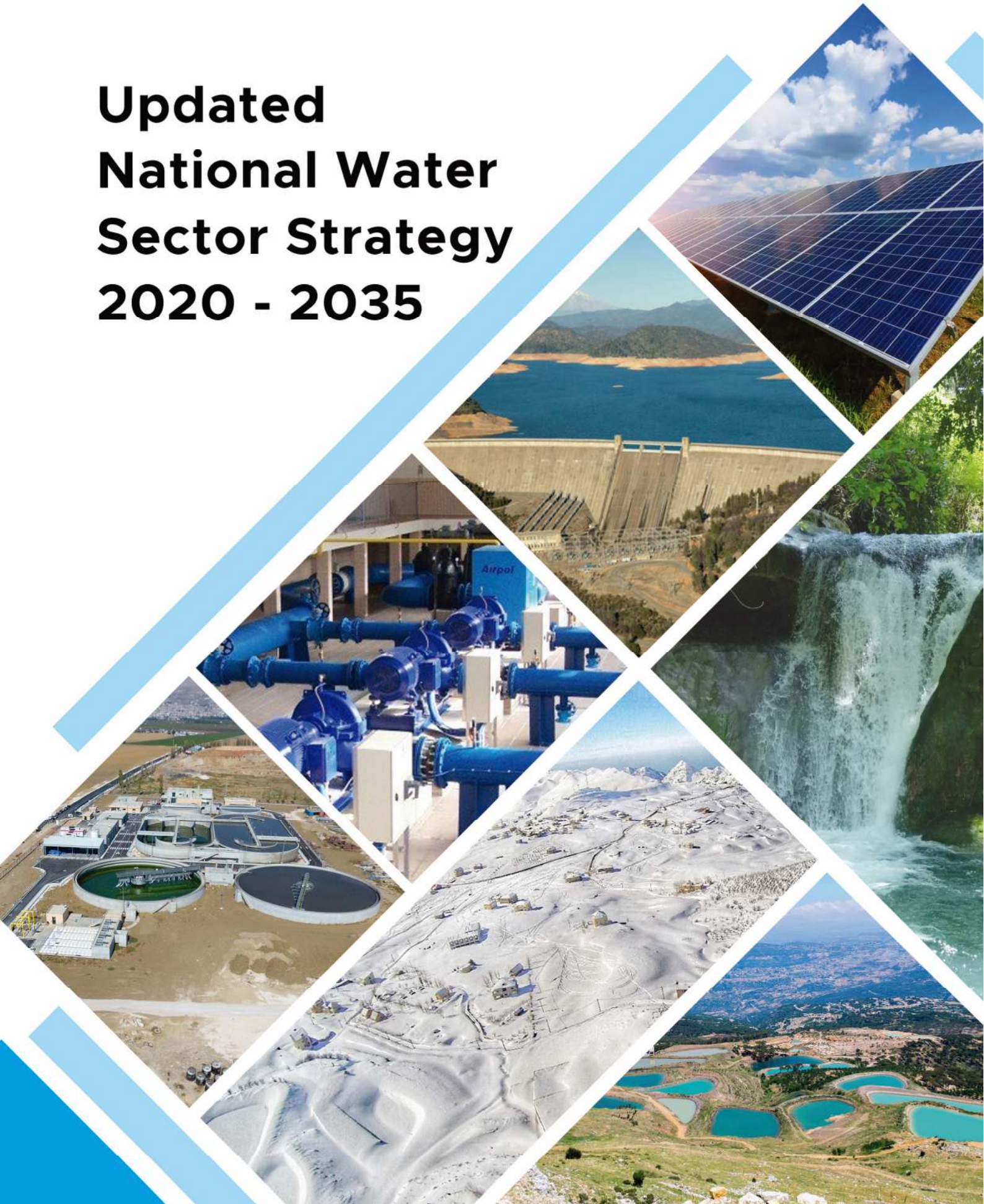




REPUBLIC OF LEBANON  
MINISTRY OF ENERGY AND WATER



# Updated National Water Sector Strategy 2020 - 2035



## CONSULTANT





### FOREWORD

It gives me great pleasure to present the Updated National Water Sector Strategy of 2020 after more than 10 years since a comprehensive strategy was set.

The rapid global and local environmental degradations, climate change, increased desertification, population growth, and shifts in economic sectors amplify the pressure on the importance of reliable water supply. As such, a solid national water sector strategy becomes more and more critical.

Updating the National Water Sector Strategy of 2020 was made possible by a generous grant from UNICEF. A consortium of five renowned local companies in the Lebanese water sector, and three international experts, worked relentlessly over a period of one year (from June 2019 to June 2020) to gather, analyze, and map the data putting together this long-awaited strategy. Following the multiple crises faced at the end of 2019, the Updated NWSS was revised in 2022 to make sure it takes into account the actual situation of the country and that of the public institutions, as well as the comments raised in the Strategic Environmental Assessment by more than 70 sector stakeholders interviewed during the process.

As you will read in this summary report, the updated strategy focuses primarily on reform initiatives under Pillar 1, considered as the basis for relaunching the sector towards sustainable management and an improved service provision. A clear and well-defined action plan is proposed, and work has started since 2020 between the Ministry of Energy and Water, the Water Establishments and the donors' community to achieve the action plan's targets. Pillar 2 is not any less important, where light is shed on the importance and urgency of setting a national information system for the water sector; and last but not least, Pillar 3 comes to fill the infrastructure gaps that would allow access to services for all.

Finally, I would like to thank everyone who has worked on this study, knowing that it has been a tedious and complicated task, but a satisfying one. This updated strategy should be a live document and the Ministry will work on reviewing it periodically, making it the basis of all interventions in the water sector.

With this comprehensive strategy in hand, I am optimistic that both, decision-makers and citizens, will refer to it frequently and implement it properly to reach the ultimate objective of the Ministry which is "safe and equitable access to services for all Lebanese".

Minister of Energy and Water

Dr. Walid Fayad





The present volume is the core of the *Updated National Water Sector Strategy – 2020*, to which are annexed the following supporting detailed technical documents:

*Annex I : WATER SECTOR GOVERNANCE*

- Section A Strategy pillar – SDG 6
- Section B Current legal and Institutional frameworks
- Section C Human Resources of the WEs
- Section D Water tariff analysis
- Section E Strategic action - recommendations

*Annex II : WATER RESOURCES MANAGEMENT*

- Section A Available water resources - Impact of climate change
- Section B Surface water resources management
- Section C Groundwater resources management
- Section D Guidelines for monitoring water quality
- Section E Wastewater and sludge management
- Section F Strategic Environmental and Social Assessment

*Annex III : WATER SECTOR CURRENT SITUATION*

- Section A Water and wastewater facilities
- Section B Demand criteria, assumptions and water balance
- Section C Appendices

*Annex IV : PROPOSED PROJECTS*

- A Criteria for projects and priorities selection
- B Proposed Projects (Bound separately)

*Annex V : DRAWINGS*



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## LIST OF ACRONYMS

Bm <sup>3</sup>	Billion cubic meter
BMLWE	Beirut and Mount Lebanon Water Establishment
BWE	Bekaa Water Establishment
CDR	Council for Development and Reconstruction
CM	Customer Management
EIB	European Investment Bank
EU	European Union
HR	Human resources
IFRS	International Financial Reporting Standards
IWMI	International Water Management Institute
l/c/d	Liters per capita per day
l/sec	Liters per second
LBP	Lebanese Pound
LRA	Litani River Authority
m <sup>3</sup> /d	Cubic meter per day
m <sup>3</sup> /h	Cubic meter per hour
masl	Meters above sea level
MCM	Million cubic meter
MENA	Middle East and North Africa region
Mm <sup>3</sup>	Million cubic meter
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
NGO	Non-Governmental Organization
NLWE	North Lebanon Water Establishment
NRW	Non-Revenue Water (unaccounted for water)
NWSS	National Water Sector Strategy
ONL	Office National du Litani
SLWE	South Lebanon Water Establishment
UFW	Unaccounted for Water
UN	United Nations
WE	Water Establishment
WEs	Water Establishments

















- Operations subject to authorizations;
  - Tariffs and fees regime;
  - Public services delegation types and arrangements;
  - Public utility services in flood-risk areas;
  - Prevention of water deficits;
  - Reuse of treated wastewater.
2. The legal advisor of the AFD Technical Assistance team will review the organizational decrees of the Water Establishments and propose the necessary changes that reflect the experience and lessons learned so far by the sector.

**2.1.2 Component 2: The Institutional Framework – Status of Human Resources**

**2.1.2.1 Challenges**

- a. MoEW is understaffed and lacks qualified management and technical staff able to supervise properly the activities of WE’s and ensure the overall sector management.
- b. Understaffing is also a recurrent issue at all WE’s that is often highlighted as the key factor behind the WE’s lack of operational capacity and their low levels of service.
- c. There are large gaps between the number of staff specified in the WE’s and MoEW’s organizational decrees and the number of positions occupied.
- d. An average of 26% of the positions defined in the decrees are filled by permanent staff within the four WE’s (20% for NLWE, 37% for BMLWE, 23% for BWE, and 12% for SLWE). By adding the temporary staff that are recruited to fill some critical positions, the sum of permanent and temporary staff combined covers only 50% of the planned positions (49% in NLWE, 51% in SLWE, and 52% in BWE).

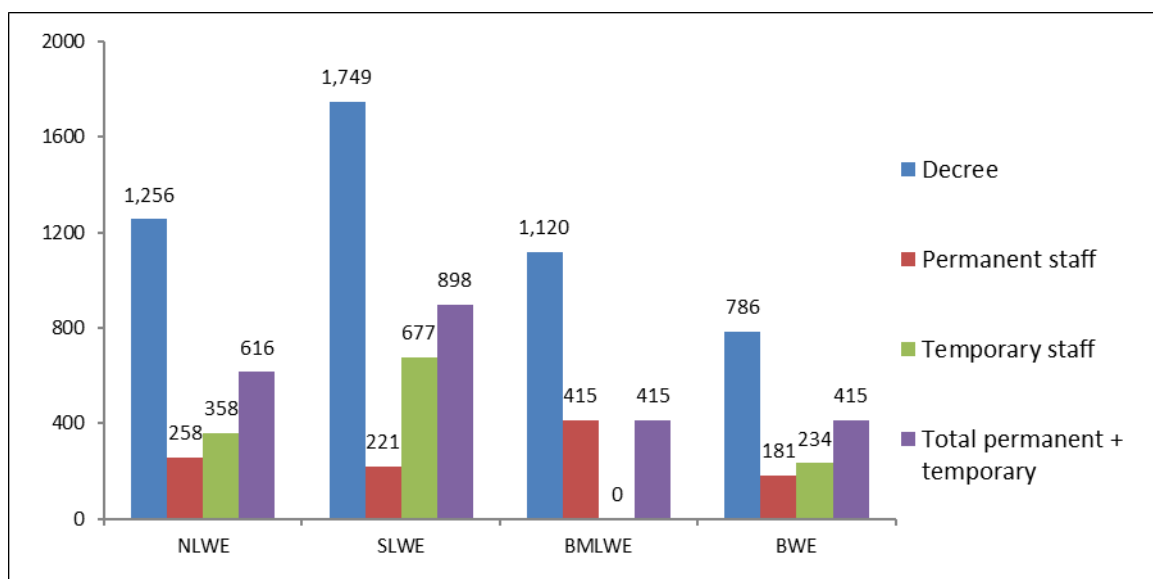


Figure 1 Staffing status of the 4 WE’s (2020)



enable a general analysis of MoEW and the WE's' situation and help define strategic orientations for their development and for service management improvements.

- d. The objective is not to achieve the staff volumes set out in the organizational decrees but to review these decrees, which are outdated and are no longer aligned with the water institutions' mission or to the opportunities for developing service management in the coming years.
- e. Currently, the WE's are delegating the management of specific services to the private sector (through Ghob Talab projects) and redirecting their focus on contract management, but this also requires staff that specialize in managing performance-based contracts and that have the technical skills to supervise and monitor private operators.
- f. The recruitment of engineers and staff with business management degrees is crucial in order to develop a customer service oriented strategy and to improve service management.
- g. It would be more efficient to include less details in the organizational decrees brought forward for adoption by the Council of Ministers, and instead set out the main orientations to give the water establishments the ability to develop their organization charts in line with their evolving needs. For example, the Litani River Authority's organization chart has never been formalized by a Council of Ministers decree. However, this allows the LRA to adapt its structure to new projects or new tasks without causing any major obstacles. This approach provides greater flexibility and should be used to inform the review of the WE organizational decrees.
- h. It is recommended to create a cell within the Ministry of Energy and Water to follow up on the implementation of all the strategy recommendations and action plans in the field of water governance, water and wastewater tariffication, and the administrative reforms. This cell would be composed of one legal and institutional expert, one water and wastewater strategy expert, a dams' expert, an irrigation expert, one financial analyst, and one public administration expert.

*Table 1 Percentage of WEs permanent staff by categories (2020)*

Category	NLWE	BMLWE	BWE	SLWE
I & II	11 %	5 %	2 %	4 %
III & IV	84 %	94 %	96 %	85 %

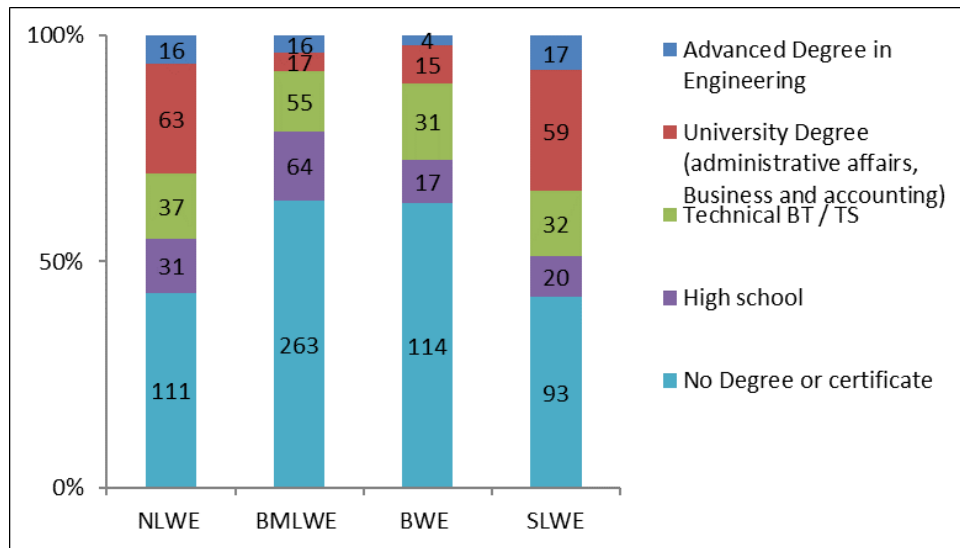


Figure 2 Overview of WE staff qualifications (2020)

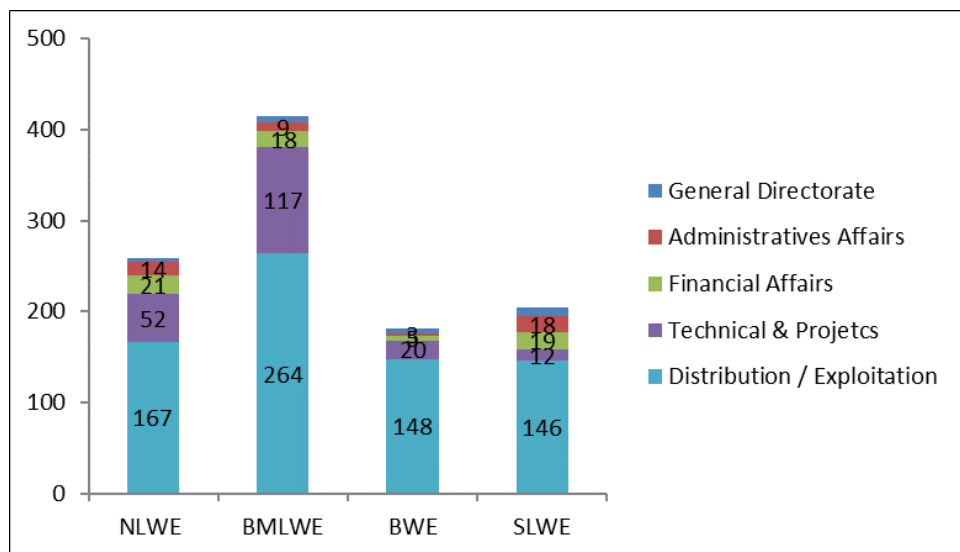


Figure 3 Staff allocation by main departments (2020)

### 2.1.3 Component 3: Supervision, Monitoring & Reporting

#### 2.1.3.1 Challenges

- a. The current tutelage framework is highly administrative, involves close supervision by the Ministry of Energy and Water over the water establishments and does not focus on monitoring their performance, leading the tutelage to suffer from a loss of purpose and effectiveness. As such, MoEW spends a lot of time validating procedures that are part of the WE day-to-day management, restricting, to some extent, the WE's ability to develop their institutions.
- b. MoEW and the WE's have very limited human technical capacities for producing technical reviews and proper reporting or for monitoring activities across the entire sector and across the country,



as there is no specific body dedicated to conduct this activity. As a consequence, the current sector data is incomplete and full of discrepancies and does not enable systematic monitoring.

- c. The sector’s transparency is hampered by the lack of reliable data communicated to users; this results in lack of trust from users in the water institutions (especially the WE’s which are the service providers), and partly explains the low recovery rate of water bills.
- d. The sector also suffers from lack of communication and coordination between its institutions leading to a dilution of responsibilities in the different segments of the services management. For instance, large infrastructure projects are financed by donors through the Council for Development and Reconstruction, which contracts the private sector to carry out the work. WE’s, who are the ultimate service providers, have little involvement in the project preparations and management. As a consequence, there is little consideration paid to the technical and financial capacities of the service operator (WE) when designing the facilities.

In reality, the infrastructure project implementation framework is more as set out in the diagram below:

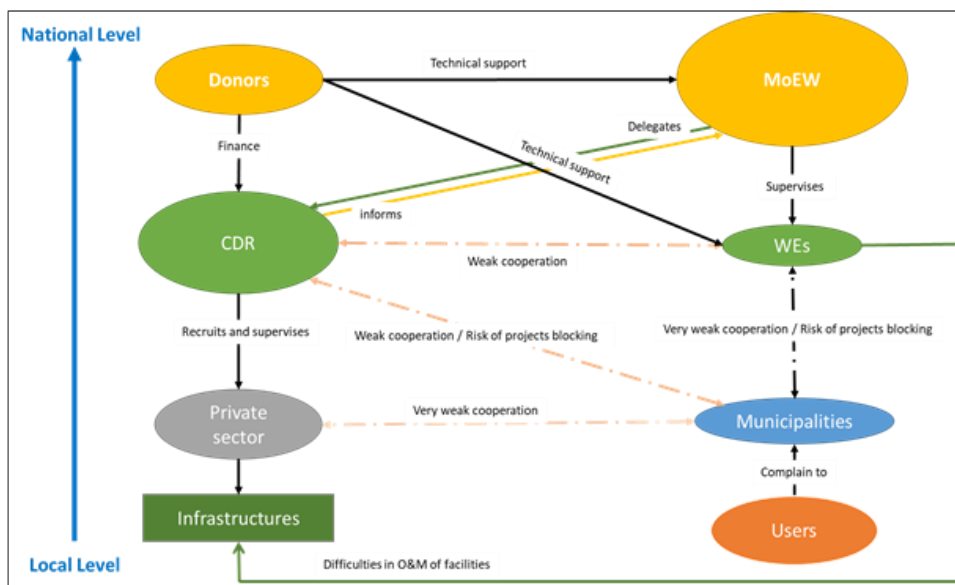


Figure 4 WE involvement according to current practice

The donors provide technical assistance to the WE’s and the Ministry of Energy and Water; the latter delegates the monitoring of works to the CDR that has a very large sphere of influence. WE’s have very little influence and there is poor cooperation between the WE’s and the CDR.

Municipalities also appear to have an influence over project implementation, mostly because they are the main point of contact for users and are able to block projects should they wish. There is poor cooperation between the WE’s and municipalities, and between the municipalities and the CDR. There is also poor communication between the WE’s and the users (as described previously).



developed after four years, in order to be able to set contractual KPI and establish performance-based contracts between the MoEW and the WE's.

The below graph shows the relationship that should be developed between stakeholders in order to achieve the reforms proposed in this strategy and in the Water Code.

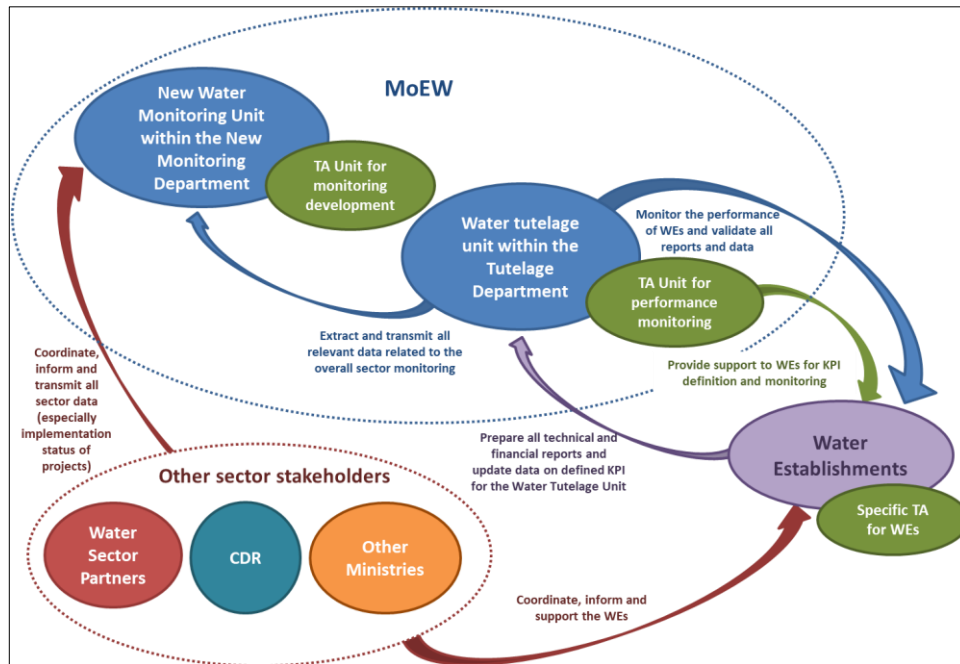


Figure 5 Proposed overall structure of the sector-monitoring framework

- To enhance transparency and proper communication, it is important to establish a unified database to include all sector monitoring data and ensure it is regularly updated (including the WE KPI): This database shall include all specific sector data on water resources, water quality, water uses, management of water, wastewater and irrigation services (as part of the WE KPI to collect and harmonize within this unified database managed by the Ministry), status of infrastructure projects and on financing tools of the sector.
- Setting up an annual sector review involving the main local and international stakeholders and partners is a key element of transparency.
- Regular reporting (annual report, financial report, commercial report) will ensure a transparent flow of information between WEs and MoEW.
- Communication with users is a key element for service sustainability through assessing existing tools and communication strategies at MoEW and WEs, while coordinating with other programs aiming to support the WEs and MoEW in their communication with users.
- A strong and clear coordination platform will be developed to improve the coordination between the CDR, MoEW and the WE's for all projects related to the water sector involving any of these institutions. This would avoid duplication of works and reduce the cost of investments and O&M of the projects at hand.

- The structuring and enhancement of the private sector involvement is a priority of this strategy and will start by reviewing existing contracts with private operators and gradually developing a new contracting framework and performance-based contracts.

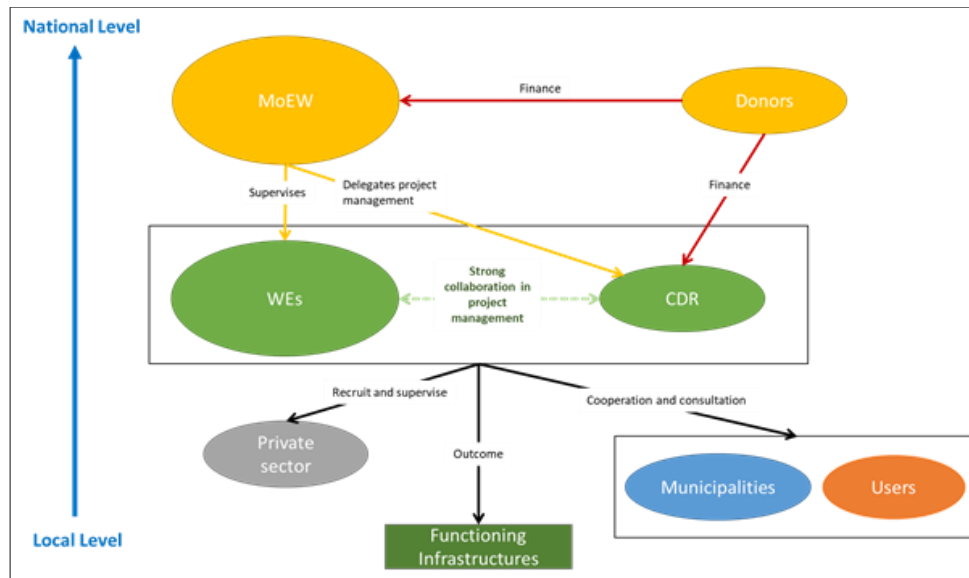


Figure 6 WE involvement according to Law 221 and the NWSS

According to Law 221 and the National Water Sector Strategy, WE's should play a central role in project planning and management, alongside MoEW & CDR.

Under this arrangement, the donors finance the CDR and the Ministry, with the Ministry then providing guidance to both the WE's and the CDR.

The WE's and CDR should be responsible for ensuring the infrastructure functions correctly by monitoring the private sector and by working with municipalities and communicating with users.

## 2.1.4 Component 4: The financial and commercial frameworks

### 2.1.4.1 Challenges

- In the financial field, the key issues refer to the absence of International Financial Reporting Standards for all WE's together with an annual audit of the financial statements and ledgers by an international independent audit firm. Such a gap obstructs the transparency of financial statements and the ability of MoEW to properly monitor the utilities and fairly compare the WE's performances.
- The current service pricing system is not adapted to the needs of the water establishments to ensure a financial balance and achieve basic performance in the service delivery across all sectors mandated by WE's (water, wastewater and irrigation).
- The gauge system is inaccurate and produces side effects both on the technical side (no measurement of Non-Revenue Water and over consumption) and on the financial side (efforts made for keeping control of NRW is not financially rewarded). The gauge system and the associated flat

rate billing system do not allow to spot the over consumption of water. Such systems lead to wasting of water and draining of the financial resources of the WE's.

Table 2 Overview of the WE's (2020)

	NLWE	BWE	BMLWE	SLWE
Est. population of the service area	1,716,000	750,000	2,907,000	1,200,000
Nbr of villages	457	250	533	385
Nbr of subscribers/subscribed households (2018)	124,793	86,761	592,835	176,000
Est. Population supplied (est. 4.5 persons per HH)	561,569	390,425	2,667,758	792,000
Est. population tapping the water from unknown origin	1,154,432 (67 %)	359,576 (48 %)	239,243 (8 %)	408,000 (34 %)
Nbr of actual employees	637	403	782	236
Nbr of autonomous sub-systems	8	11	6	7
Est. length of the networks (km)	1,839	4,384	9,000	5,000
Est. Unaccounted for water (%) <sup>(1)</sup>	46 %	48 %	35 %	55 %
Nbr of water meters	56,266	38,400	185,960	N/A
Volume produced (Million m <sup>3</sup> /Y)	106	68	171	113
Est. collection rate	63 %	32 %	79 %	51 %
Nbr of WWTP under the WE's jurisdiction <sup>(2)</sup>	27	14	19	26

- Note s:
- (1) Unaccounted for water % as per verbal communication from the WE's.
  - (2) This is the total number of existing WWTP or under construction, under the jurisdiction of the WE, and operated either directly by the WE, by CDR, or other.

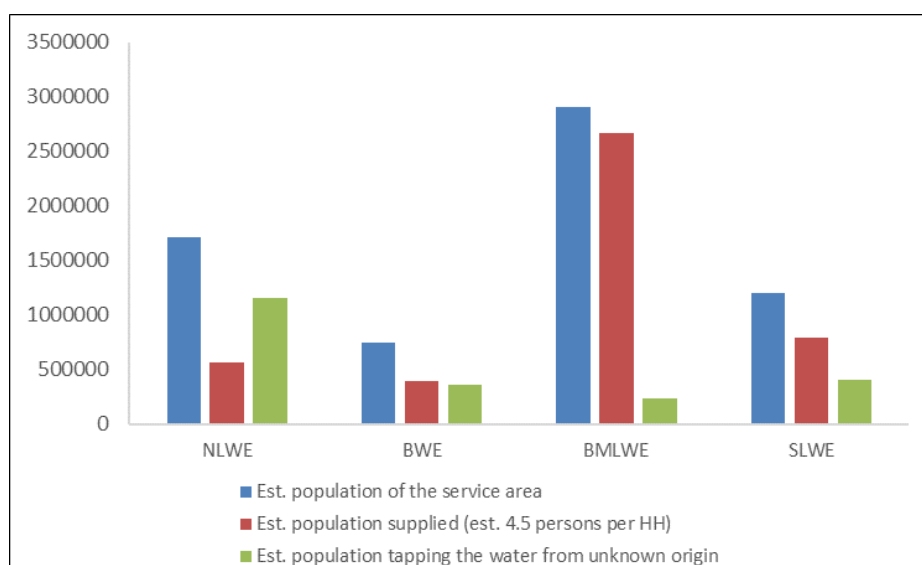


Figure 7 Population supplied vs overall population (2020)





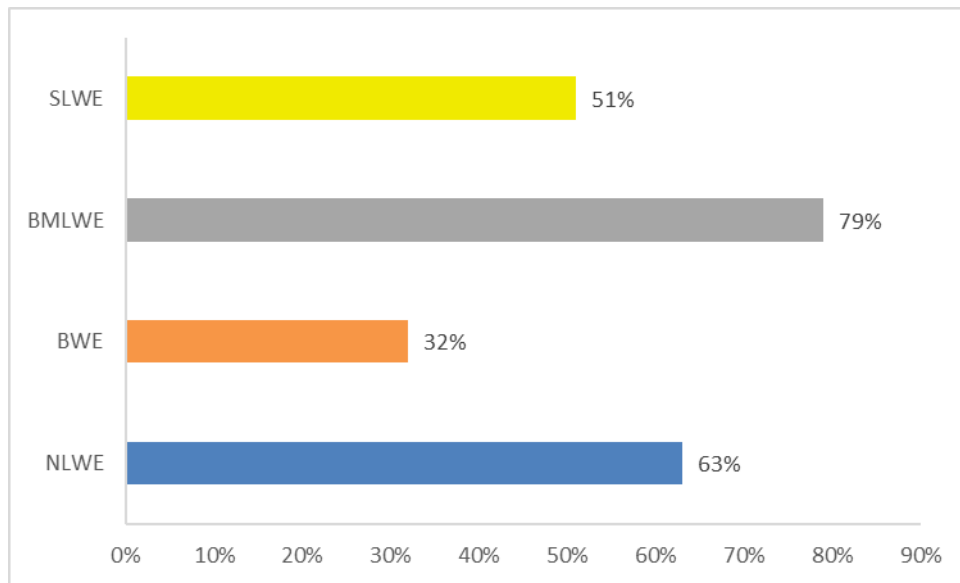


Figure 8 Estimated collection rate (2018)

- Users’ databases for the wastewater management services have not been developed yet. Users of the services need to be identified and registered in specific databases as in some regions not all users of wastewater services (households connected to sewage networks and ultimately to treatment plants) are subscribers to the water service of water establishments. According to the Water Code, a wastewater fee must be paid by non-connected houses to the sewage network as a sort of “pollution tax” for damaging the environment. Today, the WE’s are charging the fees shown in the above table but this fee is not sufficient to cover the O&M of wastewater systems.

Table 5 Yearly sewage fee (LBP) (2020)

	Connected to the Waste Water System	
	yes	no
NLWE	20,000	10,000
BWE	60,000	15,000
BMLWE	40,000	25,000
SLWE	30,000	15,000

Such fee has to be elaborated soon to become proportional to the actual water consumption. The pollution tax for non-subscribers would be a low tax when a properly designed septic tank exists and high when such a system does not exist.

#### 2.1.4.2 Recommended Reforms

Water demand and supply management initiatives, such as decreasing Non-revenue water, controlling produced and consumed volumes through the installation of bulk flow meters at source and district levels along the water systems, as well as improving collection rates and financial performances of the WE’s, restructuring the general billing system and the water-meter readings are all important and priority objectives and require the following specific actions:

1. To optimize the cost of production of water and increase the supplied volumes, the primary objective is to decrease Non-Revenue Water through initiatives such as:
  - a. Removal of illegal connections and the reduction of technical losses: The Government's political support, when it comes to removal of illegal connections, is crucial to allow for an effective enforcement of the law on all territories. In parallel, installing bulk flow meters at the sources and district meters along water systems shall be considered a top priority, as this would allow to measure the volumes of water produced, as well as the volumes wasted in the systems, and to calculate the cost of production, leading to a proper evaluation of the targets and the tariff. Eventually, this action plan would yield in an increased volume of water supplied to subscribers, and installation of water meters at household level becomes feasible and efficient, knowing that the target of this strategy is to introduce water meters on a large scale targeting 100% of households by the end of 2035.
  - b. Installation of bulk flow meters at the sources and district meters along water systems: this is considered a top priority for it allows to measure the volumes of water produced and those wasted in the systems, take the necessary action to control the water, and to calculate the cost of production, leading to a proper evaluation of the tariff. Eventually, this action plan would yield in an increased volume of water supplied to subscribers, and consequently, the installation of water meters at household level becomes feasible and efficient, knowing that the target of this strategy is to introduce water meters on a large scale targeting 100% of households by the end of 2035.
  - c. Upgrading the irrigation systems: as discussed later in the document, irrigation networks need to be upgraded from earth channels to concrete canals or piped systems, as judged feasible. Although concrete channels reduce the natural recharge of aquifers, yet they are more efficient in delivering the supplied volumes of water to the irrigable lands. Two additional elements are needed here: 1) the application of an adequate tariff that is socially and economically appropriate to farmers, and that allows WE's to maintain and rehabilitate channels and supply the needed water quantities, and 2) the use of water-efficient irrigation systems with the support of the Ministry of Agriculture.
  - d. Bridging the gap between the number of official customers as existing in the various customer databases and the actual population tapping from the network: The main recommendation is to conduct a customer census campaign (each WE in its jurisdiction) to detect and attract potential new customers and include them in the customer database and billing system. Expected output is to increase revenues of the WE's with no real additional operating cost and to reduce the commercial losses.
2. Financial reforms and changes in the water tariff structure, closely accompanied with increasing the number of subscribers and collection rates are primordial actions, and should be complemented with a communication campaign, reaching out to local citizens, informing them about the importance of paying their dues for the sustainability of the WE's services, encouraging those who are not subscribed to legalize their status, motivating them to save water and to installing water meters.











3. Structuring and enhancement of the private sector involvement by reviewing existing contracts with private operators and developing a new contracting framework based on performance and target achievement.
4. Identifying the activities to be outsourced and the outsourcing arrangements to be adopted.
5. Adopting a shared wastewater management framework: A specific study should be carried out to:
  - Analyze the current wastewater facilities management arrangements and wastewater financing tools (fee added to the water bill, municipal tax, etc.).
  - Conduct a full cycle analysis for each wastewater system currently operational.
  - Set benchmarks from successful frameworks used in Lebanon and abroad.
  - Coordinate between WEs, MoEW, CDR, donors and partners to conduct joint discussions.
  - Propose scenarios and an overall framework for wastewater facilities management and propose financial arrangements for O&M (in coordination with the tariff study that will be carried out in the framework of the water metering development).

#### 2.1.6 Summary of reforms and action plans

Table 8 below shows the detailed Priority and Short Term Action Plan, the associated activities for the reform of the Water Sector and the timeline for implementation. This Action Plan extends over a period of 5 years, and will be implemented with the help of technical assistance programs financed by Donors of the Water Sector, starting with AFD's (Agence Française de Développement) Long Term Technical Assistance programme over a period of 4 years as of September 2020.

The budget estimates of these complementary studies together with other studies, and other plans such as the surface and groundwater management that should be conducted simultaneously with the priority and short term Action Plan in order to implement reforms and abide by the requirements of the legal, institutional and infrastructures frameworks of this updated NWSS 2022 are given under Sub-Section 5.1



Table 8 Priority and short term Action Plan (continued)

Activity	Priority	Stakeholder		Means to mobilize	Deadline	Indicators	Funding
		Lead	Involved				
<b>RS-A.2. Financial and commercial</b>							
<b>RS-A.2.1 Conduct a customer and user census</b>							
RS-A.2.1.1 Identify customers connected to piped water and convert unknown customers tapping into the network into legal users	High	WE	MoEW	Recruitment of consultants (technical experts and census experts) - Census to be conducted for all customers / estimated to 1 500 000 of households (price: \$3 for 1 household)	Phase 1 : End 2020 Complete census : Beginning 2021	Census reports and updated WEs' consumers database	INT
RS-A.2.1.2 Identify users of collective wastewater services (network or network+WWTP) / identify those who are / are not WE customers (cross-reference with the water supply customer census) in order to define specific approaches for tariff-setting	High	WE	MoEW	Recruitment of consultants (technical experts and census experts)	Complete census for zone 1 by mid 2021	Census reports and updated WEs' wastewater services users database	INT
RS-A.2.1.3 Ensure the take over of new customers/users by WEs and their inclusion in the customer/users database for the billing/collection cycle		WE	MoEW	if needed support from specific TA	Beginning 2022	Increasing subscribers base	INT
<b>RS-A.2.2 Implement consumption-based tariffs for water service</b>							
RS-A.2.2.1 Streamline the water meter billing procedure			MoEW	Recruitment of financial and water tariff expert(s)	Mid 2022	Harmonized guidelines and procedures for water meter billing	INT
<b>RS-A.2.3 Revise the tariff structure for sanitation services</b>							
RS-A.2.3.1 Conduct a proper cost analysis of facilities O&M			MoEW	Recruitment of technical and financial experts on wastewater management	End 2020	Adoption and implementation of new tariff policy for wastewater management	INT
RS-A.2.3.2 Base the tariff on the cost analysis and, as a minimum, cover O&M costs			WEs		Mid 2021		INT

Table 8 Priority and short term Action Plan (continued)

Activity	Priority	Stakeholder		Means to mobilize	Deadline	Indicators	Funding
		Lead	Involved				
<b>RS-A.3. Reporting and monitoring</b>							
<b>RS-A.3.1 Enhance sector monitoring</b>							
RS-A.3.1.1	Create a Monitoring Department within the Ministry	MoEW		Recruitment of legal consultant	End of 2020	Revised Decree or Amendment to the Law 247	INT
RS-A.3.1.2	Establish a unified database to include all sector monitoring data and ensure it is regularly updated (incl. the WE KPI)	MoEW		Recruitment of water sector monitoring (part-time assistance) and 1 IT expert (full-time assistance)	Mid 2021	*TA recruitment *TA activity reports *Establishment and regular update of the sector database	INT
RS-A.3.1.3	Set up an annual sector review involving the main stakeholders and partners	MoEW		Organisation of annual sector workshop	Mid 2020	Database Workshop / annual review and annual sector review report	National
RS-A.3.1.4	Set up the process for monitoring the Strategy implementation status	MoEW		Analysis of sector data	Mid 2025	Strategy implementation status report	National
<b>RS-A.3.2 Enhance sector transparency</b>							
RS-A.3.2.1	Ensure a transparent flow of information between WEs and MoEW through regular reporting (annual report, financial report, business report)	MoEW		Reports production and publication / TA support	Continuous activity	Meeting minutes, reports	National
RS-A.3.2.2	Publish annual WE reports (incl. results of audits performed by independent auditors)	WEs		Recruitment of external auditors	starting from mid 2021	Annual WEs' reports publication	National
RS-A.3.2.3	Prepare financial reports based on IFRS book-keeping standards	WEs		Reports preparation with TA support if needed	starting from mid 2021	Financial report	National and INT TA
RS-A.3.2.4	Publish the main sector indicators, ensuring these are updated on a regular basis	MoEW		Update of sector indicators (with TA - see C.1.1)	starting from mid 2021	Publication of main sector indicators	National and INT
RS-A.3.2.5	Publish the breakdown of the water bill	WEs		Publication and communication support	starting from mid 2021	Publication by each WE of the water bill breakdown	National
<b>RS-A.3.3 Enhance sector coordination</b>							
RS-A.3.3.1	Improve coordination between CDR and WEs on infrastructure project planning and management	MoEW		Regular meetings, MoEW follow-up on coordination, support from donors and sector partners	Continuous activity	Participation of WEs in the projects design and implementation	National
RS-A.3.3.2	Organise an annual sector review involving all stakeholders and partners	MoEW		Organisation of annual sector workshop	Mid 2020	Workshop / annual review and annual sector review report	National
<b>RS-A.3.4 Enhance communication with user</b>							
RS-A.3.4.1	Develop a communication strategy for MoEW and WE	MoEW		Recruitment of communication experts	End 2020	Communication strategy, tools and supports	INT
RS-A.3.4.2	Design and launch a national communication campaign on the water sector	MoEW			Beginning 2021		



Table 8 Priority and short term Action Plan (continued)

Activity	Priority	Stakeholder		Means to mobilize	Deadline	Indicators	Funding
		Lead	Involved				
<b>RS-A.4. Capacity-building</b>							
<b>RS-A.4.1 Strengthen the MoEW monitoring capacities</b>							
RS-A.4.1.1	Appoint specific technical assistance to the MoEW to help develop monitoring		MoEW				
RS-A.4.1.2	Support the MoEW in defining sector key performance indicators		MoEW				
RS-A.4.1.3	Support the MoEW and the WEs in developing a performance monitoring framework		MoEW				
RS-A.4.1.4	Identify the MoEW staff to be trained and supported in monitoring activities		MoEW				
<b>RS-A.4.2 Streamline and structure WE internal organisation and management</b>							
RS-A.4.2.1	Conduct an overall internal audit in each WE (organisational, HR management, financial - assets, commercial, technical), propose measures and guidelines for streamlining internal WE organisation		WEs		Beginning 2021	Audit report validated by MoEW and the four WEs	INT
RS-A.4.2.2	Prepare a handbook of jobs in the WEs with minimum skills required per position and standard training / capacity-building plan to be implemented		WEs	Recruitment of the following experts: institutional, O&M of water utilities, capacity-building and HR management, water and wastewater	*Beginning of 2022 for the handbook validation *End of 2025 for implementing the capacity-building plan and TA support	*Handbook *Capacity-building plan *TA activity reports and specific studies	INT
<b>RS-A.5. O&amp;M of facilities and services</b>							
<b>RS-A.5.1 Improve operating cost control</b>							
RS-A.5.1.1	Develop a specific strategy to control the energy costs of the facilities (based on ongoing studies)		MoEW	Recruitment of technical and financial experts	End of 2021	Validated reports and strategic guidelines	INT
RS-A.5.1.2	Define guidelines to ensure that facilities design is adapted to the capacity to cover their operating costs		MoEW	Recruitment of technical and financial experts (coordinate with other financial and technical studies)	End of 2021	Publication of guidelines	INT
<b>RS-A.5.2 Enhance private sector involvement</b>							
RS-A.5.2.1	Review existing contracts with private operators and develop a new contracting framework and performance-based contracts		WEs	Recruitment of institutional, legal and technical experts in overseeing water facilities O&M contracts	Mid 2021 for pilot contract for wastewater facilities management  End of 2025 to assess the contracts and revise the framework (if needed)	Implementation of performance-based contracts  Assessment report of the efficiency and ownership by WEs of this framework and propose improvements	INT
RS-A.5.2.2	Identify the tasks or activities to be outsourced and the outsourcing arrangements to be adopted		WEs	Recruitment of the following experts: institutional, O&M of water utilities, capacity-building and HR management, water and wastewater	Mid 2021	Reports and validation of the proposed framework by WEs and MoEW	INT
<b>RS-A.5.3 Adopt a shared wastewater management framework</b>							
RS-A.5.3.1	Address the issue of the organization(s) responsible for managing the WW network and treatment plants (WEs, municipalities, private operators.) and determine the financing method		MoEW	Recruitment of institutional, financial and technical experts in wastewater facilities operation and management	Mid 2021	Publication of the wastewater management framework	INT













### 2.2.2.3 Public and Private Wells

The total number of public wells is estimated to be 1,615 distributed over the different WEs as shown in the below. A much larger number of private wells is in service, for domestic, industrial or irrigation purposes. Some are legal, but many are not. The exact total volume extracted from public and private wells is impossible to assess with an acceptable margin due to poor data availability from WEs, lack of comprehensive data measurement and collection campaign, absence of data on private wells and unknown number of operation hours due to recurrent power cuts. Despite these uncertainties, the total extraction is estimated at approximately 990 Mm<sup>3</sup>/year and was calculated based on the following assumptions for each type of wells:

- Extraction from public wells by WEs elevates to 350 Mm<sup>3</sup>/year based on 12 hours/day operation (except for SLWE 14 to 16 hours/day) under actual conditions and to 558 Mm<sup>3</sup>/year based on 24 hours/day operation for all WEs with an additional 77 Mm<sup>3</sup> for the 2035 horizon from the proposed public wells; hence a total of 635 Mm<sup>3</sup>.
- Extraction from 85,000 private wells (10% for irrigation and 90% for domestic) is estimated to be 640 Mm<sup>3</sup>/year: 315 Mm<sup>3</sup> are extracted for irrigation purposes and 325 Mm<sup>3</sup> are extracted for domestic usage.
- Total current extraction from public and private wells elevates to 350 + 640 = 990 Mm<sup>3</sup>/year.

The above figures are as accurate as possible; they are not based on actual measurements, but on data related to the installed pumps, assumptions made on the pumping hours and extracted volumes. No comprehensive data measurement and collection campaigns were conducted. Also the number of hours of operation of the boreholes, due to recurrent power cuts, is unknown, which adds to the uncertainty of the figures put forward. However, the numbers clearly show that groundwater aquifers are being exploited beyond their capacity, causing the water tables to drop tremendously, sea water to intrude further, and natural aquifer recharge to be insufficient to reverse the damage caused.

It should be noted that the Water law 192/2020, article 37, encourages citizens who have an unlicensed well to settle their infringement and legalize their situation within a period of two years, the penalty of not doing so being the closure of the well. The realistic implementation of this article should be accompanied by the formation of a committee or unit at MoEW (including, at least, a hydrogeologist, a legal advisor, a representative from the concerned WE) that assesses the applications presented by citizens, the impact of the well on the aquifers and other sources, and the ability of the WE to provide water. The aim of MoEW and the WE's is to eventually supply sufficient amounts of safe and affordable water to all citizens and economic sectors such that the need for individual water security is reduced to a minimum, and this can only be achieved after implementing the reforms and infrastructure projects identified in this strategy.



### 2.2.3 Water balance and data quality

Several studies and projects have tried to develop an annual water balance of the Lebanese water resources but failed to deliver a long term estimation which considered all the components. For example, UNDP 1970 study of Lebanese groundwater missed to include snow contribution as no monitoring stations were installed above 2000 m altitude back in that time. FAO 2008 AQUASTAT country profile report didn't calculate the evapotranspiration; however, it was adopted by the 2010 NWSS with an unjustified estimation of the evapotranspiration at 50% of the total precipitation. UNDP 2014 assessment of groundwater resources in Lebanon estimated the water balance components for only two hydrological cycles (2010-2011) and (2011- 2012) without estimating the surface and groundwater flows to adjacent countries and the flow of submarine sources. Nevertheless, UNDP (2014) advanced a serious calculation of the real evapotranspiration using Turc (1961) method over 71 meteorological stations across Lebanon with an estimation ranging between 16% and 26% of the total precipitation.

The 2020 NWSS annual water balance updated the 2010 NWSS based on the review of FAO 2008 components to include the total losses as deficit of runoff (evapotranspiration and other losses) estimated at a ratio of 30% equivalent to 2,579 Mm<sup>3</sup> closer to UNDP 2014 real evapotranspiration figures between 16% and 26% of the total precipitation, but less than the 50% ETP values adopted by FAO 2008 and the NWSS of 2012. The same figures of FAO 2008 were adopted for the water outflow leaving Lebanon, with the total surface water outflow estimated at 735 Mm<sup>3</sup>/year, of which 160 Mm<sup>3</sup> to the sea and the total groundwater outflow leaving Lebanon estimated at about 1,020 Mm<sup>3</sup>/year of which 740 Mm<sup>3</sup> to the sea. Hence, the water resources remaining in Lebanon are 4,225 Mm<sup>3</sup> /year of which 700 Mm<sup>3</sup> as dynamic groundwater reserves, 2,050 Mm<sup>3</sup> as springs discharge and 1,475 Mm<sup>3</sup> as surface runoff, estimated from the average flows measured by LRA hydrometric service between 1990 and 2013 and other private hydrometric records.

In summary, the real evapotranspiration is estimated at 30% of total precipitation, total surface runoff inside and outside Lebanon about 25% and groundwater infiltration about 45%.

It should be noted that the annual water balance was included for information only and should not be adopted for water management plans at national scale. Rather, water management plans should be based on water balances estimated at the watershed scale as part of the IWRM approach. The updated national water balance is presented in Figure 9 below. (*More details in Annex II, Section A*).

Despite all these estimations, a complete and inclusive long term annual average water balance is still missing for Lebanon and requires further knowledge and studies especially regarding real evapotranspiration estimation, groundwater resources leaving Lebanon either to adjacent countries or to the sea through submarine springs with estimations dating back to 1970's. In addition, the new information collected on snow cover contribution during last decade should be seriously integrated into the annual water balance.

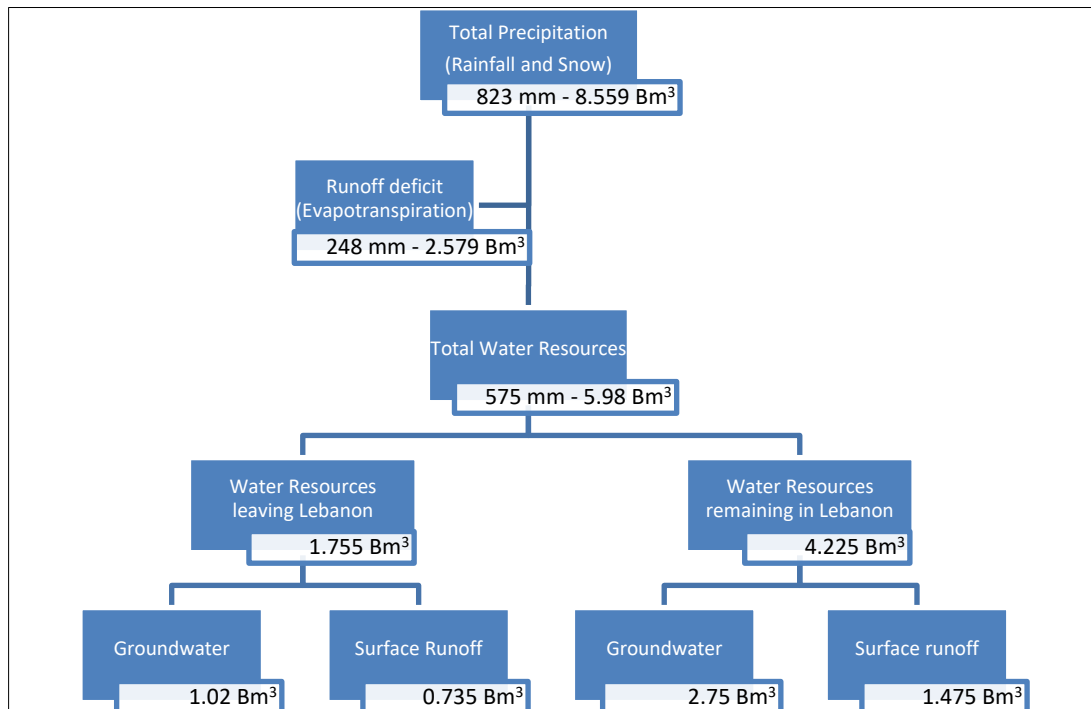


Figure 9 Simplified annual water balance diagram  
(Developed based on MEW 2010, FAO 2008 and UNDP 2014 reports)

In fact, Figure 9 is a simplified diagram. The annual water balance distribution should be detailed furthermore to show each component distribution especially groundwater resources and the resources leaving Lebanon to adjacent countries or to the sea. Exploited water resources by different water establishments and authorities could also be added to the diagram. A detailed diagram is suggested in Figure 10 which shows approximate values of all the components for an adequate water resources management, which requires:

- Implementing adequate and comprehensive coverage of the Lebanese territory with meteorological and hydrometric networks, which would provide reliable data about surface water. This is addressed in detail in *Annex II Section B*.
- Carrying out required comprehensive geological and hydrogeological studies all over the Lebanese territory, in order to properly assess the groundwater capacity (static reserves), and also to properly assess how the volumes lost by "groundwater seepage to the sea" are affected by the exploitation of the sea cost aquifers. Groundwater management is addressed in detail in *Annex II Section II C*.
- Conducting studies to set up Watershed management schemes.

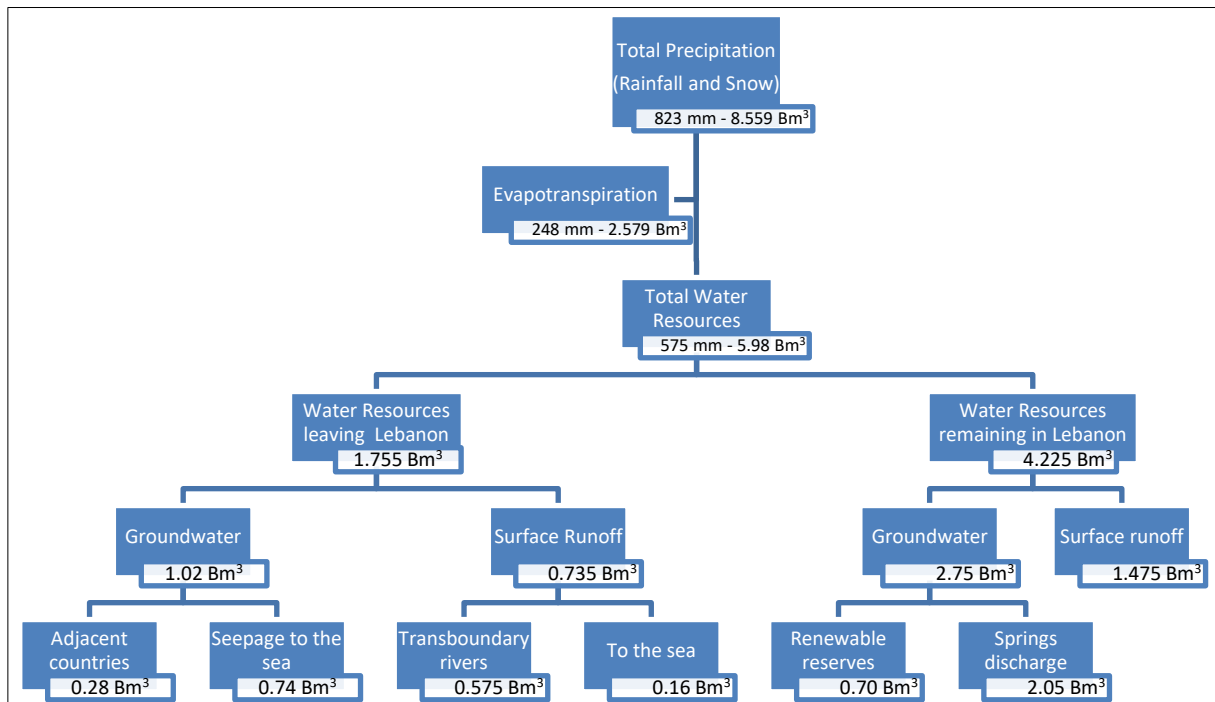


Figure 10 Suggested detailed annual water balance diagram

## 2.2.4 Impact of climate change

### 2.2.4.1 Climate change in Lebanon

The Second and Third National Communication (SNC<sup>1</sup> and TNC<sup>2</sup>) to the United Nations Framework Convention on Climate Change (UNFCCC) developed by the MoE in 2011 and 2016 presented the expected climate change effects in Lebanon obtained from university research programs and scenarios that have been developed for Lebanon through the application of the PRECIS RCM model (SNC) and MENA CORDEX RCM (TNC).

The analysis of precipitation timeseries have shown a stable trend without any clear variation in the past decades. However, it was confirmed that minimum temperatures in Beirut have an increasing trend with an estimated 3°C over the past 140 years.

On the other hand, the main results of key climate variables in Lebanon as simulated by PRECIS were presented as changes of the respective periods of the near and distant future compared to the “control” period the last 20-30 years or the “recent past/ present”. According to PRECIS model and in relation to the present climate, by 2040 temperatures will increase from around 1°C on the coast to 2°C in the mainland, and by 2090 they will be 3.5°C to 5°C higher. Comparison with Lebanese Meteorological System LMS historical temperature records from the early 20th century indicates that the expected warming has no precedent. Rainfall is also projected to decrease by 10% to 20% by 2040, and by 25% to 45% by the year 2090. This combination of significantly less wet and substantially

<sup>1</sup> MoE/UNDP/GEF, (2011)

<sup>2</sup> MoE/UNDP/GEF, (2016)



warmer conditions will result in an extended hot and dry climate. Temperature and precipitation extremes will also intensify. In Beirut, hot summer days ( $T_{max} > 35^{\circ}\text{C}$ ) and tropical nights ( $T_{min} > 25^{\circ}\text{C}$ ) will last, respectively, 50 and 34 days more by the end of the century. The drought periods, over the whole country, will become 9 days longer by 2040 and 18 days longer by 2090.

In terms of seasonal changes, temperatures will increase more in summer and precipitation will decrease more in winter, while positive changes are predicted for autumn.

While the actual considered resolution is 25 km, the SNC authors pointed out the need for a finer modeling resolution to help decision makers defining Lebanon's optimal commitments on mitigation and adaptation measures facing Climate Change. Hence the importance of the application of recent RCM models considering new CMIP5 scenarios similar to the ones applied in the Med-CORDEX project which do not rely on downscaling the GCM.

The TNC included the analysis results of the projected climatic changes in Lebanon and their impacts on natural resources based on the generation of dynamically downscaled regional climate modelling projection covering the Arab/Middle East North Africa (MENA) domain in accordance with the CORDEX program under RCP4.5 and RCP8.5 scenarios. These projections were carried out through the Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources in the Arab Region (RICCAR) led by the United Nations Economic and Social Commission for Western Asia (ESCWA). The projections were then linked to two regional hydrological models to specifically analyze the impact of climate change on the region's freshwater resources.

In Lebanon, the projections by the end of the century compared to the baseline period of 1986-2005 results showed an increase in temperature by up to  $3.2^{\circ}\text{C}$  with an increasing warming trend reaching up to 43 additional days with maximum daily temperature higher than  $35^{\circ}\text{C}$ . It also showed a decrease in precipitation by 4% under RCP 4.5 and 11% under RCP8.5 with trends towards drier conditions with an increase in number of consecutive dry days (when precipitation  $< 1.0$  mm) which indicates the extension of dry summer season. This combination of significantly less wet and substantially warmer conditions will result in hotter and drier climate<sup>3</sup>. (*More details in Annex II Section A*).

#### 2.2.4.2 Climate change impact on water resources

In what follows, we discuss the impact of climate change on water resources and consequently on SDG 6, SDG 2, and SDG 15.

##### 2.2.4.2.1 Impact on SDG 6: Ensure availability and sustainable management of water and sanitation for all

The SNC and TNC included a climate change impact assessment on Lebanese water resources taking into consideration the effect of precipitation and temperature variation on surface water and groundwater availability from direct runoff, infiltration, and snowmelt. The assessment covered the variation of precipitation during wet season including snow cover, and losses through ETP increased by temperature increases during dry season. This assessment faces multiple challenges mainly the limited recorded data and lack of meteorological and hydrometric stations.

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<sup>3</sup> ESCWA, (2015)

The expected increase in temperature as described in previous section has a considerable impact on the snow cover, main source of freshwater resources in Lebanon. It was estimated that a 2°C increase in temperature would cause a decrease of 50% in snow depth in addition to a significant reduction in the maximum volume of snowpack from 1,200 Mm<sup>3</sup> to 700 Mm<sup>3</sup>; a 4°C warming would further reduce it to 350 Mm<sup>3</sup>. The altitude of sustained snow cover would also shift upwards from 1,500 m to 1,700 m for a 2°C warming, and to 1,900 m for a 4°C warming (Najem, 2007).

These findings were confirmed by the analysis of satellite images that have shown a noticeable spatial and temporal decrease between 1990's and 2000's of the dense snow cover surface by 350 km<sup>2</sup> and residence time by 20 days (Shaban, 2009).

This has consequently major impact on the stream flow regimes of major rivers and springs. Drought periods would occur 2 to 3 weeks or even a month earlier for a 2°C and 4°C temperature increase, and peak flows would shift from the end of April to the end of March and river flows would increase during winter months while demand is low. Upon the recharge of most springs' aquifers, early snowmelt will reduce the available water supply for irrigation during summer and increase floods by up to 30%. This will have adverse impacts on rivers and groundwater recharge and will affect water availability during summer season and drought periods. The main consequence would consist in a decrease in spring and stream discharges towards the end of the dry season.

Aquifer recharge conditions, however, remain less predictable, as one cannot easily forecast whether early precipitations would efficiently recharge the aquifers or simply contribute to fast runoff.

In the absence of proper water storage structures, a considerable proportion of this water would be lost. From April to June, while the demand for irrigation water for agriculture is higher, the reduction in snowpack will not allow to sustain river flows.

These results highlight the increasingly difficult challenges that water sector is actually and will be facing in the future, particularly with respect to water supply, as a result of the expected increase in population and demand per capita, coupled with longer periods of water shortage. Drought's impacts on groundwater usage for agriculture are considerable. It increases irrigation demand, which is met almost entirely by groundwater abstraction during dry seasons. Also, large agricultural areas depend on spring systems, while the discharge of these springs fluctuates in response to climate affecting changing snow cover and precipitation. While autonomous adaptation through changing of sowing dates is possible in the agriculture sector, the shortening of the season when aquifers and springs recharge will necessitate the construction of surface and underground storage reservoirs that can store enough water for the longer dry season (Hreiche et al., 2007; Najem, 2007).

#### 2.2.4.2.2 Impact on SDG 2: End hunger, achieve food security and promote sustainable agriculture

The impact of climate change not only affects the flow regime of water, but also menaces Lebanon's food security if lower quantities of water are available for agriculture. Therefore, it is primordial that: i) the Government of Lebanon identifies the crops it considers important for the country's food security, and ii) the Ministry of Agriculture identifies the lands dedicated for these crops, so that MoEW and the WE's can properly plan their resource allocation and their infrastructure plans to cater for food security needs.



### 2.2.5 Integrated Hydrological Information System

To overcome the multiplicity of studies and estimations, and to mitigate the impacts of climate change on water resources, it has become crucial to implement an IHIS that would act a strategic tool for decision making in the water sector.

Such a system will provide real, scientific data to allow for proper planning of infrastructure, and shall provide public and private stakeholders' access to reliable information to build a holistic management approach. Decisions on integrated water resource management, flood and drought management, locations and feasibility of dams, groundwater extraction, rainwater harvesting and water allocation among economic sectors can only be made in light of data availability and reliability and proper analysis. It will also support Lebanon's decision regarding global agendas, such as the United Nations SDGs, the United Nations Framework Convention on Climate Change (UNFCCC), the Global Framework for Climate Services (GFCS), etc.

Probably the most successful design of an IHIS in Lebanon would reside in the combination between LMS's (Lebanese Meteorological System) climatic zoning, LRA's (Litani River Authority) distribution on catchment scale and completed by Lebanese Agricultural Research Institute LARI's agrometeorological network for agricultural areas. Each network would be monitored by its corresponding institution but in coordination with the IHIS office. This distribution ensures that each catchment microclimates are well covered (coastal areas, plains, lowlands and mountains), rivers specific hydrological regimes are taken into consideration (snow influence, spring contribution, etc.) and land cover characteristics are covered by LARI's network for evapotranspiration estimation. Also of utmost importance is the monitoring of groundwater aquifers based on aquifer delimitation of 1970 and the findings of other relevant hydrogeological and geological studies, as this should be an important element included in the IHIS. The cost estimate of the IHIS implementation including the upgrade and expansion of networks included are listed in Sub-Section 5.2 (*More details are described in Annex II Section B*).

Nevertheless, some gaps are still to be covered to complete this integrated system. The main gaps in the existing networks are briefed here below.

- Hydrogeological aquifers are main contributors to river flow regimes and especially karstic formation (cave and submarine springs); they should be well monitored by expanding both meteorological and hydrometric networks to detect each aquifer contribution from and into surface flows.
- The hydrometric network should be expanded to cover more streams, connections and sub-catchments;
- Snow cover makes up to 25% of Lebanese water resources. Autonomous snow monitoring stations should be installed to cover the mountainous regions above 1500 m and estimate correctly the snow contribution into river flows.
- Groundwater monitoring wells should be installed across the coastal and inland aquifers. Public wells should be quantitatively and qualitatively monitored by installing volumetric bulk meters to measure the exploited volumes of groundwater, data loggers and water level sensors to monitor the fluctuations of the groundwater static, and dynamic water levels and other sensors to monitor the quality of the extracted groundwater.





The two most prominent factors affecting groundwater availability are population growth and climate change. The study done by the UNDP in 2014 confirmed the relationship between population size and groundwater availability. It showed that stressed aquifers are located in urban areas (such as Beirut, Tyre and Tripoli), and in areas where the demand for irrigation is high (such as in the Bekaa plain and Akkar plain).

Lebanon is currently going through a critical phase in managing its natural resources. Particularly in the water sector, the socio-economic evolution of the population from one side and the Syrian refugees' crisis on the other, greatly added to the stress on available resources and will exacerbate the expected 10-20% decrease in precipitation volumes by 2040, related to climate change (SNC - MoE 2011).

The current situation of groundwater extraction can be described as follows:

- In coastal and urban areas, the number of existing drilled water wells is extremely high putting the tapped aquifers under stress and consequently preventing a full material replenishment. This uncontrolled situation has led to the draining of the groundwater resources and to their contamination by seawater intrusion.
- In the remaining areas, most of the groundwater aquifers are being overexploited by private wells which are extracting large volumes of water without any restrictions or monitoring.
- The uncontrolled number of unlicensed private wells and the uncontrolled extraction of groundwater from these wells decreased dramatically the flows discharged by many springs, which water is primarily used for domestic supply and irrigation.
- No detailed groundwater balance studies have been made on the identified aquifers since 1970.
- No monitoring on the extracted water volumes from public and private wells is made.
- No monitoring of the fluctuations of the water levels in the wells is being made.
- No monitoring of the quality of the extracted water from the wells is being made.

There is, therefore, a great necessity to sustain a serious groundwater resources management plan to avoid a water crisis in the near future.

#### 2.2.6.2 Strategic Recommendations for Groundwater Resources Management

The increased fluctuations in precipitation and extreme weather events will directly affect the availability of groundwater and our dependency on it. For example, during long periods of droughts, rivers and springs will become almost dry to the point where people will increasingly rely on wells to secure their water demand, resulting in a higher risk of aquifers depletion or contamination by seawater intrusion. In other cases, such as flooding events, the rate of surface run-off will be very high resulting in a lower infiltration rate which leads to a lower recharge rate and eventually a higher risk of aquifers depletion.

In addition to what was mentioned in the previous section which recommends that “Groundwater monitoring wells should be installed across the coastal and inland aquifers” and that the collected data



would be integrated in the IHIS, it is also necessary to build up a strategy that would enforce the management capacities of the MoEW and WE's by:

- Recruiting specialized staff in the fields of geology, hydrogeology and water resources;
- Refreshing and completing the detailed geologic mapping of Lebanon at scale of 1/20,000;
- Assessing the sea-water intrusion in the major coastal aquifers.
- Refreshing the 2014 UNDP water resources study by performing in stages hydrogeological studies and producing hydrogeological reports on the identified hydrogeological basins in the North, Central, South, North Bekaa valley, South Bekaa valley and Eastern Lebanon mountain chain area;
- Drilling deep reconnaissance water wells to detect the presence of new potential aquifers in some specific areas and proceed with their water testing;
- Enhancing the Artificial Recharge of some selected aquifers;
- Refreshing the water budgeting of all aquifers progressively;
- Performing progressively the modelling of the karstic, saline and porous aquifers.

The detailed activities (studies, investigations and works) to be performed and their sequence in time are shown in Figure 13. The cost estimates of these studies without expropriation and reforms is detailed in Sub-Section 5.3 and covers the implementation of a project management unit at the MoEW, the cost of general geological and hydrogeological studies, and the cost of drilling of new exploratory wells.



Activities and Projects	Time in years														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<b>6 Aquifer Artificial Recharge</b>															
<b>6.1 Berdaouni (A10 site) pilot area</b>															
6.1.1 Proceed with the preparation of the detailed design of the AAR pilot project facilitated in Berdaouni (A10 site)															
6.1.2 Implement the construction works of the Berdaouni AAR facilities															
6.1.3 Follow up the AAR of the Berdaouni aquifer															
<b>6.2 Damour Aquifer</b>															
6.2.1 Detailed design of the AAR facilities of Damour															
6.2.2 Construction of the AAR facilities of Damour															
6.2.3 Follow up of the AAR of Damour aquifer															
<b>6.3 Mejdlaya - Abou Ali aquifer</b>															
6.3.1 Detailed design of the AAR facilities of Mejdlaya - Abou Ali site															
6.3.2 Construction of the AAR facility of Mejdlaya - About Ali															
6.3.3 Follow up of the AAR of Mejdlaya - About Ali aquifer															
<b>6.4 Hadath-Hazmieh lower Cenomenian limestones aquifer</b>															
6.4.1 Detailed design study of the AAR of Hadath-Hazmieh aquifer															
6.4.2 Construction of the AAR facilities of Hadath-Hazmieh aquifer															
6.4.3 Follow up of the AAR of Hadath-Hazmieh aquifer															
<b>6.5 Daichounieh Jurassic limestones (J4) aquifer</b>															
6.5.1 Detailed design study of the AAR of Daichounieh aquifer															
6.5.2 Construction of the AAR facilities of Daichounieh aquifer															
6.5.3 Follow up of the AAR of Daichounieh aquifer															
<b>6.6 Akkar plain aquifer</b>															
6.6.1 Detailed design study of the AAR of Akkar plain alluvial aquifer															
6.6.2 Construction of the AAR facilities of Akkar plain alluvial aquifer															
6.6.3 Follow up of the AAR of Akkar plain alluvial aquifer															
<b>7 Drilling &amp; Testing reconnaissance and exploratory wells:</b>															
7.1 in Hadath-Hazmieh (3 wells)															
7.2 In Damour (3 wells)															
7.3 In Daichouniye (2 wells)															
7.4 In Akkar plain (5 wells)															
<b>8 Groundwater vulnerability mapping</b>															
8.1 Perform groundwater vulnerability mapping and delineation of protection zones 1 and 2 for springs whose low water flow exceeds 100 l/s															
8.2 Perform groundwater vulnerability mapping and delineation of protection zones 1 and 2 for springs whose low water flow is less than 100 l/s															
<b>9 Aquifers' modelling</b>															
9.1 Modelling of fractured and karst aquifer systems															
9.2 Modelling of porous, permeable aquifer systems subject to saline water intrusion															
<b>10 Refresh the water budget studies of the identified aquifers</b>															

Figure 13 Detailed activities to be performed (continued)

### 2.2.7 Water quality monitoring

Water quality monitoring in Lebanon should be strengthened, as data registered from samples taken by WE's are collected but not extensively analyzed. In 2021, UNICEF, in coordination with the South, North and Bekaa Water Establishments, conducted a water quality mapping that presented findings on the physico-chemical and bacteriological parameters from water analyses done by these WE's during a period of one year on several sampling points. This assessment also related the effects of land use, climate and urbanization on water quality. In conclusion, it was shown that the water quality in

general is not bad, sampling and analysis must be done more regularly and exhaustively sampling points must be unified and coded, and water quality monitoring automated as applied by SLWE.

The Ministry will take necessary measures to protect potable water from contamination as also indicated in the Water Code. Such a plan is only possible through (a) designing and implementing a comprehensive surface water, groundwater, and irrigation water quality monitoring network, (b) developing and implementing pollution prevention measures for recharge zones, and (c) centralizing data to ensure better customer service.

#### 2.2.7.1 LIBNOR Standards

Earlier in 2019, LIBNOR standards for water quality published in 1999 were revised (edition 2016) and sent to MoEW and the WE's for application (*More details in Annex II Section D*). However, the laboratories at the WE's are not well equipped to analyze the newly introduced parameters in the revised edition, such as heavy metals. As such, the revised standards will not be considered applicable before laboratories are equipped with the necessary equipment and staff is recruited and/or trained. It is recommended that Standard Operating Procedures (SOPs) be written for all water establishments under normal and emergency situations covering water sampling procedures and laboratory practices.

#### 2.2.7.2 Water Safety Plans and Protection Zones

The Water Safety Plan concept (Step-by-step risk management for potable water suppliers 2009) is described in the WHO guidelines of 2017 and an outline for developing a Water Safety Plan in 11 steps is set. It is also a requirement of the Lebanese Water Code 192/2020.

In 2019, UNHCR and IHE-Delft university, in close coordination with MoEW, and based on Law 192/2020, conducted trainings for the teams of the Water Establishments on Water Safety plans. The aim of these trainings was to familiarize the teams with the concepts of WSP's, accompany them in drafting such plans on pilot areas, and eventually assist them in setting WSP's for all water sources in their geographical mandate. Unfortunately, this training program was stopped due to shortage of funds, and to the multiple crises that started in Lebanon by end of 2019.

MoEW considers Water Safety Planning as a priority activity in the determination of sources of pollution relative to water sources, and one that enforces coordination among different stakeholders, ministries, public institutions, civil society and others.

Water Safety Plans, accompanied with regular and automated water analyses, should be fed to a data management system at each WE and at MoEW, allowing them to analyze information and extract reports easily and as needed. Such data allows the identification and delineation of protection zones and implementation of land use restrictions in the watersheds of main water resources.

The WSP's should be reviewed whenever a change happens to the water system such as a new activity in catchment occurs, new treatment infrastructure, industries or health facilities are built, and improvement plans are implemented in the catchment area. The review period should therefore not exceed 5 years.

Accordingly, the Updated NWSS 2020 is proposing the adoption of an operational water quality monitoring program (including parameters, locations, frequency of testing), the publishing of the



















Table 18 Proposed development of irrigable lands

WE	Priority	Proposed new irrigation projects	Irrigable Land (ha)
NLWE	3	Noura el Tahta &	
	2	Dar Baachtar Dam	4,200
	1-3	Hill Lakes	730
			4,930
BMLWE	2	Hill lakes	540
			540
BWE	1-2	Aassi dams	6,000
	3	Massa Dam	1,600
	3	Younine Dam	1,200
			8,800
SLWE	1-2	Conveyor 800	13,250
	2	Khardale Dam	1,300
	2	Choumaryeh Dam	4,000
	2	Ibl Saki Dam	3,800
	2	Hill lakes	1,235
			23,585
Total			~38,000 ha

Assessment of future irrigation water requirements is based on the following assumptions:

- Irrigated areas would reach in 2035 around 138,000 ha.
- Irrigation efficiency will be improved and will be upgraded from 60% to 75% by rehabilitating or constructing concrete or piped conveyance structures and catchment structures and by modernizing on-farm irrigation practices (micro-irrigation). Consequently, irrigation water requirement for 1 representative ha will drop from 8,400 m<sup>3</sup>/ha/year to 6,720 m<sup>3</sup>/ha/year (based on 5040 m<sup>3</sup>/ha/year as a net water requirement, i.e. without water losses, then 5,040/0.75=6,720 m<sup>3</sup>/ha/year would be the gross water demand per ha per year when overall system efficiency will reach 75%).

Based on the above, the present irrigation water requirement at the country level is 842 Mm<sup>3</sup> and would reach 927 Mm<sup>3</sup> in 2035, should the proposed project be implemented.

On the other hand, Agricultural National Census (MoA) 2010 reveals that only 50% of the irrigated area is supplied from natural surface water whereas the rest is supplied by “expensive” underground water or from hill lakes. Also, it shows that 65% of the irrigated areas are permanently irrigated whereas the remaining 35% are partially irrigated. Therefore, it is estimated that around 75% of the current Irrigation water requirement, i.e. around 630 Mm<sup>3</sup>, are presently sustained by available water for irrigation and reflect the actual/real Irrigation water consumption figure across the country. Out of these 630 Mm<sup>3</sup> it is estimated that 315 Mm<sup>3</sup> are covered by surface water and the rest by groundwater.

#### 2.3.1.5 Projected water demand 2020 – 2035

The national water demand is calculated at a strategic level to allow for the calculation of the national water balance relative to the national supply. However, when proposing water supply and irrigation

projects (as will be discussed later), the water balance of every system and every irrigation scheme is calculated separately to serve as a solid basis for the project development plan.

Based on water balance calculation at the distribution system level, the dynamic seasonal variation of the population, and using the above assumptions on irrigable land, the total annual demand amounts to 1,505 Mm<sup>3</sup>/year for the year 2020 for a network efficiency of 75% (1,837 Mm<sup>3</sup>/year for network efficiency of 50%). These figures are slightly higher than the predicted values in the NWSS of 2012 due to the seasonal variation of the housing unit on which the water balance was based on in this update. In details, the following figures are obtained:

- Domestic water demand makes up around 40% of the total demand and is estimated at around 580 Mm<sup>3</sup>/year.
- Irrigation water demand makes up 55% of the total water demand and is estimated at around 842 Mm<sup>3</sup>/year.
- Non Domestic including industrial and commercial water demand stands at 5% of the total and is estimated at about 83 Mm<sup>3</sup>/year.

It is worth mentioning that current water demands of the economic sectors should be measured through a census of actual consumptions, and the projected demands should be based on a national economic development plan as this can guide better the water allocation per sector.

Table 19 Comparison of annual water demand estimates between NWSS 2012 and NWSS 2020

NWSS	2012	2020 (Based on WB*)
<b>Sector</b>		
Domestic (Mm <sup>3</sup> /yr)	505	580
Non Domestic (Mm <sup>3</sup> /yr)	152	83
Tourism (Mm <sup>3</sup> /yr)	6	-
Agricultural (Mm <sup>3</sup> /yr)	810	842
Total demand (Mm <sup>3</sup> /yr)	1,473	1,505
<b>Assumptions</b>		
Population	4.43	6.9
Per capita consumption (L/d)	180	125**
Network efficiency	52%	75%
Irrigated area (ha)	90,000	100,000
Irrigation consumption (m <sup>3</sup> /ha)	9,000	8,400
Commercial demand	30%	20%

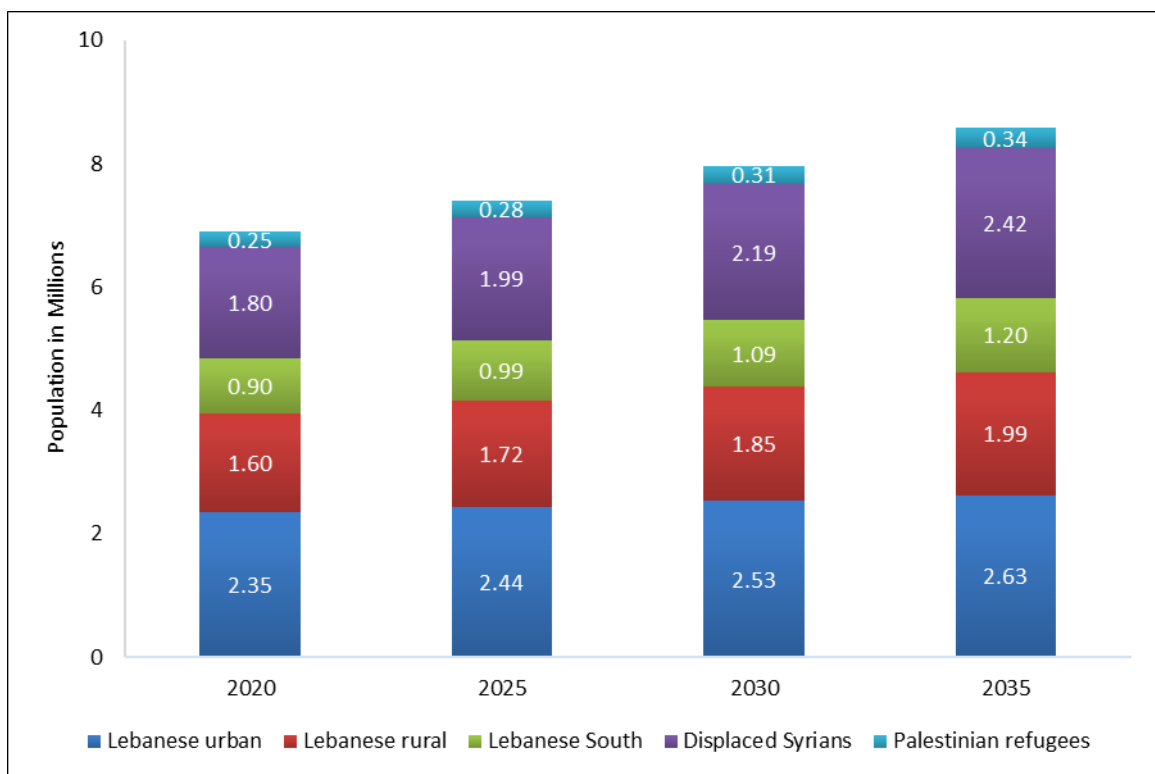
\*: Water Balance at the distribution system level

\*\* : For network design purposes, the value 200 l/c/d should be used as it includes network losses and non-domestic demand.



*Table 20 Projection of annual water demand estimates per sector for 2020 – 2035*

Sector	2020	2025	2030	2035
Domestic (Mm <sup>3</sup> /yr)	580	622	664	706
Non Domestic (Mm <sup>3</sup> /yr)	83	89	95	101
Agricultural (Mm <sup>3</sup> /yr)	842	874	902	927
Total	1,505	1,585	1,661	1,734

*Figure 14 Lebanese Resident Population projection 2020 – 2035*

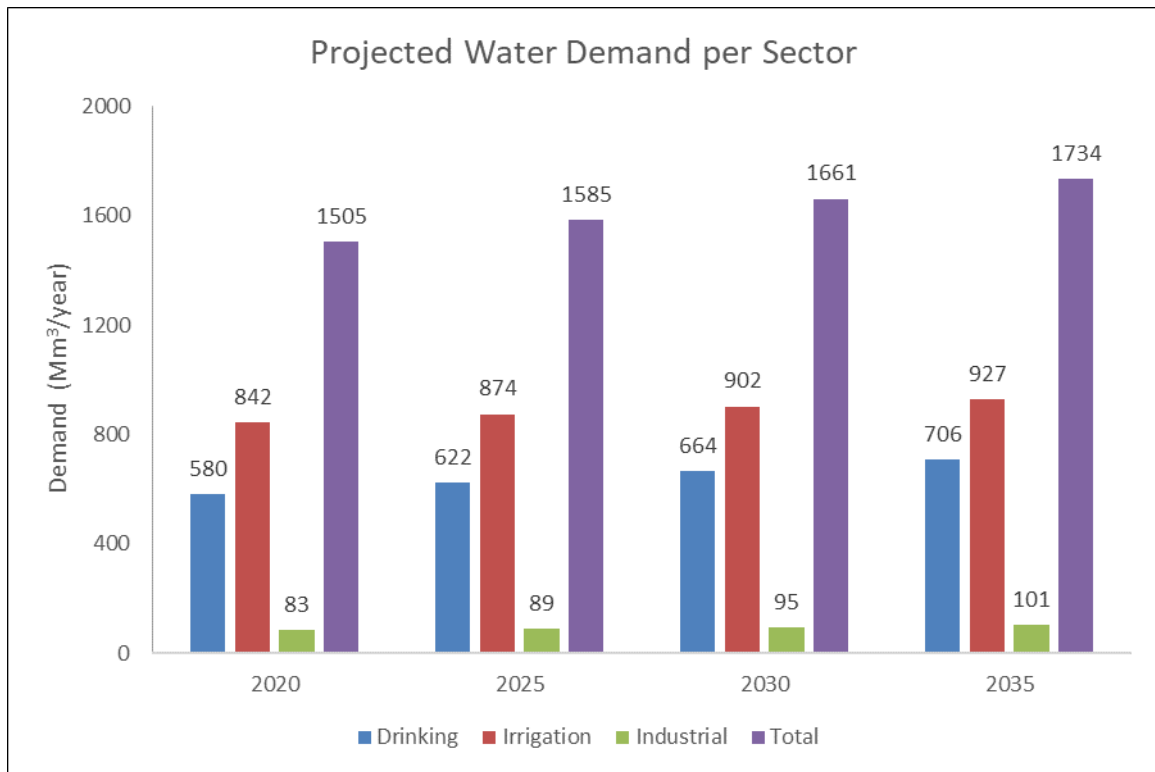


Figure 15 Total water demand projection 2020 – 2035

### 2.3.2 Total water supply

As shown previously in the estimation of the national water balance Sub-Section 2.2.3, the annual renewable available water volumes are estimated to be around 2,050 Mm<sup>3</sup> from springs, 1,475 Mm<sup>3</sup> from rivers, and 700 Mm<sup>3</sup> from wells (public and private). As for the supply, they differ per exploited resources and per source type. It is worth noting that dams are usually filled from surface water mainly rivers and that groundwater is overexploited by approximately 300 Mm<sup>3</sup> per year. The table below summarizes these figures.

Table 21 Available and exploited water resources for 2020

Source	Available Resources (Mm <sup>3</sup> /year)	Exploited Resources (Mm <sup>3</sup> /year)
Rivers	1,475	14
Springs	2,050	594
Public and Private wells	700	990
Dams (Static)	-	314 (232)
<b>Total Water Supply</b>	<b>4,225</b>	<b>1,912</b>

It is expected that exploited resources from springs will be optimized, from public wells will be increasing by 100 Mm<sup>3</sup> every 5 years as extraction from private wells will be gradually decreasing by 100 Mm<sup>3</sup> to reach its half in 2035, and dams' storage will be increasing according to the dams under construction only. Closure of private wells shall be accompanied by several actions:

- 1) Provision of drinking water supply in a continuous manner to allow for closure of private wells used for domestic purposes;
- 2) Organization of the irrigation sector under the WE’s and coordination with Ministry of Agriculture to develop and optimize sources of water for agricultural lands in order to decrease the need for private wells for irrigation purposes;
- 3) Conduct a national survey to identify locations and characteristics of private wells;
- 4) Installation of water meters and adjustment of domestic water and irrigation water tariffs to allow for a better control and monitoring. The water supply forecast is shown in Table 22 Below.

*Table 22 Projected exploited resources by sources between 2020 and 2035*

Source	Exploited Resources (Mm <sup>3</sup> /year)			
	2020	2025	2030	2035
Rivers	14	14	14	21
Springs	594	617	656	656
Public wells	350	450	550	635
Private wells	640	540	440	320
Dams (Static)	314 (232)	314 (232)	410 (260)	625 (410)
Total Water Supply	1,912	1,913	2,009	2,257

### 2.3.3 Demand versus supply balance

Figure 16 below shows that the forecasted water supply with 25% physical losses exceeds the annual demand by 20% to 25% between 2020 and 2035. This gives the illusion that demands are always met despite the various pressures on Lebanon’s water resources, be it due to the influx of displaced Syrians, the unstructured parallel market of water trucking, the impact of climate change or the excessive pollution of surface and groundwater. However, due to the unbalanced distribution of the available resources across the country and the mediocre maintenance of the infrastructure, the water resources management is challenging, and physical losses are considerable. Thus, with 50% physical losses (or more accurately network efficiency) as it is currently, the supply and demand overlap perfectly.

Hence, if no effort is put to increase and optimize our resources, and properly manage our consumption, Lebanese will witness severe water shortage (see Figure 17 below). It is crucial that surface storage shall be enhanced, springs’ catchments rehabilitated, and exploitable quantities optimized, groundwater extraction limited to only rechargeable volumes, and wastewater effluents (municipal, industrial waste, agricultural discharges and solid waste) treated and reused especially for irrigation.

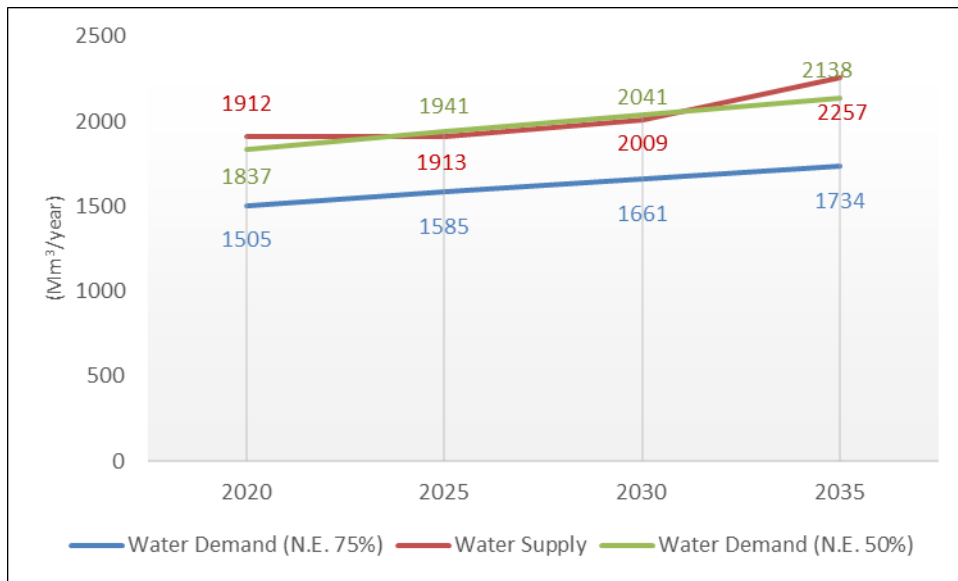


Figure 16 Demand versus supply forecast chart

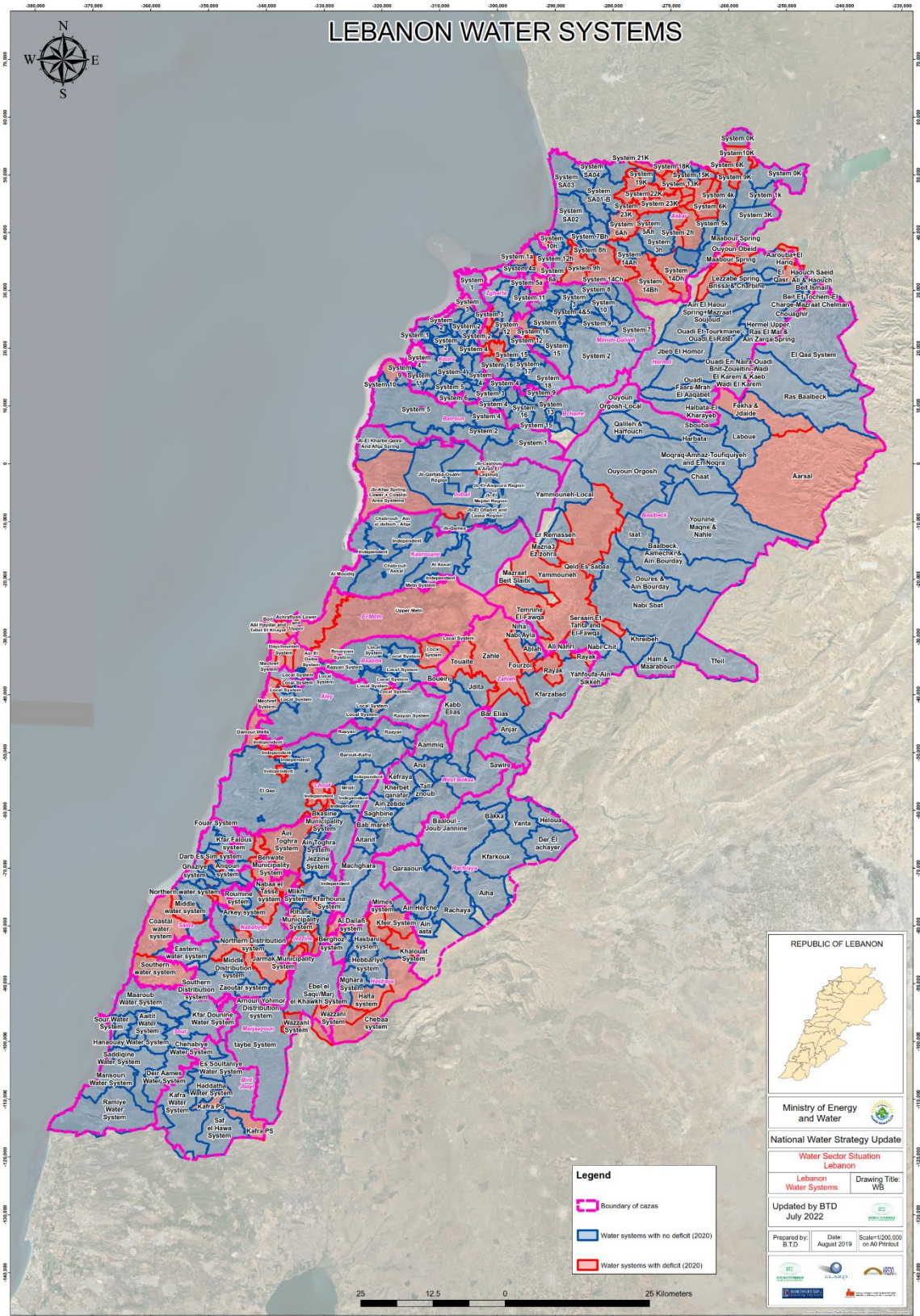


Figure 17 Excess (blue) and Deficit (red) of the Water Balance at the distribution system level









Table 23 Present status of dams considered in the NWSS 2012

Dam Name	Caza	Project status in 2020
<b>NLWE</b>		
Kouachra Lake	Akkar	Constructed (downstream irrigation system needs completion)
Bared Dam	Akkar	Priority 1; design and funds should be secured soon so that the dam is ready when the supply is needed in 2030
Adline Noura Tahta	Akkar	Priority 3; Tender Documents have to be reviewed in view of the water master plan of Akkar
Mseilha Dam	Batroun	Constructed but not yet in use
Balaa Dam	Batroun	Under Construction
Rahwe Dam	Batroun	Priority 2; after year 2026
Qarkaf Dam	Akkar	Technically not feasible
Dar Boochtar Dam	Koura	Priority 2; after year 2026
Iaal Dam	Zgharta	Technically not feasible; the site has been constructed by locals
Brissa Dam	Danniyeh	Constructed; needs concrete lining for which the funds are secured and works should start soon
Ouadi Chich – El Arz	Bcharreh	Financially not feasible ( $\$/m^3 > 26$ )
Atolbe Lake	Akkar	Technically not feasible; the optimal site of the dam has been constructed by locals
Hadath el Jebbeh	Bcharreh	Priority 3; after year 2030
Kammoua Lake	Akkar	Priority 2; after year 2026 and/or when land ownership problems are resolved







It shall be noted that the development of any type of resource will be accompanied or preceded by:

- An effective reduction in Non-Revenue Water, resulting either from technical losses in the transmission and distribution networks or from illicit connections to those networks or due to any other cause.
- The installation of District Meters allowing to track of defaults along the water systems, taking immediate action where these are detected, optimizing the cost of production, increasing the volumes and the hours of water supply to the customers.
- The installation of water meters at household level becoming realistic and efficient at this stage.

Projects are selected and prioritized according to the following criteria:

- Priority 1:
  - Development and expansion of water resources to cover potable water demands, i.e., in water systems having a negative water balance in 2020
  - Provide adequate water storage capacities, i.e. in villages that currently have very small reservoirs compared to the required storage or in those that have very old reservoirs
  - Provide adequate main transmission lines by increasing the capacity of existing ones or replacing very old ones
  - Construction of distribution networks, mainly in villages that currently don't have a distribution network or in those that have very old one (i.e. > 30 years old)
  - Monitoring of the main transmission and distribution lines through the installation of bulk water meters, in order to better control and isolate leakages.
- Priorities 2 and 3:
  - Extension of existing distribution networks
  - Expansion of existing water storage capacities
  - Development and expansion of water resources to address future negative water balances, along with the construction of any related works (i.e. transmission lines, pumping stations and reservoirs).

It should be noted that due to the fine-tuning of the daily per capita demand in the updated strategy of 2020, and because the water balance was calculated at the level of every water source or village or group of localities, many of the water balances resulted in positive figures when projected till the year 2035. The cost estimates of proposed projects is given in Sub-Section 5.4.

Table 25 Summary of proposed transmission lines, distribution network, reservoirs, wells and pumping stations under NWSS 2020

WE	Transmission Lines (km)	Distribution Network (km)	Numbers of Reservoirs	Number of Wells	Number of Pumping Stations	Proposed Priority
BMLWE	421	-	139	36	17	1
	-	3268	-	-	-	2
BWE	483	-	169	110	16	1
	-	1072	-	-	-	2
NLWE	367	-	51	29	2	1
	-	803	-	-	-	2
SLWE	623	-	200	17	15	1
	-	1737	-	-	-	2
TOTAL	1894	-	559	192	50	1
	-	6880	-	-	-	2

#### 2.3.4.4 Wastewater projects

The main objective of the proposed wastewater projects is to protect the environment and the health of the citizens by eradicating or at least minimizing the discharge of untreated wastewater into the environment or in waterbodies. The projects were selected and prioritized according to the following:

- Priority 1:
  - Implementation of new WWTPs and sewer networks in densely populated areas
  - Expansion and upgrade of major existing WWTPs if their treatment capacity isn't enough to treat the influent wastewater (in 2020) or are operating at less than secondary treatment levels.
- Priority 2:
  - Implementation of new WWTPs and sewer networks in less densely populated areas
  - Expansion and upgrade of existing WWTPs if their treatment capacity isn't enough to treat the influent wastewater flows in the near future.
- Priority 3:
  - Implementation of small wastewater treatment units in isolated villages/areas

The total cost of the wastewater projects by priority is given in Sub-Section 5.4.

### 2.3.4.5 Irrigation projects

#### Methodology

The following methodology was adopted to estimate the water demand for each irrigated scheme:

1. Estimation of the total agricultural area for each scheme and the main agricultural types;
2. Estimation of the irrigated areas per scheme using the intensification index of the agricultural land calculated from the MoA Agricultural Census of 2010 as the ratio between the irrigated area and the cultivated land by type (seasonal and permanent);
3. Characterization of seasonal and permanent crops obtained from the MoA Agricultural Census of 2010 based on the FAO classifications;
4. Definition of a cropping pattern for each Mouhafaza
5. Estimation of the water need for each type of crop in all Mouhafazas by elevation ranges;
6. Application of the water needs for latest agricultural areas of the existing schemes using the data of the Remote Sensing Center of the CNRS in 2017.
7. Re-categorization of the seasonal and permanent crops, based on crop types;
8. Delineation of the perimeters of the irrigated areas by irrigation type (gravity, sprinkler or drip).

#### Irrigation Water Balance

The water balance is thus the difference between supply and demand.

It should be noted that:

- A severe water deficit indicates the need for providing new water resources;
- A limited water deficit could be mitigated by network upgrade;
- A remarkable surplus due to a positive water balance indicates the need for water storage.

Negative values that appear in the water balance for the schemes indicate that either there are no sufficient data about public resources or that irrigation is assured through wells, private in general and illegal in many cases. Although this practice is compulsory to feed the need, it puts lot of stress on the Groundwater aquifers and cause depletions and salt-water intrusion for costal ones in the absence of good water management and sufficient storage of surface water.

#### Recommendations

Consequently, the target of this strategy is to address the following (the proposed projects - see Annex IV - are selected accordingly):

- Develop water resources by increasing water harvesting through promoting hill lakes and dams
- Rehabilitate and modernize existing irrigation infrastructure to reduce water losses and improve water efficiency by upgrading water catchment and deviation structures, and by repairing concrete broken structures and converting earthen channels into concrete one.



- Open channel systems to be eventually converted into pressurized piped system. This conversion will enhance modernization of on-farm irrigation systems.
- Accelerate execution of wastewater treatment strategies up to Irrigation acceptable standards and in conjunction with crops selection criteria.
- Perform detailed study for each existing irrigation scheme in order to assess the existing condition, and identify all necessary actions needed to upgrade and modernize the selected scheme.

#### Irrigation projects under SLWE jurisdiction

Prioritization of the projects was elaborated as follows:

- Priority 1: For projects that are included in the Litani River Authority strategy plan. These are:
  - 1st phase of conveyor 800 Irrigation Distribution Networks Project (465 km). The first phase of this project is composed of the transmission system and Related reservoirs is presently under construction.
  - Saida-Jezzine Project - Replacement of 45 km of irrigation networks in the existing project.
- Priority 2 projects include:
  - Second phase of Conveyor 800 - Irrigation Distribution networks (1335 km).
  - Rehabilitation of existing local irrigation schemes in Bint Jbeil, Rashaya, Jezzine, Nabatiyeh, Saida, Sour districts.
  - Construction of 9 hill lakes: The projects are located outside the areas served by the main irrigation projects in order to provide additional water quantities. The locations of the hill lakes were determined in a conceptual manner. A feasibility study should be conducted for the final definition of these projects.
- Priority 3 projects include:
  - Phase II of Khardaleh Dam consisting of the construction of related irrigation distribution networks (1300 km).
  - Construction of Phase II of Ibl es Saqi dam scheme consisting of the construction of related distribution networks (380 km).
  - Rehabilitation and modernization of existing small-scale projects in 39 localities. The projects are located outside the areas served by the main irrigation projects (141 km).

The total proposed area to be irrigated based on the three priorities of projects is around 41,500 ha without taking into consideration the local schemes which constitutes around 80% of the agricultural lands.

#### Irrigation projects under NLWE jurisdiction

The results of the water balance estimation for Akkar and North Lebanon schemes show that the estimated water supply from rivers, springs and few identified wells is 328 Mm<sup>3</sup>; the total crop demand is around 216 Mm<sup>3</sup>. The resulting water balance is a surplus of 128 Mm<sup>3</sup>.



### Prioritized Projects and Cost Estimate

The recommended projects per scheme were organized over four levels of priority throughout the implementation timeframe of this strategy:

- Priority 1 Network upgrade (rehabilitation and/or improvement) for schemes with a negative water balance,
- Priority 2 Hill Lake system construction for schemes with a negative balance, in addition to other projects with a direct impact on the schemes.
- Priority 3 Upgrade and /or expansion of the network for schemes with a positive water balance. Construction of dams to serve adjoining schemes.

The cost estimates of the irrigation projects by priority is given under Sub-Section 5.4.





## 4 DECISIONS TO BE TAKEN BY THE COUNCIL OF MINISTERS

1. Approve that organizational charts/decrees of the Water Establishments will be modified and made general to leave some flexibility for filling their gaps in staffing the way they find appropriate
2. Appeal for funding from the international community to the water sector, to complete ongoing projects, upgrade existing infrastructure to operate at their full capacity, and provide capacity building and technical assistance programs.
3. Approve limited recruitment within the WE's, especially for the management of the wastewater sector. Ideally, permanent employees should be recruited to ensure sustainability; otherwise, On Demand contracts or individual contracts financed by the WE can be temporarily considered, with the aim of making them permanent when the situation allows or the policy of no recruitment changes.
4. Accompany Water Establishments in law enforcement to assist them in removing illegally connection, and provide security forces for this purpose as deemed appropriate.
5. Approve the Water sector recovery plan to ensure financial sustainability of the sector.
6. Approve the increase of the flat Wastewater tariff to allow WE's to cover O&M of Wastewater systems at least partially, until the tariff restructuring study is done.
7. Accompany MoE and Mol in monitoring and controlling industrial and agricultural effluents into wastewater networks and water sources, and provide security forces support for this purpose as deemed appropriate.
8. Ensure payment of arrears to WW operators until end of 2022 to allow donors to provide grant financing to WE's.
9. Nominate a committee composed of a Water Resources Expert, a Groundwater Resources Expert, Legal and Institutional Expert, Environmental Expert, Irrigation Expert and a Dam Expert, headed by the Minister of Energy and Water to follow up the implementation of the Strategy recommendations.









5.4 CONSTRUCTION PROJECTS

Table 29 Consolidated projects cost estimates, by WE  
(in M USD, VAT and expropriation excluded)

	NLWE	BWE	SLWE	BMLWE	Total
<b>Priority 1 projects</b>					
Water	213.02	122.60	330.84	284.66	951.12
Wastewater	351.95	366.43	460.55	296.00	1 474.92
Irrigation	29.12	109.71	86.55	1.02	226.40
Dams	196.02	52.00	-	612.00	860.02
Hill Lakes	33.37	-	-	-	33.37
Aquifer Artificial Recharge (*)					3.65
Meteorological and Hydrometric networks (*)					15.61
General Studies and Investigations (**)					35.78
<b>Total</b>	<b>823.47</b>	<b>650.73</b>	<b>877.95</b>	<b>1 193.68</b>	<b>3 600.87</b>
<b>Priority 2 projects</b>					
Water	130.87	68.77	111.25	312.88	623.78
Wastewater	226.96	70.65	204.23	233.00	734.84
Irrigation	11.20	83.00	408.88	1.15	504.23
Dams	50.00	150.00	273.00	200.00	673.00
Hill Lakes	110.72	55.20	119.70	33.50	319.12
Aquifer Artificial Recharge (*)					11.60
Meteorological and Hydrometric networks (*)					-
General Studies and Investigations (**)					2.50
<b>Total</b>	<b>529.75</b>	<b>427.62</b>	<b>1 117.06</b>	<b>780.53</b>	<b>2 869.06</b>
<b>Priority 3 projects</b>					
Water	-	-	-	-	-
Wastewater	-	-	33.01	116.00	149.01
Irrigation	103.27	4.52	299.70	5.22	412.71
Dams	150.00	107.06	480.00	53.00	790.06
Hill Lakes	22.90	-	-	-	22.90
Aquifer Artificial Recharge (*)					16.50
Meteorological and Hydrometric networks (*)					-
General Studies and Investigations (**)					11.15
<b>Total</b>	<b>276.17</b>	<b>111.58</b>	<b>812.71</b>	<b>174.22</b>	<b>1 402.33</b>
<b>Total Projects</b>	<b>1 629.39</b>	<b>1 189.93</b>	<b>2 807.72</b>	<b>2 148.43</b>	<b>7 872.27</b>
15% Contingencies	244.41	178.49	421.16	322.26	1 180.84
<b>Projects Grand Total</b>	<b>1 873.80</b>	<b>1 368.43</b>	<b>3 228.88</b>	<b>2 470.70</b>	<b>9 053.11</b>

\* Including studies and implementation

\*\* Including General geological studies + PMU and Governance

Table 30 Consolidated projects cost estimates, by sector  
(in M USD, VAT and expropriation excluded)

	Water	Wastewater	irrigation	Dams	Hill lakes	Total
<b>Priority 1 projects</b>						
NLWE	213.02	351.95	29.12	196.02	33.37	823.47
BWE	122.60	366.43	109.71	52.00	-	650.73
SLWE	330.84	460.55	86.55	-	-	877.95
BMLWE	284.66	296.00	1.02	612.00	-	1 193.68
Aquifer Artificial Recharge (*)						3.65
Meteorological and Hydrometric networks (*)						15.61
General Studies and Investigations (**)						35.78
<b>Total</b>	<b>951.12</b>	<b>1 474.92</b>	<b>226.40</b>	<b>860.02</b>	<b>33.37</b>	<b>3 600.87</b>
<b>Priority 2 projects</b>						
NLWE	130.87	226.96	11.20	50.00	110.72	529.75
BWE	68.77	70.65	83.00	150.00	55.20	427.62
SLWE	111.25	204.23	408.88	273.00	119.70	1 117.06
BMLWE	312.88	233.00	1.15	200.00	33.50	780.53
Aquifer Artificial Recharge (*)						11.60
Meteorological and Hydrometric networks (*)						-
General Studies and Investigations (**)						2.50
<b>Total</b>	<b>623.78</b>	<b>734.84</b>	<b>504.23</b>	<b>673.00</b>		<b>2 869.06</b>
<b>Priority 3 projects</b>						
NLWE	-	-	103.27	150.00	22.90	276.17
BWE	-	-	4.52	107.06	-	111.58
SLWE	-	33.01	299.70	480.00	-	812.71
BMLWE	-	116.00	5.22	53.00	-	174.22
Aquifer Artificial Recharge (*)						16.50
Meteorological and Hydrometric networks (*)						-
General Studies and Investigations (**)						11.15
<b>Total</b>	<b>-</b>	<b>149.01</b>	<b>412.71</b>	<b>790.06</b>		<b>1 402.33</b>
<b>Total Projects</b>	<b>1 574.90</b>	<b>2 358.77</b>	<b>1 143.34</b>	<b>2 323.08</b>		<b>7 872.27</b>
15% Contingencies	236.23	353.82	171.50	348.46		1 180.84
<b>Projects Grand Total</b>	<b>1 811.13</b>	<b>2 712.59</b>	<b>1 314.84</b>	<b>2 671.54</b>		<b>9 053.11</b>

\* Including studies and implementation

\*\* Including General geological studies + PMU and Governance

5.5 WATER AND WASTEWATER WORKS COST PER CAPITA

Table 31 Ratio of projects cost per capita

Project	Cost M USD	Population capita	Ratio USD / cap
<b><u>NORTH LEBANON WATER ESTABLISHMENT</u></b>			
<b>Drinking water projects</b>			
NL-W A. District of Batroun	23.72	93 578	254
NL-W B. District of Halba	72.07	377 776	191
NL-W C. District of Koura	31.92	171 508	186
NL-W D. District of Minieh	30.91	167 742	184
NL-W E. District of Ed Danniyeh	32.83	121 074	271
NL-W F. District of Zgharta	48.75	139 251	350
NL-W G. District of Tripoli	30.79	483 451	64
NL-W H. District of Qobayate	72.89	179 838	405
<b>Average →</b>			<b>238</b>
<b>Wastewater projects</b>			
NL-WW A. District of Akkar	361.73	635 838	569
NL-WW B. District of Koura	17.19	171 508	100
NL-WW C. District of Minieh	99.89	167 742	595
NL-WW D. District of Zgharta	50.97	139 251	366
NL-WW E. District of Batroun	49.13	93 578	525
<b>Average →</b>			<b>431</b>
<b><u>SOUTH LEBANON WATER ESTABLISHMENT</u></b>			
<b>Drinking water projects</b>			
SL-W A. District of Nabatiye	85.72	353 107	243
SL-W B. District of Jezzine	39.36	51 764	760
SL-W C. District of Sour	82.46	558 503	148
SL-W D. District of Zahrani	54.74	216 393	253
SL-W E. District of Saida	72.52	331 772	219
SL-W F. District of Bint Jbeil	60.39	146 685	412
SL-W G. District of Marjaayoun & Hasbaya	46.91	120 903	388
<b>Average →</b>			<b>346</b>
<b>Wastewater projects</b>			
SL-WW A. District of Nabatiye	67.15	353 107	190
SL-WW B. District of Sour	78.62	558 503	141
SL-WW C. District of Bint Jbeil	217.86	301 366	723
SL-WW D. District of Jezzine	123.09	51 764	2 378
SL-WW E. District of Saida	30.05	317 202	95
SL-WW F. District of Marjaayoun	106.08	136 057	780
<b>Average →</b>			<b>718</b>

