
WHO/UNICEF

**LEBANON
WATER
QUALITY
SURVEY**



LEBANON

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ABBREVIATIONS



CAS	CENTRAL ADMINISTRATION OF STATISTICS
CDR	CENTER FOR DEVELOPMENT AND RECONSTRUCTION
DW	DRINKING WATER
JMP	JOINT MONITORING PROGRAMME FOR WATER SUPPLY, SANITATION AND HYGIENE
LCO	LEBANON COUNTRY OFFICE
LCRP	LEBANON CRISIS RESPONSE PLAN
MDG	MILLENNIUM DEVELOPMENT GOALS
MENA	MIDDLE EAST NORTH AFRICA
MICS	MULTI-INDICATOR COMMUNITY SURVEY
MoE	MINISTRY OF ENVIRONMENT
MoEW	MINISTRY OF ENERGY AND WATER
MoPH	MINISTRY OF PUBLIC HEALTH
PPES	PROBABILITY PROPORTIONATE TO ESTIMATED SIZE
PSU	PRIMARY SAMPLING UNITS
SDG	SUSTAINABLE DEVELOPMENT GOALS
SITAN	SITUATION ANALYSIS
WE	WATER ESTABLISHMENT
WHO	WORLD HEALTH ORGANIZATION
UNICEF	UNITED NATIONS CHILDREN'S FUND
UNWRA	UNITED NATIONS RELIEF AND WORKS AGENCY FOR PALESTINE REFUGEES IN THE NEAR EAST

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EXECUTIVE SUMMARY



Since the early 1990s, the United Nations Children’s Fund (UNICEF) along with the World Health Organization (WHO) established the Joint Monitoring Programme (JMP) to be the custodian for the global data on drinking water, sanitation, and hygiene (WASH). The JMP originally tracked the progress towards achieving the Millennium Development Goal (MDG) target 7c, which sought to halve the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015, and is now responsible for tracking the drinking water and sanitation targets developed under the Sustainable Development Goals (SDGs). Lebanon has long been considered to have a near full coverage with regards to providing its population with access to ‘improved’ water sources (piped networks and bottled water), reaching up to 99 percent in 2015, as reported by JMP. However, it is well accepted locally and internationally that the reality for vulnerable communities in Lebanon may differ markedly from the official national data. SDG 6.1 provides a unique opportunity to present the actual drinking water supply situation in Lebanon using more reliable indicators that focus on water quality, availability and accessibility.

Lebanon is a middle-income country with predominantly urbanized settlements, well-established water supply services (both formal and informal), and a population that appears able to adopt coping mechanisms to source sufficient water supply to meet its essential needs. Since 2000, public water supply services and wastewater management have been entrusted to the Ministry of Energy and Water (MoEW), the four public Water Establishments (WE’s), and the Council for Development and Reconstruction (CDR) who have struggled to improve water supply reliability, drinking water quality, and their financial viability. The continuous influx of refugees from Syria since 2012 has put additional strain on the existing fragile infrastructure and impacted the Government of Lebanon’s (GoL)’s ability to provide basic water and wastewater services to the most vulnerable populations in Lebanon.

With the introduction of the SDGs in 2016, UNICEF, with the support of the MOEW and the Ministry of Public Health (MOPH) and the WHO, implemented the first ever nationwide household water quality survey in Lebanon, the Lebanon Water Quality Survey (LWQS). The LWQS aimed for a preliminary assessment of the modalities of safe drinking water supply and drinking water quality in households at the national and regional domains levels. It also aimed to provide baseline estimates for SDG 6.1 and to inform policy and planning entities on the potential impacts of drinking water on the health of its

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residents, particularly children.

The LWQS was based on a similar sampling strategy adopted for the UNICEF Lebanon Country Office (LCO) Baseline survey 2016. The stratification of the LWQS was based on the ‘type of dwelling/settlement’ in the country. The survey utilized a standardized questionnaire to record household demographic data, water supply information needed for the assessment of SDG 6.1, as well as water quality data at the household distribution point¹ and cup (point of ingestion). Four water quality parameters were tested including E. coli, free chlorine, nitrates (only in Bekaa and Akkar), and turbidity. For the purposes of evaluating SDG 6.1, household water safety was assessed based only on levels of E. coli that were observed at the household water distribution point.

The total sample size of the LWQS amounted to 2,770 households, distributed over six separate domains to cover Lebanon, including (1) four regional/governorate domains (permanent residences officially serviced under the authority of the GoL covering Beirut-Mount Lebanon, South Lebanon-Nabatieh, Beqaa-Baalbek-Hermel, North Lebanon-Akkar), (2) one Informal (tented) Settlements (IS) domain consisting of unofficial and non-permanent structures with Syrian refugee populations serviced by international organizations; and (3) one Palestinian Camp domain populated by Palestinian refugees serviced by the UNRWA. In each domain, around 90 clusters of 5 households were allocated following systematic random sampling based on the size of cadasters. The LWQS was completed between May and June 2016, with a household questionnaire response rate of 99 percent and a water quality testing response rate of 88 percent, due to water unavailability at the time of the interview. The data collected from the permanent residences can be considered to be representative of the overall national summary, given that the bulk of Lebanon’s population lives in this settlement type. The water quality results for IS and the Palestinian Camps were, however, expected to vary from the national results, possibly due to their access to less formalized and independently managed water supply services.

When assessing drinking water safety, no E. coli contamination was detected in the water at the distribution point in 47 percent of the sampled permanent residents, 51 percent of sampled residences from Palestinian Camps, and 41 percent of sampled residences from IS. E. coli is used as an indicator of fecal contamination, thus drinking water should be free from E. coli. Nevertheless, the data showed

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that IS had more samples with very high risk E. coli contamination levels (> 100 / Colony Forming Unit (CFU) 100 mL), reaching 29 percent, as compared to only 10 percent for permanent residences and 2 percent for Palestinian Camps. At the level of the cup, the percent of residences showing a deterioration in water quality from the low risk category at the source (0 E. coli CFU/ 100 mL) to the moderate risk category (1-10 E. coli CFU/ 100 mL) at the cup was 8 percent for each of the permanent residences and the Palestinian camps and 3 percent for IS. On the other hand, 5 percent of samples collected at IS with very high E. coli contamination levels (> 100 CFU/ 100 mL) at the distribution point improved at the level of the cup. This could be due to the water treatment initiatives at the settlement or household level. At the national level, the E. coli results at the cup level showed that two thirds of households across Lebanon appear to be adopting practices that do not increase the risk of contamination of their water supply, 10 percent were found to be actively reducing their risks of contamination at the household, with the remaining households (23 percent) introducing a moderate to high risk of contamination between the source and point of consumption in a cup.

At the geographic domain (regional/ governorate) level, the results showed that the percent of samples free of E. coli (< 1 CFU/ 100 mL) at the distribution point of permanent residences was the highest in South Lebanon-Nabatieh (71 percent), followed by Beqaa-Baalbek-Hermel (65 percent), followed by North Lebanon-Akkar (50 percent), and finally by Beirut-Mount Lebanon (34 percent). The highest change in E. coli levels between water samples at the distribution point and water samples collected from the cup was evident in Beirut-Mount Lebanon, with the percent of samples free of E. coli decreasing from 31 to 18 percent. This raises questions as to the root cause(s) of this deterioration, with the possibility of inadequate handling, storage and hygienic practice at the point of use.

Probing into E. coli levels by mode of drinking water supply at the distribution point, the results showed that bottled water² quality had on average the best quality, with 53 percent of the samples exhibiting no E. coli contamination, followed by piped water, with 44 percent of the samples exhibiting no E. coli contamination. Water samples from tanker trucks were the most polluted with 45 percent of the samples presenting high risk (> 100 CFU/ 100 mL).

Regarding free residual chlorine levels, the LWQS results showed that almost 95 percent of households at the national level had an unacceptably low level of residual chlorine in the water they consumed

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for drinking (< 0.2 mg/L). Levels need to be maintained above 0.2 mg/L in order to protect drinking water supply from fecal recontamination at the point of use. These findings were consistent across all settlement types and for all water supply modes, yet the residual chlorine levels differed slightly among permanent residences from one domain/ region to the other.

Turbidity levels at the point of distribution were consistently low and within the acceptable range for water safety (< 5 NTU) in more than 95 percent of the samples collected at the national level. Higher levels of turbidity (49 percent between 1 and 5 NTU) were observed in drinking water accessed by households in IS. Some variations in turbidity levels were detected across the regions.

Nitrate levels were tested only in the Beqaa-Baalbek-Hermel and North Lebanon-Akkar, domains that are predominantly agricultural in nature. Results in these regions indicated that the water samples were within the acceptable levels of 45 mg/L for 95 percent of the households.

In addition to water quality, SDG 6.1 assesses whether households use improved water supply infrastructure, and whether water is accessible on premises and available when needed. At the national level, 96 percent of households in Lebanon access drinking water from an improved water supply. The majority of these households had a piped water supply (83 percent), with 38 percent also using bottled water. Around 97 and 99 percent of households in the permanent residences and Palestinian Camps, respectively, were using an improved supply, compared to only 39 percent of households in the IS, which rely primarily on informal (private) water providers, particularly water trucking.

With regards to accessibility, households in permanent residences had the highest level of access on premises (81 percent), primarily because they have access to formalized/regulated piped networks. Households in the Palestinian Camps had reduced access on premises (55 percent), as the majority of the water is supplied through the formalized UNWRA managed services that store and treat water centrally in the camp before it gets transported from this central point to the place of residence by members of the household. The heavy reliance of households in IS on privately (informal) managed water trucking and bottled water explains the low accessibility (27 percent).

As for the availability of drinking water supplies, which was assessed based on the perception of the

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householders on whether their drinking water supply needs were adequately met or not, the results revealed a relatively high (95 percent) perception of adequate availability across both the permanent residences and Palestinian Camps. At IS, households had a lower (78 percent) perception of availability. The LWQS also asked households how much they pay for water services, finding that permanent residences paid the most for the supply of drinking water services (~6.3 USD/month), while households in the Palestinian Camps and the IS paid significantly less (~4.3 USD/month), possibly due to subsidies by UNWRA and other international organizations.

Hence, based on the above assessment, while the MDG 7c baseline for Lebanon regarding household access to improved drinking water supply reported achieving 99 percent of the target in 2015, the SDG 6.1 baseline results for Lebanon showed a much more discouraging situation; whereby only 36 percent of the population had access to safely managed drinking water services. The results clearly demonstrated that although Lebanon had a high proportion (95 percent) of households accessing an improved water supply (except IS) and while the supply was generally accessible (80 percent) and available (95 percent), fewer households use a source free of fecal contamination (47 percent) rendering water unsafe to drink, and thus compromising otherwise safely managed drinking water supplies. This highlights the importance of water safety as the key factor resulting in the alarming 60 percentage point reduction between MDG 7c and SDG 6.1 when the new more ambitious “safely managed” rather than “improved” benchmark is used.

On a related note, a rapid assessment for large and medium scale WWTP’s across Lebanon, conducted separately in 2016, revealed that around 3 percent of the Lebanese population are connected to WWTP with secondary treatment capabilities (Annex 1). When refugees are accounted for, this percentage drops down to 2 percent. Yet, it was found that if the Lebanese authorities undertake an upgrading and expansion program for the existing WWTP’s, the Lebanese population served by secondary wastewater treatment can increase from 3 percent up to 75%. Furthermore, if all the existing WWTPs were to be made functional and operational, the actual treatment percentage would increase from 15% up to 80%.

Finally, the water quality results highlighted the need for developing interventions that target geographic location and settlement type to improve water safety for households across Lebanon and enhance

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Lebanon's achievement of SDG 6.1. A set of recommendations have been developed based on the LWQS and upon consultation with key government stakeholders (MoEW, MOPH, WEs, and the Ministry of Environment) and the WHO Lebanon office. These include the following:

- Map key stakeholders in the water sector and current interventions to improve water quality protection.
- Develop a holistic approach for water quality protection at all levels of the supply chain using water safety planning approaches.
- Provide training and guidance documents to water supply authorities for effective chlorination of the drinking water supply.
- Improve the quality and quantity of public and private reservoirs to regulate supply frequency and reduce risk of householders accessing unsafe water through awareness raising campaigns and through training of water service providers.
- Replace ageing water supply networks, particularly asbestos and galvanized pipes.
- Improve public awareness on (1) regulated water bottlers and the need to purchase water only from certified bottled water companies, (2) adequate household water handling and storing practices, and (3) household water treatment techniques and measures to ensure safe water, including boiling.
- Develop and implement procedures to protect water sources from septic tanks and sewer contamination. Publish and advocate guidance documents with all implementing stakeholders in the water sector.
- Increase funding for safe water supply providers and for wastewater and water treatment plants across Lebanon, to reduce contamination risk and improve quality of distributed water.
- Increase the capacity of the WE in operation and maintenance of WWTP.
- Upgrade, rehabilitate, and expand the existing WWTPs to increase secondary treatment coverage.
- Conduct detailed water quality surveys targeting water at source, during distribution, and at the household level, to determine points of contamination for each supply modality in targeted locations.
- Provide equipment and training to WEs and MoPH laboratories to improve water quality testing capability, including testing for viral contaminants.
- Integrate water quality and health data into a central database that is collected by regulating authorities, such as WEs and MoPH. Map results showing water quality disparity and clusters of contamination, and overlay with water quality related interventions.

INTRODUCTION



To support the implementation of legislation reform since the year 2000, the Ministries responsible for water (and wastewater), regional authorities and municipalities targeted capital investment and capacity building aimed to improve integrated water resource management and effect sustainable service provision. The Government of Lebanon (GoL) had initiated national strategies and master plans to support the new legislation based on predicted population demands. Although the drivers/policy levers for integrated natural resource management did not change, the demand scenarios were superseded in 2012 with a rapid population increase due to the Syrian crisis, together with associated increase in demand for services including water and wastewater.

The overall objective of this report is to inform the water sector in Lebanon on drinking water quality in households, and ultimately inform policy and planning entities on the potential impacts on the health of its residents, particularly children. This report presents the results of a recently completed national household water quality survey to provide a baseline for water sector advocacy and strategic action. The survey data and this report seek to provide the

following:

- a baseline for Sustainable Development Goal 6.1 (safely managed drinking water services) for Lebanon; and
- a better understanding of the issues related to water quality in Lebanon that can inform sustainable action.

International support to the WASH (water, sanitation and hygiene) sector in Lebanon has over the last 75 years primarily been reactive during periods of the civil strife, where repair of damaged water infrastructure and rehabilitation of water supply systems was a significant part of the emergency response.

Although the period between 1990's and 2006 witnessed several political and security issues, during which international intervention in the sector was reduced, development related activities increased and were supported directly by the Government of Lebanon (GoL). However since 2012, although Lebanon is not in a state of civil strife, Lebanon's development progress has been affected by the massive influx of refugees from Syria, putting additional strain on the existing fragile infrastructure and systems.

Throughout Lebanon's history, the issue of



water quality and its impact on drinking water supply has been a constant theme. Lebanese communities have adjusted to recurring water scarcity and water quality issues through adopting coping mechanisms to meet their demand that often mask the extent of the problem. Despite this however, Lebanon has never previously undertaken a nationwide water quality survey at the household level, and therefore has had insufficient data at household level to inform strategic decision making in water resource management. In response, water sector partners have depended on targeted, project specific studies undertaken by the regulatory authorities, civil society organizations and the private sector, which due to their ad-hoc basis are considered to be statistically insufficient to provide an overarching picture of the situation of water quality in Lebanon.

With the introduction of the Sustainable Development Goals (SDG) in 2016, allowing countries to establish their own baseline to achieve development targets, UNICEF with the support of the GoL and World Health Organization (WHO) took the opportunity to implement the first ever nationwide household water quality survey in Lebanon. This survey is therefore able to establish Lebanon's baseline for SDG 6.1 (safely managed drinking water services), and also to inform water resource management decisions, and support advocacy to improve the safety of drinking water supply in Lebanon.

1.1

Background to current situation

In 2000, the GoL introduced new water sector legislation leading to the divestment of responsibility for water service provision to four Water Establishments (WE), which operate at a regional level, with planning and policy responsibility remaining with the Ministry of Energy and Water (MoEW) at the national level. To date, this legislation is only partially implemented.

Since 2000, public water supply service and wastewater management is entrusted to MoEW and the four WE's. Their responsibilities cover planning and implementing water projects; contracting and supervising construction of projects; operating infrastructure facilities and enforcing water related laws and regulations. However, due to capacity and institutional constraints (including implementation of key new regulatory tools), WE's and MoEW have struggled to improve water supply reliability, drinking water quality and to improve their financial viability. This together with the current Syrian Crisis has exacerbated the water quality situation in Lebanon, and increased the need for strategic and sustained investment in the water sector.

Since 2012, Lebanon has been directly impacted by the Syrian crisis, with 1.5 million Syrian refugees (Lebanon Crisis Response Plan - LCRP 2017-2020), living either in informal (tented) settlements (mainly in agricultural areas) or in permanent residences within the host community. The extensive and protracted nature of the crisis has had an impact on the GoL's ability to provide basic services, particularly water and wastewater services, to the most vulnerable populations in Lebanon.

In addition to meeting the basic humanitarian needs of the refugee population in Lebanon, interventions are being implemented with the support of international donors to restore the public water and wastewater infrastructure, including improving public water access in the most impoverished Lebanese communities, and to stem further environmental damage caused by poor wastewater management practices. Investment in the water sector has increased 30-fold since the start of the Syrian crisis, although funding streams are now waning with the protected crisis and donor investment is targeting other sectors in perceived need. To ensure investment in the water sector is relevant and sustainable, up to date and reliable data is needed to inform future investment to directly address the historic and increasing health burden on populations in Lebanon due to poor drinking water quality.

Since the early 1990s, the WHO-UNICEF Joint Monitoring Programme (JMP), has reported on the status and trends in drinking water and sanitation. The JMP tracked progress towards the Millennium Development Goal (MDG) target 7c and is responsible for the drinking water and sanitation targets under the Sustainable Development Goals (SDGs). MDG 7c sought by 2015, to halve the proportion of people without sustainable access to safe drinking water and basic sanitation. JMP has reported on trends which show that coverage of improved drinking water in Lebanon has increased from 83 percent in 1995 to 99 percent in 2015. Unfortunately not all improved sources are providing safe drinking water that is accessible on premises and available in sufficient quantities, when needed. The GoL recognized this limitation in the MDG 7c achievement, and stated in its MDG report for 2014: ‘whereas the MDG indicator on access to drinking water may appear to have been achieved, quality of water and the inequitable

burden on the poorer households are serious difficulties in achieving affordable and safe access³.

In anticipation of the SDGs, the JMP facilitated a sector-led expert consultation that called for greater attention to service quality (i.e. safety) and inequalities. As a result of the efforts by the JMP, the indicator for SDG 6.1, “safely managed” drinking water services combines information on the type of drinking water source used by households, its location, whether drinking water is available when needed and, importantly whether water is free of faecal and priority chemical contaminants.

Globally, Lebanon has been long considered to have a near full coverage of its population with access to ‘improved’ water sources primarily due to its access to piped networks and bottled water, however it is well accepted by local and international stakeholders with knowledge of Lebanon that the reality for vulnerable communities differs markedly from the official data. SDG 6.1 therefore gives Lebanon a unique opportunity to present the actual drinking water supply situation using more reliable indicators that focus on water quality, availability and accessibility.

As part of SDG monitoring, the WHO/UNICEF JMP team is supporting water quality surveys in countries seeking to establish a baseline for SDG 6.1. Therefore, to establish Lebanon’s baseline for SDG 6.1, and building on the ‘Household Baseline Survey’ undertaken in 2016, the UNICEF Lebanon Country Office in collaboration with WHO Lebanon Country Office undertook a national survey of household water quality in 2016 adopting the global and standardized methods developed by the JMP.



1.2 Supporting information sources

The Lebanon Household Baseline Survey (of 5,191 households) was conducted by UNICEF between October 2015 and February 2016, and aimed to form a baseline for the 2017-2020 programming cycle. The survey adopted the same indicator for drinking water as used in the MDG assessment: population using an improved drinking water source. The data collected as part of the Lebanon Household Baseline Survey will be used in conjunction with the national water quality survey results outlined in this report, to provide the basis for SDG 6.1.

1.3 Objectives of national household water quality survey 2016 – Lebanon

The Lebanon national household water quality survey (LWQS) was implemented between May and June 2016, and aimed to:

- assess drinking water quality in households at the national and governorate levels;
- assess the modalities of safe drinking water supply for all populations living in Lebanon;
- examine inequalities in safe drinking water safety, including disparities based on settlement type, such as between permanent residences, Palestinian Camps and Informal Settlements (IS's); and
- provide baseline estimates for SDG 6.1, assessing the proportion of national level population with access to safely managed drinking water services.

The UNICEF Lebanon Country Office (LCO) initiated the survey and provided financial support with funds provided by the Bureau of Population, Refugees and Management (BPRM), for procurement of equipment, engagement of technical specialists and fieldwork. UNICEF implemented the survey in consultation with the GoL, and with the support from WHO LCO. UNICEF and WHO LCO's coordinated together with the appropriate Ministries, namely MoEW and Ministry of Public Health (MoPH). The Central Administration of Statistics (CAS) and the WEs were informed about the survey throughout its inception, development and results generation.

The WHO/UNICEF JMP team, based in Geneva and New York, provided technical and financial support for planning, purchasing of materials, training, and data/report analysis. Two international JMP consultants led a seven (7) day training for field survey teams, with the support of representatives from MoPH, MoEW and WE (Bekaa and North Lebanon), as co-trainers.

1.3.1

National water quality standards

The water quality parameters measured for the LWQS were evaluated against international guidelines developed by WHO as described in the Guidelines for Drinking-Water Quality (2011) and the Lebanese Standards Institution (LIBNOR) drinking water standard (Table 1). For each water quality parameter assessed in the survey, the most stringent value was adopted for analysis.

TABLE 1
THRESHOLDS USED FOR LWQS

Parameters	Unit	Value
E. coli or Total Thermotolerant Coliform	colony forming units (CFU)	0*
Free Chlorine	mg/L	0.2*
Turbidity	NTU	< 5**
Nitrate	mg/L	45*

* *Libnor, 1999. Drinking Water. Lebanese Standards Institution. Document Number NL 161. 1999*

** *WHO, 2011. Guidelines for Drinking Water Quality, 4th Ed.*

CHAPTER 2

THE LEBANESE CONTEXT

2.1

Populations of Lebanon



According to the Lebanon Crisis Response Plan (LCRP 2017-2020), the resident population of Lebanon is estimated at around 5.9 million in December 2016, including 3.3 estimated people in need, i.e. 1.5 vulnerable Lebanese, 1.5 displaced Syrians, and 320,174 Palestinian refugees. Geographical disparities are notable, particularly when considering the proportion of the population below the lower poverty line: in Beirut this proportion is 5.8 percent; versus 52.6 percent in North Lebanon (Akkar and Tripoli), where 17.7 percent are living in extreme poverty conditions (UNDP, 2013).

Lebanon has one of the highest per capita ratios in the world of persons registered as refugees, which has put pressure on the country's public institutions and infrastructure, severely impacting access to and quality of basic services, such as "safe drinking water", according to the LCRP⁴ (GoL, 2015 - 2016).

Poverty in Lebanon is also associated with marginalized social groups such as the disabled, the elderly and female-headed households (primarily widows). Of female-headed households, 36 percent are considered deprived, versus 23 percent of male-headed households (UNDP and MoSA 2007).

2.2

Administrative boundaries

Lebanon is divided for the purposes of government administration at the highest level by eight Mohafazas/Governorates (Beirut; Mount Lebanon; South Lebanon; Nabatiyeh; North Lebanon; Akkar; Bekaa; Baalbek; and Hermel), which also define the boundaries of the regional Water Establishments (WE's) (Figure 1.1):

- Beirut-Mount Lebanon (BMLWE): 2 mohafazats, Beirut and Mt Lebanon
- South Lebanon (SLWE): 2 mohafazats, South Lebanon and Nabatiyeh
- North Lebanon (NLWE): 2 mohafazats, North and Akkar
- Bekaa (BWE): 2 mohafazats, Bekaa and Baalbek-Hermel

All governorates are further subdivided into 26 Districts/Cazas, and there are almost 1,108 municipalities.

2.3

Physiography

Lebanon is a small country of just over 10,000 square kilometers. The main urban centres are Beirut (the capital), Tripoli (in the north), Saida and Tyre (in the south), Zahle (in the east), as shown in Figure 1.1. Lebanon has

a mountainous terrain consisting of two parallel mountain ranges, north to south, and separated by the Bekaa Valley (Plateau), a large agricultural area. The country can be divided into four main topographic regions from west to east⁵:

- A relatively flat and narrow fertile coastal strip, north to south at sea level,
- The Mount Lebanon mountain chain, parallel to the coastline with a mean elevation of 2,200 m and peaks upwards of 3,000 m above sea level.
- The Bekaa Plateau, a very fertile and rich area of topographic depression at an altitude of 900 m.

- The Anti Lebanon mountain chain, bordering with Syria in a north-south direction east of the Bekaa Plateau and reaching elevations of 2,800 m at Mount Hermon.

Precipitation, occurring mainly in winter as snow (in the mountains and Bekaa Plateau) and rain (along the coast), is highly variable across Lebanon with the driest areas in Bekaa, near Hermel, averaging 250 mm/year. In Baalbeck, annual precipitation averages 550 mm. Along the coast, precipitation averages between 830 mm in the north, 800 mm around Beirut, and 700 mm near Tyre (also known as Sour) in the south. Between 1500 and 2000 mm/year occurs across the Lebanese mountain ranges⁶.

FIGURE 1.1
ADMINISTRATIVE MAP OF LEBANON
(NPMPLT 2005)





2.4

Water Resources

Lebanon's water resources are under stress from a growing population, rapid urbanization, economic growth, mismanagement (leading to overextraction) of water resources, sterilization of supply water sources due to contamination, climate change reducing recharge, and ineffective integrated water governance. Lebanon is predominantly (65 percent) underlain by fissured and fractured limestone (called Karst terrain). This geological formation is highly permeable, and rapidly recharged by snowmelt, rainwater and any surface water that infiltrates into the subsurface (often through sinkholes). The remaining area is underlain by unconsolidated sediments of the deep agricultural Plains. Water resources in Lebanon are characterized as:

- available as groundwater in aquifers (primarily in karst geology) up to 600 m), and mainly exploited through wells (over 20,000 wells exist across Lebanon)⁷;
- available as surface water in perennial rivers and seasonal streams (almost 40 have been mapped, of which 15 are perennial watercourses, 12 are coastal rivers);
- reappear at the surface at lower elevations in the form of seasonal springs (nearly 5050 have been observed⁸) that feed into the various rivers/streams; and
- underground springs discharging along the coastline into the sea or flow as groundwater in deep aquifers beyond Lebanon's boundaries.

The high permeability due to geological features, such as existing faults and sink holes results in more than 80 percent of the Lebanese territory considered as "vulnerable" and "very vulnerable"

to water related contamination⁹.

Despite its relatively high per capita water endowment (1,000m³/capita, making Lebanon the fourth best-endowed in the MENA Region), Lebanon is already using two thirds of its available water resources, high by global standards, and there is significant groundwater mining¹⁰. There is a seasonal mismatch between that available for water supply (with recharge peaking in the winter period) and demand (peaking in the hot, dry summer period). Further to this unsustainable demand, factors exacerbating the situation are the leakage in water supply networks of up to 48 percent, sterilization of available drinking water sources due to contamination and, on the demand side, rapidly increased demand due to population growth, and from the municipal and industrial sectors.

These factors all lead to chronic water shortages, with dry season shortages common, particularly during years of reduced rain/snow recharge leading to water scarcity, and further deteriorating water quality.

2.5

Water quality related risks

Water in Lebanon is a vector for childhood disease and a contributor to child undernutrition¹¹. Water, an essential element of life, if poorly managed or contaminated provides a habitat for various pathogens responsible for communicable diseases commonly found in Lebanon.

The potential disease transmission through water increases in densely populated (urban) areas, often associated with poor water

and wastewater management. Diseases emerging from improper water and wastewater management are referred to as water-related diseases¹². The key water-related diseases that are associated with poor wastewater and water management/storage/distribution, and hygienic practice include:

- **Water-borne diseases:** caused by the ingestion of contaminated water with human or animal faeces in which the pathogen is ingested by drinking water (fecal-oral route). Resulting diseases include: Cholera; Typhoid; Bacillary Dysentery; Hepatitis A; and Giardiasis.
- **Water-based diseases:** caused by parasites found in intermediate organisms (aquatic invertebrate) living in contaminated water. Parasites are usually passed to humans through direct contact, when they drink contaminated water/food or use it for washing. Resulting diseases include: Dracunculiasis; Schistosomiasis; and other Helminths.
- **Water-washed diseases:** caused or favored by poor/inadequate personal hygiene. It is also caused contact of skin and eyes contact with contaminated polluted water resulting from poor sanitation and hygiene. Diseases such as: Scabies; Trachoma; and flea; and lice.
- **Water-related insect vector diseases:** caused by insect vectors, especially mosquitoes that breed in water or near water and depend on water for their propagation. Includes diseases such as: Yellow Fever; Dengue; Filariasis; and Trypanosomiasis.

Assessing the level (count) of Escherichia coli (E. coli) in drinking water supply is the recommended measure of microbial water

quality and an indicator of risk of water-related diseases. In addition to risks from pathogens, elevated levels of chemicals such as nitrate can negatively affect health and wellbeing.

WATER SECTOR STAKEHOLDERS AND INSTITUTIONAL MAPPING

3.1

Institutional reform of the water sector



The evolution of the water sector's regulatory laws in Lebanon dates back to the irrigation laws of the Ottomans, with further modifications and additions during the French mandate, and after independence. Water sector reform was initiated in Lebanon with the introduction of a new 'Water Law (221)', which was promulgated by the Parliament in May 2000. The current organizational framework of the water sector in Lebanon is primarily governed by three laws:

- Law 221 issued on May 29th 2000,
- Corrected by the Law 241 issued on August 7th 2000,
- Amended by Law 337 issued on December 14th 2001.

Further to this, Decree no. 8122, dated July 3rd 2002, defined application processes of Law 221, particularly relating to the merging of water (authority) bodies. Law 221 created an important restructure of the Lebanese water sector with the aim to improve sustainability, accountability and transparency. Fundamentally the regulatory changes to the water sector were:

- Fusion of 22 existing 'water offices' into the four current regional Water Establishments (WE's), each one independent and responsible of its technical and financial performance, for planning, operating and maintaining the

water supply system and for implementing a cost recovery program. The WE's assumed responsibility related to investments, equipment, operation and maintenance. WE's have an administration board with 6 persons and a General Director (DG) nominated by the Council of Ministers, based on the proposition of the Minister of MoEW.

- The WE's are responsible for wastewater, irrigation and water supply; with regards to water supply, from its extraction up to the consumption by user, through the different supply modalities in the catchment/storage, treatment and distribution; and for wastewater management, including the collection, transport, treatment and discharge.
- MoEW has responsibility for strategic planning of water resources management, including the preparation of the national water master plan, regulation and conservation of surface and groundwater resources, and design and implementation of large projects and dams.
- MoEW also has the mandate to supervise the WE's in their planning and formation of strategies for water monitoring and distribution; and to develop national scale studies (related to large-scale irrigation projects, water resources

management, monitoring, and controlling as well as conducting hydrogeological research); manage drinking and irrigation water, as well as wastewater; and control, monitor and measure water resources, and determine the needs and use of water resources on a national scale by setting the relevant quality standards to protect water resources from contamination.

- An increased role in water supply services provided by private operators.

In relation to drinking water services, the Ministry of Public Health (MoPH) is responsible for the licensing of, and health control over, water bottling enterprises under decree number 108/83. MoPH is responsible for monitoring and controlling drinking water quality to ensure water quality standards are met; and monitoring the incidence of waterborne diseases and publishing related epidemiological data.

The Ministry of Environment (MoE) is responsible, based on law 97/667 for controlling pollution and regulating all activities that impact the environment, and evaluating the requirement for an Environmental Impact Assessment (EIA), such as for major water supply infrastructure.

3.1.1

Main bottlenecks preventing an improvement of the water/wastewater public sector

The primary factors that affect the management of drinking water services in Lebanon include:

- The **internal regulations** of the WEs that have been redacted based on old procedures, are not in line with today's current legislation (Law 221), thus paralyzing the daily management of the WE's. The law dispositions are not yet reflected

in the WE's regulations and do not provide them with the required autonomy¹³.

- **Weak institutional capacity** results in difficulties to build a skilled employee base due to a Government-mandated hiring freeze¹⁴. The ratio of staff in the water related public services to the number of connected households is low (around 2 employees for 1000 connections)¹⁵. The hiring freeze has been often offset by daily hire of employees that are underqualified and unable to undertake long term projects. Law 221 allows the WE's to recruit staff without referring to the Civil Service Board (Council of State Bureau), however the budget Law of 2004 amended this recruitment to be under the Civil Service Board and the Council of Ministers. Furthermore, the specialized and qualified staff recruited by MoEW and WE's are highly solicited by the private sector, whom can pay higher salaries. A complete restructure of the public water services sector, both MoEW and WE's is required as described in the National Water Sector Strategy (NWSS).

- Due to **capacity and institutional constraints**, WE's have not been able to implement key measures to improve water supply reliability nor to improve their financial viability. Flat rate tariffs provide no incentives to consumers to save water, pay for what is used or for the WE's to improve/sustain service delivery.

- Demand for water and subsequent supply has not been moderated by management measures such as through **regulation and pricing**¹⁶. Financial deficits for three of the four WE's (excluding Beirut-Mount Lebanon) due to poor consumer payment rates, does not allow them to cover operating and maintenance costs. Water tariffs do not cover operation and maintenance



costs and collection rates are low. An overhaul of tariff structure for both water and wastewater are required to be developed and approved by the GoL.

- **MoEW has had historically weak capacity and availability of quality assured data** for integrated water resources planning, allocation and regulation. The management of groundwater abstraction, including the issue of permits for well drilling and compliance mechanisms, is currently not properly enforced, with a large number of wells reported as illegal. With respect to water resource planning, the effects of climate change on water resources or on water supply and irrigation have not been measured, or included in strategies, plans for adaptation and mitigation.

- There is an **absence of water compliance** and law enforcement mechanisms, and capacity within the MoEW and WE's to implement. There is a serious lack of trust by customers of water supply providers and a low accountability by all parties to abide by the intent of the legal framework.

- Predominance of pumping infrastructure in comparison with a supply by gravity, which leads to **significant pumping costs** that rely on an unreliable energy system supported by off the grid supply such as backup generators. Most of WE's are not able to pay the electricity/fuel bill for monthly pumping charges required for generators. The unreliability of electricity supply hampers operation of pumps and can cause damage to pumps¹⁷.

3.2

Water quality management in Lebanon

There are many water sector stakeholders in Lebanon that have a variable level of responsibility for water quality, both in supply, protection and management. The primary responsibility for drinking water services and ensuring its safe quality to consumers belongs to MoEW, WE's and MoPH. The key government stakeholders and municipalities with responsibility for water resource supply and management in Lebanon is summarized in Table 2.

In 1990, a water quality assessment in Lebanon was launched by UNICEF and the American University of Beirut (AUB), where the main water sources used for domestic water supply in Lebanon, as well as water in the network were analyzed. The results revealed a high level of contamination. This led to the creation in 1993, of a water quality monitoring system managed by AUB, supported by UNICEF, and capacity building and training to the responsible ministries, namely MoEW and MoPH. Moreover, AUB trained 53 technicians in the 22 water offices (6 months training and 6 months follow up in the field). A follow-up was done in 1997-1998, which led to the evaluation of improvements in the water supply system. At the end of 1998, the Water Quality Control Unit was created, with the aim to computerize the whole system, however it never materialized.

Subsequently there have been numerous attempts to improve water quality management in Lebanon, most recently with the Directorate of Hydraulics and Electrical Resources of MoEW supported by UNDP. Between 2011 and 2014,

a total of 20 wells located across Lebanon were equipped as monitoring wells. Data was collected over a period of 2013 to 2014, and after the study, MoEW staff were trained in the operation of the monitoring infrastructure, which had been handed over to MoEW. An assessment undertaken by UNDP in 2015, observed that of the 20 wells equipped, only 3 are currently potentially able to be used for monitoring, although none are currently used.

Currently, Lebanon does not have a systemized approach to monitoring water quality, particularly for drinking water supply. There are no drinking water quality monitoring plans nor water safety plans at the national (MoEW) or regional (WE) level in Lebanon. MoEW, responsible for planning and management of water resources does not have a laboratory to test water samples and has limited water quality specialist capacity.

The WE's each have equipped laboratories able to test water quality for key drinking water parameters and have trained lab technicians. Water samples are regularly tested on an ad-hoc basis from water sources (i.e. public wells and springs), often in response to a registered complaint about quality. Data is generally not well archived nor shared in response to requests from external stakeholders seeking information about water quality.

As an action to cope with current water quality monitoring situation; in 2015, WHO supported in the Health and WASH sector by developing "Acute Watery Diarrhea/Cholera Response Plan" for preparedness and response in case of an outbreak. They also assisted LIBNOR in updating the DW (drinking water) norm issued recently. Additionally, WHO supported the MOPH by establishing and equipping 8 drinking water laboratories in public hospitals for testing

microbiological parameters to ensure regular drinking water monitoring. Again in 2015, WHO organized training sessions on water quality analysis and on water sampling for MOPH water laboratories staff in different mohafazat of Lebanon.

The Litani River Authority has an equipped laboratory with trained staff whom manage a well populated water related database. Water is tested for agricultural purposes and from surface waters, although not specifically related to drinking water quality (as Litani have no regulatory responsibility for drinking water supply).

MoPH have equipped laboratories to test bottled water (as per their regulatory authority) with trained technicians. Focus by MoPH is on testing for water (and food) related diseases, which are published on their epidemiological website.

There are no laboratories in Lebanon, either private or public, able to test for viruses found in water.



TABLE 2
LEBANESE INSTITUTIONS RELATED TO
DRINKING WATER SUPPLY

Institution	Comment
Ministry of Energy and Water (MoEW)	<p>¹⁸ Central public organization in the field of water: • protect and develop hydraulic natural resources; assume jurisdiction over the water resources;• study supply and demand, and global situation of the water;• prepare the national water master plan;• design, implement and operate large hydraulic facilities;• conserve and control water resources including surface & underground water;• exercise administrative supervision over the WEs and the LRA. It is formed of two General Directorates:</p> <ul style="list-style-type: none"> - General Directorate of Hydraulic and Electric Resources: Large-scale hydraulic projects; policy discussion; International coordination. - General Directorate of Exploitation: Operation; Administrative and financial control of the four WEs and the Litani River Authority (LRA).
Ministry of Public Health (MoPH)	<p>Established a Department of Sanitary Engineering to monitor water quality. Sets standards for drinking water as defined in Libnor; recommends action for pollution prevention; and operates water quality equipment in equipped laboratories. Responsible for bottled water compliance.</p> <p>Epidemiological Surveillance Unit reports on water-related diseases through surveillance reporting.</p>
Ministry of Environment	<p>Responsible for the protection of the environment in general, providing studies on wastewater treatment, environmental impact assessment and natural resources management and conservation.</p> <p>Responsible for proposing legislation that ensures the implementation of relevant measures based on Environmental guidelines.</p>
Performance Evaluation Com.	<p>Part of the Law 221 of 2000 as an attempt to set up “independent” regulatory body within the General Direction of Hydraulic and Electric Resources in charge to prepare the supervision work especially with regard to evaluation and monitoring of the Water Establishment. Not yet established but regulations prepared.</p>
Council for Development and Reconstruction (CDR)	<p>Established in 1977 in replacement of the Ministry of Planning (Government unit for reconstruction and development), the CDR was granted extended power to avoid official administrative and financial routine. It is an implementation agency which signs project agreements (many loans) with any non- Lebanese organization and international donors. CDR is also responsible for funds from Paris III Donors Conference (25.01.07) allocated to reconstruction and infrastructure projects (grants but also loans, soft loans and subsidies). They can manage operation and maintenance of infrastructure, and technical assistance contracts, although the bulk is on constructing major infrastructure projects (including irrigation, water networks, wastewater and solid waste facilities), to rehabilitate, extend, modernize existing infrastructure projects by appointment from the Council of Ministers;</p>

Institution	Comment
Water Establishments (WE's)	WEs are required to study, implement, operate, maintain and replace water supply, wastewater and irrigation projects in the areas under their jurisdiction. In addition, implement the required investments in line with the Master Plan, achieve cost recovery and propose tariff adjustments, and control of the domestic and irrigation water quality, as well as the quality of wastewater discharged.
Litani River Authority (LRA)	Public establishment under the authority of the MoEW, the LRA was established in 1954 to develop the Litani River Basin domestic, irrigation and hydropower water schemes; develop a national power grid, and build electrical power stations and distribution networks. In 1955, the LRA was given the technical and the financial power for operating and exploiting all Litani River Basin related projects , extended in 1962 to include a water development plan for all the Litani/Awali Basins, the area between the Beirut-Damascus Road and the southern Lebanese boundary. The naming of 'Litani Water Authority' often leads to confusion because LRA is not only responsible for the management of the Litani River , its action extends over the whole Lebanese territory, especially in the domain of rivers and spring gauging.
Municipalities	<p>According to Article 49 of Decree-law no.118 dated 30/6/1977, the Municipal Council shall be in charge, without limitation, of the following:</p> <ul style="list-style-type: none"> - Public programs for works, aesthetics, cleaning, health affairs, water projects and lighting, - Granting construction permits, housing permits, certificates of completion for the routing of water, electricity and telephone, after the approval of the competent technical departments - Authorizing the excavation of public streets in order to lay water, electricity, telephone and wastewater pipes and others, in return for a guarantee for the return of the premises to their previous state, on the expenses of the license applicant; the public institutions, the independent services and the State administrations are not being excluded from the said authorization <p>According to Article 136 of the same Decree-law, the municipalities shall be entitled to use the municipal public properties in order to execute their public projects, carry out excavation and installation works for lighting, sewers and water projects. However, the municipality shall not be entitled, in any case whatsoever, to exercise its power outside its municipal area or to collect fees from another municipality or from the tax payers related to the said municipality.</p>



3.3

Data issues

Data collection and sharing is a major challenge in Lebanon. Availability of updated data particularly for water resources is limited; statistics are not centralized, and there is no vision or strategy synchronizing the country's statistical output (UNDP, 2013). Additionally, data are often only available in aggregate form and do not reflect important geographic variation across Lebanon. A lack of available and functioning water resource monitoring infrastructure at the national and regional water authority level, that is properly maintained and prioritized is a significant hindrance to ensuring water resource sustainability in Lebanon, particularly to protect water quality at the source, in the distribution system and in the household. No national or regional water resource monitoring plans exist in Lebanon, and dedicated technical capacity to monitor water resources is not prioritized in water supply authorities.

LEBANON WATER QUALITY SURVEY (2016)

4.1

Survey design



The Lebanon water quality survey (hereafter the 'survey' or LWQS) design was based on a similar sampling strategy adopted for the Lebanon Household Baseline Survey conducted by UNICEF between October 2015 and February 2016, and the globally developed JMP/Multiple Indicator Cluster Survey (MICS) household water quality module. The stratification of the survey was based on the 'type of dwelling/settlement' in the country, rather than population cohorts. This approach has been agreed as appropriate by Lebanon's Central Administration of Statistics (CAS) experts, which considers that the variables of interest need to be correlated with the type of settlement, rather than nationality of the household. Three strata for the survey are defined accordingly (as shown in Figure 4.1):

1. Permanent Residences

– permanent buildings and dwellings sample frame is officially serviced under the authority of the GoL by established piped networks, but also by private sector bottling suppliers, water tankers/trucks and private wells/springs. This stratum includes all Lebanese and those populations not considered in the other strata, such as Syrian refugees living within the host community.

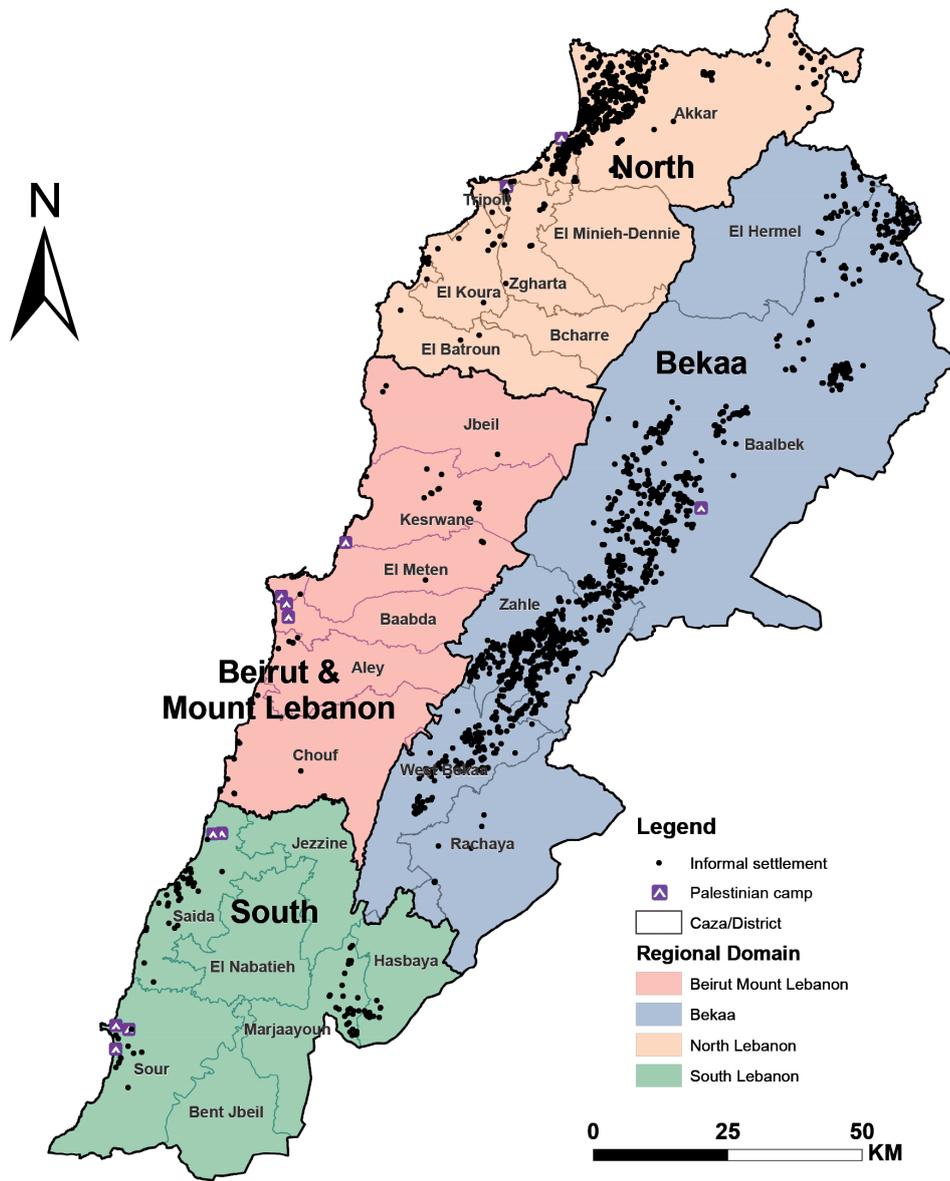
2. Informal (tented) Settlements (IS)

– unofficial and non-permanent structures (1942 IS's of 4 tents and above) primarily on agricultural lands with Syrian refugee populations, serviced predominantly through the international humanitarian sector by water trucks, bottled water and also by private wells/springs. The GoL does not officially supply water services to households in the IS's.

3. Palestinian Camps

– 12 official and semi-permanent Camps, populated by Palestinian refugees, and serviced by the United Nations Relief Works Agency (UNRWA) whom manage wells and bottled water providers. The GoL does not provides water services to the Camps.

FIGURE 4.1
 DISTRIBUTION OF INFORMAL SETTLEMENTS
 AND PALESTINIAN CAMPS AS PER WATER
 ESTABLISHMENTS



The LWQS survey took place over the period of May to June 2016, and before the summer break when householders are most mobile (i.e. out of the country/living in locations outside of their normal residence). The survey adapted parts of the globally established Multiple Indicator Cluster Survey (MICS) household survey design and questionnaire, and included the water quality module developed in collaboration between the JMP and MICS teams, specifically for water quality surveys to assess SDG 6.1. The survey utilized the standardized questionnaire to record demographic household data, as well as water quality data at the household distribution point and cup (point of ingestion), based on agreed water sampling methodology. The questionnaire was designed to provide all necessary information on the components for the assessment of SDG 6.1, namely: water supply technology; accessibility; availability and quality. A copy of the questionnaire used in the survey is provided in Appendix A. The questions used in the survey were translated into Arabic to ensure that the field teams were able to accurately communicate the intent of the questions to the householder and record the results of the interview. WHO, CAS, MoEW and MoPH reviewed the questionnaires, and provided feedback on the sampling methodology.

In total, six separate domains were required to cover Lebanon, including: 4 regional/governorate level (permanent residence) domains; one IS domain; and one (Palestinian) Camp domain. Each permanent residence domain covers two governorates, and within each are several cazas. The survey aimed to have representative estimates of water quality samples in all domains. These domains nominally represent primary water supply responsibilities/modes (i.e. formal GoL regulated services; informal services; and international organization managed service)

across Lebanon to provide national coverage representative for all populations in Lebanon.

The IS 'households' are primarily non-permanent structures, typically located on rural/agricultural lands, and the Palestinian Camps are semi-formal structures within established permanent residences (covered by the regional domains). These two 'non-permanent' domains are geographically contained within the boundaries of the first frame, namely permanent residences.

4.2 Sampling and stratification

Sample size

The equation for calculating the sample size used in the survey is:

$$n = \frac{p(1-p) D}{e^2}$$

Where:

- n is the required sample size
- p is the estimated value of the parameter of interest (i.e. percent with contaminated water)
- D is the design effect
- e is the error

The Rapid Assessment of Drinking-Water Quality (RADWQ), a globally recognized tool, suggested the use of a value of 50 percent for 'p', where no previous estimate exists, as this will capture the greatest variation. The design effect (D) is recommended to be four, therefore a four times larger error due to clustering than by using a simple random sample.

An error of 5 percent would give a sample size of 1,600 for a single domain. Statistical theory states that if the sample size for a single



domain is equal to 'n', then the sample size for 'k' domains should be 'n' multiplied by 'k', or, in this case, 1,600 times 6. This gives a sample size of over 9,600 households, which is not feasible in the current context and timeline. To accommodate the required estimation and ensure a quality sampling framework in the six domain levels, the error was relaxed to 10 percent. This gives a sample size of 400 households for each domain, with a combined sample size of 2,400 households, which gives an error less than 5 percent at national level. The breakdown of samples required for each domain is shown in Table 4.1.

In addition, the required sample size was adjusted for non-response especially in the urban areas such as Beirut where previous studies estimate non-response to be as high as 65 percent (MICS 2009) (Table 4.1).

Sample allocation

The clusters were defined as the lowest geographical location where an estimate of population size is available. This includes a village/town in non-urban areas, informal settlements, neighborhoods in dense urban settings or semi-formal camps. To decrease the clustering effect and the error size, the cluster size is set at five (5) households, which results in 90 clusters to be selected in each domain. Thus having 554 clusters in total. Table 4.2 below gives the distribution of these clusters stratified by each domain.

Within each domain, clusters were allocated through probability proportionate to the size of the cadastres. The primary sampling units (PSUs), which are synonymous with the first-stage sampling units, are defined as the cadastres. They were selected with probability

TABLE 4.1
SAMPLING BY DOMAIN

Sample domains	Non-response adjustment %	Adjusted non-response sample size
Beirut-Mount Lebanon (B-ML)	77	520
South Lebanon – Nabatieh (SL-N)	90	450
Beqaa-Baalbek-Hermel (B-B-H)	90	450
North Lebanon – Akkar (NL-A)	89	450
Palestine Refugee Camps	90	450
Informal Settlements	90	450
Total		2,770

proportionate to their measure of size (or 'pps'). This layer is the only officially available layer of population estimates supplied by National Physical Master Plan for the Lebanese Territory¹⁹. A total of 374 clusters were selected in each of the four WE domains. The allocation

TABLE 4.2
SURVEY DESIGN PARAMETERS

Sample domains	Households	Cluster size	Number of clusters	Total Dwellings	Sample interval to select Cadasters
B-ML	450	5	90	89,722	1 in 996.9
SL-N	450	5	90	134,151	1 in 1490.6
B-B-H	520	5	104	428,111	1 in 4116.5
NL-A	450	5	90	139,952	1 in 1555
Palestinian Camps	450	5	90	39,116	1 in 434.6
Informal Settlements	450	5	90	34,307	1 in 381.2
Total	2,770		554	869,452	

of the clusters followed a systematic random sampling based on size of PSUs, thus the allocation of the clusters to PSUs ranged according to the size of the cadastre. A fixed cluster size of 5 households was set, as discussed above.

4.3

Data collection for LWQS

A total of 18 teams, consisting of two members each (including a water quality tester and an enumerator), conducted the survey field data collection. The work was divided across 15 teams covering the regional (permanent residences) and informal settlement domains, and three teams for the Palestinian Camps. The LWQS was completed within a six week period, between May and June 2016. The regional and IS domains were surveyed by locally recruited teams contracted by Beyond, a local Non-Government Organisation with access to most areas of Lebanon, to ensure full coverage. Due to restricted access in the Palestinian Camps, UNRWA provided support and utilized existing local staff to form teams and cover the survey in

the Camps.

Prior to gaining access to the household to conduct the interview and undertake the water testing, the interviewer requested whether the householder was willing to participate in the survey and explained in brief how the survey data will inform management of drinking water in Lebanon through defining the baseline for safely managed water services. Once permission is given, the interviewer sat with the householder to answer the questionnaire, and the tester requested water samples from both a cup and the point of distribution (where the water in the cup was provided from) to begin testing in the household. The householder was asked to provide **'a water sample that would be provided to a child to drink'**. The survey in each household takes in total about 30 minutes.

Overall, the household response rate obtained for this survey was very high, with a response rate of 99 percent, as shown in Table 4.3. Householders were generally very interested to participate in the test, and expressed concern about their drinking water quality, keen to be informed of the results. The response rate



TABLE 4.3
LWQS SURVEY RESPONSE RATES

	Households selected	Households completed	Household response rate (%)
Water quality questionnaire	2770	2750	99.0
E. coli (cup)	2750	2629	95.6
E. coli (distribution point)	2750	2426	88.2
Free Chlorine (cup)	2750	2708	98.4
Free Chlorine (distribution point)	2750	2356	85.6
Turbidity (cup)	2750	2743	99.7
Turbidity (collection point)	2750	2321	84.4

was somewhat lower for drinking water from the distribution point (84–88 percent), typically because water was not available at the time of the interview such as from tanker supply or supply source was too far away (>30 minutes).

Water quality results received during the survey were not at any time communicated to the household, due to the potential sensitivity of the results, logistical considerations and concerns that test results would be misinterpreted.

The household interviews and water quality results were recorded on android tablets uploaded with a version of CSPRO (globally used programmes adopted in other MICS surveys), formatted with the Arabic version of the questionnaire used to conduct the interviews. The data from the tablets was transferred on a daily basis to laptop computers, where the structural checks were conducted by the field supervisors and validated before being archived by a UNICEF engaged consultant expert. After input completion, the data was 'synced' with UNICEF Beirut Office central data system for immediate feedback on any issues and further processing.

4.4

Quality assurance procedures for LWQS

Prior to field work, the nominated field teams were trained by JMP international trainers in Beirut between April and May, 2016. The 18 teams were trained over a period of 7 days in water quality testing and the use of CSPRO with the tablets. In order to ensure the completion of the survey in the field was quality assured, the training was practice-oriented using the equipment that was utilized in the field. Testers were provided with all required water quality testing equipment and materials, and were required throughout the training to conduct over 15 tests on each selected water quality parameter, which also included 2 days of field testing piloting and an exam. The entire training was developed and facilitated by two WHO/UNICEF JMP international expert consultants, and supported by four co-trainers from the MoPH (2), Bekaa Water Establishment (1) and North Lebanon Water Establishment (1).

Quality control of the survey data was ensured

through the following activities:

- Targeted training with focus on hands on practice using the aseptic technique, the questionnaire, data input and the interpretation of results.
- Blank test, to verify the quality results of water samples taken by each team is correctly manipulated by the tester and, more specifically, to check contamination is not inadvertently introduced to the water during testing. Blank testing was conducted every 10 percent of households (i.e. each 10 households sampled) using a water sample that was known to be free of coliform i.e. single-use mineral water or distilled water.
- The enumerator/supervisor whose role was to observe the procedure, was also checking that the testing steps are respected according to the equipment manual, and was responsible for identifying any issues for correction.
- Random field visits from UNICEF WASH team and WHO Lebanon staff were undertaken to validate correct field procedure and correct any issues as they are observed in the field.
- An expert on CSPro provided data input oversight and was responsible for managing the data on the tablets and data processing.

4.5

Challenges for LWQS implementation

In general, the survey was undertaken in an efficient and well managed approach. The few challenges that were encountered include:

- Safe water for blank tests was initially sourced

from distilled water by a local contractor, however after initial poor quality results, a more quality assured (supplier regulated by MoPH) distilled bottled water was used for the purpose of the blank test.

- Due to the infrequent service provided to many households in Lebanon, where water samples were not available from the distribution point, such as piped supply and water tanker, the surveyor attempted to return or time their visit to be able to take a sample. However, this was not always possible.
- Fluctuating electricity and prolonged periods of no electricity supply potentially affected the maintenance of temperatures required for the incubators. Teams were encouraged to use the vehicle plug while in transit as well as home plug to charge the incubator to prevent temperature reduction below safe levels.
- Ramadan, security events and restrictions reduced access in some areas, during periods of the day and prolonged fieldwork in some areas, such as Qaa and areas of South Lebanon. Teams in areas deemed unsafe were advised not to travel and also visibility of teams was limited to reduce undue attention.
- Local level consultations required to ensure access prior to listing and sampling each day limited the time available to undertake tests and the number of households accessed. Teams were able to make up time where possible by extending work hours during days that access was available.



4.5.1

Key water safety parameters and risk assessment to assess household water safety

Four water quality parameters were tested as part of the LWQS to assess household water safety, including:

- **E. coli:** the presence of faecal indicator bacteria (primarily *E. coli*) in water, indicates the presence of human excreta contamination and the possible presence of pathogenic organisms. It is used as a measure of the potability of water, and is the primary indicator for drinking water quality.

- **Free Chlorine (or residual chlorine):** the presence of free chlorine in drinking water is correlated with water safety as it is a standard treatment for drinking water supply. An optimum level of free Chlorine (0.2 to 0.5 mg/L) is required to protect water from fecal contamination.

- **Turbidity:** Turbidity is the measure of the relative clarity of water. Turbidity makes water appear cloudy or opaque. A higher turbidity above 5 NTU (Nephelometric Turbidity Units) affects ability to use chlorine/ozone as a treatment method, and affects visual aesthetics.

- **Nitrate (tested only in North and Bekaa):** High concentration of Nitrate (NO₃) in drinking water can be hazardous to the health of babies and pregnant women. Nitrate levels above 45 mg/L in Lebanon (LIBNOR) DW standard is considered hazardous to human health.

Water quality exceeding agreed standards for drinking water supply, depending of the level of deviation from the agreed standards presents a risk to human health. Household

water safety for the purposes of evaluating SDG 6.1 is based on levels of *E. coli*, as observed at the point of distribution. The water safety risk due to levels of *E. coli* is shown in Table 4.4. The other parameters tested as part this survey are additional indicators of water safety and important considerations when seeking to improve drinking water safety through strategic water supply interventions. The requirement for a water safety response based on levels of concentration of these parameters is shown in Tables 4.4 to 4.7.

An evaluation of the results for the water quality survey and the assessed risk level for each measured parameter based on survey domain and at the national level is provided in Chapter 5.

TABLE 4.4
DESCRIPTION OF *E. COLI* RISK LEVELS

E. coli [CFU/100 mL]	Risk level	Priority for action
<1	Low	None
1 - 10	Medium	Low
11-100	High	Priority
>100	Very High	Urgent

TABLE 4.5
WATER SAFETY RESPONSE FOR FREE CHLORINE

Concentration (mg/L)	Water Safety Significance
< 0.2	Insufficient (Unsafe)
0.2 - 0.5	Maintain (Safe)
> 0.5	Excessive (Unsafe)

TABLE 4.6
WATER SAFETY RESPONSE FOR TURBIDITY

Concentration (NTU)	Water Safety Significance
1	Maintain (Safe for conventional water treatment)
1 - 5	May need settlement (Safe)
>5	Needs settlement (Unsafe)

TABLE 4.7
TABLE 4.7 WATER SAFETY FOR NITRATE
(AS NO₃)

Concentration (mg/L)	Water Safety Significance
< 45	Maintain (Safe)
> 45	Treatment required (Unsafe)

4.5.2

Household water sample collection procedure

Household water samples were collected/ tested at both the point of distribution used by the householder and from the cup used for consumption. At the household level, survey respondents were asked to provide “a glass of water you would give a child to drink”. Additionally, the tester would then ask to see the distribution point of the water supplied in the cup for testing. The tester would then collect a sample directly from the distribution point for testing. The difference in water quality observed between the cup and the distribution point is an important consideration in assessing household behavior with regards to hygienic handling and

storage practices, and will be assessed further in Chapter 5.

It is recognized that the distribution point within the household is not sterilized prior to sample collection (as commonly practiced as part of the aseptic procedure for samples taken to a laboratory), so it is possible that some of the E. coli contamination found in distribution sample is due to unhygienic handling of taps and at the borehole outlet, rather than from the originating source/pipework. However, this method provides a good measure of the quality of water as it is actually collected by household members, similar to that measured in the cup, which is also not sterilized prior to testing. This method of testing directly reflects the approach for collection of water by a householder as part of their everyday activity a key parameter to assess SDG 6.1.

This survey is not intended to measure the water safety beyond the household collection system, which is the responsibility of government regulators and private vendors.



4.6

Household water testing procedure

4.6.1

coli

Field kit and procedures

To assess achievement of SDG 6.1, *E. coli* is the preferred indicator of faecal contamination in drinking water supply. *E. coli* was measured in each household by filtering 100 mL of water sample through a 0.45 micron filter (Millipore Microfil®), which was then placed onto 'CompactDry EC' growth media plates (sourced from Nissui, Japan). A 1 mL water sample was also tested from the same water sample directly onto a second growth media plate. The CompactDry plates contain a chromogenic compound (called X-gluc) which reacts with the beta-glucuronidase enzyme produced by *E. coli* bacteria, resulting in blue coloured colonies.

Incubation of the CompactDry plates to culture the growth of bacteria was done using electric incubators supplied to each team. The incubation time for *E. coli* was set to 48 hours in order to pre-empt a drop in temperature caused by problems in the supply of electricity, a common problem in Lebanon. After 48 hours, the number of blue colonies, signifying the presence of *E. coli* colony forming units (CFU), was counted and recorded by the tester. Table 4.8 describes the *E. coli* testing procedure followed by each field survey team.

TABLE 4.8
E. COLI TESTING PROCEDURE

Step	Description
1	Open Compact Dry Plate packet. Label two plates with Sample ID using permanent marker or sticker.
2	Wash hands well with soap, or use hand sanitizer.
3	Sterilize filter support using an alcohol wipe.
4	Sterilize forceps using an alcohol wipe. Put forceps down on flat surface, on top of the alcohol wipe, without touching the forceps tips.
5	Using forceps, remove one sterile filter paper. Do not use the blue paper sheets.
6	Place a filter paper on the filter support, with the grid lines up. Put the forceps down on the alcohol wipe, without touching the tips. Remove one Microfil funnel from package, without touching the rims.
7	Place a Microfil funnel on the support and press down.
8	Pour the sample into the Microfil funnel, up to the 100 mL line.
9	Open a sterile 1 mL syringe, being careful to not touch the tip. Draw 1 mL of sample from the funnel into the syringe.
10	Add 1 mL of sample to each of the two Compact Dry plates. Do not touch the plates with the syringe (or with fingers). Replace the lid on the Compact Dry plate after adding the sample.
11	Attach syringe to filter support and turn valve to open position (vertical).
12	Create vacuum with syringe, slowly filtering sample.
13	After all the sample is filtered, close the valve (horizontal position) and remove the funnel.
14	Press the lever and remove the filter paper using the sterile forceps. Remove the lid from one of the Compact Dry plates.
15	Place the filter paper on the Compact Dry plate, taking care to avoid bubbles. Keep the grid lines facing up.
16	Place the lid on the Compact Dry plate.
17	Open the valve and use the syringe to suck any remaining water from filter support. Remove the syringe and dispose of filtered water.
18	Collect all garbage (1 mL syringe and wrapper, alcohol wipe and wrapper, Compact Dry wrapper) and place in rubbish bag. Show respect to the households and do not litter.
19	Wash hands well with soap. Test is done! Read and record test results after 24-48 hours.



4.6.2

Nitrate

Field kit and procedures

A kit using comparator reagents AK163, 0 - 15 mg/L N (Palintest) was used to assess water samples for nitrate. Nitrate is not a standard parameter for measurement as part of water quality surveys used to assess SDG 6.1, however it was deemed a good opportunity to gather data in areas of Lebanon susceptible to high nitrate and will inform future drinking water safety response in Lebanon.

Table 4.9 describes the testing procedure followed by field survey teams.

TABLE 4.9
NITRATE TESTING PROCEDURE

Step	Description
1	Add 1 ml of sample, fill to 20 ml with deionised water
2	Add 1x scoop of Nitratest powder
3	Add 1x Nitratest tablet. Do not crush the tablet.
4	Cap and shake for 1 minute
5	Stand for 1 minute, then invert 3-4 times
6	Stand for 2 minutes
7	Decant clear solution into square vial to 10 ml mark
8	Add 1x Nitricol tablet, crush and mix
9	Stand for 10 minutes
10	Reading is Nitrate (mg/l N) Nitrate (N) to Nitrate (NO ₃) = N x 4.4

4.6.3

Chlorine

Field kit and procedures

Free Chlorine was assessed using a digital photometer with DPD 1 tablets (Lovibond MD100) for 10 mL of water sample. Table 4.10 describes the testing procedure followed by field survey teams.

TABLE 4.10
FREE CHLORINE TESTING PROCEDURE

Step	Description
1	Clean a vial and tablet crusher using the sample water or distilled water if available.
2	Fill the vial with 10 mL of sample to the white line and then close the lid.
3	Place the vial in the meter aligning the triangles. Make sure the plastic ring on the lid is in place.
4	Press "On/Off". The display should read "CL6" (press "mode" if it reads "CL10" until it reads "CL6"). Press "Zero/Test" to calibrate the meter for the sample.
5	Remove the vial from the meter and then add one DPD N°1 tablet. Crush the tablet and stir until the tablet has dissolved completely. Close the lid.
6	Place the vial in the meter for a second time, aligning the triangles. Press "Zero/Test" button and wait 3-5 seconds until a number is displayed.
7	Record the result shown on the screen. If the displayed result is "Lo" then record 0.00 if it is "Hi" then record 9.99.
8	Turn off the chlorine meter by pressing the "on/off" button
9	Empty and rinse the vial and then place all materials back in the carrying case including the tablet crusher and vial.

4.6.4

Turbidity

Field kit and procedures

Turbidity tests were undertaken using a digital photometer (Lovibond TB210ir) using a 10 mL of water sample. Table 4.11 describes the testing procedure for turbidity as followed by field survey teams.

TABLE 4.11
TURBIDITY TESTING PROCEDURE

Step	Description
1	Clean a vial using the sample water or distilled water if available.
2	Ensure that the water is above the white line. Fill with 10 mL of the sample water and close the lid.
3	Hold the vial by the lid and carefully clean off any finger prints and water from the glass using the cloth.
4	Line up the triangle on the vial with the triangle on the turbidity meter and put the vial in the turbidity meter. Place the cover on top to make sure it is dark inside.
5	Turn on the turbidity meter by pressing the "on/off" button.
6	Press the "Read" button and wait 3-5 seconds Record the result shown on the screen. In the example above it is 0.54.
7	If the displayed result is "Lo" then record 0.00 if it is "Hi" then record 9999.9.
8	Turn off the turbidity meter by pressing the "on/off" button.
9	Place all materials back in the carrying case including the vials and cloth.

WATER QUALITY RESULTS

5.1

Water quality results at national level



The LWQS for Lebanon (2016), focused on gathering data on globally agreed parameters that are used to indicate water safety for the purposes of drinking water supply, and particularly *E. coli*, which is a key indicator to establish the baseline for SDG 6.1, safely managed drinking water services. The results of the national household water quality survey are presented below which are based on the 'weighted' data collected as part of the survey and reflect the proportion of the population as estimated by the survey.

5.1.1

E. coli

To be considered safe to drink, water should be free of *E. coli* (0 CFU/100 mL), as recommended by WHO and Libnor. Figures 5.1a (cup) and 5.1b (distribution point) show the results for *E. coli* found in drinking water from households across Lebanon. The national data is further disaggregated based on the type of settlement (permanent residences, Informal Settlements and Palestinian Camps), and mode of supply. The water quality results for *E. coli* at the national level for households will be used to

assess the baseline for SDG 6.1, as described in Chapter 6.

It is observed that the data collected from the permanent residences is representative of the overall national summary, which is realistic given that the bulk of Lebanon's population live in this settlement type. The water quality results however for Informal Settlements and the Palestinian Camps vary from the overall national results, possibly due to their access to less formalised and independently managed water supply services. In Lebanon, there are a number of areas where informal (tented) settlements house recently arrived Syrian refugees. The majority of these IS's are located in the agricultural areas of the Bekaa-Baalbek-Hermel (B-B-H) and North Lebanon-Akkar (NL-A) governorates, however the other governorates across Lebanon also host some IS's. There are 12 formal Camps located within Lebanon that host Palestinian Refugees, that have their drinking water supply managed by UNWRA.

Nationally, half of the population in the permanent residences and overall across Lebanon, at the point of water collection (distribution point) by the householder, used

drinking water supplies which were free of *E. coli*, that is low risk. Almost a third of the population uses drinking water supplies at moderate risk (1-10 CFU), and 10 percent use very highly contaminated drinking water supplies (>100 CFU).

The risk to households in Informal Settlements with regards to *E. coli* contamination is significantly higher than for any other settlement type in Lebanon, and well below the overall national average. Results for *E. Coli* concentration at both the distribution point and the cup in IS households suggests that although a similar proportion (40 percent) of IS households, as the permanent residences, are accessing water free of *E. coli* (low risk), the overall contamination level (and by inference risk of health impacts) is much higher, with almost a quarter of IS households accessing very highly contaminated drinking water.

For households in the Palestinian Camps, on average the situation with regards to *E. coli* contamination is slightly better than for permanent residences and considerably better than for IS households. Just over 40 percent of households in Palestinian Camps are accessing water at low risk, with a third accessing drinking water with moderate (*E. coli*) contamination levels, and less than 5 percent accessing very highly contaminated drinking water.

Figures 5.1, 5.2 and Figure 5.3 highlight the impact on water quality that is occurring within households in Lebanon, represented by the change in contamination level between the cup and distribution point. Nationally, 8 percent of households in residences and overall across Lebanon with a previously low risk drinking water supply becomes a higher risk, with less

than 10 percent of households in Palestinian Camps contributing contamination to their low risk drinking water supply. Households in IS's contribute on average less contamination to their drinking water supply, which is primarily moderate level, and interestingly 5 percent of IS households are protecting/improving the quality of their drinking water supply (i.e. reduction in high level contamination between distribution point and cup).

Figure 5.3 indicates that at the national level, two thirds of households across Lebanon are adopting practices that do not increase the risk of contamination to their supply, 10 percent are actively reducing risk of contamination in the remaining household, with the households introducing a moderate to high risk of contamination.



FIGURE 5.1
E. COLI IN 100 ML OF WATER (CFU) IN HOUSEHOLDS AT THE NATIONAL LEVEL – CUP.

■ >100
■ 11-100
■ 1 - 10
■ 0
 PROPORTION OF POPULATION BY LEVEL OF E. COLI IN DRINKING WATER CUP (%)

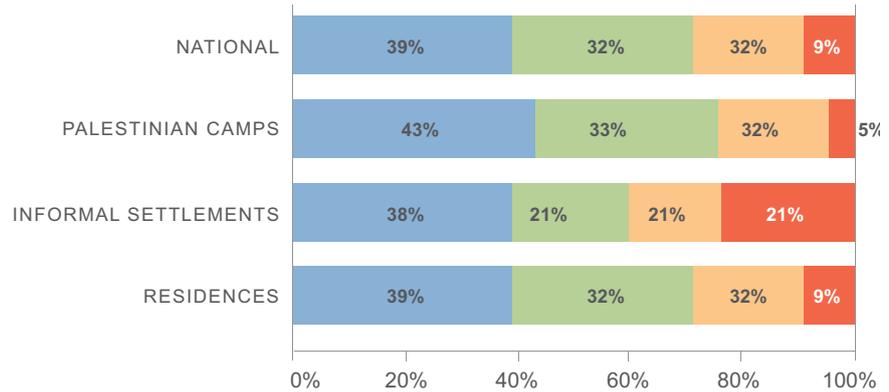
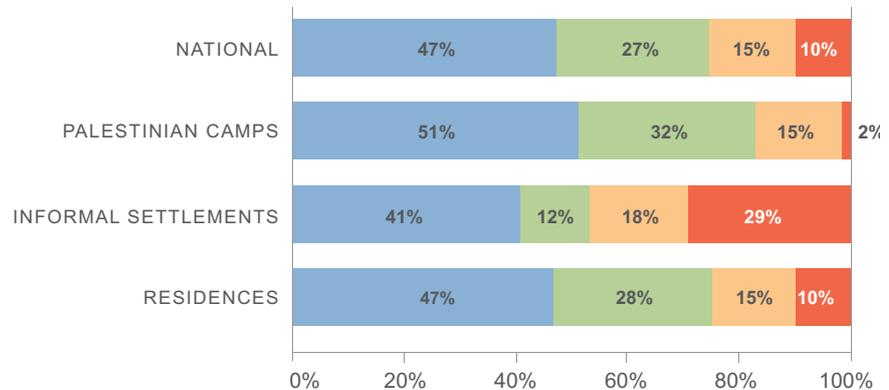


FIGURE 5.2
E. COLI IN 100 ML OF WATER (CFU) IN HOUSEHOLDS AT THE NATIONAL LEVEL – DISTRIBUTION POINT.

■ ≥100
■ 11-100
■ 1 - 10
■ 0
 PROPORTION OF POPULATION BY LEVEL OF E. COLI AT DISTRIBUTION POINT (%)



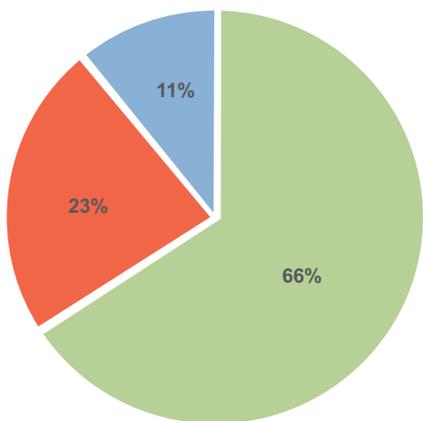
The type of distribution point (mode of drinking water supply) within a household also influences the quality and therefore safety of drinking water (Figures 5.4 and 5.5). In Lebanon, the primary modes of drinking water supply accessed by households, depending on settlement type includes: piped (networks); bottled water (Box

1); protected wells and springs; unprotected wells and springs; water tanker. Households use a range of water supply modes to augment their drinking water needs, which is likely to be primarily based on accessibility and cost, rather than safety.

Box 1:

Bottled water that was tested for LQWS refers to any type of water contained in a bottle. This could be a branded bottle, water contained in a bottle from any distribution shop, or any other water sources that a bottle could contain.

FIGURE 5.3
CHANGE IN E. COLI RISK LEVELS BETWEEN DISTRIBUTION POINT AND CUP- NATIONAL LEVEL.



supply.

For piped networks less than half of households are accessing low risk water from this supply mode, with low to high level contamination contributed by the household leading to just over a third of households consuming water with a low risk of contamination from the piped network. It is however recognised that many households in Lebanon store their water in roof top and below ground storage tank, whereby

PROPORTION OF CHANGE BETWEEN DISTRIBUTION POINT & CUP-NATIONAL LEVEL (%)

- No change in risk level occurs at HH level
- Increase in risk level occurs at HH level
- Decrease in risk level occurs at HH level

The survey data shows that bottled water is the least likely to be contaminated with E. coli, although just over 50 percent is considered low risk when tested directly from the bottle (distribution point). The risk of contamination increased by 12 percent in the cup of water for households using bottled water. MoPH \ regulate bottled water suppliers however it is recognised that many unregulated private sector (bottle water is also known as a 'gallon' in Lebanon) suppliers are operating, and are commonly used by households as an alternative drinking water

once it is piped into an individual household/ apartment building, it is potentially affected either by poor maintenance of the storage tanks and/ or also may be mixed with other sourced water, such as tanker water. This is common practice in Lebanon due to the irregular periods of access to a piped network supply, typically less than 8-13 hours a day²⁰.

Drinking water provided to households from protected wells and springs, and by tanker truck provide a similar level of safety to the piped



supply at the distribution. However, there is a higher level of contamination by the householder in water collected at protected springs likely due to the need to carry the water from the point of distribution to the house for consumption.

Unprotected wells and springs provide the lowest level of water safety (30 percent free of E. coli, low risk) in Lebanon at the distribution point, however due to an improvement of quality, 44 percent is free of E. coli at consumption (cup).

FIGURE 5.4
E.COLI PER TYPE OF DISTRIBUTION POINT AT NATIONAL LEVEL – CUP.

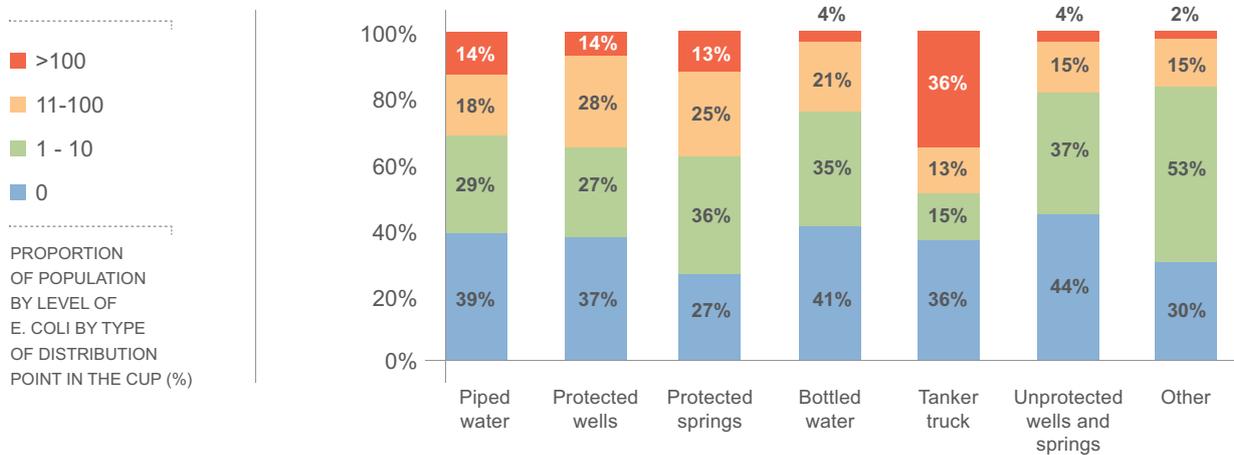
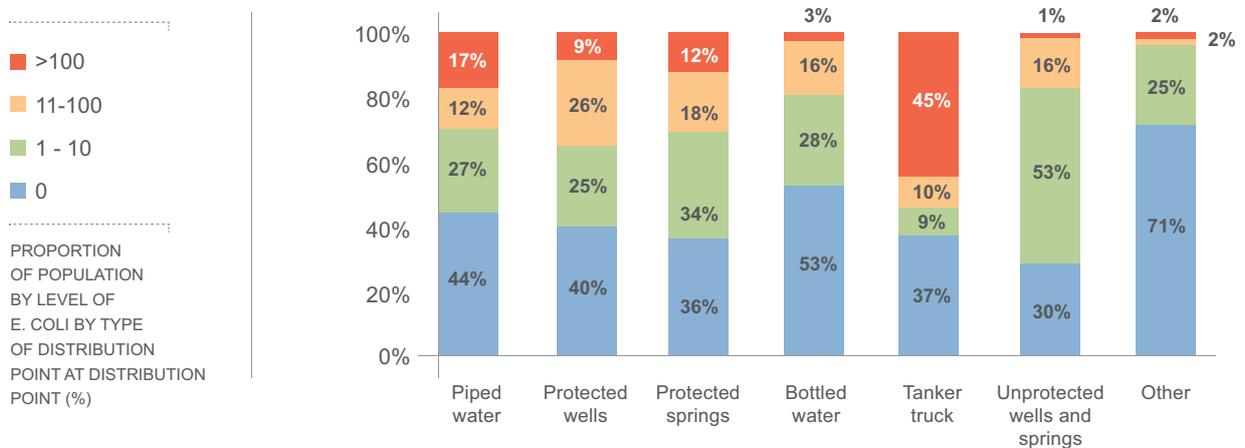


FIGURE 5.5
E.COLI PER TYPE OF DISTRIBUTION POINT AT NATIONAL LEVEL – DISTRIBUTION POINT.



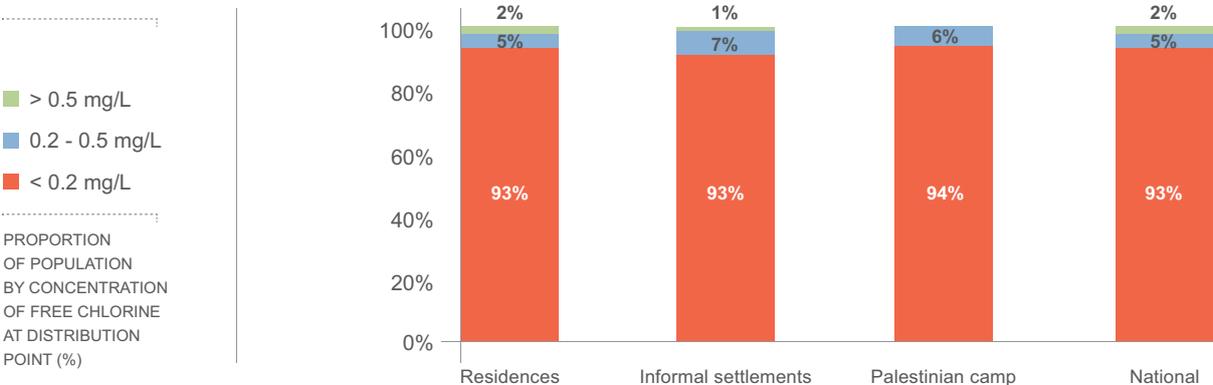
5.1.2

Free (Residual) Chlorine

Free (residual) chlorine within the range of 0.2 to 0.5 mg/L is considered acceptable to reduce the risk of E. coli contamination and recommended by global guidelines, such as WHO and Libnor for (drinking) water safety. Figure 5.6 suggests that at the national level in Lebanon, almost 95 percent of households have an unacceptable level of residual chlorine in the water consumed for drinking, which is necessary to protect the drinking water supply and reduce the risk of fecal contamination. The situation of insufficient free Chlorine is similar across all settlement types and all modes of water supply. The data suggests that difference in observed

results for Free Chlorine between the distribution point and cup for all households is negligible, which indicates that chlorine is not used as a water treatment method within households across Lebanon. This is consistent with the position of the GoL to not advocate for Chlorine as a household water treatment method and it is not required in bottled water supplies. Chlorination is however supported at the level of regional water supply provided by the Water Establishments in the piped network and for water tankers provided by the international humanitarian organizations to Informal Settlements, yet it appears not be treated at levels sufficient to attain a required Free Chlorine concentration (0.2 to 0.5 mg/L) at the point of distribution.

FIGURE 5.6
CONCENTRATION OF FREE CHLORINE (IN 1 LITRE OF WATER) AT NATIONAL LEVEL – DISTRIBUTION POINT





5.1.3

Turbidity

Turbidity is the measure of the relative clarity of a liquid, and is a commonly used indicator for the general condition of the drinking water. A turbidity level above 5 NTU is considered to be indicative of poor water quality, and could affect water treatment effectiveness. Figure 5.7 suggests that for households in Lebanon, turbidity is consistently low and within an acceptable range for water safety (< 5 NTU), with almost 90 percent of households nationally accessing water of acceptable quality. The higher levels of turbidity observed in drinking water accessed by households in Informal Settlements is likely due to sourcing water from unprotected sources, such as wells and springs. The data suggests that there is negligible difference in turbidity levels between the distribution point and cup within the household, suggesting the settlement of solids is not a commonly adopted household treatment practice in Lebanon.

5.2

Disaggregated water quality results by domain

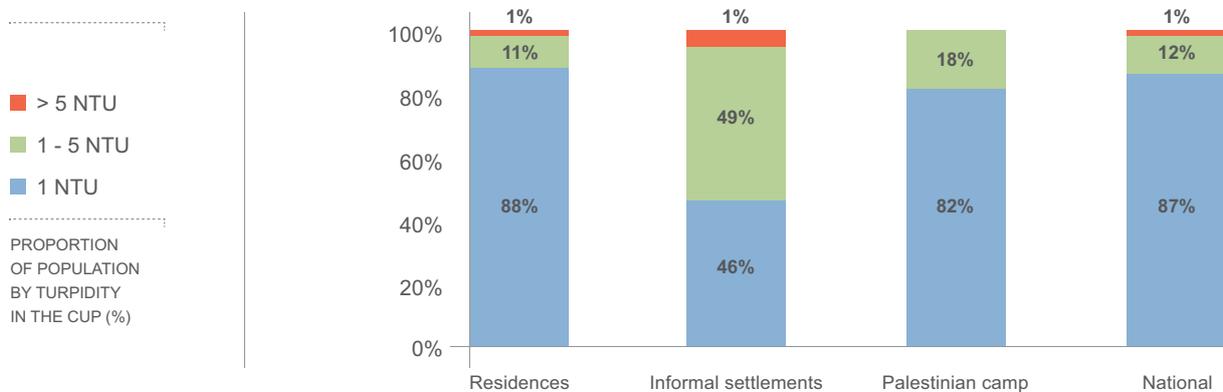
In this section results are disaggregated by regional domains, for permanent residences. Further disaggregation of data is not possible for the Informal Settlements and Palestinian Camps due to small sample sizes and has not be undertaken as the data may not be representative.

5.2.1

Regional Domains - Permanent Residences

As shown in Figures 5.8 and 5.9, low risk drinking water is accessed (distribution point) in a third of households in the regional domain for Beirut-Mount-Lebanon (B-ML) governorates, and 40 percent of these households have moderate to high risk levels (more than 100 CFU/100 mL). The data shows that households in B-ML hold a

FIGURE 5.7
TURBIDITY IN THE CUP PROVIDED IN HOUSEHOLDS IN LEBANON



decrease in moderately contaminated drinking water although it is still not considered safe when consumed (cup). There is little change in the high-risk contamination between the distribution point and cup in the households in B-ML.

For permanent residences in the governorates of North Lebanon-Akkar (NL-A), the data shows that half of these households have access to low risk drinking water, and there is negligible change between the distribution point and cup, indicating households are not practicing household water treatment. However, neither are they contributing significantly to unsafe water quality. Just under 10 percent of households in NL-A are accessing and consuming highly contaminated drinking water.

For the governorates of Beqaa –Baalbek-Hermel (B-B-H), two thirds of households in the permanent residences are accessing safe drinking water, although there is a significant decrease in water safety prior to consumption,

possibly due to handling and storage practice, with just over half of these households consuming safe water. Just under 10 percent of households in B-B-H are accessing and consuming highly contaminated drinking water, where it does not appear household treatment is occurring.

Permanent residences in South Lebanon and Nabatieh (SL-N) governorates are accessing and consuming the best quality of water in comparison with all other domains, with more than 70 percent of these households consuming safe drinking water. There is a slight increase in access to low risk water between the distribution point and cup, and a slight improvement in water safety at the highest contamination levels that suggests household water treatment may be practiced to a limited extent.

FIGURE 5.8
E. COLI SURVEY RESULTS FOR REGIONAL DOMAINS – PERMANENT RESIDENCES - CUP.

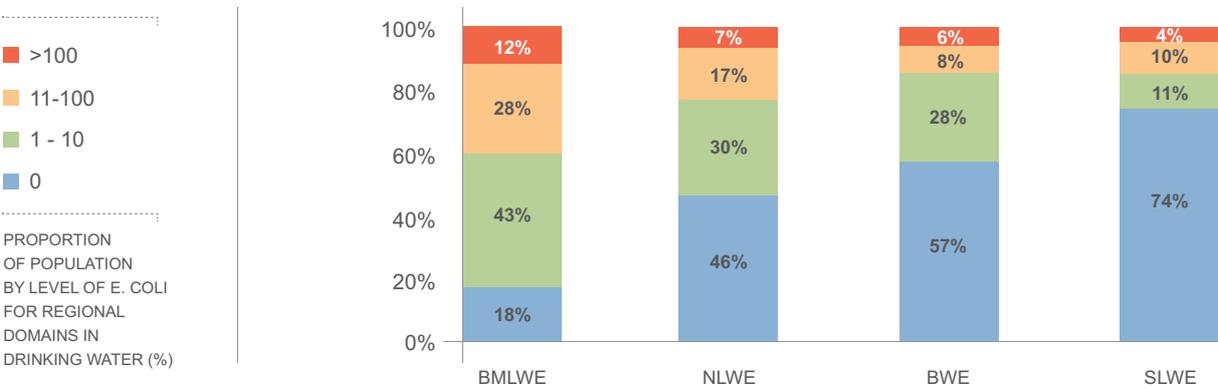




FIGURE 5.9
E. COLI SURVEY RESULTS FOR REGIONAL DOMAINS – PERMANENT RESIDENCES – DISTRIBUTION POINT.

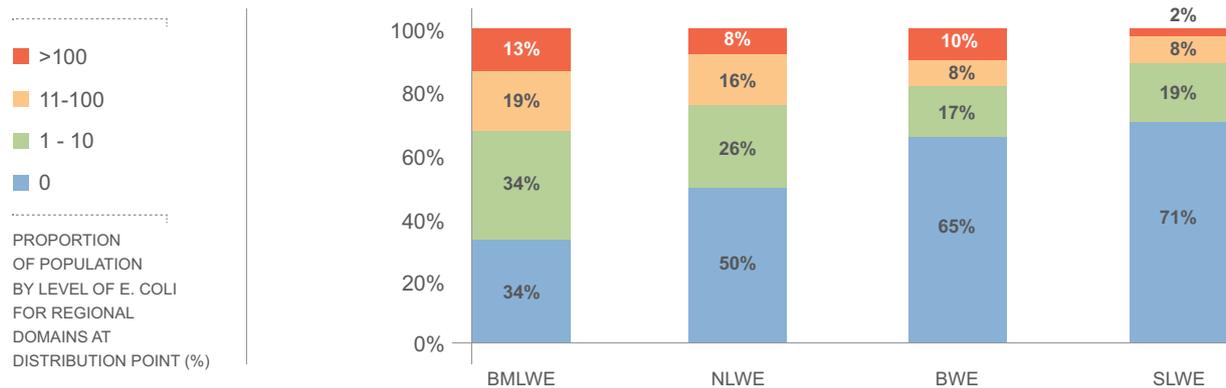


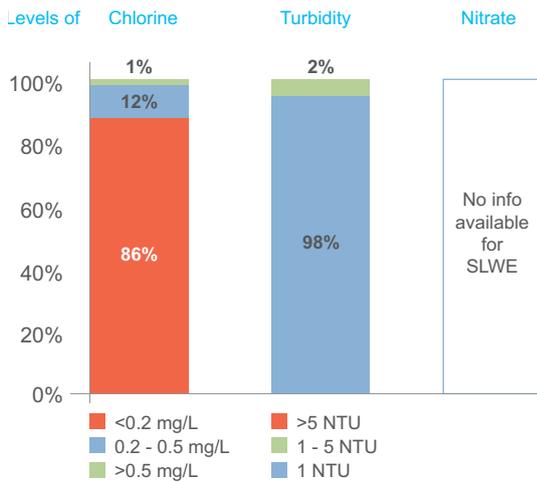
Figure 5.10 shows levels of free Chlorine and turbidity for permanent residences in the four domains. Households in the permanent residences (regional domains) in all governorates in Lebanon have insufficient protection of drinking water supply by residual Chlorine, with an average of 90 percent of households not accessing sufficiently chlorinated water supplies. Overall, the turbidity levels in drinking water accessed by households in the permanent residences meets drinking water standards, based on both WHO and Libnor guidelines.

Nitrate data was collected in the governorates of NL-A and B-B-H, and are presented in Figure 5.10. These areas are predominated by agricultural lands where the use of fertiliser on crops is a significant contributor of nitrate to

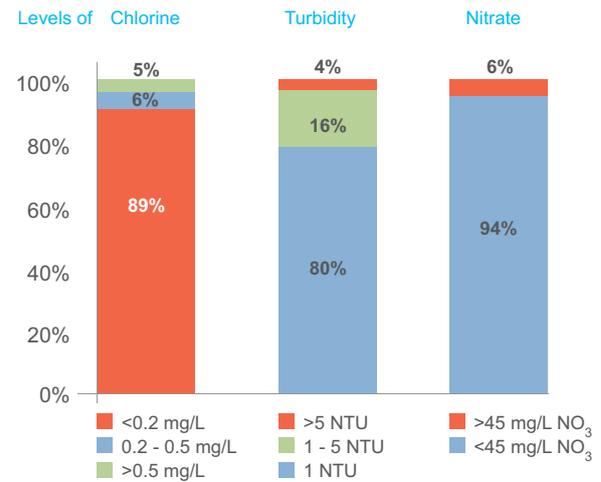
groundwater resources, the primary drinking water supply source in Lebanon. Therefore, these areas are considered most at risk from elevated nitrate in drinking water, a particular risk to those most vulnerable, babies and pregnant women. The results suggest that overall nitrate levels are within acceptable levels with the majority of households accessing water with nitrate levels within standard. There are however, a number of households that access unacceptable levels of nitrate (with very high risk levels) which over a prolonged period can have significant impact to the health of young children. These children may be at risk from developmental delays. Caregivers should be advised of the potential risk in these areas and to take mitigation measures where babies and pregnant women are using this water for drinking.

FIGURE 5.10
NITRATE DATA AT DISTRIBUTION POINT.
COMPARISON OF WATER QUALITY RESULTS FOR
REGIONAL DOMAIN – PERMANENT RESIDENCES.

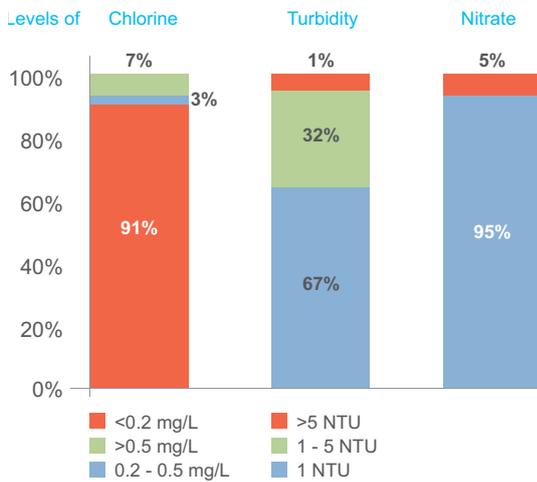
WATER QUALITY - RESIDENCES SETTLEMENTS - SLWE



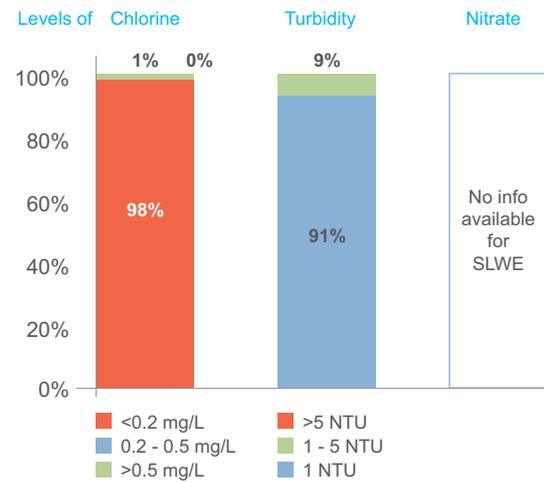
WATER QUALITY - RESIDENCES SETTLEMENTS - NLWE



WATER QUALITY - PERMANENT SETTLEMENTS - B-B-H



WATER QUALITY - RESIDENCES SETTLEMENTS - B-ML



The survey data indicates that half of permanent residences households (regional domain) have access to drinking water that is low risk through the bottled water modality, however 10 percent of these households contribute moderate to high risk of contamination prior to consumption, possibly due to unhygienic handling and unclean

storage. Less than half of the households access piped water that is low risk, and there is a 5 percent reduction in contamination risk in the cup with this modality, with just over a third of these households consuming water with a moderate risk. Protected wells offer a similar level of safety/risk as observed for piped water.

SAFELY MANAGED DRINKING WATER SERVICE IN LEBANON

6.1

Criteria for assessment of safely managed drinking water services



Based on the JMP methodology, using both the MICS questionnaire and water testing for E. coli, the following criteria are used to assess safely managed drinking water services (SDG 6.1) as accessed by a household (with data sources) in Lebanon:

1. Improved sources
2. Accessible on premises
3. Available when needed
4. Free from contamination

The assessment below is taken at the national level measured at the distribution point, and for Lebanon it considers collectively the data for permanent residences, Informal (tented) Settlements and Palestinian Camps.

6.1.1

Improved water supply modality

An improved drinking water source is one that, by the nature of its construction, adequately protects the source from outside contamination, particularly faecal matter²¹. An improved water supply modality primarily includes water piped into household premises, wells/springs that have been well designed with surface protection, and bottled water. Surface water, water trucking²²

and unprotected well/springs have been considered as unimproved. For a household to be considered to have a safely managed drinking water services, it must be supplied from an improved supply modality, together with the other criteria discussed below.

As shown in Table 6.1, Lebanon has 96 percent of households accessing drinking water supply from an improved water supply modality. At the national level, the majority of household improved supply is through piped networks (83 percent), with bottled water (38 percent) also a significant supply mode. The data indicates that 97 and 99 percent of households in the permanent residences and Palestinian Camps, respectively are using an improved supply mode, compared to only 39 percent of households in the Informal Settlements. This difference is due to the fact that permanent residences and the Palestinian Camps have access to a formalized water supply system that is supplemented by private sector water bottling, whereas the IS's are reliant primarily on informal (private) water providers, particularly water trucking.

Table 6.2 shows the progress since 1995 over the last 20 years for Lebanon in achieving its target of improved drinking water supply. The

data suggests that the significant improvement has been achieved through accessing 'other' water sources for drinking purposes which include bottled water and improved springs/wells. The reduction in households accessing unimproved water sources for drinking, such as tanker water has dramatically reduced.

TABLE 6.1
OVERALL RESULTS AT NATIONAL LEVEL FOR
IMPROVED DRINKING WATER SUPPLY

Settlement type	Basic	Improved	Piped on premises	Other improved	Other unimproved	Surface water
Permanent Residences	80%	97%	85%	12%	3%	0%
Informal Settlements	21%	39%	11%	28%	58%	3%
Palestinian Camps	55%	99%	92%	8%	1%	0%
National	78%	96%	83%	13%	4%	0%

TABLE 6.2
NATIONAL RESULTS FOR LEBANON BETWEEN
1995 TO 2015 FOR IMPROVED DRINKING WATER
SUPPLY (SOURCE: WHO/UNICEF JMP (2015)
ESTIMATES FOR LEBANON)

Year	Total improved	Piped on premises	Other improved	Other unimproved	Surface water
1995	83%	72%	11%	17%	0
2000	86%	73%	13%	14%	0
2005	92%	75%	17%	8%	0
2010	98%	77%	21%	2%	0
2015	99%	77%	22%	1%	0



6.1.2

Accessibility

Accessibility measures the ability of a household to obtain drinking water supply within their premises. Having a drinking water supply available on premises is important to reduce the risk of contamination. Even if the infrastructure/ source provides safe drinking water, it can still become contaminated by:

- Touching the water during collection,
- Collecting water from the source in dirty containers,
- Storing the water at home in open/dirty containers, and/or
- Touching the water at home with dirty utensils or hands.

In addition to the potential contamination risk, access to drinking water on premises, reduces the time taken to collect water, increases the amount of water that can be collected by all members of the household and is an important gender marker²³.

Based on the survey data presented in Table 6.3, an estimated 80 percent of households are accessing drinking water supply on premises. Households in the permanent residences have the highest level of access on premises (81 percent), primarily because these households have access to formalized/regulated piped networks that connect to the house and informal/private providers that deliver individually to the household. Households in the Palestinian Camps have a reduced access on premises (55 percent) as the majority of water supplied in the camps is through the formalized UNWRA managed service that stores and treats water centrally in the camp, which is then collected by the household from this central point.

The heavy reliance of households in ISs on privately (informal) managed water trucking and bottled water results in a low accessibility of 27 percent, as water is distributed to householders form a centralized point rather than delivered direct to the household.

TABLE 6.3
OVERALL RESULTS AT NATIONAL LEVEL FOR IMPROVED DRINKING WATER SUPPLY ACCESS ON PREMISES DISAGGREGATED FOR SETTLEMENTS TYPES

Settlement type	On premises (%)
Lebanon residents	81
Informal settlements	27
Palestinian camps	55
Total	88

6.1.3

Availability

The assessment of availability of drinking water supply is based on an evaluation (not quantified) by the householder on whether their drinking water supply needs have been adequately met. It does not necessarily imply that water services are available 24/7. As shown in Table 6.4, the survey results suggests that there is a high level of availability to drinking water supply in Lebanon, with 95 percent of households indicating that their supply needs have been met. Across both the permanent residences and Palestinian Camps, the majority (95 percent) of households have an available drinking water supply, although 78 percent of IS households are having a sufficient available supply. Lebanon as an urbanized environment, has a number of water supply modalities that allows households

to seek alternative supply where needed including through both formal regulated supply and private sector providers.

TABLE 6.4
OVERALL RESULTS AT NATIONAL LEVEL FOR DRINKING WATER SUPPLY AVAILABILITY

Population groups	Available
Permanent settlements	95%
Informal settlements	78%
Palestinian camps	95%
National	95%

6.1.4

Quality

Water quality is a key indicator to assessing SDG 6.1, and with the benefit of the LWQS survey, nationally representative water quality data can be used to understand water safety across Lebanon. Water safety is assessed based the presence of observed faecal coliforms (*E. coli*) at the distribution point in the household. As shown in Table 6.5, nationally, only 47 percent of households in Lebanon have access to low risk drinking water that is free of faecal contamination. This proportion is comparable to that observed in permanent residence households (47 percent), and higher when compared to Informal Settlements (41 percent). Water quality is best in households in the Palestinian Camps, although still only half (51 percent) have access to water free from

contamination.

Water safety is a significant issue across Lebanon and across all settlement types. There are a number of potential points of contamination in drinking water supply systems, from source to cup. Drinking water supplies can be contaminated through:

- Household handling, storage and hygienic practice
- Intermittent water supply, leaking distribution systems,
- Infiltration of surface water into groundwater extracted in wells and springs,
- Leaks in septic tanks and latrine pits, and/or
- Agricultural runoff containing chemicals/ microbiological contamination.

This survey focused on the water quality in the household, which is the basis of the SDG 6.1 assessment, and makes no assessment of contamination at other points within the supply system.

TABLE 6.5
OVERALL RESULTS AT NATIONAL LEVEL FOR SAFELY MANAGED DRINKING WATER SERVICES

Settlement type	Population using water free from <i>E. coli</i> (%)
Permanent settlements	47%
Informal settlements	41%
Palestinian camps	51%
National	47%



6.2

Costs of accessing drinking water services

SDG target 6.1 specifies that drinking water services should be affordable. The cost of accessing drinking water services is an important criterion that influences household decisions in accessing safely managed drinking water services. When developing interventions to support the water sector, it is important to understand the potential motivating factors, apart from that considered above, that may influence the behavior of the household to access safe drinking water supply. The LWQS collected data from householders on the amount of money spent in the provision of drinking water.

Table 6.6 describes the average monthly payments made by households in Lebanon for the supply of drinking water. Permanent residences pay the most for the supply of drinking water, which is close to the national average. Households in the Palestinian Camps pay the least for drinking water services, possibly as these services are subsidized by UNWRA whom manage the supply in these camps.

TABLE 6.6
HOUSEHOLD PAYMENT OF DRINKING WATER

Settlement type	Monthly Payments (Lebanese Pounds, LBP)
Permanent residences	9,503
Informal settlements	6,530
Palestinian camps	6,360
National	9,368

Table 6.7 provides a breakdown of the cost of drinking water services per supply modality.

The data shows the higher cost of water provided through the bottled water modality, as compared to piped networks.

TABLE 6.7
AVERAGE PAYMENT PER CAPITA FOR DRINKING WATER SUPPLY

Drinking water source	Monthly payment LBP
Piped water	9,098
Protected wells	2,527
Protected springs	8,569
Bottled water	11,424
Tanker truck	8,483

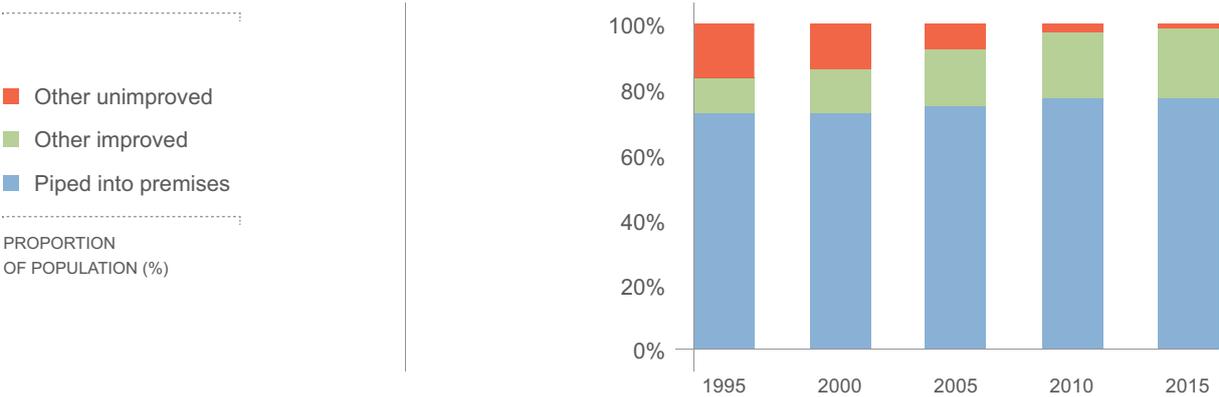
6.3

MDG 7c baseline for Lebanon

Millennium Development Goal 7c (MDG 7c), focused on assessing the household access to safe water by using the most easily accessible data to country survey teams at the national level, which was the type of water supply (infrastructure).

Lebanon has been providing data to the JMP since 1995 through MICS surveys (without water testing), and Household Living Conditions Surveys (HCS). As shown in the Table 6.2 and Figure 6.2, Lebanon has steadily been increasing its household access to improved drinking water supply, reaching **99 percent in 2015**, at the end of the MDG's. Therefore, according to MDG 7c, Lebanon achieved its goal for safely managed drinking water supply. However, as the discussion below on the SDG's shows, 'improved' does not equate to 'safe'.

FIGURE 6.2
LEBANON'S ACHIEVEMENT OF MDG 7C



Source: WHO/UNICEF JMP 2015

6.4
SDG 6.1 baseline for Lebanon

The purpose of the LWQS was to establish the SDG 6.1 baseline for Lebanon, using available information on “safely managed” drinking water that combines data 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 (as shown in Figure 6.3).

SDG 6.1 is defined as “By 2030, achieve universal and equitable access to safe and affordable drinking water for all”. The agreed indicator to measure achievement of SDG 6.1 is the “Proportion of population using safely managed drinking water services”, assessed by considering the population using an improved drinking water source which is:

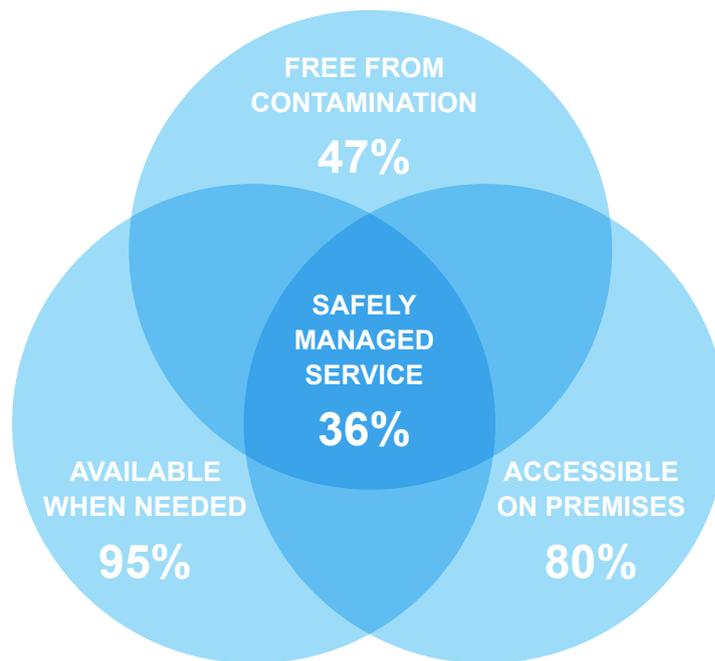
- accessible on premises - distribution point within the household’s dwelling, plot or yard;

- available when needed (available) - drinking water is available in sufficient quantities when needed; and
- free of faecal and priority chemical contamination (safe) - no faecal coliforms in drinking water supply at household level.

‘Safely managed’ is calculated by the population using improved sources that are (i) accessible on premises, (ii) available when needed and (iii) free from contamination, as shown in Figure 19. Countries are able to establish their own baseline to achieve the SDG’s, which are applicable between 2016 and 2030. Lebanon has therefore taken the opportunity to define its baseline for SDG 6.1, allowing this baseline to inform future investment, directing the significant international investment as a result of the Syrian Crisis. By achieving this, Lebanon will seek to stabilize the water sector and to support future development progress.



FIGURE 6.3
CRITERIA USED TO DETERMINE SDG 6.1



As shown in the Figure 6.3, the SDG 6.1 baseline for Lebanon is determined to be 36 percent. The breakdown of this baseline is shown in Figure 6.4. The results clearly demonstrate that although Lebanon has a high proportion (95 percent) of households accessing an improved water supply (except IS's), and that supply is generally accessible (80 percent) and available (95 percent), the high faecal contamination levels (47 percent) make the water unsafe to drink and therefore compromise accessibility to safely managed drinking water supply.

Figure 6.5 describe the variation between the different supply modes in safely managed drinking services. The data suggests that of the 'improved' water supply modalities adopted by households in Lebanon, bottled water (42 percent) is slightly more safely managed than piped supply (36 percent) and protected wells (30 percent), which are the primary drinking supply modalities used in Lebanon. Tanker water, an unimproved water supply modality, is not safely managed.

FIGURE 6.4
BASELINE FOR SDG 6.1 AT A NATIONAL LEVEL FOR LEBANON.

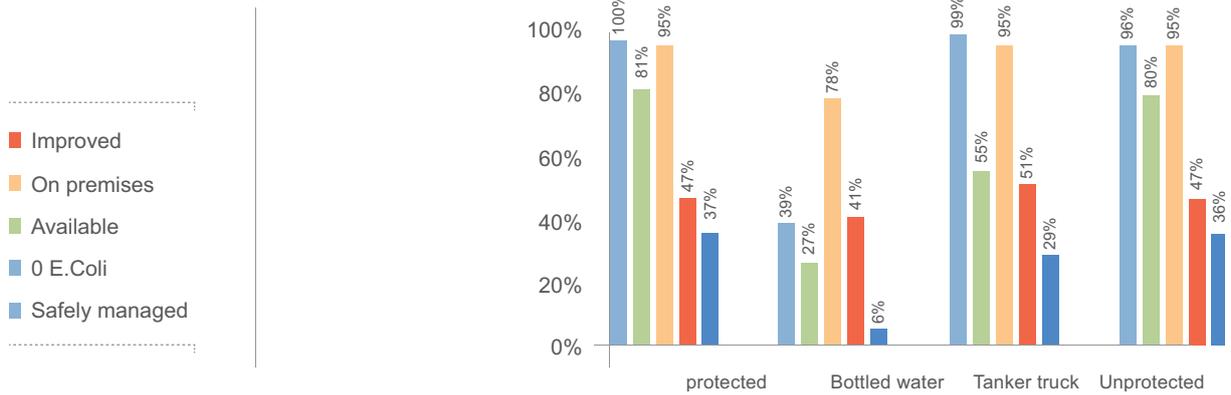
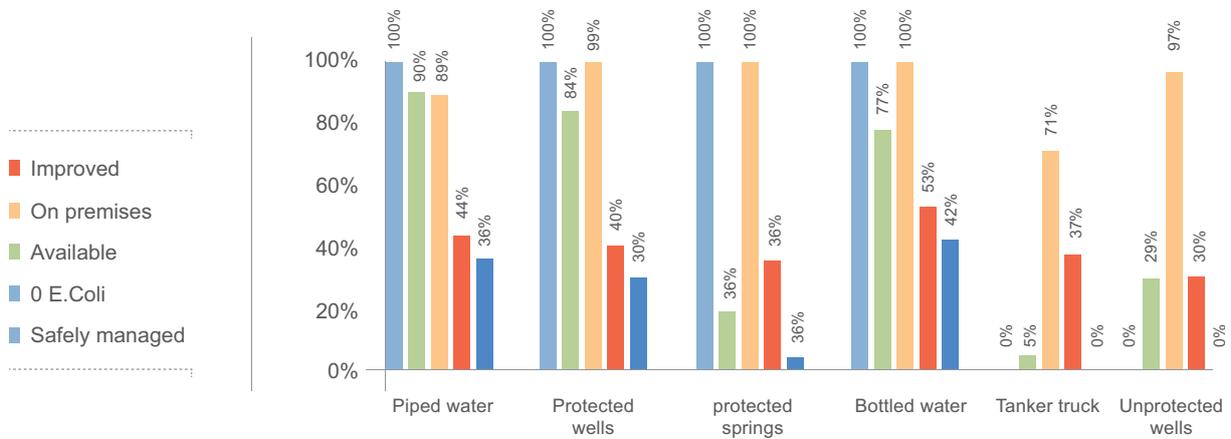


FIGURE 6.5
NATIONAL LEVEL RESULTS FOR SDG 6.1, DISAGGREGATED FOR SUPPLY MODE.





6.5

Rapid assessment of wastewater treatment

Regarding SDG 6.2, preliminary results of the project “Rapid Assessment for Large & Medium Scale Wastewater Treatment Plants across Lebanese Territories” carried out by UNICEF in December 2016, revealed that only 20,301 m³/day out of the 650,000 m³/day of the generated wastewater were treated up to the secondary (biological process) level. This indicates that less than 3 percent of the Lebanese population are connected to WWTP with secondary treatment capabilities. When refugees are accounted for, this percentage drops down to 2.3 percent. With regards to tertiary treatment, it was found that less than 1 percent of the total Lebanese population have access to such WWTPs. A summary of the main findings of the report across the 4 WEs is shown in Annex 1.

6.6

Comparison of MDG 7c and SDG 6.1

Both SDG 6.1 and MDG 7c target household access to drinking water services at national level. The SDGs set much more ambitious targets for drinking water, raising the bar from “improved” to “safely managed”, calling for a greater focus on inequality and expanding monitoring to include institutional settings. With the new focus on measuring water quality, our understanding in Lebanon of the impact of water safety for households across the different settlement types has dramatically improved. The results of the LWQS clearly show, as demonstrated in Figure 6.4, that water safety is the key factor resulting in a staggering 60 percent reduction in Lebanon’s ‘achievement’ of household access when assessed by the new global benchmark of safely managed drinking water services compared to the earlier use of improved sources.

RECOMMENDATIONS TO ACHIEVE SDG AND REDUCE DRINKING WATER QUALITY VULNERABILITY

7.1

Summary of key issues



Being a middle income country of predominantly urbanized settlements, with well-established water supply services (both formal and informal), and a population able to adopt coping mechanisms to source a sufficient supply to meet essential needs, the significance of water quality as a factor to be considered in managing drinking water supply safely in Lebanon cannot be understated. The revised estimate for household water safety in Lebanon provides a clear direction for future intervention and advocacy that is required to improve safely managed drinking water services in Lebanon. The LWQS demonstrates that the use of an 'improved' water supply modality does not assure the householder of water safety in Lebanon. The relatively low proportion (36 percent) of households accessing safely managed drinking water services is a significant issue for Lebanon, particularly in relation to the potential health risk to its population. There is a large disparity in access to safely managed services between the different settlement types, with Informal Settlements only accessing 6 percent safely managed drinking water services. The use of unregulated and informal supply modalities, such as unregulated providers of bottled water and water trucking, particularly for the Informal Settlements has a direct impact

on quality of water provided to vulnerable populations.

The low levels of free Chlorine observed in drinking water across all modes of supply and settlement types, is an issue for the protection of human health. Chlorination resulting in an adequate concentration of free Chlorine in drinking supply is a globally recognized method of water treatment to reduce the risk to human health.

There is geographic disparity and disparity across settlement types, with households in the Beirut-Mount Lebanon governorates and those in Informal Settlements the most at risk from unsafe drinking water supply. Handling, storage and hygiene in the household, contribute in an increase of contamination of up to 8 percent points.

Interventions by the water sector that seek to improve water safety for households across Lebanon and directly improve Lebanon's achievement of SDG 6.1, should be targeted based on geographic location and settlement type to maximize impact and reduction of potential health risk from consuming unsafe water.



7.2

Action plan to achieve SDG 6.1

After review of the available data and discussion with key government stakeholders (MoEW, MoPH, WEs, and MoE) at a workshop on November 18, 2016, in addition to WHO Lebanon office, the following set of recommendations were suggested to improve the water quality situation in Lebanon:

1. Map key water sector stakeholders and current interventions that improve water quality protection.
2. Develop a holistic approach for water quality protection at all levels of the supply chain using water safety planning approaches
3. Provide training and guidance documents to water supply authorities for effective dosing of Chlorine in drinking water supply.
4. Improve the quality and quantity of public and private reservoirs to regulate supply frequency and reduce risk of householders accessing unsafe water to meet basic needs through advocacy campaigns that raise awareness and include training of water service providers.
5. Replace ageing water supply pipe networks, particularly asbestos and galvanized pipelines
6. Improve awareness in public domain of the regulated water bottlers and need to purchase water only from safe service providers.
7. Improve household storing practices through advocacy campaigns that raise household and service provider awareness, including cleaning and flushing of storage tanks.
8. Improve awareness of household water treatment through measures to ensure safe water, including boiling.
9. Develop and implement procedures to protect water sources from septic tanks and networked wastewater contamination. Publish and advocate with all stakeholders implementing in the water sector.
10. Increase funding for safe water supply providers and for wastewater and water treatment plants across Lebanon, to reduce contamination risk and improve quality of distributed water, respectively.
11. Increase the capacity of the WE in operation and maintenance of WWTP.
12. Upgrade, rehabilitate, and expand the operation of the existing WWTP to increase the coverage of the population serviced by secondary treatment.
13. Conduct detailed water quality surveys starting at the water supply source, through the distribution chain to the household level, to determine point/s of contamination for each supply modality in targeted locations.
14. Provide equipment and training to WEs and MoPH laboratories to improve water quality testing capability. Provide equipment with required training to WE and MoPH laboratories to test for viral contaminants.
15. Integrate water quality and health data into a central database that is collected by regulating authorities, such as WEs and MoPH. Map results showing water quality disparity and clusters of contamination, and overlay with water quality related interventions.

CONCLUSIONS



Between May and June 2016, a national household water quality survey was undertaken in Lebanon using methodology developed by the JMP to define the baseline for SDG 6.1, safely managed drinking water services. The elements of the survey were designed to assess the main criteria used to define SDG 6.1, being: access to an improved source; accessibility availability; and water safety. The results of the survey provide a snapshot on the water quality situation and accessibility to safely managed drinking water services to households for all populations in Lebanon, identifying geographic and settlement access disparity, and variability in modes of supply used to source drinking water. The survey assessed households across the three main settlement types identified in Lebanon, which also define the sampling domains, namely: permanent residences (4 regional domains); Informal Settlement (1 IS domain), and Palestinian Camps (1 Camp domain).

The safely managed drinking water services assessed at the household level using a MICS questionnaire, was augmented by a water sample tested ‘that a child would drink’ at both the distribution point and cup, within the household. The urbanized context

of Lebanon, the extensive access to piped networks regulated by the government (formal) and considerable use of informal (private) water providers, such as bottled water and tanker water, results in the ‘source’ being a considerable distance and unknown to the householder. Therefore, water samples in the household were taken at the household collection (distribution) point, which may be a tap, tank, bottle, well, spring or water tanker, and not the source. Water samples in each domain were tested using specially designed household water quality testing equipment, for: fecal coliform (*E. coli*); free Chlorine; Turbidity; and Nitrate (only in Bekaa, Baalbek, Hermel, North Lebanon and Akkar governorates).

The baseline for SDG 6.1 in Lebanon is established as 36 percent (of households are accessing safely managed drinking water services). The primary factor that inhibits Lebanon’s level of safety managed drinking water services is unsafe water quality, assessed based on the fecal contamination risk. Nationally, only 47 percent of households have access to drinking supply that is low risk of contamination. Comparison of water safety across the settlements types indicates that water safety in the permanent residences and Palestinian



Camps is representative of the national average, with safely managed drinking water services of 37 percent and 29 percent, respectively. Safely managed drinking water services however of the Informal Settlements is considerably lower, assessed as 6 percent, primarily due to lower levels of water safety/higher levels of contamination risk, accessibility and access to an improved water source.

All water supply modes, settlement types and geographically tested well below recommended drinking water guidelines for free Chlorine, which is considered an essential parameter to protect from fecal contamination. Turbidity, however was measured as well within drinking water quality standards, for most households. Nitrate, where measured, was primarily within drinking water standards, with up to 6 percent of household in assessed governorates accessing unsafe levels of Nitrate, is a serious contamination for the health of children.

The results of the survey show that at the household level, 66 percent of households are not contributing a contamination risk to their drinking water quality, while 11 percent of households are actively improving their water quality and reducing contamination risk. It is estimated that 23 percent of households are contributing contamination risk to their drinking water supply through their behavior, and therefore would be provide an opportunity to redress through awareness activities.

A reduction in the number of households contributing contamination to their water supply, would potentially result in an estimated 9 percent improvement in SDG 6.1.

Further opportunities are available to the water sector to improve the baseline for SDG 6.1, with a focus on water quality and reducing reliance of households on informal and less regulated supply modalities. Improvements in SDG 6.1 for

Lebanon could be achieved by the water sector focusing on the following:

- increasing effective and well managed water treatment for drinking water supply, such as chlorination at the source,
- rehabilitation of existing water supply (and wastewater) networks and extending networks where needed to access the most vulnerable communities,
- improve regulation of informal/privatized water providers (such as water bottlers and water tankers) to ensure water safety, and
- reduction in contamination load discharge to water supply sources through improved treatment process for the sources of fecal (and nitrate) contamination, such as wastewater and agricultural discharge.
- Scope of the survey was limited to the water quality at the point of consumption. future measure of water quality at critical points of the water supply chain should be undertaken to enable informing health and water supply stakeholders of the challenges facing water safety management in the country.
- stimulate improvements in service delivery (both drinking water and sanitation services).

NUMBERS

- 1 The point from which the water in the cup was filled by the household member to be provided to a child to drink
- 2 Bottled water tested for this survey refers to any type of water contained in a bottle. This could be a branded bottle, water contained in a bottle from any distribution shop, or any other water sources that a bottle could contain.
- 3 GoL, 2014. Lebanon Millennium Development Goals Report 2013-2014. Prepared by UNDP and CDR.
- 4 GoL, Lebanon Crisis Response Plan 2015 – 2016, prepared by UNDP
- 5 Idem
- 6 IDRC, 2008. Towards a Human Right Approach to Water in Lebanon: Implementation beyond «Reform», Karim Makdisi, The International Development Research Center
- 7 UNDP, 2014. Assessment of groundwater Resources of Lebanon. MoEW and UNDP
- 8 Idem
- 9 See « Sanitation Needs and Management: Policy Dialogue on Integrated Water Resources Management Planning in the Republic of Lebanon», Alain Tidière, EUWI Med, 2009
- 10 World Bank, 2012. Lebanon Country Water Sector Assistance Strategy 2012-2016
- 11 MoPH, 2012. National Health Statistics Report Lebanon. Ministry of Public Health.
- 12 Bridle, 2014; Bridle, H. (2014). Waterborne Pathogens Detection Methods and Applications. Retrieved from Elsevier B.V. Retrieved from: <http://www.sciencedirect.com/science/article/pii/B9780444595430000025>.
- 13 See «Le Recensement des Industries Polluantes de l'Eau de la Ville de Tripoli (Liban Nord): Un premier pas vers la redevance assainissement», Pauline Lizion et Marc Sylvestre, Master thesis, 2007
- 14 Decree of 1982, proscription of the recruitment in public services
- 15 See «Domestic and Industrial Water Needs and Management: Policy Dialogue on Integrated Water Resources Management Planning in the Republic of Lebanon», Georges Kamar, EUWI Med, 2009.
- 16 World Bank, 2012. Lebanon Country Water Sector Assistance Strategy 2012-2016
- 17 See World Bank SIA 2008
- 18 EMWIS WEB Page – Lebanon – Institutions - <http://www.emwis-lb.org>
- 19 NPMPLT, 2005. National Physical Master Plan for the Lebanese Territory NPMPLT 2005.
- 20 Basil. G 2012. National Water Sector Strategy. Ministry of Energy and Water.
- 21 JMP, 2015. 25 years Progress on Sanitation and Drinking Water. 2015 Update and MDG Assessment.
- 22 At global level these are now considered to be improved (at least a limited service) and may be classified as higher rungs depending on accessibility, availability and quality.
- 23 WHO/UNICEF JMP, 2016. Thematic report on safely managed drinking water services. Joint Monitoring Programme.

ANNEX 1



On December 2016, the WHO/UNICEF JMP project carried out an assessment on the wastewater sector in Lebanon under the project “Rapid Assessment for Large & Medium Scale Wastewater Treatment Plants across Lebanese Territories”. The assessment was conducted by a local engineering consulting firm. The survey was conducted at the national level and covered all wastewater treatment plants (WWTPs) facilities within the 4 Water Establishments (WEs), namely Beirut-Mount Lebanon (BMLWE), South Lebanon (SLWE), North Lebanon (NLWE) and Bekaa Lebanon (BWE). The assessment aimed to portray the current status of each WWTP, estimate the actual percentage of treated wastewater by treatment level (primary, secondary, tertiary and sludge treatment), and determine the percentage of the total Lebanese population connected to the WWTPs. The assessment accounted for the wastewater effluent generated by the Syrian and Palestinian refugees currently residing in Lebanon. Given that the data provided from the different WEs were found to be incomplete, outdated, and/or often inconsistent, site visits and surveys were undertaken by the consultant along with the plant operator and a representative of the WWTP owner. As such, all the results presented in this chapter are based solely on

the observations made by the consultant during these visits.

A total of 31 facilities were visited and surveyed in all 4 WEs (Figure 1). These included both large and medium scale WWTPs. Site visits covered 9 WWTPs in BWE, 11 WWTPs in SLWE, 6 WWTPs in NLWE, and 5 WWTPs in BMLWE. The surveyed WWTPs included both operational plants as well as those under construction. Estimates of the generated wastewater volume were based on the domestic water demand defined by the National Water Sector Strategy (NSWW), which estimated it to be 180 L/capita/day for urban areas and 160 L/person/day for rural areas. An overall national domestic water demand rate was therefore defined to be 170 L/capita/day in an effort to average between the rural and urban areas. As for Syrian and Palestinian refugees, a domestic water demand rate of 70 L/capita/day was assumed. The daily wastewater generation rate was considered to represent 80 percent of the daily domestic water demand. Moreover, the generation rate also accounted for infiltration, which was assumed to contribute an additional 15 percent to the daily volume. The final daily wastewater generation rate was thus assumed to be 156.4 L/capita/day.

Preliminary estimates revealed that only 20,301 m³/day out of the 650,000 m³/day of the generated wastewater were treated up to the secondary (biological process) level. This indicates that less than 3 percent (~129,801 inhabitants) of the Lebanese population are connected to WWTP with secondary treatment capabilities. When refugees are accounted for, this percentage drops down to 2.31 percent. With regards to tertiary treatment, it was found that less than 1 percent of the total Lebanese population have access to such WWTPs. A summary of the main findings of the report across the 4 WEs is shown in Table 1

Observations from the field indicate that most of the WWTPs are basically ready to operate; but many do lack proper piping networks. Additionally, many of the WWTP are in need of electro-mechanical rehabilitation work before they can be properly operated. With respect to the technical knowhow and the available human capacities at the visited WWTPs, it was evident that all 4 WEs across Lebanon have low expertise in the wastewater treatment sector and require extensive training prior to requiring them to handle operations and maintenance. On the positive end, it was found that if the Lebanese authorities undertake an upgrading

and expansion program for the existing WWTP's, the Lebanese population served by secondary wastewater treatment can increase from less than 3.12 percent up to 75%. Furthermore, if all the existing WWTPs were to be made functional and operational, the actual treatment percentage would increase from 15% up to 80%.



Figure 1 Locations of surveyed WWTPs across the 4 WEs

ANNEX 1



TABLE 1
CURRENT WWTP OPERATING CONDITIONS IN
LEBANON ACROSS THE 4 WES

Current operating conditions for WWTPs in Lebanon								
W.E	Location	Design capacity m3/d	Actual load m3/d	Actual operational treatment type & flow m3/d				
				Pre-treatment	Primary treatment	Secondary treatment	Tertiary treatment	Sludge treatment
NLWE	Tripoli	135,000	30,000	30,000	0	0	0	0
	Chekka	1,742	0	0	0	0	0	0
	Batroun	3,230	0	0	0	0	0	0
	Ehden-Ejbaa	3,200	700	700	700	700	0	0
	Ehden-Aitourine	1,800	400	400	400	400	0	0
	Bcharreh	50	800	700	700	700	0	0
BMLWE	Jbail	1,950	0	0	0	0	0	0
	Ghadir	120,000	65,000	65,000	0	0	0	0
	Nabi Younes	11,000	2,000	2,000	0	0	0	0
BWE	Joub Jinnine	10,000	8,000	8,000	6,500	6,500	6,500	6,500
	Yammouneh	500	100	0	0	0	0	0
	Saghbine	560	200	200	0	0	0	0
	laat	24,000	12,000	7,000	7,000	7,000	0	7,000
	Bakka	160	60	0	0	0	0	0
	Rachaya	600	360	0	0	0	0	0
	Aitanit	5,000	2,000	0	0	0	0	0
	Forzol	1,500	1,000	0	0	0	0	0
SLWE	Sour	60,000	0	0	0	0	0	0
	Nabatieh	20,500	5,000	5,000	5,000	5,000	0	5,000
	Saida	85,000	50,000	50,000	50,000	0	0	0
	El Rihane	820	650	0	0	0	0	0
	Yohmor	3,000	273	0	0	0	0	0
	Chebaa	900	0	0	0	0	0	0
	Hasbaya	2,100	600	0	0	0	0	0
	Khiam	600	0	0	0	0	0	0

Total Lebanese population	Population potentially covered by WWTPs across Lebanon	Lebanese inhabitants connected to WWTPs	Pre-treated (Eq. Inh.)	Primary treatment (Eq. Inh.)	Secondary treatment (Eq. Inh.)	Tertiary treatment (Eq. Inh.)	Mud processing (Eq. Inh.)
4,156,000	3,153,529	1,145,416	1,080,563	449,488	129,802	41,560	118,286
Treated influents over maximum available treatment capacity			34.27%	14.25%	4.12%	1.32%	3.75%
Treated influents over the total Lebanese inhabitants			26.00%	10.82%	3.12%	1.00%	2.85%

