Domestic water in the Bekaa Valley, Lebanon

Demand, access and institutional aspects

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A humanitarian crisis has changed the mode and pace of international engagement with longstanding water stress and climatic challenges. In Lebanon's Bekaa Valley, both Lebanese host communities and Syrian refugees rely on a mix of public and private water sources to meet their needs. Refugee households consume approximately one-third as much water as Lebanese households do. Beyond financial and human resource injections in the public sector, international engagement should foster community participation, mutual trust and confidence in the transparency of water resource management information systems for public and private use. In this way, they can better enable sustainable development planning.

Contents

Introduction

A humanitarian crisis has changed the mode and pace of international engagement with the problem of longstanding water stress and climatic challenges in Lebanon's Bekaa Valley. Frequent water shortages and reliance on water supplies that are unsafe to drink disproportionately affect vulnerable people, including Syrian refugees. In 2018, a High Level Political Forum will review progress towards the achievement of the Sustainable Development Goals (SDGs) for access to safe water and sanitation and sound management of freshwater ecosystems for human health, environmental sustainability and economic prosperity, among others. The experiences gained in the Bekaa Valley will be of considerable interest to the international community for three main reasons:

- Many parts of the world are experiencing major challenges of water scarcity, climate extremes; conflict; refugee populations that create additional demands; and other challenges for local governments and water managers. These challenges are notably acute in the Bekaa Valley.
- In the case of the Bekaa, the international community and private donors have made large investments in response to the humanitarian situation. This engagement will likely lead to insights that can be shared.
- A genuinely inclusive dialogue and learning process including both local and international perspectives should be anticipated in the Bekaa. There are notably strong technical capacities available in-country, including significant ongoing international scientific co-operation. Further, the Bekaa has relatively strong environmental and agroecological knowledge bases (compared to many lower income countries facing similar issues where these learning advantages are not as readily mobilised).

This report presents findings from a desk study intended to map the challenges to understanding and improving access to safely managed domestic water for the population in the Bekaa Valley, along with the other targets associated with the sixth Sustainable Development Goal (SDG 6). Particular consideration is given to the institutions that are addressing these concerns, and which are also heavily engaged in responding to the humanitarian situation.

Context

Even though Lebanon is considered a water-rich country in the Middle East, its water balance situation is becoming critical. Climate variability and changes are exacerbating existing water shortages caused by water consumption for human activities and urbanisation. Other sectoral demands, such as for the agriculture sector, compete with domestic needs, especially during droughts. The situation is particularly serious for the Bekaa Valley, where Syrian refugees make up more than one-third of the population of 982,000. It is important to understand that the Bekaa is the largest agricultural production area in Lebanon. The future potential for severe water shortages and pollution of watercourses is strongly affected by the use of water for irrigation. At the institutional level, responsibilities are diluted between a wide range of stakeholders, which causes co-ordination challenges. This includes institutions responsible for domestic and agricultural water management, as well as for other aspects of environment and sustainable development planning, local governance and humanitarian response. The Bekaa Water Establishment plays a pivotal role in co-ordination between local and national government, and also convenes and co-ordinates among the international actors.

Main findings

Syrian refugees consume on average only one-third of the water of the average Lebanese citizen. Vulnerable populations are less likely to be connected to the public network, but this is true as much for host communities as for Syrian refugees. It is more complicated for refugees in informal settlements to rely on public water supplies, though some manage to do so. However, all households have to fulfil their needs with alternative sources, even well-off ones. In light of this, the source of water supply should not be seen as a criterion to define a low-income household. Each household commonly uses a variety of sources to meet its water needs.

Households in the Bekaa are bearing significant additional costs due to their reliance on private sources of water. The amounts that households spend to purchase water from private vendors adds up on average to around twice as much again as they are paying to the public service provider. Regulation of private providers is particularly weak and remains largely unenforced, bringing serious potential risks for public health, in addition to the financial strain on household budgets. The economic impact of water stress can therefore be considered quite severe, especially in the lower socio-economic groups.

Groundwater constitutes the largest share of the sources of the public water network and of public reservoirs in the Bekaa – as it does in many water-stressed regions where rainfall is low. It is also the major source of water used by private water vendors and agricultural water users. As such, the increase in water demand due to the refugee population is exacerbating the current stress on water resources in general, and on groundwater resources in particular. However, recent studies have demonstrated that the refugees are not the major source of the problem. There is therefore a need for increased public awareness and more transparent monitoring of the full picture of water stresses that are attributable to different sectors and users.

Overall, in the Bekaa Valley, international humanitarian initiatives could be contributing to the achievement of several SDGs. These include access to safe water and sanitation, sound management of freshwater ecosystems for human health, environmental sustainability and economic prosperity, among others. This example should inspire the international community. However, co-ordination challenges remain significant, and long-term institution building is needed alongside emergency assistance programmes.

Recommendations

International actions should consider the need to build capacities and clarify the responsibilities of the different actors who are engaged in water management – especially at the local level. This concerns particularly municipalities, since their de-facto role in coping with water management problems is still significant – despite the lack of legal framework and limited human and financial capacities.

There are major challenges in the Bekaa to regulate the private sector and improve information management about water-use patterns across different sectors. These can only be addressed with significant engagement between local level actors, including those in the agricultural sector and educational institutions, as well as in municipalities. This will require strengthening of the co-ordination and information systems and capacities at the Bekaa Water Establishment. International actions are contributing to this to a limited extent, but should seek to do more.

Rather than seeking short cuts and exacerbating co-ordination challenges, international actors should support ongoing efforts by the Bekaa Water Establishment and its local partners to co-ordinate sustainable solutions, even while responding to the humanitarian crisis.

List of tables and figures

All photos included in this report were taken by the author during fieldwork in 2016.

1 Overview

This section sets the context and objectives for the study. It considers the impact of climate change, urbanisation and population growth on the vulnerability of people, including refugees, living in the Bekaa Valley. In its discussion of methodology, it outlines how results are presented through five sections: water availability, water management analysis, water demand and consumption, water accessibility and distribution, and conclusions and recommendations.

1.1 Setting the context

Some 99 per cent of people in both urban and rural areas of Lebanon are reported to have access to water (WHO and UNICEF 2015); thus, the Millennium Development Goal water target appears to have been met. The reality on the ground, however, is less encouraging: "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 access" (UNDP and CDR, 2013:69). The level of public service delivery is poor, both for water and sanitation. Nor does this delivery match the level of economic development reached by the country, either in terms of numbers reached or quality of service. A lack of trustworthy data and monitoring is one of the constraints faced by the water sector.

Even though Lebanon is considered a water-rich country in the Middle East, its water balance situation is becoming critical. International partners argue strongly for national and local institutions to feature prominently in any humanitarian response.[1] Such an approach is more efficient, strengthens legitimacy and generates tangible benefits for host communities and nations. It provides a strong rationale for interventions that promote stability.

At the institutional level, the responsibilities are diluted between a wide range of stakeholders, mainly the Ministry of Energy and Water, the Council for Development and Reconstruction, water establishments, international funders and nongovernmental organisations (NGOs), and municipalities and private providers that play a role in the field even without a role defined in the legal framework.

Institutional roles are not always distinct, creating confusion, overlaps and gaps in the assignment of responsibilities. The introduction of Law 221 in the early 2000s created four water establishments (Beirut Mount Lebanon, North, Bekaa, South) in charge of water and sanitation across the territory. This was followed by the National Water Sector Strategy in 2012. However, the situation remains unclear. The additional *Code de l'Eau* is still at the project stage. The institutional situation and

[1] See www.lb.undp.org/content/lebanon/en/home/library/Response_to_the_Syrian_Crisis/Support-to-Public-Institutions-under-the-LCRP-2016.html

the functioning of the Lebanese water sector haven't evolved significantly since this period, and other issues have aggravated the situation.

Climate change and the large-scale, rapid and uncontrolled influx of people into Lebanon are putting pressure on the country's infrastructure and services, including water provision. The Bekaa Valley has particular characteristics regarding climate variability and the evolution of its demographic situation. The Bekaa Water Establishment (BWE) sees the two main challenges facing the Bekaa Valley, and by consequence itself, as droughts (and more largely climate change) and the influx of refugees (Moussalem, M, interview with author. 8th September 2016). BWE also engages with institutional co-ordination challenges, including co-ordination between different levels of government (local – national) and co-ordination with the international community.

1.2 Objectives

This paper explores challenges to understand and improve access to safely managed domestic water for the population in the Bekaa Valley, with consideration for institutions that have shaped these concerns. The situation affects the resilience of populations living in the Bekaa, particularly the most vulnerable populations among Lebanese host communities and Syrian refugees. Ultimately, it aims to help explore what approaches may support a shift from the humanitarian crisis responses to more integrated approaches that build longer-term resilience to climate change.

The growing population (including refugees), the changing climate and environmental pressures make it more challenging to achieve the sixth Sustainable Development Goal (SDG 6) on water. SDG 6, particularly the first two targets, provides a framework for assessing the Lebanese situation, especially in the Bekaa Valley:

- Target 6.1: *by 2030 achieve universal and equitable access to safe and affordable drinking water for all.*
- Target 6.2*: by 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.*

When possible and pertinent, the paper draws attention to the distinct challenges of rural and urban areas. This recognises that water practices of host communities and Syrian refugees can change depending on whether they are living in apartments or substandard shelters in urban areas, or in informal settlements in rural areas.

1.3 Climate change

Although this paper deals with water resources in the short term, it is well recognised that these are already strongly affected by climate variability and change processes. Also, the evolution of climate change impacts will continue to determine the future water balance in Lebanon. Lebanon's Second National Communication (SNC) to the United Nations Framework Convention on Climate Change (UNFCCC) (MOE 2011) presents climate change scenarios that have been developed for Lebanon through application of the PRECIS model. According to the model and in relation to the present climate, the Ministry of Environment (MOE) (2011) predicts the following scenarios for Lebanon:

- By 2040, temperatures will increase by around 1°C on the coast to 2°C in the mainland; by 2090, they will be 3.5°C to 5°C higher.
- Rainfall is projected to decrease by 10-20% by 2040 and by 25-45% by the year 2090 compared to the present. This combination of significantly drier and substantially warmer conditions will result in an extended hot and dry climate.
- Temperature and precipitation extremes will also intensify.
- Drought periods over the whole country will become 9 days longer by 2040 and 18 days longer by 2090.

The effects of climate change on water resources are expected to be significant due to less precipitation and projected changes in its spatial and temporal distribution in addition to more evapotranspiration. Droughts are predicted to occur 15 days to 1 month earlier, and the already dry regions such as the Bekaa, Hermel and the South will be most affected.

Drought events have been severe in the Bekaa agricultural centres with 40–55 per cent less water per annum (Yates 2014). These droughts have had a particular impact on the agriculture sector in the Bekaa Valley, where two-thirds of the water is used for agriculture (Yates 2014). Two-thirds of precipitation falls between December and March, and there is nearly none during peak demand in mid to late summer, affecting growth of seeds. The SNC (MOE 2011) predicts that a reduction of 6–8 per cent of the total volume of water resources is expected with an increase of 1°C, and 12–16 per cent for an increase of 2°C. According to MOE (2011 & 2016), climate change will also significantly alter snow patterns. In Lebanon, it is estimated that a 2°C increase in temperature will reduce snow cover by 40 per cent. In a more severe scenario, a 4°C increase will reduce snow cover by up to 70 per cent (MOE 2011).

Lebanon is already facing and will continue to face significant challenges in meeting the country's water demand in terms of quantity and quality in the near future. Lebanon's Intended Nationally Determined Contribution (INDC) highlights the need for climate change adaptation in the water sector. Projections of less precipitation demand increased water resources and better use of available water (Government of Lebanon, 2015). The future potential for severe water shortages and pollution of watercourses is associated with small farmers who are reliant on irrigation water. According to the Strategic Environmental Assessment (SEA) of the National Water Sector Strategy (NWSS) 2010-2020 (ECODIT 2015), the territory is prone to natural disasters caused by flood events in the plains of Aassi in Central Bekaa and desertification in the arid region of the North Bekaa.

1.4 Influx of population

Climate variability and changes are exacerbating existing water shortages caused by urbanisation and population growth, and water consumption from human activities. These activities have impacts on surface and groundwater flows, which are significantly on the increase (USAID 2011). For example, "haphazard urbanisation has been occurring for decades in Lebanon and is potentially degrading recharge areas as well as impeding water flow in flood plains" (ECODIT 2015:42). Moreover, the concentric urbanisation around big cities like Beirut, Baalbek or Zahle in Bekaa creates a higher water demand on the same territory and a water stress concentrated on the same sources.

The growing demand is difficult to assess due to uncertainty around Lebanon's current population. The 1997 Central Administration of Statistics (CAS) survey puts the Lebanese population at 4 million, while the 2004 Ministry of Social Affairs (MSA) survey (ECODIT 2015) puts it at 3.75 million. The 2004 MSA survey is considered the most up-to-date official number, with other population data based on projections. The CAS census in 2007 estimated Lebanon's resident population (including Lebanese citizens and a small percentage of non-Lebanese, except for residents of Palestinian camps) to be 3 million. However, the most accepted figure among experts would be 4 million Lebanese people (Shoufi 2015).

Additionally, Lebanon's population includes an estimated 400,000 Palestinian refugees and an estimated 1.5 million Syrian refugees since 2010. Without a doubt, Syrians constitute the second largest population bloc in Lebanon. This group includes those who worked there before the Syrian crisis and those who arrived as refugees. The UN-Habitat and IFI (2015) "No Place to Stay" report quotes the National Physical Master Plan for the Lebanese Territory estimation that the population in Lebanon will reach 5.23 million by 2030.

In 2015, in light of the Syrian refugee crisis, the population in Lebanon was estimated to have surpassed the 2030 projection, reaching 5.9 million 15 years ahead of time (UN-Habitat and IFI 2015). Syrian refugees represent 25 per cent of the population, which is the world's highest number of refugees per inhabitant (WFP *et al.* 2016). Refugees represent a particularly vulnerable population group for whom access to water may be a challenge; the share of refugee households with access to tap water decreased by 7 per cent compared to 2015 (WFP *et al.* 2016).

1.5 Vulnerable populations in the Bekaa Valley

Bekaa is the Mohafaza[2] where the Syrian refugees make up the largest proportion of the population (34.6 per cent) (MoE *et al.* 2014). In an area of about 982,000 inhabitants, 55 per cent are Lebanese, and Syrians make up the other big majority: 275,000 in Bekaa governorate (UN 2015b) and 140,000 in Baalbeck Hermel) (UN 2015a). Palestinians and other groups (foreign workers, domestic workers and people with no identity cards) are marginal. About half the Lebanese population are considered to be above the poverty line (UN 2015a, 2015b). Syrian refugees are generally considered a vulnerable population; around 54 per cent are living in substandard shelters, including around 37 per cent in informal settlements (UN 2015a, 2015b).

Moreover, there is a correlation between the high level of agricultural activity and the poverty of the population in zones in Bekaa (ECODIT 2015). The SEA of the NWSS shows that Akkar and Baalbeck represent 36 per cent of total usable agricultural area and 27 per cent of total farmers in Lebanon (ECODIT 2015). Syrians are usually highly qualified in the agricultural sector (UN-Habitat and IFI 2015).

The living conditions of the Syrian refugees are quite diverse. While the Lebanese government was reluctant to set up official refugee camps, informal settlements have emerged, especially in the north and in Bekaa to accommodate the growing number of refugees. Table 1 shows that the majority of Syrian refugees based in the Bekaa Valley are living in informal settlements (IS) and a much bigger proportion do so than in the other governorates. Most of them are renting agricultural lands to pitch their tents.

[2] It is the first first-level administrative division of Lebanon. There are six Mohafaza/Governorates in Lebanon.

Table 1: Refugee shelter accommodation types

	APARTMENTS	INFORMAL SETTLEMENTS	SUBSTANDARD BUILDINGS	COLLECTIVE CENTRES
Nation wide	44.4%	18.4%	34.6%	2.6%
LEB-Beirut & Mt Leb	59.4%	1.2%	36.2%	3.2%
LEB-Bekaa	32.4%	37.8%	27.3%	2.5%
LEB-North	43.7%	15.6%	37.3%	3.4%
LEB-South	51.1%	6.3%	40.6%	2.0%

Source: UN-Habitat and IFI (2015) based on the UNHCR Shelter Survey 2015

1.6 Methodology

For this study, the team of consultants reviewed grey literature, publications by academics, government ministries, NGOs and funders, and newspaper articles. The quantitative data used in this report are based on studies and fieldwork led by NGOs and humanitarian agencies, sometimes in conjunction with national ministries.

The analysis presented in the report is based on:

- A dozen interviews with key stakeholders from national and regional institutions, experts and donor representatives in Beirut and in the Bekaa Valley (see Appendices). These were guided by Mr Maroun Moussalem, DG of the Bekaa Water Establishment.
- Visits by Diane Machayekhi to five water infrastructure sites involving local authorities and actors (municipalities, private providers). The five sites (Hermel, Labwe, Zahle, Qab Elias, Joub Jannine) were chosen because of their good geographical coverage on the territory of Bekaa. They represent both urban and rural contexts, including different shelter types of refugees (from apartments to informal tented settlements). The visits included infrastructure managed by the BWE team and a regional office of the BWE, carrying out fieldwork in a municipality that has a treatment plant (Joub Jannine), and having an example of a city with electricity 24/7 by meeting *Electricité de Zahle* (EDZ).
- Participation in four events within the humanitarian support co-ordination process in Bekaa and in the general reflection for improvement of the water sector in Lebanon.

The results are presented through five sections dealing respectively with water availability, a water management analysis, water demand and consumption, water accessibility and distribution, and conclusions and recommendations.

2 Context

2.1 Institutional context: institutions involved in water management

Summary

This section presents key national, regional and local actors involved in water management. It considers the situation before and after the refugee crisis, including approaches by local authorities and nongovernmental and humanitarian actors to ensure that refugee populations have access to sufficient water. The institutional analysis explores the eventual interactions and blockages between these different stakeholders.

At the national level, the Ministry of Energy and Water (MoEW) is the central public organisation in charge of water in Lebanon (EMWIS 2015). It studies supply and demand, as well as the global situation of water resources in the country. To that end, it prepares the national water master plan, and conserves and controls water resources, including surface and underground water (World Vision *et al.* 2014). According to EMWIS (2015), two of the three General Directions are directly involved with the water sector:

- Direction of Hydraulic and Electric Resources:
  - Plans, studies, implements and supervises hydraulic projects, and
  - Applies laws and regulations relative to protection and exploitation of public water.
- Direction of Exploitation:
  - Maintains power of tutelage over the regional water establishments, ensuring administrative and financial control of them, and
  - Studies complaints and measures necessary to regulate infringements by organisations in the sector.

The Ministry of Energy and Water plays the leading role in the water management sector in Lebanon, (World Vision *et al.* 2014). In addition, the Ministry of Public Health (MPH) monitors the quality of drinking water, and the Ministry of Environment (MoE) and the Ministry of Agriculture (MoA) manage water quality and the supply of irrigation water.

Since the arrival of Syrian refugees, MoEW has worked with the humanitarian co-ordination process to address the crisis. It works particularly closely with UNICEF, the lead agency for the water sector in the framework of the Lebanese Crisis Response Plan (Government of Lebanon and UN 2014, 2017). MoEW requires that actions through this framework focus on all vulnerable populations, Lebanese included. The Lebanese government, which has been engaged in the LCRP since 2015, has been active in the plan for 2017-20 (Hoayes, S, interview with author. 3rd October 2016). The Inter Agency Co-ordination Process has assessed

the need for US$391 million for the Water and Energy Sector (Inter-Agency Information Management Unit and UNHCR 2016). The LCRP seeks to move towards an integrated humanitarian approach and to reinforce existing water services for a more sustainable supply (Government of Lebanon and UN 2017). Thus, in co-ordination with UNHCR and UNICEF, MoEW is carrying out two new hydrogeological studies and one on water quality.

Created in 1977, the Council for Development and Reconstruction (CDR) is a government unit in charge of financing and implementation of infrastructure projects. It constitutes six directors of departments, all appointed every five years, for the following departments: the presidency, projects, programmes, finances, legal and administrative matters, and technology. CDR is in charge of:

- Constructing water, sanitation and irrigation infrastructure financed by the Lebanese government with the help of international funds and by appointment from the Council of Ministers,
- Preparing the general plan and studies for the country, and investment and implementation programmes for reconstruction and development projects, and
- Mobilising external financing for priority projects within the investment plans.

When the projects end, the CDR, which is the delegated contracting authority, hands over the infrastructural works to the water establishments.

Law 221/2000 (Loi de réglementation du secteur de l'eau 2000-2001) merged four regional authorities, 21 pre-existing water offices and 200 local committees. The water establishments (WEs), which cover Beirut and Mount Lebanon, North Lebanon, South Lebanon, and Bekaa (based in Zahle), are the main actors for water exploitation and distribution. The establishments do the following (MoEW 2012):

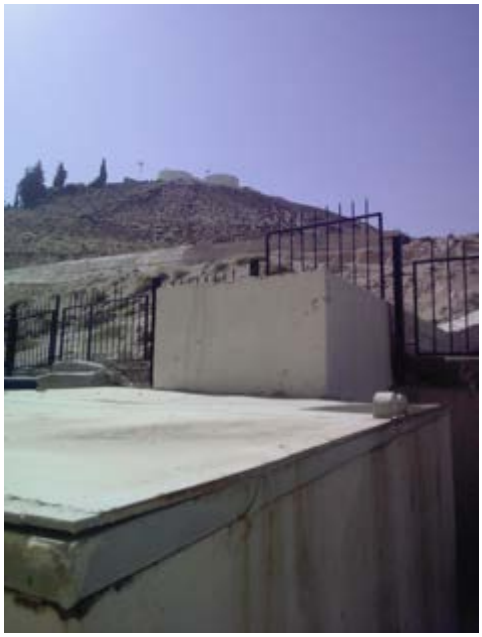
- Design, implement, operate and maintain potable and irrigation distribution projects based on the national master plan and resources allocated by MoEW,
- Collect, treat and dispose of wastewater based on treatment and outfall sites approved by MoEW,
- Propose water supply, irrigation and wastewater tariffs, and
- Monitor water quality for distributed water supply and irrigation.

The WEs are under administrative supervision of MoEW and more precisely the Direction of Exploitation. Each WE is administered by a board of directors (nominated by the Council of Ministers) and the President Director General of the water establishment. Figures 1 and 2 illustrate infrastructures managed by the BWE.

Law 221/2000 also reaffirmed the role of the Litani River Authority as being responsible for irrigation water for the whole Litani watershed.

Figure 1: The Ras el Mal pumping station managed by the BWE.

Figure 2: The water tanks of the city of Hermel supplied by the Ras el Mal pumping station.



The municipalities are structures under the Ministry of the Interior. In the past, they have played a role in the water sector especially in preparing general plans for water projects, establishing sewage disposal facilities and managing some environmental issues. Their roles have been gradually decreasing since the Law of Municipalities was published in 1977 to reconsolidate power from local to central after the civil war (Dewailly *et al.* 2004; Alles and Brochier-Puig 2014). Law 221/2000 and the creation of the water establishments have favoured centralised management at the regional level; MoEW and the CDR are key decision makers at the national level (Verdeil *et al.* 2009).

The NWSS only references municipalities twice, which seems to demonstrate this supposedly forced disengagement. However, municipalities still provide small replacements and repair equipment when the water establishment is not able to intervene. They also provide minimal services for their citizens especially regarding wastewater (Nizam 2011). In certain cases, they are even involved in the water supply process (as confirmed during the visits to municipalities that are described in the methods section).

Lebanon's decentralised response to the crisis favours free settlements rather than a centralised camp approach as in Jordan. This has given an important role to municipalities, but without the financial resources and tools to manage the situation. Moreover, the population continues to refer to municipalities in case of water problems: 18% of them contact the municipalities, 11% inform the water establishment and 14% fix it themselves (Pierpaoli 2016).

Local committees, present since the French mandate, exploded in number during the civil war years when the government could not serve most communities. Their role was generally restricted to operation, maintenance, rehabilitation and renovation of networks and equipment (World Bank 2010). A few committees for domestic water supply that refused to hand over their infrastructures to the water establishments have remained active, especially in remote areas of Lebanon.

A large range of international and humanitarian actors (NGOs, UN agencies, international funders) work in Lebanon and focus increasingly on the Syrian crisis (especially NGOs in Bekaa). The main funders who operate in the Bekaa water sector are the delegation of the European Union, the Swiss Co-operation (SDC) and USAID.

The Inter Agency Co-ordination (Inter-Agency Information Management Unit 2016) identified the following organisations in the different districts of the Bekaa Valley:

- Hermel: GVC, Red Cross, TDH
- Baalbeck: ACF, ANERA, Amel Association International, GVC, Intersos, Medical Aid for Palestinians, Mercy Corps, NRC, Oxfam, Red Cross, SCI, TDH, UNDP, UNICEF, UNRWA
- Zahle: ACF, ANERA, Intersos, MEDAIR, Medical Aid for Palestinians, Mercy Corps, NRC, Oxfam, RI, Red Cross, SCI, UNDP, WVI, UN-Habitat, UNDP, UNICEF
- West Bekaa: ACF, ANERA, Amel Association International, MEDAIR, Mercy Corps, NRC, RI, Red Cross, SCI, WVI, DRC, UN-Habitat, UNDP
- Rachaiya: ANERA, Intersos, MEDAIR, NRC, RI, DRC, UNDP.

The number of these organisations has increased since the influx of Syrian refugees. The populations targeted by the international actors include the host communities, the Syrian refugees or both. Those interviewed during the fieldwork agreed that an action aimed at one group will have indirect consequences on the other, as many Syrian refugees live in the same conditions as the Lebanese.

Each organisation has its own strategy and approach, but those working in the informal settlements of refugees commonly supply water through trucks (contracting with private providers), drill wells and work on water quality through chlorination. Some NGOs are working closely with the Bekaa Water Establishment to find solutions to connect the informal settlements to the public network. They pay the cost of water directly to the BWE based on consumption to reduce illegal connections, as well as the total cost of the service per capita. Other organisations work directly with host communities to improve infrastructure, raise awareness or to work on water demand management. Some funders are also involved in capacity building to support the BWE, for example, on its master plan, tariffs or the introduction of the private sector.

Salman *et al.* 2016 analysed the fragmented approach to water management across different sectors and between the various stakeholders working in Lebanon. The analysis aims to improve water-use efficiency and integrated water cycle management. It describes 15 institutional stakeholders: MEW, MoA, MoE, Litani River Authority, CNRS, LARI AuB, EU, UTL, SDC, World Bank, United States Agency for International Development (USAID), Associazione Volontari per il Servizio Internazionale (AVSI), Istituto per la Cooperazione Universitaria, Arcenciel. These include public entities, research institutions; development agencies; NGOs; and water users in agriculture, water supply and sanitation.

Finally, the private sector plays an important role in the water supply in Lebanon. Since the arrival of the Syrian refugees, the number of private providers has increased and the competition between them has led to a cut in the tariff. According to a private provider in Qab Elias, 1m^3 of water trucking cost LBP7,500 (US$5) in 2014 against LBP5,000 (around US$3.30) now. The involvement of the private sector was already mentioned in the NWSS, but remains informal and separate from the management of the water sector. USAID, in the framework of its new Lebanese Water Project (LWP), tackles the special potential of private actors' involvement and works on strengthening complementarities between public and private actors.

2.2 Water resource context: availability of water resources in Bekaa

Summary

This section describes how the main water sources in the Bekaa Valley are surface water, springs and underground aquifers. It explains how uncontrolled exploitation of groundwater by unregistered private wells is one of the key challenges facing Lebanese water resource management. Finally, it argues that data on water resource availability in Lebanon are limited and could be improved.

Water availability trends provide insight into implications of the increased population in the Bekaa Valley on demand for water services by both host and refugee populations, and how this demand is being met. However, reliable data on water resources in Lebanon are lacking. According to the SEA (ECODIT 2015), the NWSS was based on water data from 1970, before the Civil War. Recent groundwater studies by UNDP and MoEW, as well as hydrological studies commissioned by UNICEF, have started to update the old data. They are also studying water resources in the face of the Syrian refugee crisis (Jaafar *et al*. 2016). But much more work remains to evaluate Lebanon's water balance effectively. This includes assessing the net exploitable resources which, in order to produce reliable water data, are the cornerstone of any water planning strategy.

Lebanon is a multi-morphological country including mountains, valleys and plains. The Bekaa Valley is a fertile land corridor separating the Mount Lebanon and Anti-Lebanon ranges, drained to the North by the Aassi River (or Orontes) and to the South by the Litani River. Bekaa extends for 4,167 km^2 and represents 40 per cent of the national territory. Morphological and geological features are the main factors that make Lebanon a country with abundant and renewable water resources compared to neighbouring countries. More than 65 per cent of Lebanon is covered by karstic rocks and favourable water bodies characterised by springs, caves and sinkholes (ECODIT 2015). These aquifers are highly productive, but extremely vulnerable to water contamination due to anthropogenic activities (quarries, waste dumping, sewage).

The main water sources in the Bekaa Valley come from surface water, springs and underground aquifers. The controlling factor of the underground water is the combination of geological structures and composition: the pervasive fault systems NNE/SSW and the diffuse karstic rocks are the main indicators for water bearing formations (UNDP and MoEW 2014). The complex structure of the karstic rocks of the Anti-Lebanon unit is one of the most important holding deposits of water in the region; numerous springs form the important surface drainage system of the Bekaa Valley (AVSI 2010). These formations have characteristics for good quality water and are mainly exploited as domestic water resources via boreholes or springs (UNDP and MoEW 2014).

The hydrogeological assets of the Bekaa Valley are strongly characterised by the surface water system and its relationship with the underground aquifers. There are various drainage systems, most of which are dried for most of the year and highly influenced by snow melting. Two main rivers flow south (Litani) and north (Aassi-Oronte) with a watershed line near the Baalbeck area.

2.2.1 Underground water availability

Most exploitable underground water sources in the Bekaa Valley are located along the NNW-SSE axis. The Bekaa Water Establishment (BWE) covers the management of underground water resources.

UNDP and MoEW (2014) reported 841 public wells across Lebanon in 2012 with a total annual extraction rate of 249 (mm^3), of which 209 are public wells in the Bekaa Valley with a total extraction rate of 90,422m^3/d (33mm^3/year). According to the Lebanese Centre for Water Management and Conservation (2014), there are 2,732 private licensed wells and an estimated 18,228 unlicensed private wells in the Bekaa Valley. This compares to 20,537 licensed wells and 59,124 private unlicensed wells at the national level. Most of Bekaa's private wells are in the region's central and southern parts.

The annual yield arising from the public, licensed and unlicensed private wells in Bekaa compared to the whole of Lebanon is reported in Table 2 and water production levels in Table 3.

Table 2: Annual water production from wells

	DOMESTIC USE	IRRIGATION USE	INDUSTRY USE	TOTAL (mm^3/year)
Bekaa				115.26
Public wells managed by BWE				55
Unlicensed private wells	2.46	32.85	2.46	37.77
Licensed private wells	1.47	19.55	1.47	22.49
Lebanon				617.92
Public wells managed by WE				260
Unlicensed private wells	46.16	99.42	30.03	175.61
Licensed private wells	32.67	103.82	45.82	182.31

Elaborated from data published in MoE and LEDO (2011)

Table 3: Bekaa and Lebanon water production

	PUBLIC WELLS (mm^3/year)	PRIVATE WELLS (mm^3/year)	SURFACE WATER USED (mm^3/year)
Bekaa	53	140	206
Lebanon	267	438	649

Elaborated from data published in the NWSS (MoEW 2012)

2.2.2 Surface water

Most surface water in Lebanon comes from spring sources. Lebanon has some 2,000 springs with a total yield exceeding 1,200mm^3 (UNDP and MoEW 2014); however, less than 200mm^3 is available during the summer and the total annual exploited volume is 637mm^3 (MOE, UNDP and ECODIT 2011).

Since 1965, the monitoring activities of the surface water and springs in the southern Bekaa have been the responsibility of the Litani River Authority (LRA), which was established in 1954. The LRA would plan and operate all potable, irrigation and hydro-electrical schemes associated with the Litani River, measure all surface flows throughout the country, and establish and operate all hydro-electrical generating plants (ECODIT 2015). The Bekaa Water Establishment is responsible in the rest of the Bekaa Valley.

Of the 17 perennial rivers in Lebanon, two are found in the Bekaa Valley. The Litani River drains the southern Bekaa plain, crosses the southern periphery of the Mount Lebanon range and discharges into the sea north of Tyre. It extends for 170km with an annual flow of 793Mm^3 (MoE and LEDO 2011). A dam regulates the flow at the Quaroun Reservoir, diverging water for human uses. The Litani River Basin is experiencing increasing water demands, groundwater over-exploitation and extensive pollution. In the summer, the river shows a meagre flow, much decreased from 40 years ago (USAID 2011, 2014). The Aassi-Orontes River flows north into Syria, draining the northern Bekaa plain. It extends for 46km in the Lebanon territory with an annual flow of 480mm^3 (MoE and LEDO 2011) and rises in the springs near Labwe.

Water resources management in the Aassi-Orontes River Basin is further complicated by the transboundary nature of most surface and groundwater resources, whose allocations are often contested. An international agreement between Lebanon, Syria and Turkey, signed in 1994, allocates Aassi-Orontes the following quantities of water: 8% to Lebanon, 67% to Syria and 25% to Turkey (MoE and LEDO 2011). The river represents an important water reservoir for the agricultural area of Homs Governorate and the domestic supply of Homs town (Yaghi *et al.* 2016).

2.2.3 Rainfall

At least three institutions generate continuous rainfall and/or water data: the Lebanese Civil Aviation Authority (LCAA), the Lebanese Agricultural Research Institute (LARI) and the Litani River Authority (LRA) (ECODIT 2015). A fourth institution, the Centre National de Recherche Scientifique (CNRS), is supporting the collection of data on snow precipitation, snow coverage and melting. The Advancing Research Enabling Communities Center (AREC) generates local data in the Bekaa Valley. Historical data are partially incomplete because the flow measurement stopped during the civil war (1975-1990) (UNDP and MoEW 2014).

Lebanon faces a general decline in rainfall, calculated at 18 per cent in the last 50 years – re-elaborated from data collected by Shaban *et al.* (2013) and UNDP and MoEW (2014). Unlike many countries in the world experiencing climate change, Lebanon has not seen a variation in rain frequency and schedule (raining days/year). Rather, the volume of rainfall has declined continuously across the years. The negative trend in rainfall is less visible in the Bekaa Valley according to the data of the Meteorological station in Zahle, with a 3 per cent decline in the last 60 years (USAID 2011).

The Bekaa Valley has a generally arid climate, with precipitation decreasing from the south (more than 700mm/year up to 1,300mm in the Qaa el Rim central area) to the north (up to 200mm/year) (Makké Traboulsi 2010). The long-term weather data indicate that 95 per cent of the precipitation falls between October and April, and the remaining 5 per cent between May and September (MoA 2003).

Snow coverage and density have been declining. Historically, snow covered all the mountain regions at altitudes above 1,200m during the winter. Even without regular data, Shaban *et al.* (2013) reported a coverage of 2,280km² before 2009 against a decrease to 1,925km² in recent years. Furthermore, the average time the dense snow remains before melting has decreased from an average of 110 days before 1990 to an average of 90 days after 1990 (MOE *et al.* 2011).

2.2.4 Annual recharge and balance availability

The annual water balance in Lebanon was calculated in 1994 and again in 2001 (MoA 2003). These calculations considered an annual precipitation of 8,600mm³ against an evapotranspiration component of 4,300mm³; unexploited groundwater and water losses to sea of 880mm³; and losses and allocated water to Syria and Palestine of 900mm³. The remaining positive balance of 2,520mm³ is distributed in 400mm³ of exploitable groundwater and 2,120mm³ of potential available surface flow (MoA 2003).

Another study on water balance (UNDP and MoEW 2014) reports a positive national water balance in 2012 with a discharge of 2,588mm³/year and a recharge varying from 4,728–7,263mm³/year in dry and wet years respectively.

Total annual rainfall and snow in Lebanon can be estimated at 8,600mm³/year, of which around 2,700mm³/year are considered net exploitable water resources. In other words, net exploitable resources for all uses represent about 30 per cent of the total annual rainfall and snow.

According to the net exploitable water resources of 2,700mm³/year and the water demand projection presented in Geara-Matta *et al.* (2010), negative balance will be reached after 2020 (Table 4).

Moreover, according to ECODIT (2015), a 10 per cent decrease in average annual rainfall by 2040 would reduce the annual recharge from 8,600 million cubic metres (MCM) to 7,740MCM (about 10 per cent) and the net exploitable water resources by about 2,700MCM to about 2,430MCM.

Regarding seasonal water balance, USAID (2011) found that winter replenishments only partially compensated the summer groundwater deficit in the Litani River Basin. The National Water Sector Strategy (MoEW 2012) tackles the scenario regarding water balance and relevant mitigation measures. It planned to meet the total

Table 4: Water demand projection vs. water recharge

DEMAND (mm³/year)	1990	2010	2020	2030
Domestic	271.3	309.2	850.2	787.2
Industry	65.4	439.7	249.6	521.6
Agriculture	875.6	1538.9	1500.2	1888.0
Total	1212.3	2287.8	2600	3196,8
Annual recharge (mm³/year)	2700	2700	2700	2700

Source: Elaborated from data published by MOA (2003) and Geara-Matta *et al.* (2010)

demand by increasing water storage capacity and by recharging aquifers with treated water reuse to meet the incipient agricultural demand.

UNDP and MoEW (2014) defined the situation of the stressed aquifers in the Bekaa Valley and outlined the following factors that can influence the exact measure of the recharge potential:

- Possible percolation to deeper parts of the aquifer/ basin and lateral loss to hydrogeological bodies,
- Spring discharges are not well measured and might be underestimated,
- Number of private wells is not well defined and the extraction rates from private and public wells are not well defined, and
- Retention and storage are not well defined.

Two zones have already been identified with a negative balance in the north, in Hermel and in the zone of Zahle by UNDP and MoEW (2014). The situation in the Bekaa Valley sees a deficit in covering the water demand mainly due to irrigation use and overexploitation for domestic use in urban centres. In the Bekaa Valley, MoEW plans to increase water storage capacity to reduce significantly private wells supply and to maintain surface and public wells. Additional water resources (artificial recharge, estimated at 60mm^3/year; reuse of treated water and surface storage, estimated at 98mm^3) (MoEW 2012) would be expected to compensate the increasing demand for irrigation.

2.2.5 Water quality

Particular attention should be paid to the quality of water from available sources. Even if water availability is quite satisfactory, not all the resources of the Bekaa Valley can be considered safe to drink.

Provision of adequate water quality is quite delicate in Lebanon, considering its geology often enables pollution to seep into water tables and streams. The fractures and karst networks facilitate point and non-point source pollutants to percolate and infiltrate deep into the ground, thus making groundwater more prone to pollution. Pollutants infiltrated into the ground may reach groundwater within several hours and reappear in the springs and wells used for domestic consumption. Human activities are likely to generate pollutants that can cause serious consequences on groundwater quality. Toxic materials, even if used in small doses, can turn water inconsumable for long periods, while human and animal waste (in domestic wastewater) can cause serious illnesses to users (DAR and IAURIF 2005). However, some farmers use wastewater to irrigate their lands.

The NWSS found that Lebanon treats 8 per cent of wastewater (MoEW 2012). Only 14 per cent of Lebanese would be theoretically connected to an operational treatment plant with primary and secondary treatment, if all sewage networks were achieved (Machayekhi *et al.* 2014). In the Bekaa Valley, only a few treatment plants are operational and seem to be functional (Baalbeck-Iaat, Joub Jannine, Yammouneh, Aitanit, Saghbin) (Machayekhi *et al.* 2014). However, some are still not connected or running at full capacity.

Untreated sewage water is often used directly for irrigation in mountainous rural areas. Its discharge into surface and groundwater, especially in these rural areas, presents serious health problems as evidenced by bacterial contamination of rivers, springs and groundwater (MoA 2003). In the Bekaa Valley, the incipient agriculture expansion and the scarce coverage of sewerage and water treatment plants have exacerbated the situation of the water quality (Government of Lebanon and UN 2017). There has been a significant negative trend in waterborne diseases reported in Bekaa by MoPH, Directorate of Preventive Medicine, from 1995 to 2000 (Table 5).

Table 5: Reported water-borne diseases

	BEKAA	LEBANON	BEKAA	LEBANON
	From 1995 to 2000		2000	
Dysentery	68	471	243	354
Hepatitis A	22	286	36	239
Typhoid	99	795	140	729

Source: MoE and LEDO (2011)

According to MoE *et al.* (2014:5), "the main issue affecting water quality is the low quality and poor cleanliness of the domestic reservoirs which are not maintained regularly and lack, for the most part, proper coverage that provides protection from external sources of contamination. Moreover, due to the lack of water, proper sanitation and hygiene, a sharp rise in communicable diseases and the emergence of previously absent diseases were reported among refugees' communities and are transmitted to close Lebanese communities".

Since 2010, the amount of wastewater treated has risen, without a clear improvement in the operation, maintenance and connection of treatment plants. But the population as a whole, including both host communities and refugees, is responsible for the pollution of water resources. The dramatic situation requires an urgent rise in awareness (Farajalla, N, interview with author. 19th September 2016).

The main sources of water in Lebanon include surface water and groundwater. However, surface storage and non-conventional sources are limited (MoEW 2012). Surface water is largely exploited without the capacity to store it, while significant stress is put on groundwater mainly through private wells (MoEW 2012). The uncontrolled exploitation of groundwater through unregistered private wells and (to a lesser extent) the uncontrolled catchment of springs are key challenges for Lebanese water resource management. Beyond stress on groundwater, unauthorised extraction complicates the ability to quantify water availability in a context where data are obsolete and not regularly collected.

Renewable water resources per capita fell from a safe level of more than 1,700 cubic metres per person per year (m^3/p/y) in 2000 beyond the scarcity threshold of 1,000m^3/p/y, reaching 926m^3/p/y in 2009 and 839m^3/p/y in 2015 (MoEW 2012; Yates 2014).

3 Findings

Refugees use on average one-third of the water used by the Lebanese population. Informal tented settlements generally receive enough drinking water to meet demand. However, average access remains lower than the minimum daily domestic need per capita. The incremental water demand arising from the influx of refugees corresponds to an increase of the national water demand between 8–12 per cent.

3.1 Water demand and water consumption

3.1.1 Estimates of domestic annual demand and consumptions in Bekaa

Water demand, and more precisely domestic water demand, is the amount of water required for drinking, bathing, gardening and sanitation. The water consumed is the amount actually used by the household. In Lebanon, even if water demand can be estimated, the amount of water consumed is difficult to obtain because of the absence of water meters.

The target average minimum domestic water supply per person in Lebanon is estimated at 160 litres per person per day (L/p/d) for rural and 180L/p/d for urban populations (MoEW 2012). There are no official domestic water demand estimates for the Syrian refugees. However, humanitarian agencies active in the response apply a daily supply standard per person for Syrian refugees in informal settlements of 35L/p/day based on SPHERE humanitarian standards (WFP *et al.* 2015). Alternatively, World Vision *et al.* (2014) has a standard of 33L/p/d in informal settlements and of 160L/p/d in host communities.

Apart from the absence of water meters, domestic water consumption is hard to estimate because some households don't distinguish domestic consumption from agricultural use. This is particularly the case in the Bekaa Valley with farm activities. Illegal connections to public networks and unregistered wells also hamper any estimates.

GIZ has conducted the only available scientific calculations of water consumption. Pilot projects in two different urban areas of Lebanon measured real consumption of customers via water meters. They showed an average consumption per capita 135L/p/d (GIZ 2012).

The following estimates of consumption per capita are based on different reports and surveys in different contexts. Before the arrival of Syrian refugees, the State of Environment 2011 (MOE *et al.* 2011), summarised

three estimates of consumption per capita with the assumption that water demand and consumption were the same:

- 140L/p/day (World Bank 2009b),
- 200L/p/day (Comair 2010), and
- 180L/p/day (MoEW 2010).

Since that date, NGOs and other agencies have started to estimate water consumption of host communities and/or Syrian refugees. The government hasn't published official estimates since the National Water Sector Strategy.

- A survey by Oxfam and EDESSA in different districts of Chtoura, an urban area in the Bekaa Valley, assumed 170L/p/d consumed by Lebanese host communities and Syrian refugees living in rented apartments (no informal settlements in this zone) (EDESSA 2015).
- A study by Pierpaoli (2016) in rural areas of North Bekaa confirms that actual water consumption per capita for Lebanese communities is on average approximately 145L/p/d.
- The average daily per capita water consumption of refugees was estimated at 64–104L/p/day, depending on the types of shelter, calculated from a survey by Solidarités International (MoE *et al.* 2014 based on UNHCR 2014).
- During interviews in municipalities, many stakeholders confirmed that the assumption of 70L/p/day seemed realistic for water consumption of Syrian refugees living in informal settlements. Thus, for those living in informal settlements, the minimum standard set by humanitarian agencies of 35L/p/d is generally met.

The Emergency Market Mapping Assessment (EMMA) in North, West and Central Bekaa by World Vision and its partners (Intersos, Sawa and Oxfam) focused on Syrian refugees (in all types of shelters) and host communities. The study analysed the gap between the households' water needs and real consumption in relation to humanitarian standards set by locally active agencies, of 33L/p/day in informal settlements and a national Lebanese standard for host community settings of 160L/p/d (World Vision *et al.* 2014).

The market analysis results for North Bekaa indicate that people living in ITS and collective shelters especially struggle to access sufficient water for drinking and domestic use (including personal hygiene). This is primarily due to limited purchasing power, lack of water storage tanks and/or seasonal changes in the water provided either through trucks or the municipal system. Where there is a gap between needs and consumption in ITS, households are receiving 20L/p/d instead of 33L/p/d (World Vision *et al.* 2014:18). However, in areas where NGOs are supporting water supply through trucks such as in ITS and collective shelters, the minimum needs can be considered as covered.

For refugees in host communities, average water consumption is higher, ranging from 80–160L/p/d in urban areas and from 40–80L/p/d in rural areas. The gap analysis shows that Lebanese and Syrian refugees living within rented or owned host community accommodation receive only 70L/p/d instead of the standard of 160 L/p/d (World Vision *et al.* 2014:18).

With regard to drinking water, needs are generally covered. Only households in ITS face a shortfall, receiving 2.5L/p/d instead of the required 3L/p/d (World Vision *et al.* 2014:18).

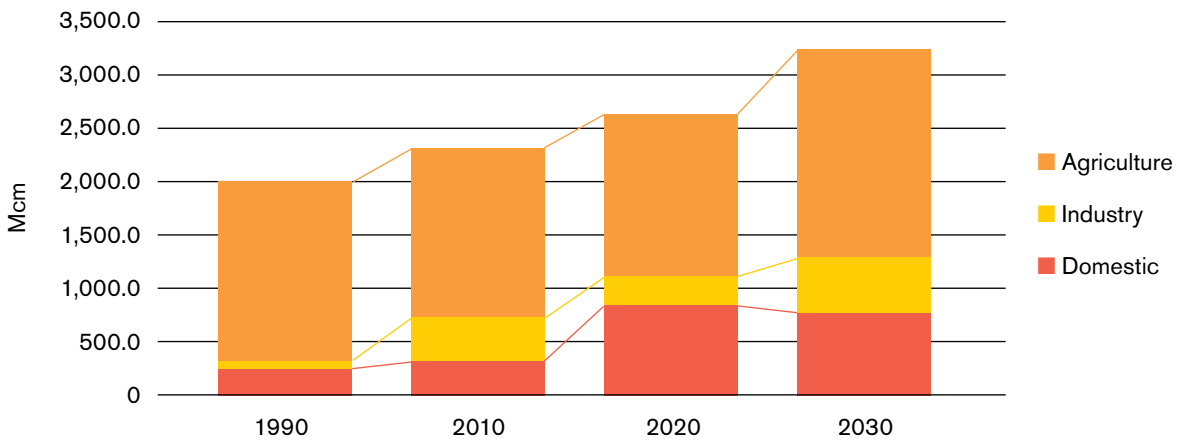
3.1.2 The evolution of demand in Lebanon

Total domestic water demand has risen since 1990 (Figure 3). Moreover, the State of Environment in 2011 compared different estimates of current annual domestic demand in 2010 by three different reports (World Bank 2009b; Comair 2010; MoEW 2010). They provide three estimates, 501mm^3, 467mm^3 and 505mm^3, respectively. As shown by Figure 3, the higher percentage of total demand, especially in Bekaa, is for agriculture rather than domestic purposes. This has been increasing since 1990.

During summer (high season), 80 per cent of connected households report that their demand exceeds supply (hours per week to meet their needs) (World Bank, 2009a). "This proportion decreases somewhat in the low seasons (winter months), when 60 per cent of households report their demand exceeding supply. The greatest water deficit is found in the Bekaa Valley region, while in the North supply actually appears to exceed demand" (World Bank 2010:32). In Bekaa, the supply deficit is present throughout the year, not only during the dry season.

This precedes the influx of refugees coming in the last five years. According to one report, "the increase in domestic water demand due to the refugees is between 43 to 70 million cubic metres (MCM) by the end of 2014. This incremental water demand of the refugees corresponds to an increase of the national [domestic] water demand between 8 and 12 per cent" (MoE *et al.* 2014:4). The report has also indicated that this increase varies across Cazas and governorates, with the Bekaa having the highest share, followed by the North, Beirut, Mount Lebanon and the South.

Figure 3: Evolution and projection of domestic water demand



Source: Elaborated on data from Geara-Matta *et al.* (2010)

3.1.3 Conclusions

While the presence of refugees is adding stress to Lebanese water demand, they seem to use on average one-third of the water used by the Lebanese population. Table 6 summarises the different data collected to give a better idea about water consumption. Because all the data are estimates and unreliable, a range of values is indicated based on the average of different results. This table tries to clarify a complex situation, but should not be considered scientific. Importantly, domestic water usage represents a proportion of overall water usage. Agricultural and industrial water usages should also be borne in mind for water management.

Since refugees use about one-third of the amount of water used by the Lebanese population, they would only produce one-third of the sewage as well. This should be taken into account when defining and quantifying the real contamination to the environment caused by Syrian refugees, while bearing in mind the deficit of wastewater treatment. The questions related to quality of water and to pollution linked to human activities also have to be tackled to preserve the availability of safe water for the future.

Table 6: Summary of water consumption estimates

	LEBANESE HOST	SYRIAN HOST (APARTMENTS)	SYRIAN (SUBST./ CENTRES)	SYRIAN IN IS
	Water consumption estimates (Litre/consumer/day)			
Rural	From 100 to 150	From 120 to 90	From 30 to 70	From 30 to 70
Urban	From 100 to 150			ND

ND: No specific data found

3.2 Water accessibility and water distribution

Summary

Most households use a mixture of different sources of water to cover their total water demand, paying three times the cost of public water supply. While water consumption in the refugee population is generally lower than in the Lebanese population, this section assesses the different formal and informal approaches used by both population groups to ensure access to sufficient water, and the costs of doing so.

3.2.1 Water supply: formal and informal approaches

To date, BWE estimates the production of water at 184,000m³/day corresponding to 67mm³/year (Moussalem, M, interview with author. 8th September 2016). In 2011, the BWE estimate was 50mm³/year (USAID 2011), which suggests that public production is increasing. However, these data have to be treated cautiously. Lack of bulk meters at the production level make it impossible to know the quantity of public water produced by water establishments. This has indirect consequences on the managerial practices in the sector and in preparation of business plans and tariffs for the sector: "Diffused lack of bulk meters at production level, and of proper reading and analysis of collected data, are major deficiencies in the managerial system of all the establishments that do not have proper data to calculate the real production cost per cubic metre" (Pierpaoli 2016:157).

Regarding distribution, the difficulty is the same: the water meters to calculate the real quantity of public water distributed to users are still marginal. In 2009, the World Bank estimated that only 4 per cent of households had water meters installed and most experiences were not successful (e.g. Baalbek project) (Pierpaoli 2016). Expected levels of acceptance by customers of the installation of water meters remains controversial. It is commonly believed in the sector that citizens would contest meters. However, in a customer survey by GVC in rural zones in North Bekaa, 91 per cent of people, after proper awareness campaigns, declared themselves to be in favour of water meters. They felt the meters could be useful for improving management of the service (Pierpaoli 2016).

One pilot project by Chemonics, under the WISE PROGRAM funded by USAID, promotes support for the installation of water meters to BWE (Chemonics 2016). The project replaced the existing network in one neighbourhood of Zahle, Haouch El Oumara. At the same time, it installed about 1,500 household meters and created three district-metered areas provided with bulk meters (Bechwaty 2016). It provided some training for the water establishment in reading water meters, as well as assistance with providing devices to read water meters. BWE is encouraging replication of this project's process. BWE has shown particular interest in receiving support in creating a unit specialised in water metering installation, reading and billing upon volumetric tariff.

Only a part of the total volume of water produced is delivered to service subscribers. The NWSS estimates the level of non-revenue water (NRW) at around half of the volume inserted in the networks due to significant leakages and illegal connections. BWE confirmed this estimate during the fieldwork. Proper quantification of NRW is difficult, considering the above-mentioned lack of production data. It is particularly difficult to estimate how much of this water is physically distributed and reaches the customers and how much is lost through illegal connections or leakages. The existing water assets in each Caza in the Bekaa region are described in Table 7.

The NWSS estimates the potable water network coverage at 62% in Bekaa and 79 per cent across Lebanon (MoEW 2012). Furthermore, the networks (both transmission and distribution) are very old: 54 per cent of transmission networks and 50 per cent of distribution networks are estimated to be more than 20 years' old (MoEW 2012).

According to the preview of the water and wastewater capital investment plan and priority action plan of the Bekaa Water Establishment, the water supply by the network in Bekaa covers varying proportions of the population in the different Cazas as shown in Table 8.

BWE supplies the area through 148 wells and 28 springs. Around 70 per cent of the wells have a yield inferior to 15 litres/second, and the majority of them are less than 10 years old (BWE 2013). Few springs are at elevation so the supply to water storage reservoirs must rely on pumping. This can create problems because of unreliable electricity. Water treatment consists largely of simple chlorine disinfection to protect from possible sources of pollution that might contaminate the distribution systems. Many chlorination stations are out of use because of lack of maintenance and supplies and lack of training for operators. Different donors supporting BWE are trying to address this problem.

Table 7: Water assets in Caza[3] in the Bekaa region

CAZA	WELLS	SPRINGS	WATER TREAT-MENT PLANTS	CHLORIN-ATION UNITS	PUMPING STATIONS	RESERVOIRS	ELEVATED TANKS
Zahle	44	14	1	3	5	39	5
Baalbeck	96	19	1	15	5	120	6
West Bekaa	39	17	0	2	7	49	9
Hermel	12	2	0	0	2	30	2
Rachaiya	41	13	0	0	7	46	10
Total	232	65	2	20	26	284	32

Source: Kredo (2014)

Table 8: Percentage coverage of water supply networks

CAZA	BAALBEK	WEST BEKAA	HERMEL	RACHAIYA	ZAHLE	TOTAL BEKAA
Percentage of population	98	88	58	95	87	90
Percentage of villages	76	64	78	80	57	62

Source: Kredo (2014)

The average continuity of water supply is estimated in the NWSS at 10 hours per day, while across Lebanon it ranges from 7.6 to 13 depending on high and low seasons (MoEW 2012). But the situation can be worse depending on the region and seasons: the Bekaa region has an average of five hours of water supply per day during summer (World Bank 2009a). There are days with no supply. The level of water distributed and access also deeply depend on provision of electricity. Electricity is available 24 hours a day only in Zahle. Elsewhere, communities have electricity for an average of 12 hours and not continuously (BWE Coordination meeting, 27 September 2016). There are low tension electricity problems in most of Bekaa. Therefore, it is more complicated to provide a continuous water service and to store it.

Due to limitations on its water supplies, the Bekaa Water Establishment is not the only supplier of water, as was intended by Law 221. Some municipalities have not yet handed over their water infrastructures to the BWE and continue to provide water to their citizens through water committees. For instance, municipalities pay the electricity bill directly to private generators to ensure water infrastructure remains operational. However, few networks still under management of pre-existing committees compared to those managed by the BWE. Some municipalities intervene in the sector as they try fill the gaps in water supplies to their citizens, especially in summer. To that end, they provide fuel for generators or finance small extensions of the network or even wells and reservoirs if they can establish a direct link with external international donors.

Moreover, and above all, since public provision is not meeting demand for domestic water, households rely on private providers as well (Figures 4 and 5). Different private alternatives exist: bottled water used especially for drinking purposes, private wells (even in urban areas and benefiting individual buildings) and trucked

[3] Each Mohafaza/Governorate is divided into Caza/Districts.

water, among others. Some inhabitants, especially farmers who need more water for agricultural uses, supply themselves directly from the springs. According to fieldwork in the Municipality of Qab Elias, Syrian refugees seem to rely on a mix of different sources to satisfy their demand. Refugees in tented settlements have the lowest reliance on bottled water and public water supply, instead using trucked water and wells for drinking water (WFP *et al.* 2016).

Figure 4: Private providers filling their water trucks in Labwe

Figure 5: Private providers filling their water trucks in Qab Elias

To conclude, each household commonly uses a variety of sources of water to meet its water needs. Regulation of private providers is particularly weak and remains largely unenforced, bringing serious potential risk for public health. Moreover, private provision of drinking water implies that the community and households are bearing significant additional costs. The economic impact on the community can be considered quite severe, especially in the lower socio-economic groups.

3.2.2 Characterisation of the cost of water access: tariff and cost recovery

Bekaa Water Establishment bills annually for public water rather than charging based on consumption; (Figures 4 and 5 illustrates lack of meters). The price depends on the surface of the accommodation and is calculated per household (and not per person):

Surface of the accommodation	Quantity of water (theoretically) received per day and per year	Lump sum per year
0–200m^2	1m^3/day = 365m^3/year	LBP238,000 (around US$159)
200–300m^2	2m^3/day = 730m^3/year	LBP433,000
> 300m^2	3m^3/day = 1095m^3/year	LBP628,000

The price is calculated in this way (Bechwaty 2016):

> (Water cost + Wastewater fee) * number of meters + maintenance fee + 10%VAT + rounding + stamp).

For 1m^3, for example, the price is: (180,000+15,000)* 1+20,000+21,500+500+1,000 = LBP238,000/year ($US159 approximately).

Wastewater fees vary between subscribers that are connected to operational treatment plants and those that are not connected. The fee is LBP60,000 (approx. US$39) for connected subscribers and LBP15,000 (approx. $US10) for others (starting price presenting above because it is the most common situation). Thus, the price of 1m^3 can vary from LBP238,000–283,000 (approx. from $US157–186). Wastewater fees remain derisory in relation to the real costs for providing the service. However, fees were raised from LBP20,000 (approx. US$13) for subscribers connected and LBP10,000 (approx. US$7) for others in 2014 (Machayekhi *et al.* 2014).

BWE estimates the number of subscribers in the Bekaa Valley to be around 82,000 households at the end of 2015 (up from 66,000 in 2012) (Moussalem, M, interview with author. 8th September 2016). The Bekaa Water Establishment estimated in 2016 that 37 per cent of the Bekaa population subscribed to the public service. However, the percentage of subscribers paying the annual fee was only 35 per cent in 2014. This percentage doesn't include the Syrian refugee population that, in most cases, when renting an apartment in municipal areas, receives water through the subscription of the landlord. It is not clear if the actual tariff is sufficient to cover full cost recovery for the service, even with a higher percentage of payment (Pierpaoli 2016). However, BWE's actual incomes are clearly insufficient to cover the proper operational and maintenance costs necessary to provide a reliable service.

To improve the situation, BWE focuses on reduction of non-revenue water, considering reduction of technical and commercial losses. To achieve this, BWE will need to work on the restoration of deteriorated networks of water and on illegal connections to the public network. One idea of BWE, tested in Ouch El Oumara zone, is a metered tariff system. This maintains the tariff of LBP238,000 for 1m^3/day/household consumed and charges LBP1,000 for each additional cubic metre consumed.

Regarding private provision of water, fieldwork collected the following costs of private providers:

- Water trucking has an average cost of LBP5,000–10,000 (US$3.25–6.50) per cubic metre. This is much more expensive than the price of 1m^3 provided by BWE (around LBP650, though each subscriber to BWE is not guaranteed to receive 1m^3 per day).
- One litre of bottled water is around LBP300; this price decreases gradually with more purchases or if the carboy[4] is refilled. In a survey in North Bekaa, GVC found the average cost of buying drinking bottled water is LBP15,400 (around $US10) per week.
- The cost of constructing a private well 100–150 metres deep is about $US50,000 plus maintenance fees. In a survey in North Bekaa, the GVC found that average monthly operating costs are estimated at LBP54,000 (US$35) with half of interviewees spending LBP20,000-30,000 per month (US$13-20). World Bank (2009b) indicated the cost of operating an artesian well was $US127 per year.

Assuming that water is delivered daily to all households at the rate of 1m^3/day, the cost of water supplied by the public network would be about LBP650/m^3 in the Bekaa Valley for a household not connected to an operational treatment plant. However, the quantity of water delivered is not constant every day. Therefore, the cost for a cubic metre from the public network should be considered higher for most people that paid with the tariff. Still, it can be considered cheaper than private provision. In fact, according to studies (Corail and Ipsos 2004; World Bank 2009; Pierpaoli 2016), the household cost for daily needs using both public and private supplies is nearly triple the cost of the public tariff.

In Chtoura, people spend even more: instead of paying LBP237,000 per year for water, a household spends on average an additional LBP1.2 million for its water needs (EDESSA 2015). Those connected to the network, even where service is not reliable, spend on average at least 10 per cent less than those not connected (Pierpaoli 2016). The 2016 Vulnerability Assessment shows that refugee households relying on trucked water pay on average US$27 per month compared to US$15 per month for public networked supply (WFP *et al.* 2016).

Where households have to purchase additional drinking or domestic water, this "speeds up the depletion of financial resources of most vulnerable households and exposes them to an increased public health risk by limiting access to sufficient and quality water" (World Vision *et al.* 2014:6). Households would have a distinct financial incentive to use the public water system if the service was available, reliable, sustainable and of good quality. Moreover, the citizen survey in rural areas of North Bekaa by GVC reveals that the willingness to pay is quite high. Some 90 per cent of citizens/customers are ready to pay approximately 50 per cent more than the actual tariff of the BWE, but only for a reliable service (Pierpaoli 2016). Most interviewees define reliability as at least two hours per day with sufficient pressure to reach roof-top storage.

3.2.3 Overview of different sources of water used by the host and refugee populations

There are no official data about water sources consumed by the host and refugee populations in the Bekaa Valley. However, several reports publish figures based on analysis and estimates in Bekaa, a part of Lebanon or at the national level. It is hard to compare them because they don't deal with the same sample (host populations, Lebanese, refugees – depending on their housing conditions). Some results seem to not correlate. Also, it can be difficult to establish water sources as some farmers can use water for both domestic and agricultural purposes.

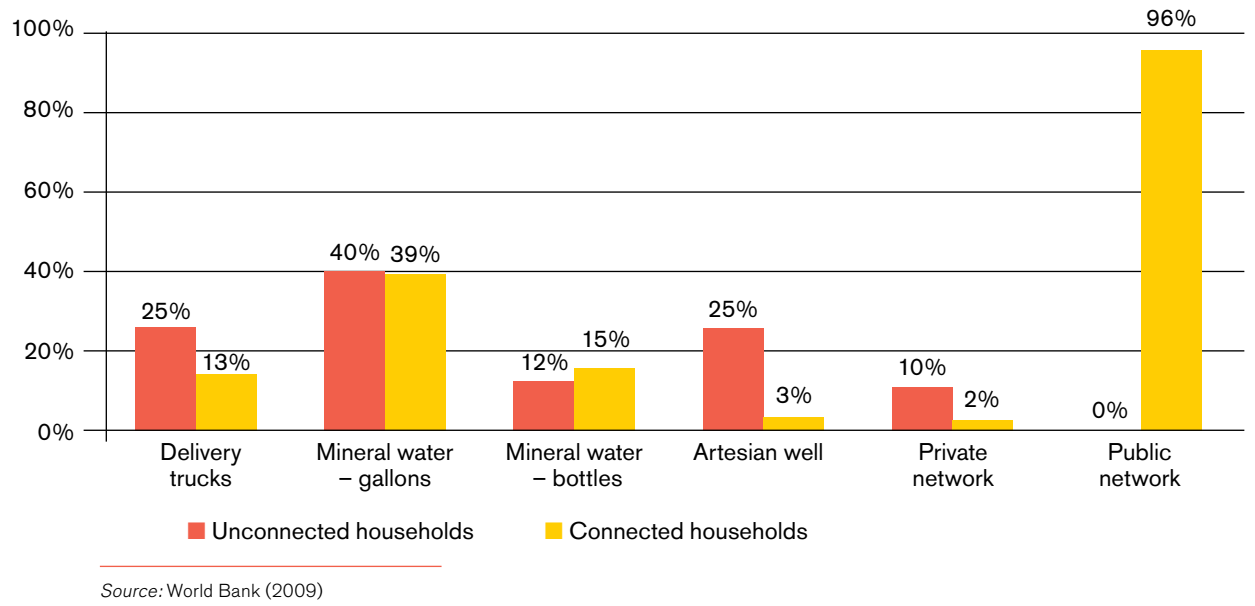
The sources of water of the Lebanese population in 2009, at the national level, are shown in Figure 6. (ECODIT 2015).

Figure 6 confirms that most host communities are connected to public networks, and that 96 per cent of those who are connected get water through their connection. It also shows that a large share of the same people connected to public networks still need to use alternative water supplies. Mineral water gallons were the first source of water for unconnected households (for drinking water) and the first alternative source for connected households. Similar percentages related to use of mineral water show that users of public service do not trust the quality of the water provided through the network. Water trucking and private wells are the other sources used by unconnected households.

Oxfam, in the framework of its project in Chtoura (an urban area of Central Bekaa) carried out a SEA based on 70 per cent of Lebanese households and 30 per

[4] A large globular glass bottle with a narrow neck, typically protected by a frame and used for holding acids or other corrosive liquids.

Figure 6: Sources of water at the household level



Source: World Bank (2009)

cent of Syrian households, all living in apartments or houses (EDESSA 2015). The conclusions show that:

- 65% of the surveyed population reported subscribing to the network (55% Lebanese and 10% Syrians). On the other hand, 30% reported not subscribing to the network (17% Syrians and 13% Lebanese). The remaining 5% reported not knowing if they are subscribed to the network.
- Of the 30% not connected to the public water network, the most common reason given was the absence of network (which confirms a further conclusion that if vulnerable people remain unconnected it is primarily a question of location).
- Only 3% of the 65% subscribers admitted not paying their annual fee; 62% reported paying their annual water bill either directly (48%), part of the rent (12%) or were exempt for disability reasons (2%).
- 51% of surveyed households relied on the public network, 60% relied on trucked water and 40% relied on water wells (26% artesian and 14% open wells) for domestic non-drinking water. Obviously, households rely on several sources for domestic use as a result of water shortages.
- Of the surveyed households, 78% (55% Lebanese and 23% Syrians) reported relying on water gallons for drinking water. Only 15% (13% Lebanese and 2%

BOX 1. SOURCES OF WATER IN NORTH BEKAA

Pierpaoli (2016) surveyed 1,006 households and units in five rural municipalities in North Bekaa (Zabboud, Bejjeje and Ain, Nabi Osmane and Labwe). The sample includes, without differentiation, host communities and refugees (a small percentage in relation to the Lebanese population) living in similar housing conditions in a rural area of North Bekaa. The conclusions show the following:

- 65% of interviewees declared they take water from the network (this is an average and the results differ between the different municipalities) and 66% declared they do not receive enough water.
- People that are connected to network, even with water schemes recently completed or upgraded, receive water on average only once every two-three days for less than two hours. Less than 10% of the sample received water every day.
- The two major alternatives in case of malfunction of the water scheme are water trucking (54%) and private wells (44%).
- Similar answers were given by those without network access: wells (40%) and trucked water (41%) are the alternatives, with 6% using bottled water.
- 38% of people interviewed have had their own wells constructed during the last 40 years.
- Only 26% of the sample used drinking bottled water for an average cost of LBP15,400 per week.
- 30% of the interviewees rely on water trucking.

Syrians) reported relying on water bottles for drinking. The main reason is likely to be the cost and the more practical aspects of handling larger containers than bottles.

The Syrian refugees living in rented accommodation often pay an additional fee for water provision to the landlord, included in the rental fee. Informal settlements and collective shelters manage water supply differently. NGOs can provide water supply, some refugees can connect to the public network (illegally in most cases) or refugees purchase water in the private market.

MoE *et al.* (2014) give information about the sources of water used by all Syrian refugees who are living in apartments, substandard shelters and informal settlements. The percentage of these water sources is based on data presented in the vulnerability assessment of Syrian Refugees in Lebanon 2013 (Table 9 and Figure 7).

For Syrian refugees in informal settlements nationally, the sources of water have been estimated at 43% from boreholes, 41% from water trucking, 9% from the water network and 7% from other sources (Inter-Agency Information Management Unit and UNHCR 2016).

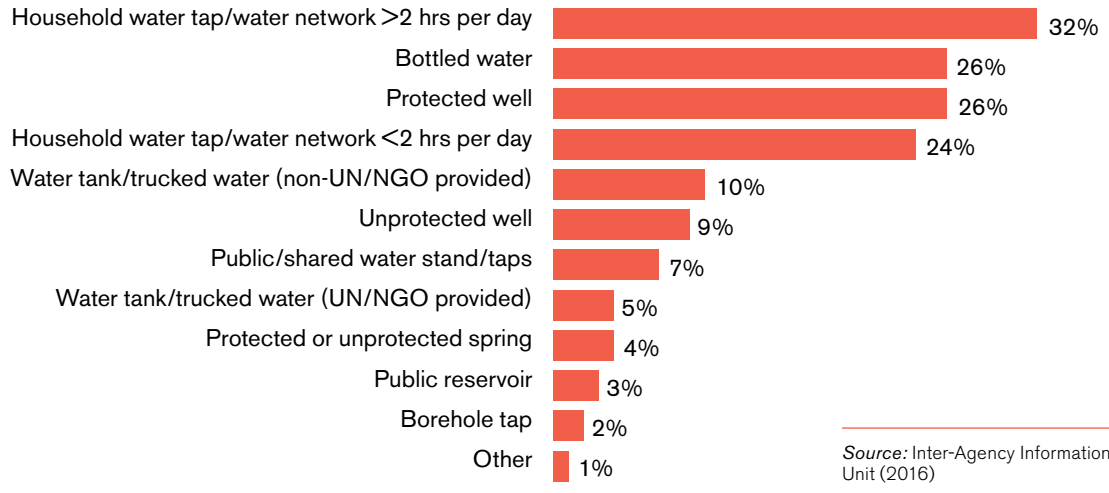
The data above demonstrate that results can differ depending on surveys and have to be considered indicative only. Table 10 summarises findings regarding sources of domestic water used by the different segments of the population – excluding alternatives for drinking water which seem to be bottles and gallons for the majority.

Table 9: Sources of water used by Syrian refugees

SOURCES OF WATER	PERCENT
Public water network	30
Wells	24
Public reservoirs/Standpipes	22
Springs	12
Purchased	10
Mineral	1
Other	1

Source: MoE *et al.* (2014)

Figure 7: Percentage of refugee households using water sources



Source: Inter-Agency Information Management Unit (2016)

Table 10: Summary of domestic water sources

	LEBANESE HOST	SYRIAN HOST (APARTMENTS)	SYRIAN (SUBST./ CENTRES)	SYRIAN IN INFORMAL SETTLEMENTS
Public network	Principal source	Principal source	ND	Marginal alternative
Water trucking	Principal alternative	Principal alternative	ND	Principal source
Wells	Principal alternative	Principal alternative	ND	Principal source

ND: No specific data found

3.2.4 Access to safe water

Not all Lebanese and Syrian refugee populations have access to safe water. Water quality from public services is generally perceived as bad, partly because of the intermittence of the service (Korfali and Jurdi 2009). The Inter-Agency Information Management Unit (2016) summarises progress by partners in the Lebanese Crisis Response and highlights trends affecting people in need (both the most vulnerable among the displaced from Syria and poorest Lebanese). Of 1.34 million people targeted, 688,644 had access to a sufficiently safe water supply at an adequate level of service. Only 210,431 of 467,172 people had access to appropriate sanitation facilities and services (Inter-Agency Information Management Unit 2016).

WFP *et al.* (2015) published data about access to improved and unimproved water for Syrian refugees.[5] Even if the report underlines that "improved and unimproved water sources are defined based on the construction method of the source and the modality of supply" and that "this definition does not consider the component of safe water supply sustainable for drinking purposes consistent with the Millennium Development Goals and the Sustainable Development Goal for drinking water", these data give information regarding water quality (WFP *et al.* 2015:20). All told, 61% of households enjoyed "improved" drinking water supplies. This consisted mainly of water piped into their homes for more than two hours a day (22%), bottled mineral water[6] (21%) or from protected wells (9%). The main unimproved water sources were "bottled water which was not from an improved secondary source (14%) and water piped into homes but for less than two hours a day (12%)" (WFP *et al.* 2015:20). It appears that the two households using unimproved water sources are highest in Baalbeck-Hermel and Bekaa governorates (Figure 8).

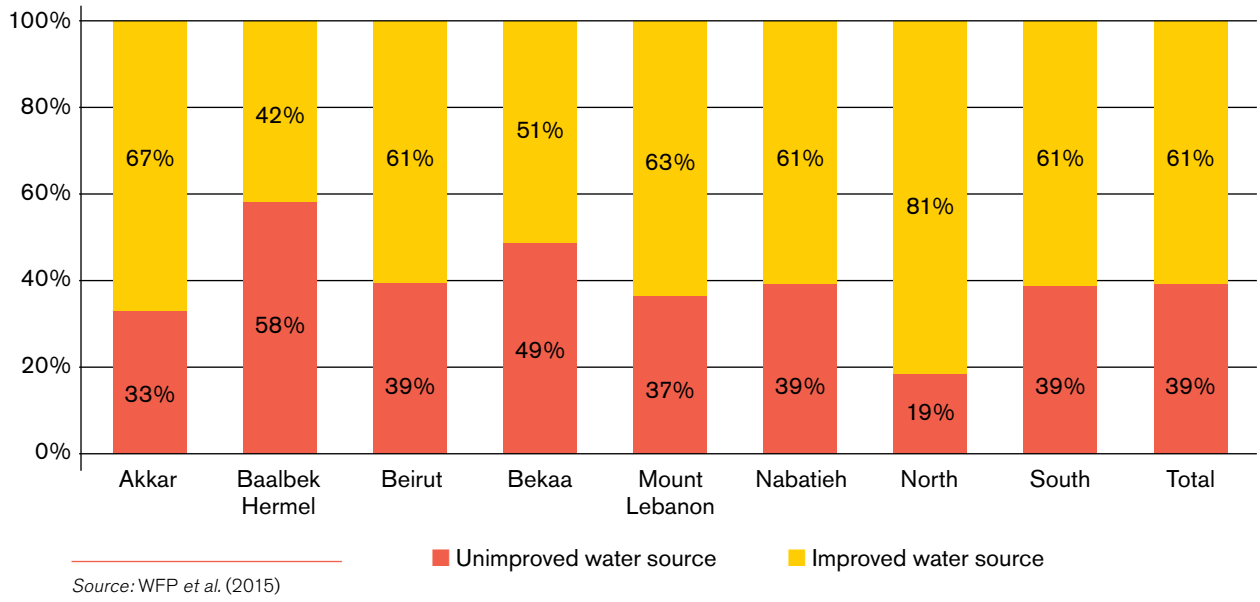
Furthermore, WFP *et al.* (2015) underline that the sources of improved and unimproved sources of water are different between the governorates of Bekaa and Baalbeck-Hermel. For instance, the main source of improved drinking water (30 per cent) in Baalbeck-Hermel is bottled mineral water (combined with improved others sources of water), whereas bottled water represents only 5 per cent in the Bekaa governorate.

The population does not generally perceive water quality as the primary concern. Pierpaoli (2016) reveals that 72% of people in North Bekaa connected to the network drink the network water even if the large majority don't know if the water quality is tested. The 2016 Vulnerability Assessment notes that only 4% of refugee households report treating their water (WFP *et al.* 2016).

[5] 105 Syrian refugee households were surveyed, including 58% living in houses or apartments, 24% in substandard building and 18% in informal settlements.

[6] In this report, bottled water is not considered automatically as an "improved" source because of limitations concerning the potential quantity of supplied water. In terms of quality as well, there is no guarantee that water used for other in-house uses like bathing, washing and cooking are supplied from improved sources (WHO and UNICEF 2011).

Figure 8: Improved and unimproved drinking water sources



Source: WFP *et al.* (2015)

BOX 2. DRINKING WATER SOURCES FOR SYRIAN REFUGEES

The safety of drinking water for Syrian refugees depends on their living conditions.

- 26% of those living in houses and apartments used bottled water for drinking (with a secondary improved source) and 24% have a tap water connection for more than two hours a day.
- 25% of those living in substandard shelters had a tap water connection for more than two hours a day.
- 34% of those living in informal settlements (including informal tented settlements) used drinking water provided by NGOs or other third parties and 15% had protected wells.
- The 2016 Vulnerability Assessment shows that the share of households with access to tap water decreased by 7% compared to 2015, leading to a 7% increase in those relying on bottled water as a primary source.

Source: WFP et al. 2015; 2016.

3.2.5 Conclusions

Vulnerable populations are less likely to be connected to the public network, but this is true as much for host communities as for Syrian refugees. According to World Bank (2010), this is primarily due to location, not affordability: only 3 per cent of unconnected households claimed they "cannot afford" or "don't want to pay" for the public network. In fact, in the case of Syrian refugees living in informal settlements, it is more complicated to rely on public water, though some manage to do so but without subscribing to the Bekaa Water Establishment. The household source of water should therefore not be seen as a criterion to define a low-income household: all households have to fulfil their needs with alternative sources, even well-off households. However, low-income populations are more vulnerable to high costs of water from non-piped sources (e.g. trucking), which is their main source of water.

Groundwater constitutes the largest share of the sources of the public water network and of public reservoirs. MoE *et al.* (2014) confirms the increase in water demand due to the refugee population is exacerbating the current stress on water resources in general, and on groundwater resources in particular. The impact on water sources of Syrian refugees – especially those living in ITS – compared to the impact of Lebanese citizens is proportionally smaller: they consume on average only one-third of the water of the average Lebanese citizen.

4

Discussion

Different actors are involved in Lebanese water management, but responsibilities are fragmented. Weak communication and co-ordination between stakeholders is exacerbated by lack of both reliable data and monitoring. Lack of human resources and financial resources may explain some, but not all, of these problems in the sector.

To improve prospects for achievement of SDG 6 by 2030, the following must be tackled as a priority:

- Safe access to water. An estimated 39% of Syrian households access "unimproved" drinking water supplies (WFP *et al.* 2015). In Lebanon, access to enough safe water is only possible if personal budgets permit drawing on alternative sources.
- Equitable and affordable access to water in Lebanon. Vulnerable populations are less likely to be connected to the public network and rely more on private providers, at greater expense than through a reliable public service.
- People in vulnerable situations. These vulnerable people are mainly Syrians, but also Palestinians and Lebanese. This work is critical to achieve target 6.2 of the SDGs.

In the short term, water access for the Syrian refugees, particularly those living in informal settlements, should be improved. Informal tented settlements should be connected when these are placed near existing water schemes. Connections should be monitored through the installation of water meters at the ITS level. This solution is envisaged by BWE and some NGOs working in the Bekaa Valley. The NGOs working in these areas could subscribe directly to BWE rather than contracting private providers to supply water to refugees.

These actions could have positive consequences: reducing the heavy reliance of NGOs on private providers, cutting the substantial financial expenses of NGOs, avoiding the contaminated water from uncontrolled trucking and enforcing the role of BWE in managing water distribution in the area (by increasing subscribers to the public service and thus BWE's income). At the same time, the level of service received by Lebanese residents needs to be verified and improved to avoid possible conflicts against the refugee community and promote social cohesion.

The heavy reliance on private sector provision affects all vulnerable populations, refugees and host communities alike. In relation to the Syrian crisis, a more regulated system for integrating the private providers into the response is needed until public authorities can provide water for refugees. This would consist of regulating and controlling sources of water to be used and monitoring the quality of the water transported. The truckers could be integrated into the public service by authorising specific filling points of Water Establishments and assuring that the Establishments are properly paid for water collected.

Furthermore, incentives should be considered to encourage users to connect to networked water. This would guarantee proper quality of water and some revenues to the Establishment. Awareness campaigns based on marketing could inform the population about the advantage of public water supply, especially in terms of affordability and quality, for the most vulnerable populations. The role of private actors should be clarified and regularised to avoid further damage to the public service, but also to benefit the water sector from their added value. The private sector should be considered as a potential partner rather than as a competitor to public delivery.

The Bekaa Water Establishment would like to move towards more inclusive, sustainable and integrated strategies and actions. The objective is to shift from short-term humanitarian crisis responses toward actions that could build long-term resilience. For years, the approach has focused mainly on building new infrastructure rather than improving operations and maintenance. However, the water public service in Lebanon is still not reliable, efficient or sustainable. It is thus necessary to improve the reliability and productivity of existing production sources. Water establishments, because of lack of personnel, infrastructure handover and operation procedures, often cannot maintain infrastructure. In certain cases, citizens still want municipalities to support operations. However, these jurisdictions are no longer entitled to intervene in the sector. In any case, they lack necessary resources to do so.

It is important to work on control and monitoring of water resources, principally groundwater. This includes controlling and recording both public and private wells, which are mostly illegal. According to UNDP and MoEW (2014:27), "Growing water demand as a result of increasing population has been meet by overexploitation of the country's groundwater resources. A large number of public and private water supply wells have been installed without proper planning and monitoring". Bulk meters at the production level and water meters at the distribution level are both needed to better manage the resources.

In the Bekaa Valley, this question of water management is deeply linked with agricultural uses, which remains the primary competitor of domestic uses. The resilience of the poorest Bekaa populations is directly linked to the availability of water for agriculture, at least as long as the region still has a large number of farmers. Working on the management of the water production sources will mean working closely with farmers to make effective changes in their water practices and reduce consumption.

Underlying all of this is the need to raise awareness of users and citizens on the following points:

- Water conservation and environmental protection. This is closely related to water quality, as well as the need for sanitation infrastructure and to reduce wastewater. On this point, different ministries (industry, energy and water, environment, health, among others) and municipalities play a role to reduce water pollution and improve awareness. Greater awareness about water quality and hygiene in the informal settlements is particularly important. More generally, improved sanitation infrastructures in IS are needed to reduce risks of contamination.
- Water tariffs. Greater awareness is needed that the water tariff covers the cost of the water service, not of water itself (ACWUA 2013). This awareness work must be co-ordinated with the water establishments to increase the number of subscriptions and reduce illegal connections.
- Rights to water. Citizens should be empowered to play an active role in the sector and to claim their rights to water in terms of quantity and quality (Assaf *et al.* 2004; Mazjoub 2010). Once the service becomes reliable and efficient and the tariff is based on real consumption, measures would be more easily introduced to enforce subscriptions and payment for the public service.
- Water usage. Users need to be sensitised about the necessity to control and limit water consumption per capita. Awareness campaigns for the introduction of water meters will encourage acceptability of these measures.

At the water establishment level, to set-up a strategy for improving cost recovery, action is needed on three levels (Pierpaoli 2016):

- Water establishments: There should be efforts to reduce NRW; metering should be applied alongside a volumetric tariff; and knowledge of production and distribution costs should inform a business plan approach.
- Customers: Greater awareness is required for the need to pay for services received, and customer databases should be updated to identify illegal connections.
- National government: The government can support these efforts by promoting the independence of the water sector from external political interferences and supporting enforcement of the law.

More generally, community and citizen participation in water management must be increased. A bottom-up approach would help increase ownership of water sector reform (World Bank 2012). Further, the role of civil society should be strengthened to ensure efficient and sustained performances of the sector (ESCWA 2009). Communities and vulnerable groups should be

empowered to participate in decision-making processes (ESCWA 2013).

To support this, greater dialogue between the establishments, municipalities and citizens could build trust (Pierpaoli 2016). This includes clarification of different roles and responsibilities of water authorities, promoting proper co-ordination among them to improve performance of the WEs (Farajalla 2016) and strengthening governance at local and national levels. This would have positive implications for overall governance and social cohesion beyond the water sector.

The Lebanese water sector itself suffers from management weaknesses. These weaknesses pre-existed the Syrian crisis and are central to understanding the functioning of the sector.

First, responsibilities are fragmented between different stakeholders (World Bank 2010):

- CDR, as mentioned also in the NWSS, is responsible for planning and execution of donor-funded projects,
- MoEW is responsible for budget-financed investments,
- Regional water establishments can execute capital works based on cash flow availability generated by revenues, and
- Other minor national actors like the Central Fund for the Displaced (CFD) or the Council of the South (CoS) also have these responsibilities.

This fragmentation is accompanied by low capacity of co-ordination, in particular between MoEW and the CDR. This is causing low levels of efficiency in public expenditures (World Bank 2010).

The discrepancy between legal and de-facto responsibilities has also created confusion in the population itself. People are not able to identify those responsible for the management of their infrastructure. This has weakened the accountability line between policymakers and service providers (World Bank 2010). This is particularly true for the role played by municipalities. The approach remains top-down, giving more power to national and, to a lesser extent, regional institutions without more participation of citizens, local communities and local institutions.

Lebanon suffers from a crucial lack of reliable data, but also a lack of monitoring systems and capacities. The data collected remain in most cases incomplete or contradictory. But monitoring is important to design infrastructure, to understand the practices and consumption of people, and to adapt actions and strategies. The lack of monitoring tools and spaces for communication and exchange of data has also previously been observed in the wastewater sector (Machayekhi *et al.* 2014).

This situation is perhaps partly a consequence of the weak communication and co-ordination between different stakeholders in the sector. There is sometimes mistrust, which can hamper relationships and communication (Farajalla 2016). It can happen between the national and regional levels, between the regional and local levels, but also inside an institution. However, co-ordination between different actors has, to a certain extent, improved over recent years. The Bekaa Water Establishment organises monthly meetings to co-ordinate the actions of donors in its territories. During these meetings, projects and priorities are analysed and the different stakeholders communicate about key challenges.

To some extent, the humanitarian interventions are contributing to improved co-ordination. For example, in September 2016, SDC launched a Water Policy Dialogue event to foster discussion, dialogue and co-operation in water management in Lebanon, in particular in the Bekaa Valley. These co-ordination processes foster local level co-ordination. There are also national workshops and seminars, which deal with the global challenges in the management of the sector.

It is particularly important to emphasise the lack of human resources and especially the lack of employees in water establishments. According to BWE, the establishment employs only one-third of its total required human resources. It could not employ people for the last few years because the national budget froze hiring. Lack of human resources is also present at the local level and particularly in municipalities that have difficulties to fulfil their functions. Technical assets are also lacking, which affects the wastewater sector in particular. The shortage of financial resources at the regional and local level hampers performance of the sector.

In 2018, a High Level Political Forum will review progress towards the achievement of several SDGs. It focus, among others, on access to safe water and sanitation and sound management of freshwater ecosystems for human health, environmental sustainability and economic prosperity. The situation in the Bekaa Valley is of considerable interest to the international debate for three main reasons:

- Major challenges faced: water scarcity, conflict, a refugee population that creates additional demand and other challenges for local governments and water managers,
- Strong technical capacities in-country, scientific co-operation, relatively strong environmental and agroecological knowledge bases (compared to many lower income countries facing similar issues),
- Major international engagement and large investments by the international community and private donors due to the international humanitarian situation.

5 Conclusions

A large range of public, private and nongovernmental actors is involved in the management and provision of water in the Bekaa Valley. Since 2012, new actors and especially NGOs have been in this territory with new staff available to reach out to citizens in the field. Various actions have improved the water infrastructure and, to a large extent, the service, which has affected both host communities and Syrian refugees.

The influx of refugees and international humanitarian agencies in their wake has had an impact on the national, regional and local Lebanese stakeholders and institutions that have to adapt to a new, complex context. To face the emergency, there is a need to clarify and categorise the approaches of those new actors intervening in the sector. While co-ordination between the actors seems to have improved recently, there is still overlap. The Syrian crisis, with the influx of investments and new actors in the sector, could represent a trigger for improving the management of the Lebanese water sector. However, difficult questions remain about what will happen when or if the international humanitarian response ends.

With or without refugees in the Bekaa Valley, water management is strongly determined by agricultural use patterns. Agriculture remains the primary competitor with domestic needs – especially during the dry seasons and droughts. The resilience of the most vulnerable Bekaa populations is also further linked to the availability of water for agriculture because the poorest households rely on water sources that are shared with agriculture – whether they are camped in agricultural areas, or receiving temporary water supplies from them. The SDG 6 Agenda is forward-looking because it encourages analysis of water demand across sectors in order to enable well-conceived, integrated and sustainable management solutions. But to ensure that this cross-sectoral approach is effective and considers domestic needs of the most vulnerable people in the Bekaa will require a high level of institutional co-ordination and transparency.

Beyond financial and human resource injections in the public sector, international engagement should foster community participation, mutual trust and confidence in the transparency of water resource management information systems for public and private use. In this way, they can better enable sustainable development planning.

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Balancing water stress and human crises under a changing climate: integrating international policy agendas in the Bekaa Valley, Lebanon, Caroline King-Okumu, Hadi Jaafar, Diane Archer (2016), IIED Report. http://pubs.iied.org/10175IIED/

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Balancing water stress and human crises in the Bekaa Valley, Caroline King-Okumu, Hadi Jaafar and Diane Archer (2016), IIED Reflect and Act. http://pubs.iied.org/17383IIED/

Dryland resilience-building under a difficult and changing climate – the Bekaa Valley, Lebanon (2016), IIED Workshop Report. http://pubs.iied.org/G04122/; http://pubs.iied.org/G04123/ (in Arabic)

Appendix

Formal Interviews

National and Regional institutions	Ministry of Energy and Water	Ms. Suzy Hoayek
	Council for Development and Reconstruction	M. Youssef Karam
	Ministry of Environment	Ms. Lamia Mansour
	Bekaa Water Establishment	M. Maroun Moussalem (2 interviews)
Funders	EU	M. Cyril Dewaleyne
	USAID	M. George Akl, M. Charbel Risk, M. Salah Saliba, M. Youssef Abou Hamad
	GIZ	M. Joerg Yoder
Experts	AUB	M. Nadim Farajalla
	LARI	M. Ihab Jomaa
	Help of Oxfam, World Vision, AFD, UNHCR.	

Fieldwork – August and September 2016

Hermel	Discussion with the municipality, visit to the BWE regional office, visit to water resources and the pumping stations/reservoirs managed by the BWE
Labwe	Discussion with the municipality, discussion with one private provider, visit to the springs and water sources
Zahle	Discussion with the municipality and discussion with EDZ
Qab Elias	Discussion with the municipality, discussion with one private provider, visit to the infrastructure of the private provider
Joub Jannine	Discussion with the municipality

Focus group of actors (humanitarian support co-ordination process / reflexion on the Lebanese water sector)

Water policy dialogue event with the objective to foster discussion, dialogue, and co-operation in water management in Lebanon, in particular in the Bekaa Valley	08/09/2016 in Zahle: Water Management and Governance in Lebanon, organised by the International Co-operation Division, Embassy of Switzerland
Co-ordination meeting 33 and 34	Held at BWE, 27/09/2016 and 25/10/2016 in Zahle
Seminar about cost recovery and demand management in Lebanese Sector	Organised by GVC (in co-operation with IFI AUB, UE project), 28/09/2016 in Beirut

Acronyms

ACF	Action Contre la Faim
AUB	American University of Beirut
BWE	Bekaa Water Establishment
CDR	Council for Development and Reconstruction
CFD	Central Fund for Displaced
CoS	Council of the South
DNC	Danish Refugee Council
EDZ	Electricité de Zahle
EU	European Union
GVC	Gruppo di Volontariato Civile
INDC	Intended Nationally Determined Contributions
IOs	International Organisations
IS	Informal Settlements
ITS	Informal Tented Settlements
JMP	Joint Monitoring Programme
LARI	Lebanese Agricultural Research Institute
LCRP	Lebanon Crisis Response Plan
L/P/D	Litres per person per day
MCM	Million Cubic Metres
MOE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoPH	Ministry of Public Health
NGOs	Nongovernmental Organisations
NRC	Norwegian Refugee Council
NWSS	National Water Sector Strategy
RI	Relief International
SCI	Service Civil International
SEA	Strategic Environmental Assessment
SNC	Second National Communication
TDH	Terre Des Hommes
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNRAW	United Nations Relief and Works Agency for Palestine Refugees in the Near East
WH–	World Health Organization
WVI	World Vision International

A humanitarian crisis has changed the mode and pace of international engagement with longstanding water stress and climatic challenges. In Lebanon's Bekaa Valley, both Lebanese host communities and Syrian refugees rely on a mix of public and private water sources to meet their needs. Refugee households consume approximately one-third as much water as Lebanese households do. Beyond financial and human resource injections in the public sector, international engagement should foster community participation, mutual trust and confidence in the transparency of water resource management information systems for public and private use. In this way, they can better enable sustainable development planning.

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