاً ومستقلاً حيث تقدم إقتراحات وتوصيات تهدف إلى الإستفادة بالطريقة الأمثل من كافة العوامل المتاحة ضمن الإطار اللبناني، كما أنها تقدم تصورات مبنية على وضع خطة وطنية إستراتيجية في القريب العاجل بهدف الإستفادة من مفاعيل الأزمة وتحويل كارثة "أزمة نفايات ٢٠١٥" إلى فرصة لتطوير الإقتصاد وإحياء الأمل عند الشباب اللبناني في هذه المرحلة العصيبة والحرجة من تاريخ المشرق.

من الناحية المالية، شككت الدراسة بالسياسة المتبعة لإدارة القطاع خلال فترة ما قبل الأزمة، بحيث أنها تكبد البلديات تكاليف عالية فيما تعاني الميزانيات البلدية بسبب قلّة الجباية. تُقدّر كلفة إدارة النفايات في تلك المرحلة بحوالي ٣٢٠ مليون دولاراً أميركياً، ما يوازي ثلث مجمل ميزانيات البلديات، ومن المتوقع، في حال استمرار النهج نفسه، أن تصل الكلفة إلى ٦٧٠ مليوناً خلال عقد من الزمن. تقنيًا تشكل طبيعة تركيبة النفايات في لبنان حجر زاوية لبناء قطاع "الإقتصاد الأخضر" وخلق فرص عمل للشباب اللبناني.

يبني فريق المهام على خطة الوزير شهيّب لإقتراح جدول زمني بهدف الحد من تداعيات الأزمة الرّاهنة عبر دمج خطة اللجنة التقنية مع الإقتراحات المتعلقة بالترحيل وسبل المعالجة المحليّة. إعتماد خيار الترحيل بشكل خاص سيكبد اللبنانيين تكاليف باهظة قد تتعدى ال٢٥٠ دولاراً أميركياً للطن الواحد وبغض النظر عن إمكانية المعالجة المحلية التي قد تعود بنفعية مالية قد تصل إلى ١٠٠ دولاراً لكل طن معالج محلياً.

لذلك، يوصي فريق المهام بإعلان "حالة طوارئ وطنية" بدءاً ذي بدء لمعالجة النفايات المكدسة عشوائياً وتلك المنتجة حديثاً والتي تضخّم وزنها بفعل هطول الأمطار. لذلك وجب إتباع خطة مرحلية تقوم على مبدأ ترحيل القسم الأكبر من النفايات لدرء المخاطر المترتبة خلال فترة الثماني عشر (18) شهراً القادمين، على أن يشهد القطاع عملية بناء قدرات وإمكانيات مكثفة يصار خلالها إلى الإنتقال التدريجي لتفعيل المعالجات المحلية من أجل تحقيق إستدامة لإدارة متكاملة للنفايات وتطوير قطاع إقتصادي أخضر ينعش الوضع الإقتصادي العام. يصل متوسط كلفة معالجة الطن الواحد خلال هذه المرحلة الى ٢٤٠ دولاراً أميركياً مع إمكانية استرداد ثلث هذه القيمة من المعالجات المحلية.

توصيات فريق المهام: يقدم الفريق تصوراته للحل عبر اقتراحات عمليّة وشاملة وذلك من ضمن توصيات عامة وجب إتباعها تمهيداً لوضع خطة استراتيجية وطنية للإدارة المتكاملة للنقايات.

على صعيد الإدارة

يقترح فريق المهام إعتماد مبدأ "فصل السلطات" – عملاً بمبدأ اللامركزية واللاحصرية الإدارية – في الإدارة المتكاملة للنفايات، بحيث تقوم الإدارة المركزيّة بوضع السياسات العامة وخطط العمل الوطنية والتشريعات الضرورية، وتقوم إدارة المحافظين والقائمقامين بعمليّة المراقبة والإدارة والتقييم لإجراءات الإدارة المتكاملة للنفايات. من المتوقع أن تقوم البلديّات وإتحادات البلديّات بالتعاون مع الجمعيات الأهلية بتطبيق الخطة الوطنية الإستراتيجية للإدارة المتكاملة للنفايات، على أن تقوم الجمعيات الأهلية بدور سلطة رقابة محليّة خلال فترة تنفيذ الخطّة.

يشجع فريق المهام على تشكيل **الهيئة الوطنية للإدارة المتكاملة للنفايات** والتي تتألف عضويتها من القطاع العام، والجمعيات الأهلية والمجتمع المدني بالإضافة إلى خبراء مختصين من القطاع الخاص. تشكل هذه الهيئة مؤتمراً وطنياً ومن مهامها المتعددة تأسيس وإدارة "المرصد الوطني لإدارة النفايات"، وذلك إضافة إلى إقتراح مسودات الحلول.

كما تضمّ الدراسة إقتراحات فريق المهام للتعبئة وتفعيل كوادر البلدية وتأسيس مكاتب تقنيّة وفنيّة وتحديد أدوار أصحاب الشأن كخطوة أولى لضمان إستدامة فعاليات بناء القدرات على مختلف المستويات الإدارية.

الحوكمة: القوانين والمراسيم

مستوحياً إقتراحاته من روحية الدستور اللبناني السّاعي إلى تحقيق اللامركزية واللاحصرية الإدارية في لبنان، يتقدّم فريق المهام، بما يلي:

- تحرير سوق "الإدارة المتكاملة للنفايات" بالتعاون مع مصرف لبنان، وذلك عبر تقديم حوافز مالية
- التشدد في تطبيق الإجراءات المتعلقة بإستيراد المواد المعاد تدويرها والأسمدة العضوية بهدف حماية الإقتصاد الأخضر اللبناني.
- تأسيس "صندوق التنمية البلدي" بهدف دعم مشاريع التنمية البلدية ومنها الإدارة المتكاملة للنفايات
- إعادة إحياء إطار "عمل تشريعي" للإدارة المتكاملة للنفايات
- إعادة تفعيل المراسيم المتعلقة بالبلديات وإدارة النفايات

وغيرها من ضمن سلسلة مقترحات متكاملة تسلط الضوء على كيفية تمويل البلديات من ضمن إجراءات أخرى لضمان تطبيق الخطة الإستراتيجية للإدارة المتكاملة للنفايات المرتقب رسمها عاجلاً.

من المصدر: حيث تبدأ الحكاية

قام فريق المهام باقتراح إطار متكامل لجمع النفايات بالإضافة إلى جدول مواعيد محدد للمساعدة في تطبيق الخطة كمرحلة أولى من خلال الفرز من المصدر.

تمّ تطوير هذا الإطار بمساعدة خبراء في إدارة النفايات وبالاعتماد على التجارب الدولية المثلى والتي تقتضي بتوزيع حاويات جمع مخصصة لمختلف أنواع النفايات (عضويّة، غير عضويّة وأخرى).

إضافة إلى ما ورد، قام فريق المهام بتسليط الضوء على أهمية بناء الوعي المجتمعي على كافة الأصعدة بالإضافة إلى إيضاح وتثقيف مكونات المجتمع اللبناني حول تقنيات معالجة النفايات، والحملات والمبادرات الواجب القيام بها.

عمليّة ما بعد الجمع

يشدّد فريق المهام على إعتماد التقنيات الأفضل والأنسب في عملية الإدارة المتكاملة للنفايات في لبنان والتي تكمن في ما يلي:

ملخص تنفيذي

في ظل غياب خطة وطنية واضحة للإدارة المتكاملة للنفايات في لبنان ولأسباب سياسية وحكومية، يواجه لبنان خلال عام ٢٠١٥ أزمة نفايات لم يشهد لها مثيلاً.

مع ارتفاع أكوام النفايات في شوارع بيروت، تفاقمت "أزمة نفايات ٢٠١٥" مما أدّى إلى إندلاع مظاهرات وتحركات إحتجاجية وتصعيدية في بعض الأحيان. تتجذر هذه الأزمة في نواح سياسية وإدارية متعددة، أبرزها سوء إدارة هذا الملف.

بناءً على ما تقدم وكردّ على "أزمة نفايات ٢٠١٥" قام "برنامج الأمم المتحدة للمستوطنات البشرية" (UN-Habitat) ومؤسسة "مهنا فاونديشن" (the Muhanna Foundation) بتأليف فريق مهام من المؤسستين، متعدد الخبرات، خاصةً في مجالات الإقتصاد، التطوير والإنماء البلدي والعلوم الأكتوارية، وذلك بهدف إعداد دراسة شاملة تنظر في "أزمة نفايات ٢٠١٥" وأسبابها الموجبة بغية إقتراح توصيات لوضع سياسة عامة قابلة للتطبيق من أجل دعم جهود السلطات المركزية لمعالجة هذه الأزمة وإغتنام الفرص المتأتية.

تحلل هذه الدراسة الأحداث والأسباب التي أدت إلى أزمة السابع عشر من تموز ٢٠١٥، يوم انفجرت "قنبلة النفايات المؤقتة" مما تسبب بشلل إداريّ في مؤسسات الدولة وخلّف إضطرابات في الشارع اللبناني، بالإضافة إلى التأثيرات السلبية الجمة على الصعيدين البيئي والصحي كما على مستوى البنى التحتية والثروات الطبيعية للبلاد.

في سياق إعداد الدراسة، تم رسم مدلولات موازية لأزمة مماثلة واجهتها محافظة كامبانيا الإيطالية مؤخراً: إستناداً إلى التجربة الإيطالية – وذلك حتى عام ٢٠٠٨ - قد ترتفع الكلفة الإجمالية للأضرار المترتبة عن أزمة النفايات إلى ما يقارب المليارَي يورو في حال لم يتم الحد من آثار الأزمة بطريقة ووقت مناسبين. بالإضافة إلى ذلك، أعد فريق المهام تحليلاً شاملاً لملف النفايات اللبناني في فترة ما قبل وما بعد اندلاع الأزمة، ومقارنة أوجه الشبه مع عينة تمثيلية من البلدان مثل أيسلندا، اليونان، تونس وسنغافورة وذلك بهدف فهم إتجاهات قطاع إدارة ومعالجة النفايات حول العالم ومقارنتها بالقدرات والطاقات والإمكانيات اللبنانية في هذا المجال.

قيّم فريق المهام خطة اللجنة التقنية المولجة معالجة أزمة نفايات ٢٠١٥ والتي يرأسها الوزير شهيب مسلطين الضوء على عدد من النقاط نذكر منها على سبيل المثال لا الحصر: ١) غياب الوضوح في الإجراءات؛ ٢)الحاجة لتنفيذ خطة متكاملة لبناء القدرات والطاقات بالتوازي مع خطة الطوارئ؛ ٣) الحاجة الملحّة لاستبدال مصطلح "الإدارة الشاملة للنفايات المنزلية الصلبة" بمصطلح "الإدارة المتكاملة للنفايات".

آخذين بعين الإعتبار إجراءات عملية متّبعة محلياً للحد من الأزمة كبلدية رومية على سبيل المثال لا الحصر، دور الهيئات والجمعيات الأهلية مثل جمعية سيدات بيصور والجدوى الإقتصادية لتكليف إتحادات البلديات عملية معالجة النفايات المجموعة (منشأة عين بعال في قضاء صور)، تم التطرق إلى النقاط المحورية التالية:

- المقاربة الأكثر جدوى للحد من أزمة نفايات ٢٠١٥
- النماذج الأكثر إستدامةً إستراتيجية للإدارة المتكاملة للنفايات
- إمكانية تطبيق هذه النماذج على إمتداد مساحة الوطن واعتمادها على مستوى السياسة العامة.

إستناداً إلى دراسة وتحليل معمّقين، عاينت هذه الورقة النواحي الصحية، الإجتماعية، الإقتصادية والتقنية، إضافةً إلى الحوكمة، مقيّمةً الواقع الحالي وماهية الإحتياجات، ليس فقط لمعالجة الأزمة بل لمساعدة السلطات المركزية للإنتقال من حالة "رد فعل للحد من الأزمة" إلى حالة "إعتماد سياسة صفر نفايات بشكل إستباقي" عبر إدارة متكاملة للنفايات أو ما اصطلح تسميته "Wasteless Lebanon 2022" كتعبير ضمني لعنوان هذه الورقة "تما يضيع لبنان ٢٠١٥".

من ناحية الحكومة، هناك حاجة ملحّة لإقرار تشريعات خاصة بالإدارة المتكاملة للنفايات، في حين يجب إفساح المجال للإدارات المحليّة (البلديات وإتحاداتها) لتحمل مسؤولياتها – القانونية والشرعية – في إدارة النفايات. تجدر الإشارة إلى أن استمرار اعتماد المكبات العشوائية والحرق كوسيلة للتخلص من النفايات سيؤدي إلى نتائج كارثية على صعيد البنى التحتية (الجسور، الطرقات والمنشآت المدنية)، شبكات المياه (الصرف الصحي، الأمطار والشفة)، البيئة والصحة العامة.

لأزمة نفايات ٢٠١٥ وجه إيجابي حيث أدّت إلى "تحوّل عقلي جماعي" مما ساهم في زيادة الوعي الإجتماعي بإضطراد حول هذا الموضوع. من هذا المنطلق، قامت بعض الجمعيات الأهلية بإغتنام الفرصة لتقديم حلول مناسبة (كسيدات بيصور) ومجابهة الخيارات المجحفة (كقضية معمل سبلين) فيما قد يشكل عامل النازحين السوريين أحد مفاتيح الحلول على المدين القصير والمتوسط إستناداً إلى تجربة مدينة لاهور الباكستانية.