جامعة بيروت العربية
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Potentiality of Treated Wastewater in Bekaa Region Lebanon for Crop Irrigation

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Summary

This report aims to contribute to knowledge on the status of wastewater treatment in Bekaa, Lebanon .and examine its potentiality for reuse in irrigation. To achieve this aim, a combination of desk analysis of related studies and reports and field data collection was conducted.

Findings of the desk analysis show that a volume of 275 million cubic meters (Mm^3) and 328 Mm3 per year is generated of municipal wastewater generated in the country. To date, 104 wastewater plants (WWTPs) exist in Lebanon, among which 41 are operational and 20 may be considered as partially operational as they face many limitations to operate adequately, another 35 are classified as not operational, and eight are still under construction. Only about 25-30% of the annually generated wastewater is treated with the remaining amounts being discharged untreated in water bodies and natural fields. At a national scale, only 28 Mm^3, or 34%, of the treated wastewater (TWW) can currently be considered suitable for reuse. This amounts to about 8-10% of the total municipal wastewater generated. This estimation was created based on factors related to WWTP's capacity and operation, the quality of TWW, as well as factors related to the potential of agricultural activities, and the availability of irrigation infrastructure in surrounding areas. In total, a considerable reuse potential was reported with 48 WWTPs, among these six WWTPs are based in Bekaa. These are Zahleh, Majdel Anjar/El Marj, Joub Janine, Iaat, Ablah, and Fourzol.

Findings of field visits and personal interviews conducted in this study with heads of units at Bekaa Water Establishment and

the six WWTPs identified by desk analysis to have considerable reuse potential, in Bekaa, show that the TWW has a high potential of being used in irrigation if the challenges that the plants are facing get solved. As is the case in all WWTPs, constraints in terms of operation and maintenance related to the high cost of energy sources, inadequate financial resources and infrastructure, discharge of untreated industrial wastewater in existing wastewater network affecting the quality of influent and the entire operation, in turn, were identified by interviewees. Coupled with challenges related to governance and the absence of regulatory and legal frameworks for reuse makes this reuse potential is far from the materialization and valorization of TWW in agriculture in the foreseen future. This especially can be considered "mission impossible" under current economic crises and the collapse of the Lebanese currency and financial resources of the country.

Background

Despite the recognition of Lebanon as a water-rich country in the Middle East, its water balance situation is becoming critical (Machayekhi et al., 2017). Increased demands caused by human activities in various sectors, urbanization, and development are among the main drivers for the emerging water supply/demand gap. This gap has further been exacerbated by climate variability and changes leading to well-observed water shortage in a large part of the country (Jaafar, 2021). With a warming climate, extended drought periods, and less snowfall, the per capita water availability has witnessed a drastic drop during the last decade (Haddad et al., 2014). The World Bank estimates that with a current population of about 6.8 million, renewable freshwater availability will be brought down to less than 660 m3 /capita/yr, very close to the absolute water scarcity level of 500 m3 /capita/yr (FAO). Much worse water scarcity levels could be found if the analysis is scaled down to regions and districts of the country (Jaafar, 2021). In this context, the Bekaa region where Syrian refugees constitute more than one-third of the population reaching 982,000 persons is considered a critical hot spot. The region is considered the agricultural hub of Lebanon hosting the greatest concentration of agricultural lands (42 percent of the 3 total cultivated area). The region is observed to strongly face severe water shortages of its water resources under the current increased water and food demands and economic crises facing the country.

Situated inland, Bekaa is projected to face a temperature increase of 2◦C and a decrease of 10–20% by 2040 compared to current precipitation levels (MoE/UNDP/GEF, 2016). This combination of substantially lower precipitation and significantly warmer conditions will cause prolonged hot and dry climates, intensified extreme events, and longer drought periods (Jaffar, 2021). Today, farmers of the region have expanded their planted lands of local wheat, legumes, potatoes, and vegetables to meet the increasing food demands (Machayekhi et al., 2017). This has certainly imposed extra pressure on water resources in the region accentuating the over-exploitation of groundwater and increasing the competition for freshwater between sectors. This has driven some farmers to irrigate with untreated wastewater not paying any attention to the harmful effects of this practice on public health and the environment (Cellamare et al., 2016). Wastewater-fed crops exposed to wastewater-born contaminants and pathogenic agents can lead to a wide range of infectious and chronic diseases. In such situations, the use of treated wastewater (TWW) stands as a promising non-conventional water resource to meet part of the increasing needs for irrigation water and replace the use of untreated wastewater for agriculture and horticulture, making more fresh water available for other critical uses (Hussain et al., 2002; FAO, 2016; Cellamare et al., 2016). This is very important considering the projected large volumes of TWW that will be potentially generated in the future. Globally, domestic-treated TWW is successfully used in agricultural crop production, aquaculture, and timber crops in agroforestry in many countries. This involves the use of secondary treated water accompanied by economic and environmental benefits and health outcomes. In response to the increased challenges of water resources in Lebanon, the Government of Lebanon issued a National Strategy for Wastewater Sector (NWSS) in 2012 (The World Bank, 2012) declaring its commitment to develop an integrated and prioritized investment program for wastewater collection, treatment and use by 2020. The strategy targets strengthening the collection and treatment of wastewater, supporting the use of TWW in agriculture, and recovery of wastewater treatment and maintenance costs. Unfortunately, the implementation of the strategy is extremely delayed due to several factors including economic constraints, security and political instability, regional conflicts, and the COVID-19 pandemic among others. Despite that, some promising initiatives and studies advocating the use of TWW in agriculture have been established by several investigators and organizations (Cellamare et al., 2016). However, there is still an urgent need for more studies on the potential of TWW for use in irrigation especially in critical and agricultural areas such as the Bekaa region.

Objectives

- To provide an updated and comprehensive scientific data on the potential use of TWW;
- To collect information on quality of TWW of WWTP and wastewater treatment units in Bekaa region;
- To evaluate the suitability of TWW for irrigation purposes.

Methodology

Study area

The area of this study is Bekaa region. It covers the governorate of Baalbek-Hermel and the governorate of the Bekaa excluding Rashaya district. It extends from Hermel in the north to Qaraoun Lake in the south.

Data Collection

Data collection was based on two main approaches;

- ***Desk analysis***: Reported information about WWTPs and characteristics of the treatment plants, quality indicators and standards of TWW use of TWW in agriculture in Bekaa were obtained from the following reports and research studies:

✓ Sustainable Sludge Management in the Bekaa Region (CDR, 2021)
✓ Wastewater Treatment: Overview, Types, Energy Consumption & Actual State in Lebanon with Proposal of Using Renewable Energy (Fayssal et al./ Acta Materialia Turcica, 2020)
✓ Progress on Wastewater Treatment- Global Status & Acceleration Needs for SDG Indicator 6.3.1 (UN, 2021)
✓ Assessment of Treated Wastewater for Agriculture in Lebanon (FAO, 2016)
✓ Lebanon Crisis Response Plan (UNOCHA, 2015-16)
✓ Analysis of Water Reuse Potential for Irrigation in Lebanon (Eid Sabbagh et al./IWMI, 2022)
✓ Council for Development and Reconstruction (CDR, 2016)
✓ Council for Development and Reconstruction (CDR, 2017)

- **Primary data collection by site visits and interviews**

To the date of the preparation of this draft report, Head offices of Bekaa Water Authority (BWE) and four WWTPs (i.e., Joub Jannine, Zahlé, Ablah and Iaat (Baalbek)) out of the six identified WWTPs with reuse potential, were visited. During the visits, heads of units of managers, engineers, officers, and consultants in charge of operating the plants were interviewed using a semi structured questionnaire (Table 1, Annex 1). Information obtained included, number and statues of WWTPs, service capacity of the plant, coverage area, the population connected to sewer network, treatment type plants follow, major challenges plants are facing.

Table 1- Names and Positions of interviewees of WWTPs, Bekaa

Name	Position	Institution/WWTP
Khalil Azar	Head of pumping stations & projects	Head Office, Bekaa Water Authority, Bekaa Water Establishment (BWE)
Joseph Mousallem	Monitoring Officer	Jib Janin Wastewater Treatment Plant, BWE
Ali Arfan	Plant Responsible, SUEZ	Zahle Wastewater Treatment Plant, BWE
Adel El Sayed Ahmad	Head of Stations	BWE
Ghassan Mazraani	Head of Irrigation Unit	Head Office, BWE
Chamoun Mello	Safety engineer	Zahle Wastewater Treatment Plant, BWE
Mohamad Ismail	Head of Network Maintenance & Distribution	Head Office, BWE
Mohamad Bou Dahyia	Operator in Charge	Ablah Wastewater Treatment Plant, Ablah Municipality

Findings & DiscussionOverview of Wastewater Treatment in Lebanon

Results of the desk analysis conducted under this study finds a list of many nationwide WWTPs that have been initiated by the Council for Development and Reconstruction (CDR) between 1992 and 2017. Some of these WWTTPs are completed and considered operational while others are still under construction or under tendering projects (Table 3, Figure 1).

To date, the wastewater sector in Lebanon, like most other services, still greatly suffers from major challenges. Historically, only old and incomplete wastewater networks in major cities of Lebanon were available until early nineties. This service was limited to wastewater networks with no existence of treatment facilities. Smaller cities, town and rural communities had till then no wastewater networks or any treatment plants. Such insufficiency of wastewater services is mainly attributed to insufficient investments in the sector, absence of appropriate operating and maintenance capacities and required infrastructure necessary to meet the growing need for this service. Despite the considerable progress made in recent years, the challenges of the sector continue to exacerbate due to the economic crises and lack of political stability in the country.

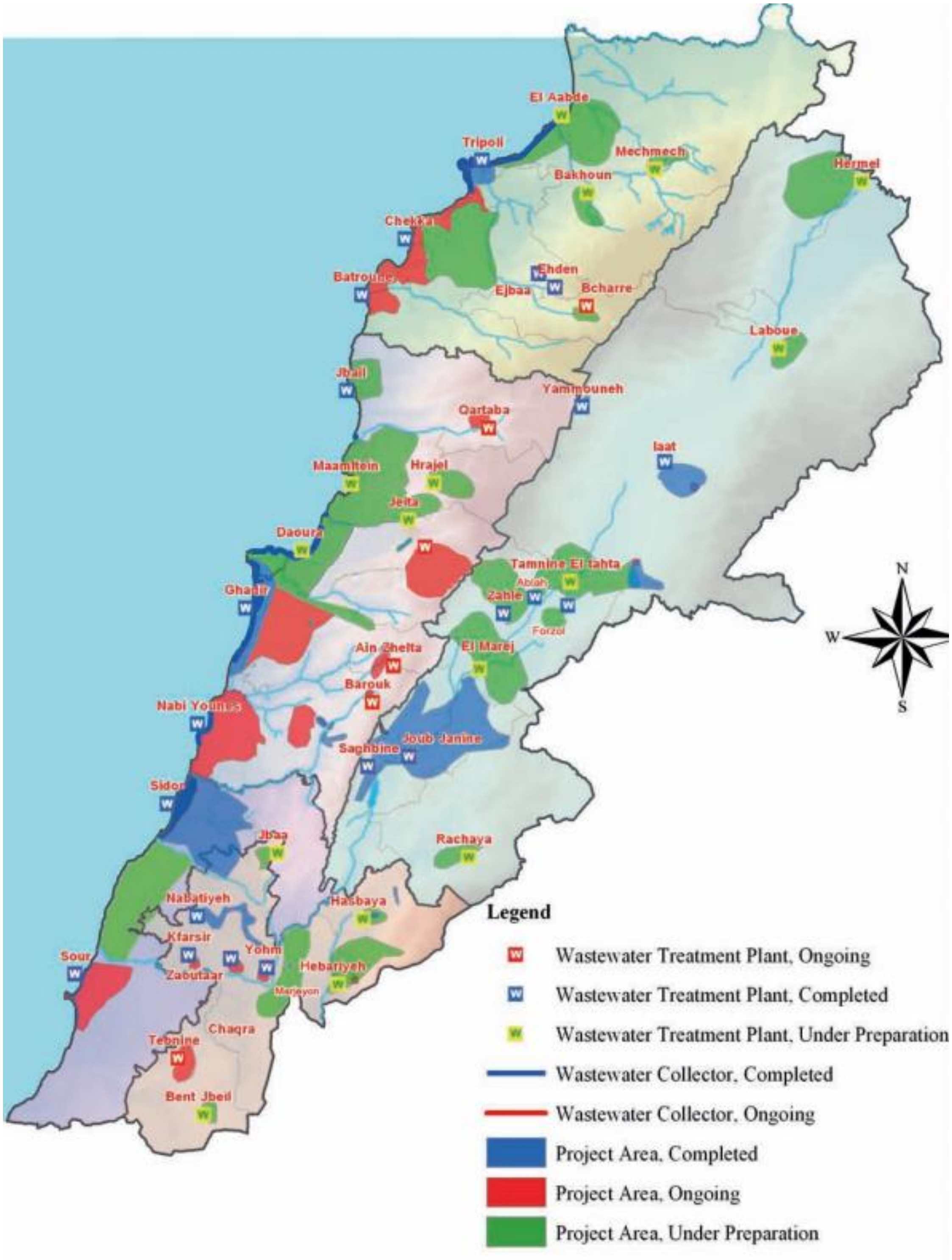

Figure 1. Map showing competed, ongoing and under preparation WWTPs (CDR, 2016)

In 2010, the Government of Lebanon developed its first water policy strategy, the National Water Sector Strategy (NWSS), to improve water supply and services for all sectors and sanitation services and to ensure water optimal services and continuity. In this strategy, the Government of Lebanon committed itself to 1) increase the collection and treatment of wastewater by up to 95 % by 2020; 2) include pre-treatment of all industrial wastewater by 2020; 3) reuse all the inland wastewater treated at the secondary level; and 4) fully recover all the treated and maintenance costs according to the polluter pays principle by 2020. This strategy was planned to be implemented in a ten-year period. But unfortunately, many projects were in 2020 still not completed or even pending funding. This resulted in a major lag in the services especially with the escalating population due to the Syrian conflict onset and the large number of Syrian refugees the country is hosting now. In an update of strategy, a new National Water Strategy (New NWSS) was released in 2020. This strategy realizes the need to peruse efforts to improve wastewater management by upscaling the operation and maintenance of major existing WWTPs, ensuring the establishment of new wastewater treatment plants, and expanding sewer networks in densely populated areas (NWSS, 2020).

To date, data on information on the status of the implementation of the WWTPs and wastewater treatment service is still generally weak. A study by FAO in 2016 (FAO, 2016) that covered data collection of 166 plants, the majority corresponding to 70 WWTPs, did not provide any information concerning the status of their implementation. Also, information on the volume of treated water, maintenance, and operation was lacking.

According to the very recent study by the International Water Management Institute (IWMI) “Analysis of Water Reuse Potential for Irrigation in Lebanon” (Eid-Sabbagh et al., 2022), Lebanon generates between 275 million cubic meters (Mm^3) and 328 Mm^3 per year of municipal wastewater and the total volume of wastewater receiving some form of treatment amounts to 81 Mm3 per year. This is about 25-30% of the annually generated wastewater with the majority of WW discharged untreated into rivers and coastal areas (Table 2). The area of the country that is not covered by wastewater networks mainly relies on septic tanks and cesspits that run a high risk to pollute groundwater by seepage.

Table 2- Total wastewater (Mm^3) generated, treated, and discharged. *Source:* Eid-Sabbagh et al./IWMI, (2022).

	Annual	**Seasonal**	**% of total**
Total municipal wastewater generated	273.7–328.5	164.2–198.2	100
Total treated water produced	81.2	48.9	25-30%
Total treated water discharged into the sea	60.2	36.3	18–22%
Total treated water discharged into inland water bodies	20.9	12.6	6.3–7.6%
Total put to direct reuse (2020)	0	0	0
Total indirect reuse	Indirect reuse, widespread as water from rivers is persistently used for irrigation, cannot be quantified because of a lack of water use and water production data.		

The reported low rate of wastewater treatment is attributed the poor connection between the existing sewage networks and the operational treatment plants (MoE, 2020). As such, less than 30% of wastewater generated by connected population reach any of the operational treatment plants. Government of Lebanon and United Nations, 2019). Moreover, electricity shortage, inadequate financial resources, limited expertise to operate these facilities present additional factors that contribute to the challenges of the sector. The aforementioned has led to the widespread discharge of untreated domestic and industrial wastewater across the country resulting in water quality degradation.

As indicated in Table 3, the type and level of treatment vary depending on the location with the majority of WWTPs involving aerobic processes which are characteristically associated with very limited methane emissions. Most of these plants feature secondary treatment by combining extended aeration and activated sludge treatment technologies. This can ideally be considered to sufficient to generate TWW suitable for reuse in irrigation being of highly socio-economic rewarded on development and community resilience.

Table 3- Table showing completed, under study, tendering, operational or not operational plants

Plants under Study or Tendering			
Treatment Plant	**Caza**	**Population**	**Status**
Aabde	Akkar	250.000	Under final tender stage
Bakhoun	Minieh Dinieh	48.000	Under preparation
Mechmech	Akkar	68.000	Under tendering
Keserwan	Keserwan	505.000	Under tendering
Hrajel	Keserwan	40.000	Under tendering
Bourj Hammoud	Baabda-Metn-Beirut	2.000.000	Under preparation
Ghadir (Phase II)	Aley-Baabda-Beirut	1.600.000	Under preparation
Bisri Watershed	Chouf-Jezzine	168.000	Under preparation
Manassef (Dmit and Serjbal)	Chouf	94.500	Under preparation
Aarkoub	Hasbaya	66.000	Under preparation
Hasbaya	Hasbaya	61.000	Under preparation
Bint Jbeil	Bint Jbeil	37.000	Under preparation
Laboue	Hermel	50.000	Under preparation
Marj – Qabb Elias	Zahleh	300.000	Under tendering
Hermel	Hermel	107.000	Under construction
Plants under Construction			
Bcharre & Al Arz	Bcharre	21000	Under construction
Kartaba	Jbeil	13000	Under construction
Khenchara	Chouf	30000	Under construction
Marjeyoun	Marjeyoun	50000	Under construction
Jezzine	Jezzine		Under construction
Timnine El Tahta	Baalbeck	210000	Under construction
Operational Plants showing the phase and status			
Tripoli	Tripoli	1.000.000	Pretreatment only
Chekka	Batroun	24.000	Operational since 2017
Batroun	Batroun	30.000	Operational since 2018
Ehden	Zgharta	40.000	Operational since 2016
Ghadir	Baabda Aley	1.500.000	Operational (only pre-treatment)
Ras Nabi Younes	Chouf	88.000	Completed
Souayjani & Kafargatra	Chouf	60.000	Operational
Salda	Salda	390.000	Only-pretreatment
Nabatieh	Nabatieh	100.000	Operational since 2013
Tibnine	Bin Jibeil	25.000	Operational
Yahmour	Nabatieh	4.500	Operational
Zawtar	Nabatieh	4.500	Operational

Tyr	Tyr	350.000	Completed
Baalbeck / laat	Baalbeck	100.000	Operational
Yammouneh	Baalbeck	6.000	Operational
Zahle	Zahle	150.000	Operational
Jib Jenine	West Beqaa	78.000	Operational
Saghbine	West Beqaa	4.000	Operational
Tripoli	Tripoli	1.000.000	Pretreatment only
Chekka	Batroun	24.000	Operational since 2017
Batroun	Batroun	30.000	Operational since 2018
Ehden	Zgharta	40.000	Operational since 2016
Completed Not Operational Plants due to Network Deficiency & Influent Low Flow			
Jbell	Jbell	50.000	Completed not operational
Barouk	Chouf	8.000	Completed not operational
Nabba	Aley	20.000	Completed not operational
Kfarsir	Nabatieh	15.000	Completed not operational

Quality guidelines of treated wastewater

- ✓ The potential reuse of treated wastewater in agriculture in Lebanon has been the focus of interest of both national and international organizations in Lebanon. This has motivated several projects to be undertaken to set standards for of the quality of TWW for agricultural reuse. The standards aim to limit the amount of bacterial pathogens, viruses, parasites, heavy metals and other contaminants in wastewater/TWW and sludge used in irrigation. Among the important projects are UN FAO on Wastewater Reuse and Sludge Valorisation and Reuse (Project UTF/LEB/019/LEB, 2010), ENEA Report on Safe Reuse of Treated Wastewater in Agriculture in Lebanon (2014) and most recently the ReWater MENA project of the International Water Management Institute (Eid Sabbagh et al./IWMI, 2022)

. In the latter, IWMI in partnership with the Lebanese Standards Institution (LIBNOR), the Lebanese Agricultural Research Institute (LARI), and several other public administrations, has helped in developing The National Analysis of Water Reuse Potential in Irrigation published in September 2022. This initiative has set the way for the establishment of national water reuse standards (Eid- Sabbagh et al., 2022). The analysis conducted was based on "Proposition for Lebanese Wastewater Reuse Guidelines" produced by FAO in 2010 (Table 4) (FAO, 2010). In these proposed standards, crop categories are defined as follows:

Category I

- Fruit trees and crops eaten cooked (the FAO guidelines have no provision for crops irrigated with treated wastewater that are eaten raw). Water treatment recommendation: Secondary treatment + filtration + disinfection.

Category II

- Fruit trees. Water treatment recommendation: Secondary treatment + filtration + disinfection, or secondary treatment + either storage or well-designed series of maturation ponds or filtration percolation.

Category III

- Cereals and oleaginous seeds, fiber, and seed crops
- Crops for the canning industry, industrial crops
- Fruit trees (except sprinkler-irrigated plantations)
- Plant nurseries, ornamental nurseries, etc.

  Water treatment recommendation: Secondary treatment with a few days' storage or oxidation.

Table 4. FAO guidelines for wastewater reuse. *Source:* FAO (2010).

Class	**Category I**	**Category II**	**Category III**
Restrictions	produce eaten cooked; irrigation of greens with public access	fruit trees, irrigation of greens and with limited public access; impoundments with no public water contact	cereals, oil plants, fiber and seed crops, canned crops, industrial crops, fruit trees (no sprinkler irrigation); nurseries, greens, and wooden areas without public access
Proposed treatment	secondary + filtration + disinfection	secondary + storage or maturation ponds or infiltration percolation	secondary + storage /oxidation ponds
BOD5 (mg/L)	25	100	100
COD (mg/L)	125	250	250
TSS (mg/L)	60 (200 WSP)	200	200
pH	6-9	6-9	6-9
Residual Cl2 (mg/L)	0.5-2	0.5	0.5
NO3-N (mg/L)	30	30	30
FC (/100ml)	<200	<1000	none required
Helminth eggs (/1 L)	<1	<1	<1

Note: Irrigation of vegetables eaten raw is not allowed

Notes: BOD – Biochemical oxygen demand; COD – Chemical oxygen demand; TSS – Total suspended solids; NO3 – Nitrate; Cl2 – Chlorine.

The analysis study reported that, with the existing volumes of wastewater treated, 48 WWTPs would have a reasonably high reuse potential, this number would go up to 130 plants if existing wastewater treatment plants were fully functional and operated at full capacity. Structural shortcomings in the wastewater sector compound with governance challenges and the lack of a regulatory framework for reuse management were reported to hinder this potential. The study proposed building capacities of local actors and engagement of irrigation committees in the development and management of future reuse systems.

Wastewater Treatment in Bekaa

The results of primary data collection conducted in this study through field visits and interviews with heads of Units in BWE as well as managers, operators, and consultants of WWTPs indicate the presence of 13 WWTPs in Bekaa. These are:

- Operational WWTPs: Yammouneh, Iaat, Ablah, Fourzol, Zahlé, Joub Jannine, Saghbine, and Aitanit (Machghara)
- WWTPs under construction: Temnine El Tahta and Marj, Hermel

- WWTPs under tendering: East Zahle
- WWTPS under preparation: El Laboue

Despite the major constraints and limited capacity, BWE represents the first water establishment that took the lead in 2017 to fully and directly be in charge to operate a WWTP (Joub Jannine) in the country. While most plants are operated by contractors under the supervision of BWE, the plants of Ablah, Fourzol, and Aitanit (Machghara) are managed by municipalities. Although the existing plants are only eight in Bekaa, all plants characteristically have a pretreatment process, secondary and tertiary treatments in some cases. While the pretreatment process consists of screening and grit and grease removal, the secondary treatment process entails aeration tank clarification/trickling filters, aerobic/anaerobic tanks clarification. Whereas the tertiary treatment is based on chlorination, filtration, and UV disinfection (Table 5). The primary treatments in the plants of Ablah, Fourzol, Aitanit (Machghara), Marj, and East Zahle include setting processes. These results are in full alignment with the results reported by the National Analysis of Water Reuse Potential in Irrigation (Eid- Sabbagh et al/IWMI., 2022)

Table 5. Treatment processes for incoming effluents by WWTPs of Bekaa and service capacity, inflow, coverage area, regulations followed, …

Plants	Pre-treatments	Primary treatment	Secondary treatment	Tertiary treatment	Year of Operation
Yammouneh	Coarse screening Fine screening Grit and grease removal		Aeration tank Clarification	Chlorination	
Iaat (Baalbeck)*	Screening Grit and grease removal		Aeration tank Clarification	Chlorination	2006
Ablah*	Coarse screening Fine screening	Primary settling	Trickling filters Clarification	Chlorination	June 2012
Fourzol	Coarse screening Fine screening	Primary settling	Trickling filters Clarification	Chlorination	
Zahle*	Coarse screening Fine screening Grit and grease removal		Aerobic/anaerobic tanks Clarification	Filtration UV disinfection	October 2017
Joub Jannine*	Coarse screening Fine screening Grit and grease removal		Aerobic/anaerobic tanks Clarification	Chlorination (filtration and UV disinfection inactive)	2006-2007
Saghbine	Coarse screening Fine screening Grit and grease removal		Aerobic/anaerobic tanks Clarification	Chlorination (filtration and UV disinfection inactive)	
Aitanit (Machghara)	Coarse screening Fine screening	Primary settling	Trickling filters Clarification	Chlorination	
Marj	Coarse screening Fine screening Grit and grease removal	Settling	Anaerobic tank Anoxic tank Aerobic tank Settling	Chlorination	
Temnine el Tahta	Coarse screening Fine screening Grit and grease removal		Pre-anoxia tank Anaerobic tank Anoxic tank Aerobic tank	Filtration UV disinfection Chlorination in case of emergency	
Hermel	Coarse screening Fine screening Grit and grease removal		Aeration tank Clarification	Chlorination	
El Laboue	Coarse screening Fine screening Grit and grease removal		Aeration tank Clarification	Chlorination Optional: disk filters and UV disinfection	

Service Capacity	Inflow	Coverage Area	**Proportion of the population	Population connected to sewer networks	Regulations followed
				40000	
12000 m^3/day (1,300-1,500 m^3 of water/ day	3000 m3/day				Monitoring Quality of influent & effluent
		1,500-2,000 m3/day	Ablah, Niha, El Nabi Ayla & parts of Fe[illegible]		
			7 million m^3/year	107000	
37300 m^3/day					Monitoring quality of effluent
10000 m3/day	10000 m3/day (dependi ng on the	25 estates connected to 9 lift pumps	3.65 million m^3/year	90000	Monitoring Quality of influent & effluent

Amount of Treated Wastewater Reuse	Reuse Type	Operation & Maintenan
Total: $20618733 m^3$	TWW is discharged	- absence of electricity
Total: $30618733 m^3$		Not connected to Zahle' s electricity
$10000 m^3/day$	TWW is discharged to Litani	Problems concerning the type of inflow -Syrian refugees

* Primary data collected during filed visits and interviews of 4 out of 6 identified WWTPs to have high reuse potential.

** The proportion of the population that is directly or indirectly connected to a sewage network that is billed for the provision of this service based on a volumetric or flat tariff schedule

As for the characteristics of effluents, the here in study relied on the data provided by CDR study on “Sustainable sludge management in the Bekaa Region” (CDR, 2021) as indicated in the Table 6.

Table 6. Characteristics of the effluents by the year 2025. *Source*: CDR (2021).

Plant	**Effluent type**	**PEx10^3**	**Avg flow rate plant inlet (m3 /d)**	**BOD5 avg load (kgBOD5/d)**	**TSS avg load (kgTSS/d)**	**TKN avg load (kg/d)**	**TP avg load (kg/d)**
Yammouneh	Household	6	788	350	438	72	12

Iaat (Baalbek)	Household + various industries	100	13 175	7 350	7 000	480	156
Ablah	Household + agri-food industries	14,63	2 000	878	1 024	176	29
Fourzol	Household + agri-food industries	7,400	1 000	444	518	89	15
Zahlé	Household + various industries	205	37 300	16 039	15 853	2 611	634
Joub Jannine	Household + agri-food industries	77	10 000	3 900	5 200	700	170
Saghbine	Household + agri-food industries	4	560	225	299	40	10
Aitanit (Machghara)	Household	35, 70	5 000	2 142	2 499	428	71
Hermel	Household	84	11 760	4 872	6 126	846	168
Temnine el Tahta	Household + agri-food industries	102	14 790	6 049	6 700	1 035	252
Marj	Household + various industries	260	31 200	12 480	13 728	1 872	468

Figure 1 Interview at LRTP on 27/7/2022,

Figure 2: Interview at BWE on 14/10/2022,

Figure 3: Interview at Zahle on 25/8/2022 WWTP

Figure 4 Interview at Ablah WWTP on 13/1/2023

Quality and suitability of TWW for Irrigation

As aforementioned, there is no regulation on TWW reuse in Lebanon making management and sustainability of projects such as Ablah a big challenge. The WWTP under study all have laboratory analysis capacities to perform water quality analysis. According to all interviewees and the quality information provided, high removal efficiency reaching 90% is reported and the quality of TWW falls in the range of suitability for irrigation.

In a study on irrigating table grapes with treated effluent (Abi Saab et al., 2020) as well as eggplants (Mcheik et al., 2017), and Spinach (Abi Saab et al., 2021). Findings generally show that the adoption of drip irrigation with water of less than 3 log E. coli CFU/100 mL is suitable for irrigation, even for vegetables consumed raw, except for root crops such as onions or radishes. Treated water does not have any harmful effects on vegetable quality.

The case study of Ablah WWTP, a promising initiative of actual reuse in irrigation

This plant is considered one of the very well-operating treatment facilities in Bekaa **representing a successful case for a reuse system in agriculture.** This plant is managed by Ablah municipality that covers the cost of operation and maintenance activities sourced from the yearly subscription of residents. The plant serves Ablah and Nabi Ayla, parts of the Ferzol villages. It is surrounded by agricultural fields of grape vines irrigated mainly from groundwater reported to face drops in levels. These conditions have motivated the establishment of a project by a joint project by Ablah municipality and USAID in 2012 to use treated wastewater in irrigation. With the support of the Institute for University Cooperation of Italy, the plant was provided with an irrigation distribution network covering an area of 200 du (20 ha) planted with grape vines. It is also provided with solar panels to provide a supporting source of energy other than the Electricity of Zahle company. Nevertheless, the solar panels are not connected to the grid eliminating storage capacity. Through this project and with the support of several international organizations, 33 small hold farmers have been able to irrigate their vines by trickle irrigation from the network during the irrigation season. Famers are offered free use of TWW, and compost on-site prepared from the twigs of vines. The TWW used experience proved successful as farmers were able to supplement or replace groundwater with the TWW to meet their needs for irrigation water. According to the operating Engineer Mohammad Bou Dayia, farmers even reported increases in their crop yields. such as the river reed known to be invasive in Litani River due to its high tolerance capacity to pollution. These results are supported by a research experiment conducted by LARI in collaboration with farmers who used the network (Abi Saab et al., 2021). However, the preparation of compost has been hurdled by the economic crises and lack of financial support of the municipality. Framers now use the vine twigs as a source of energy. This has led to the search for an alternative plant material.

Challenges of Wastewater Treatment in Bekaa

As is the case with all WWTPs in Lebanon, WWTPs in Bekaa continue to face major constraints exacerbated by the current economic and financial crisis and lack of political will be due to the profound conflicts among different political parties. The major challenges identified by interviewees include high energy costs being one of the largest expenses in wastewater treatment and insufficient resources. In addition to this, interviewees emphasized a recurrent problem: The industrial WW discharge, which is harmful to the treatment process; certain types of industrial wastewater can affect plant operation over a longer period, especially when operational capacity is weak. A toxic shock can render the wastewater useless for irrigation for days or even weeks, reducing the reliability of reuse schemes and imposing additional costs and risks upon farmers. (Eid Sabbagh et al./IWMI, 2022

Conclusion

The importance of wastewater treatment and the potential of wastewater reuse have been highly realized among the goals of the National Water Sector Strategy developed by the

Lebanese Government in 2012. Nevertheless, limited achievements in developing water reuse have been practiced in the country.
This preliminary study highlights the status of wastewater treatment in Bekaa and reuses its potential to be a useful contributor to conserving fresh water to meet other demands and meet increased food security needs in the region. Analysis in this study was based on desk reviews and field data collection (Year of Operation, Service Capacity, Inflow, Coverage Area, Treatment type, Proportion of the population connected to a sewage network that is billed for the provision of this service based on a volumetric or flat tariff schedule, Population connected to sewer networks, Regulations followed, Amount of Treated Wastewater Reuse, Reuse Type, Operation & Maintenance Challenge) and quality of TWW. The case of Ablah WWTP further shows the high potential of small plants operated by local municipalities. The valorization of the potential of reuse at both the national scale and local scale would indeed require major improvement in the sector. The establishment of a governance framework for the planning, management, and monitoring of reuse systems, as well as formulating qualitative standards are recommended.

Annex 1- Questionnaire used for interviews

Potentiality of treated wastewater in Bekaa region, Lebanon, for crop Irrigation

Name:

Interviewee Name:

Date:

Field Survey Questionnaire

Assessment on Sanitation Services and Wastewater Treatment in Bekaa Region

WWTP/on-site treatment facility		
Location		
Treatment type: (Indicate appropriate answer with X)	Primary	
	Secondary	
	Tertiary	
Year of operation		
Service Capacity		m3 /day

Inflow		m3 /day
Coverage area		m^2
Population connected to sewer networks		
Annual collected wastewater volume by piped sewer networks receiving treatment prior to discharge		million cubic meter/year
The proportion of the population that is directly or indirectly connected to a sewage network that is billed for the provision of this service based on a volumetric or flat tariff schedule		
Quality parameters tested:	TSS	mg/L
	BOD	mg/L
	COD	mg/L
	T-N	mg/L
	T-P	mg/L
	Coliform	MPN/100m
Removal Efficiency (Quality of Influent as compared to Effluent)		
Regulations followed		
Amount of Treated Wastewater Reuse		
Reuse Type		
Operation & Maintenance Challenges		

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