field infrastructure and camp improvement programme

environmental health response plan in the 12 palestine refugee camps in lebanon (2018-2021)

with inventory and needs assessment

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Inventory and Needs Assessment on Environmental Infrastructure and Environmental Health in the 12 Palestine refugee camps in Lebanon, Response Plan 2018 – 2021 by Field Infrastructure and Camp Improvement Programme (FICIP)

Cover Photo: Child walking in a street in Shatila Palestine refugee camp, Beirut © 2017 UNRWA Photo by Carlos Pérez, Scopio.

I. Foreword

Launched in June 2016, the UNRWA Environmental Health Strategy 2016 – 2021 set the strategic direction for tackling major environmental infrastructure and environmental health issues present in the 12 Palestine refugee camps in Lebanon. The overall objective is to improve the living conditions of the Palestine refugee population and to better manage the natural resources they depend on. Between October 2016 and November 2017, an inventory and needs assessment was conducted in the 12 camps to identify the major environmental infrastructure and environmental health challenges. The findings helped to shape the recommendations for the coming four years. The Response Plan presented in this document, with more than 190 proposed projects aimed to reinforce the efficiency of the operation and maintenance of environmental health services in the camps, to engage in sustainable environmentally-friendly solutions and above all, include all stakeholders and refugees in the centre of the decision-making process. The holistic approach adopted throughout the development of this document is reflected in all proposed interventions and recognizes the importance of collective action for shared solutions.

Thinking "*out of the box*" was the *vision* adopted during the inventory and needs assessment, involving stakeholders across a wide range of sectors and institutions. The principles of sustainability, efficiency and innovation, were embraced throughout the entire process and are also incorporated in the interventions outlined in the Response Plan.

Today, the Earth must be considered as a whole, where challenges are shared and comprehensive solutions are developed collectively. This holistic approach to address the environmental health issues in the 12 camps is the thread that was woven throughout the entire process of the inventory and needs assessment and is integral in the recommendations outlined in this Response Plan. Shatila Palestine refugee camp was created shortly after the first picture of Earth was taken from the space, in 1946. Thinking global and acting local, particularly in the context of the Palestine refugee camps in Lebanon, has never been so relevant. There is no planet B and therefore we must work together to find innovative solutions to the challenges we face today. The Palestine refugee camps in Lebanon are not isolated entities and environmental threats know no boundaries. On the other hand, advancements for Palestine refugees will be felt on both sides. Therefore, this Response Plan was developed in an integrated manner, with Palestine, Lebanese and international partners. Inspired by the Palestinian poet, Mahmoud Darwish who wrote that "without hope, we are lost" and also by the Lebanese author Amin Maalouf, translated into English "*New challenges, new solutions*[1]" the Response Plan aims to provide hope through innovative solutions for today and for future generations.

[1] « *A de nouveaux défis, de nouvelles solutions* », Amin Maalouf

II. Special acknowledgement

A special thanks to all persons within UNRWA for their support, expertise and time in the preparation of this document. A special thanks to all persons from the state, private, academic and humanitarian sectors who have contributed to the inventory and needs assessment contained in this report. The development and production of the Environmental Infrastructure and Environmental Health Response Plan 2018-2021 has been generously supported by the Swiss Agency for Development and Cooperation, the German Cooperation and UNICEF.

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UNRWA is a United Nations agency established by the General Assembly in 1949 and mandated to provide assistance and protection to some 5 million registered Palestine refugees. Its mission is to help Palestine refugees in Jordan, Lebanon, Syria, West Bank and the Gaza Strip achieve their full human development potential, pending a just and lasting solution to their plight. UNRWA services encompass education, health care, relief and social services, camp infrastructure and improvement, and microfinance.

III. List of Acronyms and Abbreviations

AA	Adjacent Areas
BOD	Biochemical Oxygen Demand
CAO	Chief Area Officer
CDR	Council for Development and Reconstruction
CIP	Camp Improvement Plan
CLA	Central Lebanon Area
COD	Chemical Oxygen Demand
COP	Conference of the Parties
CSO	Camp Services Officer
CSES	Centre for Sustainable Environmental Sanitation
DRU	Donor Relations Unit
EDL	Electricité du Liban
EHS	Environmental Health Strategy
EIEH	Environmental Infrastructure and Environmental Health
EU	European Union
FAO	Food and Agriculture Organization
FICIP	Field Infrastructure and Camp Improvement Programme
GBV	Gender-based Violence
GDP	Gross Domestic Product
GEF	Global Environmental Facility / UNEP
GF	General Fund
GIS	Geographical Information Systems
GoL	Government of Lebanon
HDPE	High-density Polyethylene
HH	Household
ICIP	Infrastructure and Camp Improvement Programme
ICRC	International Committee of the Red Cross
IPCC	Intergovernmental Panel on Climate Change
ISWM	Integrated Solid Waste Management
IT	Information Technology
IW	Industrial Waste
IWM	Integrated Waste Management
IWRM	Integrated Water Resources Management

JMP	Joint Monitoring Programme
LARI	Lebanese Agricultural Research Institute
LB	Lebanese Pound
LCEC	Lebanese Council for Energy Conservation (hosted by MoEW)
LCRP	Lebanon Crisis Response Plan
LEED	Leadership in Energy and Environmental Design
LFO	Lebanon Field Office
LIBNOR	Lebanese Standards Institution
LRC	Lebanese Red Cross
MAR	Managed Artificial Recharge
M&E	Monitoring and Evaluation
MENA	Middle East and North Africa Region
MoE	Ministry of Environment (Lebanon)
MoEW	Ministry of Energy and Water (Lebanon)
MoPH	Ministry of Public Health (Lebanon)
MoSA	Ministry of Social Affairs (Lebanon)
MRLs	Maximum Residues Limits
MSW	Municipal Solid Waste
N/A	Not Applicable
NGO	Non-Governmental Organization
NWSS	National Water Sector Strategy (MoEW)
NPIC	National Pesticides Information Center
OMSAR	Office of the Minister of State for Administrative Reform
OW	Other Waste
PAH	Polycyclic Aromatic Hydrocarbon
PC	Popular Committee
PCBs	Polychlorinated Biphenyls (POP)
PEX	Cross-linked Polyethylene
PHC	Public Health Centre
PIO	Programme Information Office
PLD	Procurement and Logistic Department
POP	Persistent Organic Pollutant
PPR	Pipe Penetration Radar
PRL	Palestine Refugee from Lebanon
PRS	Palestine Refugee from Syria

PSO	Programme Support Office
RAMSAR	Convention on Wetlands of International Importance
REPAC	Regional Programme for the Improvement of Living Conditions of Palestine refugee camps
RP	Response Plan
RSS	Relief and Social Services
SAI	Saida Area
SC	Stockholm Convention
SDC	Social Development Centre
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SMIS	Shelter Management Information System
SW	Solid Waste
SWM	Solid Waste Management
TOT	Training of Trainers
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children’s Fund
UNHCR	United Nations High Commissioner for Refugees
UNRCO	United Nations Resident Coordinator Office
UNRWA	United Nations Relief Works Agency for Palestine refugees in the Near East
UNRWA MTS	UNRWA Medium Term Strategy 2016 – 2021
UPM	Umwelt Projekt Management
UV	Ultraviolet
WASH	Water, Sanitation and Hygiene
WE	Water Establishments (Lebanon)
WHO	World Health Organization
WinS	WASH in Schools
WMO	World Meteorology Organization

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Executive Summary

Despite their longstanding presence in Lebanon, Palestine Refugees remain excluded from key aspects of social, political and economic life in the country. One quarter of Palestine refugees are living in multi-dimensional poverty[1], exacerbated by the lack of decent employment opportunities.[2] Those that are available are mainly low-skilled[3] and elementary informal jobs.[4]

For decades the camps lacked basic environmental health services and had severely deteriorated infrastructure. The UNRWA assessment further demonstrates that the situation in the camps and surrounding areas in this regard is critical[5]. The degradation of the land, habitat, water, sanitation, air, and energy sectors in the direct camp vicinity and in highly urbanized areas along the coast and in the Bekaa valley is highly apparent. Even though the host country is eventually expected to resume the provision of environmental infrastructure and environmental health services, the limited resources currently available are already overstretched and municipalities are facing an immense burden due to humanitarian, environmental and political instability. The under-resourced municipalities are also under serious pressure to respond to the impacts of the Syria crisis. This makes UNRWA the main environmental health services provider to Palestine refugees and others living in the 12 Palestinian camps in Lebanon.

As part of UNRWA's Environmental Health Strategy for the Palestine Refugee Camps in Lebanon (hereby referred to as the Strategy), a five-stage plan was initiated. Step one saw the creation of a strategic framework to oversee the process. Under stage two, carried out between October 2016 and November 2017, an inventory and needs assessment was undertaken in which environmental health data was collected updated and analysed.

This has led to the current third stage whereby findings and recommendations from stage two are articulated in a formal Response Plan: a series of project interventions critical to the improvement of living conditions in the 12 camps in Lebanon. The Response Plan recommendations align with UNRWA's strategic objectives and contain a long-term perspective, in line with the Sustainable Development Goals. The Plan builds on the experience of UNRWA's collaboration with the Lebanese Council for Development and Reconstruction, the Lebanese Crisis Response Plan 2017-2020 and the relevant Ministries and UN Agencies, among others. Further engagement of the international community in terms of provision of technical expertise, advocacy support and financial assistance is crucial for implementation of the Response Plan.

Solutions must be viewed in terms of operation and maintenance as well as urban planning with greater involvement from the refugees and other populations living inside the camps and who benefit from environmental health services. Any environmental health intervention must also seek to empower the populations and improve their knowledge on their rights and duties.

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[1] Socioeconomic survey by American University of Beirut, 2015

[2] UNRWA. (201). Employment of Palestine Refugees in Lebanon. An Overview. Professions of prohibited access (39)

[3] Occupation such as skilled agricultural and fishery workers, craft and trade and related workers

[4] Socioeconomic survey by American University of Beirut, 2015

[5] UNRWA inventory and needs assessment in 12 Palestine refugee camps, October 2016-November 2017

Strategic Objective

Improve the built environment by providing robust infrastructure, camp improvement services and participatory solutions in partnership with refugees and relevant stakeholders.

Strategic Outcome

Palestine refugees living in the 12 Palestine refugee camps in Lebanon are able to meet their basic environmental health needs.

With other populations living inside the camps, as well as Palestine refugee communities outside the camps, a joint and holistic approach is required, which includes UN agencies and government ministries. Enhanced, sustainable environmental infrastructure and environmental health services and management will have a positive impact on the preservation of natural resources, the diversification of employment opportunities, an increase in social cohesion and the realisation of innovative solutions for better urban planning. Building community knowledge and educating the population through a participatory communication approach is fundamental for reaching the overall objective and outcome of the Strategy.

The four-year Response Plan outlines the approach to engaging in 191 new construction projects and rehabilitation initiatives, as per the intervention logic presented below, with an estimation of the required resources equalling USD 25.3 million. The initiatives proposed under the Response Plan are based on the principles of sustainable environment health services, efficient resource management and innovative approaches. Implementation is the next and fourth step of the overall five-step environmental health strategy.

Environmental Health Response Plan Intervention Logic

STRATEGIC OBJECTIVE: improve the built environment by providing robust infrastructure, camp improvement services and participatory solutions in partnership with refugees and relevant stakeholders

STRATEGIC OUTCOME: Palestine refugees living in the 12 Palestine refugee camps in Lebanon are able to meet their basic environmental health needs

OUTPUT 1: PR have safe, equitable and sufficient quantity of water for their basic needs

Targets
- Increase % of camps with at least one water committee in charge of the operation & maintenance of the water supply from 33% to 100%
- Increase % of the population using safely managed drinking water services from 36% to 46%
- Increase # of shelters connected to adequate water networks from 70% to 100%
- Increase % of water sources equipped with adequate qualitative & quantitative surveillance system from 0% to 100%

OUTPUT 2: PR have access to solid waste management services that meet minimum acceptable standards

Targets
- Increase the collection and removal of domestic waste from the camps from 90% to 100%
- Increase % of solid waste recycled per camp from 0% to 25%
- Increase the amount of solid waste reduction via recycling from 0% to 25%
- Increase # of days per year the camps are kept clean of solid waste from 250 to 300
- Increase # of times each week street sweeping is done in the camps from 4.5 to 6

OUTPUT 3: PR live in an environment in which health and other risks posed by storm water are minimized.

Targets
- Increase % of camps equipped with operational storm water networks from 55% to 100%
- Increase % of shelters connected to adequate storm water networks from 70% to 100%
- Maintain 100% of premises (schools, health centres, offices) connected to adequate storm water networks

OUTPUT 4: PR served with adequate sewerage systems (waste water).

Targets
- Maintain % of premises (schools, health centres, offices) connected to adequate waste water networks at 100%
- Increase % of shelters connected to adequate waste water networks from 80% to 100%
- Increase % of waste water safely treated from 0% to 25%
- Increase % of camps equipped with operational waste water networks from 60% to 100%

OUTPUT 5: PR live in an environment in which health and other risks posed by inadequate habitat infrastructure, materials and technologies, inadequate land, air, energy qualities, equipment and technologies are minimized.

Targets
- Decrease the annual mean levels of fine particulate matter (PM_{10}) in camps to80 $\mu g/m^3$
- Increase # of areas equipped with independent and functional weather stations 0 to 5
- Increase the % of service generators equipped with efficient air filters and noise reducers from75% to 90%
- Increase the % of transformers aligned to the Stockholm Convention on PCBs from 50% to 90%
- Increase # of camps that have benefitted from at least one innovative technology from 0 to 12
- Decrease % of construction material containing asbestos from an unknown percentage to 0%

OUTPUT 6: PR and partners involved in sustainable, efficient and innovative environmental infrastructure management & environmental health activities are aware of public and environmental health risks and apply adapted and sustainalbe programmes & tools

Targets
- Increase proportion of boys, girls, women and men with appropriate hygiene knowledge, attitudes and practices (targer - LCRP)
- Increase proportion of camps that have at least one awareness campaign on environmental health sector with focus on IWRM and IWM to 100%
- Improve staff capacity in Environmental Health sectors and tools (to 75%) and expertise in IWRM, IWM, ACAD, GIS data management

Inventory & Needs Assessment

The inventory and needs assessment was carried out in order to produce a response plan that includes specific and practical recommendations, actions and indicators for different environmental health sectors and environmental infrastructure. Although water, sanitation, land/habitat, air and energy are all addressed individually in the response plan, with separate sets of recommendations and activities, all sectors are interdependent and interconnected. Adopting an integrated approach, involving both local and global perspectives, was crucial during the analysis of these sectors in order to find simple solutions to common, interconnected problems. This approach understands the strengths and challenges present in the camps and fosters the development of, and support for, opportunities that are common to areas inside and surrounding the camps. This ultimately benefits the community in a more sustainable and efficient manner.

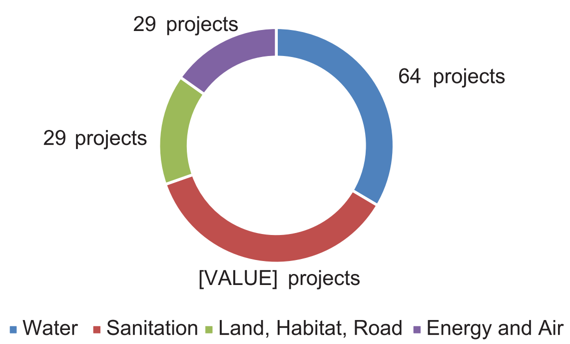
Methodology. More than 77 activities were carried out between October 2016 and November 2017, with a specific focus on obtaining primary and secondary data. Participation came primarily from UN agencies and humanitarian organizations, but also from private and academic sectors. All findings and recommendations are based on technical socioeconomic observations and surveys conducted by UNRWA and in coordination with nationally and internationally recognised expertise. The inventory and needs assessment integrated ongoing Agency activities, accessed relevant qualitative and quantitative data through the revision of secondary data and collection of primary data, and conducted an actor mapping risk assessment and environmental impact assessment.

Cross-sector activities include Integrated Water Resources Management (IWRM), Integrated Waste Management (IWM), the Self-Help Initiative and Camp Improvement Plan. The green economy, environmental impact assessment, disaster risk reduction, communication, visibility and data management are among the essential tools and concepts that will be used in implementation of the Response Plan.

Findings & Recommendations

Following the inventory and needs assessment, a total of 191 projects have been identified for a four-year period, as per the pie-chart below. The estimated total budget is $25.3 million USD, corresponding to a capital investment of $117 USD per person over four years, and just $29 USD per person per year for operational and maintenance and improvement of the environmental infrastructure and environmental health services.

Environmental Health Project Interventions



I. Water

Lebanon's water resources are under severe stress, exacerbated in the 12 camps because of their sensitive locations: coastal areas face intense urbanization and seawater intrusion and the Bekaa Valley is home to intense agriculture. Integrated water resource management, beginning with the implementation of a qualitative and quantitative water monitoring surveillance plan, is a top priority for 2018. Recommendations include: characterization of the existing infrastructure and water resources in terms of quality and quantity, identifying the origins of pollutants and protecting water sources, and supporting the development of robust infrastructure. The consideration of the entire water cycle from precipitation to the groundwater sources, as well as the entire water supply chain, is a vital feature of the proposed response.

FINDINGS: Water

Water quantity. Six of the twelve Palestine Refugee camps are experiencing water shortages.

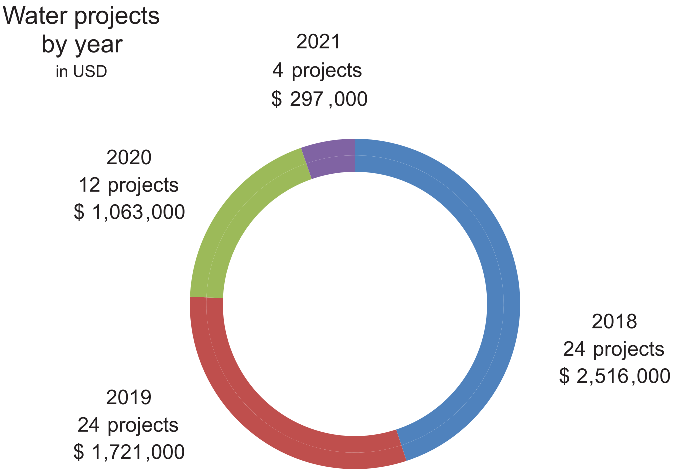
Water quality. Tap water samples and bottled water samples taken from each of the 12 camps show a higher concentration of both coliform and E. coli than the groundwater samples. Ninety-three per cent of tap water and 94% of bottled water showed the presence of total coliforms, and 40% of tap water and 57% of bottled water showed the presence of E. coli. This suggests possible contamination within the water distribution network and/or in private tanks, and that purchasing bottled water is not a viable alternative. Samples of groundwater sources also indicate salt water due to sea water intrusion. To date, four camps are located in areas with seawater intrusion and abstract non-drinking saline water. An additional two camps are showing signs of slight seawater intrusion, while other camps located in coastal environments do not face issues currently with saline water.

Water systems. A total of 78 water sources (95% wells, 5% springs), 160 km of pipe and 37 main water reservoirs were examined. Not reusing wastewater or storm water and the lack of float valves in most private tanks are contributing to additional losses besides the networks leakages that are ranging from 20% to 40%.

RECOMMENDATIONS: Water

Sustainable, integrated water management necessitated by the current conditions within the camps involves three parallel types of activities. Firstly, monitoring and understanding of the groundwater and exploitation of water resources needs to be enhanced, including a qualitative and quantitative monitoring programme on a regional scale with findings reported in an annual monitoring report. Secondly, there is a need for better management of the water sector inside the camps, including a more efficient water supply with better control of quantities pumped and a reduction in structural losses. This includes proper maintenance efforts as well as awareness campaigns to prevent water wastage and build local capacity and knowledge of the seriousness of the situation. Finally, increased participation from the population is required, resulting in the more responsible use of water. This should include approaches such as: revising the pumping hours in line with demand; implementing a public awareness and education campaign by and for the residents to prevent waste and reign in uncontrolled development; and implementing a cost-recovery system in the camps.

The graphs below show the annual funding estimates required to achieve the expected results in the Water sector.



Total cost, Water: USD 5,597,000

Output	Targets
Palestine refugees living in the 12 Palestine refugee camps in Lebanon have safe, equitable and sufficient quantity of water for their basic needs.	Increase the percentage of camps with at least one water committee in charge of the operation & maintenance of the water supply from 33% to 100%
	Increase the percentage of the population using safely managed drinking water services from 36% to 46%
	Increase the number of shelters connected to adequate water networks from 70% to 100%; maintain the same level of connection in UNRWA premises (100%)
	Increase the percentage of water sources equipped with adequate qualitative & quantitative surveillance system from 0% to 100%

II. Sanitation

Waste is an important by-product of human activity. The amount and type of waste and its management vary depending on the social and economic situation, as well as on climate and land characteristics. Overall, the preferred approach to waste is to minimize its generation. The necessary laws and policies governing the management of waste are efficient only when a population is ready to collaborate for its own benefit and that of future generations. Solid waste management (SWM), also referred to as integrated solid waste management, includes all activities and tools associated with the control of solid waste generation, reduction, sorting, storage, transfer, transport, processing and disposal within a given context (public health, natural environment, economics, social, engineering).

FINDINGS: Sanitation

Waste water. There are 12 wastewater networks, one per camp. The total wastewater network for the 12 camps is estimated to be 151 km. All networks, except for Rashidieh and Nahr el-Bared, are connected to municipal networks. The unconnected camps have sea discharge points. There is no wastewater treatment, and all effluents are connected by gravity to the municipal network (except Rashidieh, which requires a pumping station). Three camps (Wavel, Mar Elias and Dbayeh) have both waste water and storm water fully combined, and two camps partially combined (Shatila and Burj Barajneh).

UNRWA conducted a wastewater quality survey in August and September 2017. Findings common to all 12 camps include the absence of heavy metals or toxic compounds as there is no heavy industry in the camps. High levels of nitrate, nitrite and inorganic phosphate were found, with fertilizer runoff being the most common source. Many camps revealed high levels of salmonella due to chicken slaughter bi-products being disposed of in the sewers.

Burj Barajneh, Dbayeh, Mar Elias, Shatila, Nahr el-Bared have a low ratio of biological oxygen demand to chemical oxygen demand (BOD/COD), which means that the wastewater in these camps is considered toxic.

Storm water. The total storm water network is about 47 km for ten camps (Dbayeh and Mar Elias are not equipped with any storm water network, and only have a surface runoff system). Burj Barajneh, Rashidieh and Wavel have the worst storm water infrastructure and require significant interventions.

Solid waste. Lebanon has a number of solid waste infrastructure and services, but also a large number of uncontrolled dump sites. Its rugged terrain, limited surface area and additional waste generated due to humanitarian crises make waste disposal particularly complex.

The 163 tons of solid waste generated in the camps is sent for uncontrolled dumping, controlled dumping or controlled treatment. Most of the solid waste (60% of which is organic) is transferred to collection platforms within the camps where scavengers collect the valuables that are easily recycled, which equates to about 15% of the solid waste. Seventy per cent of the remaining waste is organic. Thirty-nine per cent of the total solid waste generated by the camps is treated; 12% is sent to unknown open dumping sites.

No at-source sorting is done by those who generate the waste, except for Nahr el-Bared and Rashidieh where the NGO American Near East Refugee Aid (ANERA) has initiated household sorting initiatives. This pilot project will be expanded to Burj Shemali.

The transportation costs from the platforms to the final destination exceed $200,000/year. Most (72%) is transported by UNRWA vehicles, the remainder by private contractors. The running cost for the transport and disposal of the solid waste are increasing annually by up to 50%.

RECOMMENDATIONS: Sanitation

Waste water. Approximately one km of wastewater network must be urgently rehabilitated and 10.2 km constructed. All the camps' household manholes should be cleaned regularly and a pest-control system established. The sewer system in each camp should be maintained to prevent any infiltration of wastewater into groundwater. An awareness and education campaign must be undertaken to prevent potentially harmful substances from polluting water, e.g. properly dispose of hazardous household chemicals.

Response Plan Sanitation sector/Waste Water – Output & Targets

Output	Targets
Palestine refugees living in the 12 Palestine refugee camps in Lebanon are served with adequate sewerage systems (waste water).	Maintain the percentage of premises (schools, health centres, offices) connected to adequate waste water networks at 100%
	Increase the percentage of shelters connected to adequate waste water networks from 80% to 100%
	Increase the proportion of waste water safely treated from 0% to 25%
	Increase the percentage of camps equipped with operational waste water networks from 60% to 100%

Storm water. Six hundred meters of storm water networks require rehabilitation, 7.5km must be constructed, including new storm water networks for Dbayeh, and filter pavers should be installed in Mar Elias. Roofs should be linked to either the storm water network or used as artificial recharge by converting asphalt toxic pedestrian roads into paved filtered and porous material facilitating infiltration of rainwater into the aquifer. In the long term, storm water should be considered as a resource to be exploited.

Response Plan Sanitation sector/Storm Water – Output & Targets

Output	Targets
Palestine refugees living in the 12 Palestine refugee camps in Lebanon live in an environment in which health and other risks posed by storm water are minimized.	Increase the proportion of camps equipped with operational storm water networks from 55% to 100%
	Increase the percentage of shelters connected to adequate storm water networks from 70% to 100%
	Ensure 100% of premises (schools, health centres, offices) are connected to adequate storm water networks

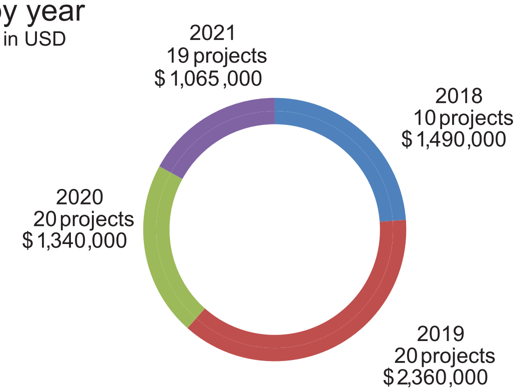
Solid waste. Recommendations for improved service provision and integrated social awareness campaigns include placement of steel bins in fixed, regular places in each camp, proportional to number of residents, with no more than 100m walking distance for each resident; the purchase of more small compactors and use of large and medium-sized compactors; as well as improving working conditions and efficiency of the UNRWA sanitation teams. E-waste, medical and toxic waste should be sent directly to the specific solid waste treatment facility so it is not mixed with material solid waste. Social mobilization and communication campaigns can be used to inform residents about the existence and proper use of the new steel bins and to educate about their role in controlling vectors that lead to destructive, vector-borne diseases.

Response Plan Sanitation sector/Solid Waste – Output & Targets

Output	Targets
Palestine refugees living in the 12 Palestine refugee camps in Lebanon have access to solid waste management services that meet minimum acceptable standards	Increase the collection and removal of domestic waste from the camps from 90% to 100%
	Increase the percentage of solid waste recycled per camp from 0% to 25%
	Increase the amount of solid waste reduction via recycling from 0% to 25%
	Increase the number of days per year the camps are kept clean of solid waste from 250 to 300
	Increase the number of times each week street sweeping is done in the camps from 4.5 to 6

The graphs below show the annual funding estimates required to achieve the expected results in the Sanitation sector.

Sanitation projects by year
in USD



Total cost, Sanitation: USD 6,225,000

III. Land / Habitat / Roads

Since 2011, the population of Lebanon has increased by 37 %, including 1.5 million Syrian refugees. Current population density in Lebanon is estimated at 565 resident/ km2. With a total area of only 2.79 km2 for all 12 camps, their average human density is significantly higher at 86,000 resident/ km2.

FINDINGS: Land/Habitat/Roads

Land/Habitat. Many shelters are at risk of collapse or are uninhabitable due to leaks and unhygienic conditions. The vast majority of the 14,000 buildings and 40,000 shelters were unplanned and were not built using safe engineering or construction practices. Most lack a foundation and were created with cheap and inappropriate construction materials, leading to cracks, leakages and in many instances structural failure.

Roads. There are 117km of roads in the 12 camps, of which 63% are pedestrianised and 37% accessible by four-wheeled vehicles. The asphalt is impermeable to runoff and its high absorption characteristics increase the urban heat island effect. Many roads are damaged due to heavy use. A total of 29 rehabilitation projects have been identified for roads within the camps.

RECOMMENDATIONS: Land/Habitat/Roads

Land/Habitat. Recommendations for buildings and shelters focus on improved planning to enhance living conditions and reduce car and motorcycle congestion and pollution, decreasing chaotic expansion, and increasing use of new building materials and construction techniques.

Roads. Upgrading and rehabilitating damaged roads and alleyways. Vehicle traffic should be limited in the main pedestrian and school/health centre areas.

IV. Energy

Energy is the most challenging sector addressed in the Response Plan. The camps' reliance (and Lebanon's as a whole) on imported oil for the production of its electricity means that transformation to renewable energy is critical. The 12 camps rely solely on fossil fuels for their energy needs, which comes from both the national grid and private generators. As the national grid can only supply 63% of the country's electricity demand, the use of private generators, which are inefficient, expensive to operate, noisy and are a significant source of air pollution, are becoming increasingly common. Greening the energy sector requires a high initial investment cost, space for the equipment and a willingness to operate on a cost-recovery basis.

FINDINGS: Energy

Generators. Workshops on renewable energy and a survey on renewable energy and green solutions were conducted. An inventory of 114 service generators was carried out. The diesel consumption of the 97 generators owned by UNRWA is approximately 22,000 litres per day.

Transformers. The approximately 25,000 transformers that are part of Lebanon's national grid do not comply with minimum environmental and safety guidelines. As part of efforts to eliminate Polychlorinated Biphenyls (PCBs) from Lebanon by 2025, a national inventory was needed to determine the "PCB non-conforming" equipment, including those in the 12 camps. Because UNRWA and the Ministry of Environment (MoE) both required qualitative and quantitative data, the two groups worked together, with UNRWA conducting the initial transformer inventory (110 transformers) and the MoE and its partners including this data in the national inventory.

Water and energy consumption. Monitoring of daily water and energy use was conducted on a very small scale (two shelters). Total daily electricity use per capita was between two kWh and four kWh, with a daily total electricity shortage of about three hours. Regular breakdowns and accidents occur due to random installations placed by the community on the networks. Electricity is mainly used for heating water. Daily water use includes saline water from boreholes (70 L per person), fresh water from a reverse osmosis system (10-15 L per person) and hot water consumption (5-20 L per person). It was found that residents preferred to purchase bottled water for drinking rather than using the fresh water from the reverse osmosis treatment plant. In terms of existing infrastructure, the very high salinity of the water is causing accelerated deterioration of the water distribution system and fixtures.

Renewable energy. The use of solar energy is promising in a country with over 300 days of sun a year. Increasing water shortages in the country mean that submersible pumps are operating sometimes around the clock and/or experiencing frequent loss of power from the national grid. Use of solar photovoltaic power for submersible pumps may provide at least cost savings for pump operation.

Fifty-eight wells equipped with submersible pumps were evaluated. Average depth was 87 metres, average horsepower (HP) of 35 and average operating hours of 11 hours per day. The study revealed that for an annual production of 2 million cubic metres of water, over 1.6 million litres of diesel fuel was used, causing significant pollution and greenhouse gas emissions.

RECOMMENDATIONS: Energy

Services generators and private generators. Extend the inventory for other services and private generators and complete the replacement of all service generators owned by UNRWA as required. All services and private generators should be equipped with adequate air pollution protection (for example, a noise reducer or ventilation pipe). Investing in one large generator per camp instead of many small ones would reduce fuel use. Along the same lines, low-electricity demand equipment should be promoted. Research should be done into the cost reduction possible through renewable energy systems with generators. Generators could be replaced with PV solar power combined with grid electricity (hybrid renewable energy systems) and solar water heating installations should be developed to reduce individual electricity needs.

Transformers. All non-conforming transformers should be replaced with new, environmentally-friendly equipment.

Water and electricity consumption. More detailed studies with a larger sample size should be done to obtain more reliable data and comprehensive knowledge of daily electricity consumption and daily water use. Improved operational practices are recommended, such as separating suspended water networks from electrical networks to limit breakdowns and improve the electrical distribution networks and use of proper materials to avoid accelerated deterioration of water connections caused by saline water. Adopting innovative incentives will help promote environmentally friendly and energy efficient behaviour in parallel with environmental and social awareness campaigns.

Renewable energy. If a pump operates for 10 or fewer hours a day, use of solar energy alone is feasible. It is possible to use a hybrid approach of both solar energy and generators for pumps operating longer than this. A good first option for migrating toward renewable energy sources would be to begin with pumps with a capacity lower than 40 HP, a maximum depth of 100 m, and a roof or open space available for installation.

V. Air

Air pollution is now the world's single largest environmental health risk. Lebanon's MoE has implemented various actions and projects related to air pollution, climate change and ozone depletion, including monitoring the operations of electric generators.

FINDINGS: Air

Sources of air pollution within the camps include smoking, heating, cooking as well as non-combustion sources. Water leakages and poor ventilation contribute to biological pollutants. The main sources of air pollution in the camps are likely private generators and transport.

UNRWA conducted an assessment of indoor and outdoor air quality in three highly populated camps with narrow streets (Burj Barajneh, Wavel and Mar Elias). The proportion of roads that are pedestrianised versus accessible to passenger cars varies between camps, with two-wheeled vehicles and passenger cars using any road where they will fit. Emissions are impacted by the poor maintenance of vehicles and the topography of the roads. Called "canyon streets" because of their canyon-like cross-section, they can trap airborne pollutants at ground level.

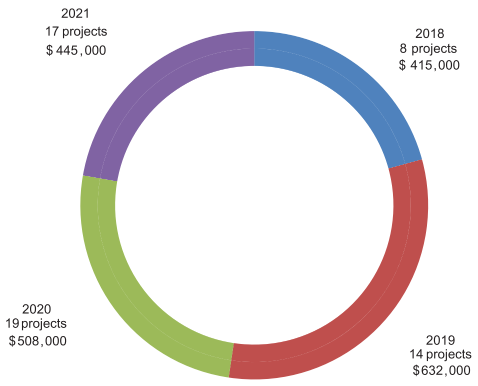
Although there were challenges collecting the data, air quality tests done in one camp show that the concentration of PM10 exceeded standard limits, with an average of 171 μg per cubic meter (80 μg being standard).

RECOMMENDATIONS: Air

In the short-term, generators should be relocated to outside the camp boundary, be fueled by diesel with low sulfur instead of "red" diesel and control equipment should be installed on private generators. In houses, low-consumption lamps should be used and continuously-operated ventilation installed to avoid accumulation of pollutants inside from indoor sources.

To decrease the impact of air pollution on refugees' health in the long term, water solar heaters and solar panels should be installed, and solar-charged, electric two-wheeled vehicles should be used. Awareness sessions about air pollution, its sources and impact, and how to avoid it should continue to be conducted as well as sessions regarding tobacco and shisha smoking and their adverse effects. In addition, pedestrianised alleyways and roads, on weekend or during market days should also be developed.

The graphs below show the annual funding estimates required to achieve the expected results in the Energy and Air Sectors.



Total costs, Land/habitat/roads: USD 1,350,000; Energy/air: USD 650,000

Response Plan Land /Habitat /Roads/Energy/Air – Output & Targets

Output	Targets
Palestine refugees living in the 12 Palestine refugee camps in Lebanon live in an environment in which health and other risks posed by inadequate habitat infrastructure, materials and technologies, inadequate land, air, energy qualities, equipment and technologies are minimized.	Decrease the annual mean levels of fine particulate matter (PM10) in Palestine refugee camps to 80 µg/m3
	Increase the number of areas equipped with independent and functional weather stations from 0 to 5
	Increase the percentage of service generators equipped with efficient air filters and noise reducers from 75% to 90%
	Increase the percentage of transformers aligned to the Stockholm Convention on PCBs from 50% to 90%
	Increase the number of camps that have benefitted from at least one innovative technology such as soil artificial aquifer recharge, filter-paved pedestrianized roads, solar energy systems (thermal or PV), Disaster Risk Reduction from 0 to 12
	Decrease the percentage of construction material containing asbestos to 0%

Response Plan Programmes & Tools – Output & Targets

Output	Targets
Palestine refugees living in the 12 Palestine refugee camps in Lebanon and partners involved in sustainable, efficient and innovative environmental infrastructure management & environmental health activities are aware of public and environmental health risks and apply adapted and sustainable programmes & tools.	Increase proportion of boys, girls, women and men with appropriate hygiene knowledge, attitudes and practices (target – LCRP)
	Increase proportion of camps that have at least one awareness campaign on environmental health sector with focus on IWRM and IWM to 100%
	Improve staff capacity in Environmental Health sectors and tools (to 75%) and expertise in IWRM, IWM, ACAD, GIS data management

Moving Forward & Implementation

The current situation in Lebanon is highly complex and fragile, due to the ongoing humanitarian context as a consequence of the Syrian crisis, and the low socioeconomic status of Palestine refugees. UNRWA must make significant efforts to promote basic rights of the Palestine refugees and provide basic services, while also maintaining and rejuvenating ageing, overloaded infrastructure. It is therefore crucial that the international community remains engaged in activities that improve the living conditions inside the Palestine refugee camps in Lebanon, as well as that of the Lebanese communities and other populations residing in the camps.

The implementation of the qualitative and quantitative water monitoring surveillance plan is the **top priority** for 2018 and will ensure a sustainable and efficient water supply in the 12 camps. The **second priority** concerns the implementation of a sustainable and viable solid waste management plan to decrease the amount of waste produced in the camps, but also to develop viable and innovative options to transform waste into an economic value. The most challenging is the energy sector and the provision of an efficient electricity supply through conventional or renewable sources of energy. This will become more and more important as it has direct impacts on other sectors, including water, sanitation and habitat. Investing in a more efficient grid system, transferring from the national to the local level, will reduce the risk of multiple generators with one of the highest cost per kWh in the region. Both habitat and air sectors can potentially be improved by enhancing urban planning with infrastructure and household thermal-energy efficient appliances. A key component to success is civil society, particularly individuals who must start by respecting “rights and duties” common to modern societies and be held accountability to rules, regulations and customs that bind a community together. Promoting innovations such as pedestrianized, non-toxic, filter-paved roads, rainfall collection for recharging the aquifer and reducing the runoffs, greening on roofs, reintroducing biodiversity in the urban context, introducing solar energy street lighting systems or awareness campaign competitions for promoting environmental health, are realistic and feasible operational priorities that will contribute to a safer and healthier environment.

Table of contents

PART 1
INTRODUCTION

Part 1

Introduction

In June 2016, in consultation with UNRWA senior management, operations departments and field teams, the Director of UNRWA Affairs in Lebanon endorsed the Environmental Health Strategy 2016 – 2021 (EHS)[1]. The EHS was shared with relevant external partners such as the Ministry of Environment (MoE) and the Ministry of Energy and Water (MoEW), as well as national, international, humanitarian, academic and private institutions and organizations active in the environmental health domain in Lebanon. The EHS, of which the Response Plan (RP) is one component, refers to global principles set by the Sustainable Development Goals (SDGs) and have been appropriately adapted to the local humanitarian context found in the 12 Palestine refugee camps.

The EHS "*rolling*[2]" strategy is composed of five steps outlined in Figure 1 below. The strategic plan was completed in June 2016, followed by the inventory and needs assessment between October 2016 and November 2017. The Response Plan is a result of this and must be considered together with the last two phases of implementation and monitoring and evaluation. This will in turn contribute to achieving the overall objectives of the EHS.

Figure 1. Steps of the Response Plan in the rolling strategy.

[1] Abdelal M., Guillot C., UNRWA Field Infrastructure and Camp Improvement. (2016), Environmental Health Strategy 2016 – 2021 for the Palestine refugee camps in Lebanon.

[2] The concept of the "rolling strategy" refers to the volatility of the Lebanese environment (humanitarian, political, environmental) in which the 12 Palestine refugee camps are located and also refers to the constant need for adaptation.

In October 2016, the inventory and needs assessment was launched as per the action plan outlined in the EHS, covering the relevant environmental infrastructure and environmental health sectors - land, habitat, water, sanitation, energy and air - present in the 12 Palestine refugee camps in Lebanon. A substantial focus was placed on the water and sanitation sectors as these are the core areas of activity of the FICIP environment health unit, in terms of infrastructure and management. The findings of the inventory and needs assessment are presented through a systematic approach starting with global analysis, followed by the national context and finally highlighting the local situation in the camps[3].

The recommendations presented in the RP are summarized in Part 4: General Findings, meanwhile the detailed findings and recommendations for each camp[4], are available in technical reports at the FICIP Department. All findings and recommendations are based on technical and socioeconomic observations and surveys conducted by UNRWA and in coordination with nationally and internationally recognised expertise. Both the infrastructure in the camps and their management, in Figure 2, were systematically considered together as interdependent in all activities.

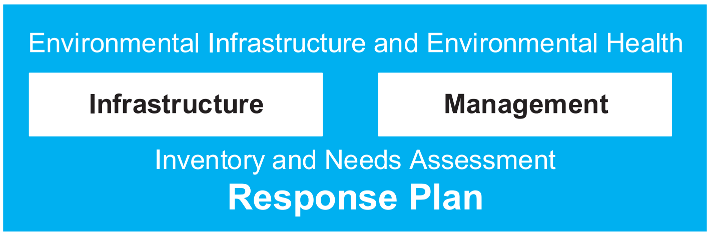


Figure 2. Infrastructure and management elements of the Response Plan.

Environmental Heatlh Field Inspection. ©2017 UNRWA

[3] Environmental Infrastructure and Environmental Health detail findings for each Palestine refugee camps in Lebanon, internal report, 150 pages, UNRWA FICIP.
[4] Environmental Infrastructure and Environmental Health detail findings for each Palestine refugee camps in Lebanon, internal report, 150 pages, UNRWA FICIP.

Objectives, Outcome and Outputs

The overall objective of the Response Plan is to provide recommendations for the improvement of living conditions in the 12 Palestine refugee camps in Lebanon. Achieving this will lead to a safer and healthier environment, ensuring the stability and development of the Palestine refugees and that of other inhabitants, including Palestine refugees from Syria (PRS), Syrian refugees, Lebanese and other nationalities temporarily residing or transiting in the camps. Enhanced, sustainable environmental infrastructure and environmental health services and management will contribute to positive impacts on the preservation of natural resources, to diverse employment opportunities, increased social cohesion and realisation of innovative solutions for better urban planning. Building community knowledge and educating the population through a participatory-communication approach is fundamental for reaching the outlined objective.

In striving towards dignity and a better life for the Palestine refugee community, the FICIP improves the built environment (new constructions and rehabilitation) by providing robust infrastructure, camp improvement services and participatory solutions in partnership with refugees and other relevant stakeholders.

The following outcome and related outputs and activities, detailed in the logical framework presented in Annex 1, cover the period 2018 – 2021 and are aligned with the UNRWA-agency vision and mandate. The target of long-term perspectives is 2030, as per the Sustainable Development Goals (SDGs). Six outputs have been identified and are outlined in Figure 3 below.

Strategic Objective (indirect impact)	In striving towards dignity and a better life for the Palestine refugee community, the FICIP, as an integrated programme, improves the built environment by providing robust infrastructure, camp improvement services, and participatory solutions in partnership with refugees and involved stakeholders.
Strategic Outcome	**Palestine refugees living in the 12 Palestine refugee camps in Lebanon are able to meet their basic environmental health needs.**
Output 1	Palestine refugees living in the 12 Palestine refugee camps in Lebanon have safe, equitable and sufficient quantity of **water** for their basic needs.
Output 2	Palestine refugees living in the 12 Palestine refugee camps in Lebanon are served with adequate sewerage systems (**wastewater**).
Output 3	Palestine refugees living in the 12 Palestine refugee camps in Lebanon live in an environment in which health and other risks posed by **storm water** are minimized.
Output 4	Palestine refugees living in the 12 Palestine refugee camps in Lebanon have access to **solid waste** management services that meet minimum acceptable standards.
Output 5	Palestine refugees living in the 12 Palestine refugee camps in Lebanon live in an environment in which health and other risks posed by inadequate **habitat** infrastructure, materials and technologies, inadequate **land**, **air**, **energy** qualities, equipment and technologies, are minimized.
Output 6	Palestine refugees living in the 12 Palestine refugee camps in Lebanon and partners involved in sustainable, efficient and innovative environmental infrastructure management and environmental health activities are aware of public and environmental health risks and apply adapted and sustainable programmes and tools (hygiene promotion, data management, visibility, communication, awareness campaigns, disaster risk reduction, integrated water resources management and integrated waste management) to mitigate them.

Figure 3. Strategic objective and expected results for the 2016 – 2021 period.

Agency Strategies and Synergies

The Response Plan is closely aligned with the UNRWA Mid-Term Strategy 2016 – 2021 (MTS); the UNRWA Strategy for Infrastructure and Camp Improvement 2016 – 2021 and the Environmental Health Strategy 2016 - 2021. It recognizes the diverse needs and vulnerabilities of women, girls, boys and men and strives to address these across a range of interventions and improvements.

Figure 4. UNRWA MTS, ICIP and EHS strategies, institutional and operational references to the 2018 – 2021 Response Plan.

The UNRWA Infrastructure and Camp Improvement Programme (ICIP), at headquarter level in Amman, Jordan, was established in 2007 to serve Palestine refugees by improving their living standards in the built environment within, around and outside of the camps. A strategy for Infrastructure and Camp Improvement 2016 – 2021 was developed, with the objective of increasing the efficiency and effectiveness of the Agency's operations. The ICIP's core functions are participatory urban planning and implementation of activities related to construction and rehabilitation of shelters; social infrastructure (health centres, schools and other UNRWA premises); environmental infrastructure (such as water and sanitation); environmental health and emergency preparedness and response for camp improvement. The ICIP Strategy[5] and its core activities and principles guided the development of the EHS in UNRWA Lebanon.

Common principles shared by the ICIP and FICIP in Lebanon have been included in the RP. These include greening (introduction of elements of environmental protection, energy efficiency and climate adaptation in architectural design and physical planning in camps); protection (ensuring that UNRWA protection standards are met); multi-level capacity development (development of effective organizational structures, efficient procedures and enhancement of human capacity); community participation (ensuring full participation and partnership with refugees, including vulnerable groups); and differentiation (acknowledgement of different contexts between the Fields[6] with adaptation of the responses). These will be developed further over the coming quadrennial period.

[5] The ICIP Strategy was development in parallel with the UNRWA Medium Term Strategy (2016 – 2021) with direct and indirect contributions to all strategic outcomes of the UNRWA MTS, including ensuring protection standards (UNRWA MTS Outcome 1), protecting refugees' health and reducing the burden of disease (UNRWA MTS Outcome 2), providing safe, accessible, suitable and conducive learning environment in UNRWA schools to school-aged children (UNRWA MTS Outcome 3), strengthening refugees' capabilities to enhance their livelihood through an integrated, comprehensive and participatory urban planning approach (UNRWA MTS Outcome 4) and contributing to ensuring the refugees are able to meet their basic human needs by improving shelter and environmental health in camps (UNRWA MTS Outcome 5).

[6] UNRWA Fields of Operations are commonly referred to as "Fields". These include Gaza, West Bank, Jordan, Syria, and Lebanon.

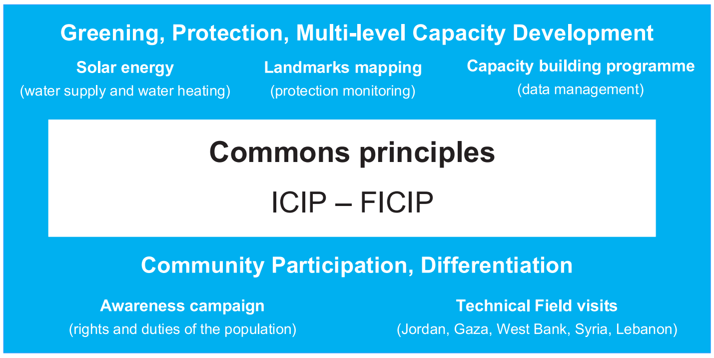


Figure 5. Common principles adapted to the Response Plan.

The Lebanon Field Office (LFO) and in addition to the FICIP Department, Health Department, Relief and Social Services (RSS) Department, Education Department and Protection Department assures the assistance and protection of Palestine refugees in Lebanon, in collaboration with other departments and units (programme, communication, donor relations, security, logistics, procurement, legal and youth).

Technical visits to environmental infrastructure and environmental health programme activities in Palestine refugee camps in Gaza, West Bank, Jordan and Syria were conducted to learn from other relevant synergies within the Agency (for example the Solid Waste Strategy[7]). In Lebanon, there exists little or no state provided environmental infrastructure and environmental health services resulting in a very high burden on UNRWA's FICIP Department and personnel.

Partnerships in the Environmental Health Domain

In September 2017, supported by the Cluster Water Sector Group, the FICIP launched an external survey among active stakeholders in the humanitarian aid and public health domain. The aim was to identify past, present and possible future collaborations within the environmental infrastructure and environmental health domain to improve the living conditions in the camps. Thirty-eight partners participated in the survey including government ministries, government institutions; United Nations agencies; the Red Cross Movement; international and national non-governmental organizations (NGOs); development and cooperation agencies and the private and academic sectors. This contributed to the subsequent actor mapping analysis.

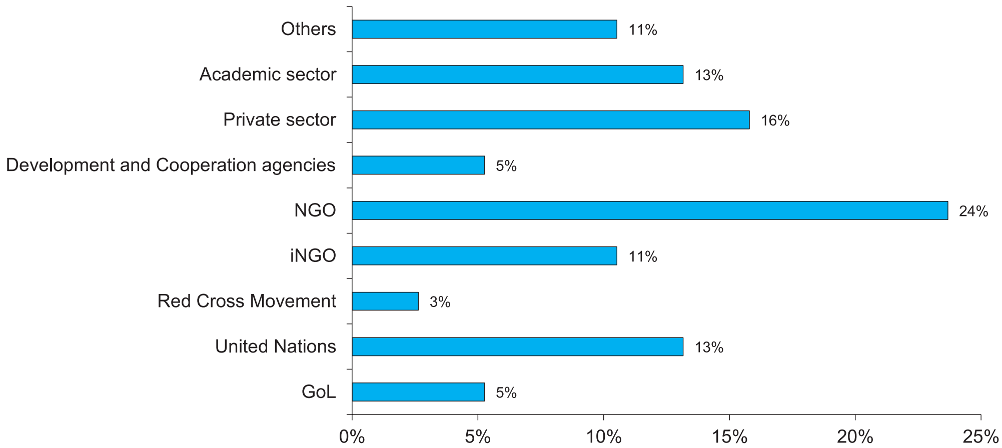


Figure 6. Participation distribution for the Response Plan survey from 38 stakeholders.

[7] UNRWA Solid Waste Management Policy and Solid Waste Management Framework. 2016.

The survey revealed that the majority of partner interventions (more than 12 per cent) focused on public health, social mobilization and hygiene promotion. The sectors with the lowest amount of investment were urban planning, disaster risk reduction, renewable energies, green economy and climate change (less than five per cent). The camps with the highest concentration of activity were Nahr El Bared (partly explained by the reconstruction project underway) and Rashidieh (with the Camp Improvement Initiative.

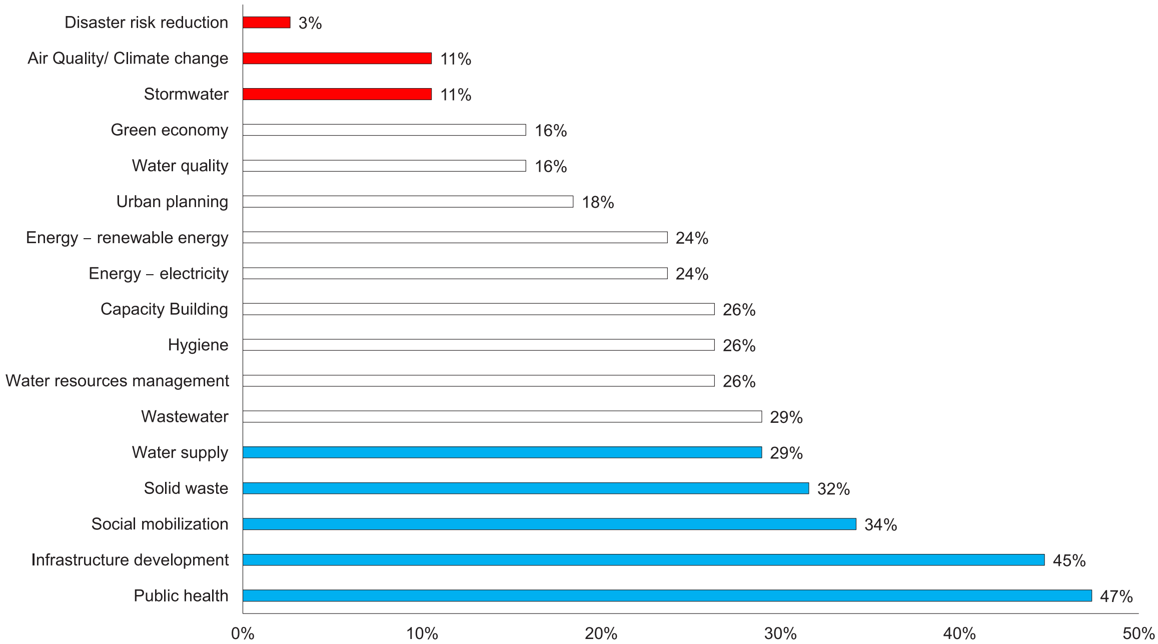


Figure 7. Environmental infrastructure and environmental health priorities recorded from 38 external partners.

An actor mapping analysis remains an essential tool for both strategic interlinkages and operational partnerships. A better understanding of the national environmental infrastructure and environmental health framework, in combination with the reality of the local resources and mandates (Water Establishments, municipalities, humanitarian, private and academic sectors) are fundamental elements for the integrated RP. Sharing information internally between UNRWA's Departments and with external stakeholders, including the Palestine refugees themselves, facilitates an efficient, transparent decision-making process. Figure 8 below summarizes all of the stakeholders, with their range of action (local, national, global) related to the Response Plan. Surveys among the refugees involved more than 645 families in the 12 Palestine refugee camps.

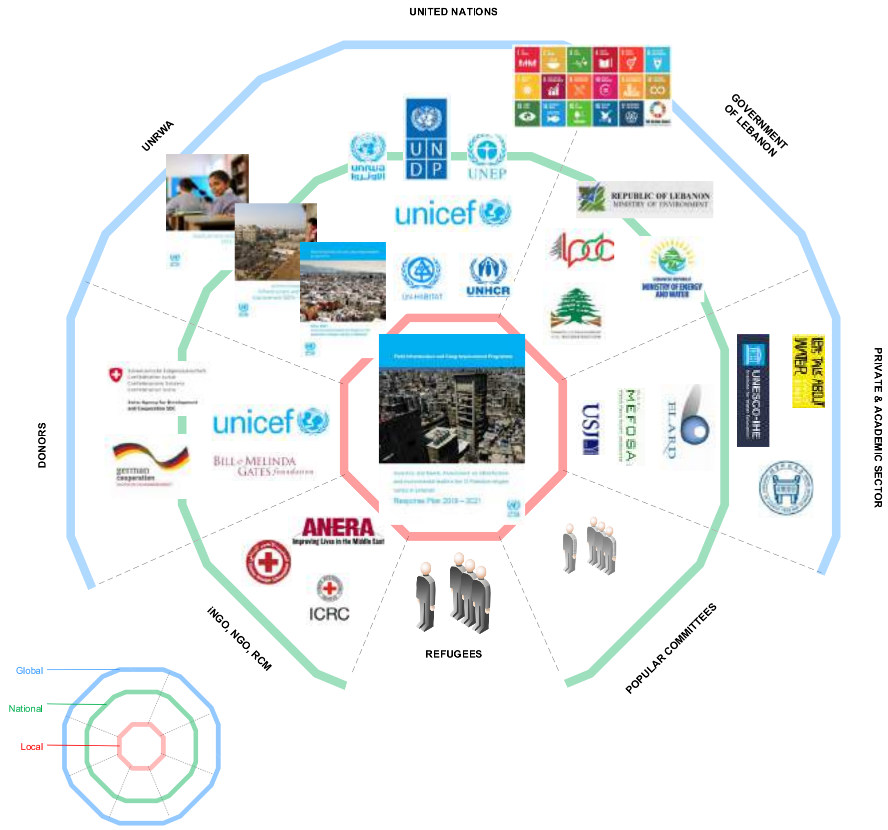


Figure 8. Actor mapping for the Response Plan.

External Interlinkages

United Nations Agencies

In June 1972 in Stockholm, Sweden, the United Nations organized for the first time the Conference on Human Environment. Following this, the General Assembly adopted two resolutions related to the environment: the first was designated as "*World Environment Day*", and became a global platform for action on environmental issues such as global warming and sustainable consumption. The second resolution created the UN Environment Programme (UNEP[8]).

In September 2015, world leaders adopted the 2030 Agenda for Sustainable Development, promising to work towards a more sustainable world where no one is left behind, and where our present way of life supports an equally good or even better life for future generations. Seventeen Sustainable Development Goals (SDGs) are at the core of the 2030 Agenda, setting high expectations for all countries in addressing challenges such as poverty, health, education, women's empowerment, growth, inequality, environment protection and governance.

[8] United Nations Environmental Programme (UNEP) https://www.unenvironment.org/

Figure 9. The 17 Sustainable Development Goals 2015 – 2030

In addressing issues that are extremely relevant to Lebanon and the Palestine refugees, the SDGs are an opportunity for the country to develop an ambitious and shared vision of Lebanon and establish measures for Lebanese and other populations living in the country to work together for a better and more equal future.

In December 2017, a Concept Note by the Joint UN Programme[9] was presented to the Government of Lebanon (GoL). Titled "*Mainstreaming Environmental SDGs into National and Local Policies and Programmes*", it includes specific Environmental mainstreaming challenges in Lebanon such as Goal 6 (ensure availability and sustainable management of water and sanitation for all); Goal 7 (ensure access to affordable, reliable, sustainable and modern energy for all); Goal 11 (make cities and human settlements inclusive, safe, resilient and sustainable); Goal 12 (ensure sustainable consumption and production patterns); Goal 13 (take urgent action to combat climate change and its impact);

Goal 14 (conserve and sustainably use the oceans, seas and marine resources for sustainable development); and Goal 15 (protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss). UNRWA Lebanon was and remains an active participant in this process.

Ministry of Environment

The Ministry of Environment (MoE) is responsible for the environmental sector in Lebanon, including the water, air, land, biodiversity and forest sub-sectors. In June 2016, the Minister of Environment and the Director of UNRWA Affairs in Lebanon, agreed to develop technical collaborations around environmental concerns related to the urban environment, including the designation of a task force comprised of experts and specialists. The function of the taskforce was to develop sustainable, efficient and innovate environmental solutions for the Palestine refugee camps in Lebanon. In September 2017,

[9] UNSF including UNRCO (support to the Office of the Prime Minister on the national SDG Agenda), UNDP, FAO, UNIDO, UNICEF, UN-Habitat, UN Environment, UNHCR, UNRWA, UNOPS in Lebanon.

an initiative supported by the Bill and Melinda Gates Foundation was engaged in the Tyre area, which aims to improve both the environmental situation in the Palestine refugee camp of Rashidieh as well as the nearby city of Tyre, including its precious wetland area under the RAMSAR[10] convention.

Ministry of Energy and Water

In 2010, the Ministry of Energy and Water (MoEW) prepared a National Water Sector Strategy (NWSS)[11] that was endorsed by the Council of Ministers and is currently being updated. The strategy is a detailed road map for improving water conditions and service delivery in Lebanon. At the local level, Water Establishments (WE) actively work with UNRWA. Collaborations between the WE and UNRWA ranges from facilitating connections to water supply networks to operational support as well as a donation from UNRWA of a water laboratory to the Beqaa WE in 2017. Hosted by the MoEW, the Lebanese Centre for Energy Conservation (LCEC) participated in a feasibility study in the Wavel Palestine refugee camp and co-organized an international workshop on photovoltaic solar energy for water supply, in September 2017.

Council for Development and Reconstruction

The Council for Development and Reconstruction (CDR) and the FICIP have worked together for many years to ensure appropriate civil engineering procedures are followed in the construction and rehabilitation of all infrastructure within the 12 Palestine refugee camps in Lebanon. This cooperation focuses on civil engineering, architectural references, regulation and guidelines as well as exchange of geodata base information on roads, water, wastewater and storm water networks which must be aligned to the municipal and national master plans "*Schema Directeur*". Accessing technical documents is essential to enable the FICIP and its partners to align the infrastructure being developed inside the 12 Palestine refugee camps with the existing and projected infrastructure in their immediate surroundings and to ensure proper and safe water, wastewater and storm water management.

However, this is not always possible due to unavailable or outdated data. UNRWA has strengthened ongoing partnerships and put in place measures to facilitate the development of new collaborations to achieve the overall objective of the Response Plan. This was done in recognition of the need for an integrated approach. Building on internal synergies and external expertise will be essential for the improvement living conditions inside the 12 Palestine refugee camps. The next part of the Response Plan outlines the scope of work undertaken during the inventory and needs assessment.

Lebanese Crisis Response Plan

The Lebanese Crisis Response Plan 2017-2020 (LCRP)[12] is a comprehensive joint plan between the GoL and its international and national partners, the aim of which is to ensure the protection of displaced Syrians, vulnerable Lebanese and Palestine Refugees; provide immediate assistance to vulnerable

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[10] The RAMSAR Convention on Wetlands of International Importance especially as Waterfowl Habitat is an international treaty for the conservation and sustainable use of wetlands. It is also known as the Convention on Wetlands. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.

[11] NWSS, "*a right for every citizen, a resource for the whole country*" produced by the MoEW is still the reference by the end of 2017. An updated or new strategy is announced for 2018.

[12] Lebanese Crisis Response Plan Water Sector 2018 Situation Analysis Response Plan. December 2017.

populations; strengthen the capacity of national and local service delivery systems to expand access to and quality of basic public services and reinforce Lebanon's economic, social and environmental stability. It reports that the water sector is unable to meet the needs of the Lebanese and Palestine populations and the additional 1,500,000 displaced persons from Syria[13]. After six years of bearing the unparalleled impact of the Syrian crisis, preceded by decades of under-investment and civil war, the water and wastewater service systems in Lebanon are under severe pressure and are in a state of disrepair. Challenges and opportunities in relation to the environment, are outlined in terms of service delivery, hygiene, awareness and responsible use of water services. The LCRP emphasises importance of developing and implementing more viable solutions to limit further delays in the transition from an emergency humanitarian response to a stabilization and recovery phase.

Uncontrolled dumping site. ©2017 UNRWA

[13] Lebanon's 2011 population growth was assessed by the World Bank at a 1 per cent annual rate. From 2011 to 2016 Lebanon has experienced the equivalent of an annual population growth rate of 6 per cent http://data.un.org/CountryProfile.aspx?crName=LEBANON. The Government of Lebanon estimates that between 2011 and 2015, the number of people inside Lebanon grew by 30 percent.

PART 2
SCOPE OF WORK

Part 2

Scope of work

Part Two of the Response Plan presents the scope of work and the methodology adopted for the inventory and needs assessment[14] of infrastructure and environmental health services in the camps.

Figure 10. Palestine refugee camps and Gatherings.

[14] The inventory, needs assessment and budget needs are not exhaustive. They are based on existing data (primary and secondary) that may differ according to the source of information and time. Update and verification of data provided in this RP remains essential.

Although the RP focuses on the 12 Palestine refugee camps in Lebanon, the FICIP adopted a holistic and integrated approach which considers that the camps are interconnected, interdependent and integrated into their surrounding natural and anthropogenic environments (municipalities, Cazas, Mohafaza[15], WEs, Territory of Lebanon, and Near East). The concept of thinking global and acting local is increasingly valid for the Palestine refugee camps in Lebanon. Deteriorated and obsolete water, sanitation and energy infrastructure and services; under-resourced municipalities and WEs; the ongoing humanitarian instability in the Middle East and North Africa (MENA) region and the consequences of climate change on the environment all impact the living conditions in the camps.

Figure 11. Global to local impact analysis considered for the Response Plan.

The integrated approach adopted in RP aims to improve the understanding of the strengths and challenges present in the camps. It also intends to develop and support opportunities which are common to the areas both inside and surrounding the camps. This holistic concept considers that cross-sector analysis and interventions will benefit the community in a more sustainable and efficient manner than the former "*piece meal*" approach, which often depended on a specific problem and financial opportunity. The integrated and holistic approach is not a theoretical model. Instead it should be translated into immediate action in response to environmental challenges, not limited to a specific location and empowering the civil society.

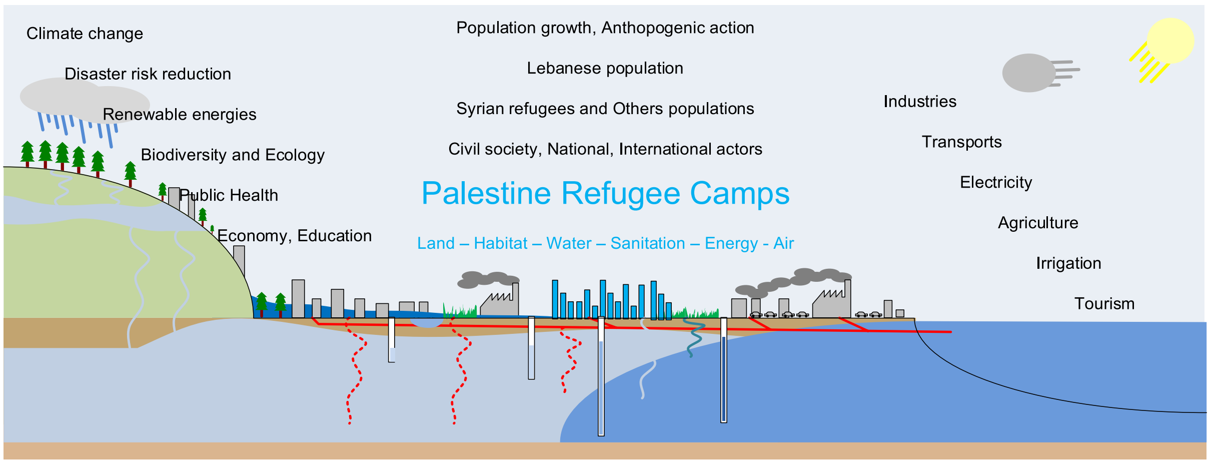

Figure 12. Schematic representation of the integrated and holistic approach applied to the Response Plan.

[15] In Lebanon, there are five governorates (Mohafaza) - North, Mount Lebanon, Beirut, Beqaa, South. Each one consists of several districts (Qadhaa/Caza) and a number of towns and villages. Each governorate has a main city.

Methodology

Between October 2016 and November 2017, more than 77 activities[16] were conducted by the FICIP for the inventory and needs assessment with a specific focus on primary data. The majority of information collected in the field and integrated into the RP was as a result of the participation of UNRWA and other UN agencies and humanitarian organizations (49 per cent) as well as contribution from the private and academic sectors (27 per cent).

UNRWA hydrogeologists and water engineer. ©2017 UNRWA

The inventory and needs assessment for the RP integrated ongoing Agency activities; accessed relevant qualitative and quantitative data through the revision of secondary data and collection of primary data and conducted an actor mapping risk assessment and environmental impact assessment, in order to answer the following key questions:

- Within each camp, where are the major environmental infrastructure and environmental health problems?
- What are those environmental infrastructure and environmental health challenges?
- How can we respond to these challenges?
- What should be the nature and the scale of the intervention?
- What are the current roles and responsibilities of all stakeholders involved?
- How can we involve the community?

Using the "*Where, Who, What*" approach for the actor mapping analysis or the "Strengths, Weaknesses, Opportunities and Threats" (SWOT) tool helped to prepare a coherent response plan, based on cross-checking, consultation and convergence analysis techniques. Data analysis considered the following parameters: location of the camp (urban, peri-urban, rural); camp geography (coastal, mountainous, latitude, topography); geology; demography (PRL, PRS, Syrian refugees, Lebanese); settings

[16] Activities took place in the land, habitat, water, sanitation, energy and air sectors and sub-sectors and programmes and tools (as per FICIP definition of environmental infrastructure and environmental health domain)

(municipalities, Cazas, Mohafaza); socioeconomic and sociocultural status; gender and vulnerable groups among others and considering numerous other assumptions.

In September 2016, a specialized environmental health team[17] composed of Palestinian, Lebanese and international personnel was composed and incorporated into the existing FICIP team. One of the team's responsibilities was to conduct an inventory and needs assessment. During the same period, between October 2016 and November 2017, a capacity building programme on environmental infrastructure and environmental health management (migration from construction to management) was developed based on existing expertise and results from a gap analysis obtained during the same inventory and needs assessment process. Finally, an "*Environmental Health Communication Strategy*" is included in the RP to encourage engagement and participation of communities and empower them to exhibit and demand their rights and duties. Due to the complex scope of work and the abundance of primary and secondary data in need of collection, analysis and revision, the entire process was conducted in a consultative and transparent manner. This involved the organization of many workshops and capacity building activities aimed at including all actors in the decision-making process. Such an approach had the advantage of reinforcing sustainability of the response. After more than 280 days in the camps and over 100 days participating in the capacity building programme, the RP was developed and immediately integrated into the FICIP strategy for 2018 – 2021.

Environmental Health workshop. ©2017 UNRWA

Environmental Health specialised team. ©2017 UNRWA

During the inventory and needs assessment process, the specialized environment health team consistently worked with the FICIP and other UNRWA departments and partners to update existing and establish new primary data. A seven-day workshop was organized and attended by over 90 staff members from UNRWA, as well as private and academic partners, to validate the findings related to the field inventory.

To maximize the efficiency of the entire process, and due to severe time and resource constraints, the inventory and needs assessment adopted a systematic methodology. All existing and accessible primary and secondary data was collected to ascertain a "*gap analysis*" to better identify the outstanding additional information required. Based on this, recommendations were drafted. The findings were based on the following:

I. Creation and incorporation of a complementary specialized environmental health team into the FICIP department, with national, international, state, humanitarian, private and academic

[17] Part of the Environmental Health Unit (EHU), environmental health expert, hydrogeologist, solid waste, habitat, energy, GIS specialists have conducted, together with FICIP team, others UNRWA departments and external stakeholders the inventory between October 2016 and November 2017. Water, sanitation and GIS specialists will continue to support the EHU in 2018 for the implementation of the Response Plan and the capacity building programme within FICIP and partners.

backgrounds. The specialists ranged in expertise from civil engineering, environmental sciences, solid waste management and renewable energies to hydrogeology, geographical information system and data management;

II. Engaging with external consulting firms and organizations (private, academic, donors and state) based on the pre-inventory findings and new database to accelerate the inventory and needs assessment tasks, which required highly specialized personnel and equipment;

III. Access to innovative and efficient monitoring and evaluation knowledge and tools (trainings, Geographic Information Systems (GIS), AutoCAD software, high-resolution satellite images, Information Technology (IT) equipment.

All partners followed the same methodology, outlined in Figure 13 below. This systematic approach helped to obtain both general and detailed findings and recommendations. The general findings for the 12 Palestine refugee camps are presented in the Response Plan, however the detailed findings, recommendations and thematic maps, are available at the FICIP Department and are presented in technical reports.

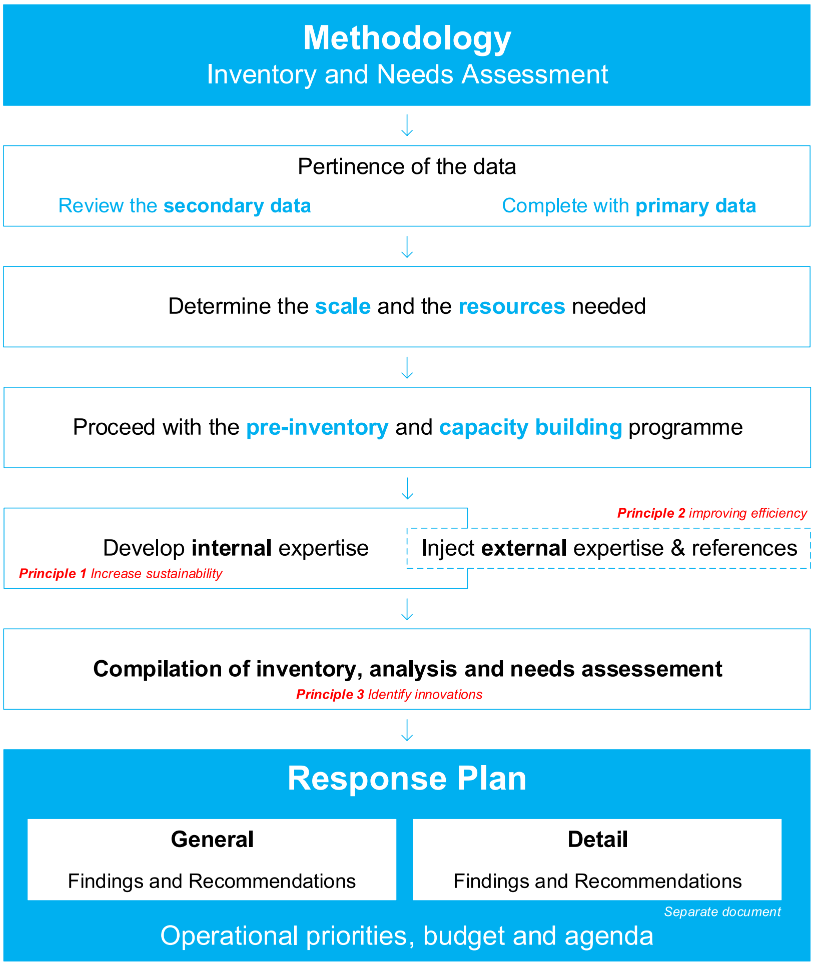

Figure 13. Methodology of the inventory and needs assessment, including the selection of the resources, pre-inventory, acceleration factor (external expertise), and adaptation for global and detailed response plan.

Every activity undertaken within this methodology adopted the three core principles of sustainability, efficiency and innovation.

Principle 1 Sustainable environment health services

Sustainable environmental health services shall be economically viable involving the best-adapted technologies and practices with consideration of the objectives and available resources. Prior to major reforms, the existing environmental infrastructure is analysed at technical, financial and human levels to identify relevant improvement measures with short-, medium- and long-term perspectives, which are well adapted to the local context and aligned to the global vision. Coordination with local partners such as WEs, NGOs and communities must be prioritized to maximize the adaptability and perennation of the services.

Principle 2 Efficient resource management

The manner in which the necessary and available resources (human, material, natural) are managed and used dictates the sustainability of the services (Principle 1). Essential services for operation and maintenance highly depend on professional skills, hardware and cost effectiveness. Improved data, resource management and planning contribute to the overall efficiency of the response and must be systematically targeted.

Principle 3 Innovative approaches

Innovative approaches which consider the micro-climate, stakeholders involved and socio-cultural aspects of the camps will be adopted. Interventions will also incorporate traditional technologies such as reverse osmosis, Ultraviolet (UV) filter, GIS software and IT. Participation of the entire community is also essential for cohesion, ownership and advancement.

Environmental Infrastructure and Environmental Health Principles		
Efficient Resources Management	**Sustainable** Environmental Health Services	**Innovative** Approaches

Figure 14. Principles of the Environmental infrastructure and environmental health domain.

Targeted Population and Geographical Coverage

Palestine refugee camps in Lebanon

The estimated population[19] in the 12 camps is 194000 including PRL, PRS and others. In addition, it is estimated that up to 30,000 visitors transit through the camps on daily basis and benefits from the provided services.

Out of the12 Palestine refugee camps in Lebanon, four are located in the Beirut area, defined by UNRWA as “Central Lebanon Area” (CLA), equivalent to an estimated population of 42,000. Two camps are found in the “Saida Area” (SAI) with a population of 53,500 and three camps are situated in the “Tyre Area” with a total population of 42,500. Beqaa area has only one camp, named Wavel, with a population of approximately 4,000, which increases significantly during the summer season.

[19] “The camps’ population figures quoted in the response plan are solely based on the amount of solid waste generated from the camps and from immediate adjacent areas in some camps and after having deducted the commercial wastes and assumed 0.7 kg solid waste generated per capita per day based on international standard. The collected solid waste covers the areas as shown in the figure 105. Accordingly, these figures are indicative only and are meant to inform and plan for targeted services”

Water tank and Reverse Osmosis plant in Shatila camp. ©2017 UNRWA

In the north and near the city of Tripoli “North Lebanon Area”, the camp of Nahr El Bared and Beddawi with an estimated population of 52,000 people, including some 16,000 living in the Nahr El Bared Adjacent Area (AA).

Area	Camp		Population per camp	Resident population (PRL PRS and others)
Central Lebanon Area CLA	Burj Barajneh	BB	21857	41942
	Dbayeh	DB	2800	
	Mar Elias	ME	2714	
	Shatila	SH	14571	
Saida Area SAI	Ein El Hilweh	EH	48214	53643
	Mieh Mieh	MM	5429	
Tyre Area TYR	Burj Shemali	BS	18000	42429
	El Buss	EB	10286	
	Rashidieh	RA	14143	
Beqaa Area BEQ	Wavel	WA	4200	4200
North Lebanon Area NLA	Beddawi	BE	22857	52000
	Nahr El Bared	NB	29143	
5 areas	**12 camps**			**194214**

Figure 15. Estimated population based on the amount of generated solid waste (0.7 kg/capita/day).

Figure 16. Palestine refugee camps and estimated populations as per environmental infrastructure and environmental health services.

In addition to the infrastructure serving the population living in shelters (households), the FICIP also ensures services and their maintenance in UNRWA schools, health centres and offices in the camps. Out of a total of 155 premises, 61 per cent are located inside the 12 camps, including 40 schools, 13 health centres and 42 other premises.

Palestine Gatherings and Adjacent Areas

Neither the Gatherings nor the Adjacent Areas fall under UNRWA's operational mandate. The formation of the first Gatherings in Lebanon dates back to the early years of the Palestine exodus (1948-1950). Most Gatherings were formed later during the Lebanese civil war (1975 – 1990), due to fighting, destruction of refugee camps and demographic expansion. Forty-two Palestine refugee Gatherings[19] are considered to be among the most vulnerable communities in Lebanon. Basic urban services such as water, sewage and solid waste are provided by different organizations including United Nations agencies and humanitarian partners. The Palestinian Gatherings in Lebanon fall under the geographical jurisdiction of 25 municipalities yet they do not provide basic urban services to these Gatherings, mainly due to lack of financial resources. According to UNDP and UN Habitat[20], an "*Adjacent Area*" is a specific category of "Gathering" located in the direct proximity or adjacent area around the boundaries of an official Palestine refugee camp in Lebanon. Gatherings and AA do not benefit from UNRWA assistance and protection but in certain circumstances, due to their direct proximity to the camps, they benefit by defacto from environmental infrastructure and environmental health services, as it is the case in Nahr El Bared and other camps.

Figure 17. Nahr El Bared "*old*" camp and Adjacent Area.

Public Health, Environment and Infrastructure

There are numerous environmental health concerns impacting the living conditions inside the Palestine refugee camps in Lebanon. Figure 16 displays many of the major concerns (list not exhaustive) of which some have been analysed and quantified during the inventory and needs assessment.

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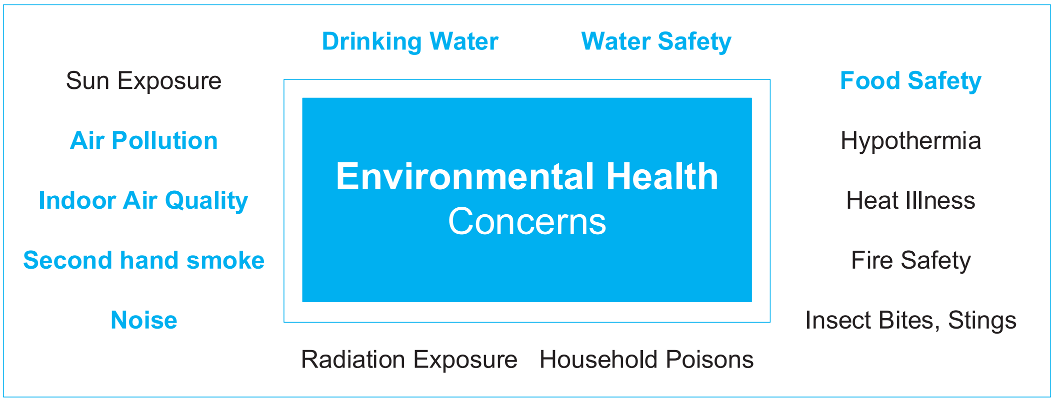
[19] Neighborhoods located outside the Palestine refugee camps where 25 or more Palestine refugee households live together, constituting relatively homogeneous refugee communities. Fafo. (2003).

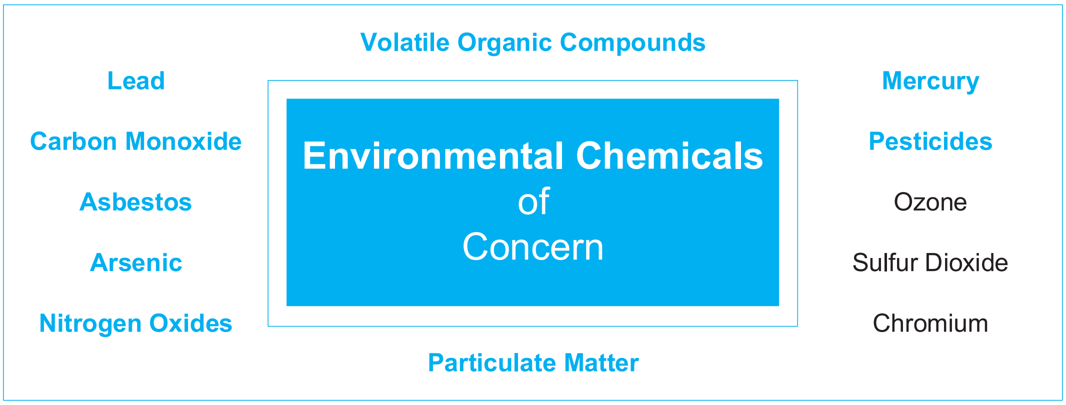
[20] UNDP / UN Habitat. (2010). Investing grey areas. Access to Basic Services in the Adjacent Areas of Palestinian Refugee Camps in Lebanon.



*Non-exhaustive list; in **blue bold**: surveys conducted during the inventory phase*

Figure 18. Environmental health concerns adapted to EHS and the Response Plan.

The major chemicals of concern to environmental health are displayed in Figure 17 (not exhaustive). Although there are thousands of chemicals and chemical compounds used daily, the RP focuses on some of those existing inside the camps - in schools, health centres and households.



*Non-exhaustive list; in **blue bold**: surveys conducted during the inventory phase*

Figure 19. Major environmental chemicals of concern adapted to EHS and the Response Plan.

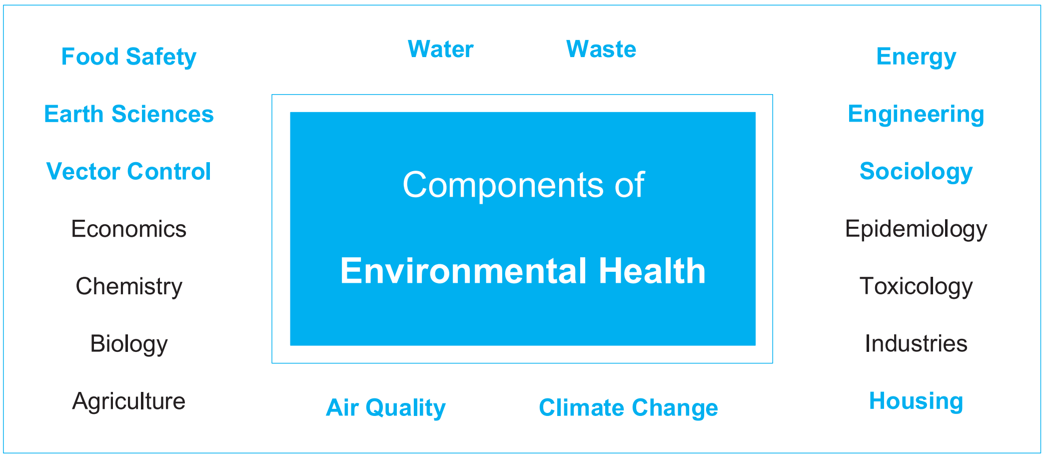
Prevention of environmental diseases is possible through a combination of means including promotion of behaviour change in communities, starting with the individual; use of sustainable, efficient and innovative technologies and developing infrastructure and services. The maintenance of existing infrastructure and application of national and international legislation and regulations is essential to improve the quality of life of the Palestine refugee population and future generations. Frequent environmental diseases, causal factors and health sectors of concern[21] are presented below.

[21] UK National Institute of Environmental Health Sciences (NIEHS), National Institute of Health. 2007.

Non-exhaustive list; in ***blue bold****: surveys conducted during the inventory phase*

Figure 20. Environmental diseases, causative factors and health sectors of concern.

The UNRWA Health Programme delivers comprehensive primary health care services, both preventive and curative, to Palestine refugees and helps them access secondary and tertiary health care services. According to recent statistics[22], 37 per cent of PRL have a chronic condition (cancer, hypertension, hyperlipidaemia, other cardiovascular diseases), 63 per cent reportedly suffered from acute illness in the last six months and more than ten per cent are disabled (physical disability including ability to walk and hear). The most commonly reported conditions are hypertension, chronic pulmonary diseases (including asthma), diabetes and cardiovascular diseases. The data found among the PRL mirrors the Lebanese national data, which shows that heart disease, stroke and diabetes are the top three causes of death in Lebanon[23]. The most common chronic disease in children (aged up to 18 years) is chronic pulmonary disease, whereas hypertension is most common in adults and the elderly. Closely linked to the health sector, the environmental infrastructure and environmental health domain addresses all human-health related aspects of both the natural environment and the human-made (anthropogenic) environment summarized below.



Non-exhaustive list; in ***blue bold****: surveys conducted during the inventory phase*

Figure 21. Components of environmental health.

[22] Health statistics from UNRWA Health Department. 2016.
[23] Institute for Health Metrics and Evaluation (IHME), 2015.

It is essential to understand the importance of the combining effect of all these elements when addressing environmental infrastructure and environmental health concerns. Nothing within this domain can be analysed in isolation. For example, the "level of danger or harm" of chemicals present in water, food, soil and air, used to be evaluated according to their dose and was done so in isolation of other contributing factors. The integrated approach adopted today highlights the fact that the number of chemical components developed in the modern human society, and to which the Palestine population are exposed, has grown immensely. The holistic approach evaluates both the "exposure" time component, as well as the "cocktail" effect, understanding that one chemical alone may not be harmful to humans and to the environment, but becomes so when associated with another. In conclusion, environmental infrastructure and environmental health is a complex domain that requires both immediate and long-term actions as well as behavioural change from the population and future generations.

Waste water sampling. ©2017 UNRWA

Street air quality survey. ©2017 UNRWA

Definitions

The general definition of Environmental Infrastructure and Environmental Health, from an urban planning perspective and as per the academic definition is as follows, "*Environmental infrastructure provides cities and towns with water supply, waste disposal, and pollution control* services. It includes extensive networks of *aqueducts, reservoirs, water distribution pipes, sewer pipes, and pumping stations, treatment systems, filters, septic tanks, desalination* plants, *incinerators and waste disposal facilities such as sanitary landfills* and secure hazardous-waste storage impoundments.[24]"

Furthermore, environmental health services aim to protect human health and safeguard environmental quality. Treatment of drinking water helps to prevent the spread of waterborne diseases such as cholera, dysentery and typhoid fever. Proper waste treatment and disposal practices prevent degradation of ecosystems and neighbourhoods. Protecting aquifers and soils from surface and underground pollutants as well as cleaning the air of pollutant gases and particles prevents adverse effects on both humans and the environment. Lastly, it ensures efficient and clean electricity production for safe and affordable use for the population.

[24] Encyclopedia Britannica. 2017.

Figure 22. SDGs applied to the FICIP Environmental Infrastructure and Environmental Health domain concept aiming to improve the living conditions of the population.

The FICIP definition and scope of activities for the "*Environmental Infrastructure and Environmental Health*" strongly focuses on water and sanitation sectors[25], but due to the multiple units of which the FICIP Department is composed (construction, shelter, camp improvement, maintenance), land, habitat, energy and air sectors are also considered as part of the adopted integrated approach and as interdependent. Without a proper energy sector, water pumps will not function, smoky generators will impact the air quality in school courtyards and ignorance of the geology formation will affect the understanding of groundwater recharge. Most of the sectors and sub-sectors have a geodata base, including attributes that can be observed in the field (a pump, a generator, a hill, an open channel, a community, a school).

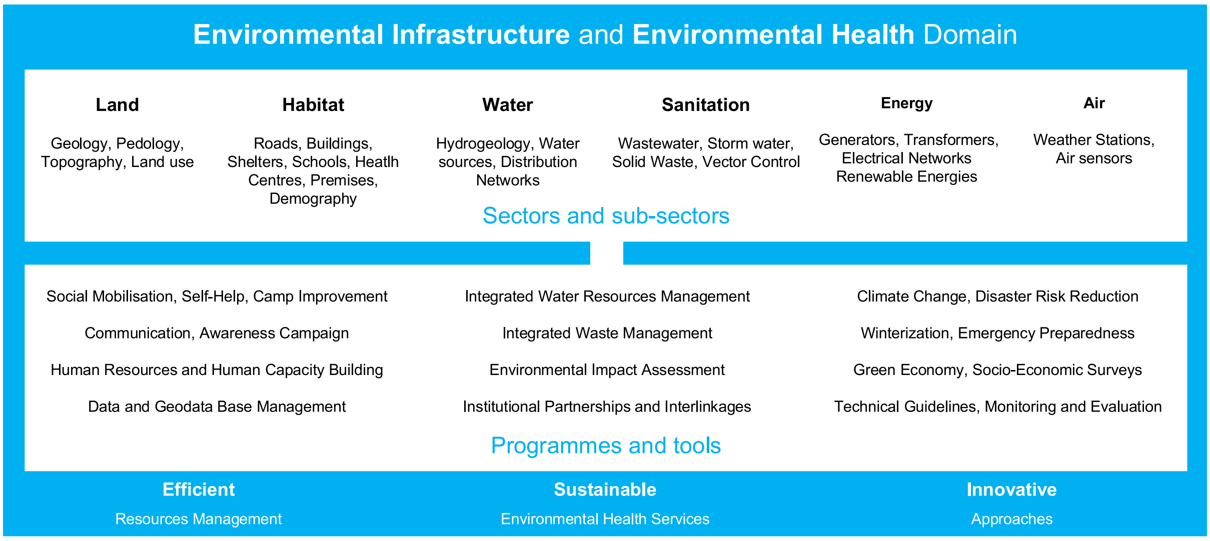


Figure 23. Environmental Infrastructure and Environmental Health domain.

The environmental infrastructure and environmental health domain is composed of all "*static*" equipment (pipes, tanks, roads, buildings), by the "*dynamic*" layer composed of human resources, refugees and vehicles, which are all together considered within the water and carbon cycles symbolised in Figure 23 below.

[25] Considered under the umbrella of the water and carbon cycles

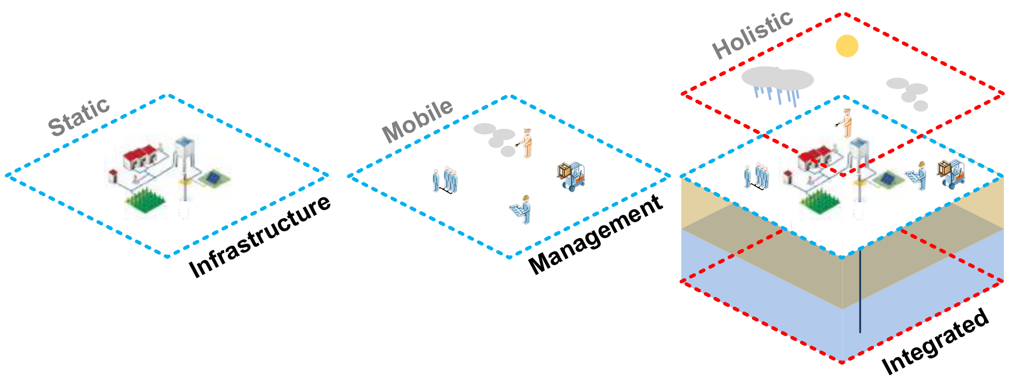
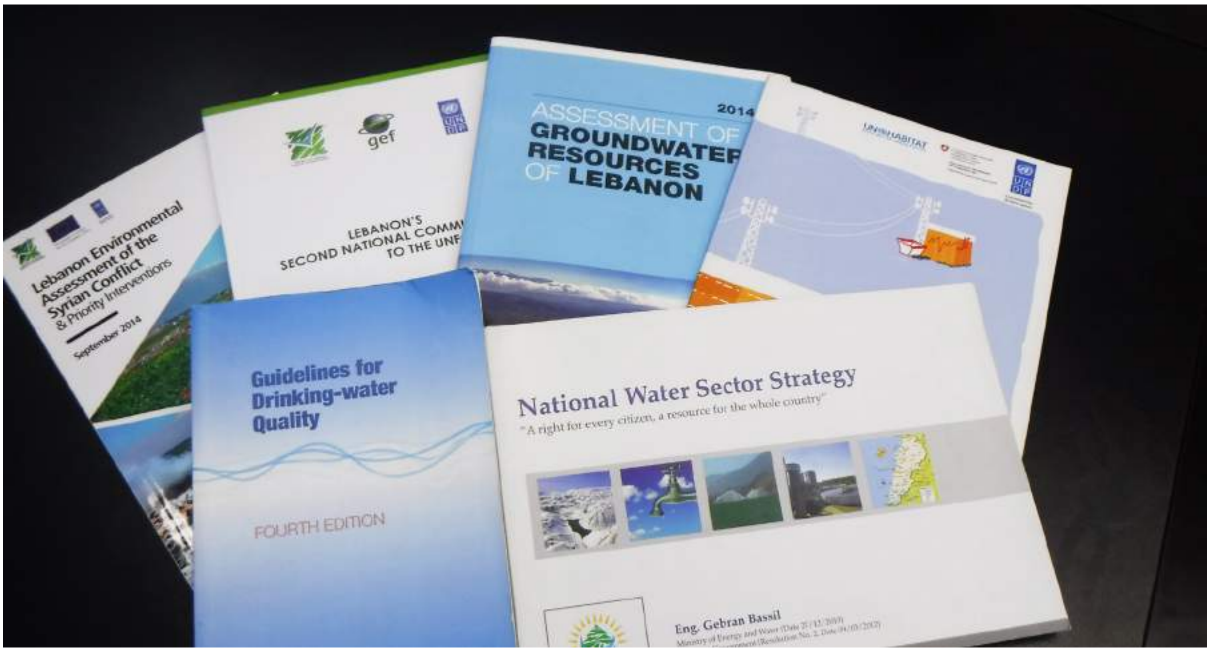


Figure 24. Infrastructure and management "layers" included in the holistic approach of the EHS.



National references for the Environmental Health Response Plan. ©2017 UNRWA

Environmental Infrastructure and Environmental Health Surveys

Between October 2016 and November 2017, a total of 11 environmental health surveys were conducted in the 12 Palestine refugee camps in Lebanon. The results and observations of these surveys, from technical and socioeconomic perspectives represent an essential part of the findings and recommendations for the Response Plan. An internal FICIP library, including exhaustive reports from UNRWA and partners, has been created and used for the development of the geodata base.

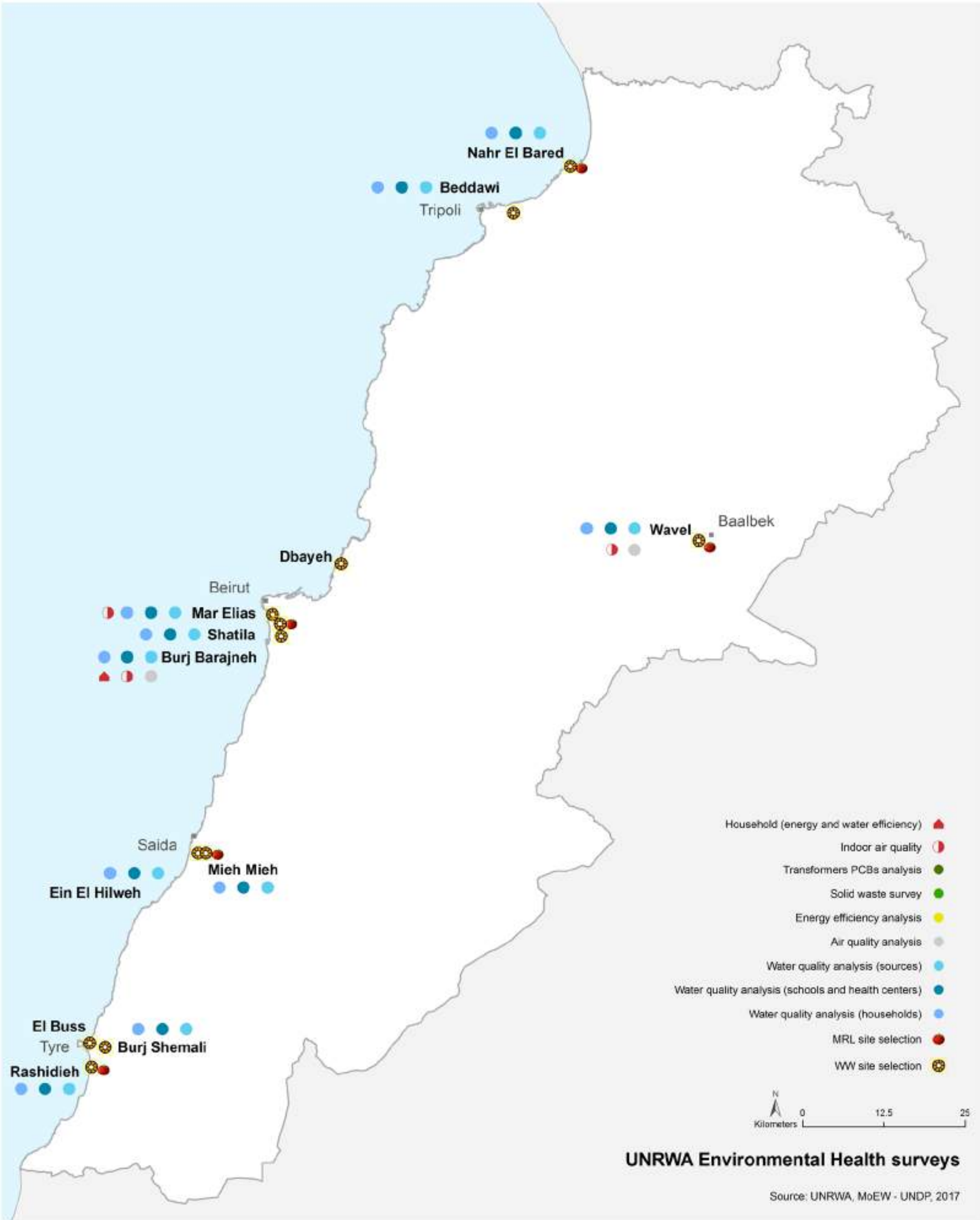


Figure 25. Environmental Infrastructure and Environmental Health surveys conducted between October 2016 and November 2017 in the 12 Palestine refugee camps in Lebanon.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PART 3
PROGRAMMES AND TOOLS

Part 3

Programmes and Tools

Programme and tools are cross-cutting and are the means by which to achieve the overall objective of the Response Plan. They are composed of essential cross-sector activities including Integrated Water Resources Management (IWRM), Integrated Waste Management (IWM), the Self-Help Initiative and Camp Improvement Plan, as well as green economy, environmental impact assessment, disaster risk reduction, communication, visibility and data management. Programme and tools are essential for all environmental infrastructure and environmental health services and contribute to their efficiency.

Environmental Infrastructure and **Environmental Health** Domain

Social Mobilisation, Self-Help, Camp Improvement	Integrated Water Resources Management	Climate Change, Disaster Risk Reduction
Communication, Awareness Campaign	Integrated Waste Management	Winterization, Emergency Preparedness
Human Resources and Human Capacity Building	Environmental Impact Assessment	Green Economy, Socio-Economic Surveys
Data and Geodata Base Management	Institutional Partnerships and Interlinkages	Technical Guidelines, Monitoring and Evaluation

Programmes and tools

Figure 26. Programmes and tools applied by the Environmental Health unit.

Not all programmes and tools are fully refined in the RP, but are mentioned to highlight the need for their development during the period 2018 – 2021. For example, an essential programme such as "*Disaster Risk Reduction*", although currently not implemented, is essential given the needs within the camps and concerns for the future, in particular those associated with climate change, high population density, risk of fire due to overcrowding, poor electrical network systems and risk of local flooding due to illegal construction and uncontrolled urban planning.

Camp Improvement Plan and Self-Help Initiative

Beginning in 2013, the Camp Improvement Plan (CIP) is ongoing in Rashidieh and has benefitted more than 5,000 families. The CIP started in Beddawi during 2017 for a period of three years and is projected to reach an expected total of 10,000 families in the first phase. In parallel, the FICIP developed a "*Self-Help*" Initiative aimed to empower families and refugees in the Shelter Rehabilitation Programme. Today 2,300 families have benefited from the initiative and a new phase will begin in 2018.

Following its destruction in 2007, Nahr El Bared has been under reconstruction since 2010. This project is managed separately by a separate team based in Tripoli. Hydrogeologists from the FICIP have contributed to the field survey for the new drilling of wells in the camp and the quantitative and qualitative water surveillance plan presented in the water sector.

Human Resources

The current environmental health unit is composed of 220 permanent staff ensuring the environmental infrastructure and environmental health services in the 12 Palestine refugee camps in Lebanon. The team is comprised of environmental engineers, administrator, area sanitation officer, area maintenance and sanitation engineer, sanitation foremen, sanitation laborers, plant mechanics and a water attendant.

The UNRWA-agency estimated ratio of sanitation laborers to refugees is one staff per 1,000 refugees. Based on this, there is a deficit of 78 sanitation laborers in the 12 camps. However, this estimation fluctuates depending on the topography of the camp, existing municipal services, climate, collaboration from the community and socioeconomic status.

To compensate this deficit allowing efficient working conditions of the FICIP Environmental Health Unit[26] (EHU), the Agency employs a "*support team*" composed of different profiles including environmental specialists (hydrogeologist, solid waste and GIS specialists) and daily laborers. The total number of support staff was 53 in 2017.The deficit remains 13 people. It is also important to note that the sanitation laborers also conduct additional tasks such as cleaning and maintenance of the wastewater and storm water networks.

Hydrogeologists visit in Nahr El Bared. ©2017 UNRWA

Sanitation laborers in Burj Barajneh. ©2017 UNRWA

Three important factors contribute to the need for additional human resources including the ageing of permanent staff who are not automatically being increased, the semi-autonomous status of the camps meaning that the municipalities do not provide full services inside the camps and deteriorating infrastructure under pressure from population growth and the additional work load to clean wastewater and storm water networks.

The current "*support team*", composed of 53 staff needs to be integrated into the permanent team and increased by an additional 13 people in 2018, resulting in an environmental team of total of 286 in 2018, 287 in 2019, 289 in 2020 and 290 in 2021 under the assumption that the current situation in Lebanon does not deteriorate.

year	2017	2018	2019	2020	2021
Permanent EH staff (GF)	220	220	220	220	220
2017 "Support" staff to the Permanent team	53				
2017 deficit to meet the total HR needs	13				
2018 – 2021 deficit to meet the total HR needs	66	66	67	69	70
Environmental Health Unit (Permanent + Support)		**286**	**287**	**289**	**290**

Figure 27. Total EH team (permanent and support) needed from 2018 until 2021.

In terms of budget and based on the FICIP salaries grid, the deficit for the "*support team*" is estimated to be 34 per cent of the permanent staffing costs supported from General Funds (GF), fixed to a floor

[26] EHU is one unit of the FICIP. Other units include construction, shelter, camp improvement, maintenance and finance.

rate in terms of number. Investing in human resources will bring an added value, including alleviating the burden on the existing permanent staff (aged, overloaded with high rates of stress and health problems), ensure efficient and safe operation and maintenance of services and improve the overall quality of service provision among the population. The deficit is estimated at around USD$ 600,000 for 2018, equivalent to a total of 66 people in the "*support team*".

In addition to these routine human resource needs, the specific situation in the Adjacent Areas of Nahr El Bared (where approximately 16,000 PRL are living) requires support staff until the completion of the reconstruction project in the "*old camp*" planned for the end of 2020.

From a coordination perspective, the Environmental Health coordinator (Field Sanitation Officer) requires specialists at LFO level (hydrogeologist, solid waste specialist, data managers). At area and camps' level, the area sanitation officer must be reinforced with a deputy which is included in the capacity building and management process for the four areas with more than one camp (except Wavel).

UNRWA and Popular Committee engineers. ©2017 UNRWA

Sanitation laborer in Rashidieh. ©2017 UNRWA

From a data and GIS / AutoCAD perspective, the specialists who worked on the inventory and the creation of the new environmental infrastructure and environmental health database, will continue their duties within the unit, but will also expand the expertise and management tool to other FICIP units (construction, shelter, maintenance and camp improvement), both at LFO and field level. Figure 26 summarizes the EHU coordination structure, at FICIP Beirut level and in each of the five areas.

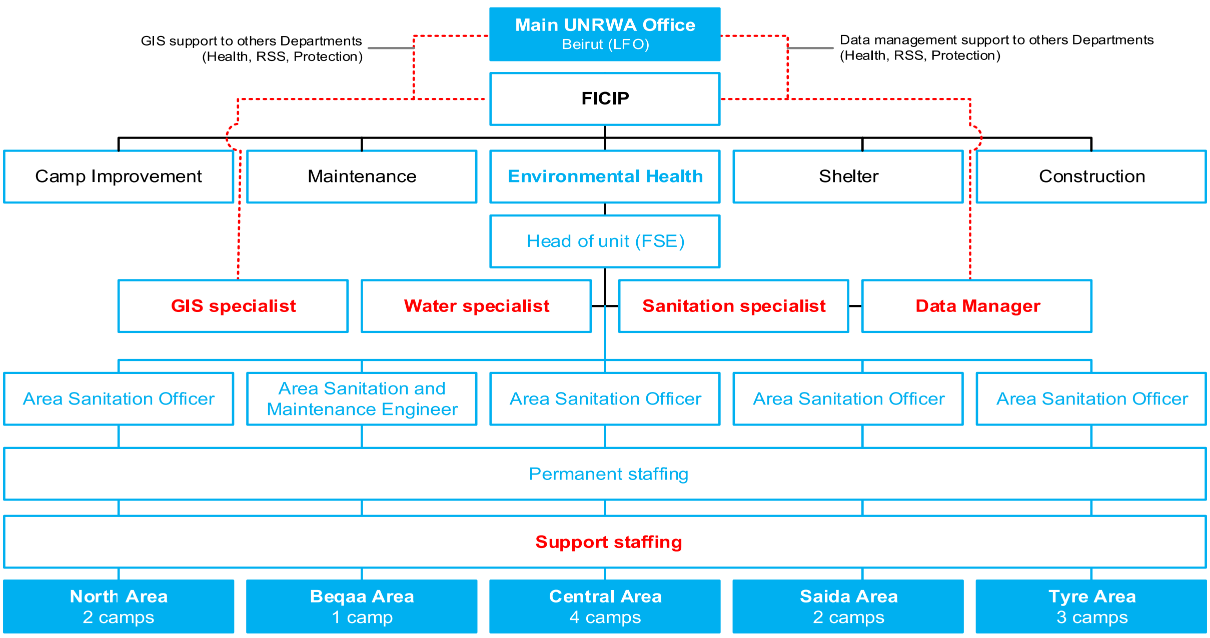


Figure 28. 2018 – 2021 Environmental Health Unit set-up at coordination and managerial level.

Human Capacity Building Programme

Human capacity building is an essential element of the RP for improving the quality of management and to ensure rapid and efficient adaptation by trained and skilled staff and partners (individuals and organizations).

The action plan for capacity building was developed in the EHS (§3.5.1. Capacity Building) and has since been conducted in different phases. In 2017, activities focused on UNRWA staff and participants from other United Nations agencies (UNICEF and UNHCR), the Government of Lebanon (ministries, Water Establishments, municipalities, various institutions) and the private sector. During the period 2018 – 2021, the capacity building programme should be expanded to local partners and civil society through specific trainings.

Internal Level (FICIP and Other Departments)

Internal capacity building activities at UNRWA focused first on the FICIP staff, but was rapidly expanded to other departments that work closely with the FICIP and its environmental health strategy. Following that, others interested in using the programmes and tools developed during the inventory and needs assessment phase were included.

An internal FICIP survey was conducted in January and February 2017. The high participation rate (82 per cent) allowed the FICIP to develop an efficient capacity building programme in response to the Agency's priorities as well as the individual's professional interests. The majority of respondents were male (90 per cent) with permanent contracts (73 per cent). The prevalent academic background within the FICIP is civil engineering (56 per cent), followed by vocational technical backgrounds, architects and environmental engineering. Sixty-five per cent of participants rated the development of professional skills as very important. Only 30 per cent had previously received specific training in their technical sector while employed at UNRWA. For those who had benefited from trainings, 48 per cent were focused on water quality and water supply, 30 per cent on project management, 24 per cent on solid waste and 19 per cent on civil engineering. Trainings on AutoCAD, public health, disaster risk reduction and GIS were provided for 10 – 15 per cent of respondents. Capacity development on environmental science, urban planning, energy, renewable energies, green economy and climate change were minimal (up to three per cent).

Regarding the use of tools and new expertise, 36 per cent of participants highlighted their daily use of tools. More than 50 per cent evaluated the quality of the trainings on tools and new expertise as "*excellent*" or "*very good*". Microsoft Word and Excel are by far the most utilized software programmes (92 percent and 89 per cent respectively), followed by AutoCAD (47 per cent) and GIS ESRI (14 per cent). The candidates require introduction or refresher courses for AutoCAD (55 per cent), GIS ESRI (53 per cent), Microsoft Excel (50 per cent) and Microsoft Visio Technical (39 per cent).

In terms of new topics for upcoming trainings during the 2018 – 2021 period, the top three priority areas include project management, AutoCAD and water resource management. Less prominent subjects mentioned were green economy, renewable energy, GIS, electricity and climate change.

Based on the EHS action plan (§3.5.1. Capacity Building) and the results of the internal FICIP survey, a training programme of 28 modules (technical missions, trainings and workshops) was developed by UNRWA. The majority of these trainings and workshops took place in Lebanon (87 per cent).

Specific missions and trainings were conducted in the MENA region (mainly in Jordan where the ICIP is located) and in Europe (Germany and UK). Regarding the profile of the experts, only institutions were included in the programme to guarantee quality and accountability. Due to the limited available facilities in Lebanon, 62 per cent of experts were international, 29 per cent national (29 per cent) and 10 per cent were combined (national and international).

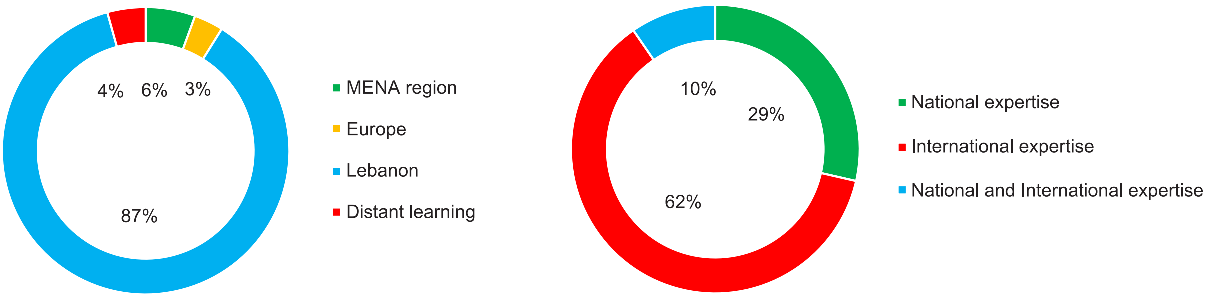


Figure 29. Location and expertise included in the UNRWA capacity building programme.

The capacity building programme included six topics (environmental health, water, sanitation, energy, air, and programmes and tools) for a total of 149 people from 31 institutions, agencies and companies[27]. Participants benefited from at least one of the 28 modules, depending on their function, interest and expertise. Due to the flexibility of expert partners, where possible, each programme was "tailor-made" to address the UNRWA and Lebanese context.

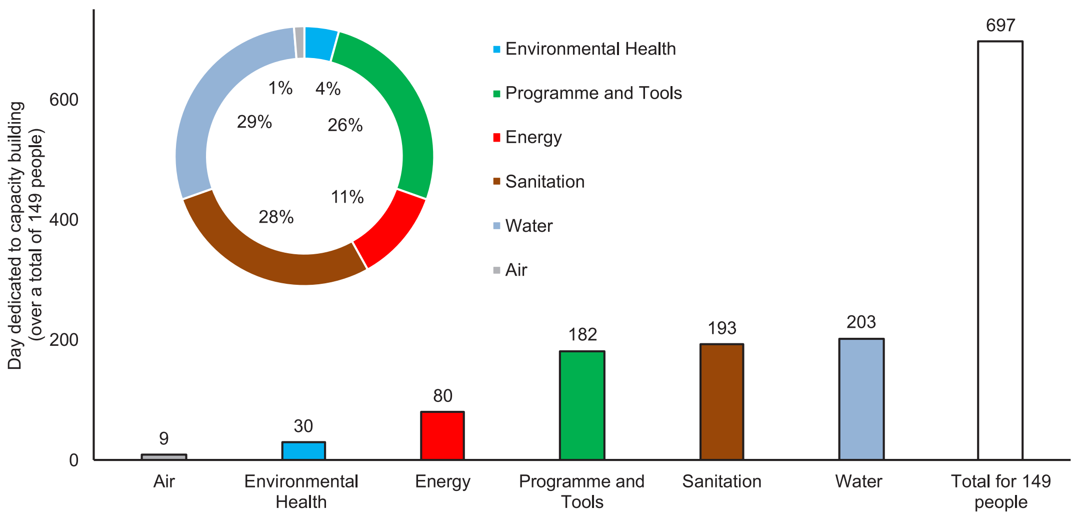


Figure 30. Distribution of trainings (by day per person) for the six EH categories (in % of the total participants).

Environmental health domain

- Strategic planning and technical visit to Gaza, West Bank, Jordan and Syria
- Environmental law and policy
- WASH and construction in the MENA region

Water sector

- Integrated water resources management
- Water quality and quantity monitoring
- Use of water laboratories, camera inspection for boreholes

[27] UNRWA, UNICEF, UNHCR, Water Establishments, Ministries, CDR, LCEC, Directorates, NGOs and private companies

Sanitation sector

- Integrated waste management
- Solid waste management
- Technical visit to incinerator company in the UK

Energy sector

- Training course on solar energy (photovoltaic) for water supply
- Technical visit to solar energy company in Germany
- Technical training on Polychlorinated Biphenyls (PCB) survey

Air sector

- Training on weather station installation and monitoring
- Training on air quality data collection (particulate matter, gases)
- Technical visit to indoor air quality company in the UK

Programmes and tools

- Monitoring and Evaluation
- Inventory workshops
- Geodata base UNRWA ICIP – UNRWA FICIP workshops
- AutoCAD (design) trainings modules 1 and 2 (introduction and advanced)
- ArcView ESRI (GIS, mapping) trainings modules 1 and 2 (introduction and advanced)
- Google Earth (GIS, management) trainings modules 1 and 2 (introduction and advanced)
- Vector Works training

Among the 149 people who benefited from the capacity building programme, 64 per cent were UNRWA staff, 30 per cent were employed by national institutions or in the private sector and five per cent were from other UN agencies and NGOs.

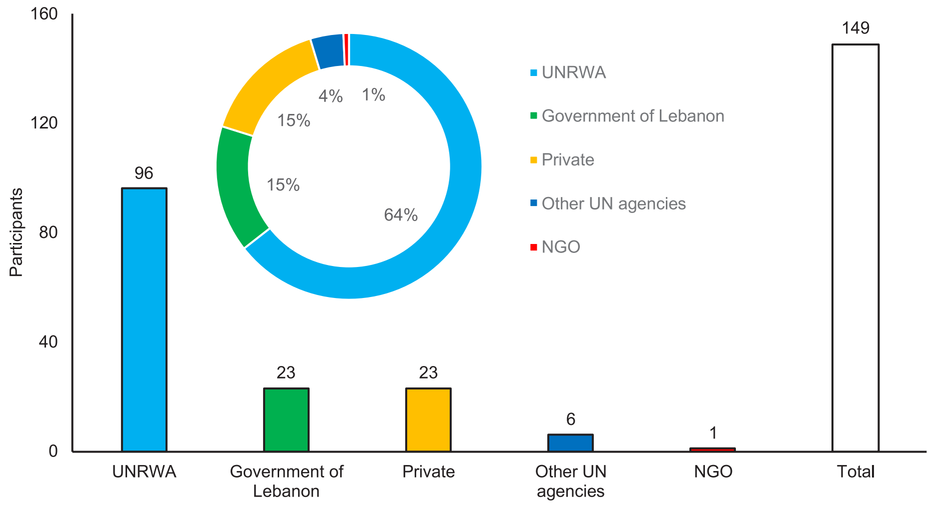


Figure 31. Distribution per category for the human capacity building programme.

IHE Delft Institute Course on IWRM and IWM (academic sector)

The first example of "human capacity-building" is related to the academic sector.

A two-week capacity building course on Integrated Water Resources Management (IWRM) and Integrated Waste Management (IWM) was organized by the FICIP and conducted by IHE Delft Institute for Water Education for 60 participants from UNRWA, UNICEF, UNHCR, national institutions and NGOs.

The first objective was to engage IHE Delft Institute in order to have an internationally recognized academic institute to conduct a "tailor-made" scientific course adapted to the MENA region and in particular to high density urban contexts such as the Palestine refugee camps and the surroundings municipalities. The second objective was to identify solutions to be developed during the 2018 – 2021 period, in an integrated and holistic manner, as it is the case for three new UNRWA projects: Qualitative and quantitative water surveillance plan for existing and new water sources, solid waste management operational plan in the 12 camps and waste-for value project on wastewater in Rashidieh camp.

The first module of the UNRWA Environmental Health Infrastructure Capacity Building Programme on Water and Sanitation Management took place in Beirut in September 2017, meanwhile the second module on Water and Sanitation Management was organized in October 2017. IHE Delft Institute for Water Education staff involved in the course addressed six different topics: solid waste management, wastewater treatment, drinking water supply through aquifer recharge, desalination for drinking water production, water transport and distribution and groundwater quality and treatment. All topics were adapted to the current situation and challenges in the Palestine refugee camps and the surrounding municipalities.

Specific application of the topics covered by these courses were initiated in several camps, including "*qualitative and quantitative water surveillance monitoring plan*", "*solid waste management project*" and "*waste-for-value wastewater project*".

Lorentz Training on PV Solar Energy for Water Supply (private sector)

The second example of "human capacity-building" is related to the private sector. The training was co-organized by the FICIP with the Lebanese Centre for Energy Conservation (LCEC), hosted by the MoEW with the participation of the United Nations, non-governmental and private sectors.

A three-day module capacity building course on photovoltaic (PV) solar energy for water supply was conducted 55 people from United Nations agencies, government institutions and the private sector in Beirut in September 2017. The course aimed to provide engineers and managers with the basics of PV and access to PV solar software to design and evaluate the advantages of solar energy as source of power for water supply.

The course addressed six different topics: solar basics, pump basics, designing a solar water system, calculation of efficiency, submersible and surface pumps for drinking water, irrigation and other application. Following the course, one field visit to Wavel was organized to evaluate the application potential for migration from the hybrid "*EDL / generator*" current system to a greener option with the "PV solar / EDL" option to pump the water for the Palestine refugee camp (feasibility study presented in the Wavel section, ELARD. 2017).

The main objective of this course was to allow engineers from UNRWA, LCEC and the private sector to share their experiences to gain a better understanding of the advantages and challenges in the domain of PV solar energy for water supply for small to medium-size project application.

PCBs Management in the Power Sector (state sector)

The third example is related to the very specific capacity building trainings conducted by the private sector under the coordination of the Polychlorinated Biphenyls (PCBs) Management in the Power

Sector Project, financed by the World Bank. Two trainings were provided for UNRWA staff related to the inventory of transformers and the sampling for PCBs' evaluation.

Training on water laboratory. ©2017 UNRWA

Training on IWRM and SWM by IHE Delft. ©2017 UNRWA

Recommendations

For the vast majority of the trainings, refreshment courses with field application are necessary, especially for innovations and relatively new technologies in Lebanon. The 2016 – 2017 capacity building programme revealed the limited expertise in the environmental health domain among UNRWA staff and throughout various institutions in Lebanon, leading to unrealistic project design or inefficient and costly projects. Reinforcing the capacity and the skills of UNRWA and its partners (decision and implementation) is fundamental for the efficiency of the solutions and the sustainability of the projects.

The migration from the construction phase (2007 – 2017) to a management phase (2017 – 2021) will only succeed if those involved possess the specific skills required and adequate knowledge of programme and tools such as AutoCAD, Environmental Systems Research Institute (ESRI) and field equipment.

The priority for 2018 is to ensure that the knowledge shared and training provided is well integrated within the FICIP team with particular focus on the following:

- Use for field monitoring and project analysis and development of GIS ESRI geodata base;
- Use and systematic application of AutoCAD guidelines and protocols for UNRWA and all partners in existing and new design projects (aligned to GIS);
- Refreshment courses and field training on IWRM implementation of the "*water qualitative and quantitative surveillance plan*";
- Capacity building programmes on solid waste management aligned to the operational plan of action for the 12 refugee camps;
- Data management systematic training (filing, monitoring and evaluation).

The second priority will be to enlarge the capacity building programme to UNRWA's local partners, including NGOs, popular committee staff, social groups and private water companies, among other relevant members of civil society. Optimizing the awareness campaign to expand and encourage the exchange of expertise and innovations, in both directions, is a priority activity to be developed during 2018 – 2021. This will alleviate some of the burden on the Agency as more people will become better informed and empowered on the daily actions which contribute to improved environmental infrastructure and environmental health services.

Due to the current humanitarian, political and environmental context, there is a genuine need to join efforts to organize and develop Human Capacity Building Programme on environmental health domain. Despite exceptional cases, leading and internationally recognized academic and private organisations are reluctant to engage in collaborations in Lebanon and in the Palestine refugee camps mainly due to the negative security situation. To maximize the efficiency of the programme, the FICIP chose to collaborate with academic, private and state sectors which has led to the achievement of results and contributed to the restoration of the trust between institutions and organisations which is necessary for sustainable collaboration.

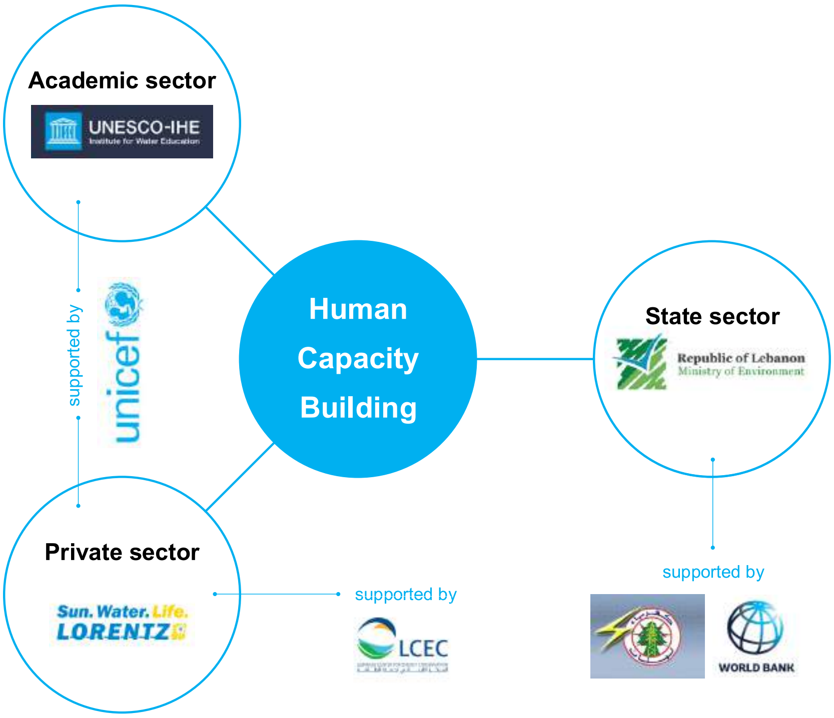


Figure 32. Academic, private and state partnerships for human capacity building programme benefiting UNRWA staff and Palestine refugee camps in Lebanon.

Sector coordination and feedback – Technical Workshop

On Thursday, June 28th 2018, UNRWA held a technical workshop with three key objectives:

1. To consult and endorse with all stakeholders the findings, recommendations and solutions proposed in the Response Plan.

2. To identify complementarity with the activities and strategies of the Government of Lebanon and various development actors.

3. To explore avenues for collective actions/advocacy to improve the living conditions of the Palestine refugee population and to better manage the natural resources they depend on.

The workshop was attended by more than 50 partners from local and national governmental institutions, the donor community, local and International NGOs, think tanks, the private sector, and other implementing partners working in the Environmental Health domain.

Special effort was made to provide a more user-friendly and dynamic forum to present the response plan and invite discussion and feedback. As such, a series of different sessions took place, including presentations of the response plan, but also plenary question and answer sessions, issue-specific group work, and a market place for presenting the work of different partners.

Participants were drawn from across government, the donor community, civil society, the private sector and more.

Reflective of this new approach, Antwork, Beirut's innovative co-working space based in Hamra was chosen to host the event. The choice of a fresh venue further demonstrated that this was not a business-as-usual workshop. Instead, participants worked both inside and out in the garden, keeping levels of engagement high.

All critical comments and feedback from the workshop has been incorporated into this response plan and the pages that follow.

Sector Specific Materials with key information were prepared for the participants (see annex 21).

Participants during group work sessions, providing feedback on the Response Plan via specially developed case study example.

Equipment and Tools

It is recommended to limit the purchase of equipment and tools to a minimum level to avoid unnecessary expense and duplication and to ensure efficiency and flexibility when cross-checking results from a service provider (private or state). For this reason, a minimum set of monitoring tools and equipment has been procured by the FICIP in order to perform field data surveys and to verify some of the findings provided by clients. Each team member has been trained on the proper use and maintenance of the equipment and tools. One part of the equipment has been rented due to the limited needs meanwhile other instruments such as water and air laboratories were purchased for use during the coming 2018 – 2021 period.

Technical Guidelines

The action plan presented in the EHS (§ 3.5.2. Technical Guidelines) aims to improve and harmonize the operation and maintenance of environmental infrastructure and environmental health services through technical recommendations and guidelines, accessible to UNRWA and partners. It includes data management, geodata base management, AutoCAD use, pumping test, drilling monitoring, solid waste management and assets management. Additional efforts to harmonize the lessons learned in 2016 and 2017 and to compile relevant technical information from UNRWA and its partners will be necessary during 2018 through the intensification of technical exchanges and efficient coordination between stakeholders. Existing technical guidelines (hygiene promotion) from other UN agencies or the Government of Lebanon should be included by the FICIP.

For each environmental health sector in the inventory and the needs assessment, a transfer of knowledge through short technical guidelines (power point presentations, circulars, reports) accompanied by individual or group trainings were conducted for internal use and for sharing with external partners, including private sector.

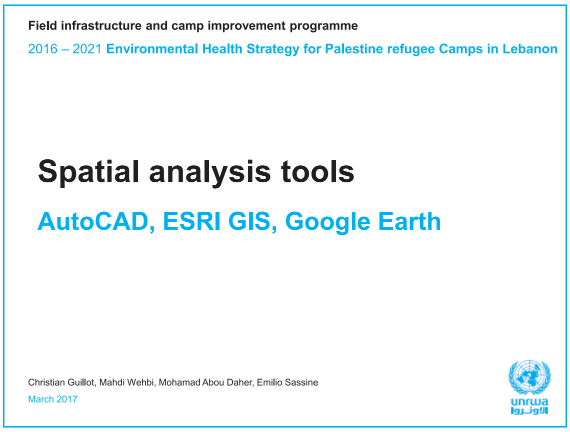


Figure 33. FICIP environmental health team and raster images used for the inventory.

Data Management

The action plan announced in the EHS (§ 3.5.3. Data Management) will be pursued during the coming 2018 – 2021 period through the systematic and organized new data management tool introduced by the FICIP and EHU. Due to the large number of objects, lines, polylines, polygons and specific definitions related to the environmental infrastructure and environmental health services inventory, the FICIP created a small library (hard and soft versions) referencing the most relevant internal and external reports and documents. It is organized as per the environmental infrastructure and environmental health domain, into five categories per camp – sector, sub-sector, programmes, tools and stakeholders. The library also contains specific project feasibility studies and maps. Special attention has been dedicated to the harmonization of the names, codes, units and presentation detail, including the sources of the data for easy access and reference.

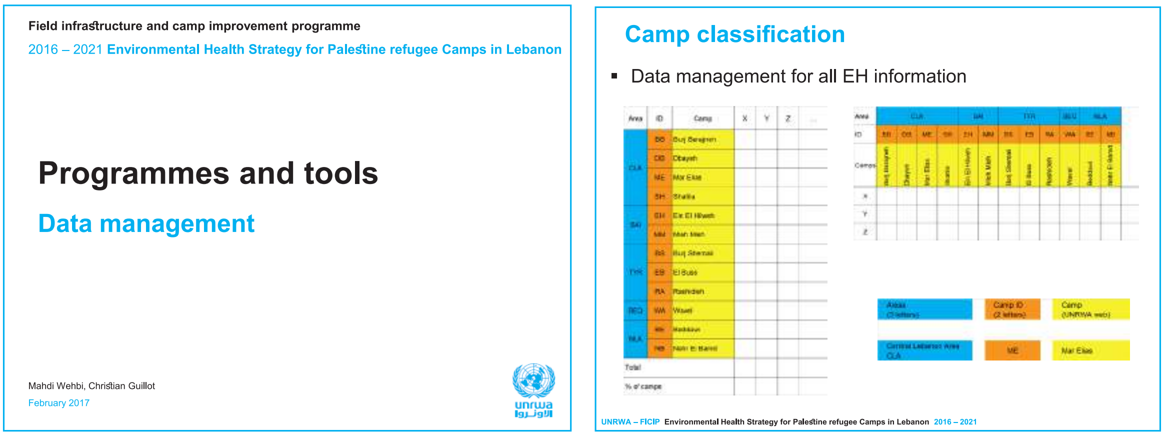


Figure 34. Data management for all EH information.

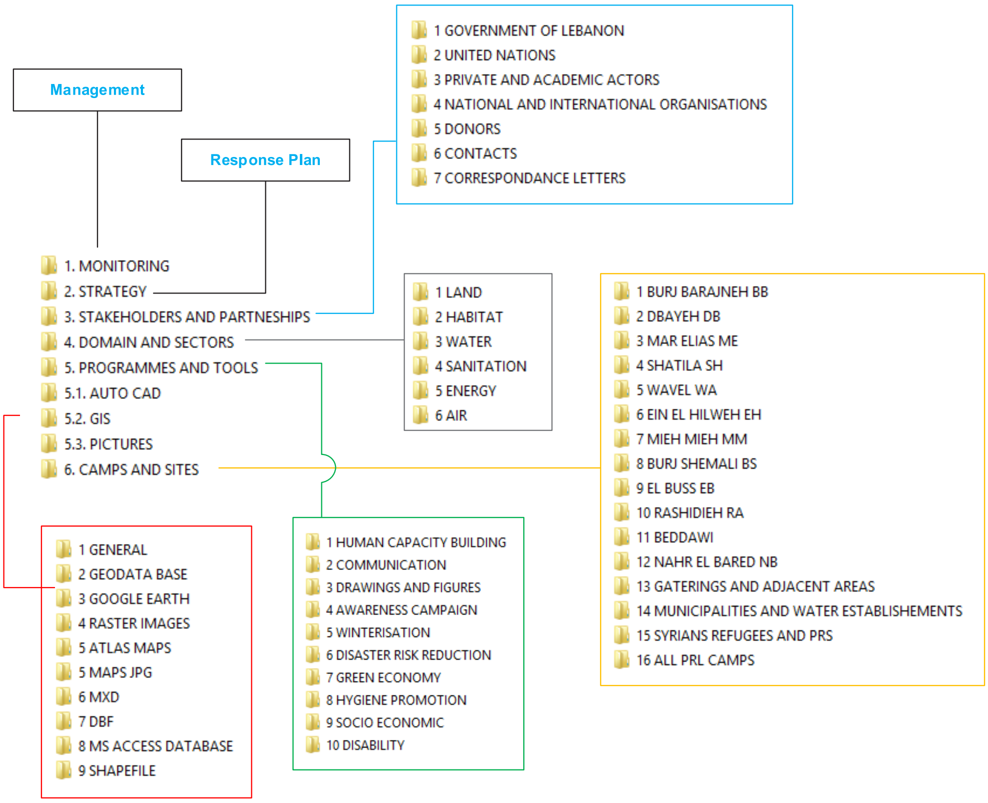


Figure 35. Environmental health data management (common data base for UNRWA FICIP server).

A specific acronym list has been created with a simple coding system for each of the objects contained in the data (geodata and AutoCAD data bases) and spreadsheets (excel) in order to establish a common language. From the name[28] of each camp down to a single a well or solid waste platform, the acronym list is particularly helpful for anyone interested, both internal and external. The acronym is also applied to reports produced by the FICIP and to all generated maps (more than 200 thematic maps were produced during the inventory).

[28] Due to the numerous versions of each camp's written name the reference used for the environmental infrastructure and environmental health response plan is aligned to the UNRWA official web site https://www.unrwa.org/where-we-work/lebanon

As a simple rule, the first letter of one word or the first two letters from two words (when applicable) is used. In case of conflict, the next letter is considered: **B**urj **B**arajneh → BB, **Bo**rehole → BO, **D**umping **S**ite→ DS, **M**edical **C**entre→ MC, **Sc**hool → SC, **S**olid **W**aste→ SW. For each object, an identity is provided following the coding system mentioned above which refers to its location and type. Based on probabilities and the permutation rule, a number ranging between 0001 and 9999 is finally attributed which guarantees a unique identity to any of the objects contained in the FICIP geodata base.

Based on the coding system, each feature (generator, well, tank, school) is attributed according to "*common*" information (ID, X and Y coordinates, custody, status, etc.) and to a "*specific*" information (power, brand, sound insulation, value) tailored by the user according to their specific needs (FICIP, Health, Protection). This set-up facilitates the exchange of information without duplication.

General Information					Specific Information (not exhaustive)				
Feature ID	Location X	Location Y	Camp	Custody	Year of drilling	Depth (m)	SWL (m)	Pump depth (m)	Pump capacity (HP)
BBBO0001	-337518.5619	-32794.7140	Burj Barajneh	Popular committee	1996	54	42	53	20
BBBO0002	-337271.1829	-32942.2737	Burj Barajneh	Popular committee	2002	32	40	42	20
BEBO0007	-301498.1726	32253.8651	Beddawi	UNRWA	1988	157	82	145	25
BEBO0008	-301854.0977	31916.1941	Beddawi	UNRWA	1983, Dry	157	.	137	25
BEBO0009	-301853.4470	31914.0971	Beddawi	UNRWA	2016	198	120	160	40

Figure 36. Example of general and specific information (fields) for each feature.

AutoCAD Base

The main problems identified in the former AutoCAD drawings concerned their organization without clear folders (random coding) which negatively impacted the ability and efficiency of FICIP staff and partners considering the absence of specifications between "*Design Drawings*[29]" and "*As-Built Drawings*". Most of the AutoCAD plans required scaling and geo-referencing with the adequate projection system in order to be useful for measurements using maps and drawings. This is deemed more profitable than conducting field surveys, which are costly in terms of logistics and manpower and which are not always necessary. The standard nomenclature corresponding to organized layers was absent including conflict between different categories of layers (for example a water pipe would be found only in the layer "building").

Based on this first analysis, and after grouping most of the AutoCAD drawings, the construction of a useful AutoCAD data base was initiated. The first objective was to organize and clean the drawings system and then to include the compatibility factor for GIS ESRI software and analysis tool which was the second objective. Following this an updated AutoCAD data base including a methodology (guideline) for UNRWA and partners was established to ensure its sustainability and easy conversion and use. Once this revised AutoCAD data base was created, the third objective was to centralize the source of information for the FICIP and to stop the duplication of folders and versions stored in personal

[29] "*Design drawings*" are prepared in advance and usually in an office with drawing architectural and civil engineering software (ACAD), meanwhile « *as built drawings* » are made during the construction works and can differ from the original and planed "*design drawings*".

computers or old CDs which were largely unreadable due to damage over time. The AutoCAD data base, for all the 12 camps, includes hundreds of drawings which are accessible to the FICIP and located in one clean and revised format, compatible with the GIS system. The new FICIP guideline is a reference for any new or updated drawings thus increasing efficiency within UNRWA and with its partners.

Two AutoCAD "*tailor-made*" trainings (introduction module and advanced module) were organized for a total of 25 engineers and architects. During these trainings, the new AutoCAD data base and guideline were introduced with practical exercises and discussions on the following topics: the choice of adaptable and unified set of layers for each environmental health sector; when is a drawing considered "as built" (closest to the real existing infrastructure); geo-referencing and scaling drawings (compatible with GIS ESRI and mapped on scale); unified legend (colour, thickness of lines, polygons, points); and relocation of elements into their correct layer in order to allow the GIS software to recognize their identity (layer-based).

As AutoCAD drawings are one of the ArcGIS supported formats, a set of prerequisites were performed before the conversion process. First, relevant AutoCAD files (usually the "*as-built drawings*") were screened and identified. Second drawings were cleaned, as per the steps mentioned in the previous section. Third, AutoCAD drawings were geo-referenced using a similar GIS coordinate system. Fourth, specific AutoCAD layers were exported using a GIS specific tool (point, line, polygon and annotation). Fifth, topological parameters were checked for overlapping, self-intersecting exporting features including the error detection in ArcGIS and lastly exported features were attributed[30].

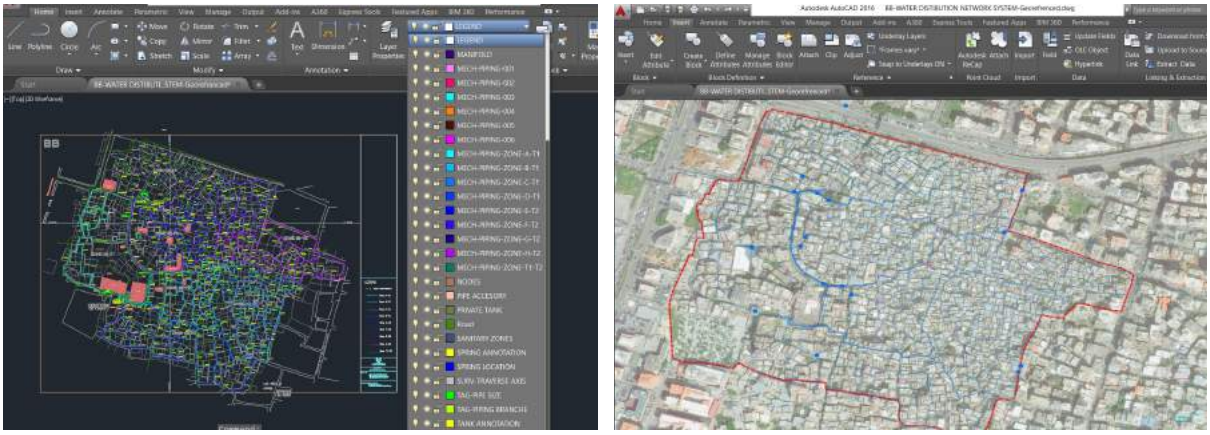


Figure 37. ACAD drawings for designing and adapted to raster images to GIS tool.

By the end of 2017, the FICIP updated all of the AutoCAD drawings (water, wastewater, storm water) in 12 camps, including the sources, storage and transmission, primary and secondary networks. The "*wastewater*" and "*storm water*" networks were completed for eleven camps (excluding Burj Burajneh). A technical guideline including the drawing formats, drawing handling requirements, layer naming convention, line type standard AutoCAD, text formatting (styles and heights), dimensioning and drawing frame setup (title blocks) was completed and introduced during the two trainings. The first one was as introduction to the tool and the second targeted advanced users. Such trainings will be conducted on a regular basis and on real projects from 2018 onwards.

[30] The time needed for the process of data conversion (geographic features) is much shorter than the time needed for the attributing process.

Maps used for the field inventory. ©2017 UNRWA

Visit of Mar Elias surrounding area. ©2017 UNRWA

The level and use of AutoCAD within the FICIP must be improved in order to benefit from the comprehensive AutoCAD and geodata base and to enable engineers and architects to better monitor the work of contractors. It will also ensure a systematic and efficient use of the drawings, from the office to the field. The new AutoCAD technical guideline must be shared with the FICIP partners as well as within the Procurement and Logistic Department (PLD) so that it can be included in all future tenders and terms of references.

Understanding the links between AutoCAD and ESRI is essential to efficiently monitor work and to provide precise and relevant figures and statistics for decision-making purposes and budget estimation. The centralization of the new AutoCAD data base needs to be conserved to avoid duplication of files. From 2018, regular refreshment trainings with updates of the new AutoCAD data base will be necessary for a select group of motivated engineers and architects within the FICIP team.

Geodata base (GIS)

The former GIS shapefile available in the FICIP was generated in a non-complete attributed shapefile format with a geographic coordinate system[31]. The former AutoCAD files were not georeferenced as "*as-built*" drawings in a planimetric[32] coordinate system. Consequently, both systems were static and difficult to use for management and updating purposes. Queries and statistics were not valid, nor the use of former raster satellite images. As a result, the GIS and AutoCAD data was revised, cleaned and recreated according to a precise methodology.

It is now recognized by national and international experts to guarantee its efficiency and sustainability. All steps have been conducted by GIS and AutoCAD specialists in the FICIP team and transfer of competences took place during 2017 with more planned for 2018. This process not only ensures increased use of the GIS and AutoCAD data integrated to raster images, but also allows UNWRA to better exchange and receive national and international data, which is compatible with the projection systems now used by the FICIP.

Consultation with other United Nations agencies (UN Habitat, UNDP, UNICEF and UNHCR) was necessary to better identify the gaps and problems in order to improve the development of the geodatabase. Regular consultations with UNRWA Headquarters were conducted to ensure alignment between the LFO and other Fields.

[31] Geographic coordinate system : spherical coordinates are measured from the earth's center (decimal degree units of measurement)

[32] Planimetric coordinate system : planar in which the earth's coordinates are projected into a two-dimensional planar surface (metres units of measurement)

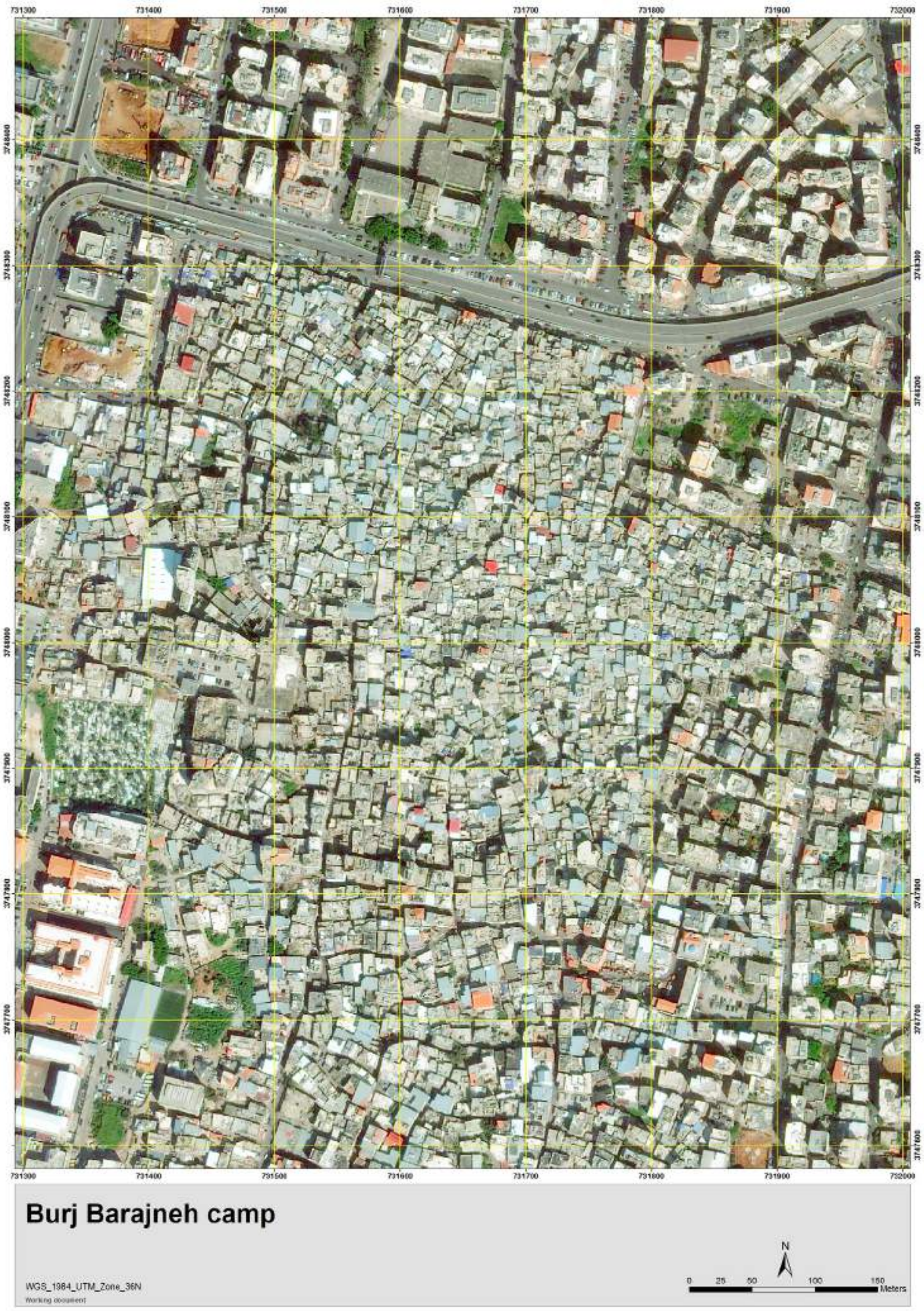


Figure 38. High resolution raster image for each area where the Palestine refugee camps are located.

In addition to data collection activities during the inventory, the AutoCAD files were cleaned and georeferenced through a conversion process to the GIS system, which is to be used as a second source of primary data for building the geodatabase and to ensure the utmost cohesion between both tools (GIS and AutoCAD). The GIS data is stored in a personal geodatabase for structural, performance and management reasons.

Aligned to the environmental infrastructure and environmental health sectors and sub-sectors definition, the new geodatabase consists of six feature data sets (Land, Habitat, Water, Sanitation, Energy and Air). Each feature data set includes related feature classes and related metadata information which will help any GIS user to understand the information of the entire process of data collection/conversion.

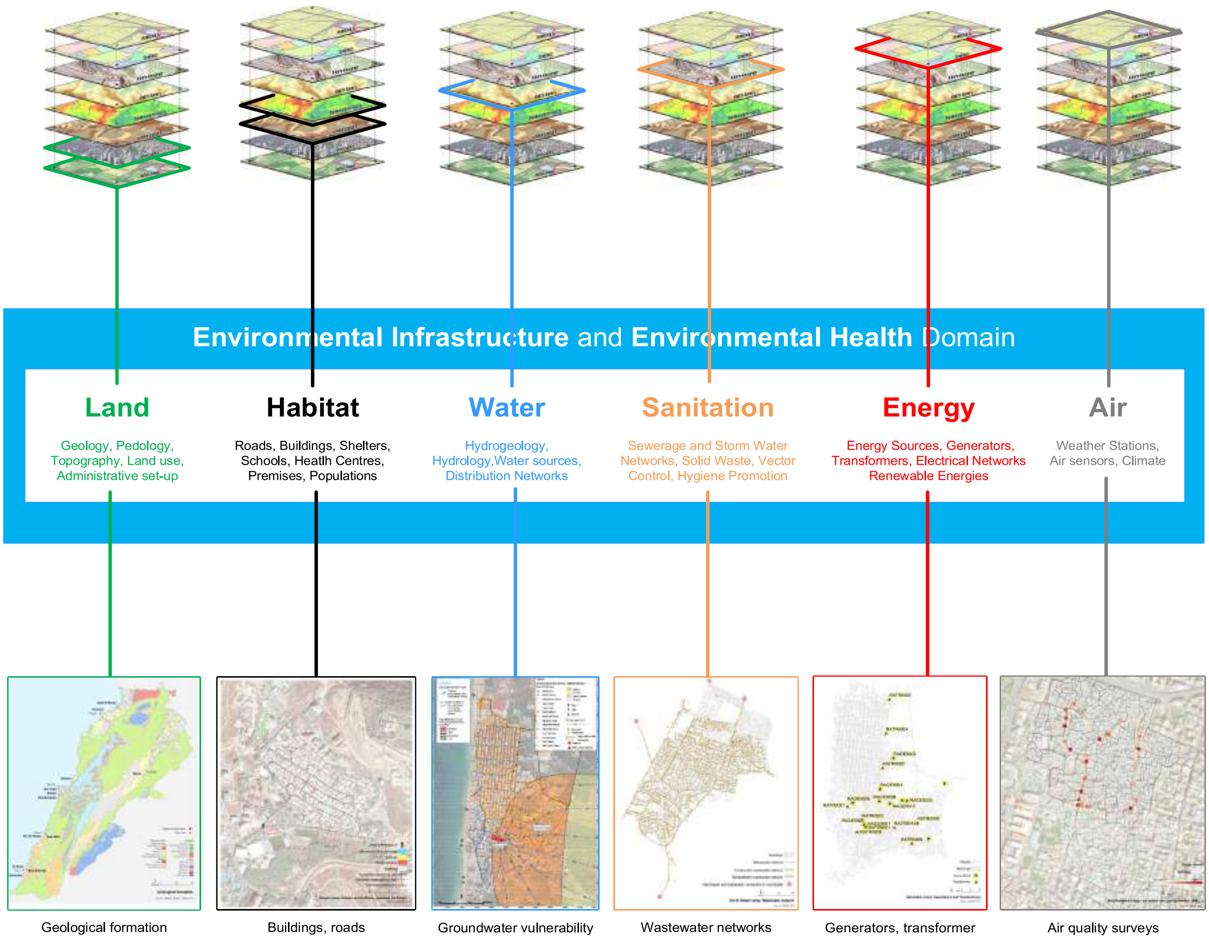


Figure 39. Feature classes organised the FICIP geodata base per sector with examples of applications from national to local levels.

The spatial information in the geodatabase is dynamic data maintained by GIS specialists using licensed ArcGIS 10.5 Desktop, which is widely used by governmental and international organizations. Considering that the majority of information is common between departments within UNRWA (Health, Relief, Social Services, Protection and Security), it is highly recommended to transfer the newly created geodatabase throughout the Agency.

Both commercial and open source GIS software is used even though the commercial option ensures performant functionalities such as topological functionalities, cartographic capabilities, network analysis, data entry and an operating system support from the provider company. Its deployment is within the secure environment of ESRI, which is relevant for the current context and sensitive spatial information.

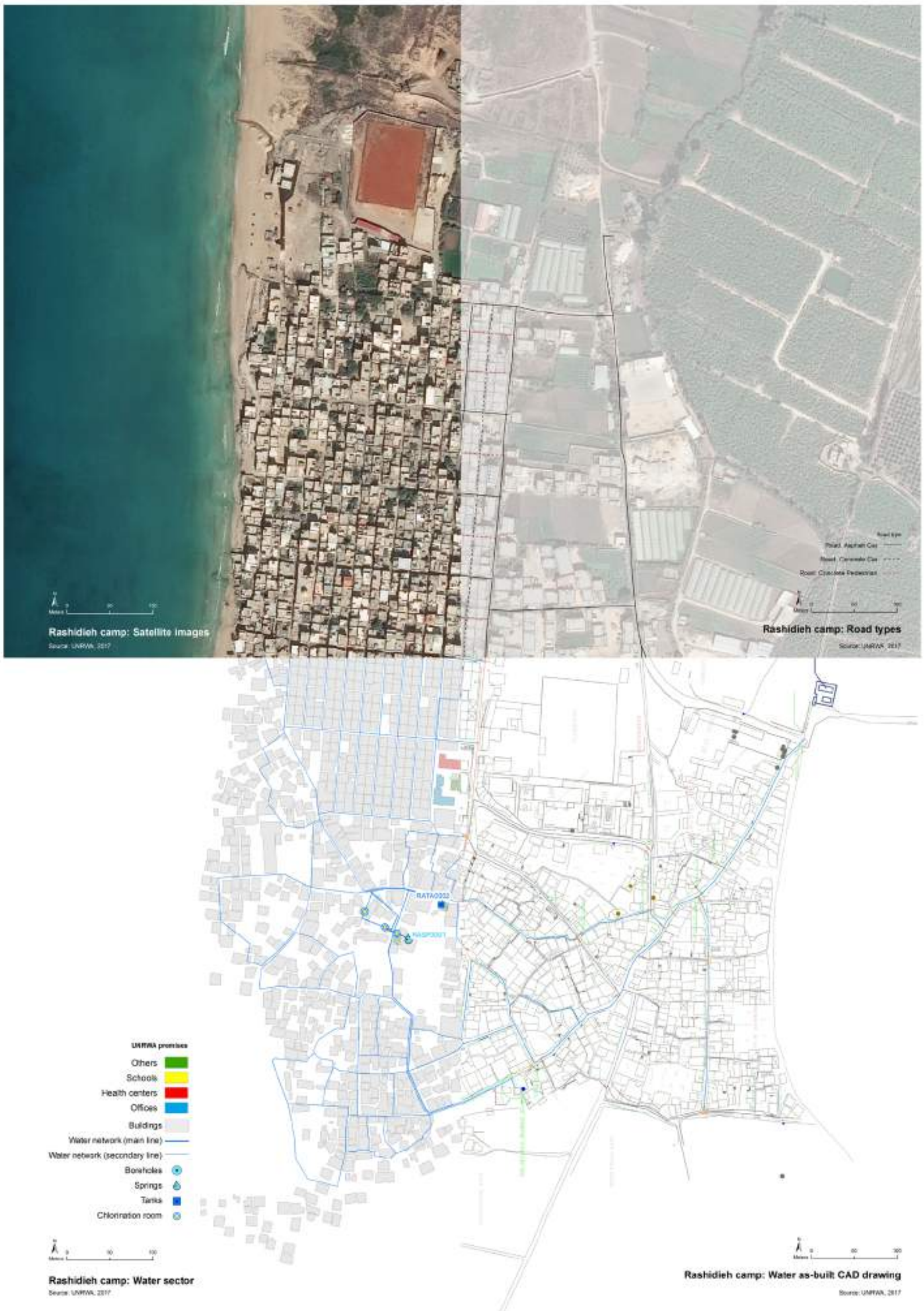


Figure 40. GIS projection of the FICIP geodata base aligned to ACAD data base. Raster high definition and update images, land, habitat, water, sanitation, energy, air fields and attributes for dynamic analysis and autoCAD data base aligned to the ESRI projection system.

Based on the previous section and when starting the inventory process, the FICIP updated its raster images with recent and high-resolution images[33]. Since the end of 2016, the FICIP GIS specialists have been working with water, sanitation, and environmental specialists, civil engineers, architects and administrators in each of the 12 camps to update existing data. This was done through simple field methodology which required printing satellite imagery and local knowledge rather than with sophisticated GPS devices deemed inefficient due to interference with their satellite signals as a consequence of the

33 Orthorectified imagery, 30 cm, 40 cm and 50 cm, UTM and Lebanese Stereographic Clarke 1880 projection, 36N UTM Zone, WGS84 datum of 25 km2 surface from 2015, 2016 and 2017 years (GEO1, WV03), digital 5 metres GRID based on existing map 1:20,000 of Lebanon.

urban context (high buildings, limited open space). Step by step, all sectors and sub-sectors have been physically checked in the camps and updated thus constituting an incredibly exhaustive and comprehensive geodatabase which is in accordance with the EHS objectives for better management of the assets through innovative tools such as GIS.

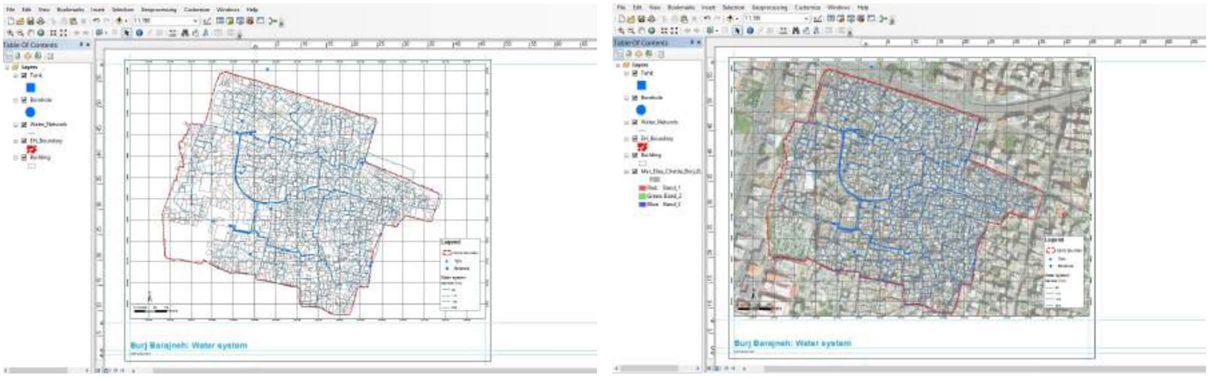


Figure 41. GIS shapefiles for monitoring and updating, adapted to raster images and to ACAD drawings.

Since the GIS geodatabase was created, the FICIP has regularly shared it with its partners (following strict contract regulation) in order to accelerate access to the environmental infrastructure and environmental health information for the 12 Palestine refugee camps, but also to benefit from the new primary data gathered by UNRWA's partners and contributing to the development of the FICIP database.

The FICIP has developed a dynamic thematic atlas regrouping most of the results obtained during the October 2016 – November 2017 inventory and needs assessment. More than 200 thematic maps, from national to local and camp level have been prepared and distributed.

Google Earth

The main information related to the UNRWA premises (schools, health centres and offices) has been updated in the Google Earth tool. Two specific "*Google Earth*" trainings were conducted for the FICIP and other UNRWA departments (Protection, Health, PIO, DRU, Education, Relief and Social Services) in order to evaluate the management potential of the GIS tool. The next step will be to include the more detailed and precise ESRI geodatabase to allow non-specialist personnel to adopt and use this efficient management spatial tool.

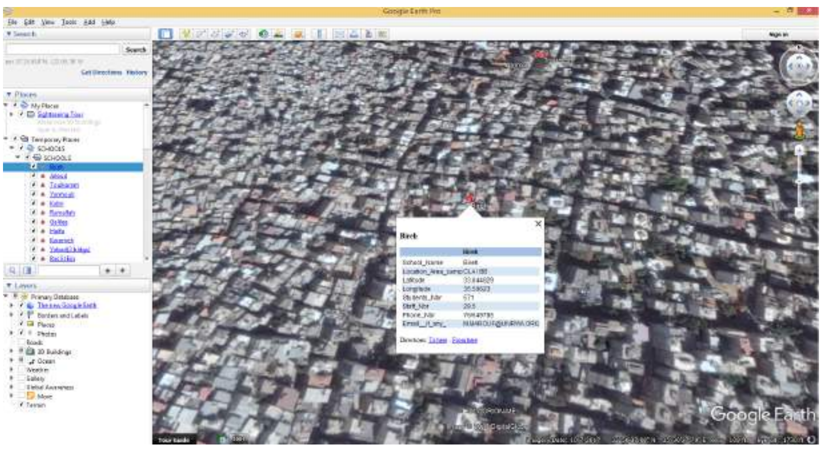


Figure 42. Screen shot of FICIP geodata base applied to limited use for Google Earth (e.g. name of the UNRWA Health centres and contact numbers).

Monitoring and Evaluation

Indicators

Relevant and easy to measure indicators are essential to monitor and evaluate the performance of activities. The baseline year is 2018 and the target year is 2021, with a perspective until 2030 (aligned with the SDGs). Adapted to the six different outputs presented in the RP, some indicators may not be evaluated as per the classic quarterly project progress reports (every trimester), but instead on an annual or bi-annual frequency. The reporting system in place will continue to facilitate the monitoring and evaluation process, but the new geodatabase of the data management coupled with innovative measuring equipment (water probes, weather stations, air particle tools) will not only increase the accuracy and rhythm of updating data, but will also reduce the financial resources required to collect such information, mostly automatic and systematic. Routine procedures such as flow-meter reading will remain essential. One of the challenges of performant monitoring and evaluation is to obtain verified and transparent information and to include all stakeholders within its methodology, to guarantee overall sustainability and accountability. For the new indicators such as "*annual mean level of particulate matter,* PM_{10}", parameters such as frequency of data collection, place where the data is measured, time of day and type of tool, have been identified, including training for UNRWA staff who perform these tasks. This indicator is guided by the Lebanese value. Included in the Logical Framework in the Appendixes part, a total of 27 indicators, including five for the water sector, 12 for the sanitation sector, six for the Land, Habitat, Energy and Air sectors and four for the Programmes and Tools.

Water quality sampling. ©2017 UNRWA

Visibility and Communication

During the development of the Response Plan, the FICIP created a communication strategy aimed at including all UNRWA stakeholders involved in the Palestine refugee camps and their direct surroundings. It is aligned to the communication department in UNRWA (PIO), the Donor Relation Unit (DRU) as well as to specialized social media and communication groups in Lebanon and abroad. The FICIP defined three activities to target audiences inside the camps, in Lebanon and at international level with a clear focus on messages around environmental infrastructure and environmental health.

The communication strategy is composed of three packages. The first package started with the distribution of the "*Environmental Health Strategy 2016 – 2021*" since June 2016. The second package includes a series of short movies highlighting the environmental situation inside and in the surroundings of the camps. They depict a wider global reality found in many countries, addressing current and future environmental health challenges facing low income and high population densities in unstable political, economic and humanitarian contexts. The third package involves an awareness campaign to be developed and implemented by the refugees themselves based on the common recommendations presented in the Response Plan 2018-2021 and the reality represented through the movies in the land, habitat, water, sanitation, energy and air sectors.

Figure 43. Three main components of the communication strategy for 2016 – 2021.

The target audience of these communication activities are the Palestine refugees themselves. In addition, national and international audiences from the public, private, academic and state sectors as well as humanitarian institutions are also important to improve their overall knowledge of environmental health challenges in the Palestine refugee camps in Lebanon.

Figure 44. Environmental Health Strategy, Response Plan and Environmental Health Atlas (A3) produced between June 2016 and December 2017 by the FICIP.

Movies and Pictures

Six short movies have been produced by filming scenes of daily life inside the Palestine refugee camps as well as the ongoing activities of UNRWA and all stakeholders. Three separate short movies focus on "land and habitat", "water and sanitation" and "energy and air". One movie highlights the efforts of UNRWA in response to infrastructure-related challenges inside the camps aligned to master plans developed at national and municipal level (camp improvement). This also features the empowerment of refugees through an example of the "*Self-Help*" initiative where families lead projects of shelter rehabilitation. Another short movie focuses on the specific camp - Nahr El Bared – and its challenging reconstruction project. The final movie summarizes the challenges, efforts and perspectives, of the Palestine refugee camps, as well as providing a larger picture of the Environmental Infrastructure and Environmental Health domain. More than 40 people from UNRWA, humanitarian, private, academic, national and international institutions and the refugees themselves agreed to participate to the movies, emphasizing a shared effort.

Figure 45. Screen shots of the short-movies to be used for awareness campaign and available in the UNRWA web site.

The movies will be projected in Lebanon and abroad during a festival "*Let's talk about Environment*", based on the existing "*Let's talk about water*[34]" initiative developed over the decades in numerous universities and cities worldwide.

In addition to the thousands of pictures showcasing the infrastructure and services that were part of the inventory and included in the FICIP geodatabase series, 200 professional pictures have been included in the communication strategy to emphasise the importance of sharing the progress and dedication of the stakeholders as well the reality of life inside the camps.

Awareness Campaign

After months of consultation and in collaboration with partners such as UNICEF and national and international NGOs, an awareness campaign is planned for 2018 with an innovative approach which includes the refugees themselves. The concept is based on an open competition for the communities, including youth groups, and women's groups, among others living inside the Palestine refugee camps and their interest to implement pilot projects which are recommended in the Response Plan 2018 – 2021. An "*Environmental Health Awareness Campaign Competition*" will be launched in January 2018 in five camps (one per area). The campaign will act as a mechanism for interested groups to apply for grants related to an environmental infrastructure and environmental health oriented project to be developed and implemented in each of the camps. A jury composed of different organizations and UNRWA will select the grantee according to the pertinence of their proposition and according to precise criteria, including projects improving living conditions (from an environmental health perspective), introducing innovations with a strong potential of scaling up in the 2018 – 2021 period and with socioeconomic impacts for the community.

[34] Let's talk about water official website http://letstalkaboutwater.com/

Each project and group will have the opportunity to participate in the festival event, organized in 2018 in the camps and several universities in Lebanon, with the hope that the best projects will be used as a model for other camps and be supported by education grants from national and international partners.

Green Economy

One of the goals of a green economy is to help reduce poverty, while increasing resource efficiency and improving social welfare. The term green economy[35] came from a pioneering 1989 report for the Government of United Kingdom by a group of leading environmental economists, entitled "*Blueprint for a Green Economy*[36]", referring to "*sustainable development*" and economic progress. Later, in 2008 and related to the financial crisis and concerns of a global recession, the UN Environment Programme (UNEP) revived the green economy concept, inspiring several governments to implement significant "*green stimulus*" packages as part of their economic recovery efforts[37].

Green jobs for the Palestine refugee camps do have a future in the domain of renewable energy, bioclimatic construction and architecture, transportation, waste management, agriculture and forestry in the camps. Subsidies, technical and capacity building guidance, research and development, and international aid will all be needed to launch the development of this social segment of the green economy, with a strong equitable potential for the most vulnerable aiming to contribute to such an innovative field.

Transport is central to economic activity. In restricted areas such as the Palestine refugee camps in Lebanon there are more than 115 kilometres of roads and large numbers of vehicles that currently harm the environment and generate harmful economic consequences, such as productivity-lowering congestion. Encouraging innovative alternatives, such as reduction of private vehicle traffic, migration to electrical powered vehicles or simply pedestrianized path development is crucial.

Cost Recovery Dilemma

Introducing a viable cost recovery system adapted to the environmental infrastructure and environmental health services currently provided in the 12 Palestine refugee camps remains challenging for numerous reasons. First, the economic status in Lebanon remains preoccupying despite a modest GDP growth increased between 2015 to 2017, and still dependant to the Syrian conflict and its consequences in the country. Second, investments in the water, energy and sanitation sectors are insufficient to drastically improve the service quality leading to customers paying higher prices for better operation and maintenance of the network (vicious circle). Third, the mixture of custodies (UNRWA as United Nations and non-profit organisation, popular committees as political parties, Water Establishment under-resourced to control metering) do not facilitate the establishment of a viable cost-recovery system by a low socioeconomic population that, in most cases, would be reluctant to pay for a service considering they are refugees deprived from many civil rights and the right to work (36 jobs are still not authorized for the Palestine refugees in Lebanon). In this context, introducing a cost recovery system, as it has been in Mar Elias for the water supply provided by reverse osmosis, remains complex and requires significant efforts of coordination and good governance between parties and among the communities.

The "*cumulative*" effect, often described during a conflict is, in the case of the Palestine refugee camps, also relevant and particularly hard to resolve. Solutions have to disaggregate large camps in small units,

[35] There is no internationally agreed definition of green economy
[36] Pearce, Markandya and Barbier, 1989.
[37] Including the UNEP Green Economy Initiative, and Global Green New Deal (mix of policy actions

focusing on social and technical conveniences, where the population is ready (thanks to awareness campaigns) to contribute to the recovery system. The smaller the target, the easier the investment plan that shall be considered as an independent system. Investing in the private sector involved in the environmental health infrastructure services shall be accompanied with jobs' creation with a more sustainable operation and maintenance service at longer-term perspective for the major part of the population not considered as "*extreme economic vulnerable*". For those, financial support should be continued.

Disaster Risk Reduction

The risks resulting from climate change (floods, fires), natural seasonal effects (winterization), and earthquake as well as security incidents (clashes) on the most vulnerable population of the Palestine refugee camps are summarized under Disaster Risk Reduction (DRR).

Flooding due to heavy and intense short rains as a consequence of man-made action interferes with the existing drainage system (uncontrolled construction over infrastructure utilities or uncoordinated works by individuals) and causes infrastructure and human damages in some Palestine refugee camps. To limit such risks, UNRWA implements, on yearly basis, a winterization programme aimed at cleaning and removing obstacles from most of the drainage channels in each of the 12 camps, prior to the rainy season, which starts between September and October each year.

Drainage problems after heavy rains. ©2017 UNRWA

Adequate anticipation of flooding (consequence of upstream runoff and sea rise for the camps immediately located on the seashore such as Rashidieh and Nahr El Bared) encompasses the integration of precise topographical maps from the definition of the watershed where the camps are located, and also the local topography, including roads, storm water networks and outlets or connection to municipal or natural media.

Another growing risk is related to the electrical networks which every year cause more electrocution and fires due to their obsolete, disorganized and poorly maintained status. The high density of buildings and limited natural ventilation also increase the risk of fire propagation as well the reduction of accessibility for the firefighter's vehicles or teams.

Within the framework of joint efforts between the Government of Lebanon and UNDP (among other agencies including the Lebanese army, the Lebanese Red Cross) to reduce the risk of disasters and increase awareness among the population on disasters, trainings and discussions on DRR are regularly organized in Lebanon.

Climate and Climate Change

The action plan presented in the EHS (§3.4.4. Climate) has been completed minus the "simulation of surface water runoff" that will be developed from 2018, based on the topography and roof spatial analysis now available in the FICIP geodatabase. The information from existing and newly installed weather stations will be essential considering the importance of local weather patterns and possible application such as artificial recharge of groundwater, greening of roofs, rainwater roof collection, solar energy application (electric and thermal), among others.

One year after the 21st Conference of the Parties (COP[38]), the threshold for entry into the Paris Agreement was achieved by Lebanon. The Paris Agreement entered into force in November 2016 with the ratification of 170 Parties (out of 197 Parties[39] to the Convention). The COP 2017 was an important time of negotiation ahead of the 2018 COP in Poland during which the operational rules of the Paris Agreement will be discussed and agreed with the "*Paris Rulebook*". Although Lebanon has not yet ratified the Paris Agreement, the country remains committed to the targets as it is strongly affected by climate change including the disturbance of rainfall patterns and rising sea levels.

Water tank in Wavel camp. ©2017 UNRWA

[38] Countries that have signed up to the 1992 UN Framework Convention on Climate Change
[39] The State of Palestine deposited its instrument of accession to the Convention on 18 December 2015.

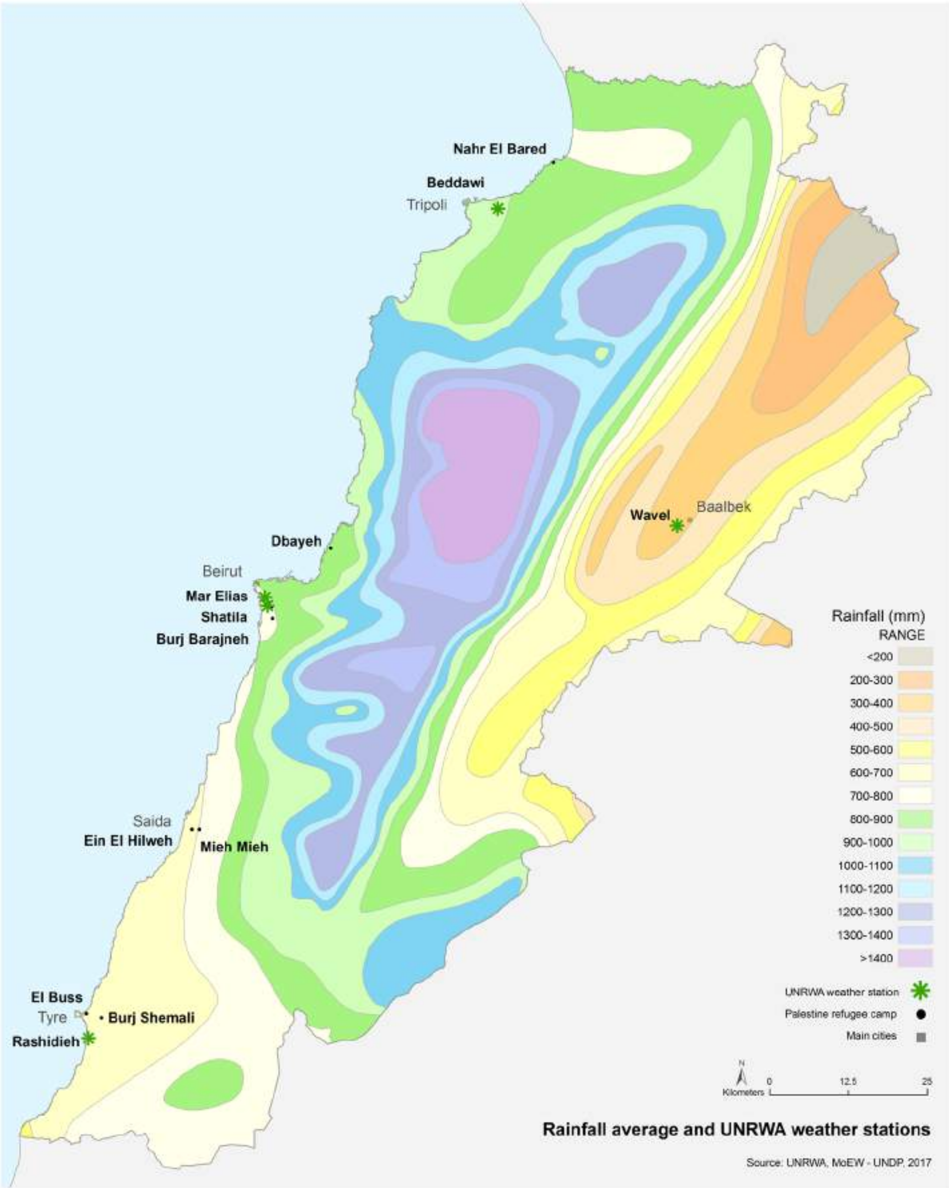


Figure 46. Rainfall average for the last decades' record and Installation of UNRWA weather stations.

For Lebanon and its 12 Palestine refugee camps as well as other countries in the MENA region, water resources remain, together with agriculture, most affected by climate change with crucial impacts on demography, public health and the economy. Decreasing greenhouse gas emissions is one of the Government of Lebanon's strategies that require the involvement of non-state actors.

The average climate for the Palestine refugee camps in Beirut, Saida, Tyre and Tripoli areas can be qualified as "*dry-summer subtropical*", often referred to as "*Mediterranean*" according to the Köppen-Geiger climate classification[40], with an average temperature above 10°C in warmest months, and an average between 18 and -3°C on the coldest months. Summers tend to be dry with less than 30 mm of precipitation in a summer month and average yearly precipitations ranging between 400 and 1,000 mm, with a rainy season starting around November and ending around April, summing an average of 70 to 80 days of rain per year. Average insolation is around 4.5 to 5.5 kWh/m^2/day with highest values in June and lowest in January and average wind speed ranging between 4 to 6 m/s with local variations

[40] Köppen Climate Classification subtype for this climate is "Csa", Mediterranean Climate

due to the topography and the presence of the sea. Wavel, at an elevation above 1,000 metres, is the only camp that registers frozen temperatures during the winter period.

Lebanon signed the Paris Agreement on climate change, and established several institutions dedicated to the protection of the environment. The country is vulnerable to extreme events such as winter floods and extended hot summer days that are increasing due to climate change.

In Lebanon, during 2012, more than 50 per cent of the total greenhouse gas emissions derived from the energy sector mainly depended on imported oil. Lebanon increased its greenhouse gas emissions (gases that are harmful to the environment and contribute to climate change) by nearly five per cent annually between 1994 and 2012.

Lebanon has made some positive steps having reduced the consumption of Chlorofluorocarbon (CFC), a substance that depletes the ozone layer from 928 to 0 tons in less than fifteen years through environmental legislation requiring industries to minimize their pollution and other measures such as raising awareness on the benefits of sustainable consumption and production. It is estimated that by 2040 rainfall in Lebanon will have decreased by between 10-20 per cent. At the current rate, sea levels in Lebanon will rise with up to 60 cm in the next 30 years.

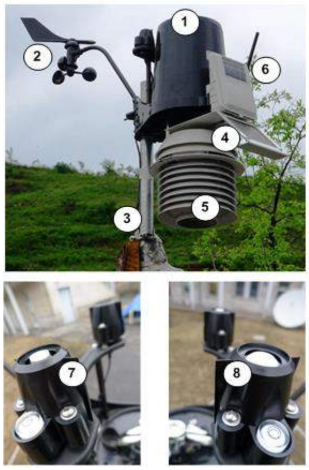
One Planet Summit, Weather Stations (Global to Local)

Green finance aims to identify new financing solutions to fight global warming. In December 2017, two years after the Paris Agreement, the "*One Planet Summit*" was organized to develop a greener financing system to fight global warming effects. Co-organized between the United Nations and the World Bank, actors of public and private finance worked together to explore innovative solutions.

At the very local level of the Palestine refugee camps, and to obtain essential climate data at local level (and in the absence of operational national coverage), the FICIP installed five weather stations[41]. Used for internal capacity building and field tests, the first weather station was installed in the roof of the UNRWA LFO, in Beirut. Once authorization was obtained (apart for Saida area), the additional four weather stations were installed in the main water tanks in the Palestine refugee camps of Mar Elias (West), Beddawi (North), Wavel (East) and Rashidieh (South). The second capacity building training was provided to the UNRWA field teams in order to operate and maintain the weather stations for the coming 2018 – 2021 period.

The weather stations aim to provide a set of climate data automatically transferred through the console to computers, at two-hour collection intervals and a transfer of data every two months. Immediate data collection will also be possible in the near future. The weather data has been used for different surveys, including outdoor air quality, but is essentially important to be combined with the "water monitoring surveillance plan" with rainfall precipitations and impact on the static water level recorded in the wells around the country.

[41] Davis Instruments Vantage Pro 2



1. Rain collector
According to the World Meteorological Organization, reads rainfall in 0.2 mm

2. Anemometer
Wind speed and wind direction up to 290 km/h

3. Mounting pole
Guarantee the weather station to be fixed in horizontal and solid way

4. Auto-power of the weather station
Allow the motordriven fan to be functional 24 h

5. Temperature and humidity sensors
Temperatures protected from solar radiation and reflected heat

6. Solar panel
Power the station during the day and charges the lithium battery for night use

7. Solar radiation Sensor
Measure solar radiation and solar energy

8. UV Sensor
Measure the sunburning portion of the UV spectrum

Figure 47. Weather station characteristics and parameters.

Meteorological conditions play an important role in the dispersion of plumes[42] near the source vicinity or even further which means that it might get emissions from a far source to the camps. The weather stations were installed on the roof of water tanks in the camps at a height of 25 to 35 metres above ground level as per the World Meteorology Organization (WMO) recommendations (installation at a ten-metre height in a space where no obstacle is near) as well as for security reasons. For these reasons, the data generated should be used with caution and in the right context.

While in Beddawi a SSE wind prevails most probably caused by the topography, whereas the Wavel station shows winds with higher speeds with a dominating South direction. Full year observed wind vanes from the national weather network for 2013 show the land and sea breeze for Beirut station with an average speed of 2.8 m/s while Zahle showed winds blowing from the west with an average wind speed of 2.9 m/s. In general and for each place where data from the weather station is available, the identification of the prevailing winds and its speed are fundamental to monitor the air quality and eventual energy potentials. Identification of the major air sources of pollution sites located in the vicinity of the upstream prevailing wind area might be also relevant to propose mitigations measures.

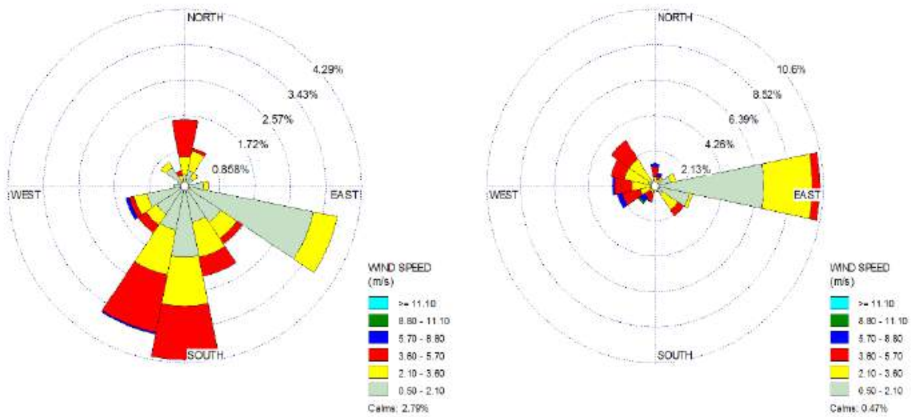


Figure 48. Wavel Observed Wind Rose (average wind speed: 2.00 m/s) and Rashidieh observed wind rose from September to mid-November 2017 (average wind speed 20.6 m/s).

[42] An area or section of **air**, water, or soil containing pollutants released from a point source

Earthquake, Fire and Floods Risks

Located on the Yammouneh fault line, Lebanon is a seismic prone country acknowledging the importance of earthquake activity[43] in the Eastern Mediterranean and the potential danger associated with it. Little action has been taken in the preparation for such disaster in the Palestine refugee camps and especially those with uncontrolled urban planning and limited access due to the check points and reduced entrances and exits between the camps and their surrounding municipalities.

An earthquake or its consequences (including building collapse, fires, water shortages, solid waste crisis, and tsunami for Rashidieh camp) would result in a catastrophic situation in the highly-dense Palestine refugee camps such as Shatila, Burj Barajneh or Beddawi. This is in large part due to the absence of retrofitting and anti-seismic construction techniques despite the 1994 law[44], government decrees and scientific articles[45] highlighting the underestimation of seismic risks for structures less than 20 metres high, poorly constructed or on unstable soil.

Shatila Camp. ©2017 UNRWA

Narrow streets in Palestine refugee camps. ©2017 UNRWA

It is essential that UNRWA, with the participation of civil engineers and architects within the FICIP, engage in collaborations and partnerships to mitigate the risks inside the Palestine refugee camps, and join UNDP who is working with the Prime Minister's office on a project to help the Government of Lebanon develop its disaster management and risk reduction strategy. Signed in 2009, the Disaster Risk Management Project has developed a National Response Plan to deal specifically with natural or man-made disasters, including earthquakes, which feature high on the list.

The following figures summarizes the level of risks related to floods, fires and earthquakes in each camp. In-depth assessment using the new GIS system (including the buildings, topography and roads data) is urgently needed to be developed in high-risk camps.

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[43] "*Eastern Mediterranean clearly demonstrates that this part of the world has been shaken since 2000 B.C. by strong earthquakes that destroyed thousands of structures and caused severe casualties and loss of human life in present day Lebanon, Syria, Jordan, Israel and Palestine. Three earthquakes stand out in the history of seismic activities in Lebanon: the earthquakes of 551 A.D., 1202 A.D and 1759 A.D (two events). The magnitudes of these earthquakes were estimated, based on historical accounts, to be in excess of 7.0, and caused destruction in most coastal cities including Beirut, Tripoli, Jubail, Saida, and Tyre as well as the ancient city of Baalbeck. Occupying 225 km of the 600 km long segment making up the Eastern Mediterranean coastal region, Lebanon lies right across an estimated 1,000 km long fault which extends from the seafloor spreading in Red Sea to the Taurus Mountains in southern Turkey*." Evaluation of the seismic hazard of Lebanon, M. Harajli, S. Sadek and R. Asbahan, 2002.

[44] "All new construction must be built according to standards incorporating seismic resistance. But most residential buildings are old, built before these laws were introduced". Due to little government oversight, construction laws are rarely enforced.

[45] M.C. Arango & Z.A. Lubkowski, Seismic Hazard Assessment and Design Requirements for Beirut, Lebanon. 2009.

Camp	Floods		Fires		Infrastructure damages	
	level of risk	main cause(s)	level of risk	main cause(s)	level of risk	main cause(s)
Burj Barajneh	High	rainfall, uncontrolled urban planning	High	uncontrolled urban planning, electrical network, narrow streets	High	uncontrolled urban planning, earthquake
Dbayeh	Low		Low		Low	
Mar Elias	Medium		Medium	narrow streets, limited access by fire brigade vehicles	High	uncontrolled urban planning, earthquake
Shatila	High	rainfall, uncontrolled urban planning	High	uncontrolled urban planning, electrical network, narrow streets	High	uncontrolled urban planning, earthquake
Ein El Hilweh	Low		Low		Medium	uncontrolled urban planning, earthquake
Mieh Mieh	Low		Low		Low	
Burj Shemali	Medium		Low		High	uncontrolled urban planning, earthquake
El Buss	Medium		Low		Medium	
Rashidieh	High	rainfall, sea level rise	Low		Low	
Wavel	Low		Low		Medium	
Beddawi	High	rainfall, uncontrolled urban planning	Medium	uncontrolled urban planning	Medium	uncontrolled urban planning, earthquake
Nahr El Bared	Medium	sea level rise	Low		Low	

Figure 49. Level of risks for floods, fires and collapses of buildings due to earthquake or uncontrolled urban planning.

In 2017, UNRWA faced several emergencies including consequences resulting from the clashes between the factions in the camp of Ein El Hilweh and tensions between communities inside and in the surroundings of the Burj Barajneh camp. By providing instant and precise mapping of the damage to buildings and roads and to identify social zones or emergency premises to be used for protection of people or during repairs it is an essential part of the FICIP GIS support tool to other departments and partners.

Recommendations

As a consequence of a natural or anthropogenic causes, the emergency preparedness programme needs to be reinforced by developing more synergies between human and environmental causes. By using more efficient monitoring and response tools such as GIS and satellite imagery, the FICIP and partners will be in a better position to anticipate such risks but also to respond in a more effective way. Awareness of the population and communities, by involving them in participatory-oriented workshops together with organizations such as the Lebanese Red Cross and Palestine Red Crescent and other specialized bodies is urgent.

A tight equilibrium between "*emergency*" and "*routine*" management has implemented. The expiration dates of reagents (chlorine and other chemicals) and appropriate storage of the protection equipment (facial masks) must be adhered to for the routine activities and their replacement for emergency with updated ones. Similar logistic management is essential for the infrastructure and tools equipment such as dewatering or drinking water pumps, generators, vehicles, among others.

It is essential that UNRWA is better represented at local, national and regional levels within the climate change domain, considering the important impact of climate on the fragile resources such as water as well as other natural disaster risks as a consequence of global warming and climate impacts. Active participation from UNRWA environmental specialists and head of climate change projects to the future Climate Action Summit which will be organized in California in 2018 or in 2019 by the United Nations Secretary General. The development of green finance also one of the pillars of the COP21 and the UNRWA donor relations unit should be more involved in the topic to better identify financing options.

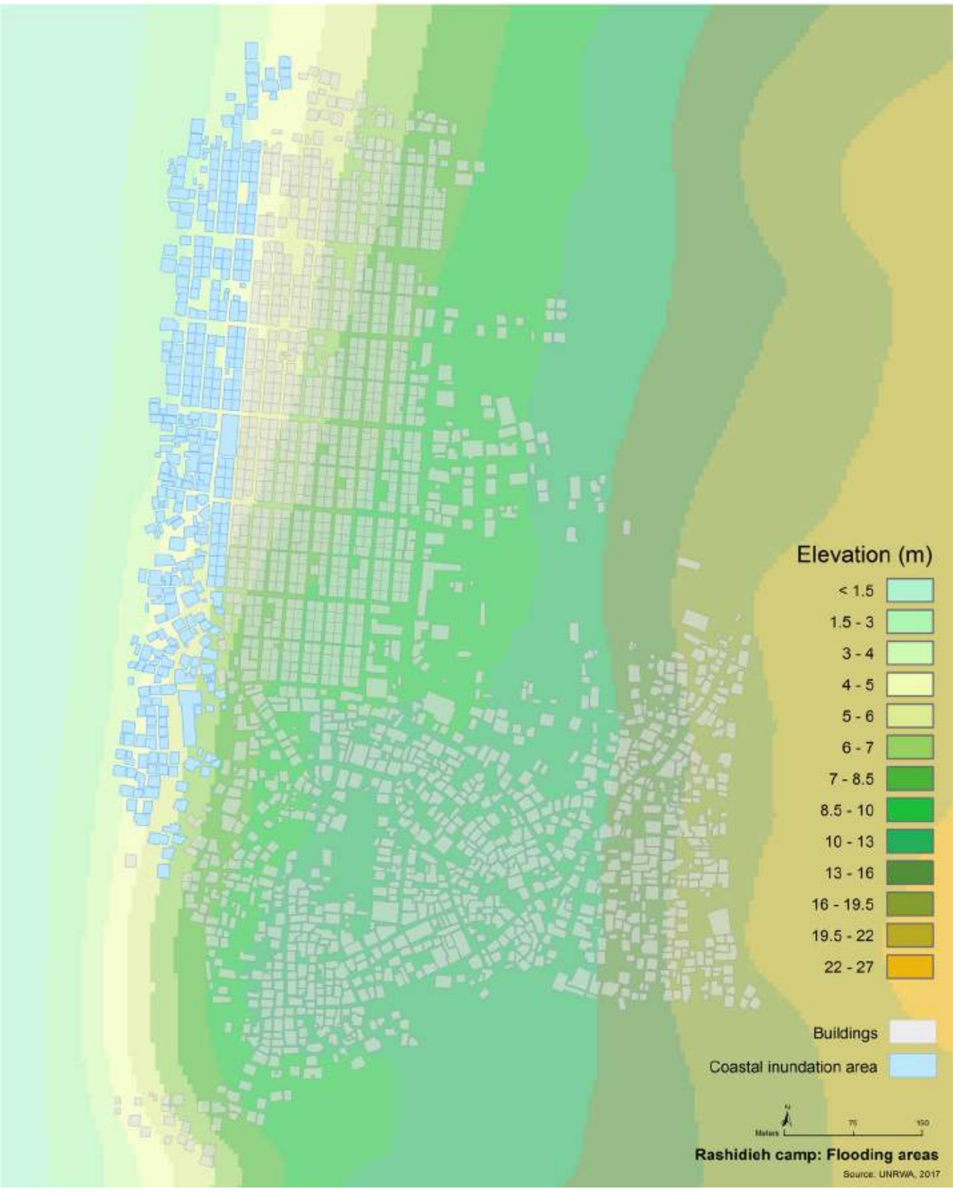

Figure 50. Simulation of flooding areas in Rashidieh camp using topographic and ACAD data base.


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PART 4
FINDINGS AND RECOMMENDATIONS

Part 4

Findings and recommendations

Lebanon has relatively more water resources than neighbouring countries in the Near East region, due to adequate rainfall and its rich aquifers. However, due to poor water management and climate change impacts, substantial water shortages must be anticipated. According to the World Bank, the cost of climate change in Lebanon is estimated to be around USD$ 90 million per year. The majority of wastewater and storm water, collected in cities and villages across the country, is discharged directly into the Mediterranean Sea with limited or no treatment or recycling processes.

According to a national survey[46], there are more than one thousand illegal solid waste open dumping sites and open burning sites which lead to increased surface water, groundwater and air pollution. Since the onset of the Syrian crisis and subsequent influx of Syrian refugees across the Lebanese border, there has been a marked increase of 15 per cent in the amount of solid waste generated in Lebanon[47].

Electricity production in Lebanon largely depends on imported fossil fuels such as oil. Efficiency is particularly low with significant price gaps between the price of electricity provided by the national grid, Electricité du Liban (EDL) and that which is locally produced by private generators. The Government of Lebanon[48], within the UN Climate Change Conference, announced its goal to produce up to 15 per cent of its energy needs through renewable energy by 2030. The current consumption of renewable energy is only five per cent of the total energy consumed in Lebanon[49].

Part 4 focuses on the general findings from the inventory and needs assessment in the 12 Palestine refugee camps and outlines recommendations that can be applied to all camps, based on the current national context. Specific findings and recommendations per camp are available in reports at the FICIP Department,

Since their creation in 1948, the Palestine refugee camps in Lebanon have remained confined to the same restricted areas. In contrast to other UNRWA Fields (Gaza strip, West Bank, Syria and Jordan), the camps in Lebanon are semi-autonomous settlements, with limited services from the local municipalities. In line with other UNRWA Field operations, the eventual objective in Lebanon is for the host country to resume the provision of environmental infrastructure and environmental health services, regardless of political, economic, environmental and humanitarian challenges. Furthermore, the limited resources of municipalities and Water Establishments are under considerable pressure to respond to growing impacts of the Syrian crisis and are already overstretched.

The ongoing instability in Lebanon continues to undermine the living conditions of Palestine refugees and other populations living in and transiting through the camps. Palestine refugees have limited basic

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[46] UNDP – ELARD survey on solid waste
[47] Lebanon Environmental Assessment of the Syrian Conflict, 2014
[48] Lebanon ratified most Multilateral Environmental Agreements as early as 1996, and has accordingly benefited from international support to address priority response to the national and international challenges facing Lebanon's environment. (Protection of Ozone Layer, Combat Desertification, convention of climate change Climate of Rio De Janeiro and biological Diversity etc.), UNEP 2017
[49] Human Development Report, 2016

civil and political rights and must endure socioeconomic exclusion. The degradation of the land, habitat, water, sanitation, air, and energy sectors in the direct vicinity of the camps and in highly urbanized areas along the coast and in the Bekaa valley is apparent. Adopting an integrated approach, involving both local and global perspectives was crucial during the analysis of these sectors to find simple solutions to common problems.

Palestine refugees in Lebanon face one of the worst socioeconomic situations in the region second only to the Gaza Strip. Conditions have continued to deteriorate given the country's weakened state and the overspill from the protracted conflict in Syria. Poverty among Palestine refugees in Lebanon remains a major concern, particularly for youth with more than 70 per cent of adolescents living in poverty and five per cent in extreme poverty. A socioeconomic survey conducted by the American University of Beirut in 2015 found that one quarter of Palestine refugees are living in multi-dimensional[50] poverty, exacerbated by the lack of decent employment opportunities[51], mainly low-skilled[52] and elementary jobs. As a consequence, low income remains the primary cause of high poverty rates among Palestine refugees. Variations in poverty according to geographical location exist and are highlighted in surveys conducted by AUB in 2010 and 2015 showing that the North area is the poorest, followed by Tyre, Saida, Bekaa and the Central areas.

Following almost a year of conducting field surveys, both in the camps and at the municipal level, and after multiple exchanges between ministerial, local institutions and representatives from the academic and private sectors, it is evident that the environmental infrastructure and environmental health situation in the camps and surrounding areas is critical. Solutions must be viewed in terms of operation and maintenance as well as urban planning with greater involvement from the refugees and other populations living inside the camps and who benefit from environmental health services. Empowering the population and improving their knowledge on their rights and duties is essential to alleviate some of the workload undertaken by UNRWA and the municipalities.

Land and Habitat sectors

Lebanon, with a unique biodiversity, has an identity that is deeply linked to the cedar tree. Unfortunately, its forests are at grave risk of disappearing resulting in soil erosion and biodiversity loss. Development after the civil war has come at a cost to the natural ecosystems mainly due to unsustainable urban growth. Lebanon has a very high biodiversity with 0.25 different species per square kilometre, but growing urbanization is estimated to be consuming about five square kilometres of natural areas every year. By protecting, restoring and promoting terrestrial ecosystems, through urban planning and public awareness, Lebanon can take advantage of its rich and diverse ecosystems and habitats.

The natural and built environment is strongly affected by land management planning. In Lebanon, current land management practices are not sustainable as they continue to erode the natural resource base (soil, water, green cover, landscapes). Whereas traditional practices such as terracing, controlled grazing and forest management helped protect the lands, modern practices (many of which emerged during the civil war) have significantly altered the natural and social make-up of the land including the perception of natural resources. Population growth, the continued loss of arable land and biodiversity,

[50] Multidimensional poverty index includes education, employment and expenditures
[51] UNRWA. (201). Employment of Palestine Refugees in Lebanon. An Overview. Professions of prohibited access (39).
[52] Occupation such as skilled agricultural and fishery workers, craft and trade and related workers

food insecurity and the rising cost of infrastructure due to population growth and urban sprawl are major factors impacting land resources and the natural environment, as well as social behaviours[53].

Outlined in the EHS (§3.4.3. Land Use, Soil Quality), the sector has been renamed "*Land*" and concerns the soil, geology, hydrogeology, topography and land use from an administrative distribution perspective. Some of the related activities, highlighted in the EHS have been only be partially conducted, due to time and resource constraints. Introduced in the EHS (§4.1. Targeted Population), the "*Habitat*" sector implies all tangible features such as roads, buildings, schools, health centres and the population (demography). The inventory of roads and of open "green" fields (§3.4.3. land use, soil quality) are included in this "*Habitat*" sector.

Demographic Information

According to UNDP, the population in Lebanon is estimated to be 5.9 million. Since 2011, according to the Government of Lebanon, the population increased by 37 per cent including the influx of 1.5 million Syrian refugees (inclusive of those 1.05 million registered with UNHCR). Around 90 per cent of the population in Lebanon live in urban areas and about 30 per cent live in the Beirut Metropolitan area. The majority of Syrian refugees live in high density, urban areas, poor neighborhoods and often in vulnerable conditions. Over 60 per cent of Palestine refugees in Lebanon and more than 55 per cent of Palestine refugees from Syria live inside the 12 Palestine refugee camps, most of which are located in urban areas and along the coast. The human density (number of people per square kilometre) in Lebanon is 565[54] people/km^2 (Gaza Strip ranges 5th with 5,000 people/km^2, West Bank is 25th with 466 people/km^2, Germany 54th with 226 people/km^2).

Buildings in Palestine refugee camps. ©2017 UNRWA

Roofs in Shatila camp. ©2017 UNRWA

More than 67 years after their initial presence in Lebanon, Palestine refugees are still considered as foreigners under Lebanese law, which does not grant them any special legal status. Palestine refugees live in appalling conditions in Lebanon. The right to work, except for odd jobs, is denied by the Lebanese constitution. The needs and natural growth of the refugees have led to the evolvement of shelters in the camps from single family tents to mud or zinc shelters to extended family multi-storey buildings. Construction was first developed based on need in a horizontal manner and when circulation space became limited or unavailable, extension became vertical with some buildings today up to six floors. Due to the shortage of financial means and the ad-hoc nature of extensions, the vast majority of buildings were unplanned and did not follow safe engineering construction practices. As a consequence, most of these buildings are without foundations and created with cheap and inappropriate construction materials

[53] Source: Republic of Lebanon, Ministry of Environment. 2017.
[54] 445 people/km^2 for UNDP

leading to cracks, leakages and in many instances structural failure, causing serious risks to the lives of inhabitants and passers-by. UNRWA runs 66 schools, 27 health centres and more than 50 offices and other premises are under UNRWA supervision and administration.

As of March 2015, over 495,985 PRL were registered with UNRWA in Lebanon, but it is estimated that 194000 people currently reside in the camps. The number of people living and transiting in the camps is only an estimation and subject to variation due to the presence of PRS, Syrian refugees and other populations including Lebanese. The total population also varies according to the season (summer and winter) and according to the commercial activity on weekdays and at weekends. Out of the total estimated PRL population settle in Lebanon, more than 60 per cent live inside the camps and the remainder live in different locations outside, including cities, villages and Gatherings. The average household size is estimated at 4.5 members and the average age of the PRL population is 30 years old.

The estimated Palestine refugee population is distributed in approximately 13,000 buildings and in more than 40,000 shelters. Based on the FICIP inventory, the total area of the 12 camps is equivalent to approximately 2.79 km^2, corresponding to an average human density of 86,000 people/km2, highlighted by the verticality of the habitat found in most of the camps. Shatila is the most densely populated camp, followed by Mar Elias and Burj Barajneh, all located in Beirut city. The less dense camps are Rashidieh, followed by Dbayeh, Mieh Mieh and El Buss. The largest camps are Ein El Hilweh and Rashidieh and smallest camps are Mar Elias and Wavel. The average number of floors in a building is three (ranging from two to seven floors) and the average number of people per shelter is 4.5[55].

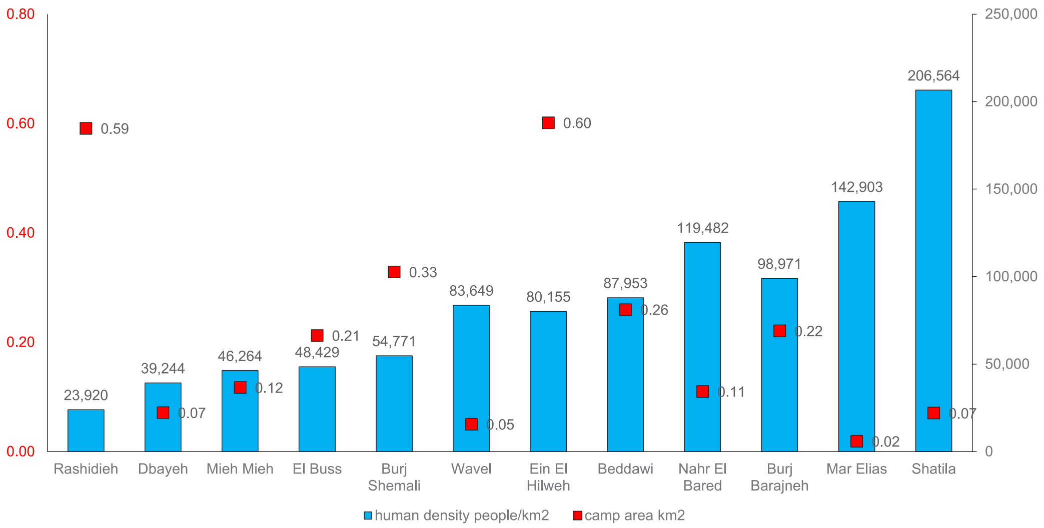


Figure 51. Estimated camp area (km^2) and projected human densities, people/km^2.

Administration Distribution and Geographical Context

From an administrative point, the 12 camps are located in 6 Mohafazas, eight Cazas, 13 municipalities and four Water Establishments. The end of the civil war in Lebanon represented a watershed moment for UNRWA when the organization shifted from only facilitating environmental infrastructure and environmental health services to being responsible their full provision. Furthermore, this new role involved working in an increasingly complex environment with instability both inside and in the

[55] Such figures may not be updated and the LPDC Census on Palestine refugee population in Lebanon, launched on February 7, 2017, might bring new statistics (http://www.lpdc.gov.lb/selected-articles/hariri-launches-census-of-palestinian-refugees/355/en)

surrounding areas of the camps. For decades, the camps lacked basic environmental health services with severely deteriorated infrastructure. Since 2004, major works have been undertaken by UNRWA to improve the living conditions inside the camps. External assistance has and continues to be vital and necessary for safeguarding and promoting the well-being of vulnerable people within the camps (particularly children, women and the elderly) whose access to clean and safe water and general health services would otherwise be compromised.

Figure 52. Administrative organisation in Lebanon.

Eleven out of the twelve Palestine refugee camps are located along the coast with Rashidieh and Nahr El Bared directly on the seashore. Wavel camp is located in the Bekaa plain. In terms of topography, lowest altitudes are found in three camps located at sea level (Rashidieh, El Buss and Nahr El Bared) and reach up to 1,179 metres above sea level in Wavel. Due to the small area of each camp, average height variations are equivalent to 22 metres, with the largest difference found in Ein El Hilweh (67 metres) and the lowest in Mar Elias (six metres).

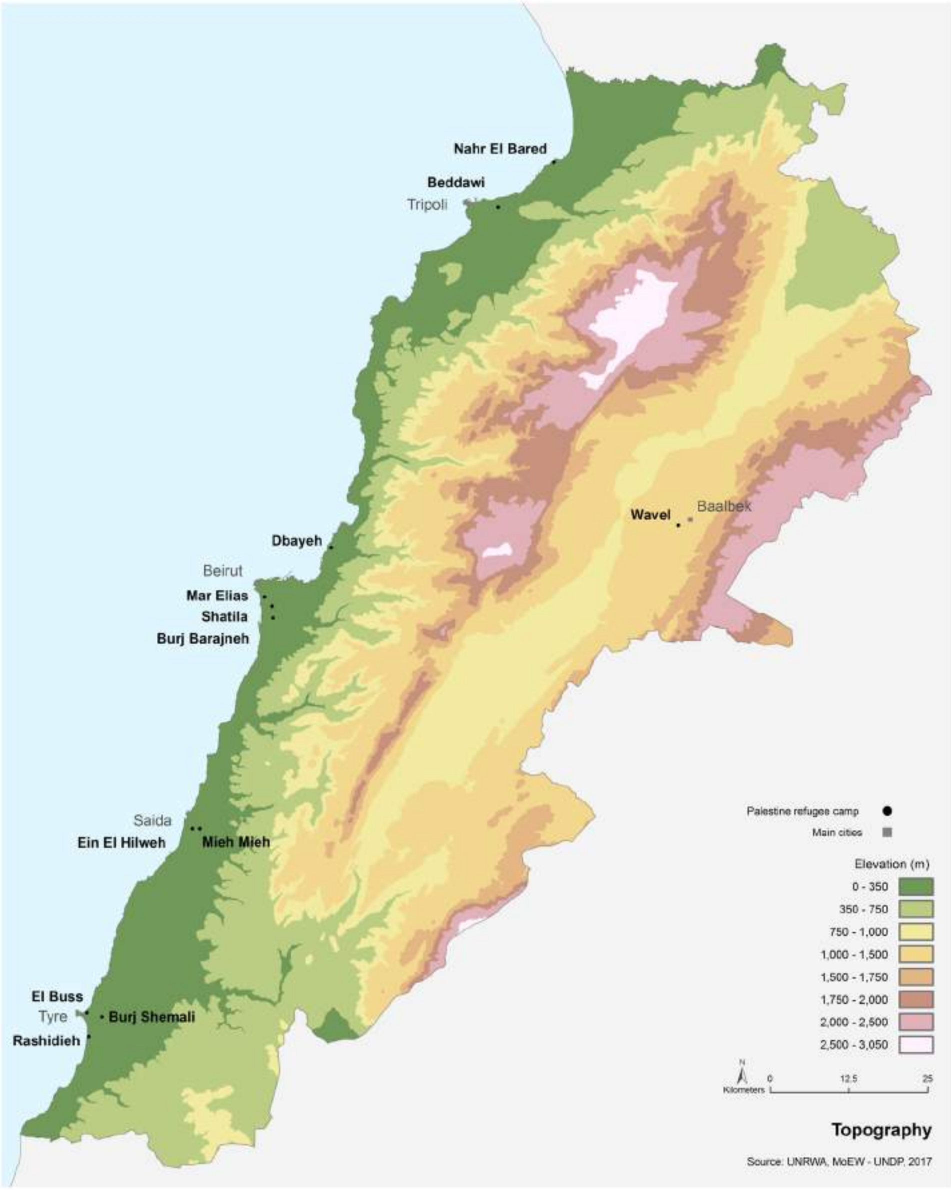


Figure 53. Topography of Lebanon.

The inventory and needs assessment systematically referred to the geology, hydrogeology, topography, soil, demography and other administrative distributions within Lebanon, according to Geodatabase obtained from national institutions and other United Nations agencies.

The main findings and recommendations per sector, sub-sector are concisely outlined. It is a summary of all existing and ongoing surveys and feasibility studies developed before and during the 2016 – 2017 period. The 12 Palestine refugee camps are located in five areas across Lebanon (Central, Saida, Tyre, Beqaa and North) with an estimated total population of 194,000 people. The largest area (in terms of population distribution) is Saida, where approximately one third of Palestine refugees live in the biggest camp – Ein El Hilweh. Following this is the North with 27 per cent, Tyre (22 per cent), Beirut (22 per cent) and Beqaa (2 per cent).

Using essential geologic and groundwater data (obtained through collaboration with the MoEW, MoE, and UNDP) allowed the FICIP to gain a national understanding with a detailed local analysis. Technical maps and data require expertise for proper interpretation therefore the FICIP included in its team an environmental health expert, hydrogeologist, chemists, agronomists and GIS specialists..

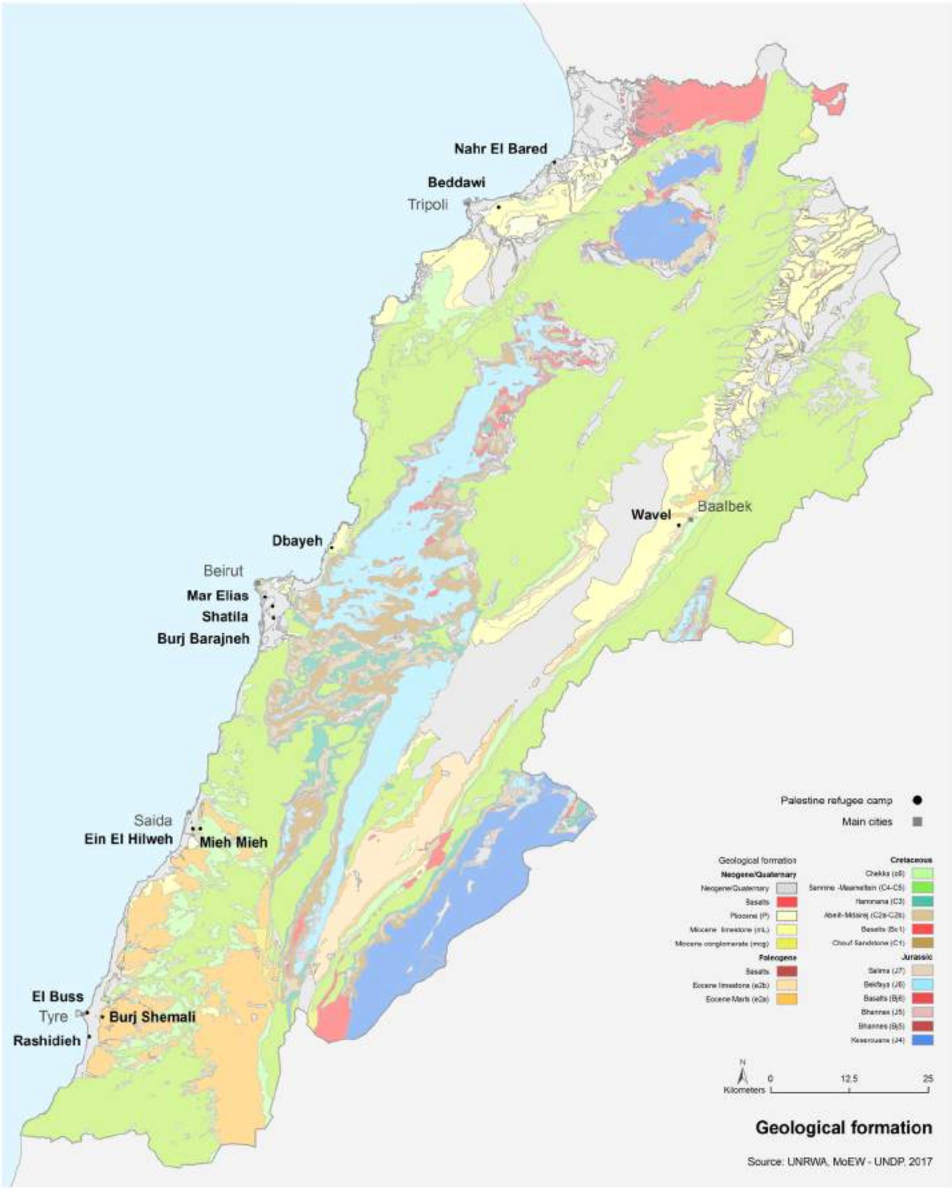


Figure 54. Geological formation of Lebanon.

Central Lebanon Area (Beirut)

The Central Lebanon Area (CLA), which refers to Beirut, is one of the five areas supported by the UNRWA Lebanon Field Office (LFO). CLA hosts four Palestine refugee camps: Burj Barajneh, Dbayeh, Mar Elias and Shatila, which have an population of 42,000 people (22 per cent of the total population for the 12 Palestine refugee camps).

Figure 55. Palestine refugee camps in Central Area of Lebanon (CLA).

Burj Barajneh

Burj Barajneh refugee camp is located within the Burj Barajneh and Haret Hreik municipal region, part of the Baabda District and Mount Lebanon Governorate. It is also included in the Beirut and Mount Lebanon Water Establishment. From a topographic perspective, the camp's highest elevation reaches 32 metres above sea level and its lowest elevation is 23 metres, with an average height of 27 metres. There are 14.2 kilometres of road in the camp, including 10.2 kilometres which are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles). There are an estimated 1,279 buildings representing 118,369 m² of the total area of the camp. The median number of floors per building is three with an average of five people per shelter[56]. The estimated surface area of the camp is 0.22 km^2.

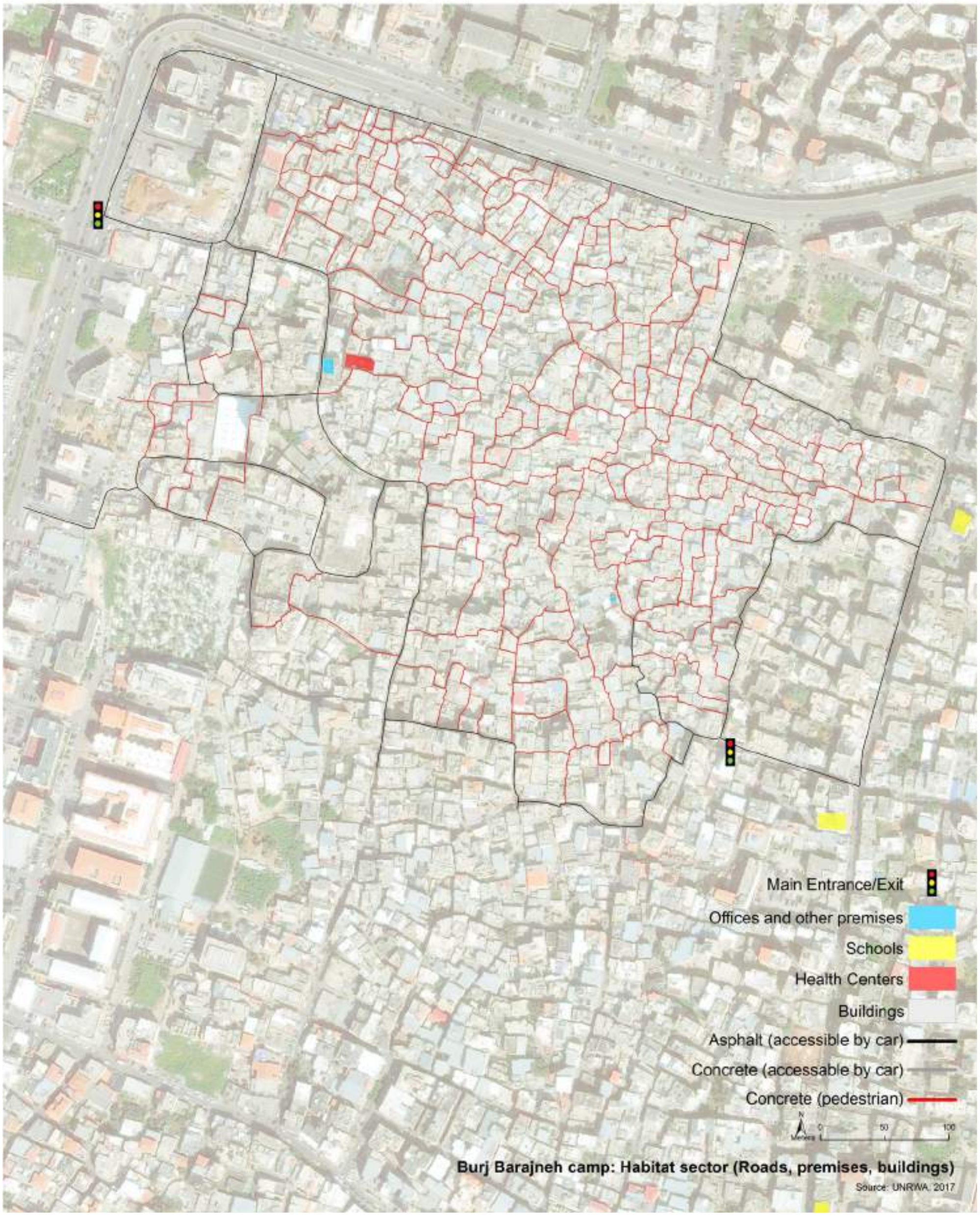


Figure 56. Burj Barajneh camp.

[56] A shelter is equivalent to a flat (can be used by various families' size – nuclear, etc.)

Dbayeh

Dbayeh is located in the Zouk Elkharab municipality, which is part of the El Metn District and Mount Lebanon Governorate and it is included in the Beirut and Mount Lebanon Water Establishment. From a topographic perspective, the camp's highest elevation reaches 100 metres above sea level and its lowest elevation is 93 metres, with an average height of 96 metres. There are 3.9 kilometres of road in the camp, including 1.9 kilometres which are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles). There are an estimated 383 buildings representing 34,972 m² of the total area of the camp. The median number of floors per building is two with an average of three people per shelter. There is one health centre and one premises building located inside the camp. The estimated surface area of the camp is 0.07 km^2.

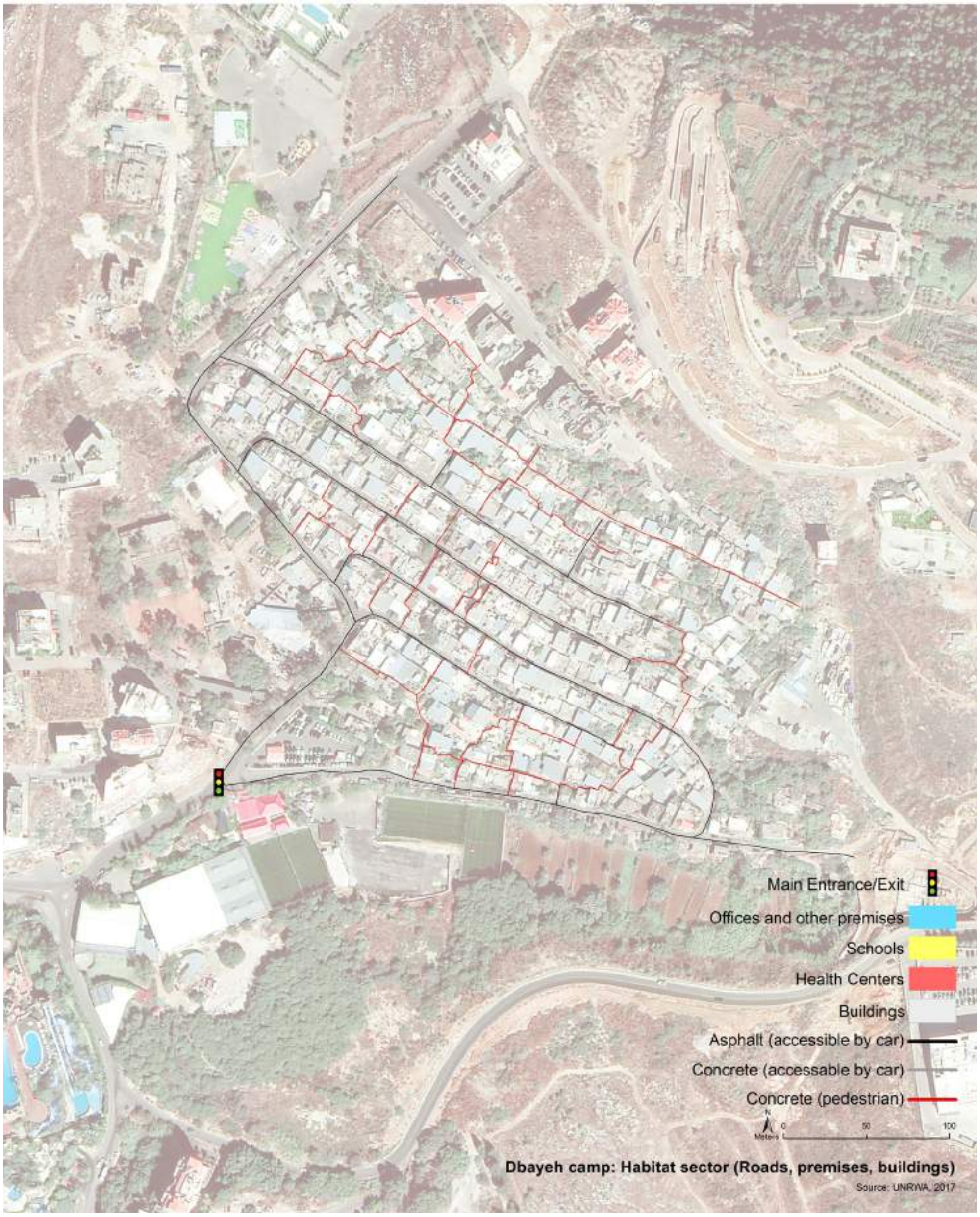


Figure 57. Dbayeh camp.

Mar Elias

The Mar Elias refugee camp is located in the Msaitbe municipality, which is part of the Beirut District and Beirut Governorate and it is included in the Beirut and Mount Lebanon Water Establishment. From a topographic perspective, the camp's highest elevation reaches 39 metres above sea level and its lowest elevation is 33 metres, with an average height of 36 metres. There are 1.1 kilometres of road in the camp, all of which are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles but still accessible for two-wheeled vehicles). There are an estimated 159 buildings representing 10,521 m² of the total area of the camp. The median number of floors per building is three with an average of five people per shelter. There is one school, one health centre and one premise building located inside the camp. The estimated surface area of the camp is 0.02 km^2.

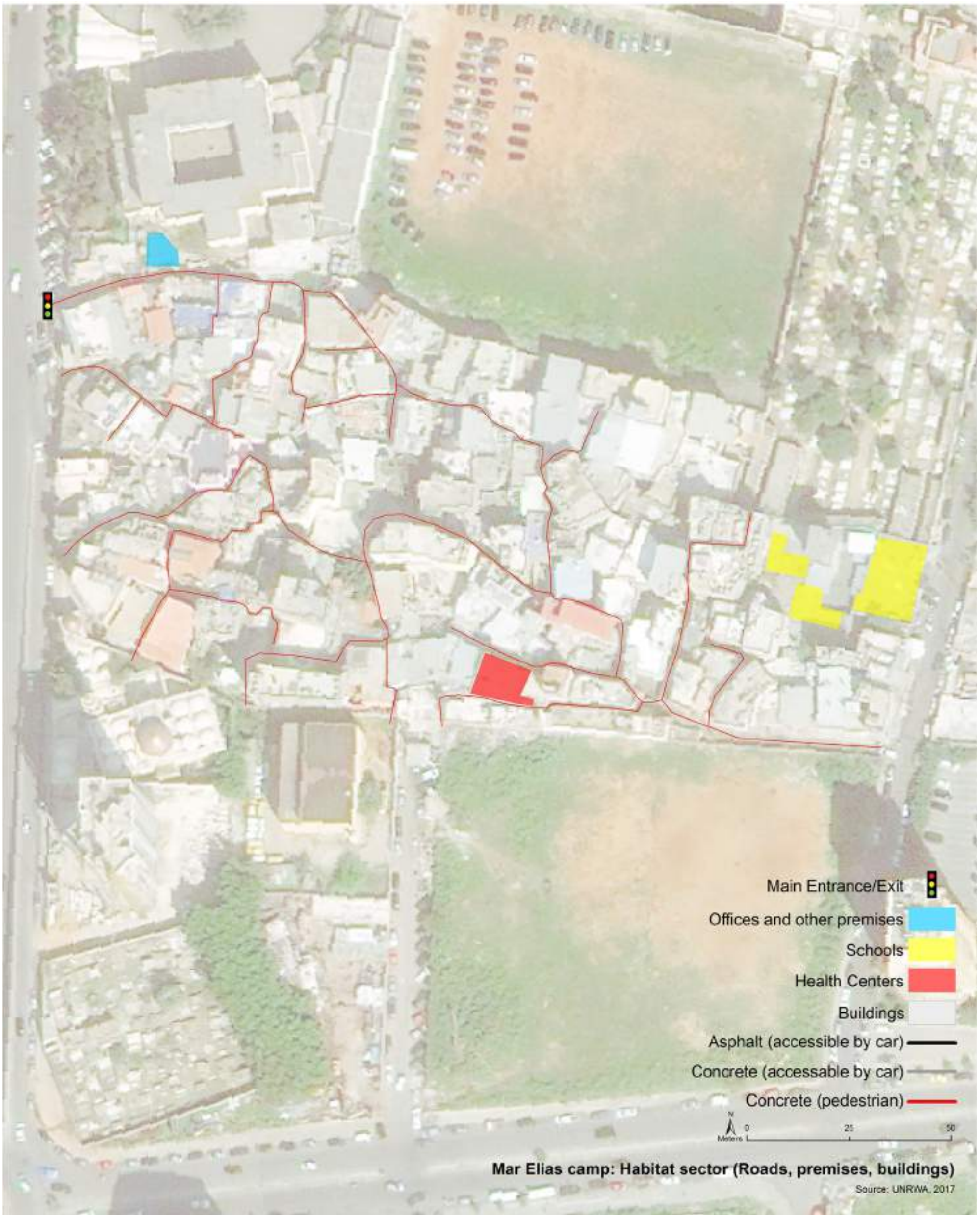


Figure 58. Mar Elias camp.

Shatila

Shatila is located in the Chiyah municipality, which is part of the Baabda District and Mount Lebanon Governorate and is included in the Beirut and Mount Lebanon Water Establishment. From a topographic perspective, the camp's highest elevation reaches 37 metres above sea level and its lowest elevation 30 metres, with an average height of 34 metres. There are 4.8 kilometres of road in the camp, including 3.1 kilometres that are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles). There are an estimated 452 buildings representing 38,747 m² of the total area of the camp. The median number of floors per building is three with an average of five people per shelter. There is one school, one health centre and one premise building located inside the camp. The estimated surface area of the camp is 0.07 km^2.

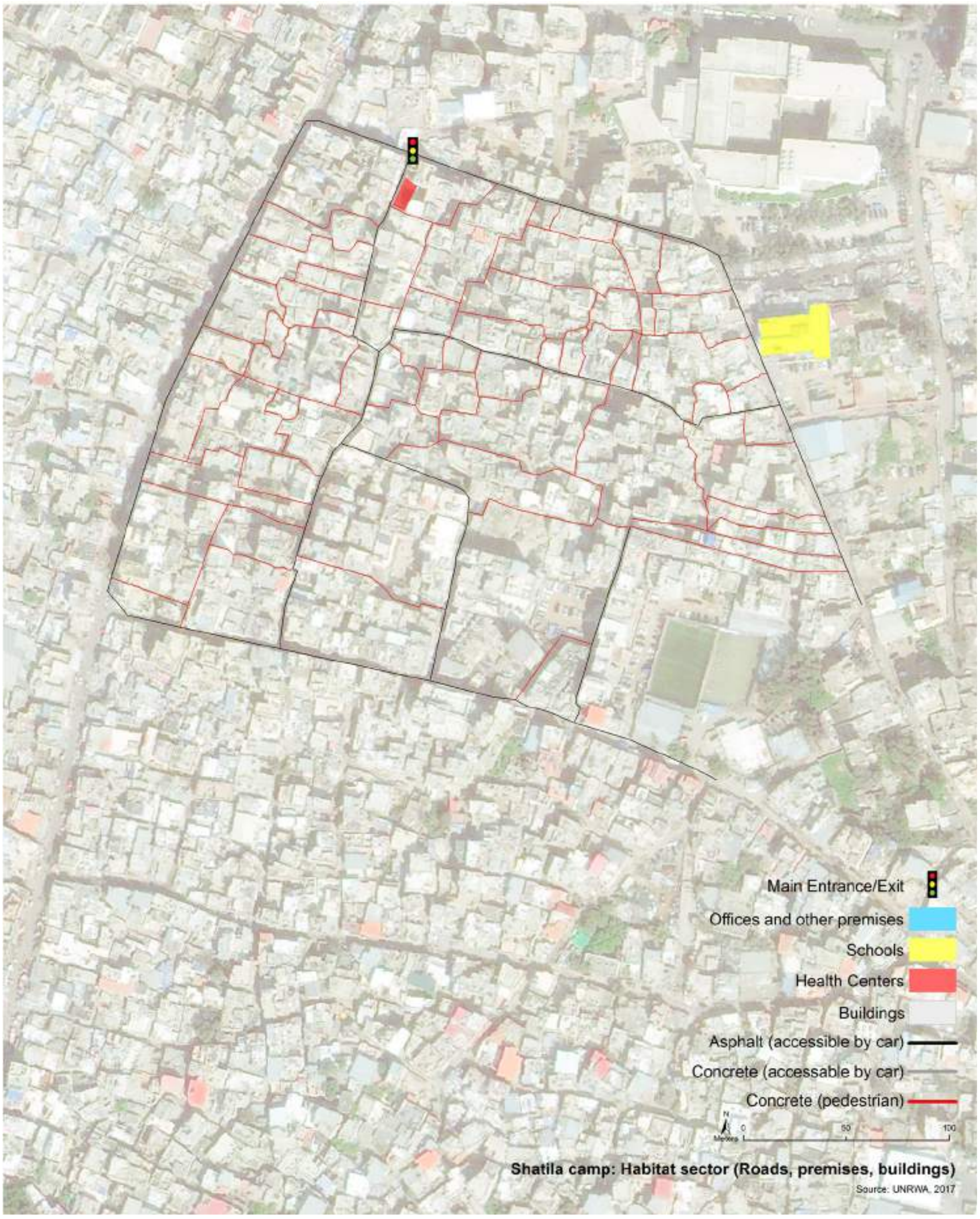


Figure 59. Shatila camp.

Saida Area

Saida Area (SAI), often referred to as Saida city, hosts two Palestine refugee camps: Ein El Hilweh and Mieh Mieh. They have an estimated population of 53,500 (27 per cent of the total population for the 12 Palestine refugee camps).

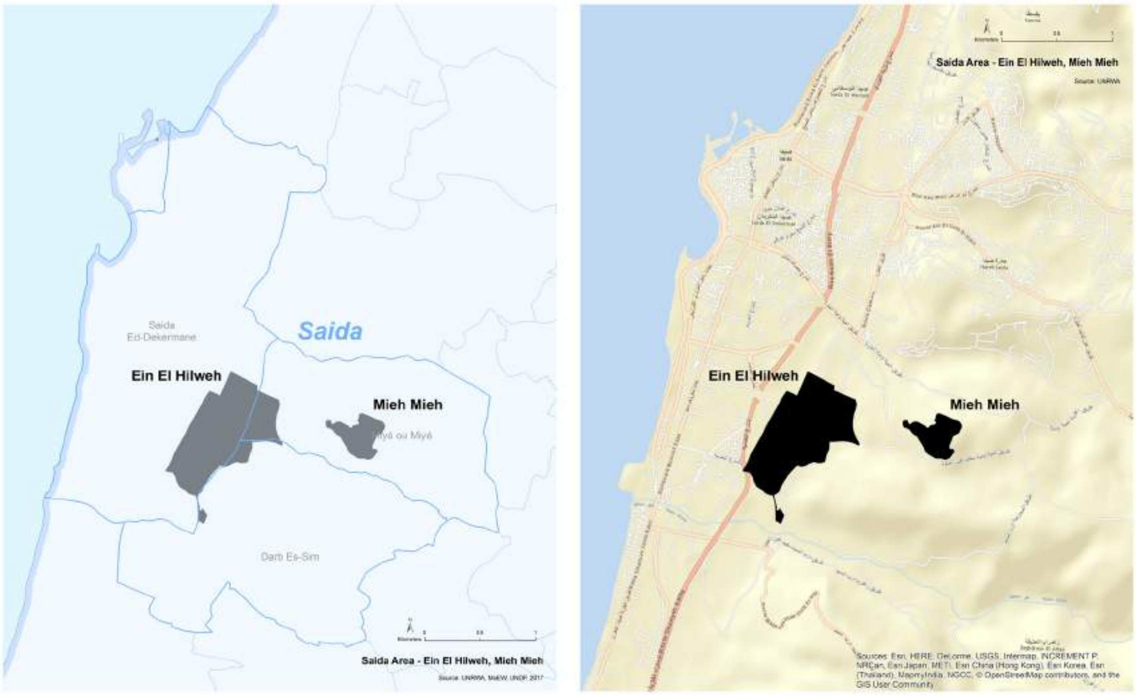


Figure 60. Palestine refugee camps in Saida Area (SAI).

Ein El Hilweh

The camp is located in the Darb Es-Sim, Mieh Mieh, Saida Ed-Dekermane municipality, part of the Saida District and South Governorate and it is included in the South Water Establishment. From a topographic perspective, the camp highest elevation reaches 100 metres above sea level and lowest elevation 33 metres, with an average height of 55 metres. There are 22.1 kilometres of road in the camp, including 16.4 kilometres that are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles). There are an estimated 3,689 buildings representing 301,439 m² of the total area of the camp. The median number of floors per building is three with an average of five people per shelter. The estimated surface area of the camp is 0.6 km^2. There are eight schools, two health centres and three premises buildings are located inside the camp.

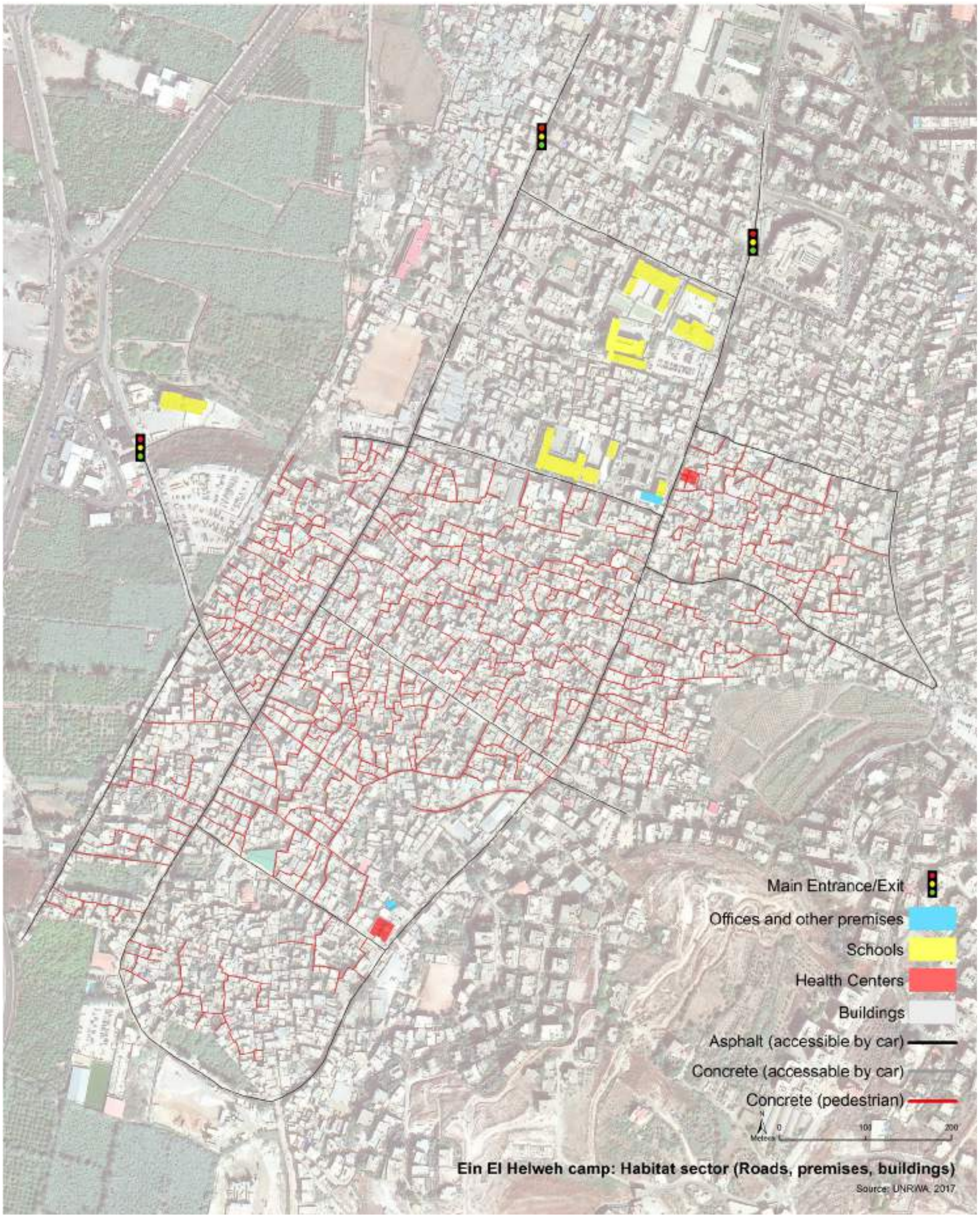


Figure 61. Ein El Hilweh camp.

Mieh Mieh

The camp is located in the Mieh Mieh municipality, part of the Saida District and South Governorate and is included in the South Water Establishment. From a topographic perspective, the camp highest elevation reaches 150 metres above sea level and lowest elevation 142 metres, with an average height of 150 metres. There are 4.7 kilometres of road in the camp, including 2.8 kilometres that are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles). There are 468 buildings representing 45,970 m² of the total area of the camp. The median number of floors per building is three with an average of four people per shelter. The estimated surface area of the camp is 0.12 km^2.

There is one school, one health centre and two premises buildings located inside the camp.

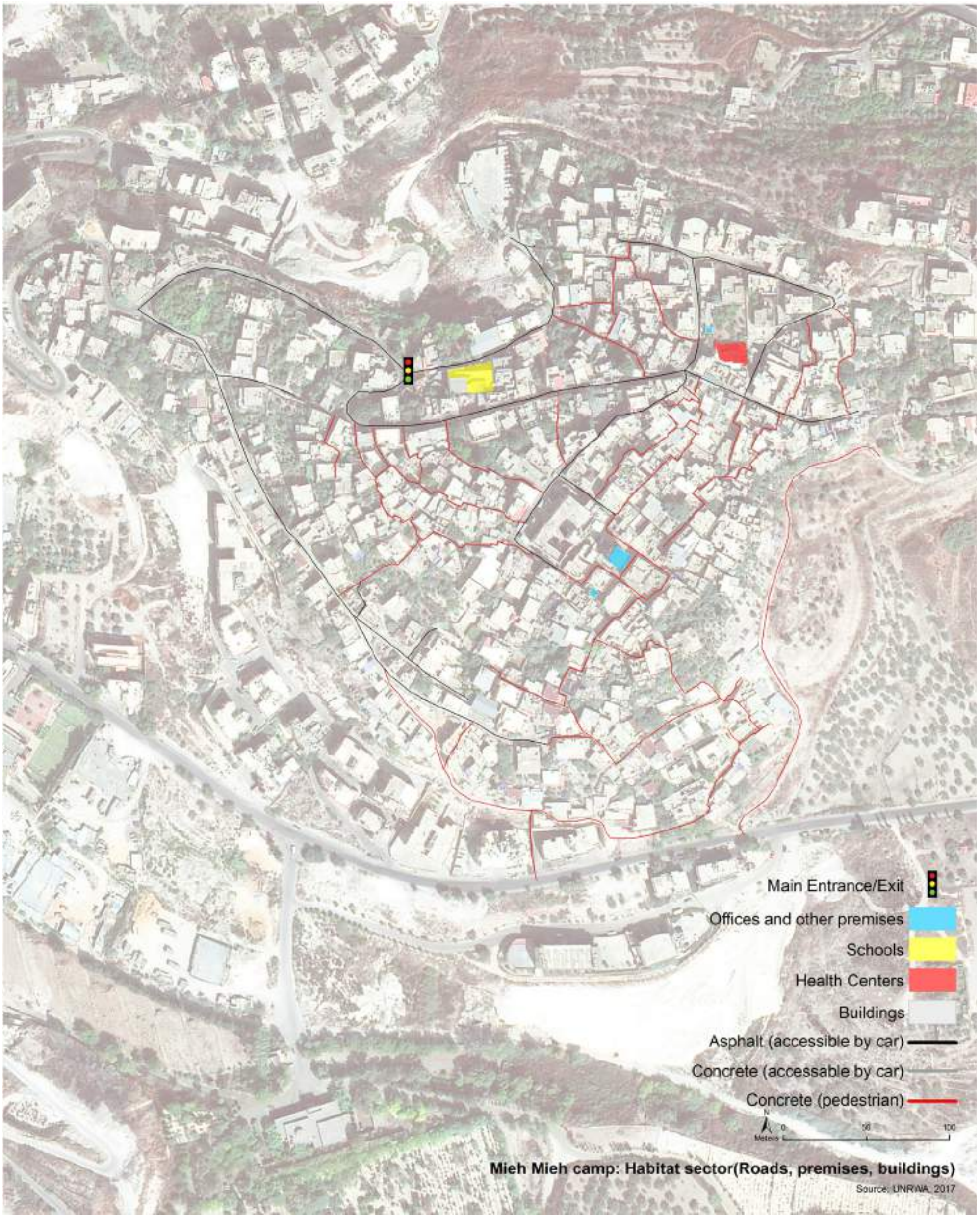


Figure 62. Mieh Mieh camp.

Tyre Area

Tyre Area (TYR), referred to as Tyre city, is one of the five areas supported by the UNRWA LFO. Tyre area hosts three Palestine refugee camps: Burj Shemali, El Buss and Rashidieh, equivalent to an estimated population of 42,500 people, 22 per cent of the total population for the 12 Palestine refugee camps.

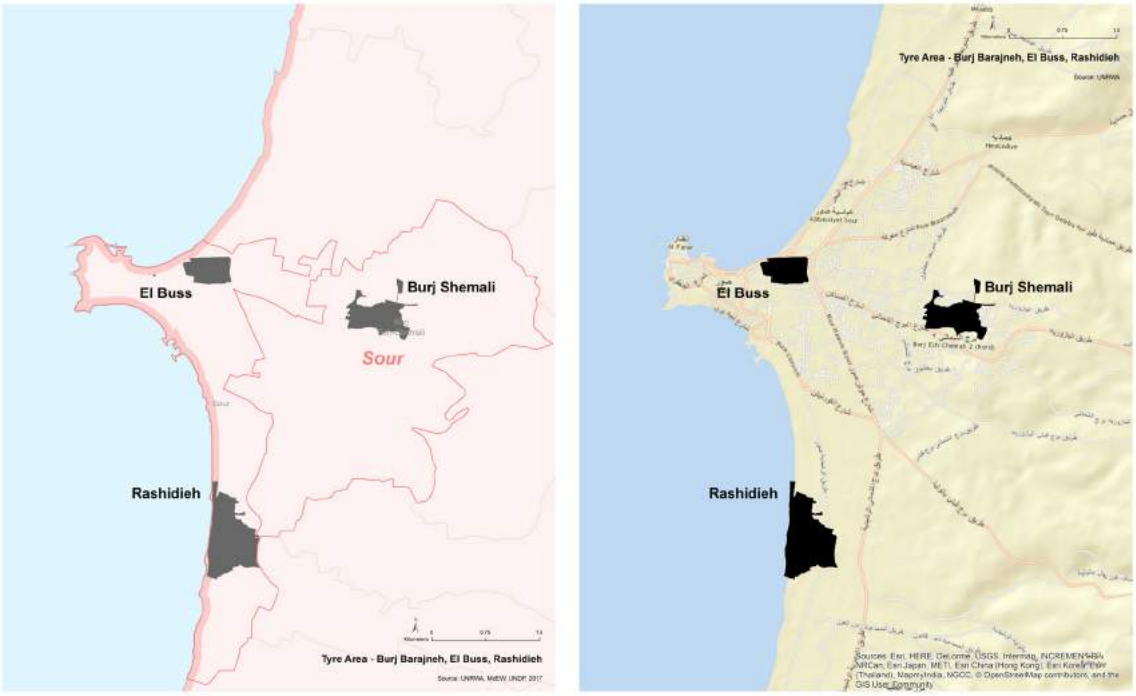


Figure 63. Palestine refugee camps in Tyre area (TYR).

Burj Shemali

The camp is located in the Burj Shemali municipality, part of the Tyre District and South Governorate and is included in the South Water Establishment. From a topographic perspective, the camp highest elevation reaches 100 metres above sea level and lowest elevation 44 metres, with an average height of 73 metres. There are 16.1 kilometres of road in the camp, including 9.3 kilometres that are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles). There are 1,375 buildings representing 155,783 m² of the total area of the camp. The median number of floors per building is three with an average of five people per shelter. The estimated surface area of the camp is 0.33 km^2.

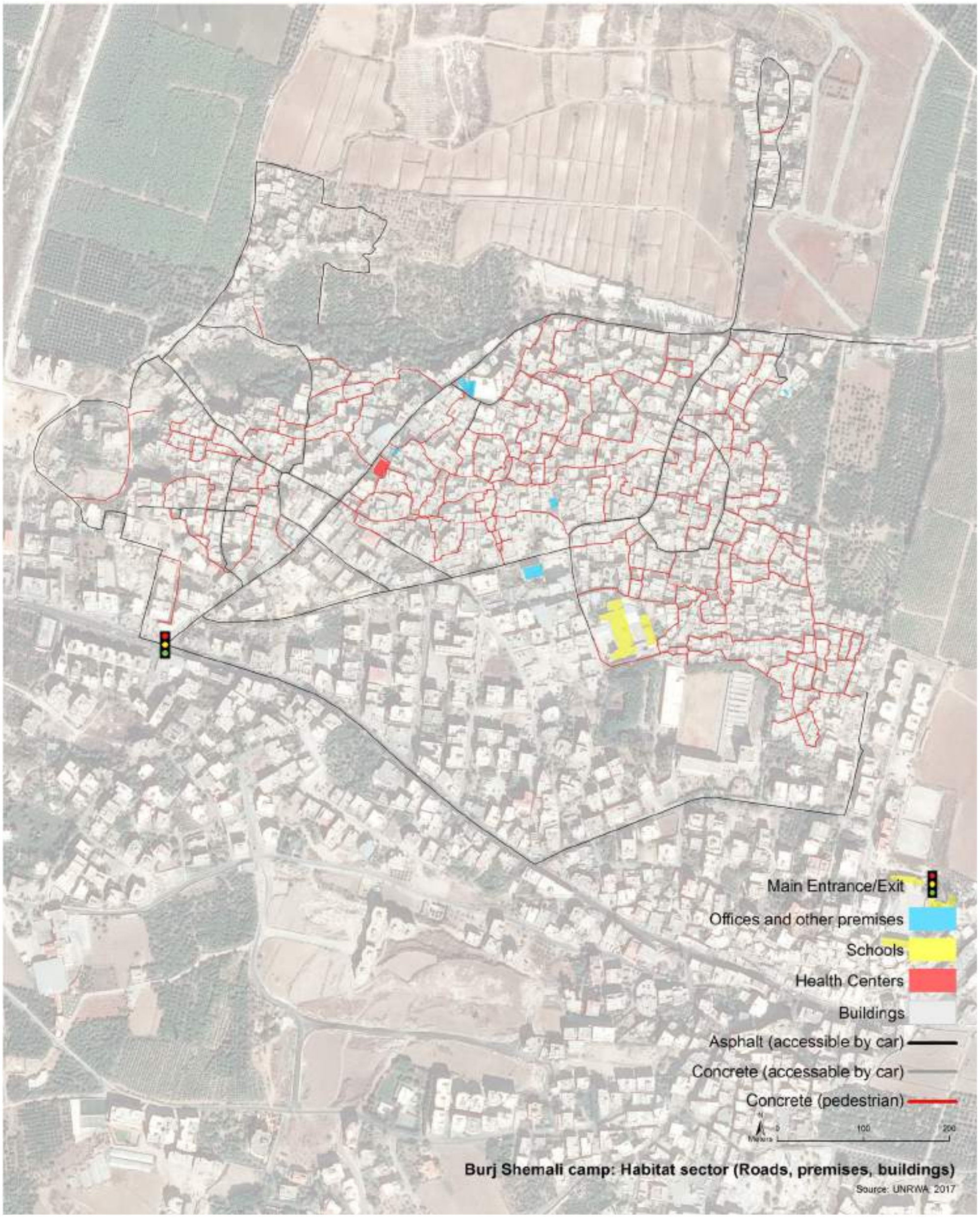


Figure 64. Burj Shemali camp.

El Buss

The camp is located in the Tyre municipality, part of the Tyre District and South Governorate and is included in the South Water Establishment. From a topographic perspective, the camp highest elevation reaches 11 metres above sea level and lowest elevation is at sea level, with an average height of four metres. There are 6.9 kilometres of road in the camp, including 0.6 kilometres that are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles). There are 782 buildings representing 94,799 m² of the total area of the camp. The median number of floors per building is three with an average of five people per shelter. The estimated surface area of the camp is 0.21 km^2.There are three schools, one health centre and two premises buildings located inside the camp.

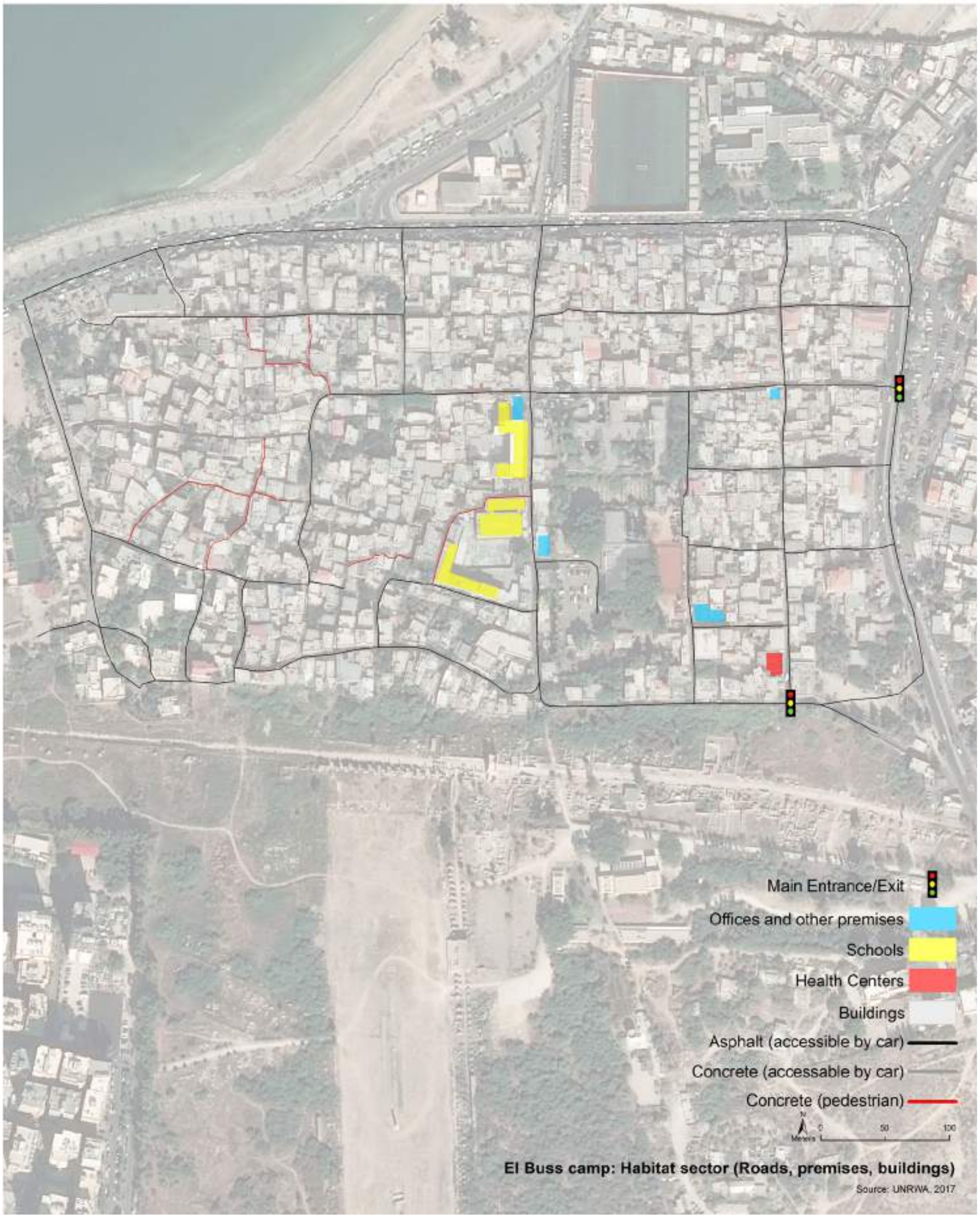


Figure 65. El Buss camp.

Rashidieh

Rashidieh is located in the Tyre municipality, part of the Tyre District and South Governorate and is included in the South Water Establishment. The camp is situated 17 kilometres from the southern Lebanese border and five kilometres south of Tyre. It is divided into "old[57]" and "new[58]" sections. From a topographic perspective, the camp's highest elevation reaches 24 metres above sea level and its lowest elevation is approximately one metre, with an average height of ten metres. There are17.8 kilometres of road in the camp, including 3.7 kilometres that are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles). There are 2,231 buildings representing 237,992 m² of the total area of the camp. The median number of floors per building is three with an average of four people per shelter. The estimated surface area of the camp is 0.59 km². There are four schools, one health centre and one premises building located inside the camp.

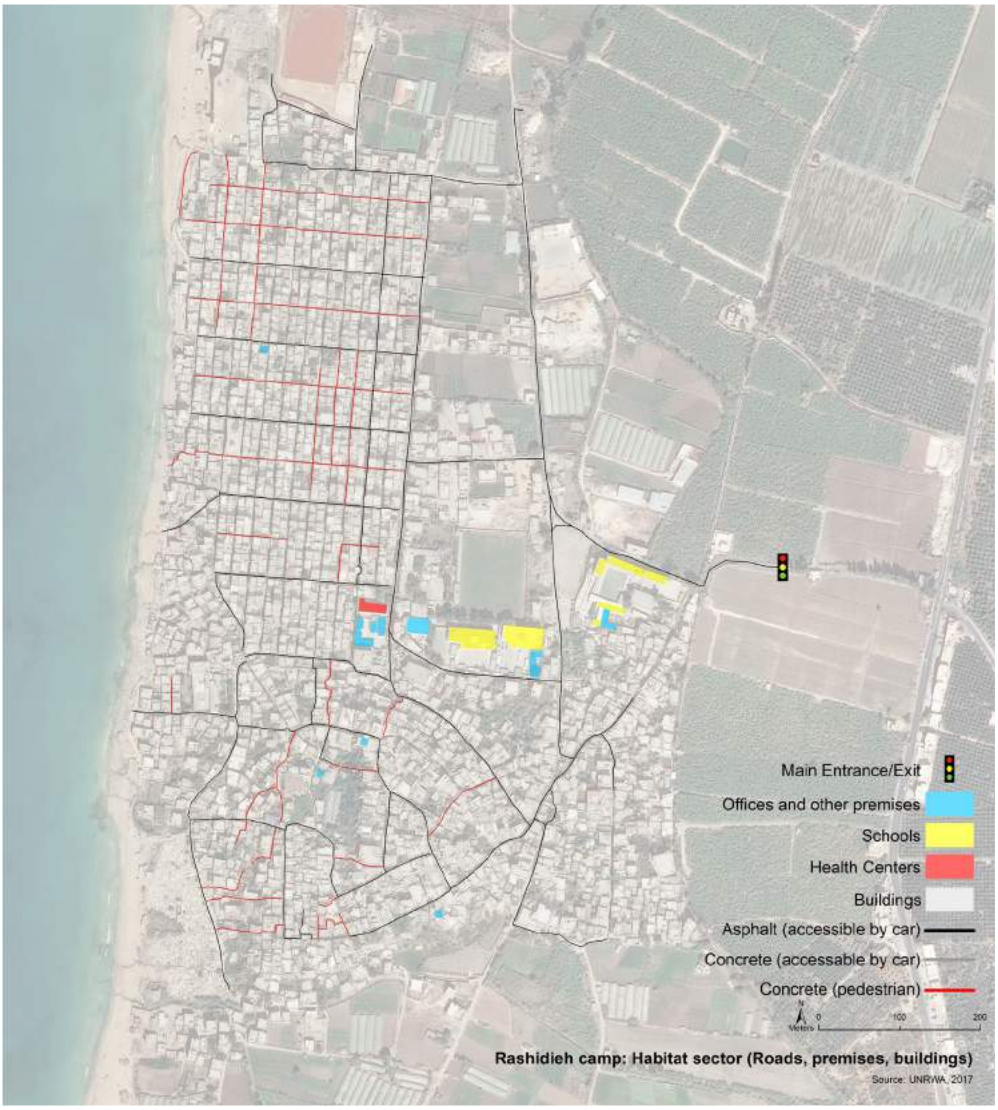


Figure 66. Rashidieh camp.

[57] The older part was built by the former French colonial government in 1936 to accommodate Armenian refugees who fled to Lebanon. In 1950, the Lebanese authorities decided to relocate all Palestinians residing in southern towns to designated refugee camps. The authorities established one of these camps adjacent to the Armenian camp with tents. The residents of the newly established camp began to build walls from mud and clay to reinforce the tents. For every eight housing units, they built a shared bathroom fifty metres away. A decade later, as Armenian residents began to leave, the Palestinian refugees began moving into those lots. Of the 311 Armenian houses, about two hundred of them remain today and are commonly referred to as the "Old Camp."

Bekaa (Baalbek)

Bekaa Area (BEQ), also referred to Baalbek city, is one of the five areas supported by the UNRWA LFO. Bekaa area hosts one Palestine refugee camp: Wavel, with an estimated population of 4,000 people, two per cent of the total population for the 12 Palestine refugee camps.

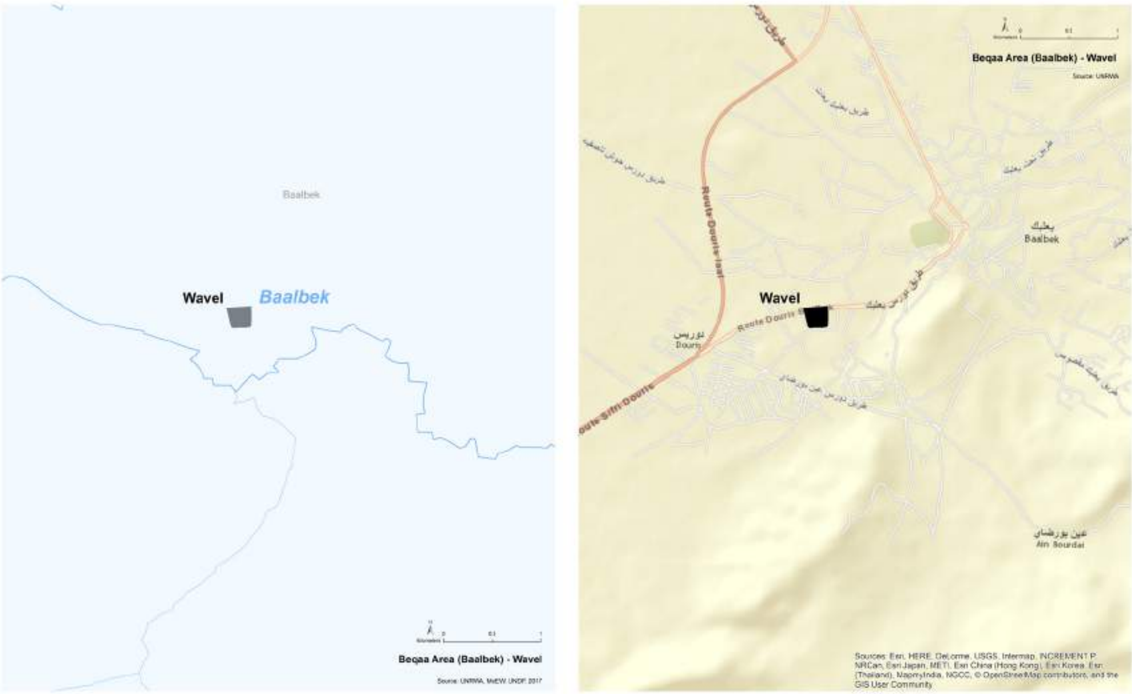


Figure 67. Palestine refugee camps in Bekaa area.

<?> In 1963, UNRWA built a new camp to house Palestinian refugees who were then residing in French mandate military building called “The Gouraud Barracks” in the Bekaa city of Baalbeck. After the Lebanese government had decided to evacuate the barracks, construction of the new camp began in Rashidieh, adjacent to the Old Camp. The single housing units were ninety-nine meters (9m*11m) squared and composed of three rooms, a bathroom and a courtyard lined with a grid network of roads. The residents of “Gouraud Barracks” moved in, along with some others who moved out of the Old Camp. Over the years, Rashidieh camp residents demolished these houses and built their own houses. Throughout the years, large numbers of Rashidieh residents worked in the surrounding orchards either as seasonal or daily laborers, benefitting from the generous amounts of water in the area. Most of the inhabitants of Rashidieh originally arrived from villages in northern Palestine.

Wavel

The camp is located in the Baalbek municipality, part of the Baalbek District and Bekaa Governorate and is included in the Bekaa Water Establishment. From a topographic perspective, the camp highest elevation reaches 1,179 metres above sea level and lowest elevation 1,167 metres, with an average height of 1,173 metres. There are 3.0 kilometres of road in the camp, including 1.4 kilometres that are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles). There are 349 buildings representing 27,962 m² of the total area of the camp. The median number of floors per building is three with an average of four people per shelter. The estimated surface area of the camp is 0.05 km^2. There are two schools, one health centre and two premises buildings located inside the camp.

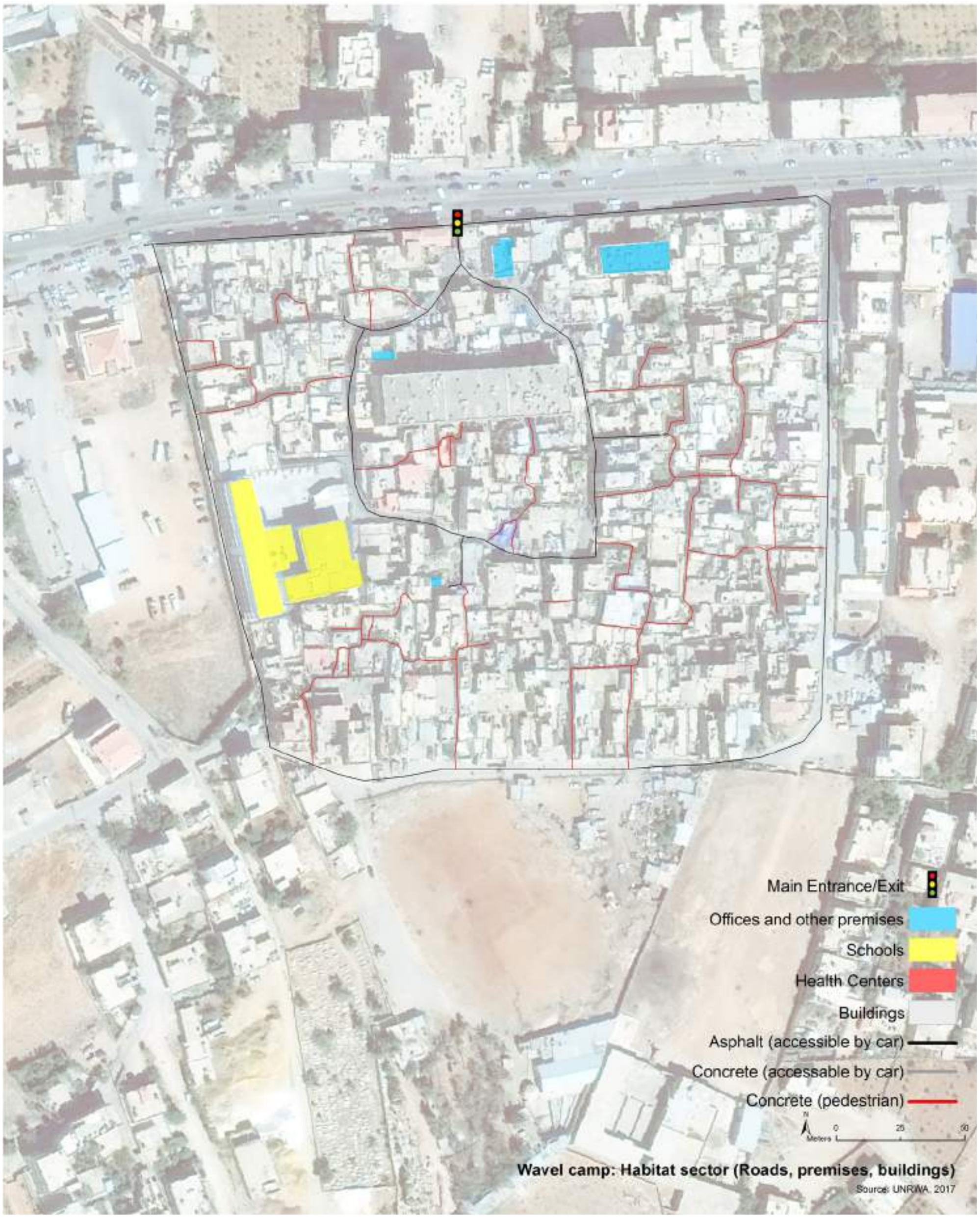


Figure 68. Wavel camp.

North Lebanon Area (Tripoli)

North Lebanon Area (NLA), also referred to as Tripoli city, is one of the five areas supported by the UNRWA LFO. North area hosts two Palestine refugee camps: Beddawi and Nahr El Bared, with an estimated population of 52,000 people, 27 per cent of the total population for the 12 Palestine refugee camps.

Figure 69. Palestine refugee camps in North Area of Lebanon (NLA).

Beddawi

The camp is located in the Beddawi municipality, part of the Minieh-Danieh District and North Governorate and is included in the North Water Establishment. From a topographic perspective, the camp highest elevation reaches 86 metres above sea level and lowest elevation 50 metres, with an average height of 65 metres. There are 9.7 kilometres of road in the camp, including 5.0 kilometres that are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles). There are 1,141 buildings representing 145,105 m² of the total area of the camp. The median number of floors per building is three with an average of four people per shelter. The estimated surface area of the camp is 0.26 km^2. There are seven schools, one health centre and four premises buildings located inside the camp.

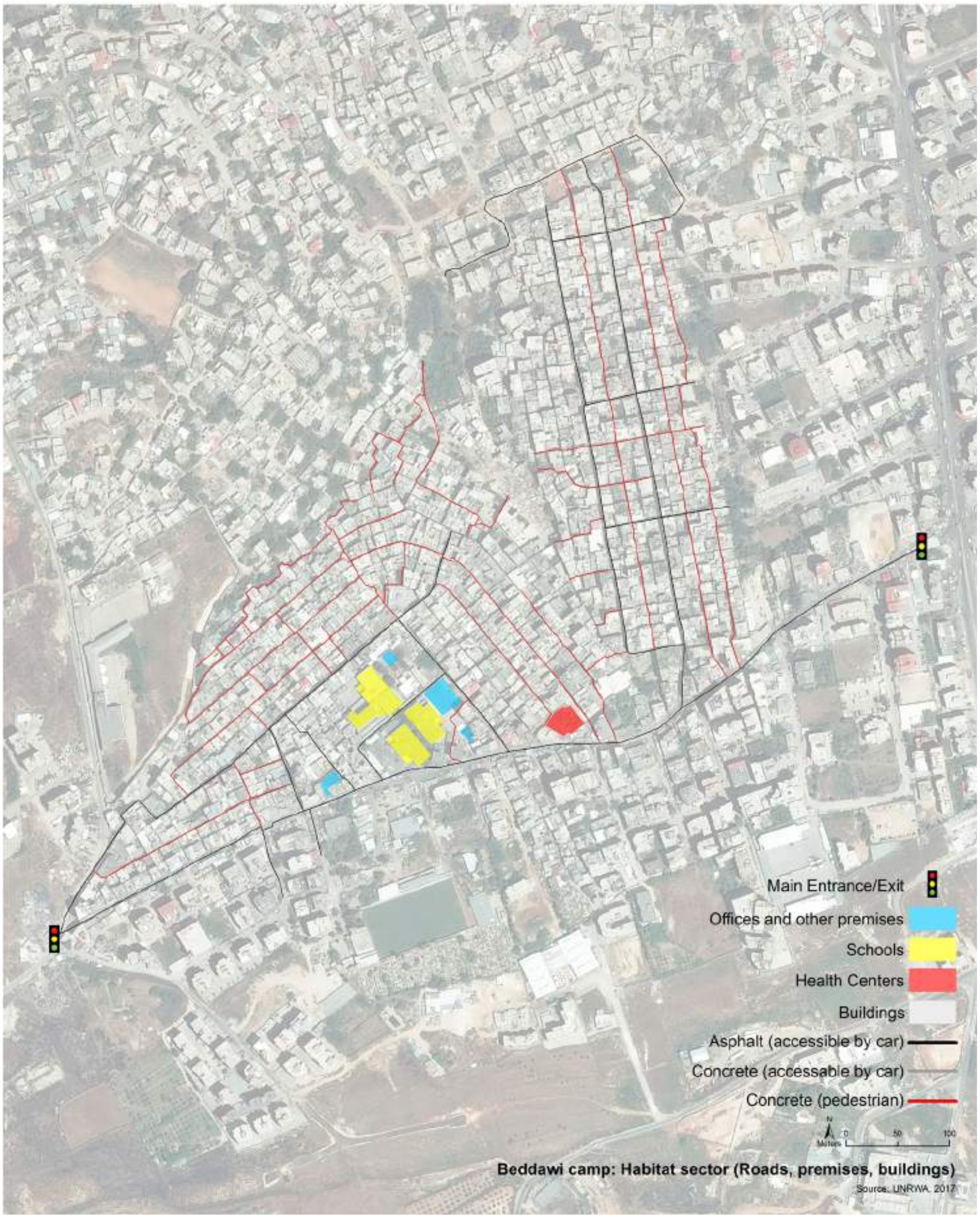


Figure 70. Beddawi camp.

Nahr El Bared

The camp is located in the Mhammaret municipality, part of the Akkar District and North Governorate and is included in the North Water Establishment. From a topographic perspective, the camp highest elevation reaches 27 metres above sea level and lowest elevation is at sea level, with an average height of 12 metres. There are 13.3 kilometres of road in the camp, including 4.4 kilometres that are pedestrianized (their width is less than two metres and unable for four-wheeled vehicles). There are 557 buildings representing 63,633 m² of the total area of the camp. The median number of floors per building is three with an average of five people per shelter. The estimated surface area of the camp is 0.25 km^2. There are seven schools, one health centre and three premises buildings located inside the camp.

Figure 71. Nahr El Bared camp.

Shelters

The definition of a "*shelter*" ranges from a simple place providing temporary protection from bad weather or natural and anthropogenic threats to the equivalent of an apartment or house, commonly found in the Palestine refugee camps in Lebanon. The first shelters, during the early stages of camp construction, were simple tents.

Field inventory. ©2017 UNRWA

Environmental Health Unit workhop. ©2017 UNRWA

The needs and natural growth of the Palestine refugees have led to the evolution of shelters in the camps from single-family tents to mud and zinc shelters and buildings that are several storeys high. Buildings were originally developed based on need, firstly horizontally and when circulation space became unavailable, extensions were made vertically. Construction techniques and materials are similar to those used for Lebanese buildings, hollow blocks of 10 or 15 centimetres), tile flooring on sand or marble on mortar), roofing (typically terraced roofs with reinforced structure to support water tanks and windows and doors (sliding horizontally, aluminium opening leaves of single glazing).

Figure 72. Example of floors' projection with topography in Burj Barajneh.

Within the current situation, refugees in the camps are confronted with the harsh reality that many shelters are at risk of collapse or are uninhabitable due to leakages and unhygienic conditions. The UNRWA Shelter Rehabilitation Programme provides the minimum standards of a decent and dignified life and has a direct effect on the education of children and the health conditions of families. In addition, lack of personal space in inadequate shelters can increase additional protection risks, particularly for women and children, and can result in disputes within families and between neighbours, due to the absence of basic privacy such as proper windows or doors. Rehabilitation varies depending on the assessment conducted, but generally comprises either total or partial reconstruction or repairs.

As an example, the FICIP completed an assessment in Shatila during 2017. Data was obtained for 104 assessed shelters for verification and analysis. The number of rooms varies between one and four with an average of 2.3 rooms per shelter. The range of variation of the occupants is very wide (between one and eight persons per shelter) with an average of 4.7 persons per shelter.

Structural Safety

The main infrastructure damages in Shatila are related to beam deflection due to overloaded structures, including presence of cracks and risk of collapse. Spalling of concrete is regularly observed with severe cases in five per cent of the shelters. In term of stability of the structure, 25 per cent of assessed buildings present “potential danger” and five per cent are collapsing. In terms of hygiene services, the majority (80 per cent) of the shelters are equipped with internal toilets. Only a limited number of shelters remain unequipped with sanitary equipment. Few shelters do not have any kitchen and the vast majority of kitchens (80 per cent) are inappropriate (absence of efficient ventilation, natural light and safety measures). Presence of large damp patches and roof leakages, impacting on moisture problems are severe and moderate in approximately 30 per cent of the assessed shelters. Water entering through walls was recorded and is problematic.

Construction site and infrastructure workers. ©2017 UNRWA

Construction site and infrastructure workers. ©2017 UNRWA

Access to building materials for rehabilitation or new construction is difficult and affecting the vertical and horizontal expansion is taking place in many camps regardless. On the other hand, existing shelters are generally unhealthy and in need of maintenance. The habitat sector constitutes a challenge for a number of reasons which are outlined below:

- Vertical expansion should not limit and reduce the access to light and aeration in the camp. 3D modelling for insulation and air flow in the camp should be conducted for improved master planning.
- Law enforcement mechanisms adopted and enforced to reduce chaotic urban expansion within the camps.
- New building materials and construction techniques should be used to reduce the congestion caused by construction sites and their associated waste. Light reflective colours should be used on building facades and roads to reduce urban heat island effects.

- Urban planning should be encouraged in the camps to improve living conditions and reduce car and motorcycle congestion and pollution inside the camps. It will also help to secure the growth of green spaces (green roofs, trees on the border of the roads, small public spaces)
- Optimization of indoor spaces should be considered for any shelter rehabilitation or new construction site.

Nahr El Bared reconstruction project. ©2017 UNRWA

Surveying engineering work. ©2017 UNRWA

Water and Energy Consumption

Water and energy monitoring was conducted in two shelters in Mar Elias to assess the water and electricity consumption at the end user level. This study and its methodology may be adopted on a larger scale (10 to 100 shelters) to gain a more comprehensive and scientific outlook. Shelter One has two residents and an estimated total area of 45 m^2 while Shelter Two has seven residents and an estimated total area of 55 m^2.

In terms of total electricity consumption, the analysis of the results shows that the total daily electricity consumption per capita is comparable for both shelters and varies between two kWh and four kWh. In addition, the daily total electricity profile shows an electrical shortage of approximately three hours for the two shelters. Commonly observed in the Palestine refugee camps, the two shelters do not have private electricity generators subscription. In terms of hot water electricity consumption, utilization directly correlates with the morning and afternoon hygiene and cooking demand.

Private tanks in Mar Elias camp. ©2017 UNRWA

Individual water tank and booster pump. ©2017 UNRWA

The water consumption for the surveyed shelters is divided into three main categories:

- Saline water from boreholes;
- Fresh water from the reverse osmosis system;
- Hot water consumption.

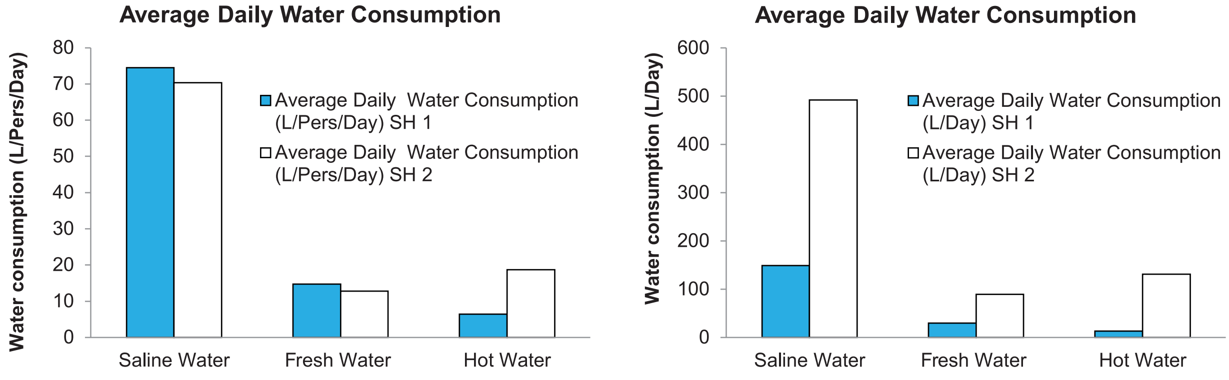


Figure 73. Daily water consumption per day (per person) and per day (per shelter).

The analysis reveals that daily water consumption per capita is comparable for both shelters and is as follows:

- Daily saline water consumption which is directly supplied from boreholes without treatment was measured as approximately 70 litres per person;
- Daily fresh water consumption which is supplied from the reverse osmosis treatment station varies between ten and fifteen litres per person;
- Daily hot water consumption is estimated to be five litres per person for Shelter One and 20 litres per person for Shelter Two.

Following discussions with the occupants of Shelter One and Shelter Two about the water situation and checking the general degradation of water fixtures and the water system, it was concluded that saline water was responsible for the accelerated deterioration of the system, inducing rust and limestone deposits.

The total daily electricity consumption per capita is comparable for both shelters and varies between two kWh and four kWh. This value could be used as a reference to scale up the energy needs in a camp. However, a more detailed study would increase the accuracy of the average value.

A daily three-hour electricity shortage was confirmed by measurements. The majority of shelters in Mar Elias are not subscribed to any private generator distributor. Regular breakdowns and accidents occur in the camp due to random installations on the networks. Two breakdown incidents occurred during the project period (three weeks). It is therefore crucial to implement programmes and projects that separate suspended water networks from electrical networks and to improve the electrical distribution networks within the Palestine camps.

Electrical energy savings are not applied in Palestine refugees camps. Therefore, the economical factor is not currently a motivator for the use of renewable energy resources or any alternative energy efficient system. Innovative incentives must be put in place to promote environmentally-friendly and energy efficient behaviour in parallel with environmental and social awareness campaigns.

The water quality for domestic usage is associated with very high salinity and is causing the deterioration of the water distribution system and fixtures. Pipe Penetration Radar (PPR), cross-linked Polyethylene (PEX), or any other plastic pipes are recommended to avoid accelerated deterioration of the water connections.

Inhabitants do not trust the water quality of fresh water coming from the reverse osmosis treatment plant to be used as drinking water and purchase bottled water instead. Electricity is mainly used for water heating since the majority of refugees use illegal electricity connections.

Overall, the assessment was considered to be successful and it is recommended to be replicated on a larger scale and in other camps in order to obtain more reliable data and comprehensive knowledge about water and energy consumption at the end user level.

Roads

In Lebanon, the cost of traffic congestion is estimated to be between five and ten per cent of GDP annually. Lebanon has one of the highest levels of debt in the world (as a percentage of GDP), attributed to weakened public finances, partly owing to a higher debt service burden, expansionary public spending, and low real growth which negatively affects tax revenues. The crisis in Syria has also had a profound impact on social stability on the economy which was already facing many difficulties.

There are 117 km of road in the 12 camps - 63 per cent are pedestrianized and 37 per cent are accessible by four-wheeled vehicles (more than three metres in width). Mar Elias is the only camp with exclusively pedestrianized alleyways (less than three metres in width) and El Buss the camp with more than 90 per cent roads suitable for motor vehicles. In addition to the impermeable and high absorption characteristics of asphalt, that increase the urban heat island effect in hot climates, one of its main disadvantages is that it contains polycyclic aromatic hydrocarbons compounds (PAHs). They are natural constituents of coal and oil and are classified as carcinogens.

Camp		total road (m)	Asphalt (m)	Concrete (m)	Asphalt of total length	Concrete of total length
Burj Barajneh	BB	14,180	3,848	10,332	27%	73%
Dbayeh	DB	3,935	2,060	1,875	52%	48%
Mar Elias	ME	1,056	0	1,056	0%	100%
Shatila	SH	4,768	1,694	3,074	36%	64%
Ein El Hilweh	EH	22,133	5,724	16,409	26%	74%
Mieh Mieh	MM	4,726	1,811	2,916	38%	62%
Burj Shemali	BS	16,082	6,424	9,658	40%	60%
El Buss	EB	6,929	5,513	1,416	80%	20%
Rashidieh	RA	17,788	7,943	9,846	45%	55%
Wavel	WA	2,952	1,321	1,632	45%	55%
Beddawi	BE	9,706	3,783	5,924	39%	61%
Nahr El Bared	NB	13,275	3,514	9,761	26%	74%
Total		**117,532**	**43,633**	**73,899**	**37%**	**63%**

Figure 74. Detail length of roads by type.

A total of 26 projects of rehabilitation have been identified during the inventory for section damages due to heavy use. Whenever possible, filter pavers should be introduced in pedestrianized alleyways and in parking, where there are little structural risks related to the surrounding buildings. Such material will allow rainwater infiltration to the groundwater and reduce the runoff quantities, while maintaining its function to keep the surface clean from mud. Applications should consider the protection recommendations for the water resources, the overall topography and the identification of possible pollution sources.

Runoff drainage. ©2017 UNRWA

Runoff of fresh water into the sea in Beirut. ©2017 UNRWA

Another recommendation aims to limit vehicle traffic in the main pedestrian and "*schools/health centres*" areas to reduce the air pollution (matter particle, noise, and smell), mainly for children and people of ill-health. By installing fixed fences on road access, the objective will be to prevent all four- and two-wheeled vehicles from passing. Such physical intervention should be accompanied by an awareness campaign to promote community buy-in.

Presence of Pesticides in Vegetables and Fruits

The water and sanitation sectors were the main focus of the inventory and needs assessment. In addition to specific analyses on the water quality, wastewater quality and air quality, it was considered important to also evaluate the presence of pesticides in commodities found in the local markets and produced locally to gain a holistic perspective of the environmental health context in the camps. The results would be then used to bring a clearer understanding of the "water and carbon cycles", and in particular, the linkages between the environmental health sectors and sub-sectors.

Based on The FICIP conducted one specific survey (Maximum Residues Limits) between September and November 2017 on a selection of commodities produced in Lebanon and available in the markets inside the Palestine refugee camps.

The objective of the Maximum Residues Limits (MRLs) survey is to compare the MRL of pesticides against specifications of the Lebanese Standards Institution (LIBNOR). Samples of fruits and vegetables were collected from five camps (one per area).

Based on the results, corrective actions as well as recommendations have been proposed to sensitize the population and shop owners about the quality of the fruits and vegetables sold in the markets in the 12 Palestine refugee camps. Due to the complexity and sensibility of the subject, it was not possible to trace[59] all fruits and vegetables. This pilot survey was conducted to gain a first insight and to investigate if further efforts should be dedicated to this area in the future.

[59] In Lebanon, the traceability of agricultural production is still not easy and does not allow to identify the exact source or the farm identity where the food was produced.

The MRL analysis was performed based on the national LIBNOR[60] norms and the international Codex Alimentarius[61], with an accredited laboratory and under the supervision of the Ministry of Agriculture (MoA). In theory and to assure proper agricultural and manufacturing processes in Lebanon, the inspection of raw materials must be achieved bilaterally between the MoA and the Ministry of Public Health (MoPH) and according to a specific criteria checklist. In addition to national institutions, UN agencies, such as the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) were also involved.

Methodology

The work plan included two field visits. The first visit consisted of a short survey of market owners in the five target camps (Nahr El Bared, Shatila, Mieh Mieh, Rashidieh and Wavel) with sampling from each selected[62] market conducted during the second visit. The sampling procedure followed international standards set by the European Commission (EU) and validated by the GoL, including the standards set by the Lebanese Agricultural Research Institute[63] (LARI), and also included sampling and analysis protocols (applied by UNRWA partners[64] during the survey). Six commodities (apple, peach, cucumber, grape, potato and lettuce) were chosen for conformity and to detect the presence of MRL.

The next figure summarizes the main findings for the 30 commodities. In terms of MRL, non-conformity to the national standards can affect the most vulnerable people if ingested regularly. Children are the most affected because early exposure to environmental chemicals can result in subtle changes that affect a child's development. These changes can occur during foetal development and in early childhood and can contribute not only to adverse neurodevelopmental and behavioural changes, but also to adult diseases, including obesity and neurodegenerative diseases (Parkinson's and Alzheimer disease). This emphasizes the importance of minimizing exposure to potentially toxic agents early in a child's life[65].

	Conformity to national standards (MRL)						Pesticides presence					
Camp	Apple	Peach	Cucumber	Grapes	Potato	Lettuce	Apple	Peach	Cucumber	Grapes	Potato	Lettuce
Shatila	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes
Mieh Mieh	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No
Rashidieh	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Wavel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No
Nahr El Bared	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	No	No

Figure 75. Results of the food quality in the Palestinian refugee camps in Lebanon.

[60] The Lebanese Standards Institution (LIBNOR) is a public institution attached to the Ministry of Industry. It was established in 23-7-1962 by a law giving it solely the right to prepare, publish and amend national standards, as well as to grant the Lebanese Conformity Mark NL. http://www.libnor.gov.lb/

[61] The Codex Alimentarius, or "*Food Code*" is a collection of standards, guidelines and codes of practice adopted by the Codex Alimentarius Commission. The Commission, also known as CAC, is the central part of the Joint FAO/WHO Food Standards Programme and was established by FAO and WHO to protect consumer health and promote fair practices in food trade. It held its first meeting in 1963. http://www.fao.org/fao-who-codexalimentarius/about-codex/en/

[62] According to a set of criteria including acceptance from the market's owner, the variety of commodities and their national origin of production

[63] LARI is a governmental organization under Minister of Agriculture Supervision. The institute conducts applied and basic scientific research for the development and advancement of the agricultural sector in Lebanon. http://www.lari.gov.lb/

[64] The MRL survey was conducted by MEFOSA.

[65] Northwest Bulletin, 2006

For the 30 commodities analysed, pesticides were identified in 53 per cent of cases, ranging from 0 per cent in potatoes (no pesticide presence) up to 80 per cent in apples and 100 per cent in grapes. Out of this, 83 per cent of commodities analysed conformed with the national standards (MRL). Five cases (lettuce in Shatila, apple in Rashidieh, peach in Mieh Mieh and Rashidieh and grape in Nahr El Bared) did not conform with national guidelines and action should be taken in the form of requesting the producer to limit use of pesticides or change production provider.

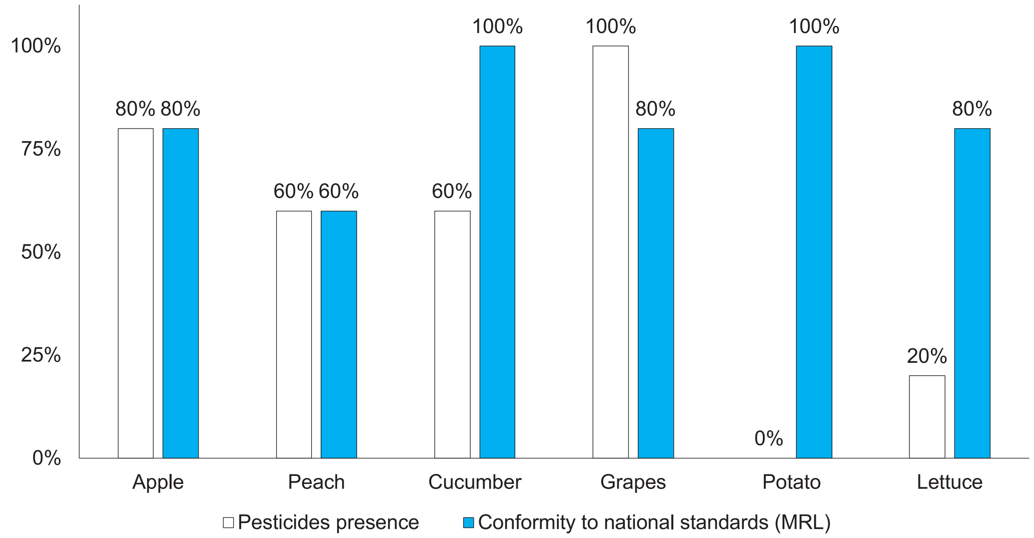


Figure 76. Results per commodity.

From a geographical perspective (where the commodities are sold – not produced), the camps that have the largest presence of pesticides are Shatila and Rashidieh, followed by Mieh Mieh and Nahr El Bared and Wavel. All markets sold commodities with pesticides. In terms of conformity to the national norms, only Wavel met the criteria, followed by Shatila, Mieh Mieh and Nahr El Bared and Rashidieh where apples and peaches were identified with pesticides presence exceeding national standards.

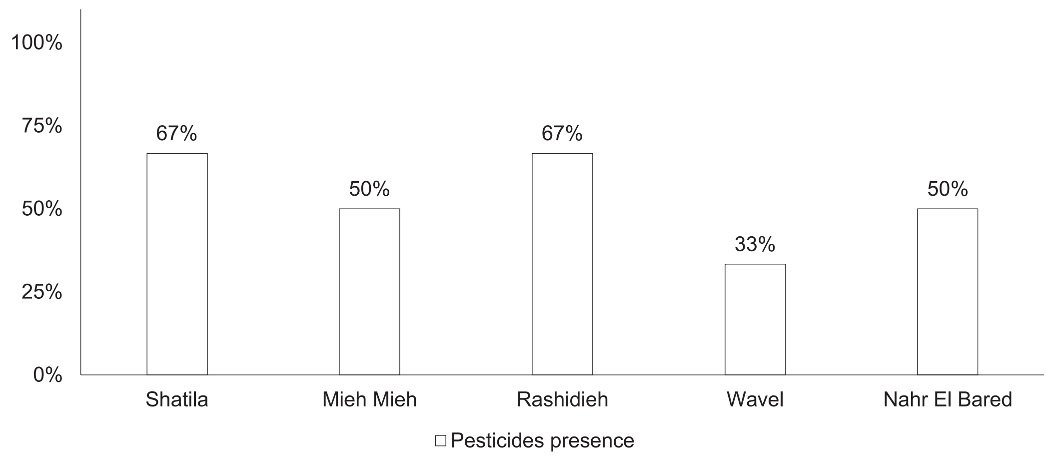


Figure 77. Results per camp.

According to the National Pesticides Information Centre[66] (NPIC), to reduce pesticide residues in ingested food, the following actions by the population are suggested. First, eat a variety of fruits and vegetables to minimize the potential of increased exposure to a single pesticide. Second, wash all fruits and vegetables, even organic or those consumed when peeled. Third, wash the fruits and vegetables

[66] National Pesticides Information Centre (NPIC). http://npic.orst.edu/

under running water rather than soaking or dunking. Fourth, dry crops with a clean towel. Fifth, scrub firm fruits and vegetables. Sixth, discard the outer layer of leafy vegetables (lettuce) and seventh, peel fruits and vegetables if possible (apples, peaches). These recommendations should be included in an awareness campaign. It must be noted that although these results are significant this sampling exercise remains too limited to make wider conclusions. Preventive actions for households and at the site of production (through the market owners) are the most applicable recommendations for the coming period.

Camp's problem	Household recommendations
In Shatila: the lettuce showed the presence of high toxic pesticide that is also banned in Lebanon (Carbofuran).	Use lettuce less frequently in this camp, discard its outer layer when consumed and use alternative vegetables for salads, such as cabbage.
In Wavel: all commodities were compliant with standards, but there is a presence of Acetamiprid which is a highly hazardous pesticide, in apples and grapes.	Consume a variety of fruits and vegetables. it is preferable to peel apples before eating, avoid eating grapes or eat them less frequently. Markets should buy these fruits from other reliable sources where GAP is applied.
In Nahr El Bared: grapes showed the presence of high toxic pesticide that is banned in Lebanon (Carbofuran).	Grapes are a seasonal fruit that are not consumed frequently. It is advisable to consume other types of fruits until grape agricultural practices are better maintained in this area, or find another reliable source (especially for children).
In Mieh Mieh: peaches showed the presence of Fenpropathrin that exceeded the standards.	Peaches are also a seasonal fruit that is not consumed frequently. It is advisable to consume other types of fruit until peach agricultural practice are better maintained in this area, or find another reliable source (especially for children).
In Rashidieh: apples and peaches showed the presence of high toxic pesticides especially in peaches.	It is preferable to peel apples before consuming it. For peaches, it is advisable to consume other types of fruits until peach agricultural practice are better maintained in this area, or find another reliable source (especially for children).

Figure 78. Description of the pesticides identified and recommendations for the public.

Water sector

Water is one of the most precious resources in Lebanon. Available water sources include rivers (16 perennial rivers and 23 seasonal rivers) and springs (some 2,000 springs), storage dams (the Qaroun dam on the Litani River and Chabrouh dam), and groundwater (estimated discharge at 2,000-2,700 million m^3 per year). However, Lebanon's water resources are under severe stress due to several factors such as unsustainable water management practices, increasing water demand from all sectors, water pollution and ineffective water governance.

The driving forces affecting the quality and quantity of water resources in Lebanon are population growth and age structure, urbanization (88 per cent of the population live in urban areas), economic growth and, more recently, climate change. Other factors affecting water availability are the inter-annual variability in rainfall in the drier inland regions of Lebanon and decline in snow coverage and density.

According to United Nations, in Lebanon, major advances have been made and the majority of people have improved access to water supply. However, the population experiences frequent water shortages and, in many places, the water is not safe to drink. While Lebanon has relatively well-established water and wastewater networks, only a small portion is treated and managed safely. With up to 70 per cent of natural water sources in Lebanon bacterially contaminated, increasing salt water intrusion in fresh aquifers and an overall water balance deficit (0.7 billion cubic metres of groundwater extracted per year for only 0.5 billion cubic metres replenished), major investment in improved water infrastructure and promotion of safe water management from source to household is necessary to ensure that people in Lebanon have a safe and sustainable drinking water supply in the future.

Water connections in Burj Barajneh camp. ©2017 UNRWA

Detailed in the 2012 NWSS, the water sector in Lebanon faces infrastructure and management shortcomings. Infrastructure is challenged by constrained resources with suboptimal exploitation and high demand growth. Insufficient and poorly maintained transmission and distribution system networks lead to significant losses and supply interruptions. There is a limited focus on demand management monitoring of networks resulting in a lack of treatment and efficiency. The absence of institutional, financial, legal, environmental and conservation implementation activities has resulted in major gaps and deteriorating infrastructure. This jeopardizes the ability to establish a sustainable and viable integrated water resources management system. Lebanon stands below the "*Water scarcity threshold – 1,000 m^3/person/year*" with growing deterioration (*926 m^3/person/year in 2009, 839 m^3/person/year in 2015*[67]). The surface water resources are largely exploited with limited storage, while significant stress is placed on groundwater due to the multiplication of private and unlicensed wells[68]. Despite the coverage and continuity of water services in Lebanon being better than the regional average, more than 50 per cent of its networks are obsolete and require to be replaced, especially the transmission networks. Meanwhile the standard practice for water storage ranges from between 12 - 24 hours, with the national average estimated at around nine hours. The domestic water demand is equivalent to 505 mcm/year and the collection rates, in 2010, were evaluated at 47 per cent (National average value) with only 18 per cent for the Bekaa valley. Unaccounted for water in Lebanon corresponds to 48 per cent as a National average value. The irrigation sector, with open channels and limited technologies remains the largest water consumer69 with low efficiencies.

[67] MoEW, NWSS, page 7. 2012.
[68] ELARD sources

Palestine Refugee Camps in Lebanon

The action plans outlined in the EHS (§3.2.1. Water Resources) and (§3.2.2. Water Quality) were completed and used to elaborate the following recommendations and were also enlarged to specific water analysis parameters to better prepare the "*Water Qualitative and Quantitative Surveillance Plan*" presented in this Response Plan. This was started in three Palestine refugee camps in 2017. Three large water quality surveys were conducted during 2016 and 2017, in collaboration with UNRWA, UNICEF, WHO and various government ministries.

The water cycle is an essential of element of the inventory and the understanding of the equilibrium between water supply, water consumption, water recharge and wastewater, especially in highly dense, urban and coastal contexts such as eleven out of the twelve Palestine refugee camps in Lebanon.

Findings

Water Quantity

National Scale

The geology of Lebanon consists mainly of limestone and dolostone rocks subject to dissolution processes. Karst aquifers are therefore widespread in the country and lead to a significant infiltration of precipitation and the surface water. The main water resources therefore consist of groundwater.

The presence of low permeability layers such marls and volcanic rocks (aquicludes) results in a stack of separated aquifers, which are locally interconnected due to either previous erosion of the aquicludes in-between or to the presence of faults. It is important to note that water velocity in the karst aquifer is generally high and therefore does not allow for natural filtration. This is contrary to the local Quaternary upper aquifers, which are composed of sand and gravels and therefore characterised by low water velocity and natural filtration (porous aquifers).

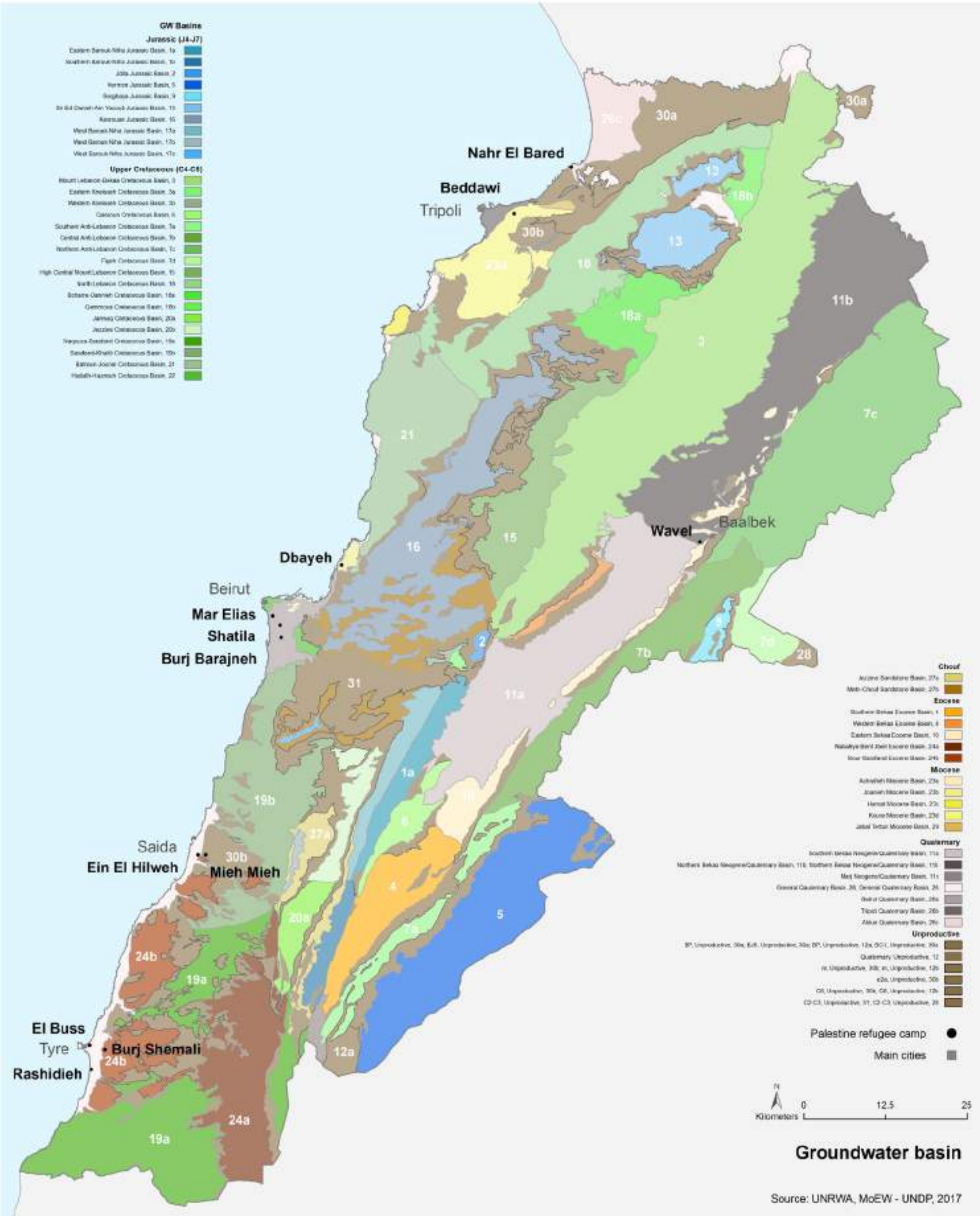


Figure 80. Groundwater basin formation of Lebanon.

At local level, a better understanding of the groundwater status in the Palestine refugee camps is possible due to available data (UNDP, MoEW) at a larger scale and as displayed in the next map.

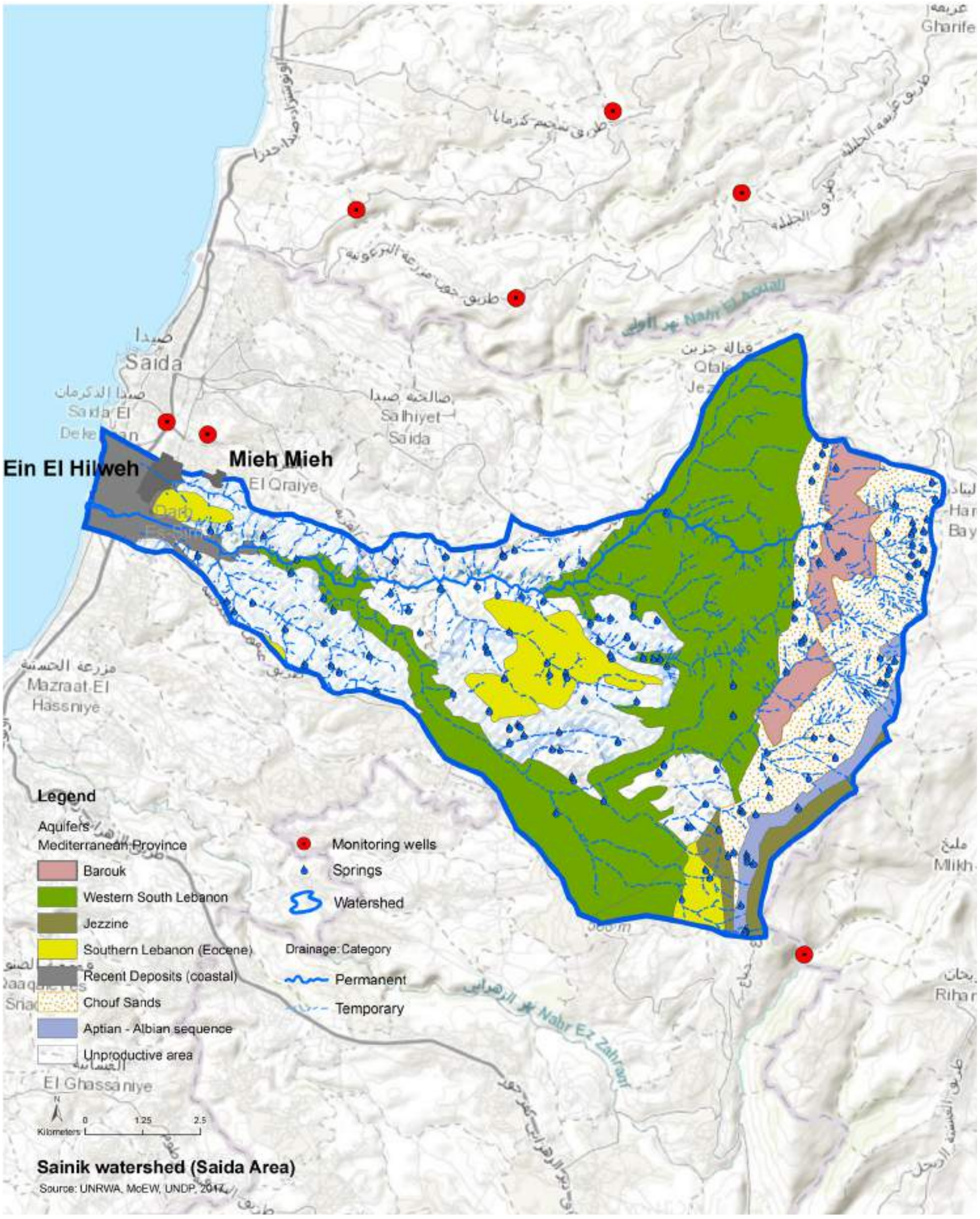


Figure 81. Example of watershed analysis (Sainik) where 2 Palestine refugee camps are included.

The annex 19 summarizes the findings and observations jointly concluded by the hydrogeologists and experts of UNRWA and partners. The data obtained during the inventory must be carefully interpreted. Groundwater scientific coding was used below as a reference for each detailed groundwater analysis.

Despite yearly precipitation which is considered high in comparison to neighbouring countries, Lebanon puts a high degree of pressure on its water resources. This situation is observed in most of the camps, and it can be partly explained by the sensitive locations of the 12 Palestine refugee camps: mainly situated on coastal areas (high water stress due to intense urbanization) and partly in the Bekaa valley (high water stress due to intensive agriculture).

The upper aquifers (Q, mcg or even m2a) are generally overexploited. This is explained by a greater ability to reach the groundwater and consequently the implementation of numerous pumping wells (public wells, private wells with a license and unlicensed wells). A general drawdown of the water table is induced from this long-term over-abstraction, leading to a progressive drying up of pumping wells and increase in seawater intrusion in coastal aquifers.

In depth, water resources are less exploited (due to their inaccessibility) and generally present a positive water balance. In addition, they typically benefit from a large recharge area in the mountains, where they are mainly outcropping, due to substantial anticline (slope) structures of the Lebanese geology. A higher degree of uncertainty exists in assessing in-depth water resources. Possible exchange with deep aquifers, drainage along faults and submarine discharge into the Mediterranean Sea therefore cannot be ruled out allowing for a margin of inaccuracy of the analysis. Moreover, there are always exceptions (local situations) to the rule (large-scale analysis). A critical eye is therefore necessary for reading and interpreting such extensive water balance assessments. Complementary observations such as water quality could help to further refine the analysis.

In coastal environments, the varying densities of seawater and fresh water causes a natural inland intrusion of the denser saline water by gravity. This encroachment is however counterbalanced by the head of the fresh water, above the sea level, which tends to repulse the seawater. The groundwater head controls the location in depth of the interface[69] between fresh water and seawater, with a very sensitive ratio: a head (*h*) of one metre above the sea level implies an interface at around -40 metres ($z = 40 \cdot h$ according to the theoretical Ghyben-Hertzberg principle). Groundwater abstraction close to the seashore could therefore highly impact the groundwater quality depending on the induced drawdown of the water table and the depth of the pumping wells (screened part). On the contrary, additional recharge of the aquifer could decrease the water salinity by repulsing in depth the fresh water / seawater interface. Hence, the balance is very sensitive and groundwater quality and quantity are closely linked.

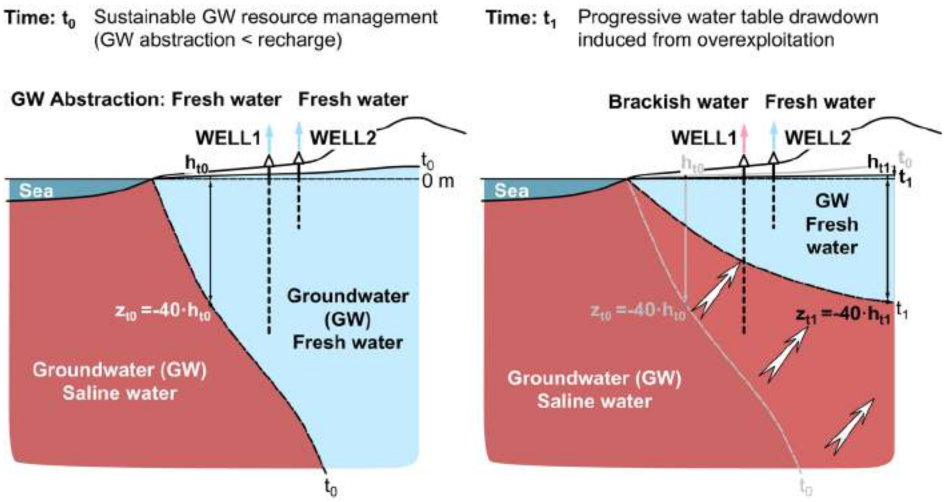


Figure 82. Schematic illustration of seawater intrusion and the negative effect due to high abstraction (drawdown of the water table). The depth of the borehole is also crucial in such an environment. A potential recovery is possible with an adapted groundwater abstraction and/or an artificial recharge of the aquifer.

For example, the Rashidieh spring, emerging along the coast south of Tyre, presents enough water head to repulse the seawater and maintain good water quality.

[69] In reality the situation is more complex due to the groundwater flow and the dispersion mechanism, and a transition zone (or mixing zone) usually exists in-between the two bodies of water. The simplified model however provides a good preliminary assessment.

Local Scales (areas and camps)

The inventory shows that nine of the twelve camps present water shortage and significant wastage of water is observed in 75 per cent of the camps. This simple observation implies that the implementation of adapted mitigation measures cannot only focus on technical solutions, but must also include awareness campaigns for the prevention of water wastage and build local capacity and knowledge of the seriousness of the situation. Ten camps have their own water supply whereas two camps (Dbayeh and El Buss) are supplied from external water sources from the local Water Establishments.

To date[70], three camps (Burj Barajneh, Mar Elias and Shatila) are located in areas with seawater intrusion and abstract non-drinking saline water (60-90 per cent seawater). Treatment plants with a reverse osmosis system were installed in these camps, however, not all are fully operational due to organizational challenges.

Reverse osmosis in Shatila camp. ©2017 UNRWA

Head inspection in Palestine refugee camp. ©2017 UNRWA

In addition, two camps show signs of slight seawater intrusion (Burj Shemali and Beddawi). Currently, the content of salt remains low and the brackish water may be consumed even if its quality is slightly below the national standard for drinking water. There is no available data covering the last ten years to help quantify the evolution of the pumping discharge, water table level and water quality and project for the future evolution. For these two camps, the implementation of a detailed surveillance programme is therefore crucial.

Nahr El Bared and its adjacent areas are located at the interface between seawater and fresh water bodies. The spatial distribution of the pumping wells and their salinity reveal a coherent pattern from seawater (two wells are up to 90 per cent seawater) to brackish water (two wells) and finally fresh water with a continuous decrease of the salinity (seven wells). The geometry of the interface is not parallel to the seashore as preliminary expected, but it presents an oblique structure in the direction of a river. This local pattern is explained by the infiltration of the river which recharges the aquifer and repulses the seawater intrusion. This particular hydrogeological scenario presents a good opportunity for developing a strategy for a sustainable groundwater supply of acceptable quality despite the regional seawater intrusion. Meticulous management will be necessary, particularly detailed monitoring, for the prevention of any further deterioration related to this sensitive balance between freshwater and seawater.

Other camps located in coastal environments, Rashidieh, Mieh Mieh and Ein El Hilweh, primarily abstract groundwater from the C4-C5 aquifer. They generally present a positive water balance and do not face issues with saline water.

[70] December 2017

A preliminary assessment of the situation by comparing each well depth with the theoretical depth of the seawater interface (based on the static water head measured within the well) indicated that Mieh Mieh and Ein El Hilweh could theoretically face salinization. The current good quality of the abstracted water could be explained by the uncertainty on the head (no detailed measurements of the elevation of the wells are available) or a possible transient state with progressive deterioration of the water quality. A surveillance programme is therefore crucial in these camps to assess the evolution of the water supply, in terms of quality and quantity. A detailed topographic survey of the elevation of all the groundwater sources of the twelve camps will be necessary for refining the preliminary assessment of potential seawater intrusion and for the sustainable management of the water resource.

Wavel is the only camp located at a distance from the sea. Situated in the Bekaa valley, it presents a significant shortage of water supply and the tapped upper aquifers are overexploited.

Water Quality

Several water quality surveys were conducted during the inventory and needs assessment, including:

- Routine UNRWA water quality analyses;
- Complete water analysis parameters in 15 specific water sources
- Water quality survey at household level (Joint Monitoring Programme) – SDC 6.2.
- Water quality survey in schools and health centres

The results obtained have allowed the FICIP to define a new "*Qualitative and Quantitative Water Surveillance Plan*" for the coming 2018 – 2021 period (see annex 18).

Joint Monitoring Programme[71]

Following the Joint Monitoring Programme (JMP) which took place in Lebanon during June 2016 (covering Lebanese, Palestine and Syrian refugees), UNICEF, WHO and the MoEW embarked on collecting data on the institutional settings and public spaces with regards to water, sanitation and hygiene (WASH). In 2017, the UNICEF country office completed the national water quality and WASH census for 2,300 public institutions in collaboration with the WHO country office, the Ministry of Education and Higher Education (MEHE), the Ministry of Public Health (MoPH), the Ministry of Social Affairs (MOSA) and UNRWA. The census included public and UNRWA-run schools, primary health care centres (PHCs) and UNRWA clinics, social development centres (SDCs) and child care centres. Water quality samples were concurrently collected at each surveyed facility in an effort to assess compliance with national drinking water standards and WHO guidelines for drinking water quality.

Households

Lebanon's national baseline for SDG 6, Target 6.1 (for safe drinking water supply) is 36 per cent of the entire population (Lebanese, Palestinian, and Syrian). It was important to establish the SDG 6.1 baseline for the proposed post-2015 indicator for SDG 6, "safely-managed" drinking water that combines

[71] WHO/UNICEF Joint Monitoring Programme (JMP) is the custodian of global data on drinking water, sanitation and hygiene (WASH). The JMP has been monitoring global progress since 1990 and is responsible for reporting on Sustainable Development Goal (SDG) targets and indicators related to WASH.

information on the type of drinking water source used by households, its location, whether drinking water is available when needed and if water is of safe quality. In addition, obtaining nationally representative data was vital to gauge the extent of contamination and enable targeting of populations for advocacy and programmatic intervention. As part of the JMP in 2016, water samples from household tap water and bottled water in the 12 Palestine refugee camps were sampled for bacteriological pollution (total coliforms and Escherichia coli – E. Coli).

Data collection and social surveys. ©2017 UNRWA

Drinking water supply for Palestine refugees. ©2017 UNRWA

A total of 405 water samples from the 12 camps were collected from household tap water for laboratory analysis.Bacteriological pollution was detected. From the total collected samples in all camps, 93 per cent showed presence of total coliforms and 40 per cent showed presence of E. Coli. Household tap water samples from El Buss, Burj Shemali and Wavel showed the highest contamination of faecal coliforms (100 per cent) and those from Mar Elias showed the highest percentage (80 per cent) of E.Coli contamination in the water. Similarly, 413 samples from household bottled water from each of the 12 camps were collected for laboratory analysis. Bacteriological pollution was detected. From the total collected samples from all camps 94 per cent showed presence of total coliforms and 57 per cent showed presence of E. Coli. All household bottled water samples from El Buss, Burj Shemali and Wavel showed the highest contamination of faecal coliforms (100 per cent) and those from Mar Elias showed the highest percentage (80 per cent) of E. Coli contamination in water.

Integrated Water Resource Management is a priority for 2018-2021 to enable characterization of the existing infrastructure and water resources in terms of quality and quantity, to identify origins of pollutants and to protect water sources and develop robust infrastructure. In addition, improvement in hygiene, household storage and handling will reduce E. Coli contamination. Hence, focusing on water quality will improve water safety for all populations and the achievement of SDC 6.1, in which a second census for the JMP will be conducted in 2020 to access the progress for better drinking water quality.

Schools

The results of the WASH in Schools (WinS) census in UNRWA schools in Lebanon are presented and analysed in this section. The overall aim of the census was to inform UNRWA on the level of WASH services in schools under its custody across the country. This would provide evidence for the identification of interventions needed for the improvement of these services. Sixty-eight UNRWA schools are attended by approximately 38,000 pupils. The UNRWA Education Programme provides schooling for all children from Grades 1 to 12, but does not provide pre-school and kindergarten education (UNRWA, 2016). A total of 67 UNRWA schools were visited in Lebanon during the JMP census. Of those visited, 52 (78 per cent) were successfully surveyed and constitute the total sample that was analysed.


Water borehole inspection. ©2017 UNRWA


Reverse Osmosis distribution tap in Shatila. ©2017 UNRWA

Less than four per cent of the surveyed UNRWA schools had no drinking water sources on their premises. The remaining 96 per cent had a drinking water source, which was either the same as that used for hand washing (44 per cent) or was dedicated for drinking (52 per cent). It was also found that UNRWA schools in Lebanon provided drinking water for their students from a variety of sources. The most common source was piped water supply (42 per cent), followed by water sources managed locally and private artesian wells (25 per cent and 23 per cent respectively).

Free residual chlorine levels in drinking water that are considered acceptable and sufficient to reduce the risk of faecal contamination according to WHO and LIBNOR standards, should be within a range of 0.2 to 0.5 mg/L. Around 86 per cent of UNRWA schools in Lebanon have available water sources with free residual chlorine levels that are below standards. Thus, the percentage of schools with basic water supply and an acceptable free residual chlorine level was very low (only six per cent).

Twenty-four (46 per cent of surveyed UNRWA schools) schools exceeded basic services with respect to their drinking water sources and were found to be free from E. Coli contamination. Results from observations of the toilet facilities at the schools showed that only eight per cent of schools had clean, basic sanitation services (absence of strong smells or significant numbers of flies, no visible faeces). Twenty-nine per cent were considered somewhat clean (some smell and/ or signs of faecal matter) and 61 per cent were not clean (presence of strong smell and/ or faecal matter). No reported observations of cleanliness were provided for the remaining two per cent of the schools. Only 19 per cent of schools had a female toilet used by less than 25 students and 27 per cent had a male toilet used by less than 25 students which meets the WHO standard for schools in low cost setting (WHO & UNICEF, 2016). Around 46 per cent of UNRWA schools had a female toilet and 48 per cent had a male toilet used by more than 26 students. Note that data on the number of toilets available on site was not available in 30 per cent of the surveyed schools.

Health Centres

The "*Report 2b: WASH in UNRWA Primary Healthcare Centres*", presents results of the Lebanon WASH in UNRWA PHCs census are presented and analyzed in this section. The overall aim of the census was to inform UNRWA on the level of WASH services in PHCs run by UNRWA across the country. The quality of drinking water was also assessed providing evidence for the identification of interventions needed for the improvement of these services.

In Lebanon, UNRWA runs 27 primary health care centres with 357 health staff that serve an estimated 331,000 persons (UNRWA, 2016). Twelve centres are located inside the camps while the remaining 15 centres are situated in Lebanese cities and Palestine Gatherings in Lebanon.

In total, 27 PHCs were visited across Lebanon by the Lebanese Red Cross (LRC) in addition to the questionnaire and the facility inspection. The LRC teams were asked to conduct water quality testing at all visited institutions.

Sixteen out of the 27 PHCs (59 per cent) were successfully surveyed. Out of the remaining 11: Three (11 per cent) were successfully surveyed, but the data was lost due to technical problems, two (seven per cent) refused to participate in the census and six (22 per cent) were closed. Those surveyed were concentrated in the South Governorate (56 per cent, n=9) where the Palestine refugee camps are concentrated. The remaining PHCs were distributed across the Beirut (n=1), Mount Lebanon (n=2), North (n=2), Akkar (n=1), and Baalbek El-Hermel (n=1) Governorates

Results from the census showed that, across Lebanon, only 12 per cent (n=2) of PHCs surveyed had no drinking water sources on their premises. The remaining 87 per cent had a drinking water source, which was either the same as that used for hand washing (69 per cent) or was dedicated for drinking (19 per cent). It was also found that UNRWA PHCs were providing drinking water for their patients from a variety of sources. The most common source was piped water supply (56 per cent), followed by bottled water (19 per cent).

Moreover, the results reveal that the available drinking water in 69 per cent of UNRWA PHCs were free of faecal contamination and thus safe to drink from a microbiological perspective.

Free residual chlorine levels in drinking water that are considered acceptable and sufficient to reduce the risk of faecal contamination according to WHO and LIBNOR standards should be within a range of 0.2 to 0.5 mg/L. Free residual chlorine levels in drinking water at all surveyed PHCs that had available water sources were below these standards (n=13). Thus, there were no UNRWA PHCs within the census with a basic water supply and an acceptable free residual chlorine level.

The results from observations of the toilets at the UNRWA PHCs by the LRC teams showed that around 44 per cent had improved functional toilets that can be considered as clean (absence of a strong smell or significant numbers of flies and no visible faeces) and 31 per cent somewhat clean (some smell and sign of faecal matter). No toilets were reported as not clean.

Water Sources in the 12 Palestine Refugee Camps

The quality of water in samples taken from groundwater sources in the 12 camps indicate two main areas of concern: salt content related to seawater intrusion and the presence of indicators for faecal contamination (annex 20).

As previously mentioned, seawater intrusion is evident in Burj Barajneh, Mar Elias and Shatila. It is also occurring in some wells in Nahr El Bared. The percentage of seawater could be estimated between 60-90 per cent in the abstracted water.

The presence of brackish water in the wells of Beddawi and Burj Shemali indicate that seawater intrusion is partly occurring in these camps, with values exceeding Lebanese standards. Monitoring of the water level and electrical conductivity (salinity) is essential in these camps for assessing any potential deterioration and in such case, proactive mitigation measures must be implemented (reduction of pumping, artificial recharge).

The other six camps present fresh water.

Coliforms and E. Coli are very often present in the abstracted water. According to the drinking water standards, no coliform or E. Coli should be observed in a sample of 100 millilitres (ml). The concentration is however low (in general: 0-10 bact./100 ml).

In Nahr El Bared and its adjacent areas, surface water (river) presents, as expected, a high faecal contamination (indicators: 10'000 E. Coli / 100 ml). The natural filtration of the aquifer media is efficient since very little bacteria is observed within the wells located close to river (These wells are coded as follows in the UNRWA database: NBBO0006, NBBO0002, NBBO0007). Moreover, since the river presents low concentration in persistent contaminants, an artificial recharge of the groundwater by a partial diversion of the river could be an additional solution for repulsing seawater intrusion in the future (by groundwater head increasing, cf. Ghyben-Hertzberg principle[72]). This should be studied in more detail, but drilling injection wells downstream from the planned deep new well and existing wells is also a recommended option (if necessary).

The Hamed well (NBBO0010) presents a high concentration of E. Coli which is abnormal in the present setting. High faecal contamination from wastewater is suspected (contamination from the wellhead or from leaking sewer). Due to the poor water quality in the well (high salinity and faecal contamination), it should be decommissioned. Additional assessments should be performed on NBBO0009 which likely presents similar conditions.

The turbidity within the 12 camps is generally lower than five NTU and consequently is not a problem for chlorination.

Generally, hardness in the water is observed in all camps. This comes from the geological setting (limestone formations or calcareous clasts) and seawater intrusion. This could induce encrusting of the wells and network pipes however no health concerns are related to elevated levels of total hardness.

The nitrate concentration is locally higher than national and international WHO standards. The source of pollution likely comes from wastewater (rather than agriculture) in the present urban setting.

Some traces of hydrocarbons and heavy metals are locally observed and are to be expected in such urban areas. This indicates the presence of hazardous activities within the catchment zones of the wells such as solid waste disposal, roads, industries, storage and distribution of fuels, and mechanics. However, no parameter exceeds the acceptable threshold limits.

No pesticides were observed in groundwater and surface water. However, this result is based on only one sampling campaign in September 2017.

The bacteriological analyses performed on samples of tap water showed that all the camps present some contaminations at the end of the water supply chain. Forty-eight per cent and 93 per cent of the 405 samples were contaminated with E. Coli and total coliforms respectively. These results indicate that the water quality at the taps is worse overall than the groundwater sources and suggests possible contamination within the network and/or the private tanks. The alternative option of purchasing bottled

[72] Ghyben-Hertzberg principle state that for every meter of groundwater above sea level there are forty meter of fresh water below sea level.

water is not preferable since similar results were observed: 57 percent and 94 per cent of the 413 samples were contaminated with E. Coli and total coliforms respectively. Current water treatment practices and bottling are not sufficient or appropriate.

Water Networks

With a total of 78 water sources at the time of the inventory, five per cent are springs (four in total in Rashidieh) and 95 per cent wells (equipped boreholes), are all considered as underground water. The oldest water point registered is 45 years old (1972) and the most recent drilled in December 2017 in Nahr El Bared completed in December 2017 but unfortunately dry. Custodies vary between UNRWA, Popular Committees and private groups. All wells and springs are equipped with submersible pumps at depths ranging between 2 and 225 metres, powered with hybrid electric supply (EDL and generators).

For each water resource, the FICIP geodata base contains the following fields:

- Feature ID (BB**BO**0001 = Burj Barajneh **Bo**rehole n°1)
- Feature ID (RA**SP**0004 = Rashidieh **Sp**ring n°4)
- Given name by the community = "*Al Amleya*"
- Location (X,Y)
- Altitude
- Custody (UNRWA, Popular committee, Water Establishment)
- Operational, non-operational, dry
- Year of drilling
- Depth (total)
- Static Water Level (SWL)
- Pump depth, capacity, brand, date of installation
- Delivery (m3/h), daily pump operation (hours)
- Generator (index, capacity)
- Zones, buildings and population served
- Date of visit (inventory)
- Presence of piezometer, flow-meter, probe
- Quality data (Temperature, EC, TDS, pH, Dissolved oxygen)
- Treatment installation (chlorinator, reverse osmosis)
- Picture (georeferenced)

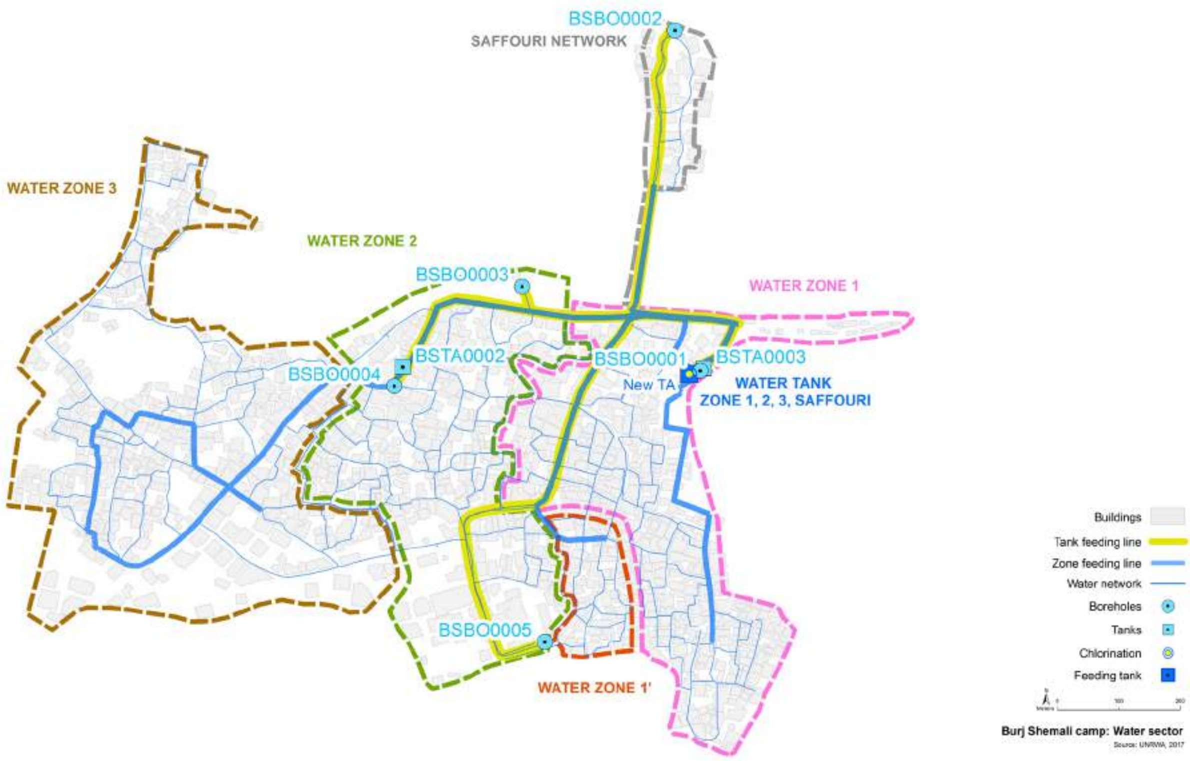


Figure 83. Example of "water zones" for each camp.

The inventory only focused on transmission, primary and secondary lines with a total length equivalent to 160 kilometres of pipe. The vast majority of the material is HDPE (154.8 km – 97.7 per cent), followed by small portions of galvanised iron (2.5 km – 1.6 per cent) and ductile iron (1.1 km – 0.7 per cent). Diameters range between 25 to 600 mm. Each portion (there are more than 5,650 portions) are available either on AutoCAD or ESRI GIS systems, part of the FICIP geodatabase and can be easily identified per area, camp, zone, diameters and material.

For each water supply pipeline segment (total 160 km), the FICIP geodatabase contains the following fields:

Camp	Type	Diameter	Length
Beddawi	Ductile Iron	200.00	64.39
Beddawi	Ductile Iron	200.00	10.57
Beddawi	Ductile Iron	200.00	48.85
Beddawi	Ductile Iron	200.00	9.98
Beddawi	HDPE	100.00	128.23
Beddawi	HDPE	100.00	3.41

Figure 84. Example of pipe inventory for the 160 kilometres of pipes (mains) in the 12 Palestine refugee camps in Lebanon.

- Material (HDPE, GI, DI)
- Diameter
- Length
- Connection to water resources ID
- Connection to water tank ID
- Custody

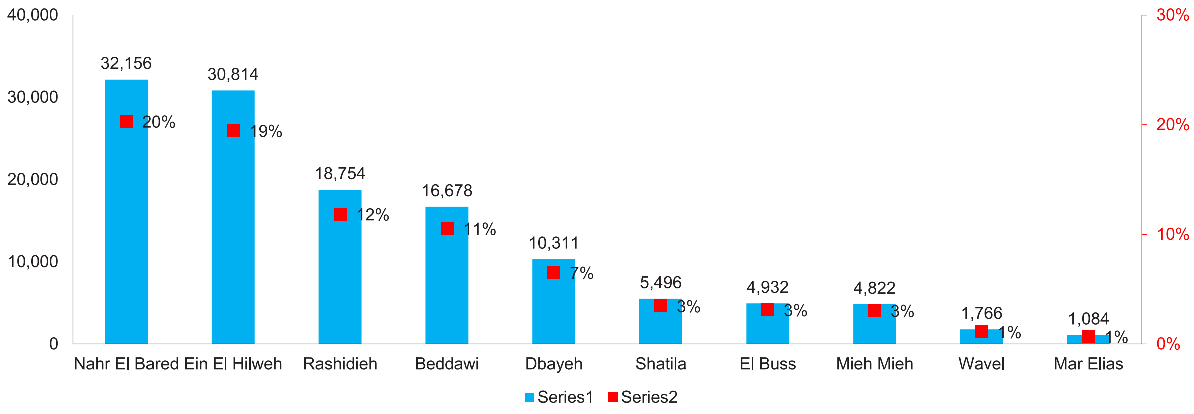


Figure 85. Lengths (m) and % of total water main and secondary water network in the 12 Palestine refugee camps in Lebanon.

In terms of water storage, apart the private tanks installed individually by the population, the total number of service tanks is 37 main reservoirs with capacities ranging from 4 to 1,500 m³, a total equivalent to 6,484 m^3, representing 25 litres capacity per person. As per all infrastructure included in the inventory, each tank is georeferenced and attributed with the following fields:

- Feature ID (WA**TA**0001 = Wavel **Ta**nk n°1)
- Given name by the community = "*New tank*"
- Location (X,Y)
- Installation date
- Status (functional, non-functional, not used)
- Custody
- Volume (m^3)
- Elevation at bottom (m)
- Material construction (if not concrete)
- Roof area (m^2)
- Shape (rectangular, circular)
- Daily usage (number of refill and distribution)
- Zone, buildings and population served
- Picture (georeferenced)

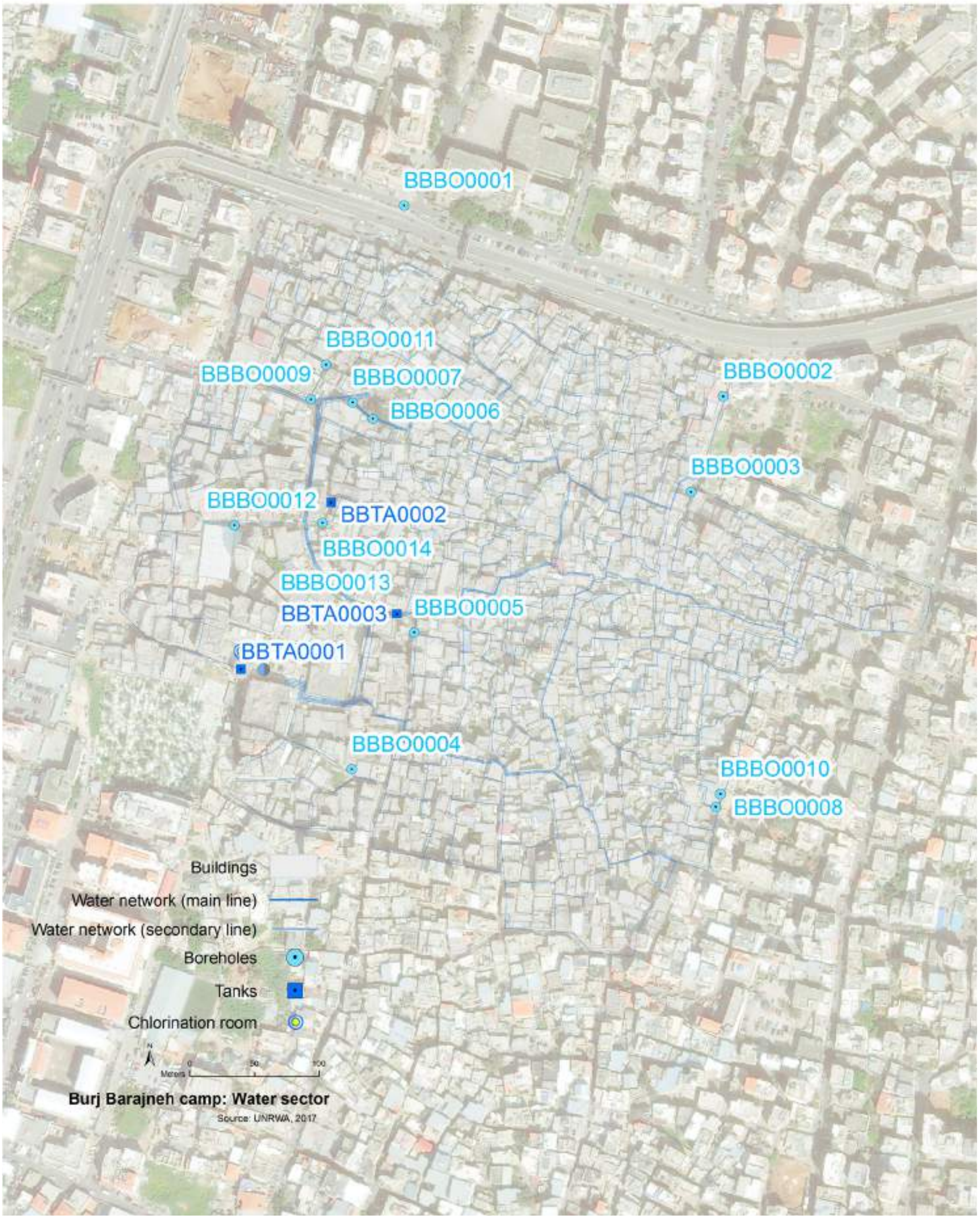


Figure 86. Example of geodata base (including attributes) for the water sector and sub-sector – wells, springs, networks, tanks, water quality) for each camp.

Described for each camp, losses are estimated for each network based on the year of construction and operation and maintenance status. It is estimated that leakages range from 20 – 40 per cent in the worst cases. Apart the pipeline losses (mains and individuals), other important leakages are due to the absence of float-valves in most of the private tanks installed by individuals. Together with booster pumps, important water is wasted once the private tanks are full. Finally, losses are also represented by the absence of re-use of the wastewater or storm water (apart from Wavel camp where all wastewater flows to the sea).

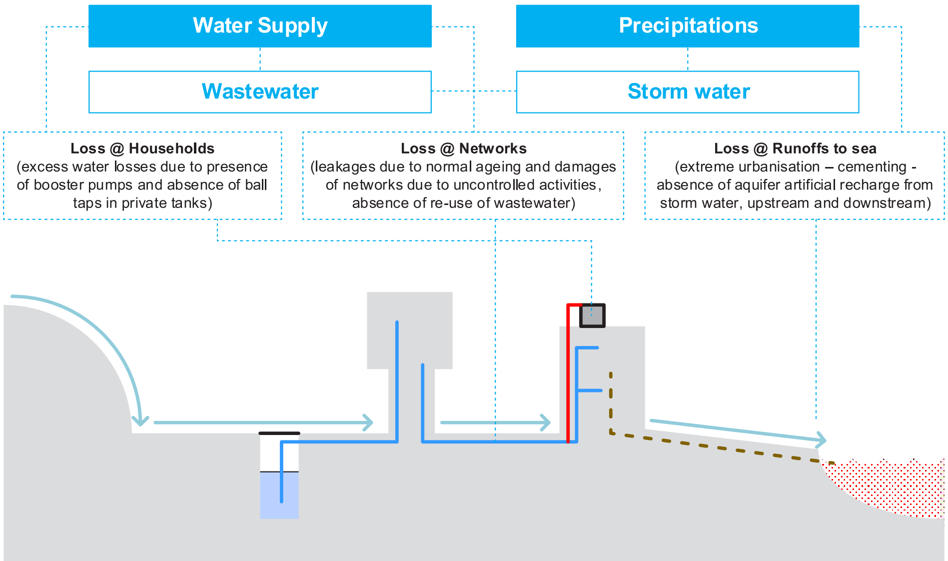


Figure 87. Relation between water supply, wastewater and storm water.

Rainwater harvesting is not applied within the 12 Palestine refugee camps, with the majority of fresh water running off in open channels or on paved roads and alleyways directly to the municipal collectors and then into the sea.

Recommendations

Sustainable Integrated Water Management

Sustainable integrated water management requires prudence and meticulous management (both quantitative and qualitative). This is particularly important in the present coastal environment often affected by overexploitation resulting seawater intrusion.

Management should consider the whole water cycle from precipitation to the groundwater sources, as well as the entire water supply chain (to the taps).

From a quantitative perspective, the abstraction of groundwater based on demand should respect the large-scale water balance in order to avoid overexploitation. In the case of a negative water balance, alternative water resources should be prospected. The abstracted water should then be used with care to avoid wastage (for example overflowing water due to the lack of float valves observed on numerous private tanks).

A deepening of the existing wells could be an option for the progressive drawdown of the groundwater table and decrease in the wells' yield, this can be applied only if the boreholes do not already attain the bottom of the aquifer and if the risk of seawater intrusion remains acceptable; to be confirmed, notably with a top survey.

A local option for managed artificial recharge (MAR) should be investigated for possible improvement of the situation.

The possibility of connecting to the Water Establishment supply should be investigated as a long-term solution.

From the qualitative side (see annex 20), the risk of contamination should be assessed within the whole catchment zone of the groundwater sources and along the complete water supply chain.

The preparation of vulnerability maps is highly recommended. This necessitates first the preparation of a conceptual model of the groundwater flow, based on field observations and existing data. The confrontation of the vulnerability map with a survey of potential hazardous activities directly provides an assessment of the risk of contamination. It is important to mention that the vulnerability of the groundwater is generally significant in karst aquifers due to the rapid groundwater flow without natural filtration. The next figures give examples of hydrogeological conceptual models and vulnerability assessments on the basis of profiles. Examples of vulnerability maps are provided in annexes (15,16 & 17). Since there is no national guideline for assessing the vulnerability of groundwater sources, the preparation of maps was based on the Swiss Development Corporation (SDC) Guideline for sustainable groundwater resource management (T. Bussard, 2016). Similar assessments should be prepared for the twelve camps.

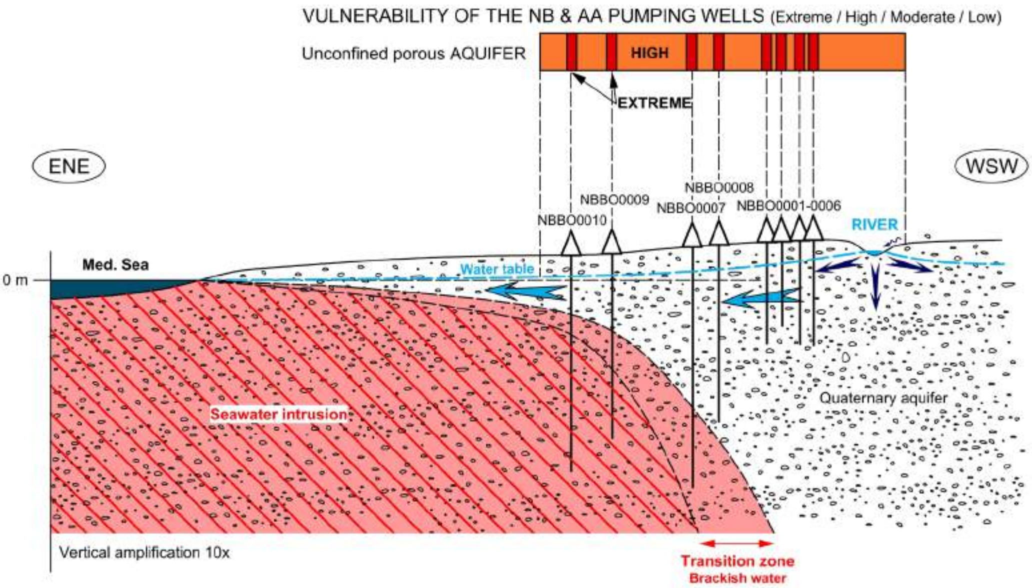
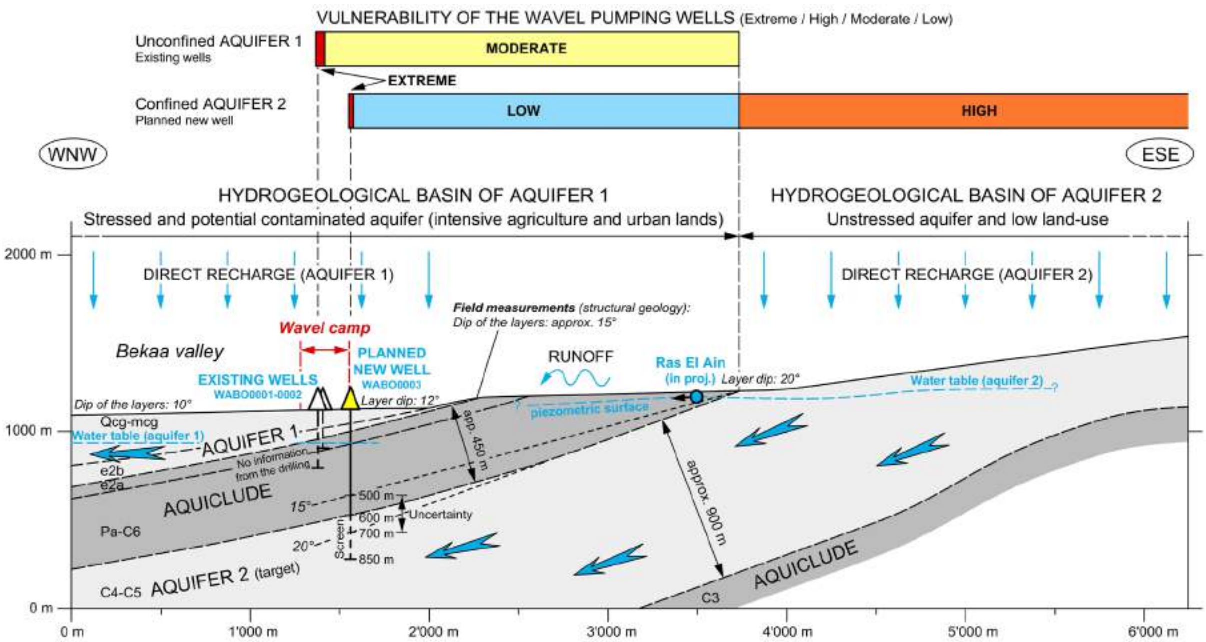


Figure 88. Conceptual model of the groundwater flow in the area of NB camp, and assessment of the vulnerability the existing wells.



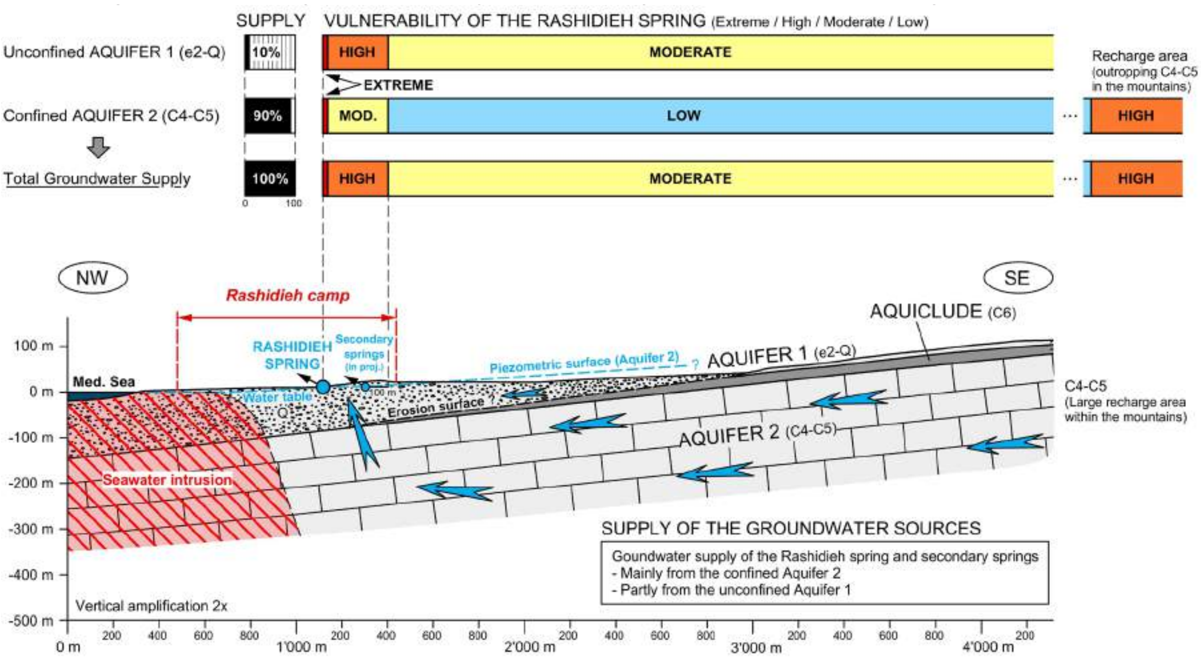


Figure 90. Conceptual model of the groundwater flow in the area of RA camp, and assessment of the vulnerability of the Rashidieh spring.

The next figure illustrates, for example, the confrontation of the vulnerability assessment for the Rashidieh spring with hazardous activities located in its immediate vicinity. In this situation, the risk of contamination is very high. A displacement of the generator or at least the installation of safety retention tanks should be undertaken as a precaution. Moreover, installation of protection fences should also be installed. It is highly recommended also to start using solar technologies for the operation of water plants.

The survey of the hazardous activities should be refined and completed within the catchment zone of the groundwater sources.

Awareness must be built to avoid any contamination of the water cycle (quality aspect) and to preserve the water resources (quantity aspect), in particular within the aquifer areas. Specific restrictions and strategies for remediation in case of a persistent contamination must be established in the catchment zone. In the presence of a point-source pollution, local dedicated mitigation measure has to be done directly on site.

At the groundwater source, the water quality could be affected from the top, by (1) direct infiltration of surface water or a contaminant through the wellhead (if not appropriately sealed and protected), (2) shallow infiltration of superficial water in the case of inappropriate well equipment (screened part located close to the ground surface without any sanitary seal), (3) contamination within the catchment zone, or from the bottom, by (4) seawater intrusion. A detailed assessment of the situation of each well is thus essential for defining specific improvement measures.

The whole water supply chain should be maintained in good condition to avoid deterioration and possible infiltration of contamination. It is important to maintain sufficient pressure in the network to prevent infiltration from the outside.

A surveillance plan should be implemented to follow the evolution of the water resources and to be able to install proactive mitigation measures in the case of any abnormal evolution. Both quantitative and qualitative aspects should be monitored.

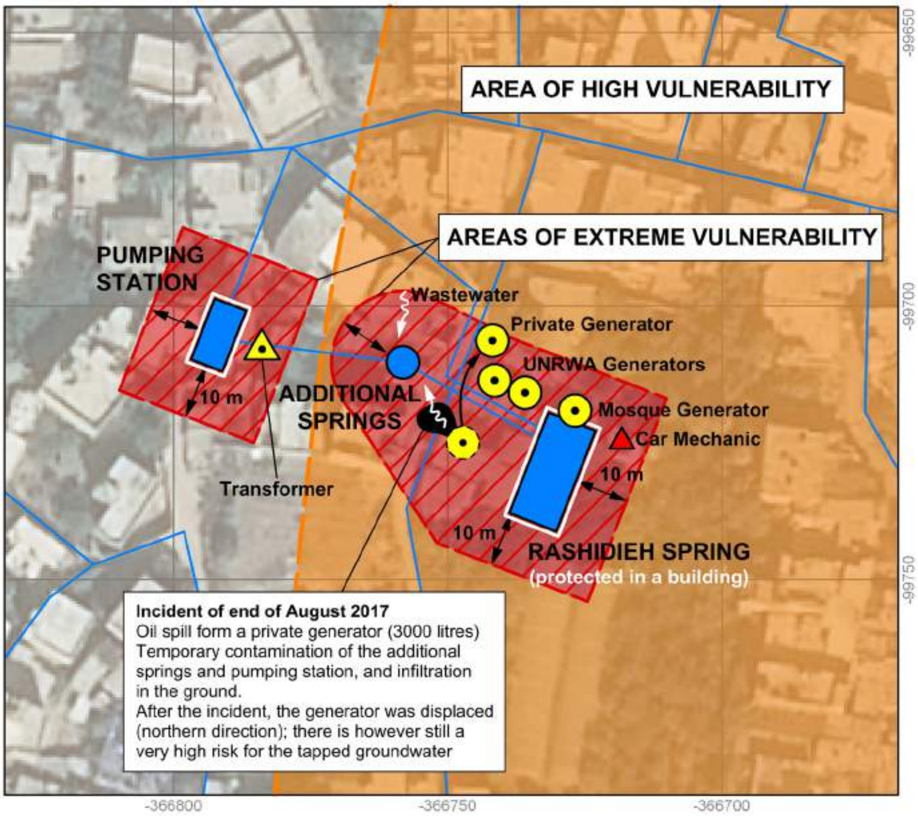


Figure 91. Detailed map of the vulnerability assessment around Rashidieh spring and survey of the hazardous activities.

Technical Measures

The status of wellheads (overall in poor condition) and the numerous underground structures (rather than wellheads constructed above ground) facilitate possible contamination by infiltration of surface water. A general improvement of the wellheads and the installation of protective fences would be conducive to better water quality. For instance, two tested wells in Burj Shemali (BSBO0001 and BSBO0003) with good design (structure above the ground surface and immediate fenced protection zone) presented no coliform and no E.Coli (water analysis of September 2017).

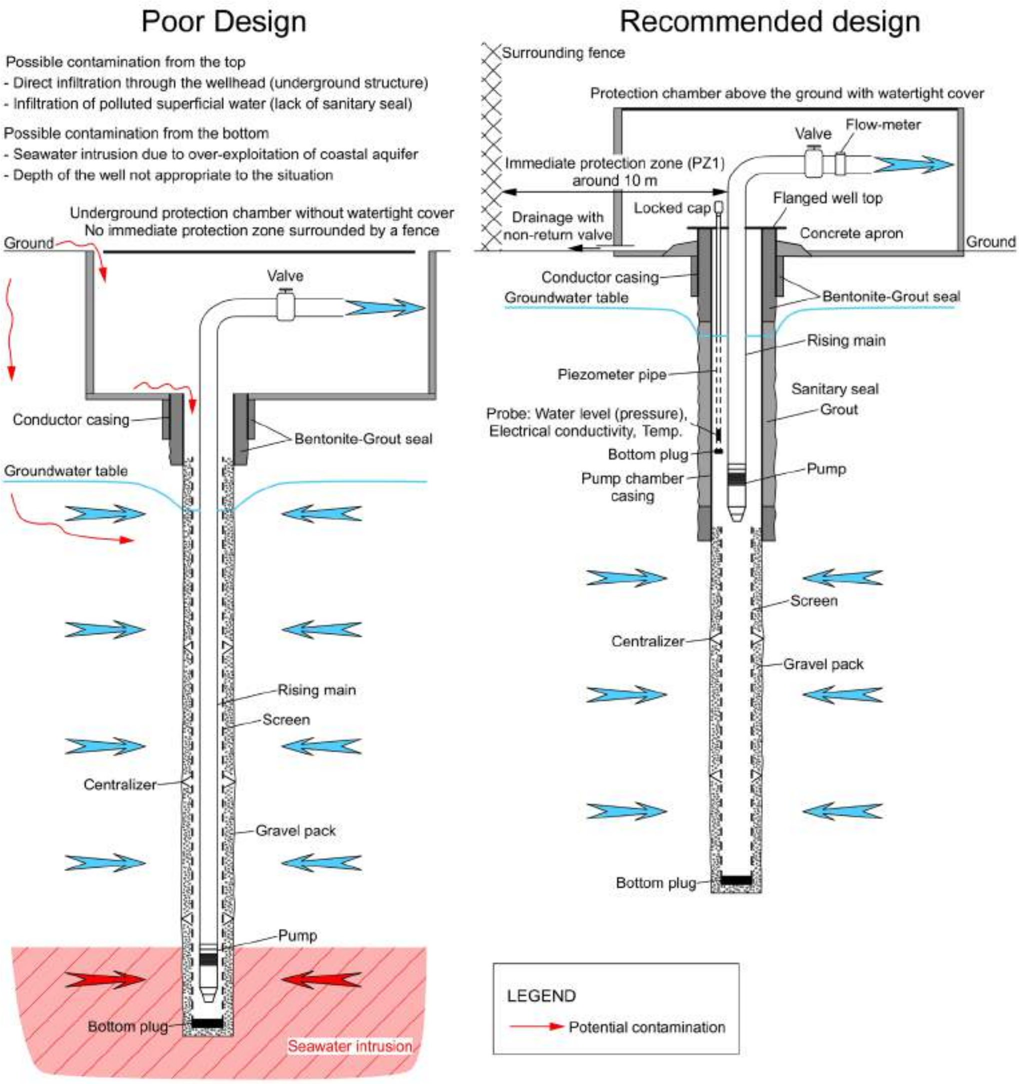


Figure 92. Poor and recommended designs.

An inspection of all the accessible pumping wells was performed with a CCTV borehole camera. Out of the 74 existing wells, 15 wells allowed an inspection with the camera (possible access through the wellheads). The inspection was limited by the length of the camera cable to 150 metres. Wells were generally found to be in poor condition (rusted pipes, encrusting, local leakages) despite the recent construction of some (for example, a number of wells were constructed in 2013 in Burj Barajneh). This status is probably related with the general high salt concentration of the abstracted groundwater. Some rehabilitation works will be necessary including cleaning out the well and repair of leaking pipes (particularly in Burj Barajneh and Mieh Mieh).

Local rehabilitation works on tanks and the network are also necessary.

Water treatment against the general low concentration of bacteria requires a simple treatment such as chlorination (the residual free chlorine should be in the range of 0.2 to 0.5 mg/l for the prevention of regrowth).

Treatment of saline water requires a complex and costly treatment chain such as a reverse osmosis system. It is therefore recommended to manage with the greatest care the water resources in these sensitive coastal environments to avoid overexploitation of the aquifers and wastage of water.

Recharge of the aquifers are considered from river (Nahr El Bared) and from roof rain water harvesting under certain conditions guaranteeing the absence of toxic pollutants including hydrocarbons. Recycling old cement alleyways with porous materials allowing infiltration in the soil are also recommended under strict civil engineering control (stability of the building) and based on topography and pedology favourable conditions.

Water Qualitative and Quantitative Surveillance Plan

A monitoring programme should be implemented on a regional scale, including the 12 Palestine refugee camps in Lebanon. The goal of the proposed monitoring exercise is not to achieve a global understanding of the groundwater resources at the scale of the hydrogeological basin, but to provide information on the quantity and quality of water within or around the camps, especially to produce a vision of their evolution over time, to identify improvement actions or proactive measures in the case of a progressive deterioration of the resource. The monitoring will include both continuous[73] and periodic measurements of qualitative and quantitative parameters. Groundwater Monitoring of existing wells should include the following elements:

- Operational flow meters should be installed on every pumping well for quantifying the abstracted groundwater and its evolution and assessing potential impacts on the aquifer during exploitation.
- Rigid and screened piezometer pipes[74] must be installed inside the pumping wells / springs (along the rising pipe) and water level monitoring conducted over time (periodic manual measurements in all the wells and complementary automatic water level with data loggers in a selection of representative wells). This also includes barometric monitoring for compensating the pressure record within the wells to obtain the real variation of the water level, and a detailed topographic campaign to determine the precise elevation of the top of the piezometer in order to transform the water level measurements in head value [m.a.s.l].
- Conduct water sampling campaigns to monitor the water quality of the abstracted water (on the basis of the detailed qualitative surveillance plan).
- Prepare a monitoring report on an annual basis.

[73] The frequency and parameters for the continuous recording and monitoring will be agreed between UNRWA and various stakeholders involved in former and ongoing quantitative and qualitative water monitoring, including UNDP, Ministry of Energy and Water (MoEW), ELARD

[74] Continuous screened pipe with cap at the bottom.

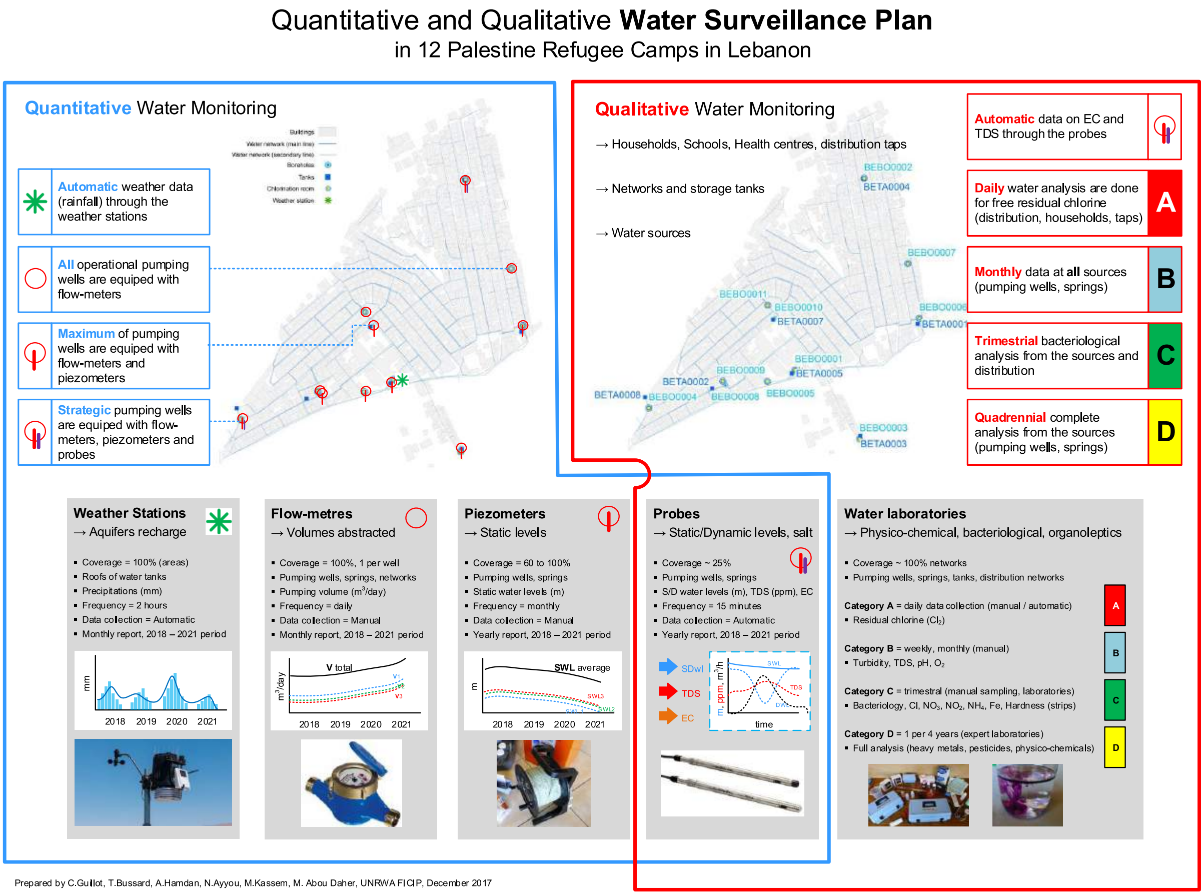


Figure 93. Quantitative and qualitative water monitoring plan proposed for the water sources in the 12 Palestine refugee camps during the 2018 – 2021 period.

Water Supply

A detail work plan has been prepared for each water supply network for each camp, including transmission, main and secondary supply lines, water tanks, replacement of used pumps and generators. Due to the extreme use of the equipment and the limited electricity supply from EDL, the life-time of the generators and submersible pumps are limited despite numerous recommendations of moderate operation and maintenance. There is a need for a more drastic planning with potentially billing or limited pump hours, well adapted to the uncontrolled private booster pumps and household's water tanks that are jeopardizing not only the hydraulics of each designed water network but also create excessive water and energy losses. It is estimated that, over the quadrennial 2018 – 2021 period, between 50 to 80 submersible pumps[75] will have to be replaced due to ageing, electrical damages or/and inadequate monitoring. In summary and for the water supply infrastructure, the main recommendations are:

- Replace the submersible pumps that are out of order or damaged (50 to 80 units);
- Maintain a minimum of spare pumps in the UNRWA warehouse (based on the yearly replacement plan of 50 to 80 pumps);
- Replace progressively the obsolete generators according to the national and international standards on fuel consumption, noise and air quality;
- Start hybrid "*PV solar – EDL*" electricity production for water supply based on power of the

[75] Estimated budget for the equipment (pumps) ranging between 250,000 to 500,000 USD for the quadrennial period

pump (less than 40 Hp, available roofing or area for safe PV modules installation, appropriate well characteristics – SWL/DWL, water quality, water committee contribution);

- Repairs the transmission and distribution water supply to maintain the average water losses between 10 to 20 per cent;
- Increase the water storage capacity and reduce the individual water tanks by awareness campaign and then restriction of use;
- Revise the pumping hours as per demand.

Public Awareness and Education

Education programmes such as lectures in schools, at public centres and other learning institutions can directly favour water savings by persuading communities to avoid wastage of water and by understanding the seriousness of the water situation.

Safe and efficient integrated water resources management (better knowledge and monitoring of the natural resource and exploitation), reduction of leakages from the network with better pumping programme have to be accompanied by awareness campaign by and for the residents to prevent waste of water as well as uncontrolled development (from the community and from individuals).

A cost recovery system is necessary to assure the viability of the water supply in the camps.

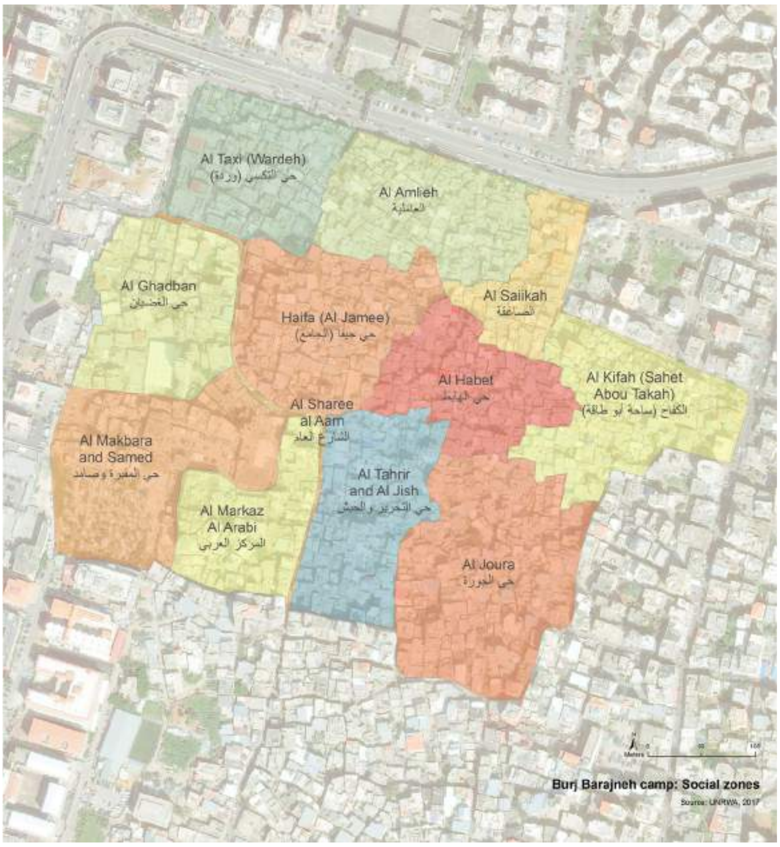


Figure 94. Example of “Social zones” included in the EIEH inventory for each camp.

Overall, there are three parallel activities to be developed from 2018. Inside the camps, improved management of the water sector is needed including a more efficient water supply with better control of the quantities pumped combined with a reduction of structural losses but also, at social level, increased participation from the population with responsible use of water, despite its gratuity. From a larger perspective and integrated with the municipal and national challenges, enhanced monitoring and understanding of the groundwater is urgent and must be combined with exploitation of the rainfall and consequent runoff resources for an artificial recharge of the aquifers rather direct losses into the sea. A better Re-use of the runoff will also have an impact on the operational and maintenance costs on storm water management.

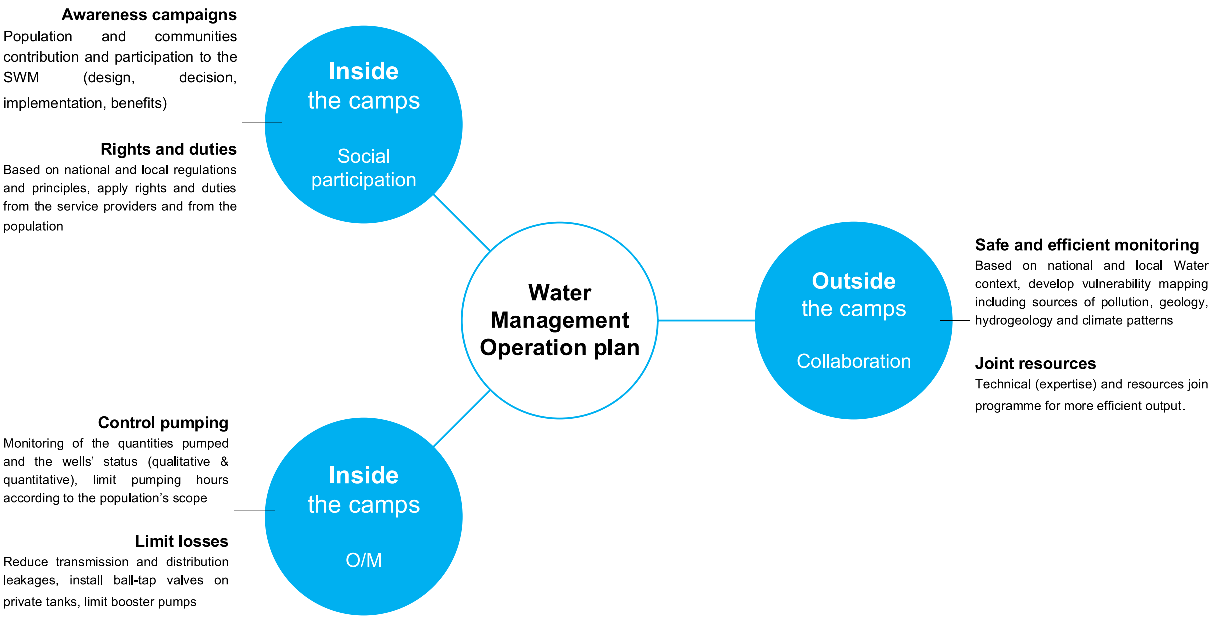


Figure 95. Water management operation plan.

Sanitation Sector

With around 240 kilometres of coastline, Lebanon's coastal zone is a key element of its wealth and natural beauty. Only eight per cent of the wastewater network coverage in Lebanon is treated, much lower that the MENA average of 32 per cent (UAE, 63 per cent; Algeria, four per cent, Jordan, 33 per cent). However, the lack of coastal protection measures is negatively impacting these ecosystems and the present species. In Lebanon, in 2010, 65 per cent of total sewage was deposited, mostly untreated, into its coastal waters. Between 1975 and 2001 an estimated 1,269 illegal properties were constructed along the coastline, which negatively affected coastal and marine life. By creating effective management policies, Lebanon can go a long way in protecting the natural treasure of marine and coastal ecosystems.

Waste is an important by-product of human activity and can be divided into several categories. The amount and type of waste, and the management methods used vary depending on the social and economic situation, as well as climate and land characteristics. Each category of waste has a potential effect on human health and on natural resources, with short, medium and long-term impacts at different levels. Overall, the preferred approach to waste is to minimize its generation. The necessary laws and policies governing the management of waste are efficient only when a population is ready to collaborate for its own benefit and that of future generations. Solid waste management (SWM), also referred to as "Integrated Solid Waste Management – ISWM" englobes all activities and tools associated with the control of solid waste generation, reduction, sorting, storage, transfer, transport, processing and disposal within a given context (public health, natural environment, economics, social, engineering). Depending on the stakeholder's set-up, the socio-economic context and natural environment (land characteristics) various SWM solutions are possible.

Population growth and urbanization and dwindling land areas are exacerbating SWM issues in Lebanon to the brink of a national crisis. Nationwide, an estimated 51 per cent of all municipal solid waste (MSW) is landfilled, 32 per cent is dumped, and the remaining 17 per cent is recovered through sorting and composting. Lebanon generates about 1.57 million tons of waste per year and is expected to increase by 1.65 per cent annually. A study conducted by the World Bank in 2004 on the state of environmental degradation in Lebanon, quantified the cost of degradation caused by pollution from illegal dumping and waste burning to be around USD$10 million per year, and rising[76].

The MoE prepared in 2005, a draft law on the ISWM which currently awaits approval by the Parliament. The draft law aims to regulate hazardous and non-hazardous solid waste management in Lebanon, including the process of financing and cost recovery, especially considering the multiple challenges faced by this sector. This law will ensure better management of the solid waste sector in Lebanon and thus reduce the resulting negative effects on the environment.

The average waste generation in Lebanon, is estimated as 0.95 kg per day per person, with 1.1 kg/d/p in the urban areas and 0.7 kg/d/p in the rural areas, equivalent to approximately 1.57 million tons per year. The expected waste generation for 2030 (measured by an annual increase of 1.65 per cent) is estimated at 2.3 million tons per year. The additional waste generation by the Syrian refugee population is estimated at 380,000 tons per year and the waste generation by the people living inside the 12 Palestine refugee camps is estimated at approximately 60,000 tons per year.

Waste disposal is particularly difficult in Lebanon because of its rugged terrain and limited surface area. The organic fraction of solid waste in Lebanon is very high but varies according to the lifestyle, economic status and seasonal social and agricultural habits. The percentage of organic fraction increases in rural areas and for low economic income groups (Palestine and Syrian refugees). In Lebanon, SW is divided into three groups: Municipal solid waste which is usually collected on a daily basis on the streets, industrial waste (IW), composed of non-hazardous and hazardous waste and other waste (OW) such as e-waste, construction and demolition waste and bulky items.

Ain Baal Solid Waste plant in Tyre area. ©2017 UNRWA

Ain Baal TP. ©2017 UNRWA

[76] Cost of Environmental Degradation: The Case of Lebanon and Tunisia, World Bank, June 2004.

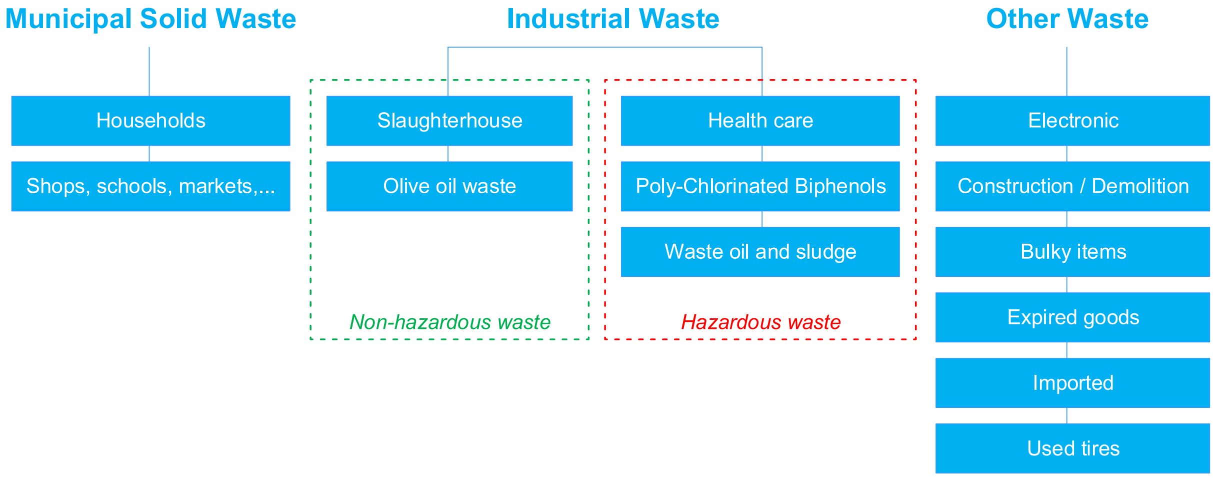


Figure 96. Definition of the groups for Solid Waste categorization in Lebanon.

While Government and donor funded studies and master plans related to municipal SWM have started to show modest results, very little has been achieved insofar as managing industrial waste, including hazardous waste, as well as other types of waste such as construction and demolition waste. Political indecision has so far prevented the implementation of a comprehensive plan for SWM in Lebanon (UNDP, Ministry of Environment, 2010). In July 2015, Lebanon faced an unprecedented waste crisis with negative consequences on the environment and public health system. This was largely due to the absence of a clear national plan for SWM as well as various political and governmental issues, including the additional SW burden on municipalities as a result of the Syrian refugee population.

In Lebanon, solid waste disposal is organized according to two areas: inside Beirut and Mount Lebanon and outside Beirut and Mount Lebanon. The country is equipped with various SW infrastructure and services such as treatment plants, sanitary landfills, open controlled dump sites in each of these two geographical areas. However, there is also a large number of “uncontrolled” dump sites. For the other MSW that is generated outside Beirut and Mount Lebanon, various techniques are applied depending on the municipalities’ organisation and resources and the existing capacities of SW infrastructure (Zahle sanitary landfill, Tripoli controlled dump, Saida dump). In terms of cost efficiency, SWM in Lebanon appears to be one of the least attractive options for the population, particularly in the collection of disposal services ranging between USD$ 40-150 per ton.

Solid waste sorting workers in Ain Baal. ©2017 UNRWA

Solid waste sorting workers in Ain Baal. ©2017 UNRWA

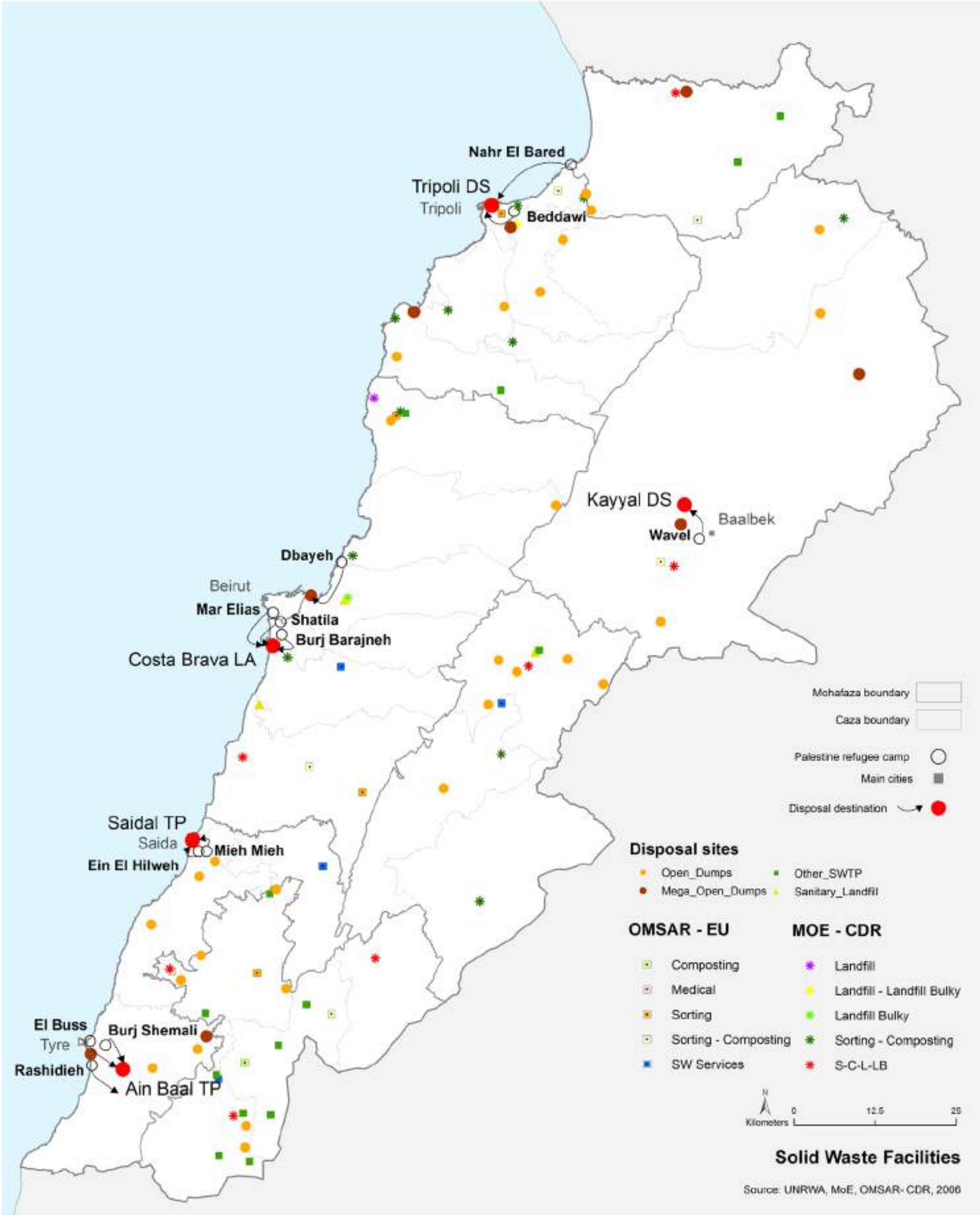


Figure 97. Solid waste facilities in Lebanon.

The situation, at national level, remains fragile due to the absence of a clear plan at the national level and multitude local initiatives developed by the municipalities and the private sector in response to the ongoing SW crisis. The multiplication of “uncontrolled” dump sites around the country (more than 900 sites identified – sources UNDP/ELARD) is perceived as a major environmental risk if not rapidly tackled[77]. The influx of Syrian refugees, mainly living in informal settlements, brings another burden for the limited resources of the Government of Lebanon and its civil society.

Ongoing investment and efforts are being developed, including the pursuit of the Emergency Plan for SWM (1997 – present), Master Plan for SWM (2006), Waste-to Energy plan (2010), MWM plans, EU-OMSAR[78] investment plan, Naame sanitary landfill, Zahle sanitary landfill, Tripoli controlled dump, and Saida dump, among others. Little success has been achieved for industrial waste, including non-hazardous waste (including inter alia slaughterhouse waste) and hazardous waste (healthcare waste,

[77] Closing illegal dumping site or conversion into sanitary landfills

[78] EU Fact sheet on EU intervention in SW (ARLA, MUFIN, SWAM I & II, PROMARE)

Poly-chlorinated Biphenols (PCBs[79]), waste oil and sludge). For e-waste, construction and demolition waste, bulky waste, expired goods and medicine, and used tires, the response remains limited due to the lack of reliable estimations of such waste and the limited regulation mechanism. Since 2004, the EU has financed the construction of new solid waste treatment facilities, sanitary landfills and other SW infrastructures, based on the principles of decentralisation and collaboration with the municipalities and Unions of Municipalities, identified as the key players outside of Beirut city. If additional skills or resources are required, EU supports public-private partnership for the operation and maintenance of the existing and planned facilities.

Depending on market trends, political and institutional development and the awareness of the civil society to improve its public health and the preservation of its environment, assumptions can be made for the 2020 horizon. Today, and despite numerous initiatives at central and municipal level, the SWM problem is far from being solved with an accumulation of SW on the streets of Beirut and around the country. From a technical point, the municipalities and private companies are facing many constraints to cope both with the reality of the situation in the ground (to efficiently dispose of the SW) and the environmental standards imposed by the state (CDR, OMSAR, MoE). This includes the introduction of necessary incinerators to limit the unsorted SW in each plant to reduce the volume of SW to be landfilled, with potential production of energy. The design of former SW treatment plants developed in Lebanon was not systematically adapted to the context (technical, SW composition, volumes, energy needs, regulation) with an additional challenge for the operators in a market not ready for SW valorisation.

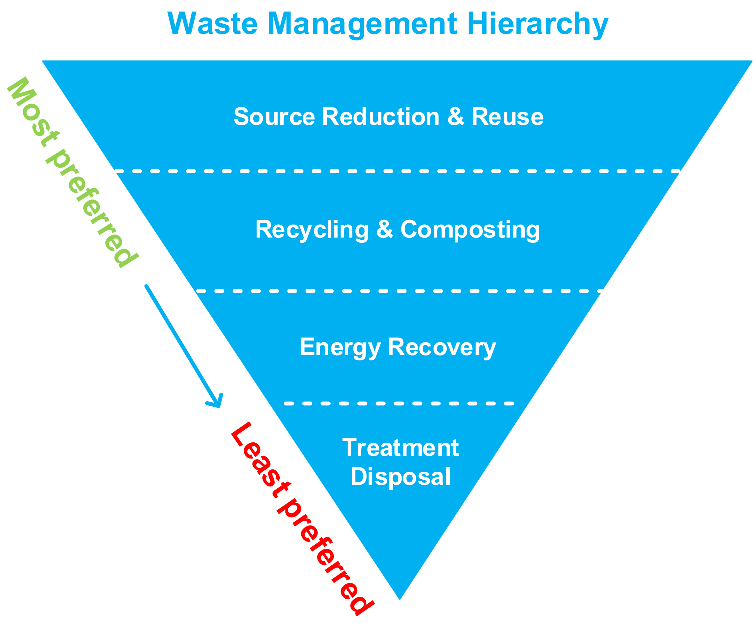


Figure 98. Waste management hierarchy.

[79] UNRWA FICIP participates, together with MoE and the World Bank, to the national inventory of PCBs in transformers within the Stockholm convention for 2030 « free PCBs » in Lebanon

Palestine Refugee Camps in Lebanon

The action plan outlined in the EHS (§3.3.1. Wastewater and §3.3.2. Storm Water) have been completed and used to elaborate the following recommendations.

Wastewater

Findings

Based on AutoCAD drawings, ESRI geodatabase and field visits, the wastewater sector has been inventoried for the main lines. Due to the scope of the network and sometimes the difficult access to building courtyards, the inventory is not exhaustive. Household infrastructure does not appear in this inventory and needs assessment.

Constructed between 2004 and 2015, there are 12 wastewater (WW) networks functional (one per camp). Apart for the camps of Rashidieh and Nahr El Bared, all WW networks are connected to the municipal networks with a total of 26 connections points. For the camps not connected to the municipal WW networks[80], 17 sea discharge points have been identified. All the WW connections to the municipal ones and to the sea also contain the storm water effluents. The total WW discharged is based on the water supply in each camp to approximately 20,000 m^3 per day. It considers the water supply leakages losses ranging between 20-40 per cent according to the state of the water supply network. There is no WW treatment and all effluents are connected by gravity to the municipal network (except for Rashidieh which requires a pumping station). For each camp, the closest WW treatment plants have been identified.

Wastewater sampling in Shatila camp. ©2017 UNRWA

[80] Rashidieh camp: the WW municipal network is not completed; Nahr El Bared: the WW at camp and municipal levels are still under construction

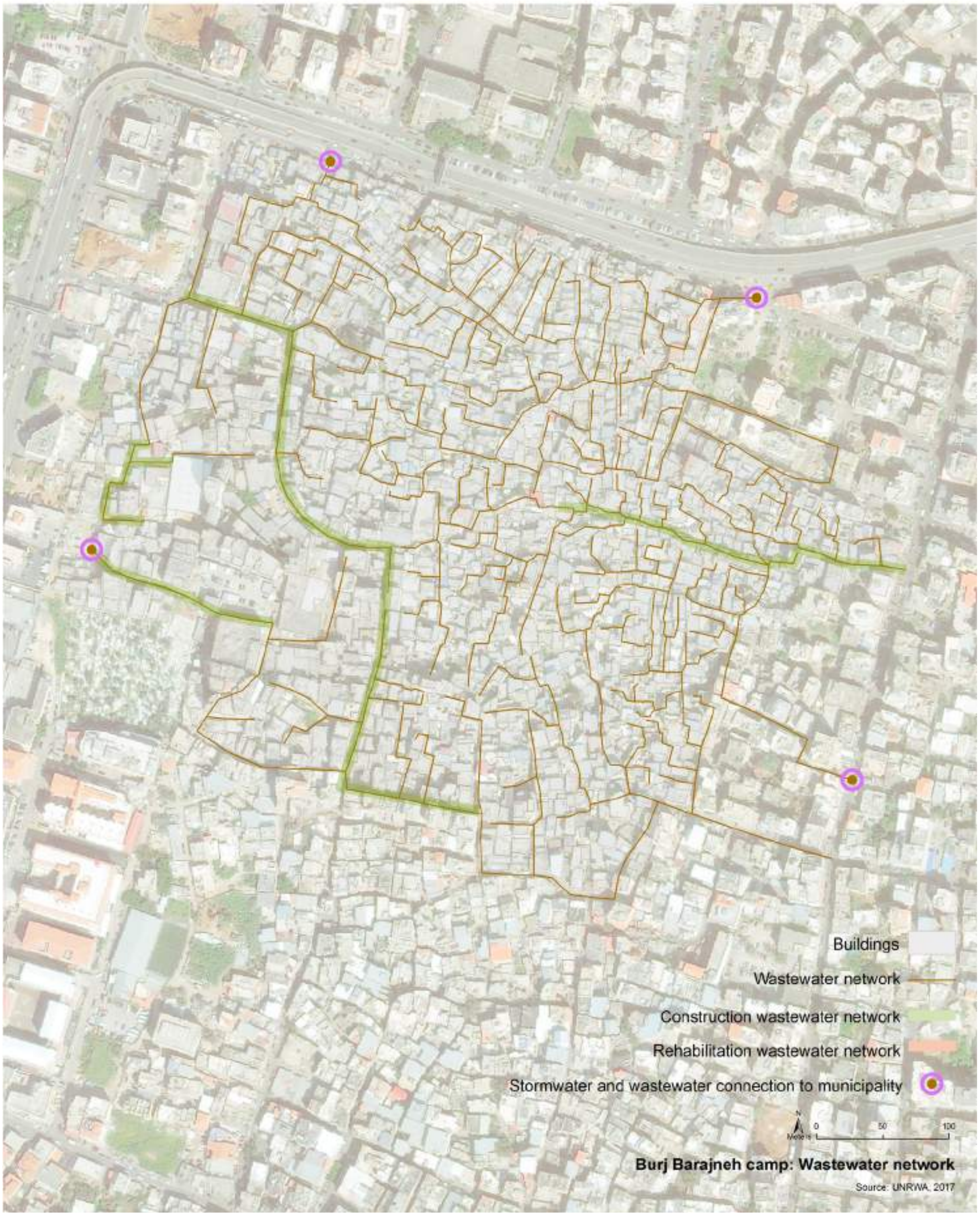


Figure 99. Example of geodata base (including attributes) for the wastewater subsector for each camp and used for the Response Plan's project distribution.

The total WW network is estimated to 151 kilometres for the 12 camps (including the WW not connected or incomplete in Rashidieh and Nahr El Bared). A total of 20,155 manholes are registered in the FICIP geodatabase, including their precise position, design and network ID. Apart for two camps where there are no storm water networks (Dbayeh and Mar Elias) and five camps have both the wastewater and storm water networks mixed together (WW and StW). The main materials used are PVC and concrete with diameters ranging between 50 mm up to 1,200 mm. The wastewater diameter ranges from 50 mm to 800 mm. For all 151 kilometres of WW pipeline and 20,155 manholes, the geodatabase is available including the following characteristics:

- Material (UPVC, PVC, Concrete)
- Diameter
- Length

- Manhole and altitude
- Connection to wastewater municipal network (collector point)
- Connection to treatment plant (existing or future)
- Custody

Camp	Length	Diameter	Type
Beddawi	1.11	200.00	UPVC
Beddawi	16.64	200.00	UPVC
Beddawi	16.63	200.00	Concrete
Beddawi	13.90	200.00	PVC
Beddawi	14.09	200.00	UPVC

Figure 100. Example of wastewater pipe inventory for the 160 kilometres of pipes (mains) in the 12 Palestine refugee camps in Lebanon.

Wastewater Qualitative Survey

As a component of the inventory and needs assessment of environmental health infrastructure in the 12 Palestine refugee camps in Lebanon, the FICIP conducted a wastewater quality survey in August and September 2017. The aim of the survey was to test the quality of wastewater from two sources within each camp (one from the camp effluent and the other from a household effluent). By comparing both results, the effect of commercial[81] activity on the quality of wastewater was assessed and the necessary treatment to reach national standards of wastewater discharge limits were identified and presented in Figure 63. Twenty-four wastewater samples were collected from the 12 camps and taken to the laboratory for analyses of several parameters including:

Temperature	Total Copper
Total dissolved solids (TDS)	Total Lead
Total suspended solids (TSS)	Mercury
Oil and grease	Total Tin
pH	Chlorine free
Biochemical Oxygen Demand 5 days	Cadmium
Chemical Oxygen Demand (COD)	Total Coliforms
Total Organic Carbon (TOC)	Salmonella
Total Nitrogen	Cyanides
Ammonia	Turbidity
Nitrate	Silver
Nitrite	Phosphate inorganic
Phosphorus	Barium

Figure 101. Parameters for the wastewater analysis.

[81] The residential activity was measured by the sample taken from house (extra pollution is the contribution of commercial shops).

Recommendations

Two WW projects must be completed in Rashidieh and Nahr El Bared. In Rashidieh, a "*Waste for value*" initiative project is currently underway to identify an ecological and local solution applicable to the old and new camps including recycling and re-use of bi-products for agriculture and until the municipal network being completed.

In total and based on the inventory and georeferenced in the FICIP geodatabase, approximately one kilometre of WW must be urgently rehabilitated and 10.2 kilometres constructed. Nine camps are will be affected by those works over the coming 2018 – 2021 years, including the new network in the old camp in Rashidieh.

Results[82] common to all 12 Palestine refugee camps include the absence of heavy metals or toxic compounds due to no heavy industry in the camps. Additionally, high levels of nitrite, nitrate and inorganic phosphate were observed. Fertilizer runoff is the most prevalent source of nitrate contamination. Many camps revealed high levels of salmonella which can be correlated to the discharge of waste from the chicken butchers into the sewer network. Salmonella is treated by ordinary disinfection using chlorine compounds, UV radiation or ozone.

Inorganic phosphate is also high in most camps. Controlling inorganic phosphate is a key factor in preventing eutrophication of surface waters. Chemical precipitation is used to remove the inorganic forms of phosphate by using a coagulant. From the microbiological point of view high levels of total coliform are obtained (found generally in the nature flora of the human waste) which can be considered uncountable and normal in the same time since there is no significant treatment for the WW.

To determine the toxicity of WW, the BOD/COD ratio is the key indicator and it has been calculated for all the camps and for all the samples. If the BOD/COD ratio for untreated WW is 0.5 or higher, the waste is considered to be easily treatable by biological means. If the ratio is below 0.2, either the waste may have some toxic components or acclimated microorganisms may be required in its stabilization (Meng et al., 2014). In other terms, when the COD is high, the ratio is very low and the WW is not biodegradable or in other terms organic materials are not used by the bacteria. The accumulation of these materials increases the toxicity of WW. Therefore, further advanced treatments are mandatory to eliminate these components.

Five camps have a low ratio of BOD/COD, which means COD is very high and WW in these camps is toxic. These camps are Burj Barajneh, Dbayeh, Mar Elias, Shatila, and Nahr El Bared. In conclusion, WW in these camps is more toxic than other camps.

Different activities divided into short-, mid- and long-term are suggested. Every activity is correlated with those responsible for implementation. Finally, the expected outputs are also listed to better visualize the future situation when the corrective actions are applied.

[82] Detail results available at FICIP (Middle East North Africa Food Safety Associates MEFOSA. (2017). Wastewater characteristics: Sampling and analysis for wastewater effluent in the twelve Palestine refugee camps in Lebanon.)

Plan	Activities	Parties responsible	Expected outputs
Short term	Clean blocked sewers	UNRWA field team	Avoid any overflow accident that can affect humans and others
	Improve the pest control management system	Assign a pest control company for this matter	Control the pests and decrease their effects
	Monthly monitoring for the network (manhole specially)	UNRWA field team	Having a monthly chart of all the problems related to the network in the camps with the corrective actions
Mid-term	Test WW by taking samples every season to test specially BOD and COD	Private laboratories	Monitor the parameters of WW and see if corrective actions are efficient
	Raise awareness on seashores pollution and cleaning	UNRWA should do events and collaborate with different associations	Seashore cleaned and WW is less toxic
Long term	Implementation of WW treatment in discharging points	Municipalities, government, funding parties	This implementation will result in decreasing the pollution.

Figure 102. Short, medium and long-term activities.

All camps household manholes should be cleaned regularly with the establishment of a pest control system. Also, and as mentioned above, awareness should be raised to prevent any waste being thrown in the network. In addition, maintenance of the sewer system in each camp is important to prevent any infiltration of WW into the groundwater that contaminates wells. Untreated wastewater reaching potable water source can result in significant health risks. The best strategy for protecting health and the environment and preserving valuable water resources is done by preventing potentially harmful substances from polluting water. An effective and educational programme can be implemented to engage homeowners to properly dispose of hazardous household chemicals, such as paints and varnishes.

In communities where wastewater treatment is inadequate or non-existent, the opportunities for people to become infected are high. Untreated WW contains many types of pathogens that are hazardous to humans, such as bacteria, viruses, and parasites (including worms and protozoans). Fungi that also grows in sewage and sewage sludge can cause skin, eye, and respiratory infections. WW is source of several related diseases, including typhoid, paratyphoid, bacillary dysentery, gastroenteritis and cholera.

The sanitation laborers, protection equipment, tools and vehicles are essential for the routine activities (operation and maintenance). The specific needs are included in the RP's project and budget estimation accordingly.

Storm Water

Findings

Based on AutoCAD drawings, ESRI geodatabase and field visits, the storm water sector has been inventoried for the main lines. Due to the scope of the network and difficult access to building courtyards, the inventory is not exhaustive. The household infrastructure also does not appear in this inventory and needs assessment.

Constructed between 2004 and 2016, along with the WW projects, there are ten functional storm water (StW) networks. The camps of Dbayeh and Mar Elias are not equipped with any StW network and have only a surface runoff system. Except for Rashidieh and Nahr El Bared, 17 connections points join the StW camps' networks to the municipal ones. As for the WW. The status of StW in Burj Barajneh, Rashidieh and Wavel is poor and require significant interventions, followed by Shatila, Ein El Hilweh, Mieh Mieh and Nahr El Bared, which are considered as medium with little intervention required. The StW in the other camps are in good condition.

The total StW network is estimated to 47 kilometres for the ten camps (excluding Dbayeh and Mar Elias) A total of 2,113 manholes are registered in the FICIP geodatabase, including their precise position, design and network ID. The StW pipeline diameters range from 20 mm to 1,200 mm, open channel dimensions range from 400mm to 1,000 mm for their widths and 300mm to 800 mm for their depths. For all 47 kilometres of StW pipeline and manholes, the geodatabase is available including the following characteristics:

- Material (Concrete)
- Diameter for pipe, width and depth for open channel
- Length
- Manhole and altitude
- Connection to storm water municipal network (collector point)

Camp	Type	Diameter	Length	Width	Depth
Beddawi	Concrete channel	0.00	17.67	400.00	300.00
Beddawi	Concrete channel	0.00	17.67	400.00	300.00
Beddawi	Concrete channel	0.00	3.89	400.00	300.00
Beddawi	Concrete channel	0.00	3.35	400.00	300.00
Beddawi	Concrete pipe	50.00	0.50	0.00	0.00
Beddawi	Concrete pipe	50.00	0.50	0.00	0.00

Figure 103. Example of storm water pipe and open channel inventory for the 160 kilometres of pipes (mains) in the 12 Palestine refugee camps in Lebanon.

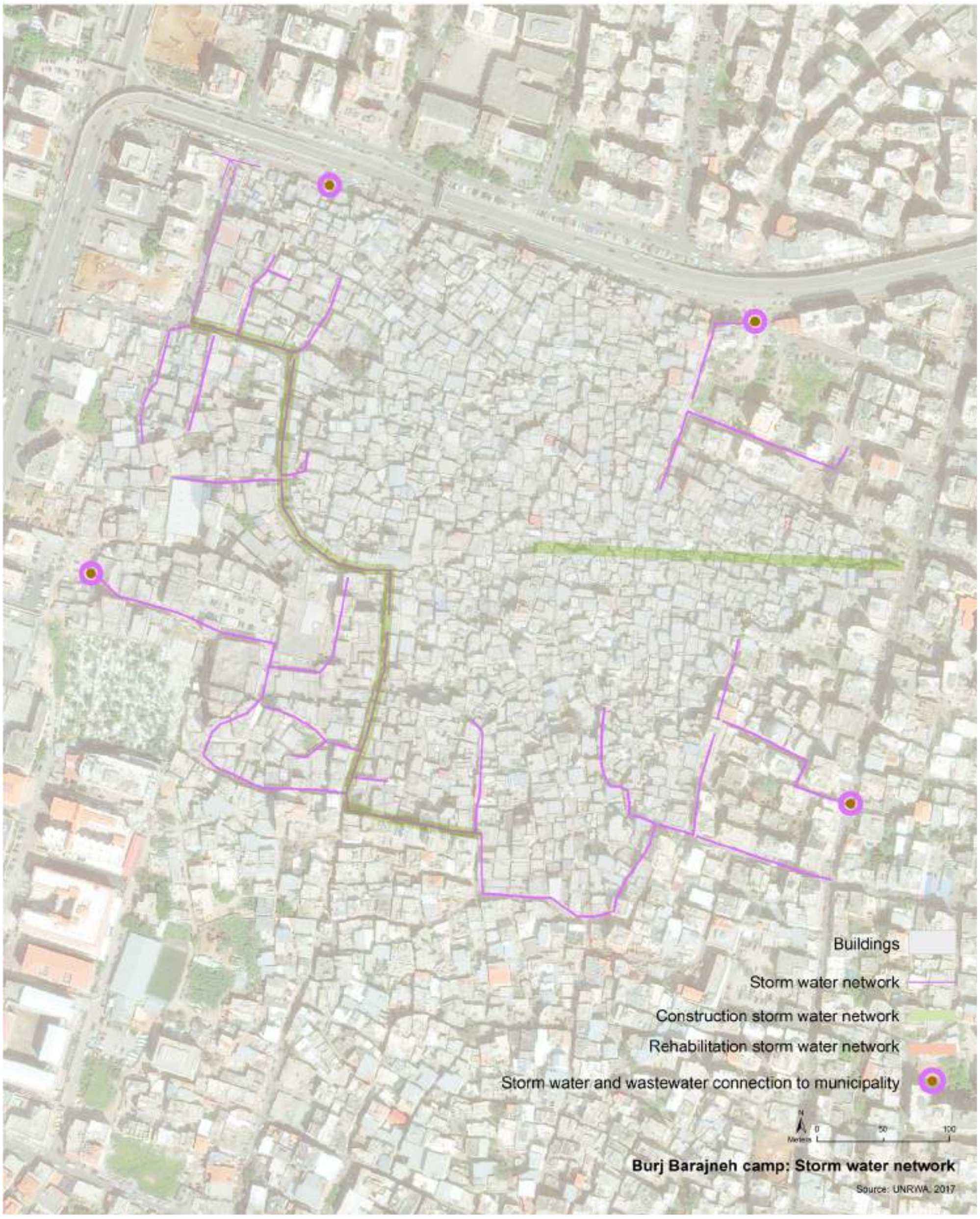


Figure 104. Example of geodata base (including attributes) for the storm water subsector for each camp and used for the Response Plan's project distribution.

Recommendations

New storm water networks in Dbayeh are recommended. In Mar Elias, due to the limited width of the alleyways, filter paved may be a better option.

In total and based on the inventory and georeferenced in the FICIP geodatabase, approximately 600 metres of StW require rehabilitation and 7.5 kilometres must be constructed. Six camps are involved with those works over the coming 2018 – 2021 years to improve the rainwater management and reduce the risks of flooding.

The roofs are currently connected to the streets but should be linked either to the storm water network or better, used as artificial recharge, potentially by converting asphalt toxic pedestrian roads into paved filtered and porous material facilitating the infiltration of rainwater into the aquifer rather than runoffs or congestion of open channels. Storm water shall be considered, in the longer term as a resource to be exploited rather to be lost in the sea or as a risk of floods. Artificial recharge of groundwater, under controlled conditions, is highly recommended.

Extensive feasibility studies can be done on the possibility of applying rainwater harvesting inside the camps following the Ministries Master plans, National Strategy and standards and the National Guidelines for Rainwater harvesting. These technical studies should include the option of constructing underground reservoirs or artificial tanks inside the camps that will collect Storm water to be later used for domestic and irrigation purposes. Besides that, social acceptance and public engagement and commitment should be raised through awareness campaigns for a constructive implementation of these technical solutions.

The sanitation laborers, protection equipment, tools and vehicles are essential for routine activities as well as in case of special season (winterization) or/and during heavy and intense precipitation events. The specific needs are included in the RP's project and budget estimation accordingly.

Solid Waste

Findings

The action plan outlined in the EHS (§3.3.3. Solid Waste) has been completed and used to elaborate the following recommendations. According to UNRWA agency-wide "Solid Waste Management" frameworks, the objectives are to ensure that residents of Palestine refugee camps in Lebanon (as well as for other UNRWA Fields) have access to minimum acceptable standards of sustainable collection and removal of solid waste with an efficient sweeping of the estimated 117 kilometres of streets inside the 12 camps. The reduction of waste generation and the encouragement of recycling and its reuse according to verified techniques and resources management highlighting cost efficiency and environmental advantages are imperative. In line with the Logical Framework presented in the RP, indicators for measuring the performance of SWM services are mainly related to the level of waste collection on daily basis, the frequency of street sweeping on weekly basis, the amount of waste reduced (through awareness of the population, recycling and re-use efforts) and operational running costs.

Daily, approximately 163 tons of solid waste are generated in the 12 camps in Lebanon. The population in the Palestine refugee camps has seen a significant increase due to the influx of additional Palestine refugees fleeing from the conflict in Syria, relocating to the camps as a result of their low economic status. There are currently some 30,600 Palestine refugees from Syria in Lebanon, half of which reside inside the camps and more than 10,000 Lebanese and other nationalities[83]. As a consequence, levels of waste generated inside the camps, by residents and visitors, have increased and continue to compound the impact on the environmental health infrastructure in the camps. This represents a substantial public health risk for camp residents due to the potential for leakage of pollutants and the spread of disease-bearing insects and rodents. Additionally, a substantial burden remains on the already fragile financial, human and infrastructure resources dedicated to SWM.

[83] UNRWA Social and relief department, 2016


Solid waste collection in Palestine camps. ©2017 UNRWA


Solid waste transfer to platform in Shatila. ©2017 UNRWA

Area	Camp Name		Daily SW generation (Ton)	Commercial Fraction of SW	HH SW generation (Ton / day)
Central Lebanon Area	Burj Barajneh	BB	18	15%	15.3
	Dbayeh	DB	2	2%	1.96
	Mar Elias	ME	2	5%	1.9
	Shatila	SH	12	15%	10.2
Saida Area	Ein El Hilweh	EH	45	25%	33.75
	Mieh Mieh	MM	4	5%	3.8
Tyre Area	Burj Shemali	BS	14	10%	12.6
	El Buss	EB	8	10%	7.2
	Rashidieh	RA	11	10%	9.9
Bekaa Area	Wavel	WA	3	2%	2.94
North Lebanon Area	Beddawi	BE	20	20%	16
	Nahr El Bared	NB	24	15%	20.4
Total			**163**		**136**

Figure 105. SW generation for the population living in the 12 Refugee Camps in Lebanon.

UNRWA provides SWM services to 12 Palestine refugee camps in Lebanon, distributed in five areas. The demographic pressure in some camps such Shatila, Burj Barajneh and Ein El Hilweh remains a real concern in terms of environmental health.

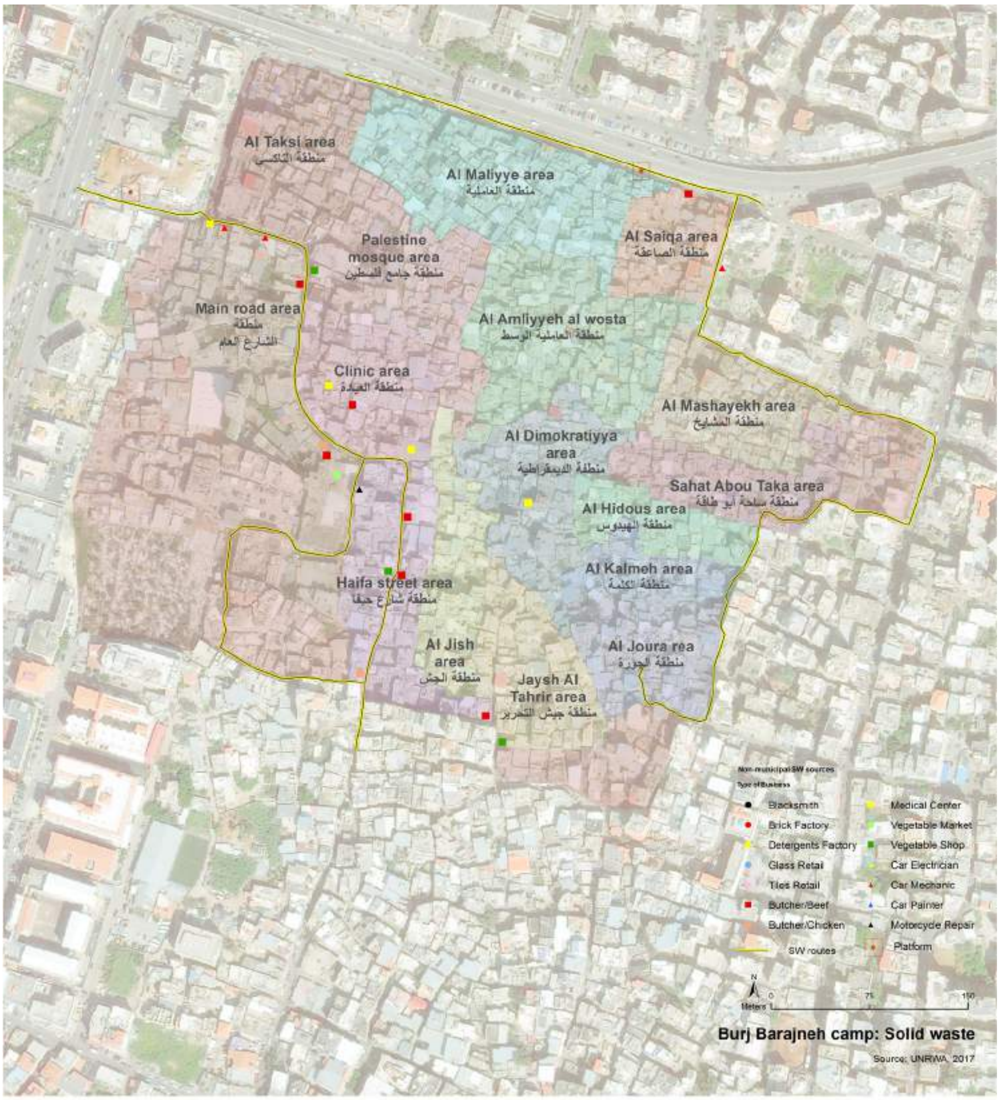


Figure 106. Example of geodata base (including attributes) for the solid waste subsector for each camp and used for the Response Plan's project distribution.

Composition

MSW is collected daily by UNRWA sanitation laborers (in the streets and mostly outside of households) and transferred to the platforms located inside each camp and directly to the SW disposal sites (official treatment plant, unstructured dumping site). Platforms are used for any SW not compacted. All SW compacted during their collection (via the compactor, usually equivalent to seven tons capacity) are directly sent outside the camps.

The SW generated inside the camps is comprised of all SW categories[84]. Most of the SW is equivalent to MSW, but it also contains, construction/demolition waste with negative consequences on the MSW equipment and vehicles which are not designed to process heavy and hard waste such as stones, bricks and iron bars. The percentage of industrial waste and "other" waste (e-waste, construction and demolition waste, bulky waste, expired goods, and used tires) is currently unknown, but should never be mixed with MSW[85].

[84] Based on Ministry of Environment definition of SW for Lebanon

[85] Similar constraints are faced by the SW private companies around Lebanon (Sukleen, Ain Baal, etc.)

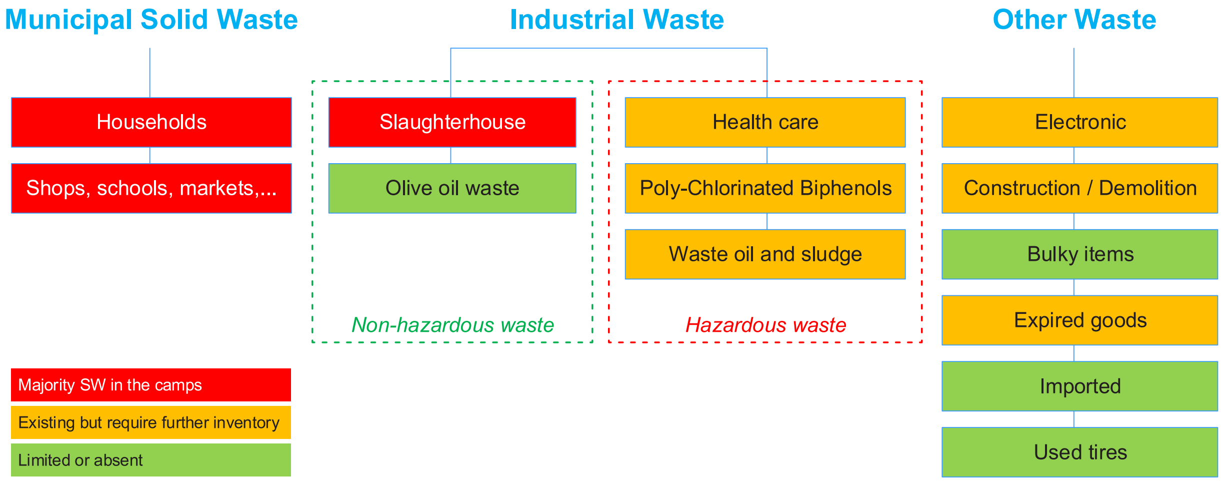


Figure 107. Categories of SW generated inside the Palestine refugee camps.

On average, the SW generated inside the camps is composed of 60 per cent of organic waste and 40 per cent other waste. No sorting is conducted by SW "generators" (households, shops, markets, slaughterhouses) and most of the SW is transferred to the collection platforms. American Near East Refugee Aid (ANERA) started household level sorting in two camps (Nahr El Bared and Rashidieh). Prior to the evacuation of the SW from the platforms to different disposal sites (structured/legal or unstructured/illegal), one first sorting is done by the scavengers collecting "valuables" which are easily recycled without a specific process. The scavengers are collecting the equivalent of 15 per cent of the total generated SW, either in the street (in the bins or directly from the plastic bags disposed by households) or at the platforms.

The total SW generated inside the camps is equivalent to approximately 163 tons per day. The total SW to be disposed of, after the scavengers have finished, is equivalent to 139 tons per day, composed of 70 per cent organic and 30 per cent other. In the Central area (four camps), 22 per cent of the total population generates 21 per cent of the total SW. In Saida (two camps), 27 per cent of the total population generates 30 per cent of the total SW.

In Tyre area (three camps), 22 per cent of the population generates 20 per cent of the total SW. In the North area (two camps), 27 per cent of the total population generates 27 per cent of the total SW.

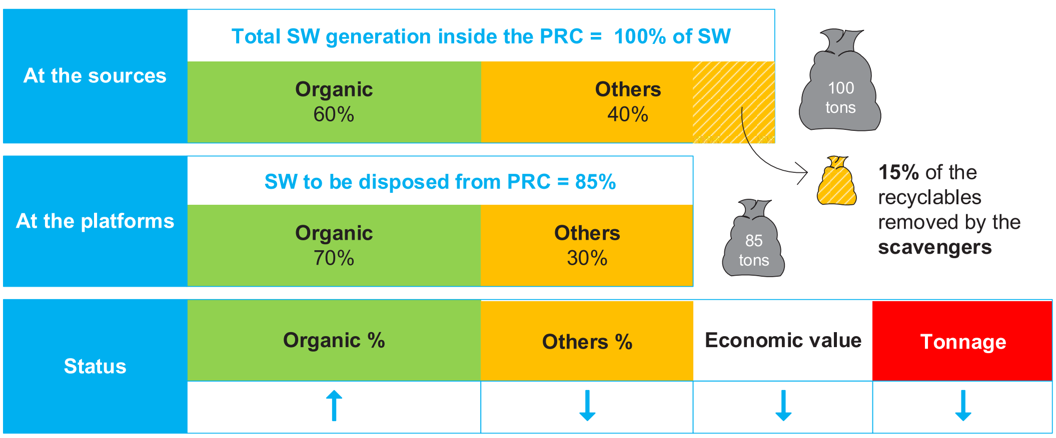


Figure 108. SW status from the sources of collection to the platforms.

Regarding the SW generated from the 69 educational facilities and 29 health care centres, respectively 38 per cent (27) and 53 per cent (16) are located outside the camps. All of the SW is, as for most of Lebanon, mixed with the MSW, even though medical waste is sorted prior to disposal. The ongoing FICIP inventory on medical SW intends to better determine the situation and the destination of toxic waste in the future.

Disposal

Most of the MSW is transferred to 1,876 plastic and steel bins installed in all of the camps. Each bin (120, 240, 360 and 1,100 litres capacity) is periodically replaced[86], every two years[87]. In 2017, it is estimated (based on the last distribution of bins) that 2,525 bins (120, 240, 360 and 1,100 litres) were replaced (approximately USD$ 313,450). Sanitation teams collect the SW from the bins using dumpers, pick-ups and compactors depending on the road access and the system of collection in place (with or without platforms). For SW that is not compacted and sent directly to the SW disposal plants, vehicles such as a pick-up are used to transfer the un-compacted SW to the final structured (legal) and unstructured (illegal) disposal sites via municipal, private (Sukleen, City Blu), and/or UNRWA vehicles (pick-up, dumper) for their final disposal outside of the camps. For the UNRWA vehicles, daily expenses such as fuel (ranging from 20 - 40 litres of gasoline or diesel) and manpower (four to eight-hour operation) are required. For each type of vehicle, additional running costs such as insurance, plate registration, oil, spare parts and tires are included in the overall budget.

The transportation costs from the platforms to the final destination (treatment plant, landfill, and dump site) exceeds USD$ 200,000 per year. Out of the 163 tons of SW (at the platforms), 72 per cent is transported by UNRWA vehicles, 21 per cent by private contractors hired by the GoL and nine per cent[88[1]] by private contractors hired by UNRWA. The transportation and disposal of the SW is free of charge for the Central and Saida areas. The highest costs are attributed to Tyre area with 87 per cent of the total monthly expenses. In comparison, the cost per ton for SW collection and disposal in Lebanon (USD$ 175 per ton in Beirut area, USD$ 50 per ton for Tripoli and Zahle and USD$ 25 per ton in rural areas) is higher than that paid by UNRWA (ranging from USD$ 2.3 to USD$ 24.2 per ton). The SW transported from the platforms of each camp result in three categories of disposal - uncontrolled, controlled dumping and controlled treatment. In Tyre area, 12 per cent of the total SW generated in the 12 camps is transported to unknown open dumping sites. When the treatment plant of Ain Baal is closed or rejects SW from Burj Shemali camp (nine per cent of total SW), the SW is then disposed of in uncontrolled dumping sites and burning sites. In addition to the damage to the environment, this SW aspect is the most expensive for UNRWA.

The distance travelled by SW vehicles from the camp to the final disposal site vary from camp to camp. The shortest distance is 2.4 km (Ein El Hilweh) and the longest is 14.8 km (Nahr El Bared)

The SW from Ein Hilweh and Mieh Mieh is treated in the Saida treatment plant. Together with the SW from Burj Shemali (when Ain Baal treatment plant is functional), 39 per cent of the total SW generated by the camps is treated. The remaining 49 per cent of SW, corresponding to the camps in Central area (Beirut), North (Tripoli) and Wavel (Zahle), is sent to sanitary landfills or controlled dump sites.

[86] The SW bins procured in 2015 with a specific distribution plan per camps require for replacement due to intense use

[87] The life time of steel bin is estimated to 4 to 5 years but due to heavy duty and limited care inside the camps, the life time is currently estimated to 2 years

[88] [1] This only 9% represents the majority of the SW transportation costs

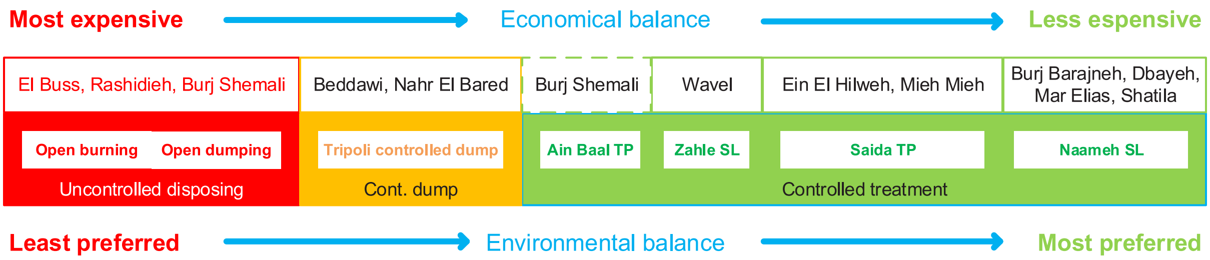


Figure 109. Distribution of SW according to the SWM last and most preferred and transportation costs.

Collection and Disposal Costs

According to recent data collected by the FICIP, the running costs for the transport and disposal of the SW are increasing annually by up to 50 per cent. The increase could stabilize the national SW cost for disposal but might also lead to its increase due to the limited SWM capacity and the market trend (high opportunity). The unsolved national crisis remains a serious risk for SWM in the Palestine refugee camps. The presence of approximately 1.5 million Syrian refugees remains a burden on the existing SWM infrastructure at municipal level.

The existing UNRWA staff dedicated to the SWM is insufficient (despite emergency funds for additional sanitation laborers) which are underperforming due to the additional population inside the camps, the complex urban environment (narrow streets) and limited participation of the population. Consequently, vehicles and manpower are over-used with many incidences of breakdown, injury and sickness amongst the staff.

Improvement Measures

Recommendations

The first step is to improve the SW management in the camps through activities and equipment aimed at rationalizing the SW collection at household levels and to improve the working conditions and efficiency of the UNRWA sanitation team. It is also essential that the governmental Master Plan Strategies to include the Palestine Refugee Camps in the future Environmental Health Strategies and to have a close coordination between the governmental institutions and UNRWA to enhance UNRWA's environmental Health unit expertise for Solid Waste capacity building .The participation of the population, through social mobilization and communication campaigns is a crucial element of the strategy, based on the existing situation outside the camps and the necessary measures to the ongoing SW crisis by increasing the percentage volume of SW directly evacuated from the streets to the disposal sites developed by the state and private sectors with national and international funding. In terms of implementation, the priority will be given to the following areas:

- Tyre area (three camps)
- Central area (four camps)
- North area (two camps)
- Saida area (two camps)
- Bekaa (one camp)

Collection at Household level and Transfer

The current SW collection system that consists of a minimum effort by the population (dropping MSW in front of each household) will be progressively replaced by the national set-up consisting of steel bins in fixed and regular[89] places in each camp. Each steel bin (or plastic bin in case of absence of space) will be installed within a well-identified protection shed, proportional to the number of residents and at a maximum walking distance of approximately 100 metres.

Large and medium-size[90] compactors (seven tons and three tons) of different widths (access to the narrow streets) will collect the solid waste from the steel bins to be directly transported to the SW treatment plant. By multiplication of the SW bins (mainly steel) and small-sized compactor, larger volumes of SW will be immediately evacuated from the camps, without transiting to the SW platforms (only for the SW collected from the large roads). It will on one side increase the SW value from the professionals (recycling waste) but also reduce the public health risks with high SW volumes at the platforms, especially after week-ends and during market days. For the remaining SW, the platforms will continue to be used as per the current system. This system (currently applied at national level) will limit the negative effects of the platforms and will increase the value of the SW for the private sector (plastic, metal, glass). It will also limit the risk of SW accumulation. The procurement of SW vehicles (including smaller compactor capacities) will complete the existing SW fleet. The existing SW platforms will be rehabilitated to facilitate the SW collection.

Figure 110. Small-size waste bins according to the category of waste (handling at source).

Non-MSW (e-waste, medical, toxic, etc.) will be sent directly to the specific SW treatment facilities outside the camps, not to be mixed with MSW.

[89] Calculated on the field and with the new ESRI GIS mapping of UNRWA FICIP for a maximum of 100 meters walk distances from HH, adapted to the roads' width and use (parking, market, etc.)
[90] Identification of smaller compacter (between 2 to 3 tons capacity) to access narrow streets in the PRC

Social Mobilization and Awareness Campaigns

UNRWA will Introduce and integrate the concept of Environmental Health Sustainability including Solid Waste Management to UNRWA schools' curriculum and to be scaled up to the Community and household levels through awareness campaigns.

UNRWA will roll out a massive and continuous communication campaign via traditional and social media, developing advertisement materials (on walls, on the bins) to sensitize the residents and the private companies inside the camps. Messages will include those for proper SW disposal by using the new steel bins in the correct way and, most important, prevent inclusion of construction and demolition waste impacting the SWM (destruction of the compactor).

Because regular application of chemical products to control vectors may cause undesired health effects and have an impact on the environment and the biodiversity, the FICIP will engage in alternative and prevention options, including environmental-friendly products but also awareness campaigns for the residents about their duties to control the proliferation of vectors in such urban context.

Based on a new collaboration with UNICEF and ANERA, two pilot projects on source-sorting at the household level have been developed in Nahr El Bared and Rashidieh in the coming months to evaluate the response of the population to SW sorting (organic, others, toxics/medical) from homes and to evaluate the advantages and disadvantages of such system. The project development will be conducted by a community steering committee. In 2018 ANERA will start developing the same project in Burj Shemali.

In Tyre area, where the SWM is the most critical, both at financial and environmental level, an operational plan has been developed based on the inventory in the three Palestine refugee camps of Burj Shemali, El Buss and Rashidieh and the existing solid waste disposal and treatment set-up in the Tyre area, Ain Baal. The purpose of the SWM operational plans are to improve the quality of the SWM services being delivered by organizing SWM services and improving efficiency and allocation of laborers. It integrates the various components of ISWM by introducing the concept of source segregation and sidewalk collection. Amending the division of sanitation zones in each camp; introducing adequate distribution of laborers; redefining the tasks and roles of the SW laborers; acquiring new equipment and vehicles; guaranteeing that treatment and disposal options are aligned with the local and regional practices; creating centralized systems to ensure proper handling treatment and/or disposal solutions for hazardous and butchery waste; ensuring stakeholder involvement; launching and organizing trainings needed for capacity building; developing clear and comprehensive health and safety guidelines; and creating effective quality management system to ensure regular monitoring, analysis and reporting are specific activities currently being introduced in the Palestine refugee camps in Tyre area. Scaling up to the other nine camps will be developed during 2018 – 2019 period as per the project priority list prepared in this RP.

Scaling Up

The first operational response is starting in the three camps in the Tyre area (Burj Shemali, El Buss and Rashidieh) with three simultaneous actions. The first two actions aim to improve the technical response of UNRWA (reduction, re-use and recycling of SW, improvement of collection methods and equipment) and to better include the population's contribution through social participation and innovative approaches.

The third action is focused outside of the camps and is aligned to the municipal and national efforts on better SW disposal, treatment and recycling, from technical, environmental and financial perspectives. UNRWA will continuously collaborate and coordinate with the surrounding Municipalities for the final disposal of the Solid Waste, and to be closely aligned with the National Strategy

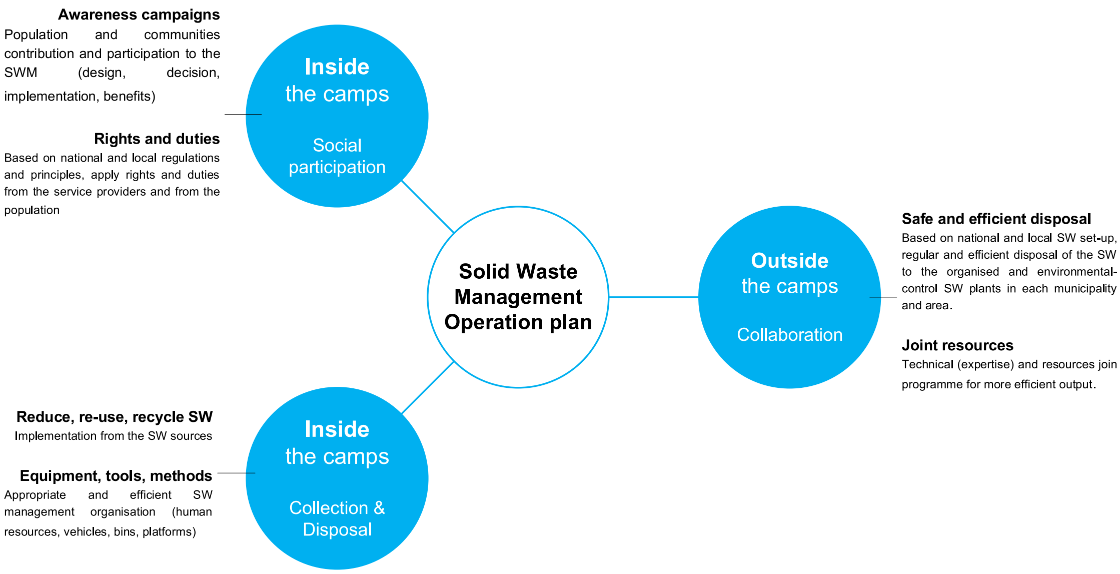


Figure 111. SW strategy for FICIP at camp and area level.

Vector Control

Pests[91], cause health hazards to humans and animals, through stinging, biting, ingesting food or fabric, destroying wooden structure are numerous and can carry serious diseases such as encephalitis, dengue

fever, malaria, yellow fever, as well infections, allergic reactions, food poisoning, pain and aching and respiratory diseases. Consequently, some of the world's most destructive diseases are vector-borne, transmitted to humans by ticks, mosquitoes, fleas. Vector-borne diseases are among the most difficult of infectious diseases to prevent and control.

The main vectors found in the Palestine refugee camps are rodents, including rats and mice, and insects such as mosquitoes, cockroaches, and flies. Most interventions are curative through chemical products applied in different sites according to the targeted vector and the infrastructure. Application is either performed by UNRWA staff (spraying of manholes, public areas, school playgrounds) or directly distributed to residents' shelters for immediate use after operation and safety training provided by UNRWA. The frequency of use also varies upon the vector targeted: monthly for the rodents and weekly for the insects, due to their reproduction cycle and resistance to the chemicals.

The sanitation approach to control these vectors targets their environment which facilitates their breeding. This may include eliminating the breeding places of insects, prevention of stagnant water and provision of proper solid waste management, in addition to the use of chemicals to control their breeding. Also, personal hygiene contributes to the control of the infections.

[91] Pests, presenting potential health hazards to humans and animals, as well as destructive to buildings and buildings structures, include ants, bees, fleas, bedbugs, flies, lice, mosquitoes, spiders, ticks, centipedes, cockroaches, moths, silverfish, termites, wood-boring beetles, lizards, mice, moles, rabbits, raccoons, rats, snakes, skunks, squifferls, voles

Vector type	Chemical product	Application sites	Frequency	Costs	Quantities
Rodents Rats and mice	Bromadiolon equivalent of 0.05 % Bait- waxblock	Manholes mainly streets and public areas (school playing grounds)	Monthly	5.6 USD/Kg	245 Kg/ month
	Bromadiolon equivalent of 0.05% Bait- Pellet	Distributed to residents' houses, used in medical centers and schools	Monthly	2 USD/Kg	575 Kg/ month
Insects Mosquitoes and Cockroaches	Delta Methrine (commercial name: K-othrine SC 25)	Liquid Delta Methrine is diluted with water to be sprayed at in-fected areas	Weekly	4.8 USD/ Gallon	513 Gallon/ month
Flies	Delta Methrine + green oil	Used in fogging machine sprayed in streets of the camps	Weekly	Green oil 2 USD/Gallon	As per need

Figure 112. Chemical products needs per year.

In total, a yearly operational budget of USD$ 100,000 is dedicated to the purchase and application of chemical products for vector control on rodents and insects, including the equipment to proceed with the vector controls campaigns (sprayers).

Energy sector

Lebanon currently consumes over 106,700 oil barrels (42 gallons or 159 litres of crude oil) per day (CIA World Fact book 2011), which is equal to approximately 17 million litres of oil every day. The cost of electricity powered by fossil fuel is low compared to that which is provided by generators (also powered by fossil fuel). However, both are necessary in Lebanon due to a shortage of grid energy nationwide (up to nine-hour electricity cuts outside the Beirut area). These elements – a society based on oil consumption without national production and double standard electricity – require a constant and safe source of energy as well as sufficient surface space for the proper and efficient installation of renewable energy equipment. As a response to the shortage of electricity production from the national grid (Electricité du Liban - EDL), a multiplication of private generators has been observed which have an impact on air quality. According to the Office of the Minister of State for Administrative Reform (OMSAR), the air pollution produced by these private generators must be prevented. Similarly, the absence of national strategies for solid waste management can also encourage an increase in small sized incinerators and these too have the potential to negatively impact the quality of air.

Lebanon has a high potential to move away from oil as a main energy source and rely more on renewable energy from resources such as the sun, wind and water. Significant efforts are needed to improve greenhouse gas emissions and the affordability of energy. Currently only 4.5 per cent of electricity comes from hydropower and up to 95.5 per cent from oil. In 2012, EDL only met 63 per cent of the country's electricity demand. By shifting from diesel oil as a main fuel for energy to more sustainable forms, Lebanese citizens, and as a consequence Palestine refugees in Lebanon, could access more affordable energy while also improving the environment.

For countries such as Lebanon, without substantial fossil fuel reserves and that are dependent on oil importation for the majority of its electricity production, the transformation to renewable energy is critical. Any transition must include investment in the development and promotion of renewable energies (solar, wind turbine, hydraulic, geothermal, tidal energy, biomass); adequate storage of intermittent energies; and energetic efficiency all of which are included in the so-called "green economy" with necessary participation from the academic and private sectors. Massive awareness and educational campaigns for civilians residing in the territory of Lebanon are also vital throughout the process.

According to the Ministry of Energy and Water, the energy sector has been facing significant problems since the start of the war in neighbouring Syria in 2011. One such concern is the drastic decrease in the ability to purchase fuel from Syria to feed the power plants in Lebanon resulting in higher operational costs.

The gap between the energy supply needs and available resources are particularly high in Lebanon. The annual budget allocated for electricity supply equipment was USD$ 5 million in 2016, much lower than the original request. Since the beginning of the crisis in Syria, the average request for electricity in the municipalities has increased by 70 per cent, while the MoEW budget has remained unchanged. A need for an exhaustive inventory of the electricity supply at national level was one of the main recommendations from the MoEW and EDL.

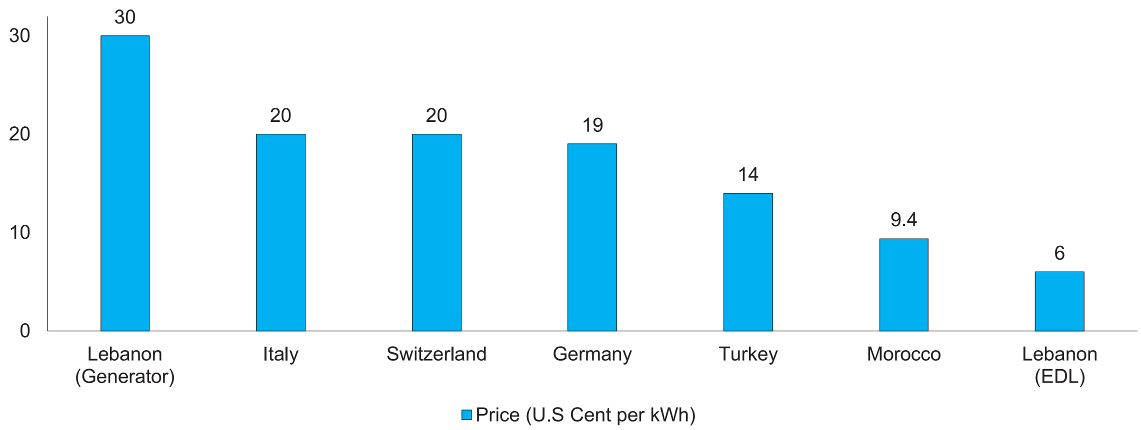


Figure 113. Price of power in Lebanon.

Extremities in the cost of electricity exist in Lebanon, between the national grid power[92] (EDL), which ranks among the cheapest per kilowatt (kWh) in the world and the local generators which are among the most expensive. This does not allow for a stable and sustainable electricity market. From an environmental cost-perspective a recent study by the American University of Beirut (AUB) found that the concentration of potent atmospheric pollutants spiked in urban areas of Lebanon at peak times for diesel generator use.

Palestine Refugee Camps in Lebanon

The entire energy needs in the Palestine refugee camps for the water supply and sanitation services, as well as for domestic electricity, depends on fossil fuel (through EDL or backup generators). The equivalent running costs for UNRWA and the impact on the environment are substantial and difficult to mitigate without innovative technologies (renewable energies), rejuvenation of the country's electricity park and gradual replacement of less energy consuming electrical equipment. Gas oil is also used for all UNRWA service vehicles which has an impact on air quality, soil and water. To tackle the very complex energy sector, the FICIP conducted an inventory of the service generators, and conducted several workshops on renewable energies, including a survey on renewable energies and green solutions for

[92] Average cost for national grid power equals US$ 0.06 per Kwh; cost for generator power US$ 0.30 (five times higher in cost)

the water supply of the 12 Palestine refugee camps in Lebanon. Power cuts are a common occurrence in the 12 Palestine refugee camps, as in the rest of Lebanon. These power cuts range from 3-12 hours per day which increases the need to rely on local diesel fuel generators. These generators are known to be inefficient in comparison to large scale generation, are relatively expensive, and are a main contributor to air pollution as well as noise pollution.

Electrical Transformer in Wavel. ©2017 UNRWA

As part of the Environmental Health Strategy 2016-2021, which covers multiple sectors including the energy sector, an inventory of all UNRWA generators was performed as well as a sampling of private generators. The findings (both qualitative and quantitative) are summarized in this document. The figure below summarizes the main factors contributing to the energy crisis in Lebanon and the Palestine refugee camps.

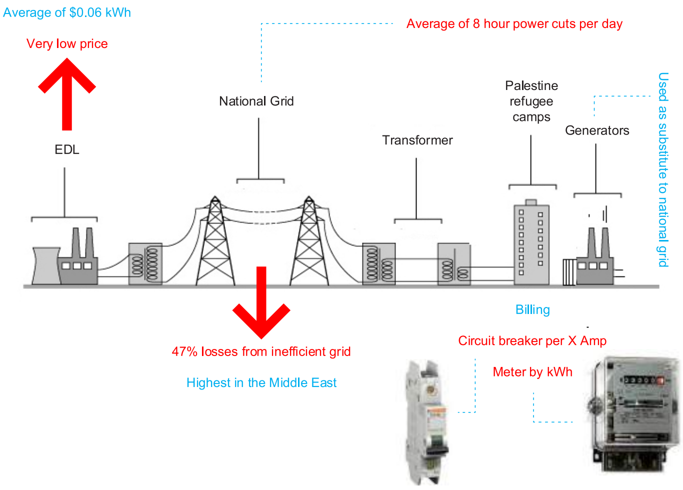


Figure 114. Electricity set-up and main problems in Lebanon and in the Palestine refugee camps.

Losses are high in the grid while the selling price of national EDL electricity is relatively cheap. This type of mismanagement contributes to daily power cuts, raising the need for local generators which tend to operate for most of the day. However, this accumulates a high economic and environmental cost.

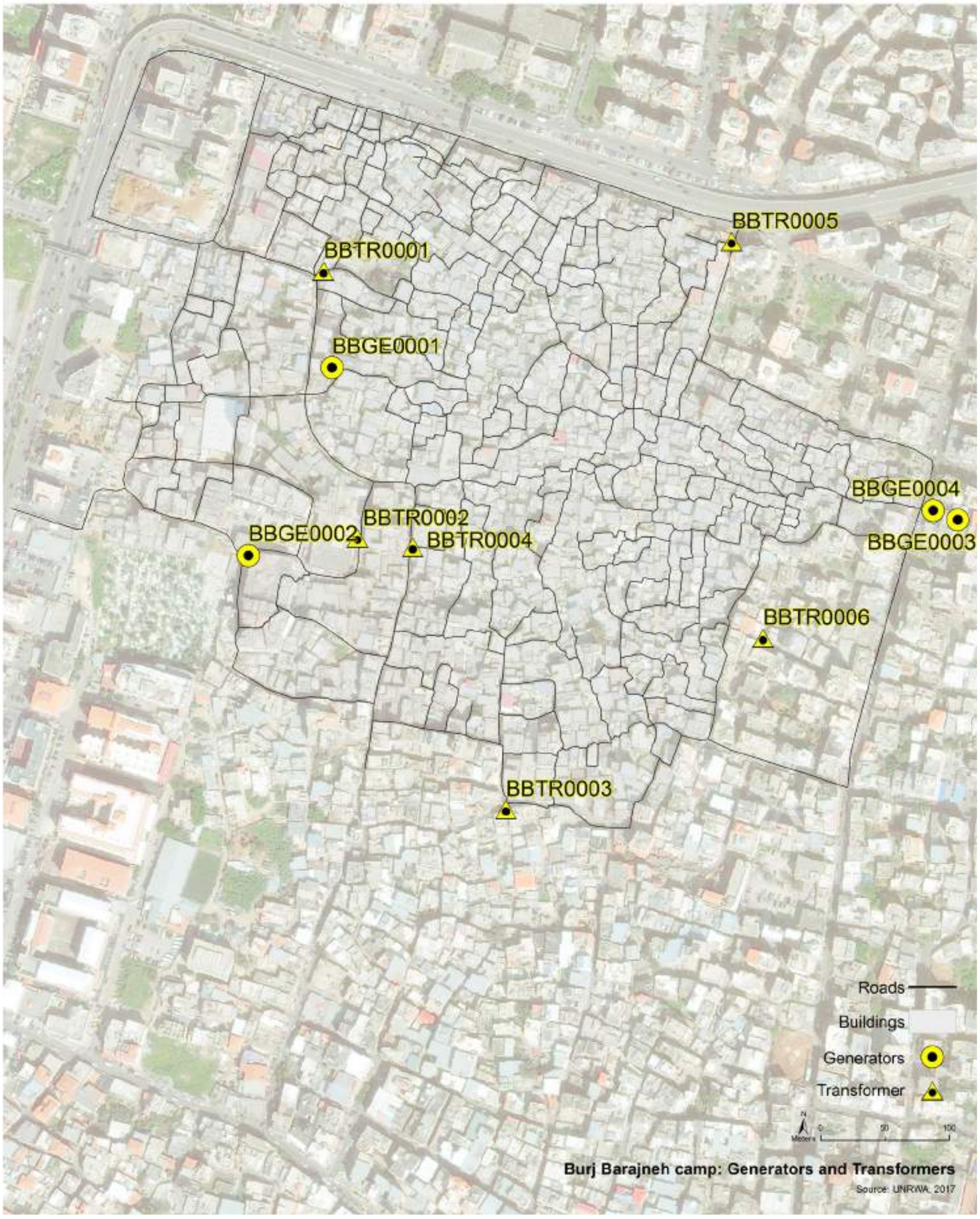


Figure 115. Example of inventory for the service generators and transformers for each camp.

Generators

Findings

Between November 2016 and February 2017, a total of 114 service generators across the 12 Palestine refugee camps were visited and inventoried. Eighty-five per cent of the surveyed generators are under UNRWA custody[93]. The total power capacity of all 97 UNRWA premises generators is equivalent to 10,000 kW of which about 5,300 kW (55 per cent of total) is generated only to serve the activities in one camp - Nahr el-Bared. The total energy generated from all generators in the camp is 79,948 kWh per day.

[93] Private and other custodies' generators are particularly difficult to access

From a distribution point (non-exhaustive inventory where it was not possible to identify all generators), more than 60 per cent of the services generators supply the schools and water plants located inside the camps. More than 20 brands have been identified.

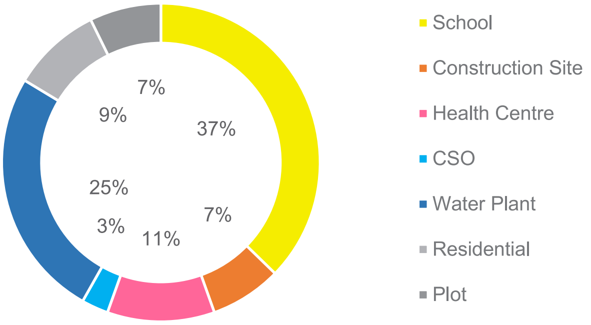


Figure 116. Distribution of the service generators (among total generators included in the inventory).

Considering the size of an average generator is 250 kW at a consumption rate of 47 l/h, the daily diesel consumption of all UNRWA generators is approximately 22,000 litres per day, depending on the grid supply. For each generator, the FICIP geodata base contains the following fields:

- Feature ID (ME**GE**0003 = Mar Elias **Ge**nerator n°3)
- Status (on – off)
- Custody (UNRWA, Popular committee, NGO, private)
- Location (X,Y)
- Power (KVA)
- Date of visit
- Brand
- Power (KVA)
- Brand
- Serving (school, water resource, health centre)
- Price (USD/kWh or USD/5 Amp)
- Operating hours per day
- Description of the place (physical position)
- Picture

Recommendations

The inventory of the generators remains particularly difficult for those not under UNRWA custody. The access to private homes or buildings is limited. The first objective is to complete the replacement of all services generators under UNRWA custody that are obsolete or that do not match the minimum standards. The list of those generators, mostly those for the water supply, has been completed by the FICIP. The inventory for the other services and private generators must be extended through and by the communities and different organizations to evaluate the needs for the coming years in order to reduce the impact on the air quality and to reduce excessive fuel consumption due to poor operation and maintenance or over-use.

Regarding the service generators (UNRWA, Popular Committees, Organizations' custodies):

- Equip all generators with adequate air pollution protection (noise reducer, ventilation pipe);
- Research cost reduction through renewable energy systems with generators;
- Promote PV solar power combined to grid electricity to replace generators (hybrid renewable energy systems);
- Investing in one large generator per camp instead of many small ones should be considered as an effective solution to fuel reduction.

Regarding individual generators (private), the main recommendations are:

- Equip all generators with adequate air pollution protection (noise reducer, ventilation pipe);
- Develop solar water heating installation to reduce individual electricity needs;
- Promote low-electricity demand equipment.

Transformers

Findings

Connected to EDL electricity network, the transformers of the 12 Palestine refugee camps (partly inside and outside the official boundaries) are, as the rest of the national transformers, not in compliance with the minimum environmental and safety guidelines applied in Lebanon. Due to billing constraints (private and service connections) and poor operation and maintenance electricity network, the transformers allowing energy transfer from the grid require a proper survey status, both at technical and environmental levels.

Benefiting from a unique opportunity to address a first (and not exhaustive) inventory, the FICIP and MoE agreed to work together to obtain an update "*qualitative*" and "*quantitative*" status of this crucial electricity component, often problematic due to financial or managerial constraints.

Background

Since its ratification for the Stockholm Convention in 2002, Lebanon made significant efforts to assess the usage of the Persistent Organic Pollutants (POPs) in the country. Under the context of its commitment to the Stockholm Convention and its broader commitment to sound chemicals management, Lebanon initiated the implementation of the Global Environmental Facility (GEF) Full Size Project in 2015, entitled "*Polychlorinated Biphenyls (PCBs) Management in the Power Sector*" with the Ministry of Environment acting as National Executing Agency and the World Bank acting as the GEF Implementing Agency.

Objectives

Given the risk associated with high content PCBs equipment and the priorities set by the Stockholm Convention to eliminate PCBs from Lebanon by 2025, a technical collaboration between the MoE and UNRWA was developed in order to dispose of high risk PCBs and improve the inventory management of transformers in the power sector in an environmentally sound manner. The project is aligned with the GoL's progress and development programme, which seeks to improve the quality of Lebanese life through better safeguarding the environment and recognizes the need to pay special attention to the challenges posed by environmental degradation.

Contained in a collaboration note between the MoE and UNRWA, a cooperation background and objective was developed including capacity building programme and field inventory and sampling. Meanwhile the responsibility of the FICIP was to conduct the initial transformer inventory, the responsibility from the MoE and partners (EDL, Private and World Bank) was to include the UNRWA inventory within the national one, equivalent to approximately 25,000 transformers.

By December 2017 and according to the management of the power sector project of the MoE, the national inventory was 80 per cent complete. The FICIP inventoried 110 transformers[94] (not exhaustive), georeferenced with attributes information recommended by the MoE.

- Feature ID (BS**TR**0011 = Burj Shemali **Tr**ansformer n°11)
- Location (X,Y)
- Date of visit
- High pole, grounding status
- Manufacturer
- Plate ID, serial number
- Year of production
- Power (KVA)
- Cooling system
- Picture

Recommendations

Still ongoing at national level and to be completed in the Palestine refugee camps in Lebanon, the qualitative results of the PCBs' survey is about to be completed by MoE and its partners. The objective will be to replace of the "*PCB's non-conform*" transformers by environmental-friendly new equipment. The list of such transformers located or supplying the camps shall be available during the first semester 2018.

[94] 25 transformers in Ein El Hilweh and Mieh Mieh surrounding area, 60 to 70 transformers in Shatila camp's area and 25 transformers in Nahr El Bared's area (source: MoE, December 2017)

Renewable Energies

Potential renewable energy projects in Lebanon were presented by the Lebanese Centre for Energy Conservation (LCEC) in August 2016. These were based on the Declaration by the Lebanese Government (2009) that "*The adoption of a national road map built on modern environmental concepts (green energy) and counting on renewable energy sources to reach 12% of Lebanon's needs by the year 2020*" as well on the Policy Paper for the Electricity Sector (2010) which "*Commits to launching, supporting and reinforcing all initiatives to adopt the utilization of renewable energies to reach 12% of electric and thermal supply*". By reaching these goals, the quantity of energy produced through renewable energy sources (solar PV for water supply, collective solar water heating systems for public hospitals and social centres, solar PV public street lighting systems and rehabilitation of small hydro power plants for water use) would relieve Lebanon the burden of importing 767,000 tons of oil.

The challenges facing the Palestine refugee camps, and to a large extent UNRWA and the Government of Lebanon, in terms of energy security, are growing, making the greening of the energy sector imperative. Shifting to renewable energy, for environmental infrastructure and environmental health services is proving difficult. The main constraints include the high investment costs associated with shifting from fossil fuel to renewable energy, absence of a population that is willing to shift to a cost-recovery system, and limited surface space for the safe and efficient installation of renewable energy equipment.

According to the International Energy Agency (IEA), "*Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth. Included in the definition is energy generated from solar, wind, biomass, geothermal, hydropower and ocean resources, and biofuels and hydrogen derived from renewable resources*".

From this definition and the evaluation of the electrical needs inside the camps, Lebanon's current renewable energies opportunities, including solar energy for electricity, heat production and biomass (wastewater, solid waste, compost) appear to be the most realistic options.

Photovoltaic Solar Energy for Water Supply Study

In Lebanon, there are many problems associated with electrical energy used to pump water from wells. The utility grid operating submersible pumps is unreliable. When available, it frequently disconnects, with unstable voltage. This results in shortening the lifespan of submersible pumps with high replacement costs.

Diesel generators are the most common source of electricity used to operate submersible water pumps for drinking and domestic water use in the 12 Palestine refugee camps. Diesel generators consume diesel fuel and operate at low conversion efficiencies (approximately 35 per cent) in transforming fuel to electricity. Such generators also pollute the environment producing exhaust combustion products including carcinogenic particulates, greenhouse gases, noise, and waste heat. Savings and improvements in operating diesel generators may still be achieved as follows:

- Use of soft starters or drives to start the pump;
- Reduce the size of the generator;

- Maintain or upgrade diesel generator to improve efficiency;
- Recover heat from generators;
- Replace old pumps with more efficient ones;
- Replace undersized electrical cable with pumps;
- Improve water distribution networks.

In addition to the above improvements in operating diesel generators, savings and benefits achieved when switching to solar photovoltaic energy to power submersible pumps can offer more important environmental and financial benefits. Lebanon experiences more than 300 days of sunshine per year and attractive solar irradiance averages, which makes the case for assessing the feasibility of solar photovoltaic power for submersible pumps. A study was conducted by ELARD to quantify and summarize the energy and corresponding costs needed to pump water from existing wells in the camps. It considers the prospect of utilising solar energy offered by new technology and different solar system architectures.

Solar power in Lebanon

Summers in Lebanon are long and summer skies are mostly clear. For this reason, there is a strong case for operating pumps on solar systems. Groundwater in Lebanon is generally considered to be deep and submersible pumps are required for extracting water from tube wells. Mechanical friction is inherent in the operation of most submersible pumps and tends to be more evident while running at very low speeds when lubrication does not efficiently occur. This may drastically shorten the pump's service life. In contrast, the solar pump inverter is configured to turn off the pump at low speed and keep it on standby until enough power is available to run the pump at or greater than a configured minimum start-up frequency.

The larger the pump the more critical the programmed protections in the drive are. This is particularly important when the water supply is critical and no other sources of water are available in case of malfunction. Replacement costs of such pumps are high and repairs are lengthy considering the lead time to acquire the replacement pump, extract the dysfunctional one from the well, and install the new pump.

As a result of the increasing water shortages in Lebanon, existing pumps in wells are operated for longer periods, often exceeding 12 hours and even reaching 24 hours per day in some cases. Solar PV systems, which provide power during the daytime, may not offer an autonomous solution where long operating hours are required, but may still provide substantial cost savings during the day.

Feasibility Study on Energy for Water Supply

All equipped water points at the time of the survey (61 pumps based on the FICIP database) were evaluated. The average depth of the pumps was found to be 86 metres with an average pump power of 35 Horse Power[95] (HP) equivalent to 26 kW.

[95] While pump power is often listed in hp (horse power), this number is readily convertible to kW (the standard SI unit) according to the following conversion rate: 1 hp = 0.7457 kW.

Energy consumed by each pump in kWh can be calculated based on average operational hours and pump power. Fuel consumption of the generator[96] can be estimated based on a fuel to energy consumption rate. For example, a new and well-maintained generator running at optimal efficiency (70-80 per cent of full rated load) can produce four kWh of electric energy with every litre of fuel at a hence, a fuel consumption rate of 0.25 L/kWh.

An energy and fuel consumption comparative analysis for 58 wells equipped with submersible pumps (with a diesel price of 0.5 $/L) found that the average depth of the pump's installation is 87 metres. The average pump's power is equivalent to 26 kW. Ranging from 4 - 20 hours, the average daily operation time corresponds to 11 hours. The average energy consumption (and equivalent diesel consumption by calculation) corresponds to 100,000 kWh/year (with highest values found in Wavel and Beddawi) and 27,000 litres/year. The equivalent total diesel consumption equals 1,607,562 litres for the yearly production of approximately two million cubic metres of water.

Sites	Pump depth	Daily pump operation	Pump power	Energy consumption	Diesel consumption
	(m)	(h)	(kW)	(kWh/year)	(litres/year)
Average	87	11	26	98,988	27,717
Total				5,741,307	1,607,562
Wavel	237	18	56	367,263	102,834
Shatila (reverse osmosis)	48	20	15	108,770	30,456
Beddawi	191	18	56	367,263	102,834

Figure 117. Average depths, pump operation, power, energy and diesel consumption for 58 equipped wells and total energy and diesel estimated consumption per year.

Pollution and Greenhouse Gases

Burning diesel in generators causes pollution based on the fact that every kWh produced through diesel generators releases greenhouse gases and particulates including carcinogenic ones. Emission factors[97] are presented below and refer to the 2006 Inter-governmental Panel on Climate Change (IPCC) guidelines[98].

Item	Factor	Unit
NOx Emission	1.40	g NOx equ/ KWh
SOx emissions	2.10	g SO_2 equ/ KWh
PM Emissions	0.20	g PM equ/ KWh

[96] Traditionally, in Lebanon, generators purchased and dedicated to powering a water pump are always oversized to withstand the higher load needed at pump start up. In agricultural areas around Lebanon, it is common for generators to operate with fuel consumption rates between 0.3 L/kWh and 0.33 L/kWh. However, for the purpose of this study, a fuel consumption rate of 0.28 L/kWh has been adopted; it is considered conservative. The energy consumed by a pump in a year can be calculated using the following formula: *Pump Energy (kWh/year) = Pump Power (kW) x Operating Hrs / day x Operating Days/Year*.

[97] It is important to note that these factors are for regularly maintained generators operating at nominal efficiency, and are therefore considered conservative compared to improperly sized generators expected to be operational in the camps that are running on lower than international quality diesel.

[98] IPCC, National Greenhouse Gas Inventories, Volume 2, Energy

CO_2 Emission Factor	725.50	g CO_2 equ/ KWh
CH_4 Emission Factor	0.29	g CH_4 equ/ KWh
N_2O Emission Factor	0.02	g N_2O equ/ KWh

Figure 118. Key pollutant emission factors from diesel generators.

Emissions resulting from generators powering submersible pumps in the camps for an equivalent of six million kWh/y total consumption have been estimated for the above key pollutant gases. The figure below highlights the equivalent values (in kg per year) for Particulate Matter (PM), methane (CH_4) and carbon dioxide (CO_2).

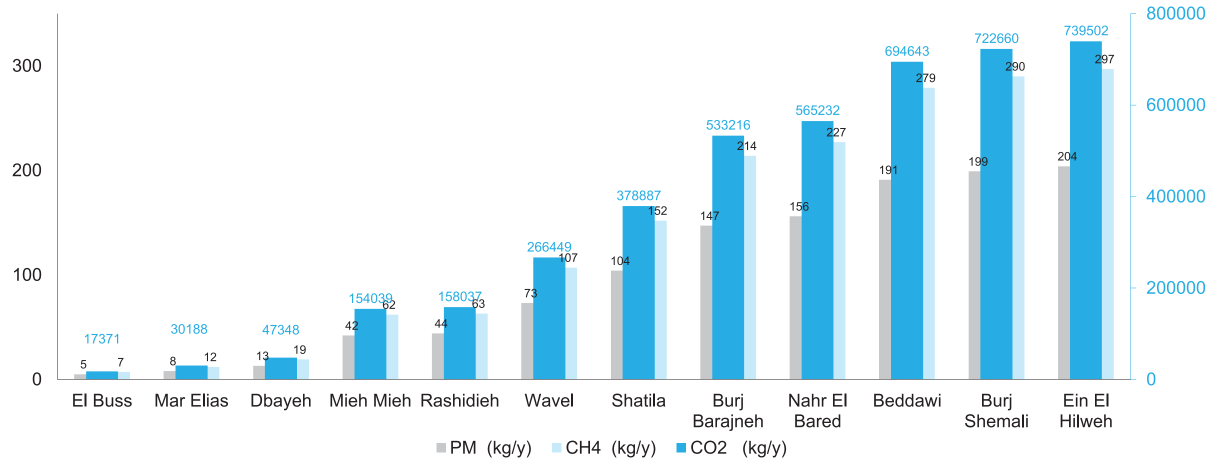


Figure 119. PM, methane and carbon dioxide equivalent emissions in kg/year for each camp's water production.

Operational savings with solar energy

When the pump is operating less than ten hours per day, it is possible to use standalone solar system configurations and replace the diesel generator entirely thus eliminating all operational costs and emissions. The investment cost remains high relative to the cost of a new diesel generator, but feasibility and payback periods are attractive. When the pump operates for longer than ten hours during daytime with grid power outages, it is possible to combine solar and existing diesel generators to save on fuel consumed during the day. Savings will vary depending on many factors, including daily pump operational hours, size and efficiency of solar system, size and efficiency of the generator, seasonal distribution of water demand and availability and access to space for solar system photovoltaic panels installation.

General findings and recommendations

The choice of solar system, between standalone, hybrid with diesel, and grid-tie has little impact on the total cost. The grid-tie system is however inadequate for areas with long hours of grid power outage as is currently the case in Lebanon. The selection between standalone and hybrid power is dependent on the choice of pump size conditional on the sustainable well yield. Important yields and pumping rates can be powered by standalone systems with EDL grid power backup because of short operational hours. Therefore, power can be secured by either a standalone solar system large enough to satisfy a high pumping capacity or by EDL grid power. While a generator may not be necessary for short pumping hours, it may still be required due to additional network storage because two hours of pumping can yield over 250 m^3, which is larger than existing network storage (210 m^3). This could lead to frequent pump shut down and decreased reliance on the solar system whereby energy savings may become compromised even during summer.

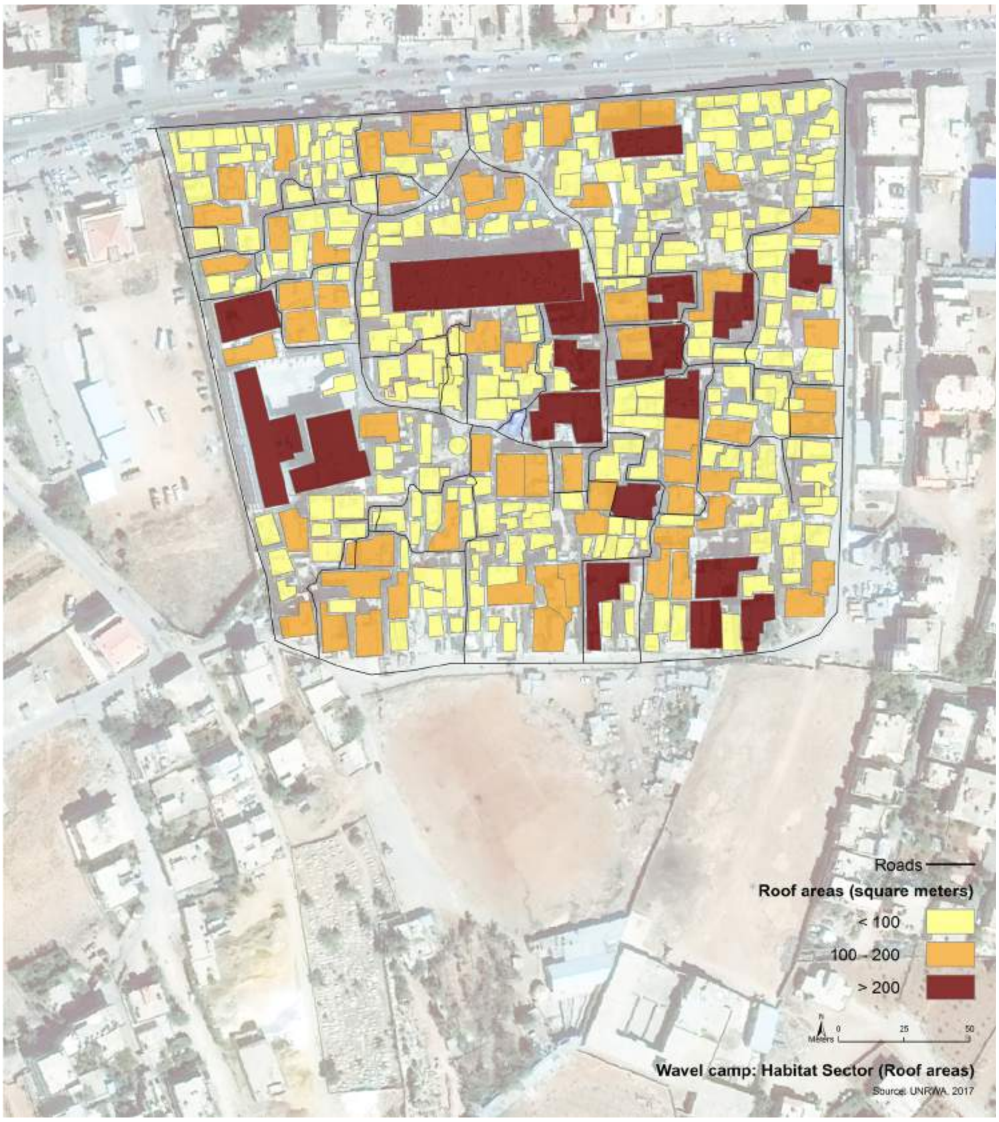


Figure 120. Simulation of roof's surface analysis in Wavel to evaluate the largest surfaces for PV module installation with FICIP geodata base.

In conclusion and for most of the water systems currently powered with generators and EDL, the migration to PV solar remains challenging due to the lack of space for installation in an efficient and safe manner and to the overall large yields pumped with high depths. The preselection of pumps with capacity lower than 40 HP and with maximum depths of 100 metres would be a good first option, to be combined with surface analysis of the roofs and open space potentially used for the module installations. The operation and maintenance of the systems is low in a standard situation, but damages to the module (including debris such as stones, bullets) would represent a risk of high cost.

Air Sector

Urban air pollution, in addition to the widespread health impacts, costs between two and five per cent of gross domestic product in developed and developing countries. As a consequence of rapid urbanization, more than 90 per cent of the air pollution in cities is attributed to vehicle emissions (old vehicles coupled with poor maintenance; inadequate urban planning; and substandard fuel quality). In 2012, WHO estimated that more than seven million people died as a result of air pollution exposure. More significant are the recent studies and data that underline how increases in air pollution have a direct impact on public health. This confirms that air pollution is now the world's single largest environmental health risk[99]. There is a clear relation and interdependence between indoor and outdoor air pollution exposure and cardiovascular diseases, such as stroke and other heart diseases, as well as cancer and respiratory diseases (acute respiratory infections, chronic obstructive pulmonary diseases).

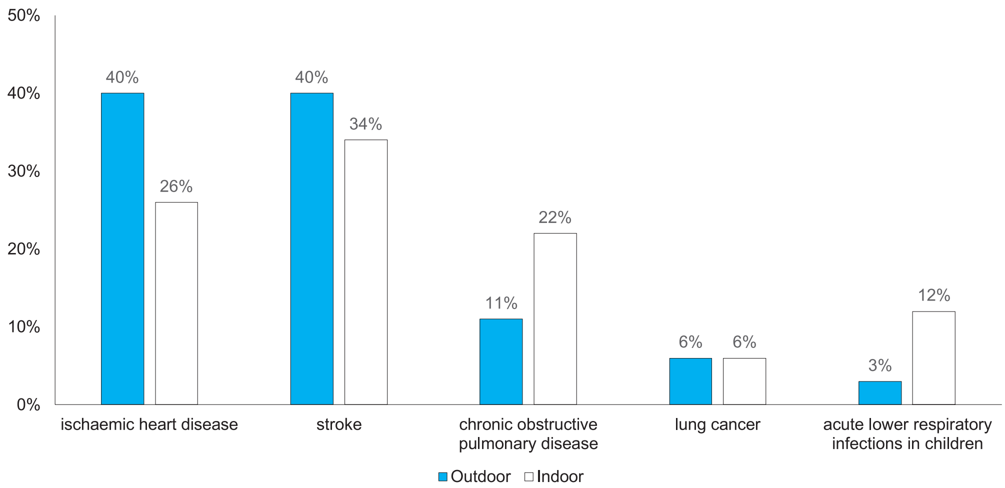


Figure 121. Causes of death related to outdoor and indoor air pollution.

Health Impacts of Air Pollution

In 2014, 92 per cent of the world population lived in places where air quality levels were below WHO guidelines (WHO, 2017). There is widespread evidence on the adverse health effects associated with exposure to ambient air pollution (WHO, 2006). In fact, exposure to air pollution is now the fourth leading fatal health risk worldwide after metabolic risks, dietary risks, and tobacco smoke (World Bank, 2016). More than six times as many people die from air pollution each year as from malaria and more than four times as many die from air pollution as from HIV/AIDS. A World Bank study determined that 1,816 deaths were caused by outdoor air pollution in Lebanon in 2013.

There is a heightened focus on Fine Particles ($PM_{2.5}$), an air pollutant, since it was discovered that outdoor air pollution is carcinogenic to humans, with the $PM_{2.5}$ component closely associated with increased incidences of cancer, especially lung cancer[100]. Moreover, studies conducted by WHO showed that long-term exposure to $PM_{2.5}$ can be a cause of both cardiovascular mortality and morbidity. Negative health side effects were found to occur at fairly low levels of $PM_{2.5}$, the reason for which WHO reconsidered its current guidelines.

99 7 million premature deaths annually linked to air pollution, WHO Geneva, 2014.
100 According to the International Agency for Research on Cancer (IARC) in 2013

Based on accumulated evidence from epidemiological time series studies[101], WHO lowered the global threshold for O_3 and long term NO_2 because adverse health impacts were presented among some individuals with low rates of exposure. The next figure summarizes the major effects of air pollution on health.

Pollutant	Health effect
Particulate matter (PM)	Can cause or aggravate cardiovascular and lung diseases, heart attacks and arrhythmias. Can cause cancer. May lead to atherosclerosis, adverse birth outcomes and childhood respiratory disease. The outcome can be premature death.
Ozone (O_3)	Can decrease lung function. Can aggravate asthma and other lung diseases. Can lead to premature mortality.
Nitrogen dioxide (NO_2)	Exposure to NO_2 is associated with increased all-cause, cardiovascular and respiratory mortality and respiratory morbidity.
Sulphur dioxide (SO_2)	Aggravates asthma and can reduce lung function and inflame the respiratory tract. Can cause headaches, general discomfort and anxiety.
Carbon monoxide (CO)	May lead to heart disease and damage to the nervous system; can also cause headache and fatigue.
Benzene (C_6H_6)	Is a human carcinogen.

Figure 122. Health impact of main air quality pollutants.

Exposure to poor indoor air quality can cause short-term eye, nose and throat irritation as well as headaches, dizziness and fatigue. It can also exacerbate the effects of asthma, particularly in children. Over time, this exposure can lead to respiratory disease, cardiovascular disease or even cancer. In addition, people who may be exposed to indoor air pollutants for the longest periods of time are often those most susceptible to the effects of indoor air pollution. Such groups include the young, elderly and chronically ill persons, especially those suffering from respiratory or cardiovascular disease.

SDGs and Air Pollution

Air pollution was not well integrated in the SDGs, only being included in two targets and two indicators (in relation to other sectors).

SDG	Targets	Indicators
SDG 3 Ensure healthy lives and promote well-being for all at all ages	**Target 3.9.** by 2030 substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination	**Indicator 3.9.1.** Mortality rate attributed to household and ambient air pollution

[101] Giovannucci E. /2001) An Updated Review of the Epidemiological Evidence that Cigarette Smoking Increases Risk of Colorectal Cancer. Hackshaw A., Law M R., Wald N J. (1997). The accumulated evidence on lung cancer and environmental tobacco smoke.

SDG 11	Target 11.6.	Indicator 11.6.2.
Make cities and human settlements inclusive, safe, resilient and sustainable	by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality, municipal and other waste management	Annual mean levels of fine particulate matter (i.e. PM2.5 and PM10) in cities (population weighted)

Figure 123. SDGs goals related to the air pollution

In Lebanon, the MoE is combating the issue of air pollution through the implementation of various actions and projects related to air pollution, climate change and ozone depletion. Many anthropogenic sources of air pollution are being controlled by the MoE through decisions 52/1 in 1996 on the "*Specifications and rates relative to reducing pollution of air, water and soil*", and 8/1 in 2001 on specifications and standards related to air pollutants and wastewater discharges from classified establishments and wastewater treatment plants. The MoE issued a circular No. 10/1 in 2011 related to monitoring the operations of electric generators.

Air Quality Regulation

WHO developed a set of guidelines[102] for ambient air quality that could serve as an international benchmark and offer guidance in the reduction of health impacts from air pollution (WHO, 2006).

WHO also developed indoor air quality guidelines to provide a uniform basis for the protection of public health from adverse effects of indoor exposure to air pollution and to eliminate or reduce to a minimum, exposure to those pollutants that are known or are likely to be hazardous (WHO, 2010). Lebanon adopted indoor occupational air quality standards in 1996 with Decision 52/1, but since removed them in 2001 through Decision 8/1.

Palestine Refugee Camps in Lebanon

Based on the action plan outlined in the EHS (§3.4.2. Air Quality) and to identify short- and long-term recommendations to improve the air quality inside the Palestine refugee camps in Lebanon, the FICIP carried out a field survey on indoor and outdoor air quality in highly populated camps with narrow streets.

The assessment was conducted between June and November 2017 in three camps (Burj Barajneh, Wavel, and Mar Elias) based on qualitative methodology. Few air quality studies have been conducted in Lebanon[103] and the Palestine refugee camps have not been included or subject to other air assessments.

Indoor Air Pollution Sources

Findings

There are several causes of poor indoor air quality including combustion-related activities and sources such as smoking, heating, cooking and non-combustion sources such as household items (carpets,

[102] Based on a review of the accumulated scientific evidence. They help nations worldwide in setting their own guidelines and implementing them according to their socio-economic situation

[103] In 2013, the MoE launched real time air quality monitoring in five sites using online analyzers connected to a supervisory control and data acquisition system located at MOE. The current network includes around 16 urban background stations

fabric, foam, chair cushions, pillows, mattresses), personal care products (cosmetics and perfumes), building materials, and hobbies (woodwork, carving, arts and craft release gases and particles). In addition, dampness and water leaks are also sources for biological pollutants such as bacteria, mould and fungi. Finally, poor ventilation (quantity of fresh air entering the building from outside and how effectively dumped air is exhausted form the house) is also a contributing factor.

In 2011, the MoE coordinated a national air quality modeling exercise with ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) and St. Joseph University (USJ) in Lebanon to determine annual background concentrations of some pollutants (MoE, 2015). This data is averaged over a 25 km² area (cell of 5 km x 5 km), hence covering areas where the camps are located.

Camp	$PM_{2.5}$ ($\mu g.m^{-3}$)	PM_{10} ($\mu g.m^{-3}$)	CO ($\mu g.m^{-3}$)	NO_2 ($\mu g.m^{-3}$)	SO_2 ($\mu g.m^{-3}$)
Burj Barajneh	56	71	1670	88	66
Wavel	12	14	238	10	7
Mar Elias	58	63	1271	84	68

Figure 124. 2011 average values of areas where the three Palestine refugee camps were located.

When compared with the national air quality standards for the one-year averaging period (according to the MoE Decision 52/1 (1996)), all concentrations were within air quality limits. However, the following pollutants exceeded WHO air quality guidelines in Beirut area where the Palestine refugee camps are located, including Sulfur dioxide (SO_2), Nitrogen dioxide (NO_2), Particulate matter (PM_{10}, $PM_{2.5}$) and in Wavel $PM_{2.5}$.

Methodology

The methodology adopted a qualitative approach given the time, security, and logistic constraints. The methodology encompassed:

- Measurements of different indoor and outdoor pollutants (CO, CO_2, volatile organic compounds and particulate matter), were obtained using Sensio AIR devices. One sensor measured outdoor background and the other measured indoor air quality for a period of two weeks in each camp;
- Punctual measurements of the outdoor presence of PM_1, $PM_{2.5}$, and PM_{10} were attained using Dust Track DRX equipment;
- Measurement of meteorological parameters were obtained after the installation of five weather stations in the 12 camps;
- A survey in Burj Barajneh, Mar Elias and Wavel was conducted to assess the perception of air quality among Palestinian residents.
- Indoor and outdoor measurements in three camps were conducted in one school and one health care centre using Sensio AIR sensors throughout a duration of two weeks.

Household Indoor and Outdoor Air Pollution

The survey first aimed to obtain personal information from the Palestine refugees related to their presence in the camp: socio-demographic data, occupation, current and past smoking habits (cigarette or shisha), and number of cigarettes or bowls per week. These variables were important in determining environmental problems inside the camps and bias was minimized by using three camps in the survey. Interviews were conducted between August and November 2017 and the total number of respondents was 207 (110 in Burj Barajneh, 67 in Wavel and 30 in Mar Elias). Mostly men were interviewed.

For the occupational history of the residents of the camps, the interviews revealed that 42 per cent (WA), 27 per cent (ME) and 61 per cent (BB) were exposed to dust in the workplace (carpentry, cleaning, masonry) for a year or more. Concerning smoking habits in the camp, 66 per cent, 50 per cent and 60 per cent were smokers in Wavel, Mar Elias, and Burj Barajneh respectively. There is no significant difference between the three camps regarding this parameter. Most of the respondents are heavy smokers, consuming more than 300 cigarettes per week. Inhabitants indicated smaller percentages for smoking shisha (a cultural practice of tobacco consumption in Lebanon). These were recorded as 16 per cent in Wavel, 13 per cent in Mar Elias and 15.5 per cent in Burj Barajneh. Most shisha smokers consumed more than four bowls per week.

There are significant differences in how inhabitants heat their homes across the three camps. Most respondents in Wavel (95.5 per cent) use diesel while 47 per cent in Mar Elias do not use heating and 23.3 per cent heat by gas. In Burj Barajneh, 40 per cent use gas while 31 per cent use electrical heating.

The second section of the survey focused on the perceptions of environmental concerns. Answers varied considerably when inhabitants were asked what they considered to be the three major sources of air pollution in the camp. In Wavel, private generators, transport, and solid waste are the three main sources whereas in Mar Elias, overpopulation, private generators, and sewers were the most popular opinions. In Burj Barajneh respondents believed construction, overpopulation, solid waste, and transport to be the main contributing factors.

When asked about the air quality status in the camp, there was significant dissimilarities according to the three camps. In Wavel 46 per cent considered air quality to be good whereas in Mar Elias 43 per cent believed it to be poor. The highest percentage, in Burj Barajneh (74 per cent) considered the air quality to be very poor. These answers may be influenced by the geographic location of the camps (Wavel has a rural aspect while Mar Elias and Burj Barajneh have an urban aspects). In each camp, the respondents perceived air pollution in different ways. Forty-eight per cent of respondents perceived air pollution as smoke in Wavel and 45 per cent as odour in Burj Barajneh. The majority of residents in Mar Elias did not provide an answer since they perceived the camp to be free of air pollution while 30 per cent perceived it as odour.

In all three camps, inhabitants perceive higher amounts of air pollution during the day than at night. When asked about the effect of weather conditions on air pollution, 70 per cent of respondents in all three camps believed that more pollution was occurring during the summer than in winter. Across all camps, it is believed that the impact of air pollution on their health is very important. A high percentage in Wavel and Burj Barajneh claimed that the air pollution had affected the health of someone of their circle of family and friends.

In conclusion, the survey revealed that residents in the camps know what air pollution is and understand that it is a major problem and an environmental and health concern which directly impacts their immediate environment. They are aware that the longer they are exposed to air pollution, the greater the risk of suffering from its related diseases such as pulmonary disease, heart problems and allergies.

Results from the survey highlight that more smokers suffer from pulmonary diseases than non-smokers and are four times more likely to have heart problems. There is also a higher chance that someone in the family suffers from allergies related to pollen or dust, or that a family member has died from lunch cancer. These results correspond to multiple studies worldwide that establishes smoking as the main risk factor for developing respiratory diseases and lung cancer (Cornfield *et al.,* 2009).

Transport and Air Pollution

Worldwide, on-road transport is the one of the major sources of pollutants. Various studies show that in the Middle East, the highest contributors to total carbon monoxide (CO) and nitrogen oxides (NOx) emissions (78 and 79 per cent respectively), are countries with a population exceeding 20 million such as Iran, Saudi Arabia, Iraq, Turkey and Egypt[104]. In Lebanon, emissions per capita are higher than those for bigger countries in the region[105], making Lebanon an important case study for environmental impacts of these pollutants. In 2010, 93 per cent of CO, 52 per cent of NOx, and 67 per cent of volatile organic compounds (VOC) of the total national emissions came from on-road transport in Lebanon[106].

The three camps participating in the survey have an archaic building organization with narrow passageways between buildings covering the entire area of the camp. This results in a road network that is primarily only suited for pedestrians since it is not wide enough for a passenger car. On the other hand, the roads that are suited for passenger cars are not designed to allow two cars passing at the same time. Burj Barajneh is one of the busiest and largest camps in Lebanon and 72 per cent of the road network is pedestrianized roads. Also in the Beirut area, Mar Elias is a small camp which makes the use of passenger cars a low priority since it is accessible from almost all directions on foot. This has resulted in having solely pedestrianized roads. On the other hand, Wavel in the Bekaa is a small camp, less populated with more organized buildings and has more roads for vehicles (54 per cent of the total road network). Reportedly, in all three camps, two-wheeled vehicles and passenger cars use any road where they will fit.

Roads in the camps are known as canyon streets, described by their two-dimensional cross-section. This refers to the dimensionless ratio H/D where H is the height of the buildings adjacent to the street and D the distance between the parallel sides of the street or width. H/D is also known as the canyon aspect ratio. It is important because it is relevant to many features of urban climates including radiation access, shade and trapping, wind effects, thermal comfort and the dispersion of vehicle pollutants.

If the wind comes from the side, perpendicular to the street, pollutants emitted near the ground are not properly dispersed and remain locked in the street. Emissions, mainly due to vehicle traffic, are driven by the swirling flow formed inside the canyon, and pollutants accumulate. In the case of a wind parallel to the direction of the street. The dispersion of pollutants through the street, by wind blowing parallel to the direction of the street is favoured. However, this can lead to a deterioration of air quality and pollutant accumulation upstream of the canyon street.

[104] Waked and Afif, 2012
[105] Ibid
[106] Ibid

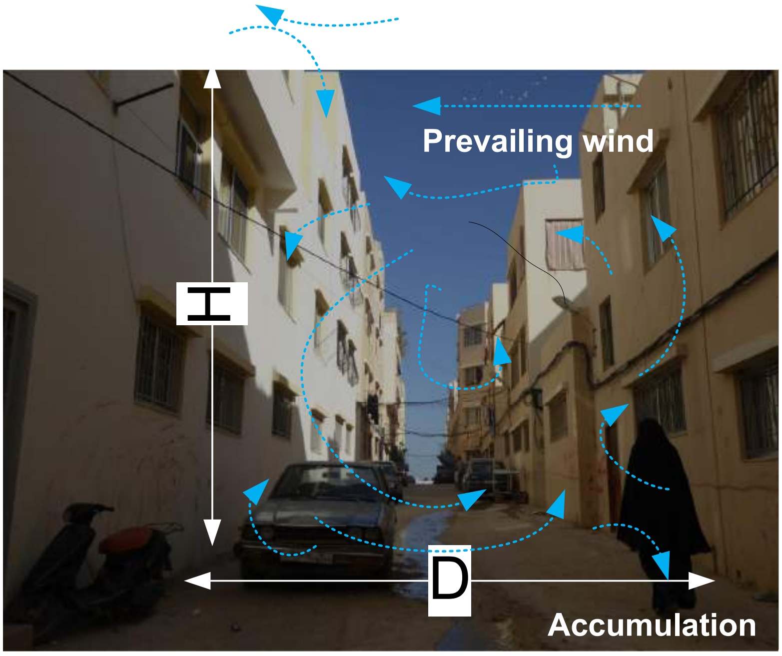


Figure 125. **Dispersion of pollutants in canyon streets.**

In order to test emissions of the traffic in the camps (qualitatively but scientifically) and compare them to the national average, an experiment was conducted in Burj Barajneh to determine the average emission factor of the vehicle fleet in this camp. The methodology adopted consisted of measuring the particle matter (PM) emission factor through the Dust Trak DRX Aerosol Monitor 8533 for PM measurement and the AMI 300 for CO and CO_2 measurement. Both instruments were provided and calibrated by the FICIP team. It is worth noting that the fleet in Burj Barajneh is mainly composed of two-wheeled vehicles which emit more particles per kg of fuel burnt than passenger cars. The poor maintenance of the camp fleet results in higher emission factors especially when white exhaust plume is observed as a result of poor engine maintenance. The high emissions from the fleet along with the weak dispersion of pollutants in canyon streets increase the population risk to air pollution and its adverse side effects.

Private Generators and Air Pollution

For many years, the electricity provided by EDL in Lebanon has been insufficient in meeting the basic demand from households, offices and national businesses. Electricity outage is overcome with diesel generators.

The Ministry of Environment has set regulations for the use of generators in order to lower the impact on the population's health. To be compliant with the air quality regulations in Lebanon, a private generator must obey by two Ministerial Decisions from the Ministry of Environment: 8/1 (2001) for emissions limit values (ELV) and 52/1 (1996) for ambient air quality. If a generator is compliant with the ELVs, but it breaches the standards of air quality (Ministerial decision 52/1), action must be taken to lower the emissions or enhance the dispersion.

The factors that affect the dispersion of a plume[107] include the surrounding topography such as the elevation and the coast, nearby buildings, meteorological conditions such as the wind direction and

[107] Smoke plume = air and its particles dispersion from a vehicle or generator exhaust (example)

wind speed, stack height[108], type of land of the surrounding area and characteristics of the flue gas released. The minimum stack height is related to the following conditions:

- Capacity range of applicability: > 500 kVA total generator capacity
- Minimum height: one metre + height of neighbouring buildings in [m] (inside 50 metre diameter from the stack or the average building height in the neighbourhood)
- Minimum exhaust gas velocity: 15 m/s
- More than one generator: total generator capacity
- <500 total generator capacity [kVA = kW] : one metre + height of installation hall

Wavel is served by seven generators, three of which are installed inside the camp while the other four are located outside the camp boundary. Mar Elias and Burj Barajneh are alike with three generators installed inside each camp and one outside.

Indoor and Outdoor Air Quality in the Camps

Air quality measurements (indoor and outdoor) were conducted between August and October 2017 in different shelters in the three camps using Sensio AIR devices. One device was installed outdoors in each camp to measure the background concentrations inside the camp. One school and one health care centre in Bir Hassan, Beirut were also monitored. The instruments were provided by White Lab and installed by UNRWA with the assistance of USJ-EMMA team. The sites were chosen by UNRWA. White Lab manufactured air quality monitors with the following sensors:

- PM_1, $PM_{2.5}$ and PM_{10}: Laser sensor using the scattering of laser irradiation in the air suspended particles.
- Semiconductor Flat Surfaced VOC gas sensor
- Carbon monoxide and carbon dioxide: NDIR Infrared

Sensio AIR devices are connected devices designed to stream data 24/7 to the cloud (managed by the private partner). An analysis of pollutant levels is carried out and a Sensio air quality index is calculated in real time. During the installation of the devices in the refugee camps, a number of infrastructure problems made it very difficult to obtain reliable pollution data due to the following:

- Connectivity: Transfer of data to the cloud was done via 3G dongles. During the installation, several sites had poor 3G signal therefore jeopardising the integrity and continuity of collected data;
- Electricity: Due to frequent power shortages and fluctuations, the sensors' performance was sub-optimal and baseline calibration could not be achieved on a daily basis.

Taking the above information into consideration, it is clear that the major limitation of this study is data completeness. For this reason, the intended use of the provided information is for qualitative analysis only. According to the air quality guidelines of the Lebanese decision 52/1, UNRWA applied the maximum concentration of PM_{10} (less than 10 µm) equivalent to 80 µg per cubic meter.

[108] According to good engineering practice, stack height is greater than or equal to the height at which plume dispersion form the stack is not influenced by downwash. Downwash, in turn, refers to the stagnant, recirculating eddy of air that forms on the leeward side of a building.

During the measurements in Burj Barajneh camp, measured values exceeded the standards limits where measured values ranged between 97 and 393 µg per cubic meter with an average value of 171 µg per cubic meter. These results give an idea that air quality is poor and improvements need to be done to improve outdoor air quality.

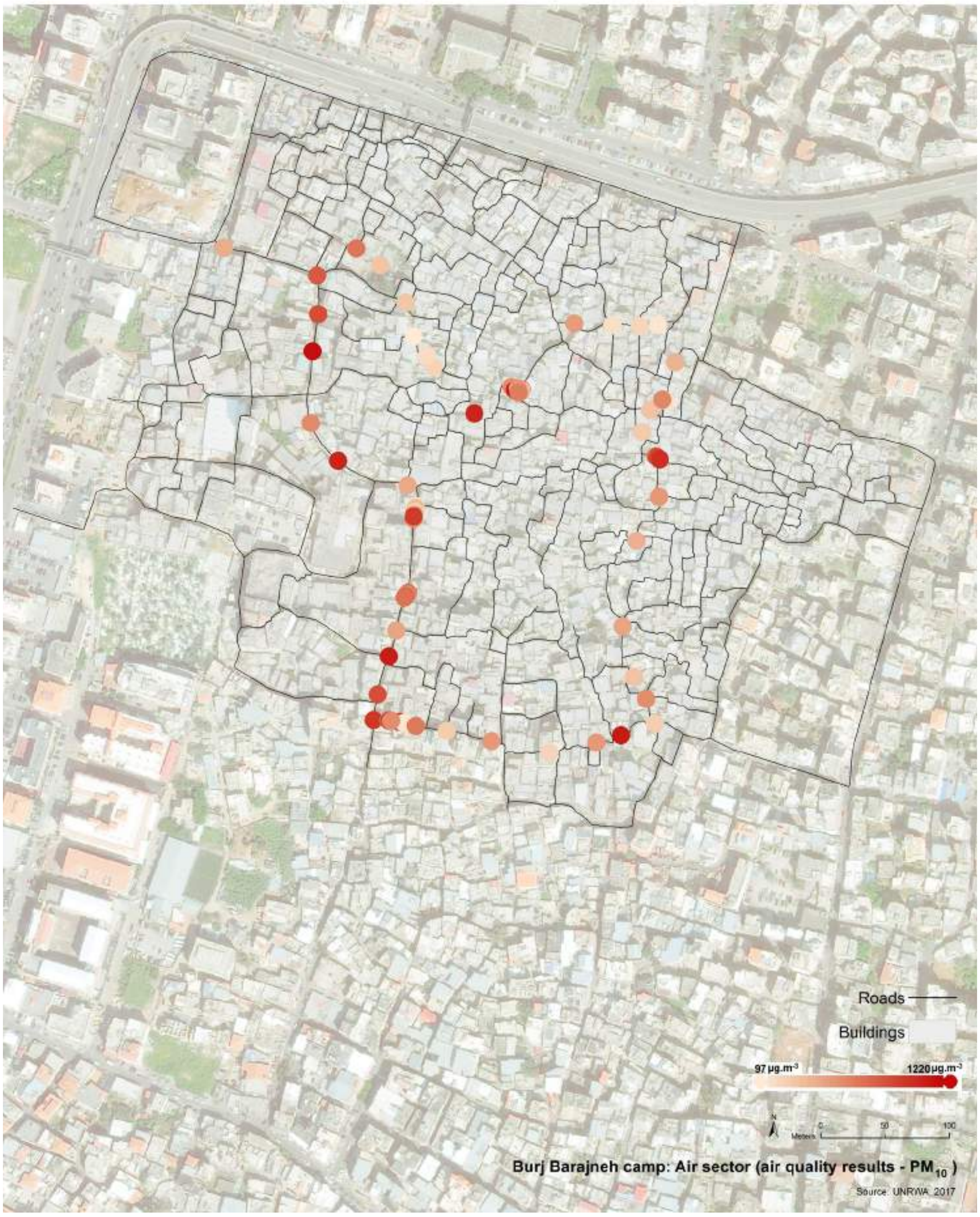


Figure 126. Outdoor air quality survey in Burj Barajneh on PM_{10}.

Recommendations

The results of the survey show that the camps are polluted by particles both indoors and outdoors. The main sources of outdoor air pollution are most probably the private generators and transport. Short term recommendations focus on the private generators, ventilation within the shelters and awareness about air pollution while the long-term recommendations focus on renewable energy, transport, and awareness. Awareness of the population on indoor air pollution sources is important to mitigate adverse effects as well as for the promotion of good ventilation. During periods of high levels of outdoor air pollution, actions should be taken to reduce air entering the house from outside, including closing the windows and turning on the air conditioning (with good maintenance of the filters and gases). Urban planning does not help with the dispersion of the emitted pollutants. Based on the study conducted and results obtained, different recommendations are provided to decrease the impact on refugees' health. Short-term recommendations include the following:

- Relocate generators to outside the camp boundary while abiding by Lebanese regulations;
- Use diesel with low sulfur for generators instead of "*red*" diesel;
- Use low consumption lamps at home to decrease the demand on energy;
- Install control equipment on private generators;
- Install ventilation in houses that operate continuously to avoid accumulation of pollutants inside from indoor sources.

For a long-term perspective, the following recommendations are provided:

- Install water solar heaters to decrease the demand on energy;
- Install solar panels to maximize the use of renewable energy in camps and minimize the use of private generators;
- Switch to the use of electric two-wheeled vehicles to be charged through a solar station or the solar panels installed in the camp;
- Continue conducting awareness sessions about tobacco and shisha smoking and their adverse effects;
- Continue conducting sessions about air pollution and its sources and impact and how to avoid it;
- Revise urban planning and develop pedestrianised alleyways and roads, on week-end or during market days;
- Identify main pedestrian streets to access schools and health centres.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PART 5
RESPONSE PLAN

Part 5

Response Plan

This section presents the Response Plan 2018-2021 for engaging in new construction projects, rehabilitation of initiatives and all required resources (human, operational and maintenance, reagents, tools, communication, transportation) to improve the environmental infrastructure and environmental health in the 12 Palestine refugee camps in Lebanon. It is based on the findings and recommendations previously outlined and also considers other populations living in and transiting through the camps.

The current situation in Lebanon is highly complex and fragile. Progress is curtailed by two main factors primarily the ongoing humanitarian context as a consequence of the Syrian crisis, rendering Lebanon unable to meet the needs of the refugee community and struggling to ensure those of its own population. Secondly, the low socioeconomic status of the Palestine refugees who are not permitted to participate in routine economic activities and the absence of a cost recovery system (the mandate of UNRWA as non-profit) means the Agency must significantly overcompensate in order to ensure even the most basic rights of the Palestine refugees while also maintaining and rejuvenating ageing, overloaded infrastructure.

It is therefore crucial that the international community remains engaged in activities that improve the living conditions inside the Palestine refugee camps in Lebanon and as a consequence Lebanese communities and other populations residing in the camps. The RP adopted a holistic approach to ensure better conditions within the 12 camps and their surrounding areas.

The semi-autonomous nature of the camps means that camp boundaries are permeable, allowing adverse effects of water, air and poor sanitation services to penetrate the adjacent areas. In reverse, advancements and progress within the camps will have shared benefits outside. Without sufficient support, there is an increased security risk and most likely further deterioration of public health inside the camps.

Due to high population density, a characteristic of all the 12 camps, these challenges will not remain contained and most certainly have the potential to permeate camp boundaries. The interconnectedness of the civil societies on both sides of the perimeter as well as the municipalities cannot be ignored. Investing inside the camps through integrated and joint collaborations means a shared benefit will be experienced by more than just the Palestine refugees.

Considering there are other populations residing inside the camps in addition to Palestine refugees, a joint and holistic approach is necessary from UN agencies including UNDP, UNICEF, and UNHCR who have various mandates as well as government ministries, to merge efforts and coordinate efficiently to support the entire population and improve infrastructure inside the camps.

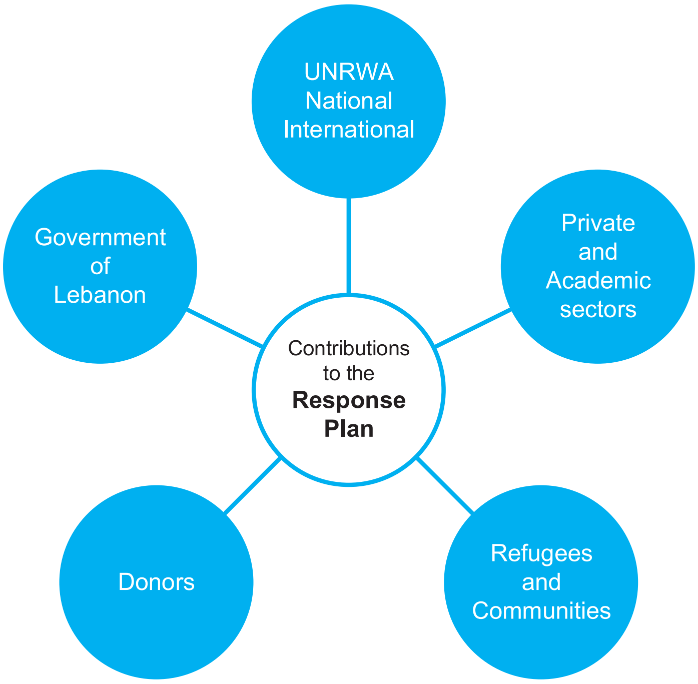

Figure 127. Actor interlinkages applied to the EHS and for the actor risk assessment.

Priorities

Within the water sector, the implementation of the qualitative and quantitative water monitoring surveillance plan is the top priority for 2018 that will ensure a sustainable and efficient water supply for the 12 camps, including those supplied through municipal and private lines. Stabilizing the water supply by reducing losses through leakages; safe re-use of wastewater and storm water; monitoring water quality and mitigating the risk of sea intrusion are as essential as promoting knowledge and civic responsibility among the population and through awareness campaigns.

The second priority concerns the implementation of a sustainable and viable solid waste management plan to decrease the amount of waste produced in the camps, but also to develop viable and innovative options to transform waste into an economic value. Improving solid waste management and awareness inside the camps, together with joint efforts at the municipal level, will lead to successful results over the coming 2018 – 2021 period.

The most challenging is the energy sector and the provision of an efficient electricity supply through conventional or renewable sources of energy. This will become more and more important as it has direct impacts on other sectors, including water, sanitation and habitat. Investing in a more efficient grid system, transferring from the national to the local level, will reduce the risk of multiple generators with one of the highest cost per kWh in the region.

Both habitat and air sectors can potentially be improved by enhancing urban planning with infrastructure and household thermal-energy efficient appliances. However, the key component to success is the civil society themselves, particularly individuals who must start by respecting "*rights and duties*" common to modern societies and be held accountability to rules, regulations and customs that bind a community together. Promoting innovations such as pedestrianized, non-toxic, filter-paved roads, rainfall collection for recharging the aquifer and reducing the runoffs, greening on roofs, reintroducing biodiversity in the urban context, introduction of solar energy street lighting systems or awareness campaign competitions for promoting environmental health, are realistic and feasible operational priorities that will contribute to a safer and healthier environment

Identification of Projects and Required Resources

In terms of quadrennial resources, the overall needs of the Response Plan 2018-2021 are composed of three complementary components:

i. Project costs
ii. Running costs
iii. Human resources "*support*" costs

The total budget for the entire FICIP environmental health unit Response Plan is equivalent to USD$ 25.3 million, out of which 61 per cent is projects costs, 22 per cent operation and maintenance and 11 per cent human resources (additional to the permanent staffing).

	Environmental Infrastructure and Environmental Health functions	Target	Total cost (in million USD)
1	Cost for implementing projects to improve environmental infrastructure	191 Projects	15,237,200
2	Cost for implementing projects to improve environmental health (support staff)	12 camps	2,533,920
3	Cost for the operation and maintenance of the environmnental infrastructure	12 camps	5,009,970
	Sub-total for 2018 – 2021 period		**22,781,090**
	Overhead	11%	2,505,920
	Grand-total for 2018 – 2021 period		**25,287,010**

Figure 128. Quadrennial budget needs.

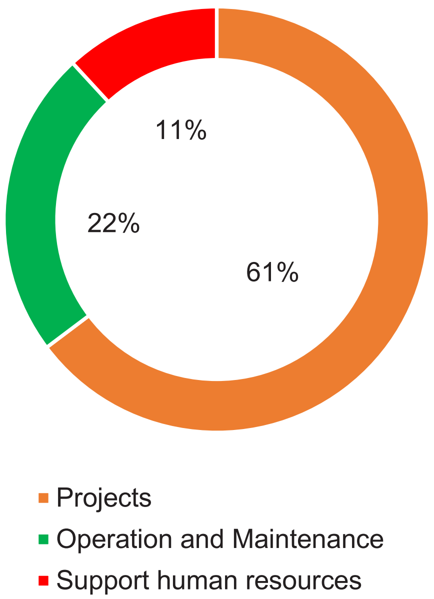

Figure 129. Budget needs distribution.

While the "*project*" is decreasing over the four-year period[109], starting at 73 per cent in 2018 and dropping to 50 per cent in 2021 of the total budget needs, the "*running, operation and maintenance and human support resources*", on the other hand are increasing slightly, but remain relatively stable in terms of cost increase (24 per cent in 2018 and 26 per cent in 2021).

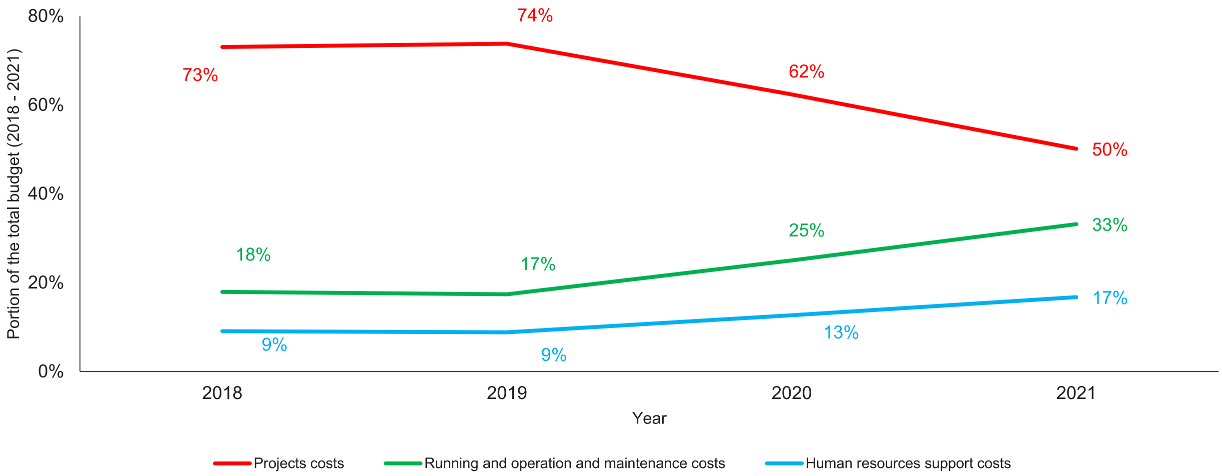

Figure 130. Trend, in percent of the annual budget needs and per parts – projects costs, running O&M costs, human "*support*" resources.

Project Costs

Project costs are calculated based on the results of the field inventory (camp per camp, sector per sector). It mainly concerns water and sanitation projects, but also interventions (rehabilitation and new construction) in the land, habitat and energy sectors. Road repairs as well as wastewater and storm water networks works are also considered. Each project corresponds to one intervention such as the construction of a new water tank to increase the storage capacity in one camp or to similar activities such as water well monitoring equipment composed of flow-meters, piezometers and probes, detailed for each camp and including equipment, installation and operation and maintenance costs. Water pumps, generators, sanitation vehicles and garbage bins are considered in the project costs due to their limited lifespan and must be regularly renewed due to extreme burden. In total, 191 activities have been identified over the quadrennial plan. The total quadrennial budget is estimated at USD$ 15.2 million.

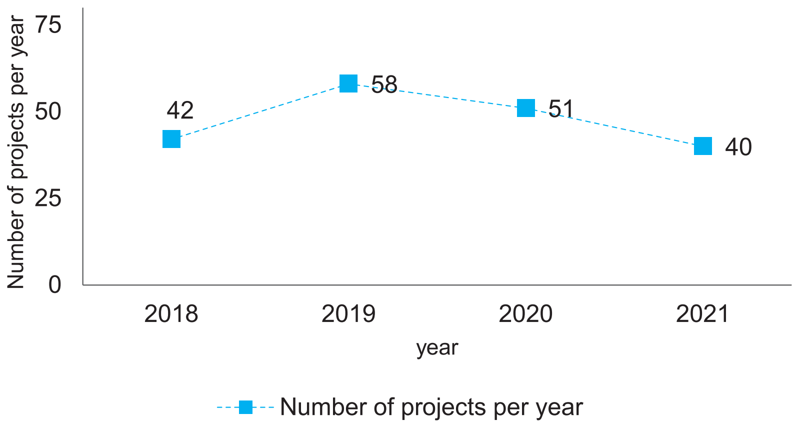

Figure 131. Number of projects identified per year and for all EIEH domain.

[109] Justified on the « *transition* » phases from construction (2007 – 2017) to management (2017 – 2030)

Running Costs

In terms of annual running costs that facilitate the operation and maintenance of water and sanitation services in the 12 camps, 67 per cent are associated with the water sector (cash subsidies, gas oil, electricity bills water quality analysis and water supply from private lines and 33 per cent for the sanitation sector (solid waste transportation to dumping sites, vector control and equipment). The total quadrennial budget is estimated at USD$ five million. Based on the expected impact of the RP, some of these running costs are subject to decrease, but due to inflation and population growth and ageing of the existing infrastructure, they are considered relatively stable. Due to the new solid waste operational plan, the running costs paid to the private sector for solid waste disposal should decrease from mid-2018.

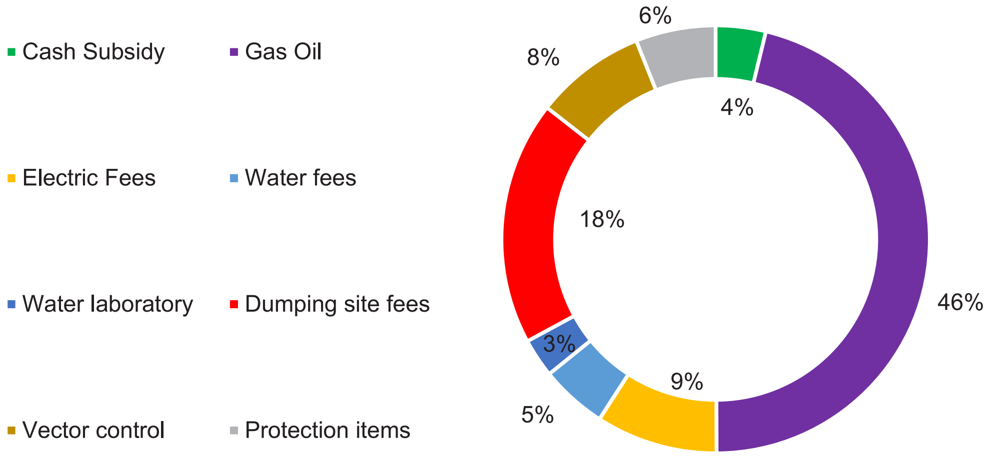

Figure 132. Portion of annual running costs for operation and maintenance services.

Due to the UN mandate (non-profit) and low socioeconomic status of Palestine refugees in Lebanon, cash subsidies are needed through international support, to continue the operation and maintenance of water and sanitation services in the 12 camps. The introduction of a cost recovery system and improving the status of Palestine refugees are the only viable solutions to reducing the need for this support.

Human Resources Costs

Human resources costs are composed of the permanent staffing, fixed by the Agency due to financial restrictions and covered by GF. To compensate the important deficit (equivalent of 30 per cent of the permanent staffing), UNRWA employs additional personnel under temporary contract "*support*" basis. The total quadrennial budget is estimated at USD$ 2.5 million.

Exceptional Project Running Costs and Human Resources

There are two exceptional budget needs which must be considered. The first is related to the additional demand in the Adjacent Areas of Nahr El Bared, corresponding to approximately USD$ 1,420,000 with distribution funds starting at 30 per cent in 2018 and reducing to 23 per cent in 2021. The second is related to the possible construction of a solid waste treatment plant in the Burj Shemali municipality, complementary to the existing one in Ain Baal. According to the preliminary study, the cost-investment budget for such a facility to be able to treat waste from the municipality and the three Palestine refugee camps in Tyre area, is USD$ 4.5 million plus additional annual operational and maintenance costs of USD$ 360,000 per year. This budget does not include the environmental health unit's quadrennial budget plan.

The financial resources needed for the 2018 – 2021 period consider the national context, non-profit humanitarian mandate (UNRWA and its humanitarian partners), the low socioeconomic conditions in the camps and to a larger extent in Lebanon, and the semi-autonomous conditions of the 12 Palestine refugee camps.

Based on the integrated and holistic field analysis approach, a total of 191 projects have been identified during the quadrennial period and in the 12 Palestine refugee camps. Thirty-four per cent are related to the water sector, 36 per cent the sanitation sector, 15 per cent the land, habitat, energy and air sectors and 15 per cent roads infrastructure.

With an estimated total budget of USD$ 25.3 million, corresponding to a capital investment of USD$ 117 per person for the quadrennial period and investing USD$ 29 per person per year will allows the operational and maintenance as well as improvement of environmental infrastructure and environmental health services with a positive impact on the living conditions inside the camps.

Perspectives

With the Environmental Health Strategy 2016 – 2021 and the Inventory and Needs Assessment of Infrastructure and Environmental Health in the 12 Palestine refugee camps in Lebanon Response Plan 2018 – 2021 in place, the next phase focuses on using these instruments to guide the migration from a decade of construction (2007-2017) towards the management and development of new innovative infrastructure.

The holistic approach adopted for the inventory and needs assessment, underlined the immense burden that the municipalities are facing, due to the humanitarian, environmental and political instability in Lebanon and also due to limited resources.

Aligned to the UNRWA Medium Term Strategy 2016-2021 and the Infrastructure Camp Improvement Programme Strategy (headquarter level), the Response Plan follows sustainable, efficient and innovative principles while remaining adapted to the volatile and complex humanitarian situation in Lebanon and in the Near East.

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PART 6
APPENDIXES

Part 6

Annexes

Annex 1: Logical Framework 2018 – 2021

The FICIP recognizes the importance of and people's critical need for healthy living environments in the 12 Palestine refugee camps in Lebanon, and as such is also responsible for the provision of environmental health services as well as design, construction and maintenance, and operation of environmental infrastructure such as water and sanitation systems that are well adapted to the Field of Lebanon. The logical framework (log-frame) for the FICIP strategic outcome 3: "*Environmental infrastructure and environmental health*" 2016 – 2021 considers UNRWA MTS, UNRWA ICIP, LCRP, UNSF and Government of Lebanon indicators and MDGs' related targets.

	Impact hypothesis	Indicator	Source of verification	Assumptions
Strategic objective (indirect impact)	In striving towards dignity and a better life for the Palestine refugee community the FICIP, as an integrated programme, improves the built environment by providing robust infrastructure, camp improvement services, and participatory solutions in partnership with refugees and involved actors.			
Strategic outcome	**Palestine refugees living in the 12 Palestine Refugee Camps in Lebanon are able to meet their basic needs of environmental health.**			
Results: (output 1)	Palestine refugees living in the 12 Palestine refugee camps in Lebanon have safe, equitable and sufficient quantity of water for their basic needs.	- % increase in proportion of population using safely managed drinking water services [1] *Baseline (2018): 36%* *Target (2021): 46%* - % of water sources equipped with adequate qualitative and quantitative	- Feedback from end users - Results of water analysis (physical, chemical, bacteriological) - Sanitary inspection and environmental impact assessment reports	- JMP 2016 and 2020 (4-year frequency) - Authorities and partners provide access to adequate quantities of safe drinking water to the camps, or allow the digging of new wells in the appropriate aquifers

[1] LCRP Final frame work for 2018: from an improved water source (SDG 6.1.1.), that is located on premises, available when needed, and free from faecal contamination. Value englobing all populations in Lebanon.

		surveillance system *Baseline (2018): 0%* *Target (2021): 100%* - % of shelters connected to adequate (qualitative and quantity) water networks *Baseline (2018): 70%* *Target (2021): 100%* - % of premises (schools, health centres, offices) connected to adequate (quality and quantity) water networks *Baseline (2018): 100%* *Target (2021): 100%* - % of the camps with at least one water committee in charge of the operation and maintenance of the water supply *Baseline (2018): 33%* *Target (2021):100%*	WHO and national water quality guidelines - Evaluation of quality of trainings provided - Average water supply per capita per day	Climate change, modes of precipitation, and urbanization will allow continuity of water resources - People and staff trained as planned or required - Aquifer catchment areas are protected from sources of pollution - Energy is available to operate pumping stations - Private and public sectors collaborate and welcome academic and national/international support and expertise - Population respects its rights and duties to facilitate UNRWA and municipal services - Funds are available on time and in quantity - Absence of emergencies (natural and man-made) - Other UNRWA LFO departments (Health, RSS, Protection, Education) provide data to FICIP on time and in quality
Activities	- Identify aquifers and water sources potential and risks and implement a quantitative and qualitative surveillance plan - Rehabilitate and/or implement water supply networks in camps and/or surrounding areas - Conduct and update water sector inventory for all water sources and water networks supplying the camps - Develop technologies and methods to reduce the losses and to improve the efficiency and sustainability of the water recharge, water treatment and water supply in the camps - Identify private companies selling drinking water to the Palestine refugees and support and advice on efficient, safe and sustainable systems - Identify existing or absence of water committee and support their development and/or creation			

	- Train staff and sensitize population on the importance of sustainable water operation and maintenance systems - Collaborate with private, public and academic sectors to identify integrated and sustainable solutions (sharing of data and results)			
Results (output 2)	Palestine refugees living in the 12 Palestine refugee camps in Lebanon are served with adequate sewerage systems (wastewater).	- % increase in proportion of wastewater safely treated [2](household components to WWTPs of SDG 6.3.1) *Baseline (2018): 0%* *Target (2021): 25%* - % of camps equipped with operational wastewater networks (level of camp) *Baseline (2018): 60%* *Target (2021): 100%* - % of shelters connected to adequate wastewater networks *Baseline (2018): 80%* *Target (2021): 100%* - % of premises (schools, health centres, offices) connected to adequate wastewater networks *Baseline (2018): 100%* *Target (2021): 100%*	- Feedback from end users and/or complaints - FICIP GIS database - Connections to municipal networks - Water and wastewater establishments - Surveys - Number of sewage floods - Water quality analysis	- Camps are permitted to connect to municipal sewage systems - UNRWA is only responsible for operation of sewerage systems in the camps - Energy is available to operate pumping stations - People and staff trained as planned or required - Population respects their rights and duties to facilitate UNRWA and municipal services - Funds are available on time and in quantity - Municipal collaboration and resources are ensured in the surroundings of the camps - Absence of emergencies (natural and man-made) - Other UNRWA LFO departments

[2] LCRP Final frame work for 2018: The proportion of wastewater generated by households and by economic activities (based on ISIC categories) that is safely treated compared to total wastewater generated by households and economic activities.
The household component includes WWTPs and on-site facilities.
Treatment implies any process for rendering wastewater fit to meet applicable environmental standards or other quality norms; treatment can be categorized into primary, secondary, and tertiary treatment levels, with further categorization by mechanical, biological, and advanced technologies and treatment efficiency.
Importantly, the treatment level and performance of the treatment plant should be considered together with the end use of the treated fractions.
Data on the household component will come from the monitoring of 6.2.1. The excreta from on-site facilities may either be managed in-situ or removed from the premises for treatment and disposal elsewhere. Sewered networks and on-site facilities are often regulated by different authorities so these data may need to be collected separately. Similarly, separate data sources will also be required for rural areas and urban centres.
For the economic activities component, an initial monitoring step would be to make estimations based on registers of economic activities, and to focus on hazardous industries.

				(Health, RSS, Protection, Education) provide data to FICIP on time and in quality
Activities	- Rehabilitate and/or implement sewerage networks in camps and/or surrounding areas - Conduct and update wastewater sub-sector inventory for all sewerage networks implemented in the camps - Develop technologies and methods to reduce the risks of contamination from wastewater and to improve the efficiency and sustainability of disposal with possible valuable advantages - Identify public and/or private companies and/or partners to operate and maintain the sewerage systems - Evaluate wastewater efficiency (adequacy) - Train staff and sensitize population on the importance of sustainable sewerage operation and maintenance systems - Collaborate with private, public and academic sectors to identify integrated and sustainable solutions (sharing of data and results)			
Results (output 3)	Palestine refugees living in the 12 Palestine refugee camps in Lebanon live in an environment in which health and other risks posed by storm water are minimized.	- % of camps equipped with operational storm water networks (level of camp) *Baseline (2018): 55%* *Target (2021): 100%* - % of shelters connected to adequate storm water networks *Baseline (2018): 70%* *Target (2021): 100%* - % of premises (schools, health centres, offices) connected to adequate storm water networks *Baseline (2018): 100%* *Target (2021): 100%*	- Feedback from end users and/or complaints - FICIP GIS database - Connections to municipal networks (if different from wastewater/sewerage) - Water and wastewater establishments - Surveys - Number of rainwater floods - Water quality analysis	- Camps are permitted to connect to municipal storm water systems (if different from wastewater/sewerage) - UNRWA is only responsible for operation of storm water systems in the camps - Energy is available to operate pumping stations - People and staff trained as planned or required - Population respects their rights and duties to facilitate UNRWA and municipal services - Funds are available on time and in quantity - Municipal collaboration and resources are ensured in the surroundings of the camps

				- Absence of emergencies (natural and man-made) - Other UNRWA LFO departments (Health, RSS, Protection, Education) provide data to FICIP on time and in quality
Activities	- Rehabilitate and/or implement storm water drainage systems in camps and/or surrounding areas - Conduct and update storm water sub-sector inventory for all sewerage networks implemented in the camps - Develop technologies and methods to reduce the risk of contamination from storm water and to improve the efficiency and sustainability of disposal with possible valuable advantages (recharge of aquifers, exploration of further opportunities of storm water harvesting from roofs and surface run-off) - Identify public and/or private companies and/or partners to operate and maintain the storm water systems - Evaluate storm water efficiency (adequacy, absence of floods) - Train staff and sensitize population on the importance of sustainable storm water operation and maintenance systems - Collaborate with private, public and academic sectors to identify integrated and sustainable solutions (sharing of data and results)			
Results (output 4)	Palestine refugees living in the 12 Palestine refugee camps in Lebanon have access to solid waste management services that meet minimum acceptable standards.	- % of collection and removal of all domestic waste from the camps (A1, ICIP) *Baseline (2018): 90%* *Target (2021): 100%* - % of solid waste recycled per camp (B, ICIP) *Baseline (2018): 0%* *Target (2021): 25%* - % solid waste reduction through recycling *Baseline (2018): 0%* *Target (2021): 25%* - # days per year the camps are kept clean of solid waste *Baseline (2018): 250* *Target (2021): 300*	- Feedback from end users and/or complaints - Reports - FICIP GIS database - Surveys - Vehicle logbook data - Cost monitoring data	- Camps are permitted to connect to municipal solid waste facilities - UNRWA is only responsible for operation of solid waste management in the camps - People and staff trained as planned or required - Population respects their rights and duties to facilitate UNRWA and municipal services - Funds are available on time and in quantity - Municipal collaboration and resources are ensured in the surroundings of the camps - Other UNRWA LFO departments (Health, RSS, Protection, Education)

		- Street sweeping in camps (times/week) (A2, ICIP) *Baseline (2018): 4.5* *Target (2021): 6*		provide data to FICIP on time and in quality
Activities	- Rehabilitate and/or implement existing/new solid waste infrastructure in camps and/or surrounding areas - Conduct and update solid waste sub-sector inventory for all camps direct surroundings - Develop technologies and methods to reduce the risk of contamination from all sources of solid waste (municipal, medical, toxic, e-waste, slaughterhouses, construction/demolition) and to improve the efficiency and sustainability of disposal with possible valuable advantages (waste for value, compost, energy, socio-economic) - Identify public and/or private companies and/or partners to run the solid waste management - Evaluate solid waste management efficiency (adequacy, absence of nuisances, safe and healthy environment, absence of vectors) - Develop SWM plan for each camp in Lebanon and at the area level in collaboration with state and private partners - Revise institutional set-up and human resource management - Intensify performance and cost monitoring system - Train staff and sensitize population on the importance of sustainable solid waste management system (inside and outside the camps) - Collaborate with private, public and academic sectors to identify integrated and sustainable solutions (sharing of data and results)			
Results (output 5)	Palestine refugees living in the 12 Palestine refugee camps in Lebanon live in an environment in which health and other risks posed by inadequate habitat infrastructure, materials and technologies, inadequate land, air, energy qualities, equipment and technologies, are minimized.	- Annual mean levels of fine particulate matter (PM_{10}) in Palestine refugee camps (based on Lebanese regulation and data) *Baseline (2018): none* *Target (2021): 80 µg/m^3* - Areas equipped with independent and functional weather stations *Baseline (2018): 0* *Target (2021): 5* - % of the service generators are equipped with efficient air filters and noise reducers. *Baseline (2018): 75%* *Target (2021): 90%* - % of the transformers aligned to	- UNRWA Health and MoPH data - Air and Household quality surveys - Use of DRX PM equipment in each pre-selected site in each camp - Feedback from population	- UNRWA FICIP team is trained on the use of the air quality equipment - Private, academic and refugee communities collaborate and facilitate the air quality monitoring surveys - Funds are available on time and in quantity - Absence of emergencies (natural and man-made) - Weather stations are not damaged or stolen - Other UNRWA LFO departments (Health, RSS, Protection, Education) provide data to FICIP on time and in quality

	Stockholm Convention on PCBs *Baseline (2018): 50% (est.)* *Target (2021): 90%* - Camp have benefited from, at least, one innovative technology such as soil artificial aquifer recharge, filter-paved pedestrianized roads, solar energy systems (thermal or PV), Disaster Risk Reduction *Baseline (2018): 0* *Target (2021): 12* - % of construction material containing asbestos. *Baseline (2018): unknown* *Target (2021): 0%*
Activities	- Update energy and air inventory for all camps direct surroundings - Identify the sources of air pollution and propose corrective measures in collaboration with the users - Identify the sources of energy pollution and propose corrective measures in collaboration with the users - Identify the pedestrianized roads to limit the vehicles circulation - Identify the natural and artificial air regulation systems (indoor and outdoor) and propose innovative improvements - Evaluate the potential to recycle the roofs for alternative use (rainwater catchment, social areas, greening, gardening) based on better air quality parameters - Conduct regular air quality surveys and inform the public with protective measures if necessary - Sensitize the population of public health risks of air pollution - Evaluate the renewable energies potentials for services and at individual (households) levels - Promote ecological habitat and energetic practices for infrastructure and at individual level (bioclimatic and *baubiologie* approaches) - Collect weather and climate data to be used for the daily activities (water, sanitation, green economy) and long-term monitoring and evaluation of the IWRM and IWM activities - Train staff and sensitize population on the importance of sustainable solid waste management system (inside and outside the camps)

Results (output 6)	Palestine refugees living in the 12 Palestine refugee camps in Lebanon and partners involved in sustainable, efficient and innovative environmental infrastructure management and environmental health activities are aware of public and environmental health risks and apply adapted and sustainable programmes and tools (hygiene promotion, data management, visibility, communication, awareness campaign, DRR, IWRM, IWM) to mitigate them.	- % increase of boys, girls, women and men with appropriate hygiene knowledge, altitudes and practices [3] Baseline (2018): LCRP Target (2021): LCRP - % of FICIP staff participating in human capacity building programme on environmental health sectors (land, habitat, water, sanitation, energy, air) and programmes and tools Baseline (2018): 25% Target (2021): 75% - % of expertise and autonomy among UNRWA FICIP permanent staff on IWRM, IWM, ACAD, GIS data management Baseline (2018): 0% Target (2021): 100% - % of camps that have at least one awareness campaign on environmental health sector with focus on IWRM and IWM Baseline (2018): 0% Target (2021): 100%	- UNRWA FICIP database and geo data base - Reports of projects (UNRWA and partners) - Social surveys (monkey surveys, tablets field survey) - Feedback from population	- UNRWA FICIP team is consistently trained on the main EH programmes and tools introduced or reinforced between 2016 and 2017 - Private, academic and refugee communities collaborate with UNRWA - Population actively participate in FICIP projects - Funds are available on time and in quantity - Absence of emergencies (natural and man-made) - FICIP keeps adequate in-house expertise for IWRM, IWM and data management - Data management is well organised and update in a systematic and organised manner - Other UNRWA LFO departments (Health, RSS, Protection, Education) provide data to FICIP on time and in quality

[3] LCRP Final frame work for 2018: Proportion of population that has knowledge of:
1) 3 out of 5 critical times for handwashing (before eating, before feeding the baby, before handling food, after using toilet, after change diapers)
2) 2 out of 4 ways to prevent of disease transmission (hand washing, drinking safe water, using latrines, food safety)
and practice:
3) using hygienic latrine/toilets (no strong smell or significant numbers of flies or mosquitos, no visible faeces on the floor, walls, seat or around the facility)
4) disposing solid waste safely and hygienically (municipality collected)

Activities	- Train staff and partners on GIS system/software for update/creation of new projects and to monitor and evaluate their impacts - Train staff and partners on AutoCAD design system/software for update/creation of new projects and to monitor and evaluate their impacts - Conduct human capacity building programmes for UNRWA staff - Conduct human capacity building programmes for UNRWA and partners (including refugees) - Develop socioeconomic activities based on refugees' participation and contribution with specific activities inside the camps - Develop communication strategies that include refugees, partners, national and international stakeholders to increase awareness of the population on the risks and potential of environmental infrastructure and environmental health services, rights and duties - Promote UNRWA FICIP activities among the population and the external partners through social-media, movies, activities based on operational needs - Promote green economy through innovative solutions and by introducing renewable energies technologies adapted to the natural and human environment in the camps and their surroundings

Annex 2: Risks and Assumptions

	Risks	Likelihood	Impacts	Mitigation measures
Strategic factors	- Implementation of strategy milestones and targets is not achieved.	Medium	- Delay of strategy implementation (response plan), possibly after the 2021 period.	- Monitoring and review, conduct regular coordination meetings.
	- Effectiveness in governance (ministries, Water Establishments, municipalities) and commitment to FICIP environmental health strategy (change) direction declines.	Medium	- Lack of confidence among stakeholders.	- Make sure that plans and project proposals are aligned with the FICIP EHS and Response Plan.
	- Expectations of refugees are unmet.	Medium	- Inconsistency in strategic direction and negative image of UNRWA within the targeted population and/or partners.	- Continue working with the Central, North, Saida, Tyre and Bekaa areas and the management to support the FICIP strategic direction of the environmental infrastructure and environmental health.
Operational factors	- Accidental pollution of the water sources (aquifers/wells).	Medium	- Ceasing or reduction of water quantities supplied to the population.	- Conduct risk assessments and environmental impact assessment analysis (mapping) with mitigation responses according to the category and level of pollution. - Improve prevention and limit access to vulnerable areas and infrastructure. - Organize emergency response (water trucking or connection to safe water sources).
	- Overexploitation of the water sources (aquifers/wells)	Medium	- Reduction of water quantities supplied to the population.	- Identify alternative sources and/or recharge of the existing sources. - Identify losses and wastages among the infrastructure and the population for urgent action.
	- Seawater intrusion in the exploited aquifers	High	- Water sources request high-cost and high-technology treatment process (reverse osmosis). - Reduction of the water quantities supplied to the population.	- Reduce over pumping rates to maintain the “salt/fresh” water balance in the aquifers. - Recharge the aquifers with surface waters. - Implement reverse osmosis treatment plants. - Identify losses and wastages among the infrastructure and the population for urgent actions.

	- Stopping the evacuation of the solid waste from the camps	Medium	- Solid waste piled inside the camps with high risk of health hazards, communicable diseases and other nuisances (odours, fires, toxic smoke, aquifer pollution, access)	- Implement emergency response plan to treat the waste locally. - Immediate information campaign amongst the population to limit waste generation or to organize its evacuation from an individual perspective. - Identify sites for emergency solid waste storage.
	- Increase of the running costs of the water and sanitation services	Medium	- Solid waste piled inside the camps with high risk of health hazards, communicable diseases and other nuisances (odours, fires, toxic smoke, aquifer pollution, access)	- Identify innovative technologies reducing the operation and maintenance costs. - Sensitize the population to reduce the consumption of water and the generation of waste. - Transfer the services to private sectors inside the camps. - Implement strict regulation through improved participation from the population and communication campaign.
	- Natural and/or man-made disaster	Medium	Delays and/or increased of needed resources to meet the needs.	- Improve the emergency preparedness capacity.
Financial Factors	- Shortfall of funding for strategy interventions	Medium	- Less improvement in the quality of refugees' living conditions	- Continue working with DRU and PIO to identify more innovative ways of funding.
	- Lack of resources allocated for training and human resources	High	- Less monitoring of quality and quality assurance.	- Improve the cost effectiveness of the implemented measures/operations.
	- Loss or significant decrease of internal allocated budget.	High	- Inability to introduce some of the envisaged innovative and new techniques and approaches	- Integrate the operation and maintenance with all stakeholders and promote private approach with more contribution (rights and duties) from the population.
		High	- Negative impact on the continuity of the FICIP Response Plan.	- Promote "green economy" approaches within the civil society inside the camps. - Accelerate the transfer of responsibility by the host country - Develop private sector inside the camps

		Medium	- Increase of the resources needed to rectify the medium-term deterioration impacts due to lack of proper operation and maintenance of existing and new infrastructure.	- Develop efficient and innovative technical and social-oriented solutions and tools on operation and maintenance - Share resources with partners - Increase awareness campaign and visibility among population and donors
Socio-political factors and hazards	- Increase of political, economic and humanitarian instability	High	- Delay or ceasing of implementation of interventions in the camps.	- Monitor situation and re-plan when unrest softens and/or stops
	- Insecurity and/or limit access to the camps	Medium	- Negative impacts on environmental infrastructure and environmental health services.	- Maintain critical functions related to basic needs.
	- Unfavourable changes in regulatory environment	Medium	- Negative image among the civil society inside the camps	- Maintain participatory work environment by the population and organizations.
	- Safety and security of staff compromised.	Low		- Maintain communication with donors, partners and refugees.

Annex 3: Implementation Plan, level of priority for 2018 – 2021 (per sector)

		2018	2019	2020	2021
Land sector	Soil preservation, biodiversity, food quality	Low	Low	Low	Low
Habitat sector	Building materials, natural ventilation, lighting, roads	Low	Low	Low	Low
Water sector	Water resources	High	High	Medium	Medium
	Water supply	High	High	Medium	Medium
	Water quality	High	High	Medium	Medium
Sanitation sector	Wastewater	Medium	Medium	Low	Low
	Storm water	Medium	Medium	Medium	Low
	Solid waste	High	High	Medium	Low
Energy sector	Electricity, renewable energies, greening	Medium	Medium	Medium	Medium
Air sector	Indoor and outdoor air quality and pollution	Medium	Medium	Medium	Medium
Programmes and Tools	Human resources	High	High	High	High
	Data management	High	Medium	Medium	Low
	Human capacity building	High	High	Medium	Medium
	Awareness, communication, visibility	High	High	High	High

High	(red)
Medium	(orange)
Low	(green)

Annex 4: Implementation Plan, level of priority* for 2018 (per camp and per sector)

		Burj Barajneh	Dbayeh	Mar Elias	Shatila	Ein El Hilweh	Mieh Mieh	Burj Shemali	El Buss	Rashidieh	Wavel	Beddawi	Nahr El Bared
Land	Soil, green areas	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Habitat	Materials, roads	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Water	Water resources	High	Low	High	High	Medium	Low	Medium	Medium	High	Medium	High	High
	Water supply	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
	Water quality	High	Low	High	High	Medium	Medium	Medium	Medium	Medium	High	Medium	High
Sanitation	Wastewater	Medium	Low	Low	Medium	Low	Low	Low	Low	High	Low	Medium	Medium
	Storm water	High	N/A	N/A	Medium	Medium	Medium	Low	Low	High	High	Low	Medium
	Solid waste	High	High	High	High	High	High	High	High	High	High	High	High
Energy	Electricity	High	Low	Medium	High	Medium	Low	Medium	Medium	Medium	Medium	Medium	Low
	Renewable energies	Low	Low	Low	Low	Low	Low	High	Low	High	High	Medium	High
Air	Air pollution	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
DRR	Floods	Medium	Low	Low	Medium	Low	Low	Low	Low	High	Low	Medium	Medium
	Fires	High	Low	Medium	High	Low	Low	Low	Low	Low	Low	Medium	Low
	Infrastructure	High	Low	High	High	Medium	Low	Medium	Low	Low	Medium	Medium	Low

High	red
Medium	orange
Low	green

*In reference to the "*initial environmental health status*" presented in the EHS, page 71.

Annex 5: Distribution of Projects for 2018 – 2021 (per camp and per sector)

Area	Camp	Sector	2018	2019	2020	2021	2018/2021
Central (Beirut)	Burj Barajneh	W	2	3	2	0	7
		SW	0	1	1	1	3
		WW/StW	1	1	1	1	4
		E/A	1	1	1	1	4
		L/H/R	1	1	1	1	4
	Dbayeh	W	0	1	1	1	3
		SW	0	1	1	1	3
		WW/StW	0	1	0	1	2
		E/A	0	0	1	0	1
		L/H/R	0	1	1	1	3
	Mar Elias	W	2	3	1	0	6
		SW	0	1	1	1	3
		WW/StW	0	1	1	0	2
		E/A	0	0	0	1	1
		L/H/R	0	0	1	1	2
	Shatila	W	1	4	1	0	6
		SW	0	1	1	1	3
		WW/StW	0	1	0	1	2
		E/A	0	1	1	1	3
		L/H/R	1	1	0	1	3
Saida	Ein El Hilweh	W	2	2	2	0	6
		SW	0	1	1	1	3
		WW/StW	0	0	1	0	1
		E/A	0	1	1	1	3
		L/H/R	0	0	0	1	1
	Mieh Mieh	W	2	0	1	1	4
		SW	0	1	1	1	3
		WW/StW	0	1	0	0	1
		E/A	0	1	1	0	2
		L/H/R	0	0	0	1	1

Tyre	Burj Shemali	W	2	2	0	0	4
		SW	1	1	1	1	4
		WW/StW	1	1	0	1	3
		E/A	0	1	1	1	3
		L/H/R	1	0	1	0	2
	El Buss	W	0	1	0	1	2
		SW	1	1	1	1	4
		WW/StW	1	0	1	0	2
		E/A	0	0	0	1	1
		L/H/R	1	0	1	0	2
	Rashidieh	W	3	1	0	0	4
		SW	1	1	1	1	4
		WW/StW	1	0	1	1	3
		E/A	0	0	1	0	1
		L/H/R	1	0	1	0	2
Bekaa	Wavel	W	4	0	0	0	4
		SW	0	1	1	1	3
		WW/StW	1	0	1	0	2
		E/A	0	1	1	1	3
		L/H/R	0	1	1	0	2
North (Tripoli)	Beddawi	W	3	2	1	1	7
		SW	0	1	1	1	3
		WW/StW	1	1	1	1	4
		E/A	1	1	1	1	4
		L/H/R	0	1	1	1	3
	Nahr El Bared	W	3	5	3	0	11
		SW	0	1	1	1	3
		WW/StW	1	1	1	1	4
		E/A	0	1	1	1	3
		L/H/R	1	1	1	1	4
Projects			42	58	51	40	191
			22%	30%	27%	21%	100%

W-Water; SW-Solid Waste; WW/StW-Wastewater, Storm Water; E/A- Energy, Air; L/H/R- Land, Habitat, Roads

Project implementation will be based on priority and the security situation.

Each detail's project is available at FICIP.

Area	Camp	Sector	2018	2019	2020	2021	2018/2021
Central (Beirut)	Burj Barajneh	W	160,000	157,000	224,000	0	**541,000**
		SW	0	120,000	40,000	60,000	**220,000**
		WW/StW	100,000	200,000	50,000	50,000	**400,000**
		E/A	5,000	24,000	35,000	20,000	**84,000**
		L/H/R	50,000	100,000	40,000	30,000	**220,000**
		PT	31,500	60,100	38,900	16,000	**146,500**
	Dbayeh	W	0	177,000	160,000	55,000	**392,000**
		SW	0	30,000	35,000	15,000	**80,000**
		WW/StW	0	60,000	0	10,000	**70,000**
		E/A	0	0	10,000	0	**10,000**
		L/H/R	0	25,000	25,000	25,000	**75,000**
		PT	0	29,200	23,000	10,500	**62,700**
	Mar Elias	W	41,000	73,000	5,000	0	**119,000**
		SW	0	20,000	5,000	10,000	**35,000**
		WW/StW	0	70,000	20,000	0	**90,000**
		E/A	0	0	0	10,000	**10,000**
		L/H/R	0	0	20,000	10,000	**30,000**
		PT	4,100	16,300	5,000	3,000	**28,400**
	Shatila	W	52,000	98,000	52,000	0	**202,000**
		SW	0	65,000	20,000	25,000	**110,000**
		WW/StW	0	30,000	0	30,000	**60,000**
		E/A	0	21,000	30,000	15,000	**66,000**
		L/H/R	35,000	25,000	0	25,000	**85,000**
		PT	8,700	23,900	10,200	9,500	**52,300**
Saida	Ein El Hilweh	W	98,000	222,000	265,000	0	**585,000**
		SW	0	425,000	45,000	350,000	**820,000**
		WW/StW	0	0	100,000	0	**100,000**
		E/A	0	28,000	30,000	30,000	**88,000**
		L/H/R	0	0	0	30,000	**30,000**
		PT	9,800	67,500	44,000	41,000	**162,300**

	Mieh Mieh	W	44,000	0	53,000	65,000	**162,000**
		SW	0	65,000	10,000	50,000	**125,000**
		WW/StW	0	30,000	0	0	**30,000**
		E/A	0	21,000	10,000	0	**31,000**
		L/H/R	0	0	0	40,000	**40,000**
		PT	4,400	11,600	7,300	15,500	**38,800**
Tyre	Burj Shemali	W	141,000	161,000	0	0	**302,000**
		SW	200,000	60,000	55,000	60,000	**375,000**
		WW/StW	100,000	50,000	0	40,000	**190,000**
		E/A	0	25,000	25,000	25,000	**75,000**
		L/H/R	120,000	0	30,000	0	**150,000**
		PT	56,100	29,600	11,000	12,500	**109,200**
	El Buss	W	0	20,000	0	25,000	**45,000**
		SW	100,000	15,000	20,000	15,000	**150,000**
		WW/StW	50,000	0	40,000	0	**90,000**
		E/A	0	0	0	10,000	**10,000**
		L/H/R	80,000	0	40,000	0	**120,000**
		PT	23,000	3,500	10,000	5,000	**41,500**
	Rashidieh	W	456,000	50,000	0	0	**506,000**
		SW	200,000	60,000	65,000	60,000	**385,000**
		WW/StW	500,000	0	175,000	30,000	**705,000**
		E/A	0	0	20,000	0	**20,000**
		L/H/R	50,000	0	50,000	0	**100,000**
		PT	120,600	11,000	31,000	9,000	**171,600**
Bekaa	Wavel	W	804,000	0	0	0	**804,000**
		SW	0	40,000	30,000	30,000	**100,000**
		WW/StW	40,000	0	20,000	0	**60,000**
		E/A	0	30,000	5,000	25,000	**60,000**
		L/H/R	0	30,000	10,000	0	**40,000**
		PT	84,400	10,000	6,500	5,500	**106,400**

North (Tripoli)	Beddawi	W	562,000	227,000	152,000	152,000	1,093,000
		SW	0	140,000	200,000	55,000	395,000
		WW/StW	100,000	500,000	100,000	60,000	760,000
		E/A	25,000	28,000	18,000	50,000	121,000
		L/H/R	0	150,000	70,000	50,000	270,000
		PT	68,700	104,500	54,000	36,700	263,900
	Nahr El Bared Including AA	W	158,000	536,000	152,000	0	846,000
		SW	0	180,000	250,000	75,000	505,000
		WW/StW	100,000	200,000	60,000	40,000	400,000
		E/A	0	25,000	20,000	30,000	75,000
		L/H/R	50,000	100,000	20,000	20,000	190,000
		PT	30,800	104,100	50,200	16,500	201,600
Project budget (USD)			**4,863,100**	**5,184,300**	**3,202,100**	**1,987,700**	**15,237,200**
			32%	**34%**	**21%**	**13%**	**100%**

W-Water; SW-Solid Waste; WW/StW-Wastewater, Storm Water; L/H/E/A-Land, Habitat, Energy, Air; R-Roads
PT-Programmes and Tools: equivalent of 12.5% of the project cost in average.
Each detail's project is available at FICIP.

Annex 6: Distribution of Projects for 2018 – 2021 (per camp)

Area	Camp	Sector	2018	2019	2020	2021	2018/2021	
Central (Beirut)	Burj Barajneh	W SW WW/StW E/A L/H/R PT	346,500	661,100	427,900	176,000	1,611,500	11%
	Dbayeh	W SW WW/StW E/A L/H/R PT	0	321,200	253,000	115,500	689,700	5%
	Mar Elias	W SW WW/StW E/A L/H/R PT	45,100	179,300	55,000	33,000	312,400	2%
	Shatila	W SW WW/StW E/A L/H/R PT	95,700	262,900	112,200	104,500	575,300	4%
Saida	Ein El Hilweh	W SW WW/StW E/A L/H/R PT	107,800	742,500	484,000	451,000	1,785,300	12%

Tyre	Mieh Mieh	W SW WW/StW E/A L/H/R PT	48,400	127,600	80,300	170,500	426,800	3%
Tyre	Burj Shemali	W SW WW/StW E/A L/H/R PT	617,100	325,600	121,000	137,500	1,201,200	8%
Tyre	El Buss	W SW WW/StW E/A L/H/R PT	253,000	38,500	110,000	55,000	456,500	3%
Tyre	Rashidieh	W SW WW/StW E/A L/H/R PT	1,326,600	121,000	341,000	99,000	1,887,600	12%
Bekaa	Wavel	W SW WW/StW E/A L/H/R PT	928,400	110,000	71,500	60,500	1,170,400	8%
North (Tripoli)	Beddawi	W SW WW/StW E/A L/H/R PT	755,700	1,149,500	594,000	403,700	2,902,900	19%

	Nahr El Bared	W SW WW/StW E/A L/H/R PT	338,800	1,145,100	552,200	181,500	2,217,600	15%
Projects budget (USD)			**4,863,100**	**5,184,300**	**3,202,100**	**1,987,700**	**15,237,200**	

W-Water; SW-Solid Waste; WW/StW-Wastewater, Storm Water; E/A- Energy, Air; L/H/R- Land, Habitat, Roads
PT-Programmes and Tools: equivalent of 12.5% of the project cost in average
Each detail's project is available at FICIP

Annex 7: Distribution of Projects for 2018 – 2021 (per sector)

Sector	2018	2019	2020	2021	2018/2021	
Water	24	24	12	4	**64**	34%
Sanitation	10	20	20	19	**69**	36%
Energy, Air	2	8	10	9	**29**	15%
Land, Habitat, Roads	6	6	9	8	**29**	15%
Total	**42**	**58**	**51**	**40**	**191**	**100%**
Distribution	**22%**	**30%**	**27%**	**21%**		

Annex 8: Budget Needs for 2018 – 2021

	2018	2019	2020	2021	Total 2018 - 2021
Environmental Infrastrucutre and Environmental Health activities (2018 - 2021)					
Projects	4,421,000	4,713,000	2,911,000	1,807,000	**13,852,000**
Programmes and tools	442,100	471,300	291,100	180,700	**1,385,200**
Running costs	1,191,600	1,221,390	1,282,460	1,314,521	**5,009,970**
Human resources	603,480	618,480	648,480	663,480	**2,533,920**
Sub-total	**6,658,180**	**7,024,170**	**5,133,040**	**3,965,701**	**22,781,090**
Overhead					**2,505,920**
Grand-total					**25,287,010**

	2018	2019	2020	2021	Total 2018 - 2021
External activities related to the FICIP and Environmental Health Unit					
AA Nahr El Bared	426,000	340,800	326,600	326,600	**1,420,000**
Burj Shemali Solid waste plant		2,152,625	2,152,625	367,372	**4,672,622**
Sub-total	**426,000**	**2,493,425**	**2,479,225**	**693,972**	**6,092,622**

Sector	Camp	Projects 2018	COST ($)
Water	Burj Barajneh	Rehabilitation of underground drinking water network to provide water from the R.O. to households	30,000
		Rehabilitation of 5 wells in the camp (wellheads, pumps, and pipes).	130,000
	Mar Elias	Rehabiliation of 1 well in the camp (wellheads, pumps, and pipes)	26,000
		Replacement of all steel cabinets	15,000
	Shatila	Rehabiliation of 2 wells in the camp (wellheads, pumps, and pipes)	52,000
	Ein El Hilweh	Installation of Monitoring Probes in two wells (water level and Electric conductivity measurements)	12,000
		Rehabilitation of 2 wells (wellheads, pumps, and pipes)	86,000
	Mieh Mieh	Rehabilitation of one well MM1 (well heads, pipes, and pump)	38,000
		Installation of Monitoring Probes in one wells (water level and Electric conductivity measurements)	6,000
	Burj Shemali	Rehabiliation of all 3 wells in the camp (wellheads, pumps, and pipes)	129,000
		Installation of Monitoring Probes in two wells (water level and Electric conductivity measurements)	12,000
	Rashidieh	Installation of Monitoring Probes in the main spring (water level measurement)	6,000
		Construction of the tank RATA0002 (Old tank)	400,000
		Rehabiliation and extension of the network to household lacking connections to the network	50,000
	Wavel	Rehabiliation of the 1 well in the camp (wellheads, pumps, and pipes)	28,000
		Construction of deep Borehole (800m) with PV solar system and connect to the tank (WATA0001)	750,000
		Installation of Monitoring Probes in one well (water level and Electric conductivity)	6,000
		Upgrading and extension of the network to households lacking connection to the network	20,000
	Beddawi	Construction of a new water tank for the new well	350,000
		Construction of one well	200,000
		Installation of Monitoring Probes in two wells (water level and Electric conductivity measurements)	12,000
	Nahr El Bared	Rehabiliation of 3 wells in the camp and AA (wellheads, pumps, and pipes)	78,000
		Installation of Monitoring Probes in 2 wells (water level and Electric conductivity measurements) and one in the river	30,000
		Rehabiliation of AA network (enlarging the diameter of the current pipes for sufficient water supply)	50,000
Solid Waste	Burj Shemali	Camp solid waste operational plan and operation and maintainance of solid waste system	200,000
	El Buss	Camp solid waste operational plan and operation and maintainance of solid waste system	100,000
	Rashidieh	Camp solid waste operational plan and operation and maintainance of solid waste system	200,000

Waste water/ Storm water	Burj Barajneh	Rehabilitation/ Construction of WW/StW Network	100,000
	Burj Shemali	Rehabilitation/ Construction of WW/StW Network	100,000
	El Buss	Rehabilitation/ Construction of WW/StW Network	50,000
	Rashidieh	Rehabilitation/ Construction of WW/StW Network	500,000
	Wavel	Rehabilitation/ Construction of WW/StW Network	40,000
	Beddawi	Rehabilitation/ Construction of WW/StW Network	100,000
	Nahr El Bared	Rehabilitation/ Construction of WW/StW Network	100,000
Energy/Air	Burj Barajneh	Air pollution monitoring	5,000
	Beddawi	Replacement/repair of generators for water wells	25,000
Land/Habitat/ Roads	Burj Barajneh	Pavement of roads and alley	50,000
	Shatila	Pavement of roads and alley	35,000
	Burj Shemali	Pavement of roads and alley	120,000
	El Buss	Pavement of roads and alley	80,000
	Rashidieh	Pavement of roads and alley	50,000
	Nahr El Bared	Pavement of roads and alley	50,000
Total			**4,421,000**

Sector	Camp	Projects 2019	COST ($)
Water	Burj Barajneh	Rehabilitation of 5 wells in the camp (wellheads, pumps, and pipes)	6,000
		Installation of Monitoring Probes in two wells (water level and Electric conductivity measurements)	15,000
		Rehabilitaion of R.O. system	52,000
	Dbayeh	Rehabilitation of the existing network and provide connections to households	25,000
	Mar Elias	Rehabiliation of 2 wells in the camp (wellheads, pumps, and pipes)	6,000
		Installation of Monitoring Probes in one well (water level and Electric conductivity measurements)	15,000
		Rehabilitation of the R.O. system	172,000
	Shatila	Rehabiliation of 2 wells in the camp (wellheads, pumps, and pipes)	50,000
		Rehabiliation of the underground old network to provide potable water from R.O. system	86,000
		Installation of Monitoring Probes in one well (water level and Electric conductivity)	75,000
		Rehabilitation of R.O. system	20,000
	Ein El Hilweh	Rehabilitation of 4 wells (wellheads, pumps, and pipes)	50,000
		Rehabilitation of 3 non functional water tanks	152,000
	Burj Shemali	Rehabiliation of all 2 wells in the camp (wellheads, pumps, and pipes)	75,000
		Rehabiliation and extension of the network	156,000
	El Buss	Maintanance of the network and replacement of all steel cabinets	100,000
	Rashidieh	Rehabiliation and extension of the network to household lacking connections to the network	30,000
	Beddawi	Rehabiliation of 4 wells in the camp (wellheads, pumps, and pipes)	150,000
		Extension of the Network to some areas in the camp lacking connections	100,000
	Nahr El Bared	Rehabiliation of 6 wells in the camp and AA (wellheads, pumps, and pipes)	48,000
		Rehabiliation of NB old camp network (Division of network into sectors)	100,000
		Installation of Monitoring Probes in 3 wells (water level and Electric conductivity measurements)	30,000
		Construction of one well (250 m depth)	150,000
		Rehabiliation of AA network (enlarging the diameter of the current pipes for sufficient water supply)	100,000
Solid Waste	Burj Barajneh	Operation and maintainance of SW system	120,000
	Dbayeh	Operation and maintainance of SW system	30,000
	Mar Elias	Operation and maintainance of SW system	20,000
	Shatila	Operation and maintainance of SW system	65,000
	Ein El Hilweh	Camp solid waste operational plan and operation and maintainance of solid waste system	425,000
	Mieh Mieh	Camp solid waste operational plan and operation and maintainance of solid waste system	65,000
	Burj Shemali	Operation and maintainance of SW system	60,000

	El Buss	Operation and maintainance of SW system	15,000
	Rashidieh	Operation and maintainance of SW system	60,000
	Wavel	Camp solid waste operational plan and operation and maintainance of solid waste system	40,000
	Beddawi	Operation and maintainance of SW system	140,000
	Nahr El Bared	Operation and maintainance of SW system	180,000
Waste water/ storm water	Burj Barajneh	Rehabilitation/ Construction of WW/StW Network	200,000
	Dbayeh	Rehabilitation/ Construction of WW/StW Network	60,000
	Mar Elias	Rehabilitation/ Construction of WW/StW Network	70,000
	Shatila	Rehabilitation/ Construction of WW/StW Network	30,000
	Mieh Mieh	Rehabilitation/ Construction of WW/StW Network	30,000
	Burj Shemali	Rehabilitation/ Construction of WW/StW Network	50,000
	Beddawi	Rehabilitation/ Construction of WW/StW Network	500,000
	Nahr El Bared	Rehabilitation/ Construction of WW/StW Network	200,000
Energy/Air	Burj Barajneh	Replacement/repair of generators for water wells	24,000
	Shatila	Replacement/repair of generators for water wells	21,000
	Ein El Hilweh	Replacement/repair of generators for water wells	28,000
	Mieh Mieh	Replacement/repair of generators for water wells	21,000
	Burj Shemali	Replacement/repair of generators for water wells	25,000
	Wavel	Replacement/repair of generators for water wells	30,000
	Beddawi	Replacement/repair of generators for water wells	28,000
	Nahr El Bared	Replacement/repair of generators for water wells	25,000
Land/Habitat/ Roads	Burj Barajneh	Pavement of roads and alley	100,000
	Dbayeh	Pavement of roads and alley	25,000
	Shatila	Pavement of roads and alley	25,000
	Wavel	Pavement of roads and alley	30,000
	Beddawi	Pavement of roads and alley	150,000
	Nahr El Bared	Pavement of roads and alley	100,000
Total			**4,713,000**

Sector	Camp	Projects 2020	COST ($)
Water	Burj Barajneh	Rehabilitation of 4 wells in the camp (wellheads, pumps, and pipes)	104,000
		Extension of the Domestic Water Network	120,000
	Dbayeh	Rehabilitation of the water tanks	160,000
	Mar Elias	Rehabiliation of the underground network	5,000
	Shatila	Rehabilitation of 2 wells in the camp (wellheads, pumps, and pipes)	52,000
	Ein El Hilweh	Rehabilitation of 5 wells (wellheads, pumps, and pipes)	215,000
		Rehabiliation of the network	50,000
	Mieh Mieh	Rehabilitation of the MM2 well (well head, pipes, and pump)	53,000
	Beddawi	Rehabiliation of 4 wells in the camp (wellheads, pumps, and pipes)	152,000
	Nahr El Bared	Rehabiliation of NB old camp network (Division of network into sectors)	50,000
		Rehabiliation of 2 wells in the camp and AA (wellheads, pumps, and pipes)	52,000
		Rehabiliation of AA network	50,000
Solid Waste	Burj Barajneh	Operation and maintainance of SW system	40,000
	Dbayeh	Operation and maintainance of SW system	35,000
	Mar Elias	Operation and maintainance of SW system	5,000
	Shatila	Operation and maintainance of SW system	20,000
	Ein El Hilweh	Operation and maintainance of SW system	45,000
	Mieh Mieh	Operation and maintainance of SW system	10,000
	Burj Shemali	Operation and maintainance of SW system	55,000
	El Buss	Operation and maintainance of SW system	20,000
	Rashidieh	Operation and maintainance of SW system	65,000
	Wavel	Operation and maintainance of SW system	30,000
	Beddawi	Camp solid waste operational plan and operation and maintainance of solid waste system	200,000
	Nahr El Bared	Camp solid waste operational plan and operation and maintainance of solid waste system	250,000
Waste water/ Storm water	Burj Barajneh	Rehabilitation/ Construction of WW/StW Network	50,000
	Mar Elias	Rehabilitation/ Construction of WW/StW Network	20,000
	Ein El Hilweh	Rehabilitation/ Construction of WW/StW Network	100,000
	El Buss	Rehabilitation/ Construction of WW/StW Network	40,000
	Rashidieh	Rehabilitation/ Construction of WW/StW Network	175,000
	Wavel	Rehabilitation/ Construction of WW/StW Network	20,000
	Beddawi	Rehabilitation/ Construction of WW/StW Network	100,000
	Nahr El Bared	Rehabilitation/ Construction of WW/StW Network	60,000

Energy/Air	Burj Barajneh	Replacement/repair of generators for water wells	35,000
	Dbayeh	Replacement/repair of generators for water wells	10,000
	Shatila	Replacement/repair of generators for water wells	30,000
	Ein El Hilweh	Replacement/repair of generators for water wells	30,000
	Mieh Mieh	Replacement/repair of generators for water wells	10,000
	Burj Shemali	Replacement/repair of generators for water wells	25,000
	Rashidieh	Replacement/repair of generators for water wells	20,000
	Wavel	Replacement/repair of generators for water wells	5,000
	Beddawi	Replacement/repair of generators for water wells	18,000
	Nahr El Bared	Replacement/repair of generators for water wells	20,000
Land/Habitat/ Roads	Burj Barajneh	Pavement of roads and alley	40,000
	Dbayeh	Pavement of roads and alley	25,000
	Mar Elias	Pavement of roads and alley	20,000
	Burj Shemali	Pavement of roads and alley	30,000
	El Buss	Pavement of roads and alley	40,000
	Rashidieh	Pavement of roads and alley	50,000
	Wavel	Pavement of roads and alley	10,000
	Beddawi	Pavement of roads and alley	70,000
	Nahr El Bared	Pavement of roads and alley	20,000
Total			**2,911,000**

Sector	Camp	Projects 2021	COST ($)
Water	Dbayeh	Rehabiliation of the network	55,000
	Mieh Mieh	Rehabiliation of the network	65,000
	El Buss	Maintanance of the network	25,000
	Beddawi	Rehabiliation of 4 wells in the camp (wellheads, pumps, and pipes)	152,000
Solid Waste	Burj Barajneh	Operation and maintainance of SW system	60,000
	Dbayeh	Operation and maintainance of SW system	15,000
	Mar Elias	Operation and maintainance of SW system	10,000
	Shatila	Operation and maintainance of SW system	25,000
	Ein El Hilweh	Camp solid waste operational plan and operation and maintainance of solid waste system	350,000
	Mieh Mieh	Camp solid waste operational plan and operation and maintainance of solid waste system	50,000
	Burj Shemali	Operation and maintainance of SW system	60,000
	El Buss	Operation and maintainance of SW system	15,000
	Rashidieh	Operation and maintainance of SW system	60,000
	Wavel	Camp solid waste operational plan and operation and maintainance of solid waste system	30,000
	Beddawi	Operation and maintainance of SW system	55,000
	Nahr El Bared	Operation and maintainance of SW system	75,000
Waste water/ Storm water	Burj Barajneh	Rehabilitation/ Construction of WW/StW Network	50,000
	Dbayeh	Rehabilitation/ Construction of WW/StW Network	10,000
	Shatila	Rehabilitation/ Construction of WW/StW Network	30,000
	Burj Shemali	Rehabilitation/ Construction of WW/StW Network	40,000
	Rashidieh	Rehabilitation/ Construction of WW/StW Network	30,000
	Beddawi	Rehabilitation/ Construction of WW/StW Network	60,000
	Nahr El Bared	Rehabilitation/ Construction of WW/StW Network	40,000
Energy/Air	Burj Barajneh	Replacement/repair of generators for water wells	20,000
	Mar Elias	Replacement/repair of generators for water wells	10,000
	Shatila	Replacement/repair of generators for water wells	15,000
	Ein El Hilweh	Replacement/repair of generators for water wells	30,000
	Burj Shemali	Replacement/repair of generators for water wells	25,000
	El Buss	Replacement/repair of generators for water wells	10,000
	Wavel	Replacement/repair of generators for water wells	25,000
	Beddawi	Replacement/repair of generators for water wells	50,000
	Nahr El Bared	Replacement/repair of generators for water wells	30,000

Land/Habitat/ Roads	Burj Barajneh	Pavement of roads and alley	30,000
	Dbayeh	Pavement of roads and alley	25,000
	Mar Elias	Pavement of roads and alley	10,000
	Shatila	Pavement of roads and alley	25,000
	Ein El Hilweh	Pavement of roads and alley	30,000
	Mieh Mieh	Pavement of roads and alley	40,000
	Beddawi	Pavement of roads and alley	50,000
	Nahr El Bared	Pavement of roads and alley	20,000
Total			**1,807,000**

Annex 9: Project, Running and Support Costs for 2018 – 2021

(per camp and cost per capita in USD)

Area	Camp	Project costs	Running costs	Support staff costs	Total
Central (Beirut)	Burj Barajneh	1,611,500	578,106	279,209	**2,468,815**
	Dbayeh	689,700	33,635	24,861	**748,196**
	Mar Elias	312,400	119,826	30,598	**462,824**
	Shatila	575,300	416,236	191,239	**1,182,775**
Saida	Ein El Hilweh	1,785,300	660,092	717,147	**3,162,539**
	Mieh Mieh	426,800	93,338	71,715	**591,853**
Tyre	Burj Shemali	1,201,200	840,881	239,049	**2,281,130**
	El Buss	456,500	235,447	143,429	**835,376**
	Rashidieh	1,887,600	660,092	172,115	**2,719,807**
Bekaa	Wavel	1,170,400	332,148	43,029	**1,545,577**
North (Tripoli)	Beddawi	2,902,900	607,116	315,545	**3,825,561**
	Nahr El Bared	2,217,600	433,054	305,983	**2,956,637**
Total		**15,237,200**	**5,009,970**	**2,533,920**	**22,781,090**

Annex 10: Thematic EIEH Atlas[110]

Coverage	Title	Repetition
National	Palestine refugee camps and administrative boundaries	1
National	Estimated populations in the 12 Palestine refugee camps	1
National	Palestine refugee camps, Gatherings and Syrian Informal Settlements	1
National	Water Establishments	1
National	Solid Waste Facilities	1
National	Geological formation	1
National	Groundwater basin	1
National	Rainfall average and weather stations	1
National	Topography	1
National	Environmental health surveys	1
Local	Central Area of Lebanon (Beirut) – Burj Barajneh, Dbayeh, Mar Elias, Shatila	1
Local	Saida Area – Ein El Hilweh, Mieh Mieh	1
Local	Tyre Area – Burj Shemali, El Buss, Rashidieh	1
Local	North Area (Tripoli) – Beddawi, Nahr El Bared	1
Local	Beqaa (Baalbek) – Wavel	1
Local	Solid waste context in Tyre area	1
Local	Sainik watershed (Saida area)	1
Camp	Habitat sector (Roads, premises, buildings)	12
Camp	Habitat sector (Roofs) – Wavel	1
Camp	Habitat sector (Building floors and topography) – Burj Barajneh	1
Camp	Water sector (Sources, treatment, tank, pipeline)	12
Camp	Water sector (Vulnerability zones) – Nahr El Bared, Wavel, Rashidieh	3
Camp	Sanitation sector (Wastewater)	12
Camp	Sanitation sector (Storm water)	12
Camp	Sanitation sector (Solid waste)	12
Camp	Energy sector (Generators and transformers)	12
Camp	Air sector (Air quality results - PM_{10})	1
Camp	Programmes and tools (Flooding areas) – Rashidieh	1
Camp	Programmes and tools (Social zones)	12
		127

[110] Document available separately from the Response Plan. UNRWA FICIP. 2017.

Annex 11: List of Fields and Attributes Georeferenced[111]

Sector	Sub-sector	Fields and attributes	autoCAD
Land	Administrative	National, Mohafaza, Caza, Municipality, Water Establishment, Cities	
	Geology	Characteristics, classification	
	Hydrogeology	Characteristics, classification	
	Soil	Characteristics, classification	
	Topography	Altitudes, level lines	Yes
	Rainfall	Precipitations	
	Food	Presence of pesticides in vegetable and fruits	
Habitat	Premises	Schools, health centres, offices, various	Yes
	Population	Palestine refugee camps (PRS, PRL, Syrians, others)	
		Gatherings and Informal Settlements	
	Roads	Entrances, length, width, categories (asphalt, cement, open)	Yes
	Area	Surface of the camps	Yes
	Buildings	Numbers, roof's surface, number of shelters per camp, number floors[4]	Yes
Water	Sources	Wells, boreholes, total depth, pumps – depth of the pump –, yields, pumping hours, brand, consumption, monitoring equipment, SWL, DWL, treatment station, vulnerability zones, year of construction, custody	Yes
	Quality	Households JMP, schools, health centres, water sources (physico-chemical and bacteriological)	
	Supply	Main, second pipelines, diameters, material, year of installation, tanks, capacity, year of construction	Yes
Sanitation	Wastewater	Main, second pipelines, diameters, material, year of installation, treatment plan, manholes, topography	Yes
	Storm water	Main, second pipelines, diameters, material, year of installation, treatment plan, manholes, topography	Yes
	Solid waste	Quantities disposed, sources, categories (municipal, medial, e-waste,…), platforms, roads, vehicles, destination of solid waste	
Energy	Generators	Number, brand, consumption, power, working hours, size, supply services, presence of exhaust pipe, year of installation, custody	
	Transformers	Number, brand, power, working hours (EDL), size, supply services, PCBs presence, year of installation, custody	
Air	Weather stations	Rainfall, insolation, wind speed and direction, temperatures	
	Indoor	Particle matter, air pollution parameters	

[111] Fields included (with different level of precision) in the Environmental Infrastructure and Environmental Health Inventory GIS geodata base developed by UNRWA FICIP. 2017.

P&T	Social	Zones
	Sanitation	Zones
	Landmarks	Entrances, exits, open area, sport area, pumping station, mosque, church, soccer fields, etc.

Annex 12: Lebanese Maximum Admissible Value

SUBSTANCE	Maximum Admissible Value For Potable Water	
	Lebanese Standards	WHO Guidelines
Turbidity	5 NTU	5 NTU
pH	6.5-8.5	
Conductivity (20ºC)	1,500 µS/cm	
TDS	500 mg/l	1,000 mg/l
Free Cl_2	0.3 mg/l	0.5 mg/l
Total Hardness	250 mg/l $CaCO_3$	
Calcium (Ca^{2+})	200 mg/l	
Magnesium (Mg^{2+})	50 mg/l	
Potassium (K^+)	12 mg/l	
Sodium (Na^+)	150 mg/l	50 mg/l
Alaminium (Al)	0.2 mg/l	
Nitrite (NO_2^-)	0.05 mg/l	0.2 mg/l
Nitrate (NO_3^-)	45 mg/l	50 mg/l
Sulfate (SO_4^{2-})	250 mg/l	
Chloride (Cl^-)	200 mg/l	
Fluoride (F^-)	0.7 mg/l	1.5 mg/l
Phosphate (PO_4^{3-})	1 mg/l	
Iron (Fe)	0.3 mg/l	
Manganese (Mn)	0.05 mg/l	0.4 mg/l
Hydrogen Sulfide (H_2S)	0.05 mg/l	
Silica (SiO_2)	20 mg/l	
Arsenic (As)	0.05 mg/l	0.01 mg/l
Barium (Ba)	0.5 mg/l	0.7 mg/l
Cadmium (Cd)	0.01 mg/l	
Chromium (Cr)	0.05 mg/l	0.05 mg/l
Copper (Cu)	1 mg/l	
Cyanide (CN^-)	0.05 mg/l	0.07 mg/l
Mercury (Hg)	0.001 mg/l	0.006 mg/l

Molybdenum (Mo)		0.07 mg/l
Zinc (Zn)	5 mg/l	
Benzene		0.01 mg/l
Ethylbenzene		0.3 mg/l
Tolune	0.00018 mg/l	0.7 mg/l
Xylenes		0.5 mg/l
Styrene		0.02 mg/l
Phenols	0.001 mg/l	
Pyrene	0.0002 mg/l	
Halogenated Organic Hydrocarbons	0.06 mg/l	
Total Coliform	0 (CFU/100ml)	0 (CFU/100ml)
Escherichia coli	0 (CFU/100ml)	0 (CFU/100ml)
Fecal Enterococci	0 (CFU/250ml)	
Fecal Coliform	0 (CFU/250ml)	
Pseudomonas aeruginosa	0 (CFU/250ml)	

Annex 13: National Standards of Wastewater Discharge Limits

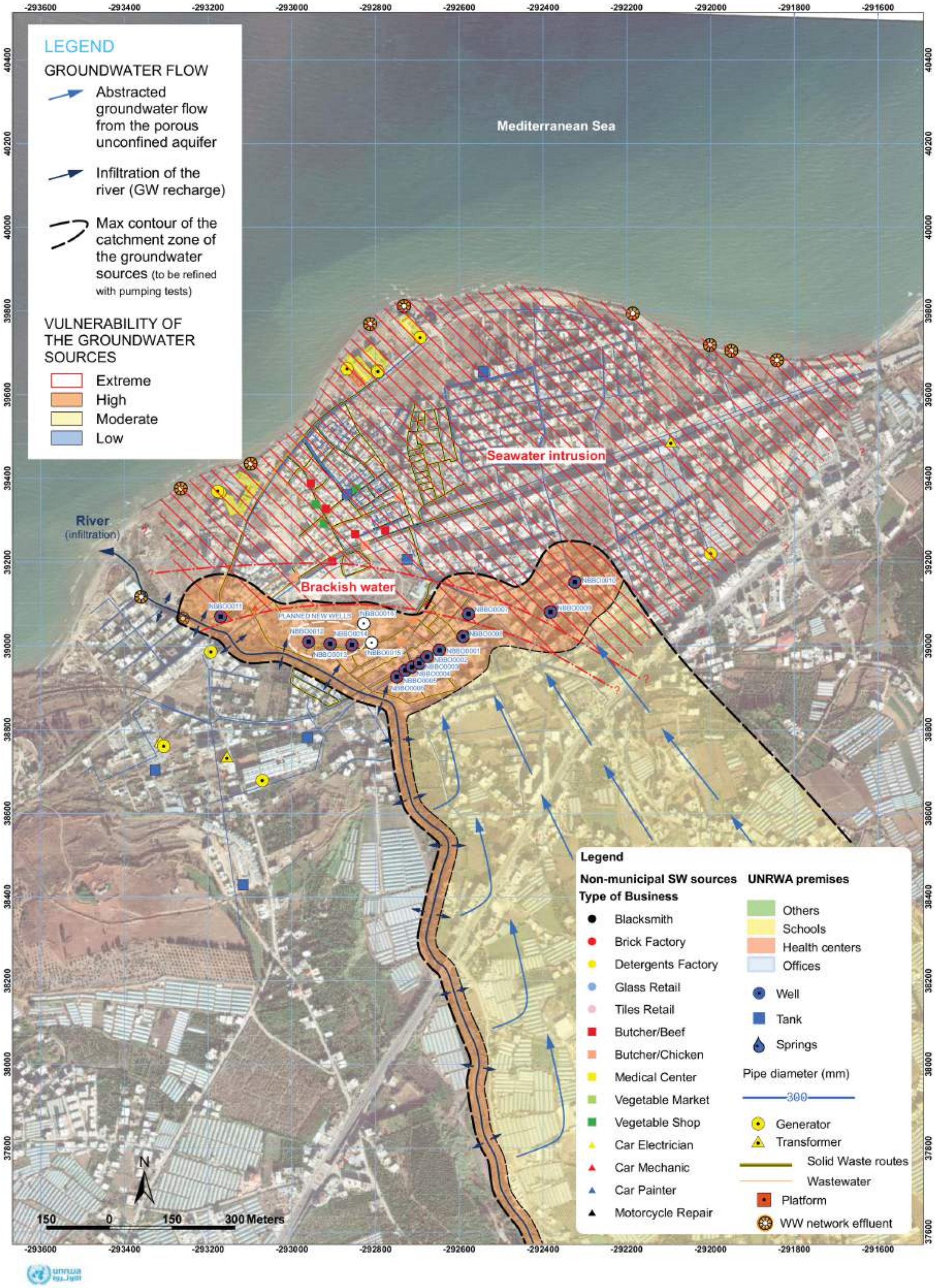
SUBSTANCE	Maximum Allowable Limits For Receiving Water Bodies		
	Sewerage System	Surface Water	Surface Water
Colour	none	none	none
pH	6-9	6-9	6-9
Temperature	35ºC	30 ºC	35ºC
BOD (5 day, 20ºC)	125 mg/l	25 mg/l	25 mg/l
COD (dichromate)	500 mg/l	125 mg/l	125 mg/l
Total Phosphorus	10 mg/l	10 mg/l	10 mg/l
Total Nitrogen	60 mg/l	30 mg/l	30 mg/l
Suspended solids	600 mg/l	60 mg/l	60 mg/l
AO_X	5	5	5
Detergents	-	3 mg/l	3 mg/l
Coliform Bacteria 37°C in 100 ml	-	2,000	2,000
Salmonellae	Absence	Absence	Absence
Hydrocarbons	20 mg/l	20 mg/l	20 mg/l
Phenol Index	5 mg/l	0.3 mg/l	0.3 mg/l
Oil and grease	50 mg/l	30 mg/l	30 mg/l
Total Organic Carbon (TOC)	750 mg/l	75 mg/l	75 mg/l
Ammonia (NH_4^+)	-	10 mg/l	10 mg/l
Silver (Ag)	0.1 mg/l	0.1mg/l	0.1 mg/l
Aluminum (Al)	10 mg/l	10 mg/l	10 mg/l
Arsenic (As)	0.1 mg/l	0.1 mg/l	0.1 mg/l
Barium (Ba)	2 mg/l	2 mg/l	2 mg/l
Cadmium (Cd)	0.2 mg/l	0.2 mg/l	0.2 mg/l
Cobalt (Co)	1 mg/l	0.5 mg/l	0.5 mg/l
Chromium total (Cr)	2 mg/l	2 mg/l	2 mg/l
Hexavalent Chromium (Cr^{VI+})	0.2 mg/l	0.2 mg/l	0.2 mg/l
Copper total (Cu)	1 mg/l	0.5 mg/l	1.5 mg/l
Iron total (Fe)	5 mg/l	5 mg/l	5 mg/l
Mercury total (Hg)	0.05 mg/l	0.05 mg/l	0.05 mg/l
Manganese (Mn)	1 mg/l	1 mg/l	1 mg/l

Nickel total (Ni)	2 mg/l	0.5 mg/l	0.5 mg/l
Lead total (Pb)	1 mg/l	0.5 mg/l	0.5 mg/l
Antimony (Sb)	0.3mg/l	0.3mg/l	0.3mg/l
Tin total (Sn)	2 mg/l	2 mg/l	2 mg/l
Zinc total (Zn)	10 mg/l	5 mg/l	5 mg/l
Active (Cl_2)	-	1 mg/l	1 mg/l
Cyanides (CN^-)	1 mg/l	0.1mg/l	0.1mg/l
Fluorides (F)	15 mg/l	25 mg/l	25 mg/l
Nitrate (NO_3^-)	-	90 mg/l	90 mg/l
Phosphate (PO_4^{3-})	-	5 mg/l	5 mg/l
Sulphate (SO_4^{2-})	1,000 mg/l	1,000 mg/l	1,000 mg/l
Sulphide (S^{2-})	1 mg/l	1 mg/l	1 mg/l

Annex 14: Air Quality Guidelines

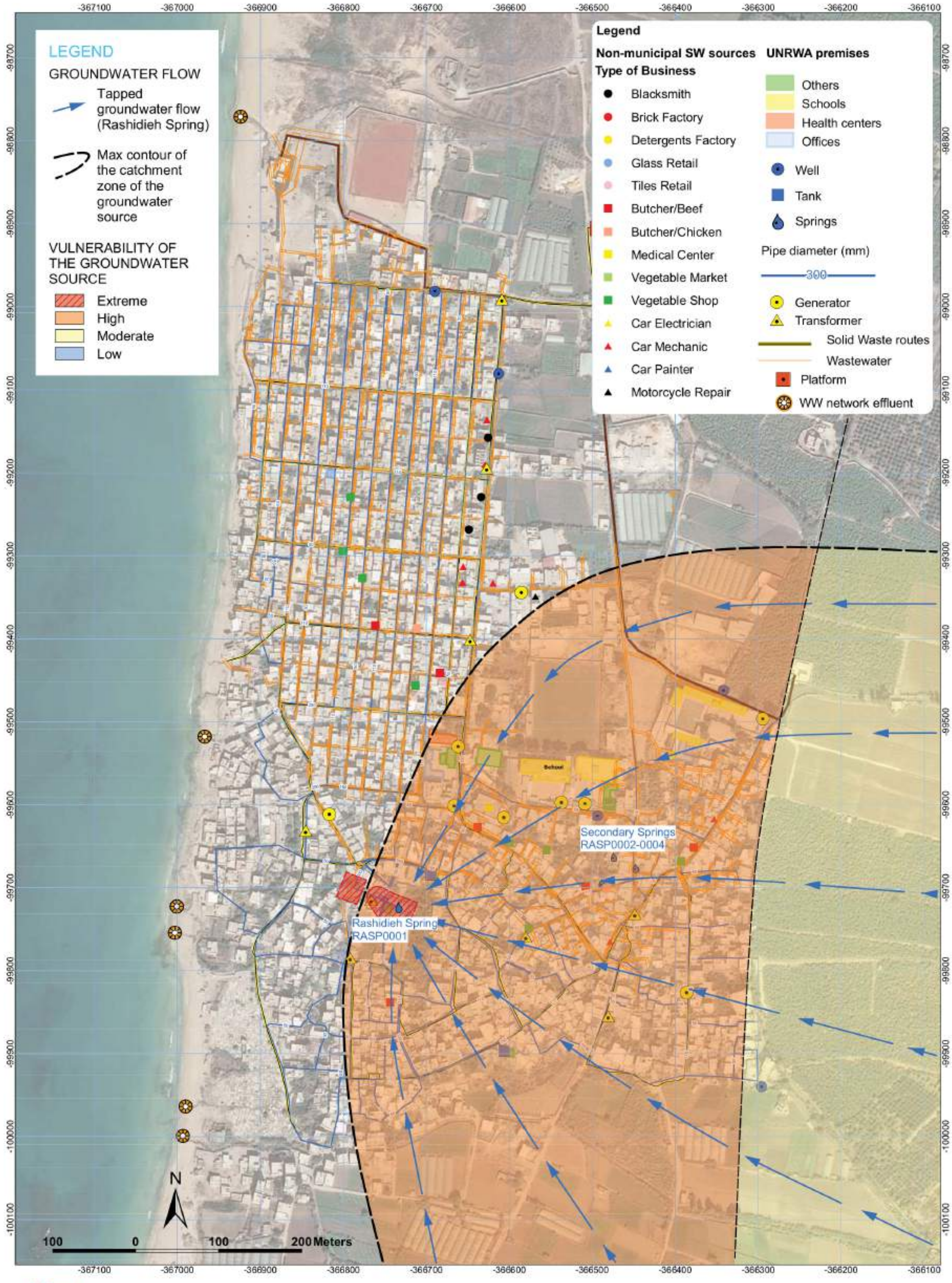
Pollutant	Maximum concentration	Averaging period
Sulphur dioxide (SO_2)	500 $\mu g.m^{-3}$	10 minutes
	20 $\mu g.m^{-3}$	24 hours
Nitrogen dioxide (NO_2)	200 $\mu g.m^{-3}$	1 hour
	40 $\mu g.m^{-3}$	1 year
Ozone (O_3)	100 $\mu g.m^{-3}$	8 hours
Carbon monoxide (CO)	100,000 $\mu g.m^{-3}$	15 minutes
	60,000 $\mu g.m^{-3}$	30 minutes
	30000 $\mu g.m^{-3}$	1 hour
	10,000 $\mu g.m^{-3}$	8 hours
Particulate matter smaller than 10 μm (PM_{10})	50 $\mu g.m^{-3}$	24 hours
	20 $\mu g.m^{-3}$	1 year
Particulate matter smaller than 2.5 μm ($PM_{2.5}$)	25 $\mu g.m^{-3}$	24 hours
	10 $\mu g.m^{-3}$	1 year
Lead	0.5 $\mu g.m^{-3}$	1 year
Benzene	no safe level of exposure can be recommended	excess lifetime risk of leukemia at a concentration of 1 $\mu g.m^{-3}$ is 6×10^{-6}

Annexe 15: Groundwater vulnerability in Nahr El Bared



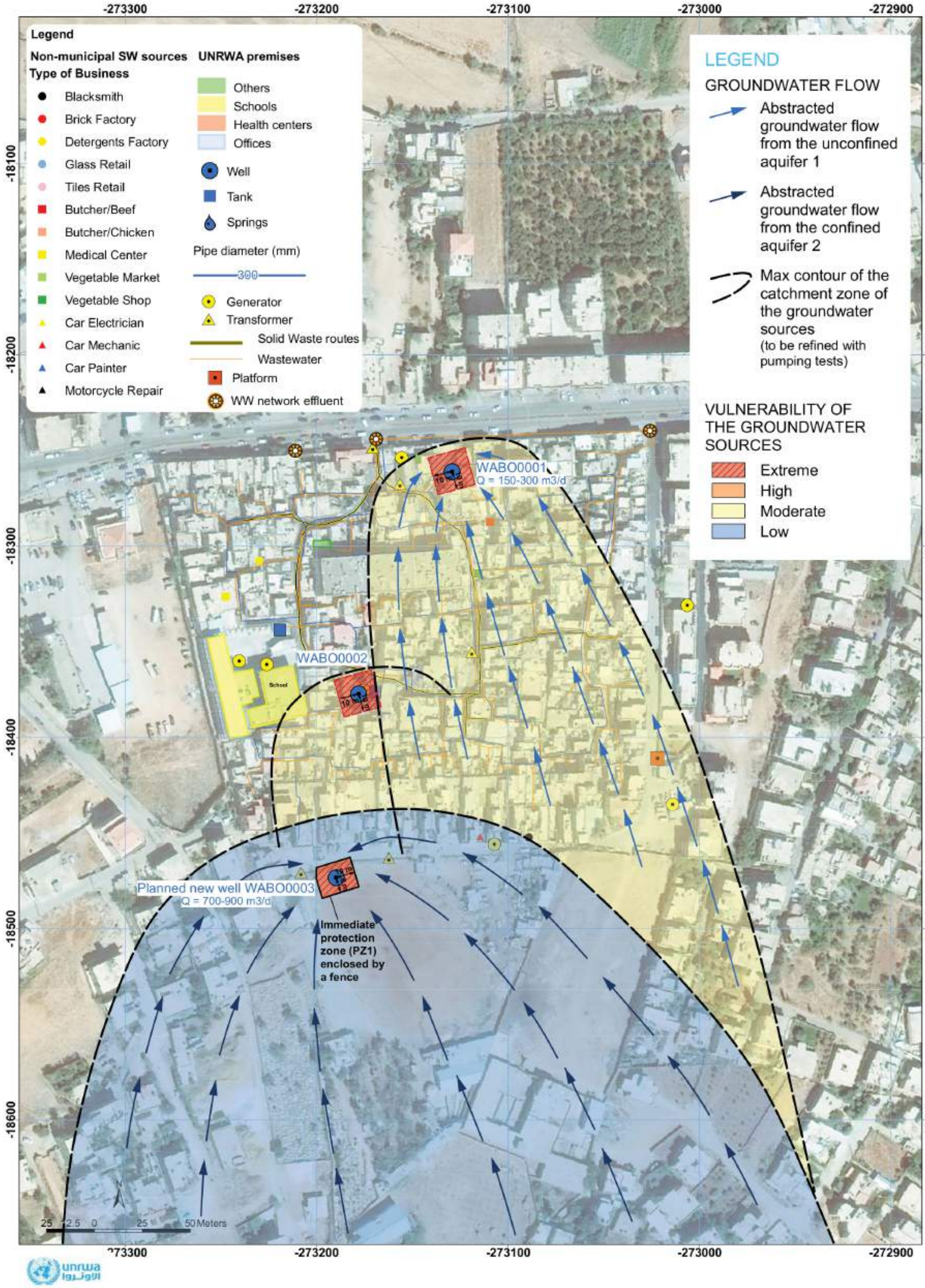
Nahr El Bared: Assessment of the vulnerability of the groundwater sources and the risk of contamination

Annexe 16: Groundwater vulnerability in Rashidieh



Rashidieh: Assessment of the vulnerability of the groundwater sources and the risk of contamination

Annexe 17: Groundwater vulnerability in Wavel



Wavel: Assessment of the vulnerability of the groundwater sources and the risk of contamination

Annexe 18: Qualitative and Quantitative Water Surveillance Plan (Applicable to the 12 camps)

Quantitative Water Monitoring

- **Automatic** weather data (rainfall) through the weather stations
- **All** operational pumping wells are equiped with flow-meters
- **Maximum** of pumping wells are equiped with flow-meters and piezometers
- **Strategic** pumping wells are equiped with flow-meters, piezometers and probes

Qualitative Water Monitoring

→ Households, Schools, Health centres, distribution taps

→ Networks and storage tanks

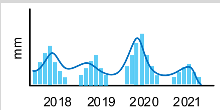
→ Water sources

- **Automatic** data on EC and TDS through the probes
- **A** — **Daily** water analysis are done for free residual chlorine (distribution, households, taps)
- **B** — **Monthly** data at **all** sources (pumping wells, springs)
- **C** — **Trimestrial** bacteriological analysis from the sources and distribution
- **D** — **Quadrennial** complete analysis from the sources (pumping wells, springs)

Weather Stations

→ Aquifers recharge

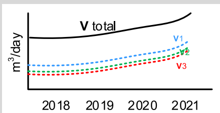
- Coverage = 100% (areas)
- Roofs of water tanks
- Precipitations (mm)
- Frequency = 2 hours
- Data collection = Automatic
- Monthly report, 2018 – 2021 period



Flow-metres

→ Volumes abstracted

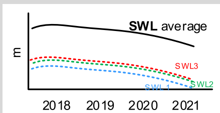
- Coverage = 100%, 1 per well
- Pumping wells, springs, networks
- Pumping volume (m^3/day)
- Frequency = daily
- Data collection = Manual
- Monthly report, 2018 – 2021 period



Piezometers

→ Static levels

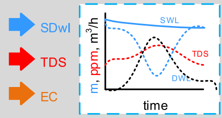
- Coverage = 60 to 100%
- Pumping wells, springs
- Static water levels (m)
- Frequency = monthly
- Data collection = Manual
- Yearly report, 2018 – 2021 period



Probes

→ Static/Dynamic levels, salt

- Coverage ~ 25%
- Pumping wells, springs
- S/D water levels (m), TDS (ppm), EC
- Frequency = 15 minutes
- Data collection = Automatic
- Yearly report, 2018 – 2021 period



Water laboratories

→ Physico-chemical, bacteriological, organoleptics

- Coverage ~ 100% networks
- Pumping wells, springs, tanks, distribution networks

Category A = daily data collection (manual / automatic)
- Residual chlorine (Cl_2)

Category B = weekly, monthly (manual)
- Turbidity, TDS, pH, O_2

Category C = trimestral (manual sampling, laboratories)
- Bacteriology, Cl, NO_3, NO_2, NH_4, Fe, Hardness (strips)

Category D = 1 per 4 years (expert laboratories)
- Full analysis (heavy metals, pesticides, physico-chemicals)

Prepared by C.Guillot, T.Bussard, A.Hamdan, N.Ayyou, M.Kassem, M. Abou Daher, UNRWA FICIP, December 2017

Annexe 19: Synthesis of the water quantity assessment

Camp	**Exploited aquifers** for the water supply of the camps	Large scale (hydrogeological basin)		Local scale (camp)					
		Water balance	Observations	Demand (90 l/p/day) [m^3/d]	Supply [m^3/d]	Assumption of the losses along the network	Difference (including losses): Surplus (+) Shortage (-) [m3/d]	Wastage (percentage of private tanks equipped with float valves)	Remark
BB	Q-mcg	Negative	Regional overexploitation and seawater intrusion	1967	3324	20%	692	High (1%)	Mainly saline water (for domestic use)
DB	J4-J6	Positive	-	252	144	35%	-158	High (20%)	Water supply from an external GW source; a new water network was implemented but is currently not operational
ME	Q-mcg	Negative	Regional overexploitation and seawater intrusion	244	240	20%	-52	Moderate (70%)	Mainly saline water (for domestic use)
SH	Q-mcg	Negative	Regional overexploitation and seawater intrusion	1311	2180	20%	433	Low (93%)	Mainly saline water (for domestic use)
EH	C4-C5	Positive (Cretaceous)	The upper aquifers (Quaternary and Eocene) are however overexploited, as well as the lower aquifer locally	4339	7188	20%	1411	High (23%)	-
MM	C4-C5	Positive (Cretaceous)	Local overexploitation in the north of Saida	489	726	20%	92	Low (87%)	Unequal water distribution, due to the installation of 5 booster pumps (individual acts).

BS	e2b, C4-C5	Nil to Positive (Eocene and Cretaceous)	The upper aquifers (Quaternary and Eocene) are however overexploited	1620	3552	20%	1222	Low (88%)	-
EB	C4-C5 (+Q)	Negative to nil (Quaternary and Eocene); the lower aquifer C4-C5 presents however a positive balance	Regional overexploitation and seawater intrusion	926	720	20%	-350	Moderate (80%)	Water supply from an external GW source; no water shortage is reported by the camp
RA	C4-C5 (+Q)	Positive	Numerous artesian springs along the coast	1273	3300	20%	1367	High (20%)	Supply mainly provided by the Rashidieh spring (which also supply Tyr Municipality)
WA	e2b	Negative (upper aquifers); the lower confined aquifer C4-C5 (target) presents however a positive balance	Regional overexploitation of the upper aquifers (progressive drawdown of the water table)	378	300-420	20%	-42 to -138	Moderate to High (no detailed data)	Planned new pumping well (approximately 850 m in depth) targeting the lower confined aquifer (C4-C5)
BE	m2a	Positive (or even nil due to high uncertainty)	Sign of local seawater intrusion	2057	2500	20%	-57	High (7%)	A new well is planned. The total discharge should however not significantly increase in this sensitive environment
NB	Q	Negative (upper aquifer); the lower confined aquifers present however a positive balance	Regional overexploitation and seawater intrusion	2623	1800	25%	-1273	Moderate to High (no detailed data)	Construction of planned new deep well within the camp (approximately 800 m in depth); artificial recharge of the aquifer could be a potential additional option

Annexe 20: Synthesis of the water quality assessment

Camp	Analysis (results locally based on one sample only)							Observations				
	Groundwater sources					Tap water	Bottled water	Wellhead / Intake		Water Treatment	Tank	Network
	Salt contamination	Total hardness	Urban pollution	Pesticides	Indicator of fecal contamination (E. Coli)			Setting	Status		Status	Status
BB	Saline water	High	Low content* of HCs and heavy metals	No	No	Yes	Yes	Mainly underground; no surrounding protective fence	Poor state, local leakage	Partial chlorination and RO system	One tank of acceptable state; two tanks requested rehabilitation work	Acceptable state of the suspended networks; poor condition of the old network
DB	No data	No data	No data	No data	No data	Yes	Yes	External water supply form the Water Establishment	No data	No data	Acceptable state	Poor state of the old network; a new network was installed but is not in operation
ME	Saline water	High	Low content* of HCs and heavy metals	No	No	Yes	Yes	Underground; no surrounding protective fence	Poor state	Partial chlorination and RO system	Acceptable state	Acceptable state of the suspended networks; poor condition of the old network
SH	Saline water	High	Low content* of HCs and heavy metals	No	No	Yes	Yes	Underground; no surrounding protective fence	Poor state	Partial chlorination and RO system	Acceptable state	Acceptable state of the suspended networks; poor condition of the old network
EH	Fresh water	High	Low content* of HCs and heavy metals	No	Yes	Yes	Yes	Underground and above ground; local protective fence or building; local high risk of pollution due to fuel storage	Poor state to acceptable state	Chlorination	One tank of acceptable state; the other tanks requested rehabilitation work	Acceptable state

MM	Fresh water	High	Low content* of HCs and heavy metals	No	Yes	Yes	Yes	Underground and above ground; local protective fence	Poor state (local leakage) to acceptable state	Chlorination	Acceptable state	Acceptable state
BS	Brackish water	High	Low content* of HCs and heavy metals	No	No	Yes	Yes	Above ground and surrounding protective fence; local underground structures	Acceptable state in general, local poor state	Chlorination	Acceptable state	Acceptable state
EB	No data	No data	No data	No data	No data	Yes	Yes	Mainly external water supply form the Water Establishment	No data	No data	No tank	Acceptable state (new network), but lack of supply; poor state (old one)
RA	Fresh water	High	Low content* of HCs and heavy metals	No	No	Yes	Yes	The spring is located inside a building dedicated for this purpose; no surrounding protective fence	Acceptable state; presence however of numerous generators in the immediate zone (risk of pollution)	Chlorination	Poor state of the RATA0002 tank (fissures, etc.)	Acceptable state; some adjustments are required
WA	Fresh water	High	Low content* of HCs and heavy metals	No	No	Yes	Yes	Above ground; no surrounding protective fence	Poor state	Chlorination	Acceptable state	Acceptable state
BE	Brackish water	High	Low content* of HCs and heavy metals	No	No	Yes	Yes	Mainly underground (locally above the ground); no surrounding protective fence	Poor state in general; locally not accessible	Chlorination	Acceptable state; some tanks were decommissioned due to an insufficient elevation	Acceptable state
NB	Fresh to saline water	High	Low content* of HCs and heavy metals	No	Yes / No**	Yes	Yes	Underground; no surrounding protective fence	Poor state	Chlorination	Acceptable state	Acceptable state within NB camp (some adjustments are required); poor state in AA

* Below Lebanese standards for maximum admissible value

** Depending on the wells

Annexe 21: Sector Specific Materials with key information.

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

german cooperation

unicef

13 CLIMATE ACTION

7 AFFORDABLE AND CLEAN ENERGY

ENERGY & AIR

Environmental Health Response Plan in the 12 Palestine Refugee Camps in Lebanon (2018 – 2021) with inventory and needs assessment

BACKGROUND STATS

- **12 Palestine refugee camps rely solely on fossil fuels**
- **Costing comparison: • EDL national grid cost = $0.06 kWh • Average generators cost = $0.30 kWh**
- **Air pollution is the world's single largest environmental health risk**
- **90% urban air pollution is due to vehicle emissions, challenges in urban planning, fuel quality**

CAMP RESIDENTS SUFFER FROM SEVERAL CHALLENGES

- Existing practices and equipment do not comply with minimum environmental and safety guidelines
- Unorganized & inefficient electricity network causes energy loss
- Regular breakdowns and fatal accidents occur due to random installations by community
- Lack of renewable energy sources in the camps due to high investment costs and limited available space
- High concentrations of PM indoor & outdoors. This leads to cardiovascular, respiratory diseases, including lung cancer, also causing mortality and morbidity
- High concentrations of CO or CO2 due to poor ventilation

TO MEET THESE CHALLENGES, SEVERAL SOLUTIONS ARE PROPOSED

In order to minimize health and other risks posed by inadequate air and energy qualities and technologies, 29 different projects are proposed, including:
• Renewable:
- Promotion of hybrid renewable energy systems
- Feasibility study on use of solar photovoltaic power for submersible pumps to extract water
- Installation of water solar heaters to decrease the demand on energy
• Replacement of UNRWA service generators and "PCB's non-conforming" transformers with environmentally-friendly equipment
• Establishment of air quality monitoring system based on international standards
• Installation of ventilation in houses to reduce accumulation of pollutants
• Public awareness and education campaigns in energy conservation and air pollution and its impact on health
• Better management practices ensuring optimal equilibrium between supply and demand

SIX KEY TARGETS HAVE BEEN DEVELOPED, TO BE ACHIEVED BY 2021

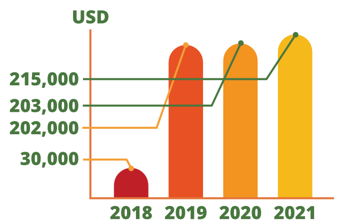
- Decrease the annual mean levels of fine particulate matter (PM10) in Palestine refugee camps to 80 µg/m3
- Increase the number of areas equipped with independent and functional weather stations from 0 to 5
- Increase the percentage of service generators equipped with efficient air filters and noise reducers from 75% to 90%
- Increase the percentage of transformers aligned to the Stockholm Convention on PCBs from 50% to 90%
- Increase the number of camps that have benefitted from at least one innovative technology such as solar energy systems (thermal or PV) from 0 to 12
- Increase the number of areas equipped with independent and functional weather stations from 0 to 5

OVERALL GOAL

Palestine refugees living in the 12 Palestine refugee camps in Lebanon by 2021, live in an environment in which health and other risks posed by inadequate air and energy qualities, equipment and technologies are minimized

ESTIMATED COST

TOTAL 650,000 USD



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ROAD & HABITAT

Environmental Health Response Plan in the 12 Palestine Refugee Camps in Lebanon (2018 – 2021) with inventory and needs assessment

11 SUSTAINABLE CITIES AND COMMUNITIES

BACKGROUND STATS

- Total area for all camps is 2.79km²
- Average human density in the camps is 86,000 residents/km2, compared to average of Lebanon at 565 residents/km²
- 98% of assessed shelters show an average of 2.3 rooms per shelter, housing an average of 4.7 persons

CAMP RESIDENTS SUFFER FROM SEVERAL CHALLENGES

Urbanization
- All 12 camps are totally urbanized, with no open or green areas.
- High population density (86,000 people/km2).
- No urban planning, natural light, and poor ventilation.

Intensive Agriculture
- All camps are surrounded by intensive agriculture. This causes over-fertilization, while pesticides affect underground water and food quality.

Shelters
- Most multi-story buildings constructed without foundations and with low-quality materials; 25% of buildings present “potential danger”, 5% are collapsing
- In 30% of assessed shelters, the impact of moisture from leakages and humidity was moderate to severe.

TO MEET THESE CHALLENGES, SEVERAL SOLUTIONS ARE PROPOSED

In order to improve camp planning and enhance living conditions, 29 different projects are proposed, including:

- 3D modeling for master planning of camps
- Enforce regulatory mechanisms to reduce unplanned urban expansion in camps
- Encourage green space (green roofs, planting of trees, creation of small public spaces)
- Improved Agricultural and Manufacture practices to reduce use and effects of pesticides

SIX KEY TARGETS HAVE BEEN DEVELOPED, TO BE ACHIEVED BY 2021

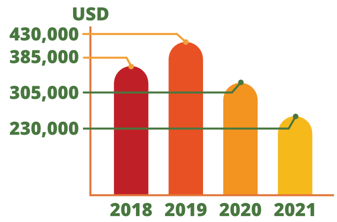
- Decrease the annual mean levels of fine particulate matter in Palestine refugee camps to 80µg/m3
- Increase the number of areas equipped with independent and functional weather stations from 0 to 5
- Increase the percentage of service generators equipped with efficient air filters and noise reducers from 75% to 90%
- Increase the number of camps that have benefitted from at least one innovative technology, such as soil artificial aquifer recharge, filter-paved pedestrianized roads, solar energy systems, Disaster Risk Reduction from 0 to 12
- Increase the percentage of transformers aligned to the Stockholm Convention of PCBs from 50% to 90%
- Decrease the percentage of construction material containing asbestos to 0%

OVERALL GOAL

Palestine refugees living in the 12 Palestine refugee camps in Lebanon live in an environment in which health and other risks posed by inadequate habitat infrastructure, materials and technologies, inadequate land, air, energy qualities are minimized.

ESTIMATED COST

TOTAL 1,350,000 USD

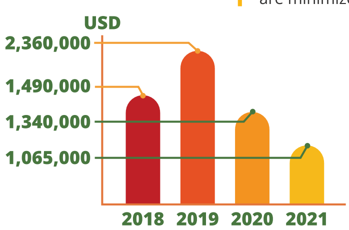


SANITATION SECTOR

Environmental Health Response Plan in the 12 Palestine Refugee Camps in Lebanon (2018 – 2021) with inventory and needs assessment

6 CLEAN WATER AND SANITATION

	WASTE WATER	STORM WATER	SOLID WASTE
CONTEXT	• The camps generate around 20,000 m3 of wastewater per day. • WW networks exist in all camps. All, except one, are connected to local municipalities	• Storm water networks exist in the 10 camps	• 163 tonnes of solid waste generated each day across the camps
PROBLEMS	• Wastewater networks are generally overloaded, old, and suffer leakages. • One camp needs connecting to local network • Commercial shops tend to increase wastewater contamination	• Storm water networks are generally overloaded, old, and suffer leakages. • Storm water network mixes with wastewater network • Certain camps run risk of flooding	• No possibility to dispose or treat waste inside the camps due to land and legal limitations. • Inefficient collection system
PROPOSED SOLUTIONS	• Completion of the network in Rashidieh camp • Rehabilitation, upgrading and construction of wastewater networks • Commercial shops to reduce disposal of hazardous waste and solid waste into the wastewater networks	• Completion of the networks in final 2 camps • Rehabilitation, upgrading and construction of storm water networks • Commercial shops reduce disposal of hazardous waste and solid waste into the storm water networks	• Develop Camp Solid Waste Operational Plan • Introduce sorting and separation practices • Change collection scheme from door to door to curbside collection
CROSS -CUTTING SOLUTIONS	• Largescale, continuous communication campaign via traditional and social media, developing advertisement materials (on walls, on the bins), and Education programs (schools, public centers) to sensitize residents and private companies inside the camps • More collaboration with stakeholders, municipalities and local authorities for better coordination and support		
KEY TARGETS	• Maintain the percentage of premises (schools, health centres, offices) connected to adequate wastewater networks at 100% • Increase the percentage of shelters connected to adequate wastewater networks from 80% to 100% • Increase the proportion of wastewater safely treated from 0% to 25% • Increase the percentage of camps equipped with operational wastewater networks from 60% to 100%	• Increase the proportion of camps equipped with operational storm water networks from 55% to 100% • Increase the percentage of shelters connected to adequate storm water networks from 70% to 100% • Ensure 100% of premises (schools, health centres, offices) are connected to adequate storm water networks	• Increase the collection and removal of domestic waste from the camps from 90% to 100% • Increase the percentage of solid waste recycled per camp from 0% to 25% • Increase the amount of solid waste reduction via recycling from 0% to 25% • Increase the number of days per year the camps are kept clean of solid waste from 250 to 300 • Increase the number of times each week street sweeping is done in the camps from 4.5 to 6
OVERALL GOAL	Palestine refugees living in the 12 camps in Lebanon are served with adequate sewerage systems	Palestine refugees living in the 12 camps in Lebanon live in an environment in which health and other risks posed by storm water are minimized	Palestine refugees living in the 12 camps in Lebanon have access to solid waste management services that meet minimum acceptable standards



COST

TOTAL 6,225,000 USD

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

german cooperation

unicef

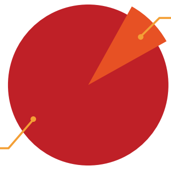
6 CLEAN WATER AND SANITATION

WATER SECTOR

Environmental Health Response Plan in the 12 Palestine Refugee Camps in Lebanon (2018 – 2021) with inventory and needs assessment

BACKGROUND STATS

There are a total of 78 water sources across the 12 camps



CAMP RESIDENTS SUFFER FROM SEVERAL CHALLENGES

Water quantity
- 6 out of the 12 camps experience water shortage
- 3 have a water surplus

Water quality
- 93% of tap water and 94% of bottled water showed the presence of total coliforms
- 40% of tap water and 57% of bottle water showed the presence of E.Coli, an indicator of faecal contamination
- Groundwater sources suffer salinization due to sea water intrusion in 4 out of 12 camps. In two camps there is brackish water

Water systems
- Network leakages range from 20% to 40%
- Wastewater and storm water is not re-used for managed aquifer recharge

TO MEET THESE CHALLENGES, SEVERAL SOLUTIONS ARE PROPOSED

Under the banner of sustainable, and integrated water resources management, 64 different projects are proposed, including:

• Production of vulnerability and hazard maps to identify areas in need of immediate intervention (at risk of contamination)

• Water treatment systems such as chlorination or reverse osmosis

• Public awareness and education campaigns in water conservation and minimizing wastage

• Technical measures, such as improvement of wellheads, rehabilitation of water network, and drilling additional wells

• Water surveillance plans for better monitoring

• Better management practices ensuring optimal equilibrium between supply and demand

FOUR KEY TARGETS HAVE BEEN DEVELOPED, TO BE ACHIEVED BY 2021

Increase the percentage of camps with at least one water committee in charge of the operation & maintenance of the water supply from 33% to 100%

Increase the percentage of the population using safely managed drinking water services from 36% to 46%

Increase the number of shelters connected to adequate water networks from 70% to 100%

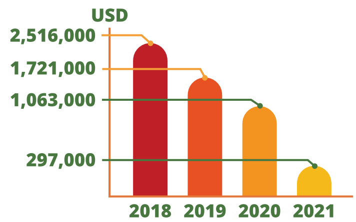
Increase the percentage of water sources equipped with adequate qualitative & quantitative surveillance system from 0% to 100%

OVERALL GOAL

Palestine refugees living in the 12 Palestine refugee camps in Lebanon by 2021, have safe, equitable, sufficient and sustainable quantity of water for their basic needs.

ESTIMATED COST

TOTAL 5,597,000 USD



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for palestine refugees in the near east

وكالة الأمم المتحدة لإغاثة وتشغيل
اللاجئين الفلسطينيين في الشرق الأدنى