Strategic Environmental and Social Assessment (SESA) of the Updated National Water Sector Strategy (NWSS) – Ministry of Energy and Water (MoEW)

Council for Development and Reconstruction (CDR)

Deliverable 3 – SESA Draft Report

ECODIT Liban SARL

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AEWA	Agreement on the Conservation of African-Eurasian Migratory Water Birds
AFD	Agence Française pour le Développement
AFDC	Association for Forests, Development and Conservation
AUB	American University of Beirut
AUB-NCC	American University of Beirut-Nature Conservation Center
BAU	Business-As-Usual
BMP	Best management Practices
BOD	Biochemical Oxygen Demand
BWE	Beqaa Water Establishment
CAS	Central Administrations of Statistics
CBD	Convention on Biological Diversity
CDR	Council for Development and Reconstruction
CEDRE	Conférence Économique pour le Développement, par les Réformes et avec les Entreprises
CEPF	Critical Ecosystem Partnership Fund
CIP	Capital Investment Program
CNRS	National Council for Scientific Research
CoM	Council of Ministers
COVID-19	Coronavirus Disease 2019
CPI	Consumer Price Index
CRI	Consultation and Research Institute
DMA	District Metered Area
DGUP	Directorate General of Urban Planning
EBRD	European Bank for Reconstruction and Development
EDL	Électricité du Liban
EIA	Environmental Impact Assessment
EU	European Union
FAO	Food and Agriculture Organization of the United Nations

FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Geographic Information System
GoL	Government of Lebanon
HCUP	Higher Council of Urban Planning
HPEs	High Precipitation Events
IBA	Important Bird Areas
IDAL	Investment Development Authority of Lebanon
IEC	Information, Education, and Communication
IEE	Initial Environmental Examination
IFAD	International Fund for Agricultural Development
IHIS	Integrated Hydrological Information System
ILO	International Labour Organization
IMF	International Monetary Fund
ISIC	International Standard Industrial Classification
IUCN	International Union for Conservation of Nature
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
LARI	Lebanese Agricultural Research Institute
LBP	Lebanese Pound
LCRP	Lebanon Crisis Response Plan
LIBNOR	Lebanese Standards Institution
LMS	Lebanese Meteorological Service
LQPP	Lake Qaraoun Pollution Prevention Project
LRA	Litani River Authority
MCM	Million Cubic Meters

MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoI	Ministry of Industry
MoIM	Ministry of Interior and Municipalities
MoPH	Ministry of Public Health
MSW	Municipal Solid Waste
NAS	National Agriculture Strategy
NBSAP	National Biodiversity Strategy and Action Plan
NC	National Communications
NCMS	National Center for Marine Sciences
NDC	Nationally Determined Contribution (to the UNFCCC)
NFP	National Forest Program
NGO	Non-Governmental Organization
NLWE	North Lebanon Water Establishment
NPMPLT	National Physical Master Plan of the Lebanese Territory
NRW	Non-Revenue Water
NT	Near Threatened
NWSS	National Water Sector Strategy
O&M	Operations and Maintenance
OSME	Ornithological Society of the Middle East
OWL	Other Wooded Land
PA	Protected Areas
PINR	Palm Islands Nature Reserve
PMC	Presidency of the Council of Ministers
PMU	Project Management Unit
PPP	Public-Private Partnership
RCP	Representative Concentration Pathway

RICCAR	Regional Initiative for the Assessment of the Impact of Climate Change on Water resources in the Arab region
RWE	Regional Water Establishment
SCADA	Supervisory Control and Data Acquisition
SDC	Swiss Agency for Development and Cooperation
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SESA	Strategic Environmental and Social Assessment
SLWE	South Lebanon Water Establishment
SOER	State of the Environment Report
SPAMI	Specially Protected Area of Mediterranean Importance
TA	Technical Assistance
TCNR	Tyre Coast Nature Reserve
TSE	Treated Sewage Effluent
TTW	Test the Water
TWEs	Treated Wastewater Effluents
UAA	Utilized Agriculture Area
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN-ESCWA	United Nations Economic and Social Commission for Western Asia
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
USD	United States Dollar
USJ	Université Saint Joseph
WASH	Water, Sanitation, and Hygiene
WSmix	Water Supply Mix

WB	World Bank
WBDS	Water Bodies Dependent Species
WDM	Water Demand Management
WEAP	Water Evaluation and Planning System
WFP	World Food Programme
WHO	World Health Organization
WSC	Water, Sanitation, and Conservation
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

BACKGROUND

The water sector in Lebanon is facing detrimental challenges, hindering the ability of the government to supply adequate and reliable water services while conserving Lebanon's water resources. Although the national coverage of water networks is around 80%, the quality of the supplied public water is questionable due to the lack of protection of water resources, insufficient water treatment at the supply level, deteriorated distribution networks, and the absence of continuous monitoring. Untreated wastewater, which accounts for around 70% of the total generated wastewater, is being directly discharged into the environment, thus polluting the groundwater and surface water resources that supply a significant portion of Lebanon's potable water. The pollution of water resources, in addition to the poorly managed water supply networks, have impacted the quality of water at the household level. An estimated 65% of the population does not have access to safely managed drinking water services.

The absence of continuous Surface Water (SW) and groundwater (GW) resources quantity and quality monitoring, and adequate data collection and management in Lebanon translates into a lack of reliable national water balance that can be used for the development of effective water management plans. Estimates provided by MoEW suggest that the population relies mostly on GW supply (springs and wells), constituting 83% (~1,587 MCM/year) of the total supply, tapping on 58% (~1,595 MCM/year) of the total available GW on the national level. Private wells provide the highest percent supply (33%; ~631 MCM/year), followed by springs (31%; ~593 MCM/year) and public wells (18%; 344 MCM/year).

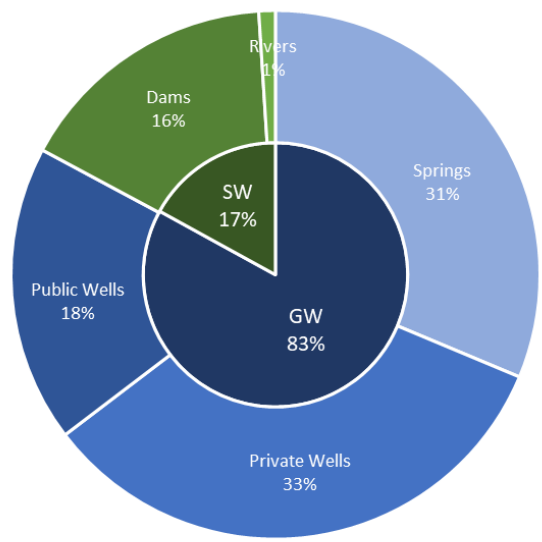


Exhibit 1. Current Water Supply Mix (2020)

Chronic water sector challenges are being exacerbated by the various crises that began in late 2019, including the economic collapse, fuel shortage, and the COVID-19 pandemic. UNICEF estimates that the price of water purchased from private water suppliers could increase by 200% a month, with more than 71% of people at immediate risk of losing access to safe water. As a result of the lack of sustainable water services and conservation of Lebanon's water resources, citizens lost trust in the governmental water authorities, resorting to unsustainable alternative private sources to secure potable water and irrigation needs and to manage their wastewater.

The governmental authorities currently managing the country's water sector are the MoEW and the public water investment institutions: the four RWEs (Beirut and Mount Lebanon, South, North and Beqaa water establishments) and the LRA. The four RWEs are not achieving cost recovery - a primary reason behind the insufficient provision of water services. The RWEs are being deprived of significant revenues considering that (1) the Non-Revenue Water (NRW) is more than 45% across Lebanon due to the lack of maintenance and presence of illegal connections, (2) customer-metered connections are around only 10% nationwide, (3) billing and collection rates are as low as 30% in some areas, (4) the flat tariff structure does not encourage a long-term water conservation behavior change among citizens, among other reasons.

To address structural changes in the water and wastewater sector and emerging challenges facing water resources management, the MoEW updated the 2012 National Water Sector Strategy (NWSS). In compliance with the Strategic Environmental Assessment (SEA) Decree 8213/2012 and funded by World Bank (WB) Lebanon – Lake Qaraoun Pollution Prevention Project, the Council for Development and Reconstruction (CDR) contracted ECODIT Liban (henceforth “ECODIT”) to prepare, in collaboration with Ministry of Energy and Water, a Strategic Environmental and Social Assessment (SESA) for the Updated NWSS-MoEW (2020).

The report seeks to satisfy the following objectives: (1) Assess the environmental and social impacts of the Updated NWSS-MoEW (2020) with the necessary stakeholder engagement and (2) Provide recommendations and high-level policy advice to MoEW to optimize the Updated NWSS-MoEW (2020) and mitigate potential adverse environmental and social impacts.

SESA METHODOLOGY

Although the SESA Draft Report is considered as an update of the previous SEA (2015) for the NWSS-MoEW (2012), ECODIT applied a shift in its methodological approach to enhance the SESA's impact in influencing the decision-making process. ECODIT adopted a “hybrid” overall approach that combines “policy” and “impact-centered” SESA approaches. The methodological steps conducted by the SESA team are presented below:

(1) Assessment of physical, biological , and socio-economic baseline conditions to understand the state of the environment and specifically the current situation of the water sector in Lebanon.
(2) Review of legal, institutional and policy frameworks governing the water sector – including legislation and regulations, multilateral agreements and conventions – as well as relevant national and regional plans, programs and projects.
(3) Stakeholder Engagement through two phases: (1) focused consultation meetings and (2) public consultation meetings.
(4) Assessment of the impacts of the Updated NWSS-MoEW (2020) based on specific and cross-cutting key themes (presented in the figure below).

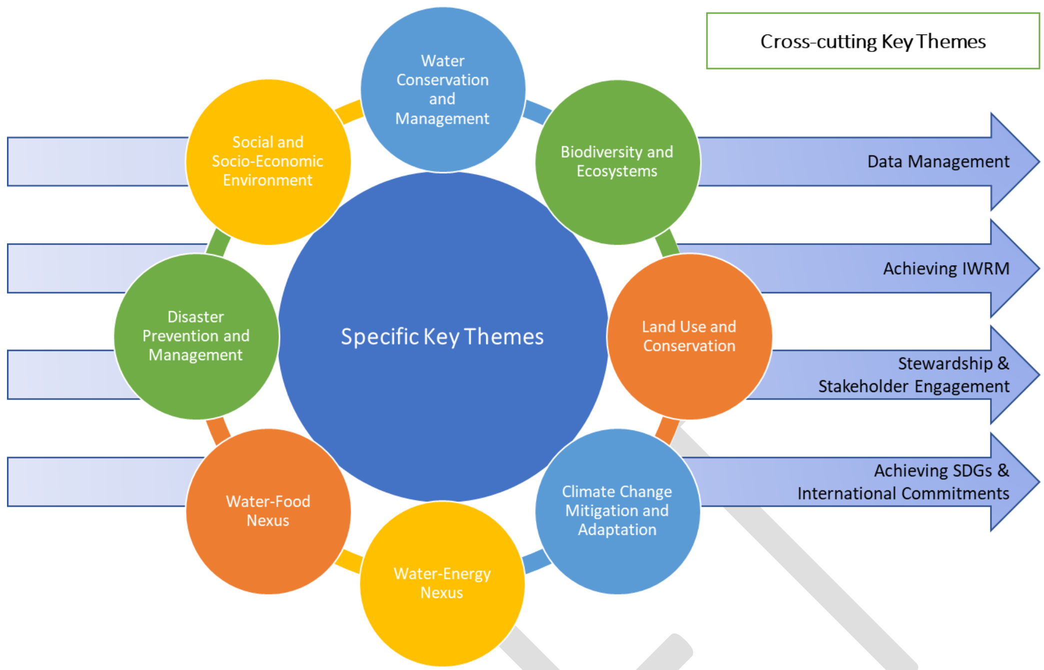


Exhibit 2. Specific and Cross-cutting SESA Key Themes

During the SESA preparation, ECODIT has been sharing with MoEW preliminary findings/recommendations to be integrated in the Updated NWSS-MoEW (2020). Accordingly, MoEW is reviewing the Updated NWSS- MoEW (2020) in parallel to the SESA preparation and finalization.

DESCRIPTION OF THE UPDATED NWSS-MOEW (2020)

The Updated NWSS-MoEW (2020) plans the water sector for the years 2020-2035 and aims to "Ensure equitable access to water and sanitation services for all". It entails a wide range of legal, institutional, technical, and financial recommendations and actions. It also includes a list of proposed projects across the Lebanese territory, divided geographically under each RWE jurisdiction. The figure below illustrates the strategy's vision, pillars, and overall objective.

All strategy initiatives are grouped under three pillars:

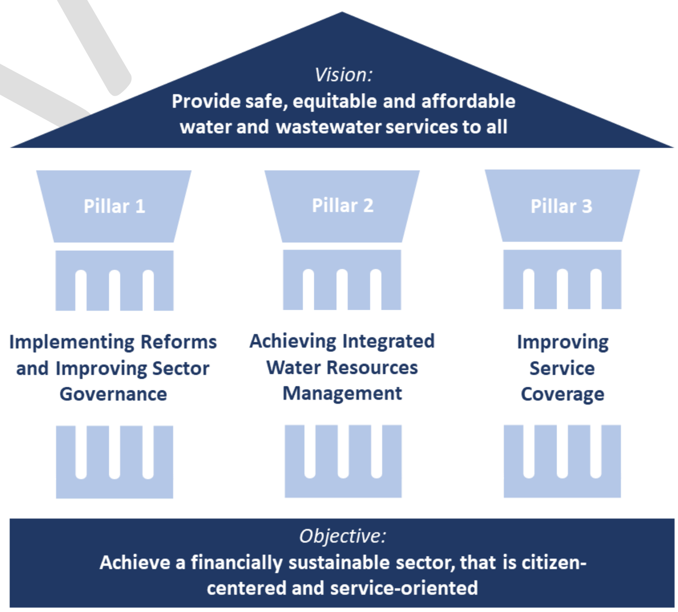


Exhibit 3. Updated NWSS-MoEW (2020) Vision, Pillars, and Objective

Pillar 1: Implementing Reforms and Improving Sector Governance

Exhibit 4. Summary of Pillar 1 Strategy Component in Updated NWSS-MoEW (2020)

Pillar 1 Aims	Pillar 1 Strategy Component	Summary of Key Initiatives	Cost Estimate (USD)
-Build solid legal, institutional, financial, commercial, and monitoring frameworks. -Enhance communication mechanisms and increased transparency with stakeholders, as well as a shift in the data sharing culture.	Legal and Institutional Framework	- Implementation of the legal and regulatory framework: Water Code and RWE organizational and operational decrees. - Establishment of mechanisms for performance monitoring within MoEW and RWEs.	1,465,000
	Financial and Commercial	- Revision of the tariff structure and implementation of consumption-based tariffs.	6,750,000
	Reporting and Monitoring	- Set-up of monitoring and reporting mechanisms to facilitate public communication.	1,257,500
	Capacity Building	- Preparation and implementation of a training/capacity building plan.	2,950,000
	Operation and Maintenance of Facilities	- Development of performance-based contracts. - Preparation of study to propose framework for wastewater facilities management.	660,000
		Total Cost Estimate for Pillar 1	13,082,500

Pillar 2: Achieving Integrated Water Resources Management

Exhibit 5. Summary of Pillar 2 Strategy Component in Updated NWSS-MoEW (2020)

Pillar 2 Aims	Pillar 2 Strategy Component	Summary of Key Initiatives	Cost Estimate (USD)
-Improve infrastructure planning and water allocation among economic sectors. -Target continuous measurement and	Integrated Hydrological Information System (IHIS)	- Implementation, operation, and supervision of IHIS[1] and Water Evaluation and Planning System (WEAP).	9,548,000
	Meteorological and Hydrometric Networks	- Expansion of meteorological and hydrometric network.	6,066,000
	Project Management Unit (PMU)	- Implementation of PMU for five-year period.	8,505,000

[1] A hydrological information system for all public and private water sector stakeholders to manage, publish and share their data, products, and services.

Pillar 2 Aims	Pillar 2 Strategy Component	Summary of Key Initiatives	Cost Estimate (USD)
monitoring of the quantity and quality of available groundwater and surface water resources across the country and address environmental concerns.		- Monitoring of springs and public wells.	
	General Geological and Hydrological Studies	- Geology and hydrogeological mapping, modelling, and studies.	21,800,000
	Drilling and Testing Exploratory Wells	- Drilling and testing 14 reconnaissance and exploratory wells to detect new potential aquifers.	6,150,000
	Artificial Aquifer Recharge (AAR)	- AAR studies at six identified sites.	31,750,000
	Water Quality Management and Monitoring	- Implementation of Water Safety Plan by all RWEs. - Publish 161:2016 LIBNOR water quality standards.	N/A
	Wastewater and Sludge Management	- Investigate and analyze the existing potential for sludge reuse.	N/A
	Strategic Environmental Assessment of the Updated NWSS-MoEW (2020)	- Development of an SEA in compliance with Decree 8213/2012.	N/A
		Total Cost Estimate for Pillar 2	83,819,000

<u>Pillar 3:</u> Improving Service Coverage

Exhibit 6. Summary of Pillar 3 Strategy Component in Updated NWSS-MoEW (2020)

Pillar 3 Aims	Pillar 3 Strategy Component	Summary of key Initiatives	Cost Estimate (Million USD)
- Proposes infrastructure projects in the water, wastewater, and irrigation sectors	Potable Water	- Upgrade and/or rehabilitation of water distribution systems to meet 2035 water demands.	1,574.33
	Wastewater	- Construction of 182 WWTPs with a total design capacity of 1,196,875 m^3/day - Rehabilitation, replacement, and upgrade of sewers	2,204.110
	Irrigation	- Rehabilitation and/or upgrade of irrigation schemes.	1,142.975
	Dams and Hill Lakes	- 14 dams proposed with around 683 MCM/year of water storage. - Construction of hill lakes.	2,151.450
		Total Cost Estimate for Pillar 3	7,072.865

The proposed initiatives are assigned a priority level based on the order of urgency according to general criteria. Section 3 of the SESA provides a detailed summary of all proposed Updated NWSS-MoEW (2020) initiatives.

LEGAL, INSTITUTIONAL, AND POLICY FRAMEWORKS

In the last five years, the most notable advancement in the water sector legal framework was the promulgation of the Water Code in 2018 and its amendment Law 192/2020. The amended Water Code aims to update and modernize the water sector's legal, financial, and institutional dimensions.

The main institutions involved in the water sector include: MoEW, four RWEs, LRA, CDR, the Ministries (Environment, Agriculture, Industry, Public Health, and Interior and Municipalities), and the Council for the South. Several other stakeholders support the water sector but do not have direct responsibilities mandated by law, including international donor agencies, the academic and research sector, non-Governmental Organizations, and the private sector.

Section 4 of the SESA reviews all relevant legislation and regulations, multilateral agreements and conventions, as well as plans, programs and projects in the water sector and relevant to the SESA assessment.

ASSESSMENT OF BASELINE CONDITIONS

Physical Environment

Despite all efforts, Lebanon still lacks a complete and inclusive long term annual average water balance that can be used for water management plans (MoEW, 2020). A summary of the water resources in Lebanon is provided below.

Exhibit 7. Water Resources in Lebanon (Source: MoEW, 2020)

Surface Water (Total available surface water is 1,475 MCM/year)	**Rivers**	• Total of 40 rivers – 16 perennials and 24 seasonal • Total exploitable surface water from rivers is around 1,475 MCM/year. • Existing volume exploited from rivers is 14 MCM/year.
	Dams	• Six operational dams/hill lakes: Chabrouh Dam (Mount Lebanon), Ballout Lake (Mount Lebanon), Qaysamani Lake (Mount Lebanon), Kouachara Lake (Akkar), Yammouneh Lake (Baalbek-Hermel) and Qaraoun Dam (Beqaa) with a total dynamic capacity of around 314 MCM/year mainly concentrated in Qaraoun and Chabrouh dams.
Groundwater (Total available groundwater resources is 2,750 MCM/year)	**Springs**	• Total number of springs exceeds 2,000 with 275 tapped springs. • Total exploitable spring discharge exceeds 2,050 MCM/year; maximum available discharge in dry months is 200 MCM/year. • Average actual extraction volume from springs is 594 MCM/year; 315 MCM/year for irrigation and 280 MCM/year for potable water.
	Wells	• Total exploitable renewable groundwater is 700 MCM/year • Total number of public wells is 1,615. • Total number of private wells is 85,000. • Actual extraction volume from public wells is 350 MCM/year (based on 12 hours per day operation). • Actual extraction volume from private wells is 640 MCM/year. • Almost all existing public wells are used for potable water.

		• An estimated 50% of extracted volume from private wells is used for irrigation.
Non-conventional Water	• Re-use is being practiced in Ablah WWTP in Beqaa for the irrigation of 20 ha. • Presence of minor hill lakes for irrigation and some household-level rainwater harvesting systems scattered across the territory.	

In addition to the challenges associated with the proper and sustainable management of water resources to meet the national water demands, high pollution levels in many of Lebanon's water sources have made them unusable or require high-cost treatment prior to use. Given that only 30% of wastewater is being treated (~292,918 m^3/day), the open discharge of untreated domestic wastewater is reportedly the main source of contamination of surface water; while other sources include point sources from industrial, healthcare, quarries and touristic establishments, as well as agricultural run-off. Groundwater quality has been also deteriorating due to water contamination as a result of both over-pumping and human activities. Sewage seepage and agricultural sources have been reported to cause nitrate pollution in groundwater sources.

Moreover, climate change, which has led to high intra- and inter-annual climate variability in Lebanon, is also leaving a high level of uncertainty regarding projected changes in water availability and water quality. End-century climate change trajectories suggest an increase in temperature in Lebanon by up to 3.2°C and a decrease in precipitation by 4%-11%[2]. The projected climate change impacts include, among others: a decrease in water availability by 29% in 2080, a decrease in agricultural activity, and an increase in droughts, floods and forest fires. Section 5.1 of the SESA describes the physical environment, including water resources and wastewater management, climate change, land resources, and natural hazards.

Biological Environment

Lebanon offers 3 Biosphere Reserves (Shouf Biosphere Reserve, Jabal Moussa, and Jabal El Rihane), 18 protected forests, 16 protected sites, 4 Ramsar Sites, 5 World Heritage Sites, 15 Important Bird Areas, and 26 Hima managed by Municipalities.

Riparian habitats in Lebanon are critical ecosystems; they extend from the edge of a water body to the edge of the upland community and constitute important habitats for wildlife, particularly for breeding birds. Moreover, river systems emptying into marine waters have very irregular flows, carrying high concentrations of sewage waste, sediment loads, and industrial and agricultural pollutants. Anthropogenic pressure on water resources from highly populated coastal urban areas (particularly the coastal area of Beirut and Mount Lebanon) Is threatening the life of sea birds, sea turtles, monk seals, dolphins, whales, and other globally threatened species.

[2] Compared to the baseline period of 1986-2005. Projections conducted by the Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources in the Arab Region (RICCAR).

Section 5.2 of the SESA describes the baseline biological and natural environment, specifically terrestrial, riparian, and coastal and marine ecosystems in Lebanon.

Socio-Economic and Cultural Environment

With the increased population growth (including influx of Syrian refugees), uncontrolled urban expansion, unprecedented economic, financial, monetary, and social crisis, blast of Beirut Port, COVID-19 pandemic and other factors, the following challenges with the provision of water services have been aggravated:

- Nearly 1.7 million people have access to only 35 liters of water a day, a decrease of almost 80% against the national average of 165 liters pre-2020.
- Blackouts and intermittent power supplies are threatening the capacity of the water system to treat, pump and distribute water.
- Public water utility providers can no longer afford essential spare parts for maintenance or fuel for their electricity generators as they had no access to hard currency due to the collapse of the Lebanese currency against the USD.
- Limited capacity to mobilize future required funds for capital investment purposes, including investments in the water sector

Section 5 of the SESA presents a baseline description of the socio-economic and cultural environment in Lebanon including population growth and urbanization, poverty and socio-economic crises, water consumption and expenditure patterns, and the agricultural, industrial, and touristic activities.

STAKEHOLDER ENGAGEMENT AND CONSULTATION ACTIVITIES

In compliance with SEA Decree 8213/2012, ECODIT conducted an extensive stakeholder consultation process, through focused consultation meetings and public consultation meetings. The aims of these consultations were to (1) gain key insights and opinions on the water sector in Lebanon and the Updated NWSS-MoEW (2020) (2) enhance strategic recommendations, and (3) solicit feedback on SESA process and outcomes.

ECODIT divided the SESA stakeholder engagement process into two phases:

Phase 1: Focused Consultation Meetings

The targeted stakeholders' meetings, which started in November 2021, involved virtual and in-person one-to-one or focus group meetings with more than 70 governmental and non-governmental stakeholders in the water sector, including water authorities and Ministries, active Non-Governmental Organizations (NGOs) and civil society, development and funding agencies, research centers and academic institutions, and other experts working in the field.

Stakeholders consulted in the focused consultation meetings provided diverse feedback regarding the Updated NWSS-MoEW (2020). Common technical concerns regarding the strategy were that it did not clearly tackle environmental components, particularly those related to the management of the wastewater sector and protection of resources. Out of the three strategy pillars, stakeholders tended to prioritize "Pillar 1: Implementing Reforms and Improving Sector Governance". Nevertheless, there was a common consensus that the three pillars of the strategy should be implemented in parallel, with focus on water resources management (data collection and storage, water demand management, and the protection of water resources) and institutional water sector reforms.

Phase 2: Public Consultation Meetings

Starting August 2022, ECODIT will organize several stakeholders' consultation meetings to solicit the feedback of the general public on the Updated NWSS-MoEW (2020) and inform them about the results and recommendations of the SESA Report. To maximize the participation of stakeholders from citizens, government, local authorities, international organizations, research and academic institutions, and the private sector, ECODIT will conduct four general consultation meetings divided by Water Establishment jurisdiction (Beirut and Mount Lebanon, North Lebanon, South Lebanon, and Beqaa).

Section 6 of the SESA compiles all information gathered from the stakeholder engagement process conducted.

ASSESSMENT OF POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS RESULTING FROM THE UPDATED NWSS-MOEW (2020)

ECODIT evaluated potential impacts of the implementation of the Updated NWSS-MoEW (2020) on the selected specific and cross-cutting key themes. The impacts are presented in the Exhibit 10 of this Executive Summary.

ANALYSIS OF ALTERNATIVES TO THE PROPOSED STRATEGIC ACTION

Section 8 of the SESA identifies five alternatives that aim to enhance the scientific dialogue regarding Lebanon's water sector and narrow the gaps between policy making and public opinion. In all alternatives, the percent reliance on GW is higher than that of SW knowing that not all available resources could be exploited as temporal distribution is not aligned with irrigation/agricultural season. On an international level, countries are implementing policies towards the sustainable use of water, reflected through the management of groundwater over-exploitation and increase in surface water exploitation and storage to meet domestic, industrial and agricultural water demand[3]. The alternative scenarios are summarized below:

[3] (Semi)-Arid but also temperate example countries include:
Spain ~ 78% SW; 22% GW (OECD,2011),
Morocco ~ 80% SW; 20% GW (Hssaisoune et. al., 2020),
Greece ~ 58% SW; 42% GW (EASAC, 2010), and
France ~ 50% GW, 50% SW (Marechal & Rouillard, 2020)

Exhibit 8. Summary of Scenarios Considered

Scenario		Description
Do Nothing Alternative		The future baseline (2035 status) without the implementation of Updated NWSS-MoEW (2020) which entails the following: - Challenges associated with the proper and sustainable management of water resources to meet the national water demands - Polluted water sources - Citizen relying on private water sources (private wells, water tankers) Accordingly, without effective action to increase supply and improve water quality, Lebanon would be in danger of facing severe water shortages in the near future.
Water Supply Mix Alternatives	Current Status 2020	Represents the baseline scenario; the general status of 2020.
	Scenario 1: "Updated NWSS-MoEW (2020) Scenario"	Represents the general status of 2035 with the implementation of the Updated NWSS-MoEW (2020)
	Scenario 2: "Updated NWSS-MoEW (2020) Scenario with Addition of Non-conventional Water Sources	Represents a duplicate of Scenario 1 of the general status of 2035, but includes the use of non-conventional resources as a water supply source
	Scenario 3: " Updated NWSS-MoEW (2020) Scenario with increase in supply from SW sources	Considers that all the proposed dams in the Updated NWSS -MoEW (2020) will be completed by 2035
	Scenario 4: "Updated NWSS-MoEW (2020) Scenario with increase in supply from GW sources	Considers that only the dams under construction will be completed and operational by 2035 (Janneh Dam, Mseilha Dam and Boqaata Dam)

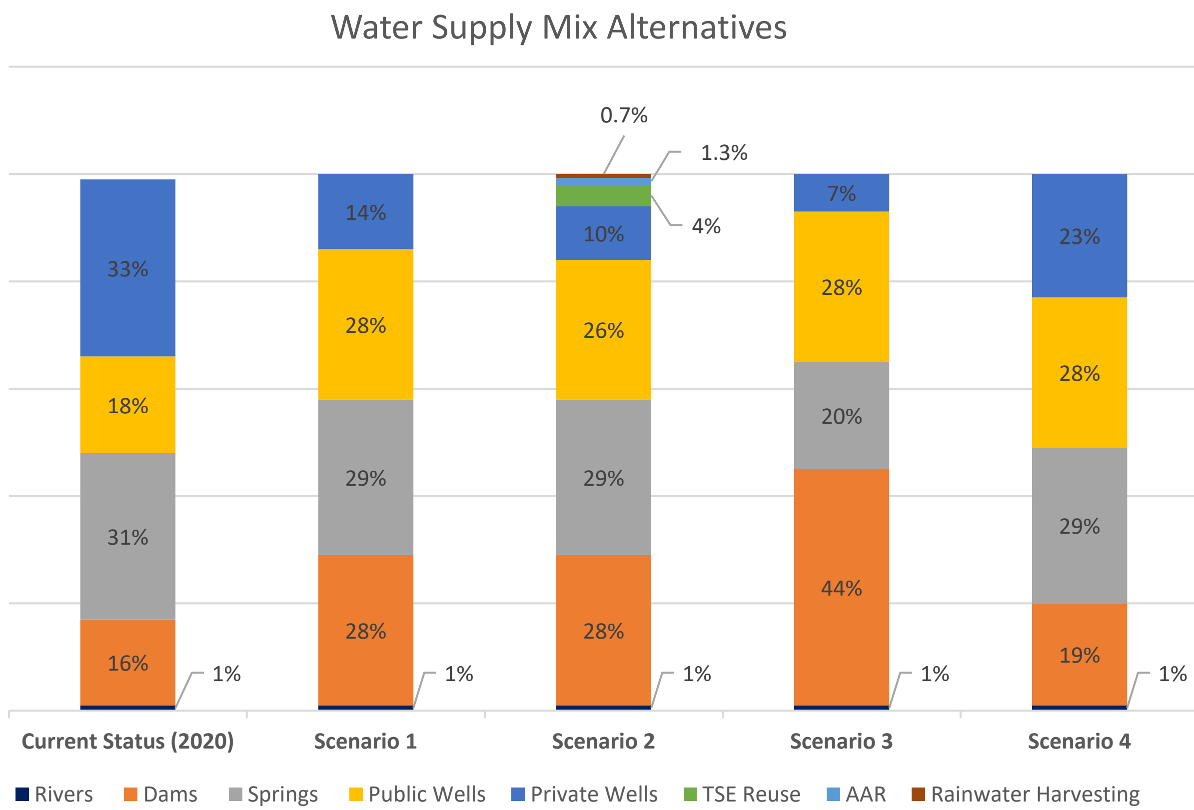


Exhibit 9. Water Supply Mix Alternatives

The scenario analysis showed that increasing supply from groundwater (Scenario 4) will exacerbate over pumping from aquifers, which necessitates to a certain extent the need for water storage in dams at the national scale (but does not justify the proposed dam locations or engineering design). The overexploitation and over-pumping of groundwater aquifers can lead to a drop in the groundwater level in most inland aquifers, seawater infiltration in coastal aquifers, and deterioration of the water quality. Furthermore, the construction of dams (Scenario 3) will significantly reduce direct costs associated with securing water supply from private sources incurred by the society. However, this does not necessarily indicate that dams, which are highlighted in the Updated NWSS- MoEW (2020) to compensate for the water supply in 2035, appear with no cost overruns. Moreover, large dam projects are heavy on the government treasury (USD 2.12 Bn excluding Bisri Dam), and they result in ecological, economic, and social costs. Nevertheless, regardless of the adopted scenario, it is crucial to:

- Develop an integrated watershed management strategy prior to the implementation and completion of proposed dams in the Updated NWSS -MoEW (2020). This will minimize and mitigate risks and damages and reduce expenses incurred by the citizen.
- Focus on increasing network efficiency to 75%, as this is a main assumption in the Updated NWSS -MoEW (2020), which has a great impact on water demand and is a main condition for sustainable water management. Although this will not offset the need for additional dams, it will reduce groundwater pumping.

- Regulate abstraction from groundwater wells, including private ones.. However, under the current circumstances, water supply from private wells cannot be reduced to null as several agricultural schemes will still be relying on it.
- Promote additional R&D efforts to assess the potential of increasing the reliance on non-conventional resources.

SELECTION OF THE «MOST SUITABLE STRATEGIC OPTION »

Based on the above, the Updated NWSS-MoEW (2020) (Scenario 1) is “the most suitable strategic option” from an environmental and social perspective, in that it is a necessary strategy which does not have irremediable negative impacts and for which there are no clearly superior available alternatives. However, the Updated NWSS-MoEW (2020) must remain flexible and can be greatly enhanced by researching and adopting other options and/or complementary measures for achieving the same goals. More importantly, the strategy can be best improved by prioritizing the governance-related initiatives to strengthen the institutional capacities and ensure sustainability of projects. For these measures to unfold, it is important that MoEW continues to moderate an open-minded and transparent discourse on Lebanon’s water strategy with all relevant stakeholders. In other words, water planning must not end in 2020 when the Updated NWSS (2020) was compiled but, rather, should adapt to the growing uncertainties and emerging opportunities in the water sector. However, it is recommended that the Updated NWSS-MoEW (2020) is implemented taking into consideration the mitigation measures and policy responses outlined in the “Framework to Optimize the Environmental and Social Effects of the Strategy” and “Recommendations for Integrating Sesa Findings in the Updated NWSS-MoEW (2020)” sections of the SESA.

A FRAMEWORK TO OPTIMISE THE ENVIRONMENTAL AND SOCIAL EFFECTS OF THE STRATEGY

The SESA compiles a list of policy responses and mitigation measures with responsibilities distributed among all stakeholders involved in the water sector, including the MoEW, MoE, CDR, RWEs, and others (listed in the table below). It also outlines other required responses, including:

(1) Advance the IWRM implementation through strengthening political will, enhance coordination between stakeholders, improving data and information sharing, and building capacity through IWRM-specific training.
(2) Re-prioritization of projects classified as Priority 1 to identify the projects which have the most significant positive impact and are required to achieve the projected development in the sector.
(3) Strengthen the EIA/EMP process as it is essential to ensure environmental compliance of the infrastructural projects proposed in the strategy.
(4) Ensure that water resource allocation regime and water demand management takes into consideration not only gradual changes in water availability due to climate change, but also sudden changes due unexpected climatic shifts.

(5) Ensure that the MoEW develops a sector investment program, to ensure that viable financing is available for the implementation of the Updated NWSS-MoEW (2020) proposed projects and their operation.
(6) Ensure that the MoEW enhances information sharing, communication, and coordination between the concerned stakeholders, including the public, on issues related to the water sector.

In addition, Exhibit 10 in this Executive Summary presents the mitigation strategies and policy responses recommended for the key themes discussed throughout the SESA report.

RECOMMENDATIONS FOR INTEGRATING SESA FINDINGS IN THE UPDATED NWSS-MOEW (2020)

ECODIT team attempts to highlight priority recommendations for integrating SESA findings in the Updated NWSS-MoEW (2020).

(1) **Integration of Mitigation Strategies/Policy Recommendations into Updated NWSS-MoEW (2020):** It is advised to begin with the integration of the "priority" SESA policy responses and mitigation measures[4] into the Updated NWSS-MoEW (2020) and continue with the integration of all other SESA policy responses and mitigation measures in the upcoming revised/updated strategies.
(2) **Oversight and Monitoring:** There is an urgent need to clearly assign responsibility for oversight and monitoring of the Strategy.
(3) **Research and Development (R&D):** Promote additional R&D efforts to assess the potential of increasing the reliance on non-conventional resources, as well as to address different water sector challenges.
(4) **National Water Dialogue:** Transparency and stakeholders' engagement is crucial for the successful implementation of the Strategy.
(5) **Appraisal of the Updated NWSS-MoEW (2020) Implementation:** There is a strong need for a "mid-term appraisal" of the Strategy through which lessons from experiences could be learned, targets and methodologies could be re-assessed, and SESA safeguards could be implemented.
(6) **Iterative Process for Revisions:** As stipulated in the Water Code, the strategy should be revisited every 5 years.

[4] ECODIT has highlighted from the mitigation measures/policy recommendations listed in the table above the "priority" responses that could be integrated immediately into the Updated NWSS-MoEW (2020).

Exhibit 10. Summary of Impacts, Mitigation Strategies/Policy Responses, and Responsibilities

Main Impacts	Mitigation Strategies and Policy Recommendations to Optimize Environmental and Social Impacts	ID	Responsibility
KT1. Water Conservation and Management			
Sustainable Resources Allocation and Efficient Water Use			
⊖ Impacts on sustainable resource allocation: - Absence of well-founded water balances due to data limitations, particularly estimations for evapotranspiration, snow cover contribution, and groundwater resources leaving Lebanon. - District-level water balances used to determine proposed infrastructure projects under Pillar 3 are not well optimized. Detailed quantification of demand and available water resources are yet to be done. - Lack of initiatives addressing the issue of uncontrolled groundwater extraction from private wells. ⊖ Estimation of demand across the various economic sectors does not seem to consider current and expected future sector productivity and the economic value derived from the productive uses of the available water, nor the strategies and plans of the concerned Ministries for the development of their respective sectors at the national or district level, and consequently their projected water needs. ⊕ Proposed irrigation initiatives focus more on water demand management which will positively impact water resources.	• Identify existing available water resources in each watershed basin based on best available scientific evidence (i.e., data collected from the IHIS proposed in the Strategy).	KT1.1	MoEW, RWE's, LRA
	• Revise the national water balance based on updated data following implementation of initiatives under Pillars 1 and 2.	KT1.2	
	• Improve the inter-ministerial coordination to optimize current and future sectoral demands: - Align current and future Ministerial strategies/vision, particularly those of the MoI, MoA, and MoT.	KT1.3	
	• Develop a well-designed water allocation regime with the following objectives: - Economic efficiency, by allocating resources to higher value uses, according to a National Economic Plan once set by GoL - Water use efficiency through innovation and investment in the sector. - Environmental performance by securing adequate flows to support ecosystems services. - Equity by sharing the risks of shortage among water users fairly.	KT1.4	
	• Assess the impact of the proposed infrastructural projects (dams, hill lakes, wells, etc.) on water availability and aquifers and accordingly optimize the management (i.e., extraction rates, etc.).	KT1.5	
	∗ **Empower and define the role of the Lebanese Center for Water Conservation and Management within the MoEW to promote policies that aim to develop and implement water conservation initiatives in the sector.**	**KT1.6**	
	∗ **Review Lebanon's dam experience to-date to inform the planning, design, construction, and operation phases of dam implementation.**	**KT1.7**	MoEW
	• Amend Building Regulations to include a requirement for a minimum standard of water efficiency in new facilities.	KT1.8	DGUP, OEA
Water Demand Management			
⊖ The following deficiencies identified in the strategy will hinder sustainable resource allocation: - Initiatives that reduce water losses in domestic supply schemes do not consider Better Management Practices (BMPs). - The strategy does not consider ecosystem water demands (particularly with the new water-energy-food-ecosystems nexus).	∗ **Develop a long-term national strategy to promote social behavior change and encourage consumers to efficiently use water.**	**KT1.9**	MoEW
	∗ **Propose initiatives to curb the uncontrolled groundwater extraction from private wells.**	**KT1.10**	
	∗ **Propose initiatives – with a defined budget and timeline – to reduce Non-Revenue Water (NRW).**	**KT1.11**	
	∗ **Prioritize rehabilitation of the distribution networks to minimize losses.**	**KT1.12**	
	∗ **Encourage investment in water loss reduction systems (i.e. active leak detection, pressure management, etc.).**	**KT1.13**	
	∗ **Strengthen regular network maintenance programs.**	**KT1.14**	
	∗ **Direct new funds towards installation, reading and maintenance of bulk and district meters, and ensure the availability of continuous funding for calibration and maintenance.**	**KT1.15**	
	• Promote installation of water saving devices for domestic use.	KT1.16	
	• Assess potential financial incentives to encourage residents and business owners to make investments in water efficiency.	KT1.17 (KT1.9)	
	• Develop programs to promote water efficiency at the household level, through partnerships with manufacturers, retailers and distributors, homebuilders, and contractors and develop branding labels.	KT1.18 (KT1.17) (KT1.9) (KT1.8)	
	• Establish minimum water efficiency specifications through codes and standards.	KT1.19 (KT1.8)	
	• Develop programs to build the capacity of contractors to retrofit facilities for water savings.	KT1.20 (KT1.18) (KT1.17) (KT1.19)	
	• Provide technical support for industries to improve water efficiency and wastewater management.	KT1.21	MoEW, MoI

Main Impacts	Mitigation Strategies and Policy Recommendations to Optimize Environmental and Social Impacts	ID	Responsibility
	* Establish monitoring frameworks to track the quantities of water used per industrial sector. Accordingly, tailored water conservation programs can be developed.	**KT1.22**	
	● MoEW to collaborate with MoA to advocate changes to agricultural practices to reduce the demand for water.	KT1.23	MoEW, MoA
	● MoA to produce irrigation best practices guide and water management toolkit for field crop growers.	KT1.24	
	● Improve efficiency of bulk irrigation water supply.	KT1.25 (KT1.23)	
	* Introduce appropriate water tariffs and incentives in order to promote water efficiency in irrigation and higher economic returns for irrigated agricultural products.	**KT1.26**	
	* MoEW to collaborate with and encourage MoA to consider the use of targeted adaptation funds or temporary technological subsidies to support farmers in adopting on-farm measures to enhance water efficiency (such as crop rotation, adjusting planting times, etc.).	**KT1.27** (KT1.25) (KT1.23)	
Non-Conventional Water Sources			
⊖ The strategy does not sufficiently address the potential of non-conventional water sources, hindering effective water management: - No targets are set to pursue the development of non-conventional water resources for 2020-2035. - Expected volumes of water from non-conventional sources as a production component were not incorporated in the national water balance.	● Assess the potential contribution of non-conventional water resources to the water balance as an available water source and set a realistic target for 2035 accordingly.	KT1.28	MoEW, MoE, MoA, DGUP, OEA
	● Promote alternative technologies such as rainwater harvesting to improve irrigation supply.	KT1.29	
	● Amend Building Regulations to include a requirement for rainwater harvesting in new facilities.	KT1.30	
	* Prioritize the exploration of the potential for Artificial Aquifer Recharge (AAR) and ensure that pilots are designed and implemented in areas where upscaling is needed to meet water deficit.	**KT1.31**	
Reuse of Treated Wastewater and Sludge			
⊖ The strategy lacks wastewater treatment and sludge re-use targets. ⊕ The following proposed initiatives in the strategy will enhance water management: - Commitment to developing the necessary legal framework for the reuse of treated wastewater. - A push for the adoption of standards and guidelines for wastewater reuse.	● Identify realistic targets for increasing Treated Sewage Effluent (TSE) reuse and work towards achieving them.	KT1.32	MoEW, CDR
	* Require that the planned WWTPs, particularly those in rural/ agricultural areas or areas with significant water deficits, be reassessed in terms of the feasibility of TSE reuse and redesigned accordingly, taking environmental costs and benefits into account.	**KT1.33**	
	* Study TSE reuse directly in irrigation or indirectly through AAR as an important source of water within the national water balance.	**KT1.34** (KT1.28)	
	* Require an assessment of the potential of wastewater reuse in the WWTP EIAs and regulate TSE reuse in different sectors.	**KT1.35** (KT1.33)	MoE. MoEW
	● Develop necessary procedures to monitor TSE and sludge reuse in agriculture and land reclamation and put in place the necessary monitoring system to respond to any incompliances.	KT1.36	MoA, RWEs, municipalities
Water Quality			
⊕ If all proposed WWTPs are successfully implemented and adequately operated, then 100% of the generated domestic wastewater will be treated and will allow Lebanon to achieve SDG 6.2, "By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations". ⊕ Wastewater collection, treatment and disposal will have significant impacts on both the natural environment and public health. Inland WWTPs will help reduce surface and groundwater pollution and coastal WWTPs will also reduce land-based sources of pollution into the Mediterranean Sea.	* Set the infrastructure initiatives to be contingent on achieving some progress on the governance end and successfully operating the existing WWTPs.	**KT1.37**	MoEW, CDR
	* Prioritize putting into operation the existing treatment plants at their design treatment levels over the construction of new WWTPs.	**KT1.38**	MoEW, CDR, RWEs
	* Abstain from the construction of additional WWTPs if the networks connecting to them are not complete and/ or if their long-term operation and maintenance are not secured by the concerned RWEs.	**KT1.39**	
	* Develop a National Plan for the Operation and Maintenance of wastewater treatment plants.	**KT1.40**	
	● Develop contingency plans for wastewater treatment plants (i.e., holding tanks, etc.). Allow raw sewage bypasses only upon approval from the MoE and MoEW as part of the EIA process.	KT1.41	MoE, MoEW
	● Verify the conditions of the receiving water to ascertain if it is in a state to receive the volume of TSE to be discharged.	KT1.42	
	● Ensure that the storm water network is separated from the wastewater network during the design of the WWTPs. If not, ensure that storm water runoff is accounted for in the WWTP design and capacity.	KT1.43	
	* Ensure EMPs of the WWTP EIAs include: daily testing of TSE, and sampling of receiving environment.	**KT1.44** (KT1.41) (KT1.35)	
	* Empower MoE and MoEW to enforce the measures of the EMP on the RWE/WWTP operator.	**KT1.45**	

Main Impacts	Mitigation Strategies and Policy Recommendations to Optimize Environmental and Social Impacts	ID	Responsibility
	* **Establish an adequate buffer zone for inland WWTPs either through MoEW/MoE/DGUP regulations or through the WWTP EIA process.**	**KT1.46**	
	• Implement the "Polluter Pays Principle" of Law 444/2002 and law 192/2020 to reduce the point and non-point sources of pollution affecting water resources.	KT1.47	MoE, MoIM
	• Continue with the efforts to ensure environmental compliance of industries, other classified establishments, health care centers etc., where wastewater is treated at the establishment level.	KT1.48	MoI, MoIM, MoPH, MoE
	• Develop a national plan/framework for agriculture point and nonpoint sources pollution prevention.	KT1.49	MoA, MoE
Governance			
⊕ Timely implementation of the various actions at the water governance level is expected to promote IWRM and ensure the sustainability of present and future initiatives.	* **Interlink the implementation schedules of proposed water governance reform initiatives and infrastructure projects in the Updated NWSS-MoEW (2020).**	**KT1.50** (KT1.37)	
	* **Aim to adopt the international frameworks for good governance (OECD Twelve Principles of Good Water Governance).**	**KT.1.51**	
	• Support the design and implementation of policies that are consistent with the long-term goals of water security, in a sustainable, integrated and inclusive way, at an acceptable cost, and in a reasonable time frame.	KT1.52 (KT1.51)	MoEW
	• Assess the possibility of public-private partnerships (PPPs) to make water services more efficient and commercially oriented and enhance the creditworthiness of their public partner and the latter's ability to raise finance – and thus contribute indirectly to financing.	KT1.53	
	• Urge donors, and businesses to promote adequate funding for R&D and innovation in water, using research grants, challenge funds, prizes, support of pilot ventures, venture capital, and other means.	KT1.54 (KT1.4)	
KT2. Biodiversity and Ecosystem			
Potential Impacts of man-made water bodies			
⊖ Proposed dams can change the natural water conditions required for riparian, terrestrial and coastal and marine species and ecosystems by: - Changing river flows, - Altering turbidity/sediment levels, - Increasing water levels, - Increasing the salinity of the coastal area at and near estuaries during the dry season. ⊖ Proposed dams create physical obstructions for riparian, terrestrial, coastal, and marine species. ⊖ Proposed dams occupy riparian areas; riparian habitats play several roles in maintaining and conserving ecosystem functioning. ⊖ Six dams listed in the Strategy are within a 500 m buffer zone from protected areas; Lebanon Law of Environment (444) imposes EIA reports for any project in or near protected areas. ⊖ Several dams will inundate forests, especially dams located on river systems. ⊕ Proposed hill lakes and ponds can promote wildlife, provide water for livestock and nearby flora, and provide helicopters and fire trucks with water to extinguish forest fires ⊖ Proposed hill lakes and ponds have the following potential adverse impacts: - Drowning of granivorous birds, reptiles, and mammals due to steep slopes. - They may collapse and consequently harm surrounding local communities.	• Develop and implement a program for monitoring the ecological effect of dams prior to their construction (pre-monitoring) and after dam completion (post-monitoring).	KT2.1	MoE
	• Develop guidelines for the preparation of EIAs of dams projects in Lebanon.	KT2.2	
	• Identify biodiversity hotspots, determine vulnerabilities and trends, and provide guidelines on the management of water bodies that include minimum environmental flows, turbidity/sediment levels, water quality patterns, and erosion-control measures.	KT2.3	
	• Prepare restoration plans for degraded man-made water bodies and lakes.	KT2.4	
	* **Consider the ecosystem water demand and water quality requirement when allocating water sources.**	**KT2.5** (KT1.4)	MoEW
	* **Prepare guidelines for the construction, operation and maintenance of water and wastewater networks.**	**KT2.6**	
	• Increase household connectivity to the wastewater treatment networks to prevent ecological exposure to contamination.	KT2.7	
	• Assess alternatives to infrastructure projects located in Important Biodiversity Areas.	KT2.8	
	• Specify activity restrictions for recreational water users of water bodies.	KT2.9	MoEW, MoE, MoT
	* **Develop guidelines for the construction of dams and hill lakes, including buffer zones, requirements to facilitate the migration of animals and birds, etc.**	**KT2.10** (KT2.2)	MoEW, MoE, MoA
	• Prepare guidelines for the restoration of riparian habitats around man-made water bodies.	KT2.11 (KT2.4)	MoE
	• Coordinate with MoEW to review the dams' program, particularly dams encroaching on protected areas or sites, to minimize the program's cumulative impact on Lebanon's ecology and natural heritage.	KT2.12	
	• Review MoA's policy on "alternative trees" to consider the restoration of riparian habitats and seedling requirements (including storage and transplanting requirements). - Require EMPs to include in this policy; the EMP should also assign an agency responsible for the monitoring of this activity.	KT2.13	MoA, MoE

Main Impacts	Mitigation Strategies and Policy Recommendations to Optimize Environmental and Social Impacts	ID	Responsibility
	Potential Impacts of Proposed WWTPs		
⊕ The proposed WWTPs (if well-operated) will reduce the growing pressure on natural ecosystems caused by the haphazard discharge of untreated wastewater.	* **Prepare guidelines for the construction and O&M of WWTPs.**	**KT2.14** (KT1.46) (KT1.40)	MoEW
	• Abstain from discharging treated wastewater into water bodies located in sensitive areas.	KT2.15 (KT1.42)	MoEW, CDR, RWEs
	• Ensure the regular maintenance of the infrastructure of the WWTPs to prevent leakages.	KT2.16 (KT1.46)	RWEs, CDR
	• Abstain from constructing WWTPs in protected areas (PAs) or their respective buffer zones; maintain a minimum distance of 1,000 meters	KT2.17	MoE
	• EIAs should assess project location alternatives to the proposed WWTPs located within sensitive areas.	KT2.18	MoE
	KT3. Climate Change Adaptation and Mitigation		
	Climate Change Adaptation		
⊖ Expected climate change impacts (changes in precipitation, temperature, evapotranspiration and sea level) can introduce a high level of uncertainty regarding the design and operation of proposed water, wastewater and irrigation infrastructure; failure to address this will impact the projects' climate change resilience. ⊖ The failure of the proposed water balances in the strategy to consider projected climate change impacts on water resources will hinder the efficacy of water development policies and projects. ⊕ The proposed IHIS in the Strategy will help improve knowledge on climate change impacts on water resources.	* **Develop basin management plans that take into consideration climate change to achieve climate-resilient water resource management. Accordingly, the Strategy's proposed WEAP models that adopt an IWRM approach ought to:** - **Consider seasonal climatic changes.** - **Consider intra-watershed climate variations.**	**KT3.1**	MoEW
	• Disseminate the proposed drought and flood management plans with the Climate Change Unit in the MoE to consider climate change forecast models.	KT3.2	MoEW, MoE
	• Take into consideration seasonal fluctuations in water resources during planning and calculation of water balance, which are expected to worsen due to climate change.	KT3.3	
	• Take into account climate change impacts on projected water availability in the proposed infrastructural projects.	KT3.4	
	• Conduct climate change risk assessment to be used as a tool to inform development policies and activities.	KT3.5	MoE
	• Develop a national adaptation framework to increase the resilience of existing and proposed water and wastewater infrastructure.	KT3.6	MoEW, CDR, MoE
	Climate Change Mitigation		
⊕ Contribution of the Strategy towards achieving Lebanon's Nationally Determined Contribution (2020) through reducing GHG emissions from regulated and unregulated pumping processes. ⊕ The proposed impoundment projects will reduce the need for groundwater use, thus reducing GHG emissions from regulated and unregulated pumping processes. ⊖ The construction activities and operation of the proposed infrastructural projects will require significant energy demands. ⊖ Resulting land-use changes or deforestation activities of the proposed infrastructural projects will lead to an increase in GHG emissions. ⊖ Improper O&M of water reservoirs can result in water body eutrophication, which increases CH_4 emissions.	• Prepare and adopt a Life Cycle Assessment for the proposed infrastructure projects to reduce GHG emissions.	KT3.7	MoEW
	• Measures to reduce GHG emissions should be identified at a project level.	KT3.8 (KT3.7)	MoEW
	* **Develop a national-level solar water pumping plan:** - **Identify and prioritize areas suitable for solar water pumping (for potable water and irrigation use).** - **Allocate a budget for the implementation of solar water pumping systems.**	**KT3.9**	
	KT4. Land Use and Conservation		
	Land Use		
⊖ The construction and operation of proposed dams and other impoundments may cause: - Changes/losses in forests, agricultural lands, wetlands, and built areas. - infringe on existing and/or planned protected areas. ⊕ Proposed irrigation schemes in the Strategy will provide water to water-scarce areas which may increase the agricultural land cover and diversify crops. ⊖ Several of the proposed infrastructural projects are located in areas with a high risk of soil erosion, landslides, and on areas with faults.	* **Coordinate with DGUP to ensure that the proposed initiatives under the Updated NWSS-MoEW (2020) are in line with the national land use and management plans (i.e., buffer zones, protected waterside habitats, pollution point and non-point sources, agricultural and industrial zones, residential agglomerations, heritage sites and recreation/touristic areas).**	**KT4.1**	MoEW, MoE, DGUP
	Land Conservation		
	• Prepare and adopt Life Cycle Assessment for the construction of the proposed infrastructure projects to use as a decision-making tool and to inform EIAs.	KT4.2 (KT3.7)	MoEW, MoE

Main Impacts	Mitigation Strategies and Policy Recommendations to Optimize Environmental and Social Impacts	ID	Responsibility
⊕ Establishing protection zones may alter the land use activities in the area, reduce the land use intensity, or halt some of the activities identified as major sources of pollution in this area. ⊖ Changes in land use can result in land degradation and impact freshwater systems; resulting soil erosion reduces water quantity and quality reaching water bodies. ⊖ The construction of proposed infrastructure projects may cause an increase in quarrying and the generation of construction and demolition waste.	• Regulate and monitor raw material extraction throughout the duration of the projects' implementation.	KT4.3	MoE
	• Develop the delineation of buffer zones for man-made water bodies and springs in coordination with the Directorate General of Urban Planning.	KT4.4 (KT4.1)	MoEW, MoE, DGUP
	• Develop land use regulations for watersheds to protect catchment areas, specifying which activities are sanctioned, delineating buffer zones for man-made water bodies and springs, implementing erosion-control measures, and others.	KT4.5 (KT4.4)	
Sustainable Urban Planning			
⊖ Absence of comprehensive strategic urban plan has led to haphazard urbanization and development and unregulated construction activities; this will be exacerbated by the proposed infrastructural projects.	• Develop updated strategic National Land Use Master Plan that is aligned with all national sectoral strategies, including the Updated NWSS-MoEW (2020) and in coordination with other relevant parties.	KT4.6	MoEW, MoE, DGUP, CNRS, MoPW, MoA, MoT
	* **Promote water-sensitive urban and building design practices (i.e. green roofs, water-permeable pavements/roads, tree pits to drain roads, swales to collect and convey stormwater).**	**KT4.7** (KT1.30)	DGUP, MoEW, MoE, MoPW, MoIM
KT5. Water-Energy Nexus			
⊖ The operation of the proposed water and wastewater infrastructure projects will require additional energy demands. ⊖ The additional energy demand needed to operate the proposed water and wastewater infrastructure should be carefully considered, as well as the billing system needed to recover the energy cost.	• Establish management information system to collect energy consumption data at RWE level by the water sector.	KT5.1	MoEW
	• Align hydropower (dams) initiatives with the hydroelectricity target in the 2020 Renewable Energy Outlook and review Lebanon's hydropower production potential.	KT5.2	
	• Remove barriers to hydropower production and clear-up the legal framework to incentivize the private sector.	KT5.3	
	• Assess the energy needs of the proposed infrastructural projects and identify energy efficient and sustainable methods for powering them.	KT5.4	
	• Improve energy efficiency in water facilities and further promote renewable energy technology.	KT5.5	
	* **Adopt strategic energy management in RWEs and other water utilities**	**KT5.6**	MoEW, RWEs
KT6. Water-Food Nexus			
⊖ The prioritization criteria for proposed irrigation projects in the Strategy do not consider the sub-regional disparities in cropland sensitivity to natural and physical environmental changes, including the effects of projected changes in climate. ⊖ MoA's National Agricultural Strategy (NAS) (2020-2025) doesn't specify the spatial distribution of the potential irrigated lands and their water needs. As such, irrigation infrastructure plans in the Updated NWSS -MoEW (2020) also doesn't consider the latter.	* **Enhance coordination between MoEW and MoA to ensure that the National Agriculture Strategy (NAS) and the Updated NWSS – MoEW (2020) are aligned.**	**KT6.1** (KT1.23)	MoEW, MoA
	• Enhance coordination between MoEW and MoA to prioritize the implementation of NAS initiatives that aim to reduce agricultural pollution at the farm-level in groundwater and surface water pollution-vulnerable regions.	KT6.2 (KT1.49)	
	* **Develop regional irrigation plans that aim to achieve more sustainable food production and that maximize water efficiency.**	**KT6.3** (KT1.23) (KT1.25)	
KT7. Social and Socio-Economic Environment			
Cost Recovery			
⊕ The proposed governance reforms will bridge the RWEs' deficit and allow for financial recovery. Thus, cost recovery will result in an increase in revenues which will allow RWEs to secure funds for future water investments.	* **Set a framework to control and monitor the water bottling industry in Lebanon.**	**KT7.1**	MoEW, MoPH, MoE
	• Promote R&D in the water sector to implement innovate solutions for productive sectors to collect, use and re-use water.	KT7.2 (KT1.4) (KT1.54)	MoEW, MoA, MoI, MoE
	* **Prioritize the planned WWTPs and WTPs in the strategy based on their impacts on the coastal areas and rivers that will generate greater economic benefits.**	**KT7.3**	MoEW
	• Develop a financing strategy for the RWEs enabling them to recruit highly qualified permanent staff to run water projects and oversee the operations.	KT7.4	MoEW, MoF
	• Introduce the water footprint tool on a household-level and on a national scale.	KT7.5 (KT1.9) (KT1.17)	MoEW, MoE, MoIM

Main Impacts	Mitigation Strategies and Policy Recommendations to Optimize Environmental and Social Impacts	ID	Responsibility
		(KT1.18)	
	• Enforce regulations to limit the illegal abstraction of groundwater and depletion of groundwater resources.	KT7.6 (KT1.10)	
	• Introduce special tariffs charged for groundwater exploitation and use as part of the permitting scheme for drilling wells.	KT7.7 (KT7.6) (KT1.10)	MoEW, MoPW, MoIM, WEs
	• Strengthen monitoring and metering to eliminate illegal water connections.	KT7.8	
	• Implement accountability measures: for example, the accountability of administration at every level (regarding implementation of plans and their achievement or shortcoming).	KT7.9	
	• Strengthen the O&M of water infrastructure by developing systems that can enhance operational management, planning, or emergency response.	KT7.10 (KT1.40)	
	• Use digital water conservancy through the application of information and communication technology in infrastructure such as in monitoring stations, data centers, telecommunication, decision support systems, etc.	KT7.11	
	• Enforce regulations and impose penalties for water-usage payment violations.	KT7.12	
	• Use water allocation models to calculate water pricing.	KT7.13	MoEW
	• Use a life-cycle assessment tool to determine the best options for domestic water conservation method.	KT7.14 (KT1.18) (KT1.17) (KT1.9)	
	• Calculate shadow prices and integrate the environmental and social cost of water use in water pricing.	KT7.15	
	• Raise the priority of water in national investment and financing programs through the following: - Develop a communications strategy for spreading evidence of the link from water to growth. - Create joint initiatives that add weight to the case for water investment. - Engage corporate businesses in water development in communities. - Develop indicators of "water risk" to the businesses' operations to help quantify their dependence on water.	KT7.16 (KT7.2) (KT1.54) (KT1.4)	
Public Health & Livelihood Conditions			
⊕ The Strategy aims to improve collection, conveyance, and treatment of wastewater, followed by continuous monitoring, which will minimize the contamination of freshwater, soil, and agriculture products.	• Promote awareness and education regarding water conservation, water issues, among the wider public, including businesses and industries. The campaign should also inform citizens and water users on their rights and responsibilities.	(KT7.18) (KT1.18) (KT1.17) (KT1.9)	MoEW, MoI, MoEHE, MoE, NGOs and citizens
	• Implement a monitoring and management program for surface water and wastewater to minimize the risk of water and soil contamination on public health.	KT7.19	MoEW, MoPW, MoA, MoPH
	* **Monitor cases of waterborne diseases to reflect the efficiency of wastewater treatment projects.**	**KT7.20**	
Purchasing Power Capacity of Water Users			
⊕ The Strategy suggests the implementation of a volumetric tariff based on blocks that will take into account the most vulnerable populations in the lower blocks; this will help diffuse the impact of the new tariff on vulnerable groups. ⊕ The Strategy proposes to increase water supply, ensuring access to sufficient and safe water for households. This will result in increasing households' savings on private water purchase and other indirect costs.	• Advocate for transparency between users/consumers and the water establishments to attain common responsive grounds in understanding the link between water scarcity and new proposed tariffs.	KT7.21	MoEW, MoSA, MoE, MoEW
	* **Assess the possibility to implement subsidized programs to help unprivileged households access drinking water supply at reduced costs (e.g., water filters, pumps, etc.).**	**KT7.22**	
	* **Align Strategy with national social protection programs to help underprivileged people afford to buy water or paying for water tariffs, given that more than 75% of the Lebanese population are living in poverty conditions.**	**KT7.23**	
	* **Align Strategy with other national strategies, such as the NAS, to collaborate on initiatives and projects that would help the farmers reduce their water consumption while maximizing their productivity.**	**KT7.24** (KT6.1) (KT1.23)	
Land Expropriations			
⊖ Land expropriation affects landowners and changes the type of land uses and landscape.	• Integrate requirement to optimize land-use in large scale water projects in the guidelines for the construction of dams and hill lakes; this will reduce the costs of expropriation.	KT7.25	MoEW, CDR
Absorptive Capacity			

Main Impacts	Mitigation Strategies and Policy Recommendations to Optimize Environmental and Social Impacts	ID	Responsibility
⊖ The proposed projects in the strategy will require large investments that exceed the capacity of the Lebanese economy.	* **Distribute the total estimated investment value in the Strategy across priority projects and different short, medium and long-term timeframes for an efficient allocation of investments, giving enough time for projects to be completed and operational.**	**KT7.26**	MoEW, CDR
Economic Resilience			
- The water sector showcased its weak resilience to adapt to external shocks and implement efficient and responsive mitigation and contingency measures; highlighting the need for a new water strategy and immediate sector reforms.	* **Develop a water emergency fund to support the implementation of mitigation measures and adaptation plans in case of external unpredictable shocks affecting the water sector.**	**KT7.27**	MoEW, MoF, CDR
	• Plan restoration and rehabilitation programs for the areas impacted by the Beirut Port blast, particularly proposed wastewater infrastructure, water networks, etc.	KT7.28	
KT8. Disaster Prevention and Management			
⊖ Failure to address the below in the strategy has hindered efforts to integrate the water sector strategy with national disaster prevention and management efforts: - Risks of dam and hill lake failures, or forest fires. - Water sector disaster management with a strategic approach and a holistic overview that can prevent hazards and mitigate the impacts of disasters.	• Set up a holistic plan at the MoEW to address the main types of water-related disasters (floods, droughts, dam breaks, fire) in alignment with the National Disaster Risk Management Strategy.	KT8.1	MoEW, MoIM, MoD, CNRS, DRMU, MoE, MoPH
	• Ensure the proposed disaster risk monitoring unit is aligned with the National Disaster Risk Management Strategy.	KT8.2	
	• Establish a dam safety program and dam break analysis.	KT8.3	
	• Consider strategic locations of hill lakes and water reservoirs to support in the response to forest fires in coordination with the Lebanese Army and Green Plan.	KT8.4 (KT2.10) (KT2.2)	
	• Include the MoEW in the inter-ministerial committee for forest fire management as a support institution.	KT8.5	
	• Establish a communication protocol between the Disaster Risk Management (DRM) and the disaster monitoring unit of the MoEW and other institutions in the National Strategy for Forest Fire Management.	KT8.6	
	• Develop guidelines for hill lake monitoring; ensure that the latter is integrated in Environmental Management Plans.	KT8.7	MoEW, MoE
	• Define and allocate responsibility for hill lake water quality, quantity, and infrastructure monitoring for both public and private hill lakes.	KT8.8 (KT8.7)	
KT9. Data Management			
⊕ The generated data from the proposed IHIS can be used as soon as practicable to revise the adopted water flow numbers, re-assess the calculated water balances at the national and river basin levels as well as to reconsider the need for some of the proposed projects and their impact on the sustainability of the water resources. ⊖ Failure to address the development and implementation of water quality monitoring in the proposed IHIS will lead to lack of data required for developing pollution prevention and management strategies for surface and groundwater sources. - Water quality needs to be managed at two levels (1) water sources and (2) water supply and distribution. ⊖ The Strategy focused on water quantity monitoring with no mention of water quality monitoring stations along the rivers or the development and implementation of water quality monitoring programs. ⊕ The Strategy proposed groundwater monitoring that will have a positive environmental and public health impact if the collected data and the mapping results are used to protect groundwater resources. ⊖ Initiatives regarding the adoption of an operational water quality monitoring are neither given a priority of implementation, nor pegged to a timeline, or included in the overall budget. ⊖ The Strategy missed to mention an infrastructure monitoring system.	• Develop technical assistance for data management. - Include staff training in the IHIS studies and timescale. - Elaborate inter-institutional coordination for better integrated management. - Establish a system that ensures the integration of the collected data as part of the IHIS into the decision-making process, to refine the proposed activities and improve water resources management.	KT9.1	MoEW, MoA, MoPH, MoE, LRA, CNRS
	• Establish water quality monitoring within the IHIS for water resources (rivers, wells, springs) and water supply and distribution.	KT9.2 (KT7.19)	MoEW, RWEs, LRA, LARI, MoPW – LMS, MoE
	• Prioritize building the capacity of the RWE laboratories to perform the needed water quality monitoring (human resources, equipment, QA/QC systems, reagents and other consumables, etc.).	KT9.3 (KT7.4)	
	• Automation of water resources monitoring system.	KT9.4 (KT7.11)	
	• Establish an infrastructure monitoring system within the RWE's and link it to the IHIS within MoEW.	KT9.5	MoEW, RWEs, LRA
	• Establish water sector data collection standards and codes to be adopted across all institutions (e.g. ArcGIS requirements) to ensure consistent database formats. Set a framework for IHIS data collection: - Develop mechanism to update data, - Develop a legal framework for data sharing.	KT9.6	MoEW
	• Develop data-sharing protocols to harmonize and standardize data collection and sharing methods and develop management and exchange protocols to allow subnational data to be interpreted and collated at the national level.	KT9.7	
KT10. Achieving Integrated Water Resource Management (IWRM)			
⊖ The Strategy's approach is not aligned with IWRM principles; thus, hindering its achievement: - The strategy proposed supply augmentation projects at the level of municipal supply systems using a simplified and unified demand across all geographic areas without showing considerations to socio-economic systems, nor showing the link between the proposed withdrawals and the basins/ catchment areas, nor looking at interlinkages with groundwater aquifers.	• Strengthen political will for IWRM by clearly communicating and demonstrating the value of implementing IWRM for achieving multiple sustainable development objectives to key stakeholders at all levels and across sectors.	KT10.1	MoEW
	• Dedicate budgeting for IWRM activities and more efficient use of existing resources in a coordinated manner are needed to address the financing gap.	KT10.2	MoEW, CoM, MoA, MoE, MoI, MoT, etc.
	• Coordinate budgeting across sectors for more efficient and transparent use of existing resources.	KT10.3	
	• Integrate IWRM through considering the socio-economic system, water balance estimation at the river basin and interlinkage with groundwater aquifers and the quantitative impact of climate change on water availability as well as climate change adaptation and mitigation measures.	KT10.4 (KT1.1) (KT1.2)	MoEW

Main Impacts	Mitigation Strategies and Policy Recommendations to Optimize Environmental and Social Impacts	ID	Responsibility
- The Strategy didn't address the need for IWRM-specific training and capacity building including the creation and functioning of River Basin Organizations, other collaboration platforms as well as the communication with citizens and users, with due consideration of gender aspects and particular vulnerable groups. - The Strategy lacks the following: o IWRM implementation plan, o Water needs by economic sector, o Monitoring, evaluation, or documentation to follow up on IWRM implementation.		(KT3.1) (KT3.6)	
	• Dedicate a unit at the MoEW to follow up on the progress towards achieving IWRM and ensure that the data collected and WEAP modelling conducted is feeding back into the strategy to refine the proposed projects.	KT10.5	MoEW
	• Enhance and retain institutional and human capacity for IWRM planning, implementation, and enforcement. In conjunction with funded capacity development programs, it is important to create incentives to keep staff in government agencies and provide practical experience-sharing opportunities.	KT10.6 (KT10.5)	MoEW, RWEs
	• Prioritize issuing Water Code executive decrees related to the National Water Council and to watershed plans, to promote cross-sectoral coordination and management activities, particularly at the basin and aquifer levels, for sustainable and efficient water management.	KT10.7	MoEW, MPs, CoM
KT11. Achieving SDGs and International Commitments			
⊖ The lack in addressing the below will hinder the timely achievement of SDG 6: - The strategy focus is more on providing water rather than "safe" water. *(refer to KT1 and KT9.)* - Wastewater reuse is mentioned but not given needed focus. *(refer to "Reuse of Treated Wastewater and Sludge" under KT1.)* - Sustainability of withdrawals is not clear in the strategy. *(refer to "Sustainable Resource Allocation" under KT1.)* - Water allocation is at the administrative district level rather than the basin/ catchment level. *(refer to KT10. and "Sustainable Resource Allocation" under KT1.)* - Groundwater withdrawal appears to be unsustainable. (*refer to "Sustainable Resource Allocation" under KT1 and KT5.)* - Withdrawals by other sectors (industry, tourism, etc.) are not considered separately. *(refer to "Efficient Water Use" under KT1.)* - Climate change consideration is not elaborated. *(refer to KT3.)* - The implementation of IWRM is in its infancy. *(refer to KT10.)*	• Establish a task force for coordinating and leading activities to work towards the achievement of SDG 6. This would bring together the key institutions and national focal points responsible for different elements of water resources management such as wastewater treatment and reuse, pollution control, ecosystems, clean water and sanitation, water-use efficiency, and water scarcity.	KT11.1	MoEW, RWEs, MoE, MoA, MoIM, MoT, MoI…
KT12. Stewardship and Stakeholder Engagement			
⊕ The Strategy has committed to strengthening water stewardship through the implementation of the water code and governance-level initiatives that enhance information sharing, communication, and coordination between the concerned stakeholders and with the public. - Lack of confidence and mistrust in the government's actions have led to public opposition that have hindered the implementation of proposed projects. The following gaps with addressing this concern remain: ⊖ The strategy does not directly address citizens and primary users of the water sector. ⊖ The strategy does not outline the roles and responsibilities of the private sector in supporting governmental mandates.	• Ensure that the data related to the water sector is accessible to the public and all stakeholders at no cost.	KT12.1	MoEW
	• Enforce Law 28/2017 (Access to information law) across water sector state administrations.	KT12.2	
	* **Propose water conservation and water-use optimization guidance actions directed towards water users, i.e. citizens (household/individual-level), industrialists and farmers in the Updated NWSS-MoEW (2020).**	**KT12.3**	MoEW, RWEs
	* **Delineate the roles and responsibilities of citizens, civil society, local authorities and private sector for achieving strategy objectives in the Updated NWSS-MoEW (2020).**	**KT12.4**	
	• Engage civil society in strategy initiatives through organizing regular meetings with a committee of selected civil society representatives, academic and non-academic experts, and media representatives, and collaborating with educational institutions to engage youth in the implementation of proposed projects by providing learning opportunities through internships and site visits.	KT12.5 (KT7.21)	
	• Establish a functional and efficient system for public-private partnership in the sector.	KT12.6 (KT1.53)	
	* **Outline public awareness campaign goals in the Updated NWSS-MoEW (2020):** - **Coordinate and collaborate with the public and private sector to implement national behavioral change and targeted awareness campaigns.** - **Endorse and build on existing community engagement initiatives, public awareness campaigns, and platforms in the water sector.** - **Develop a platform that can be used by the community to check ongoing projects and their status.**	**KT12.7** (7.18) (KT1.18) (KT1.17) (KT1.9)	MoEW, MoEHE, MoE, MoI, NGOs
	• Conduct regular local workshops and information sessions to inform the public on water sector developments and to engage with water users.	KT12.8 (KT12.5) (KT7.21)	MoEW, MoEHE, academic institutions

* Mitigation Strategies/Policy Recommendations for preliminary implementation *(See Recommendations for Integrating SESA Findings in the Updated NWSS-MoEW (2020))*

1 INTRODUCTION

1.1 Background

For the past two decades, the Ministry of Energy and Water (MoEW) has been developing roadmaps and strategies to ensure the sustainable management of the water and wastewater sector. In 2012, the Council of Ministers (CoM) endorsed the first National Water Sector Strategy (NWSS), prepared by MoEW in 2010 *(referred hereafter as NWSS-MoEW (2012)).* Since then, structural changes in the water and wastewater sector and emerging challenges facing water resources management have occurred (*discussed further in Section 1.3)*. Accordingly, this led the MoEW in 2020 to update the NWSS of 2012 in order to:

(1) Evaluate what was implemented.
(2) Reassess (a) plans for water distribution and supply, (b) plans for wastewater collection and treatment, (c) master plans for water storage/dams, and (d) plans for irrigation.
(3) Develop a reform action plan for the management of the water sector in Lebanon.

In compliance with the Strategic Environmental Assessment (SEA) Decree 8213/2012, the MoEW intends to prepare a Strategic Environmental and Social Assessment (SESA) of the Updated NWSS-MoEW (2020). Funded by World Bank (WB) Lebanon – Lake Qaraoun Pollution Prevention Project, the Council for Development and Reconstruction (CDR) contracted ECODIT Liban to conduct the SESA *(this report)*, which will be included in the Updated NWSS-MoEW (2020). During the course of the SESA preparation, ECODIT has been sharing preliminary findings with the MoEW. Accordingly, MoEW actively started in the Updated NWSS-MoEW (2020) review process.

1.2 SESA Objectives

This SESA Report seeks to satisfy the following objectives:

- Assess the environmental and social impacts of the Updated NWSS-MoEW (2020) with the necessary stakeholder engagement; and
- Provide recommendations and high-level policy advice to MoEW to optimize the Updated NWSS-MoEW (2020) and mitigate potential adverse environmental and social impacts.

1.3 A Decade in Review – The Water Sector Between 2010 – 2020

Since 2010, four main events have shaped the water sector in Lebanon: (1) the adoption of a National Water Sector Strategy in 2012 (Box 1), (2) the approval of the Water Code in 2018 (Law 77/2018), (3) the elaboration of an Updated National Water Sector Strategy in 2020 *(described in Section 3)*, and (4) the amendment of the Water Code in 2020 (Law 192/ 2020) *(described in Section 4)*.

Figure 1 presents the timeline of the main events that occurred in the past decade, which directly impacted the water sector, and the SESA study.

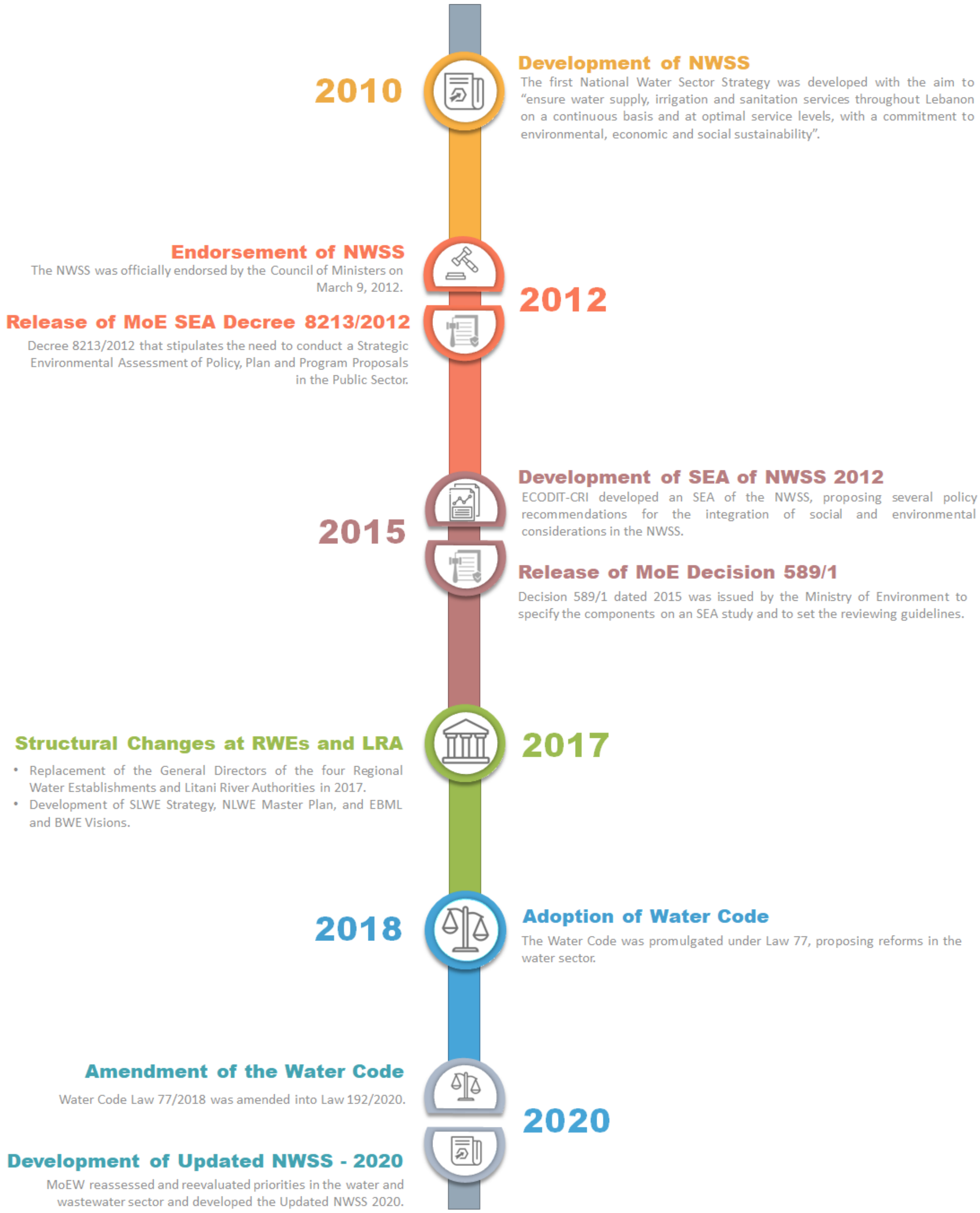


Figure 1. Timeline of Main Water Sector-Related Events 2010-2020

Box 1: Overview of the Previous National Water Sector Strategy - MoEW (2012)

Objective: "Ensure water supply, irrigation, and sanitation services throughout Lebanon on a continuous basis and at optimal service levels, with a commitment to environmental, economic, and social sustainability".

Components:

(1) Management initiatives related to improving the institutional and organizational, financial and commercial, and legal and regulatory structure of the water sector, and that address environmental concerns.
(2) Infrastructure initiatives related to the development of water augmentation projects (e.g., dams, hill lakes, transmission, and distribution pipes, etc.).

Achievements: (1) Ratification of the Water Code (Law 77/2018), which was updated by Law 192/2020, (2) RWEs formulated visions, strategies, and master plans, (3) implementation of public outreach campaigns, (4) improvement in private sector engagement, (5) increase in water metering in specific areas in Metn, Jezzine, and Keserwan, and (6) implementation of some infrastructure initiatives, mainly under donor funded projects.

Challenges: NWSS-MoEW (2012) did not achieve most of the targets it set out during its projected timeline, due to the following main reasons: (1) influx of Syrian refugees that led to the shift in priorities to address the water and wastewater challenges in refugee host communities, (2) delays in the development of strategies and master plans at the level of each RWE – consequently projects implemented by donor agencies or public authorities were prioritized inefficiently and frequently overlapped, and (3) public sector "no-employment policy" that prevented RWEs from acquiring the required human resources to conduct projects and implement master plans.

Moreover, the last ten years held additional events that affected the water sector and the SESA process. These include:

(1) Adoption of the Ministry of Environment (MoE) Strategic Environmental Assessment Decree 8213/2012
(2) Development of Strategic Environmental Assessment for NWSS-2012 (Box 2)
(3) Adoption of MoE Decision 589/1 dated 2015 which stipulates the review process of SEA reports
(4) Replacement of the General Directors of the four Regional Water Establishments and Litani River Authorities in 2017
(5) Release of the South Lebanon Water Establishment Strategy 2020-2025, the NLWE Water Supply Master Plan for North Lebanon (2040), the EBML 2020-2025 vision, and the BWE Vision.

Box 2: Summary of SEA for the NWSS-MoEW (2012) Recommendations (2015)

In 2015, the consortium ECODIT Liban – Consultation and Research Institute (CRI) prepared the SEA for the NWSS-MoEW (2012) in the context of the Regional Governance and Knowledge Generation Project funded by the Global Environment Facility (GEF) and implemented by Plan Bleu.

The main general SEA recommendations are summarized as follow:

(1) Mid-Term Appraisal of the NWSS: through which lessons from experience so far could be learned, targets and methodologies could be re-assessed, and SEA safeguards could be implemented.

(2) Iterative Process for NWSS Revisions: Based on this mid-term appraisal, the MoEW should review the NWSS and its strategic roadmap (2010-2020) and consider scaling back its dams' program in light of social, economic, and environmental constraints. NWSS revisions must be realistic and implementable in a resource-constrained environment.

(3) Implementation Unit for Oversight and Monitoring: There is an urgent need to clearly assign responsibility for oversight and monitoring the NWSS in one office (Implementation Unit) at the MoEW, which annually reports to the CoM.

(4) National Water Dialogue: A national working group/forum/committee would be able to address actions that require broad cross-sectoral co-operation, including data sharing, catchment protection, climate change adaptation, and Water Demand Management.

(5) Regulations, Guidance, and Standards: Namely; classification system for dams (small and large, based on World Bank's OP 4.37), guidance notes for the construction and operation and maintenance of water projects, man-made water bodies, and treated sewage effluent discharge into water courses.

The SEA Report also presented several specific policy responses that would help mitigate or alleviate the environmental, social, and economic impacts of the NWSS-MoEW (2012).

1.4 Overview of the Water Sector

Despite the NWSS-MoEW (2012) achievements, the water sector in Lebanon is still facing detrimental challenges, hindering the ability of the government to supply adequate and reliable water services while conserving Lebanon's water resources. Although the national coverage of water networks is around 80%, the quality of the supplied public water is questionable due to the lack of protection of water resources, insufficient water treatment at the supply level, deteriorated distribution networks, and the absence of continuous monitoring. Untreated wastewater, which accounts for around 70% of the total generated wastewater, is being directly discharged into the environment, thus polluting the groundwater and surface water resources that supply a significant portion of Lebanon's potable water.

The overall authority responsible for the water sector is the MoEW. The operational authority is exercised by Regional Water Establishments (RWEs) and Litani River Authority (LRA). The RWEs, which include (1) Beirut and Mount Lebanon Water Establishment (EBML), (2) North Lebanon Water Establishment (NLWE), (3) South Lebanon Water Establishment (SLWE), and (4) Beqaa Water Establishment (BWE), are mandated with supplying potable and irrigation water, and managing wastewater across Lebanon. LRA is mandated with managing the waters of the Litani River and the Qaraoun artificial lake for irrigation and hydropower generation purposes.

The RWEs are not achieving cost recovery – the main reason behind the insufficient provision of water services. More specifically, RWEs are being deprived of significant revenues considering that (1) the Non-Revenue Water (NRW) is more than 45% across Lebanon, (2) customer-metered connections are around only 10% nationwide, (3) billing and collection rates are as low as 30% in some areas, and (4) the flat tariff structure does not encourage a long-term water conservation behavior change among citizens (MoEW, 2020). Accordingly, the RWEs are suffering from financial issues limiting their investments in their institutional capacity and infrastructure, particularly their wastewater management capacity.

As a result of the lack of sustainable water services, citizens have lost trust in their government and water utilities, hence affecting their behavior (i.e., paying bills, conserving water, etc.). Citizens have resorted to unsustainable alternative methods of securing potable water (i.e., illegal drilled wells, private water tankers, etc.) and managing wastewater (i.e., haphazard discharge such as in streets, rivers, streams, discharge in poorly designed septic tanks, etc.) to meet their needs.

In addition to the above-mentioned challenges, the water sector has also been impacted by the multitude of crises facing the country that began late 2019 and have been gradually exacerbating; these include the economic collapse, fuel shortages, and the COVID-19 pandemic. A United Nations International Children's Emergency Fund (UNICEF) report published in July 2021 warns that the water sector in Lebanon is on the verge of collapse (UNICEF, 2021a). UNICEF projects that more than 71% of people residing in Lebanon, including refugees, are at immediate risk of losing access to safe water (UNICEF, 2021a). The economic turmoil, the maintenance costs valued in foreign currencies, the fuel shortages that led to the collapse of power grids, the devaluation of salaries of people working in the sector (i.e., public sector employees, subcontractors operating water and wastewater systems, etc.), and the disturbed workflows at public administration offices due to ongoing crises (i.e., lack of electricity, stationary, etc.) have all adversely impacted the water sector. In addition to compounding the effects of the economic crisis, the COVID-19 pandemic has added further pressure on the water sector. The new working modalities and restrictions put in place to help prevent the spread of COVID-19 have hindered the implementation of Water, Sanitation, and Hygiene (WASH) services and the Operation and Maintenance (O&M) of water and wastewater systems and delayed the implementation of projects (UNICEF, 2020).

2 SESA METHODOLOGY

2.1 Overall Approach

MoE Decree 8213/2012 defines the Strategic Environmental Assessment as a planning and management method for (1) combating or, at minimum, reducing sources of pollution and degradation of natural resources by way of assessing environmental impacts of policy, plan, and program proposals in the public sector, and (2) identifying necessary mitigation measures and enhancing positive outcomes on the environment and natural resources, prior to their endorsement. Although Decree 8633/2012 focuses on the assessment of environmental impacts, this SESA is also considering social and economic impacts.

In compliance with Decree 8213/2012, ECODIT prepared a Scoping Report and submitted it to the MoE in December 2020. In the Scoping Report, ECODIT developed the stakeholders' engagement strategy, determined the scope of work of the SESA and the SESA key themes, and explained the tools and methods that will be adopted for developing the SESA Report. Following the Scoping Report, the team prepared this SESA Draft Report, which includes an assessment of the environmental and social impacts of the Updated NWSS-MoEW (2020), as well as policy recommendations to optimize the strategy and mitigate any potential adverse environmental and social impacts. ECODIT will publish the Draft SESA Report on the CDR and MoEW websites to be reviewed by all concerned stakeholders end of August 2022, and schedule public consultation meetings fifteen days later to discuss the Draft SESA Report and disseminate its results. Based on the received feedback, ECODIT will prepare the Final SESA Report, which will be included in the Updated NWSS-MoEW (2020).

Although this SESA Draft Report is considered an update of the previous SEA (2015) for the NWSS-MoEW (2012), ECODIT applied a shift in its methodological approach to enhance the impact of this SESA in influencing the decision-making process. The previous SEA was an "impact-centered" SEA that aimed to integrate environmental considerations in the NWSS-MoEW (2012) by assessing the environmental and social impacts and risks of proposed initiatives. In this SESA of the Updated NWSS-MoEW (2020), ECODIT adopted a "hybrid" overall approach that combines "policy", and "impact-centered" SESA approaches. This "hybrid" approach focuses on assessing the environmental and social impacts of the proposed strategy, as well as establishing a policy dialogue for mainstreaming environmental and social considerations in policy and water sector reforms. Both approaches are adopted and widely used in the SESA processes around the world. However, over time, the SESA tool has become more strategic by bringing different groups of stakeholders into an environmental and social dialogue in an iterative and adaptive way through the shift from "impact-centered" to "policy-centered" and "hybrid" approaches (World Bank, 2012).

The following Sections present the methodological steps followed by the SESA team while preparing the Scoping and Draft SESA Reports.

2.2 Assessment of Baseline Conditions

ECODIT assessed the physical, biological, and socio-economic baseline conditions to understand the state of the environment and specifically the current situation of the water sector in Lebanon. The baseline conditions are necessary to evaluate projected impacts, develop holistic SESA key themes (refer to Section 2.4), and inform SESA objectives and recommendations.

For the purpose of baseline data collection, the SESA team conducted a literature review whereby several reports and documents relevant to the water sector and the SESA study were identified and studied. Data sources can be grouped as follows:

- Technical reports prepared by consultancy firms, international organizations, and donor agencies.
- Published academic articles and reports.
- Data retrieved from development and funding agencies and public authorities.
- Online databases and statistics – including bulletins published by the Central Administrations of Statistics (CAS) and CDR.
- National and regional master plans, strategies, and roadmaps.
- National and regional conferences and workshops.
- Data included in the Updated NWSS-MoEW (2020).
- Geographic Information System (GIS) shapefiles and geodatabases.

A complete list of cited references can be found in Section 12 of the SESA Report.

Moreover, ECODIT relied on GIS as a spatial analysis tool to identify, overlay, visualize, and analyze national baseline conditions. High-resolution satellite imagery, remote sensing, and digital elevation models were also used to complement the GIS analysis and provide some basic baseline maps to build the SESA analysis. Some of the baseline maps used in the project include the following: Flood Risk Map, Fire Risk Map, Erosion Map, Mass Movement Map, Landslide Map, Geology, Hydrogeology, etc.

2.3 Stakeholder Engagement

Stakeholder engagement is an integral part of the SESA process and ensures key actors, experts, and citizens are involved in the decision-making processes. The SESA study aims to engage actors involved directly and indirectly in the water sector through transparent and constructive meetings and discussions to gain key insight and opinions, enhance strategic recommendations, and solicit public feedback on the SESA outcomes and key recommendations.

ECODIT divided the SESA stakeholder engagement process into two phases (Figure 2):

2.3.1 *Phase 1: Focused Consultation Meetings*

The targeted stakeholders' meetings, which started in November 2021, involved virtual and in-person one-to-one or focus group meetings with governmental and non-governmental stakeholders in the water sector, including water authorities and Ministries, active Non-Governmental Organizations

(NGOs) and civil society, development and funding agencies, research centers and academic institutions, and other experts working in the field. The main aims of these meetings were the following: (1) discuss challenges and opportunities related to the water sector in Lebanon, (2) explain SESA objectives and methodology, and (3) solicit feedback on the Updated NWSS-MoEW (2020). Refer to Annex 10.2 which includes the list of interviewed people, and meeting notes.

2.3.2 *Phase 2: Public Consultation Meetings*

Starting August 2022, ECODIT will organize several stakeholders' consultation meetings to solicit the feedback of the general public on the Updated NWSS-MoEW (2020) and inform them about the results and recommendations of the SESA Report. To maximize the participation of stakeholders from citizens, government, local authorities, international organizations, research and academic institutions, and the private sector, ECODIT will conduct four general consultation meetings divided by Water Establishment jurisdiction (Beirut and Mount Lebanon, North Lebanon, South Lebanon, and Beqaa). ECODIT will share invitation letters, coupled with a summary of the Updated NWSS-MoEW and the SESA findings, with all stakeholders 15 days before the public consultation sessions. The stakeholders' consultation sessions will take into account all COVID-19 preventative measures as per the World Bank technical note on conducting consultations in times of constraints.

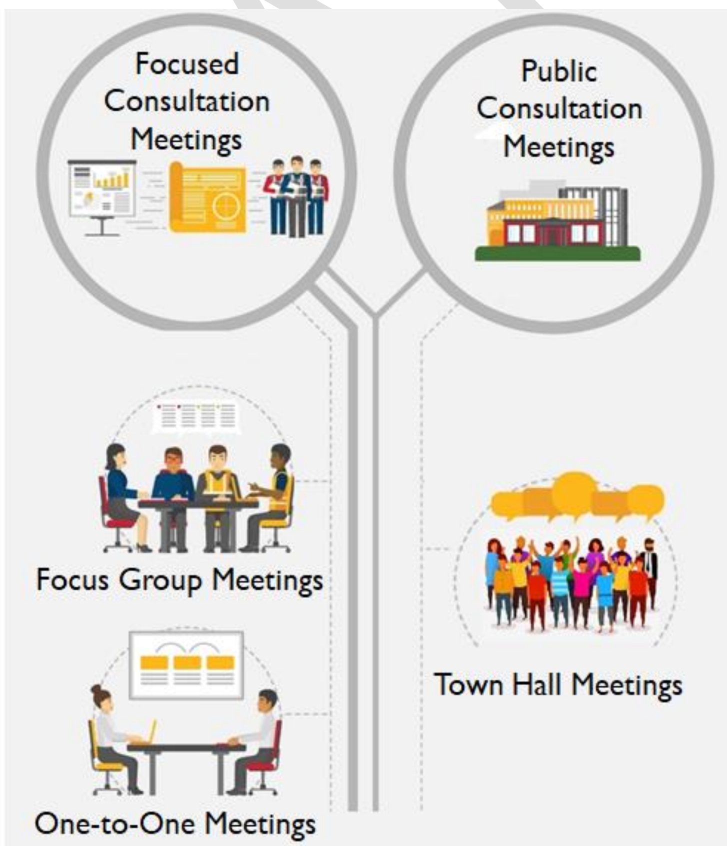


Figure 2. Stakeholders Engagement Process

Figure 3 lists all stakeholders contacted for the SESA study.

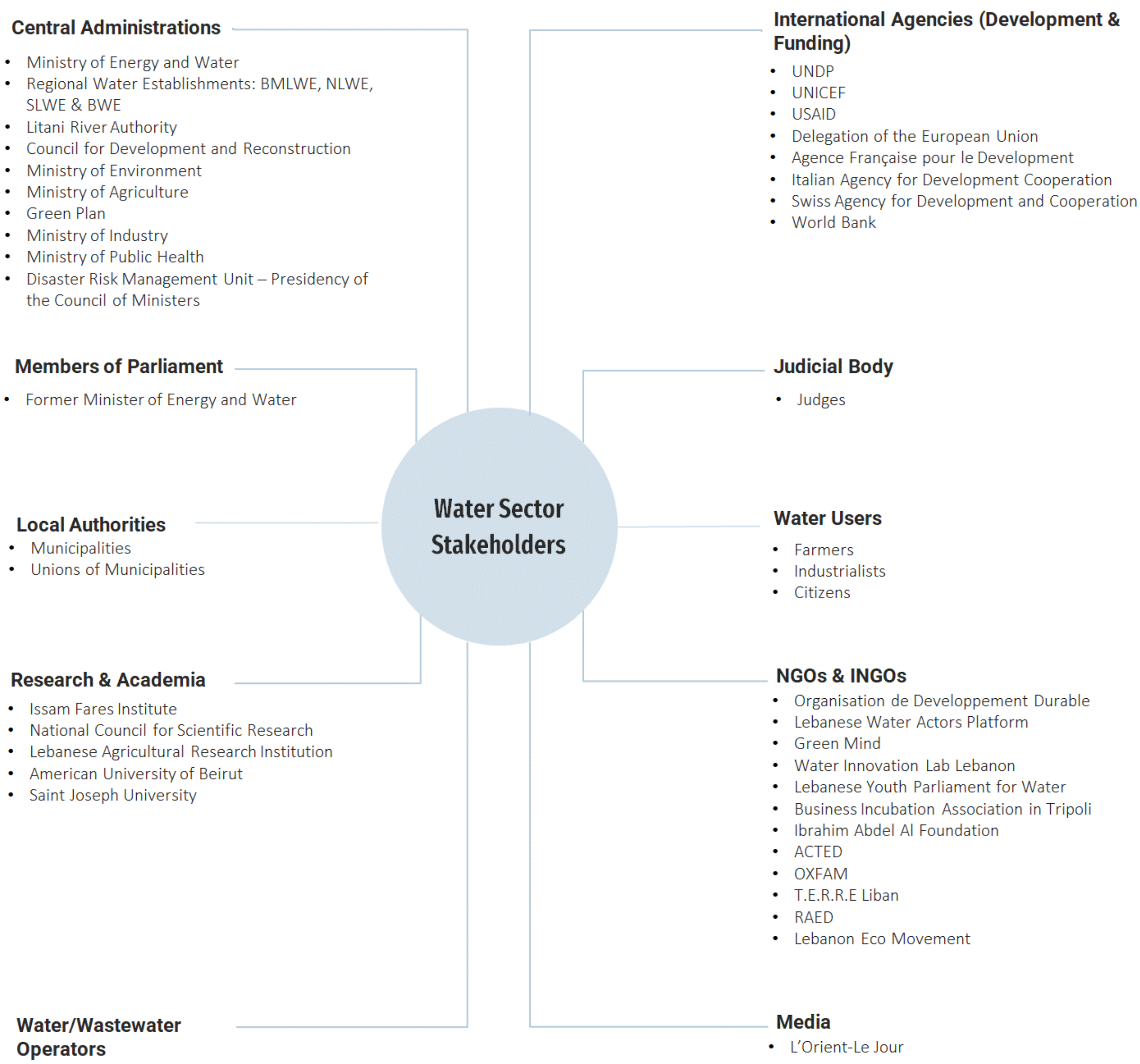


Figure 3. Stakeholders Consulted during the Focused Consultation Meetings

2.4 Impact Assessment

The SESA identifies a list of the key social, environmental, and economic themes (referred to as *SESA Key Themes*) that may be impacted by implementing the Updated NWSS-MoEW (2020). ECODIT identified the SESA key themes based on its previous experience in SEAs and the sector, identification of the main impacts of the Updated NWSS-MoEW (2020), and the stakeholders' engagement activity initiated as part of this study. Each of the SESA key themes has associated *objectives* – based on national and global plans, policies, and goals – that the Updated NWSS-MoEW (2020) will be benchmarked to, and the SESA recommendations should adhere to.

The SESA key themes are divided into *Specific* and *Cross-cutting*. Specific key themes are critical socio-economic and environmental priority areas directly affected by the implementation of the Updated NWSS-MoEW (2020) (See Table 51 in Annex 9.1).

Cross-cutting key themes are those that traverse and affect most or all of the other specific SESA key themes and are based on the vision, pillars, and objectives of the Updated NWSS-MoEW (2020).

Figure 4 illustrates the eight Specific and four Cross-cutting key themes considered in the SESA study.

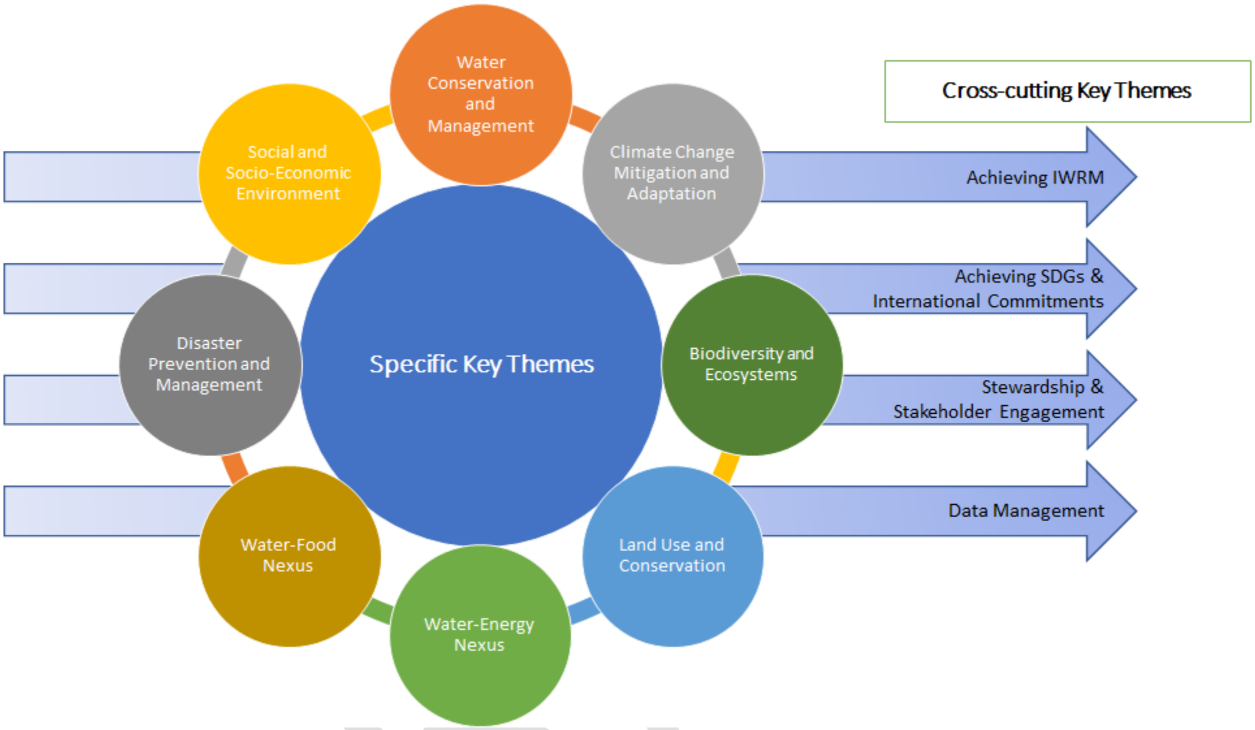


Figure 4. Specific and Cross-Cutting SESA Key Themes

The SESA team evaluated potential impacts resulting from the implementation of interventions proposed in the Updated NWSS-MoEW (2020) by assessing how the Updated NWSS achieves the objectives of each specific key theme. The assessment methodology of these impacts was mostly qualitative and was conducted based on the following:

- Determination of potential impacts on the environment (physical, biological, human, and cultural);
- Evaluation of external factors affecting the implementation of the strategy (i.e., the economic situation of the country);
- Consultation and engagement with stakeholders;
- Review of case studies to conclude lessons learned; and
- Development of GIS maps to reveal sensitive areas.

2.5 Study Limitations

The SESA team faced several limitations during the preparation of the SESA Report; these include:

- Presence of discrepancies and inaccuracies between the volumes of the Updated NWSS-MoEW (2020).
- Incomplete and outdated datasets related to the national environmental and social baseline reduced ECODIT's ability to conduct spatial analysis using GIS and guarantee the accountability of results.
- Lack of availability of data, for example:
  - Aggregated energy consumption data by the water sector.
  - Unified reference on biological hotspots in Lebanon.
  - Current water consumption by productive economic sectors in Lebanon.
- Presence of contradicting data related to controversial issues (i.e., groundwater resources availability) across different published studies and articles.
- Ongoing economic and financial crises in Lebanon presented difficulties with:
  - Accessing data due to the delays and lack of responsiveness of public institutions.
  - The unpredictable fluctuating exchange rate of the Lebanese Pound (LBP) and inflation rate renders any forecasted monetized impacts of the Updated NWSS-MoEW (2020) bound to major uncertainties.
- Absence of clear, quantifiable targets set for each initiative/objective in the Updated NWSS-MoEW (2020) makes the estimation of incremental benefits compared to the baseline a challenging exercise.
- COVID-19 pandemic restrictions and working modalities.

3 DESCRIPTION OF THE UPDATED NWSS – 2020

The Updated NWSS-MoEW (2020) serves as an update of Lebanon's National Water and Wastewater Sector strategies of 2012. It plans the water sector for 15 years (2020-2035). It is comprised of six volumes, as detailed below.

Volume I:	Executive Summary – outlines the strategy objectives and projects and provides a summary of all volumes.
Volume II:	Water Sector Governance – discusses the current legal and institutional framework, RWEs human resources, water tariff analysis, and governance recommendations.
Volume III:	Water Resources Management – covers the available water resources, surface water and groundwater resources management, wastewater and sludge management, and the SESA of the NWSS.
Volume IV:	Water Sector Current Situation – provides information on water resources and wastewater facilities, water demand, and water balances.
Volume V:	Proposed Projects – lists the cost estimates and assigns priority levels (based on deadline for implementation) of all proposed projects, studies, and investigations.
Volume VI:	Drawings – maps the strategy's proposed projects in each district under the jurisdiction of all four water establishments, namely North Lebanon, Beirut and Mount Lebanon, South Lebanon, and Beqaa.

3.1 Vision, Objectives, and Pillars of the Updated NWSS-MoEW (2020)

The strategy aims to ensure equitable access to water and sanitation services for all. It entails a wide range of legal, institutional, technical, and financial recommendations and actions, in addition to proposed projects across the Lebanese territory, divided geographically under each RWE jurisdiction (i.e., EBML, NLWE, SLWE, and BWE). Given its geographical scope, the strategy's impacts will be both national (impacts on Lebanon's various economic sectors – primarily the agricultural, industrial, and tourism sectors, the healthcare system, and social groups) and transnational (impacts on shared water bodies, marine environment, and climate change).

Figure 5 illustrates the strategy's vision, pillars, and overall objective, which are further detailed in the sub-sections that follow.

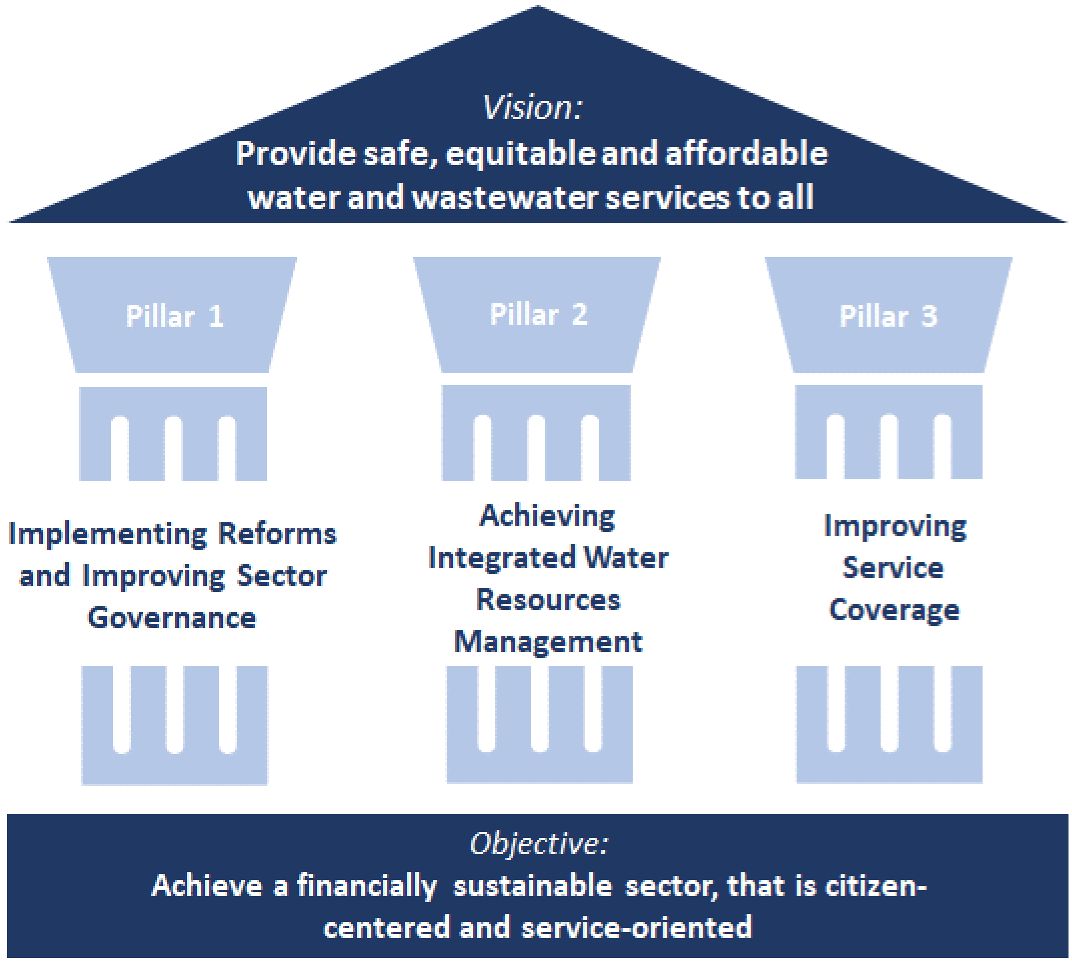


Figure 5. Updated NWSS-MoEW (2020) Vision, Pillars, and Objective

3.1.1 *Strategy's Objectives*

The Ministry aims at achieving a financially sustainable sector, that is citizen-centered and service oriented, and which would ultimately allow to reach the Integrated Water Resources Management (IWRM) approach of the sector, as per Law 192/2020.

It is built on the following three specific objectives:

1. Build an operational and sustainable legal and institutional framework.
2. Develop financing tools for the sector to set-up financial mechanisms in aims of ensuring the sustainability of services.
3. Establish sustainable and effective mechanisms for collaboration between all actors and stakeholders in the water sector to improve monitoring and transparency

The strategy is divided into six components for which specific objectives are set, as displayed in Table 1.

Table 1. Updated NWSS-MoEW (2020) Components and Related Specific Objectives

Strategy Component	Specific Objectives
Sector Governance	A.1 Implement the legal and regulatory framework reform (Water Code).
	A.2 Rationalize the tutelage framework with a view for clear dispatching between operational and regulatory activities.
	A.3 Develop proper mechanisms for performance monitoring.
Financial and Commercial	B.1 Conduct a customer and user census.
	B.2 Implement consumption-based tariffs for the water service.
	B.3 Revise the tariff structure for sanitation services.
	B.4 Revise the tariff structure for irrigation.
Reporting and Monitoring	C.1 Enhance sector monitoring.
	C.2 Enhance sector transparency.
	C.3 Enhance sector coordination.
	C.4 Enhance communication with users.
Capacity-Building	D.1 Strengthen the MoEW monitoring capacities.
	D.2 Streamline and structure RWEs internal organization and management.
O&M of Facilities and Services	E.1 Improve operating cost control.
	E.2 Enhance private sector involvement.
	E.3 Adopt a shared wastewater management framework.
Service Coverage	F.1 Enhance water service coverage.
	F.2 Enhance wastewater service coverage.
	F.3 Structure for irrigation service.

3.1.2 *Strategy's Pillars*

To achieve the aforementioned objectives, the Updated NWSS-MoEW (2020) is based on the following three pillars:

Pillar 1: Implementing Reforms and Improving Sector Governance

In this pillar, the aim is to build solid legal, institutional, financial, commercial, and monitoring frameworks to achieve sustainable water sector management. It also targets the enhancement of communication mechanisms and increased transparency with stakeholders, as well as a shift in the data sharing culture.

Pillar 2: Achieving Integrated Water Resources Management

This pillar aims to improve infrastructure planning and water allocation among economic sectors. It targets the continuous measurement and monitoring of the quantity and quality of available groundwater and surface water resources across the country and addresses environmental concerns, including wastewater reuse, sludge management and the SESA of the strategy.

Pillar 3: Improving Service Coverage

In this pillar, the strategy proposes infrastructure projects in the water, wastewater, and irrigation sectors. The proposed projects are prioritized based on criteria which considers water needs, the respective water balances of all systems, the importance of shifting from groundwater resources to surface water resources, and the urgency of storing surface water to mitigate the effects of climate change in Lebanon.

3.2 Water Sector Challenges Identified Under Each of the Strategy's Pillars

The challenges identified by the strategy under each pillar are summarized in Table 2.

Table 2. Identified Water Sector Challenges in the Strategy

Strategy Pillars	Challenges
Implementing Reforms and Improving Sector Governance	• MoEW and RWEs lack qualified staff and are generally understaffed; not in accordance with organizational charts. • Inefficient and ineffective RWE contracting framework for private sector involvement. • Current water sector tutelage framework is highly administrative and does not focus on monitoring performance. • Current water sector data is incomplete, full of discrepancies, and does not enable systematic monitoring. • Lack of sector communication, coordination, and transparency with users and between institutions. • Lack of transparency of RWE financial statements. • Inaccurate gauge system: flat rate billing system does not identify water overconsumption. • Insufficient and ineffective water meters management. • Tariff level discrepancies among RWEs. • The RWE's customer databases for drinking water services are not comprehensive. • RWEs' user databases for wastewater management services have not been developed yet. • High operating cost control of facilities and services (mainly due to energy bill). • Fragmented wastewater management framework.

Strategy Pillars	Challenges
Managing Water Quantity and Quality	• Reduced volumes of water stored in aquifers due to climate change. • Damaged or insufficient meteorological and hydrometric stations. • Mismanagement and decentralization of groundwater and surface water data and studies. • Insufficient staff to cover all the duties of the geology and underground water services in the MoEW. • Absence of monitoring systems for groundwater quantity and surface water. • Uncontrolled number of private wells and extraction of groundwater. • Overexploitation of groundwater resulting in seawater intrusion in the coastal aquifers. • LIBNOR 161:2016, related to drinking water standards, has not been published yet. • No water quality monitoring plan implemented by RWEs. • Insufficient resources and equipment at RWEs for water sample processing. • Unorganized/unavailable water quality data. • Lack of regulations, guidelines, and standards for the reuse of treated wastewater in Lebanon.
Improving Service Coverage	• Negative water balances in potable water distribution schemes due to water deficits. • Water shortages in irrigation schemes. • Aged and partially damaged irrigation infrastructure. • Inadequate transmission, storage, and distribution of potable water. • Absence of/ insufficient Wastewater Treatment Plants (WWTPs) and sewer networks.

3.3 Proposed Initiatives and Recommendations of the Strategy

All strategy initiatives, recommendations, and corresponding cost estimates to address the aforementioned challenges are summarized in the sub-sections that follow. It is worth mentioning that the total cost of all strategy initiatives (with 15% contingencies) is USD 8,245.32 million. We provide a breakdown below by pillar.

The proposed initiatives are assigned a priority level based on order of urgency according to the following general criteria:

Priority 1: Urgent projects to be implemented as soon as possible.

Priority 2: Projects that are required but could be delayed if present implementation is not possible.

Priority 3: Projects that would be required in the future, based on the foreseen evolution of the present status of the water sector.

3.3.1 *Implementing Reforms and Improving Sector Governance*

Table 3 summarizes the initiatives and associated cost estimates pertaining to Pillar 1 of the strategy. The Updated NWSS-MoEW (2020) classifies all Pillar 1 initiatives as Priority 1 projects with a total estimated cost of USD 13,082,500.

Table 3. Updated NWSS-MoEW (2020) Pillar 1 Initiatives, including Associated Timelines and Cost Estimates

Strategy Component	Initiatives	Cost Estimate (USD)
Legal and Institutional Framework	• Implementation of the Water Code by preparing and issuing of the implementation decrees, including prevention of water deficit, organization of the National Water Council, reuse of treated wastewater, etc. *(2020 – 2025)* • Review and implementation of the RWE organizational and operating decrees. *(2020-2025)* • Restructuring the Ministry's supervisory functions. *(2020) - delayed** • Set up a unit within the MoEW to coordinate and supervise the implementation of the Strategy. *(2020-2025)* • Set up a unit in charge of performance monitoring within the MoEW. *(2020-2025)* • Standardize the structure of reports and audits. *(2020-2025)* • Develop a framework for performance monitoring within each RWE. *(2020-2025)*	1,465,000
Financial and Commercial	• Conduct a customer census campaign and investigation: identify users of wastewater services and identify those who are already RWE subscribers. *(2020-2022)* • Implement consumption-based tariffs for water services. *(2020-2022)* • RWEs to set financial plans for users. • Revise tariff structure for sanitation services. *(2020-2021)* • Introduce a wastewater fee proportional to the water consumed. • Conduct an assessment of all existing WWTPs and estimate the cost of rehabilitation/upgrading.	6,750,000
Reporting and Monitoring	• Create a monitoring department within the MoEW. *(2020)* • Establish a unified database for sector monitoring data. *(2020-2022)* • Assess RWEs' monitoring capacities. • Set up an annual sector review every mid-year. *(2020)-delayed** • Set up a process for monitoring the strategy implementation status. *(2020-2025)* • Regular reporting and publishing of reports online; defining the main indicators and messages to be communicated to the public. *(Starting from 2021)* • Design and launch a national communication campaign on the water sector. *(2020-2021)*	1,257,500

Strategy Component	Initiatives	Cost Estimate (USD)
Capacity Building	• Appoint specific Technical Assistance (TA) to the MoEW for development of monitoring mechanisms. *(2020)* • Hire staff specialized in managing performance-based contracts at RWEs. • Conduct an overall internal audit in each RWE. *(2020-2021)* • Prepare a handbook of jobs in the RWEs with minimum skills required per position *(2020-2022)* • Prepare and implement training/capacity building plan. *(2020-2025)*	2,950,000
Operation and Maintenance of Facilities	• Develop a strategy to control the energy costs of the facilities. *(2020-2021)* • Review existing contracts with private operators and develop a new contracting framework and performance-based contracts; pilot contract for wastewater facilities management by 2021; complete adoption of contracts by 2035. • Conduct study to propose an overall framework for wastewater facilities management. *(2020-2021)*	660,000
		13,082,500

**Based on personal communication with MoEW on 17/02/2022*

3.3.2 *Achieving Integrated Water Resources Management*

Table 4 summarizes all initiatives and associated cost estimates pertaining to Pillar 2 of the strategy. Pillar 2 initiatives have a total estimated cost of **USD 83,819,000**. It is worth noting that the cost of Priority 1 initiatives (i.e., urgent projects to be implemented as soon as possible) under Pillar 2 represent 50% of the total estimated cost of initiatives under this pillar.

Table 4. Updated NWSS-MoEW (2020) Pillar 2 Initiatives including Associated Timelines and Cost Estimates

Strategy Component	Initiatives	Priority Level	Cost Estimate (USD)
Integrated Hydrological Information System (IHIS)[5]	• Studies for IHIS implementation, including: Flood-risk and drought management plans, and a rainwater harvesting plan. *(2021-2029)* • IHIS Implementation, operation, and supervision. *(2023-2029)* • Water Evaluation and Planning System (WEAP) operation and implementation. *(2023)*	1	9,548,000
Meteorological and Hydrometric Networks	• Network expansion: Installation of 113 additional meteorological stations and 135 additional hydrometric stations under Lebanese Meteorological System (LMS), LRA, Lebanese Agricultural Research Institute (LARI) and MoEW to reach density of 50 stations/km. *(2021-2025)*	1	6,066,000
Project Management Unit (PMU)	• Implementation of a PMU for a five-year period. *(2021)* • Review well licensing procedures of the MoEW. *(2021-2022)* • Staff recruitment in the MoEW, specialized in the fields of geology, hydrogeology, and water resources. *(2021)* • Review of all existing data in the MoEW data center and data collection. *(2021-2035)* • Monitor the flows and water quality of springs and most public operating wells with the assistance of RWEs. *(2021-2035)*	1	8,505,000
General Geological and Hydrological Studies	• Geology and hydrogeology mapping and studies. *(2022-2027)*	1	21,800,000
	• Refreshment of water budget studies of major hydrogeological basins. *(2024-2035)* • Groundwater vulnerability mapping and delineation of protection zones for springs. *(2025-2029)* • Modeling of major karst aquifers' hydrogeological basins, and porous, saline aquifer systems. *(2027-2035)*	3	

[5] A hydrological information system for all public and private water sector stakeholders to manage, publish and share their data, products, and services.

Strategy Component	Initiatives	Priority Level	Cost Estimate (USD)
Drilling and Testing Exploratory Wells	• Drilling and testing 14 reconnaissance and exploratory wells at identified areas to detect the presence of new potential aquifers. (*2022)* • Drilling and testing exploratory wells in the following areas: Hadath-Hazmieh and Daichouniye (Priority 1), Akkar Plain (Priority 2), Zahrani and Damour (Priority 3)	1, 2 & 3	6,150,000
Artificial Aquifer Recharge	• Artificial Aquifer Recharge studies in the respective areas of jurisdiction of all four RWEs. • Artificial recharge at six identified sites; Berdaouni site to be completed by 2025, remaining sites to be completed by 2035.	1, 2 & 3	31,750,000
			83,819,000

Additional water resources management recommendations which address challenges pertaining to water quality management, wastewater and sludge management, and the SESA are summarized in Table 5. These recommendations have no associated cost estimates and are not assigned a priority level.

Table 5. Updated NWSS-MoEW (2020) Pillar 2 Recommendations

Strategy Component	Initiatives
Water Quality Management and Monitoring	• Compliance monitoring; trained staff, facilities, equipment, and materials, and operating protocols at Water Establishments (WEs) for implementation. • Recommended water quality sampling locations. • Suggested operational monitoring parameters for both surface water and groundwater. • Suggested water quality monitoring parameters for both surface water and groundwater, together with their respective sampling frequencies. • Publishing of 161:2016 LIBNOR water quality standards. • Implementation of Water Safety Plan by all RWEs. • Creation of a Water Quality Data Database.
Wastewater and Sludge Management	• Investigate and analyze the existing potential for sludge reuse. • Wastewater discharge, wastewater re-use, and sludge re-use recommendations for environmental protection. • Promote regional co-operation in sludge management. • Performance monitoring parameters and sampling frequency for Treated Wastewater Effluents (TWEs) discharged into the surface water in Lebanon. • Performance monitoring parameters and sampling frequency for TWE reused for irrigation. • Proposed minimum sludge analysis frequencies based on Lebanese guidelines on sewage sludge use in agriculture prepared by the Food and Agriculture Organization of the United Nations (FAO) in 2010.
SEA	• Development of an SEA in compliance with Decree 8213/2012.

3.3.3 *Improving Service Coverage*

Table 6 summarizes initiatives and associated cost estimates pertaining to Pillar 3 of the strategy. Each individual project is assigned a Priority level in the strategy. Pillar 3 initiatives have a total estimated cost of USD 7,072.865 million; the cost of Priority 1 initiatives under Pillar 3 represent 46% of the total estimated cost of initiatives under this pillar.

The proposed initiatives under Pillar 3 were not pegged to a timeline in the Updated NWSS-MoEW (2020).

Table 6. Updated NWSS-MoEW (2020) Pillar 3 Projects including Associated Timelines and Cost Estimates

Strategy Component	Initiatives	Cost Estimate (Million USD)
Potable Water	• Upgrade and/or rehabilitation of water distribution systems across the respective areas of jurisdiction of all four RWEs to meet 2035 water demands: - Construction of 1,894 km of transmission Lines *(Priority 1)* - Construction of 559 reservoirs *(Priority 1)* - Construction of 50 pumping stations *(Priority 1)* - Drilling of 192 wells *(Priority 1)* - Construction of 6,880 km of distribution networks *(Priority 2)* • Implementation of remote control and monitoring (Supervisory Control and Data Acquisition (SCADA) and District Metered Areas (DMA)) for all systems.	1,574.33
Wastewater	• Construction of 182 WWTPs with a total design capacity of 1,196,875 m^3/day of wastewater across the respective areas of jurisdiction of all four RWEs. • Rehabilitation, replacement, and upgrade of sewers, including the construction of around 9,416 km of sewer lines across the respective areas of jurisdiction of all four RWEs.	2,204.110
Irrigation	• Rehabilitation and/or upgrade of irrigation schemes across the respective areas of jurisdiction of all four RWEs. • Irrigation of additional ~38,000 ha at country level to reach 138,000ha irrigated areas by 2035: - 4,930 ha under NLWE jurisdiction - 540 ha under BMLWE jurisdiction - 8,800 under BWE jurisdiction - 23,585 under SLWE jurisdiction	1,142.975
Dams and Hill Lakes	• 14 dams proposed with around 504.1 and 683 MCM of static and dynamic water storage respectively, at identified sites with related transmission lines and reservoirs (Table 7). • Construction of hill lakes across the respective areas of jurisdiction of all four RWEs.	2,151.450
		7,072.865

Proposed dams in the Updated NWSS-MoEW (2020) are listed in Table 7.

Table 7. List of Selected Dams in Updated NWSS-MoEW (2020)

Governorate	Dam Name	Static Capacity (MCM)	Dynamic Capacity (MCM/year)	Usage	Nature of Works	Cost Estimate (Million USD)
Priority 1						
Akkar	El Bared Dam	37	90	Water Supply	Dam, Water Treatment Plant (WTP), Transmission Lines and Reservoirs	196
Beqaa	Assi Phase I Dam*	-	63	Irrigation	-	52
Mount Lebanon	Ain Dara/ Azzounieh Dam	4.1	5	Water Supply	Dam, WTP and Transmission Lines	65
South Lebanon	Bisri Dam*	120	125	Water Supply	Dam	TBC
Priority 2						
North Lebanon	Dar Baachtar Dam	7	7	Water Supply/ Irrigation	Dam and Major Transmission Lines	50
South Lebanon	Ibl El Saqi Dam	50	50	Water Supply/ Irrigation	Dam, Transmission Lines and Reservoirs	145
South Lebanon	Choumariye Dam	28	28	Water Supply/ Irrigation	Dam, Reservoirs, WTP and Transmission Lines	128
Mount Lebanon	Damour Dam	42	106	Water Supply/ Irrigation	Dam, WTP, Transmission Lines and Reservoirs	200
Beqaa	Assi Phase II Dam	37	15	Irrigation	Dam, Power Generation and Lift Lines	150
Priority 3						
Akkar	Noura El Tahta Dam	35	50	Water Supply/ Irrigation	Dam and WTP	150
Beqaa	Younine Dam	5.8	5.8	Irrigation	Dam and Major Irrigation Lines	69.96
Beqaa	Massa Dam	8	8	Irrigation	Dam and Major Irrigation Lines	37.1
South Lebanon	Khardali Dam	128	128	Water Supply/ Irrigation	Dam, Reservoirs, WTP and Transmission Lines	480
Mount Lebanon	Maaser El Chouf	2.2	2.2	Water Supply	Dam and WTP	53
					TOTAL	**1,776.06**

*Assi Phase I and Bisri Dams are already under construction but are listed under Priority 1

4 LEGAL, INSTITUTIONAL, AND POLICY FRAMEWORKS

This Chapter provides an overview of the legal and institutional framework and policies governing the water sector in Lebanon, as well as relevant national and regional plans, programmes, and projects.

4.1 Legislative Framework

The most notable advancement in the water sector legal framework in the last five years was the promulgation of the Water Code – Law 77/2018, which was later amended into Law 192/2020. The Water Code Amendment Law 192/2020 aims to update and modernize the legal, financial, and institutional dimensions of the water sector; its key elements are summarized as follow:

1. Outlines the responsibilities of water authorities:
    - MoEW is responsible for managing publicly owned water properties and for adopting a sustainable water policy to preserve the state's water resources (Articles 6 and 7).
    - The "Public water investment institutions" (the RWEs and the LRA) are responsible of providing potable water services, wastewater services, and irrigation water services.
2. Stipulates the creation of a water register at the MoEW: public institutions are required to send all records and data pertaining to water resources to the water register (Article 13).
3. Establishes the National Water Authority (Council) at the Prime Minister's office headed by the Prime Minister and constituted of the Ministers and the Director Generals of the Public water investment institutions (the RWEs and the LRA) (Articles 14 and 15). Clauses 1 and 5 of Article 15 were removed as they conflicted with the constitutional role of the MoEW (Decision 8/2020). As such, the National Water Council has a consulting role only, with the following key responsibilities:
    - Studying the Water Sector Strategy.
    - Setting financing plans for water sector plans and programs.
    - Issuing recommendations for the improvement of water resource management.
4. Enforces a water sector strategy: it is the responsibility of the MoEW to develop a general master plan for the sector in collaboration with the public water investment institutions (the RWEs and the LRA). The master plan should be based on an integrated water resources management approach and is aimed towards achieving sustainable management of water resources in Lebanon. The master plan should be developed in coordination with a set of ministries, namely: environment, agriculture, public works, transport, and industry (Article 17). The general master plan should be revised every five years, or when necessary.
5. Stipulates the development of water basin management plans for all water basins.
    - MoEW is required to set a system to evaluate and characterize existing water basins; the results should form the basis of the general master plan for the water sector.
    - Public water investment institutions (the RWEs and the LRA) are required to generate water basin management plans. Once verified by the MoEW, the plans should form an integral part of the general master plan of the water sector.
6. Stipulates the implementation of a volumetric potable water tariff (through water metering), volumetric wastewater tariff, and irrigation tariff (Articles 47, 48 & 49, respectively).

7. Identifies institutional, technical, economic, and financial measures for the protection of water resources, including water system protection tariffs and pollution compensation fees.
8. Defines and updates prosecution procedures for crimes committed in case of violation of the provisions of Law 192/2020.
9. Delineates a licensing system for the issuance of water well licenses and the management of both legal and illegal existing wells.
10. Establishes non-profit Irrigation Water Users' Associations upon the request of public water investment institutions (the RWEs and the LRA) to assist in the management of the public irrigation utility (Article 75).
11. Stipulates the issuance of annual reports by the MoEW that describe the general status of the sustainable management of the sector and entail procedures for the implementation of Law 192/2020 (Article 79).
12. Proposes measures to improve communication and coordination with the public by stipulating the following:
    - The MoEW and the Public water investment institutions (the RWEs and the LRA) will publish all information pertaining to potable and irrigation water to consumers on a regular basis (Article 100).
    - The MoE, Ministry of Education and Higher Education, Ministry of Information, the public water investment institutions (the RWEs and the LRA), environmental protection organizations, and the private sector shall collaborate to educate citizens on water rights and water conservation culture (Article 101).
    - Proposes legal possibilities for Public Private Partnerships (PPPs), including that which is stipulated in the provisions of Law 48/2017 (The PPP Law), and Public-Public Partnerships, (i.e. Municipalities or other governmental institutions).

In addition to Law 192/2020, Table 8 presents a selected list of the most relevant legislation. Annex 9.2 presents a more exhaustive list of available legislations.

Table 8. Relevant Legislations

Legislation	Description
Law 77/2018 and its amendment Law 192/2020	The Amended Water Code: addresses the legal, financial, and institutional aspects of the water sector.
Law 48/2017	The PPP Law: Organization of the PPP in the water sector for joint projects implemented by public institutions (except for Municipalities and the federation of Municipalities).
MoE Decision 589/1 of 2015	Review process for SEA scoping and SEA reports.
Decree 8213/2012	Strategic Environmental Assessment of Policy, Plan, and Program Proposals in the Public Sector.
Decree 8633/2012	Fundamentals of Environmental Impact Assessments (EIAs).
Decree 14597/2005 (amended by Decree 1759/2009), Decree 14599/2005 (amended by Decree 1756/2009), Decree 14601/2005 (amended by Decree 1758/2009),	EBML, BWE, SLWE, and NLWE operating rules, respectively. Articles entail water establishment operating rules provisions with respect to drinking water subscriptions, wastewater subscriptions, and irrigation water subscriptions.

Legislation	Description
and Decree 14603/2005 (amended by Decree 1757/2009)	
Law 444/2002	Environmental Protection Law which sets the basic principles and general provisions to regulate environmental protection and participation in terms of management, preservation, and maintenance of environmental media (resources), to assess the effects of projects on the environment. It also defined the responsibilities and the penalties imposed on those who abuse the resources or cause environmental damage or pollution. *Notable Relevant Articles:* • Article 35: Provides legislative support for the protection of Lebanon's water resources. • Article 36: The establishment of water procedures, standards, and measures for water quality monitoring and management, by decree. • Article 37: Any facility carrying out water treatment operations must be subject to prior approval by the Minister of Environment with an implementing decree.
MoE Decision 8/1 of 2001	National standards for environmental quality that covered air emissions and liquid discharges (partly updating Decision 8/1 dated 30/1/2001).
Law 221/2000 (and its amendments Law 241/2000 and Law 337/2001)	Water Sector Reform Law: Institutional reform of the water authorities, addresses the organization of the water sector and establishes the four public water establishments for water use.
MoE Decision 52/1 of 1996	Environment quality standards and criteria for air, water, and soil pollution.
Decree 9631/1996	Additional responsibilities of the LRA.
Law 20/1966 (Amended by Law 247/2000) and implementation Decrees 5469/1966 and 6650/1973	Establishment of the MoEW and its composition, organization, and missions.
Law dated 14/08/1954	Establishment of the LRA: it is responsible for the execution and implementation of works on the Litani basin, including key dams and power stations.
High Commissioner Decision 320/1926	Conservation and use of public water, addresses the following: • Prohibitions with regards to the protection of catchment areas and buffering requirements. • Acquired rights of public waters (i.e. exclusive property over water resources), particularly underground water. • Other criminal provisions relating to the violations of water policing.
Order No. 144/1925	Protection of surface and ground water resources.
Law dated 1913 (The Ottoman Megelle)	Ottoman irrigation Code: Regulation of Agriculture use of water. *Notable Relevant Articles:* • Title 4, Chapter 10: Articles 1234 to 1328: definition of waters, utilization of water, and the maintenance of waterways.

4.2 International Conventions, Treaties, and Agreements

Table 9 lists the multilateral agreements and conventions which are relevant to the SESA assessment.

Table 9. Relevant Multilateral Agreement Laws

Legislation	Subject	Description/Relevance
Law 115/2019 and Decree 5599/2019	Paris Agreement to the United Nations Framework Convention on Climate Change (UNFCCC)	Goal of the agreement is to “limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels”. Parties are required to communicate actions they will adopt to reduce their greenhouse gas emissions and measures they will take to adapt to climate change.
Law 738/2006	Kyoto Protocol	First implementation measure under the UNFCCC. Commitment to limit greenhouse gas emissions. Relevant measures: • Adopt policies and measures to reduce greenhouse gas emissions.
Law 412/2002	Agreement on the Conservation of African-Eurasian Migratory Water Birds (AEWA)	Commitment towards the conservation and sustainable management of migratory Water Birds and their habitats, including adopting associated legal measures.
Law 23/1999	Convention on wetlands of international importance, especially as Waterfowl habitat – Ramsar	Relevant measures include: • Promoting the conservation of wetlands and establishing nature reserves on wetlands.
Law 469/1995	United Nations Convention to Combat Desertification (UNCCD) – Paris	Commitment to mitigate effects of drought to reduce poverty and support environmental sustainability. Relevant measures include: • Implementing strategies, policies, legislation, and mechanisms which promote the conservation, rehabilitation, and sustainable management of water resources to improve the living conditions of communities. • Promote awareness and participation of local communities in aims of mitigating drought and desertification.
Law 359/1994	UNFCCC	Commitment requires implementing measures to reduce greenhouse gas emissions and climate change mitigation measures.
Law 292/1994	Protocol for the protection of the Mediterranean Sea against pollution from land-based sources – Athens	Prevention of land-based pollution – particularly polluting outfalls discharging into the Mediterranean Sea. Relevant measures include: • Adopting standards, guidelines and/or criteria for quality and quantity of discharges. • Monitoring of pollution along the coast.
Law 360/1994	United Nations Convention on Biological Diversity (CBD)	The convention has three main goals: • The conservation of biological diversity.

Legislation	Subject	Description/Relevance
		• The sustainable use of the components of biological diversity. • The fair and equitable sharing of the benefits arising out of the utilization of genetic resources. Parties to the convention are required to submit national biodiversity strategies and action plans that align with CBD strategic goals.
Decree-Law 126/1977	Convention for the protection of the Mediterranean Sea against Pollution – Barcelona	Relevant measures include: • Prevention of land-based pollution (including hazardous waste). • Implementing environmental legislation. • Monitoring of pollution. • Protecting biodiversity. • Facilitating public access to information and increasing public participation.

4.3 World Bank Safeguard Policies

The World Bank Safeguard Policies provide a framework to mitigate adverse social and environmental impacts during the design, implementation, and operation of World Bank-funded projects. The environmental and social Safeguard policies consist of 11 operational policies. The policies relevant to this SESA report are detailed in Table 10.

Table 10. Description of Relevant World Bank Environmental and Social Safeguard Policies

Safeguard Policy	Policy Description
OP/BP 4.01 - Environmental Assessment	Projects proposed for World Bank financing require an environmental assessment that investigates the potential environmental risks in the project's area and analyzes methods to prevent and minimize such risks. The Environmental Assessment policy considers the impact of proposed projects on the natural environment (water, air, land), human health and safety, social aspects such as indigenous people and forced resettlement, and global environmental aspects. A range of environmental assessment instruments can be used to satisfy this policy, including EIAs, SESAs, Environmental Assessments, and EMPs.
OP/BP 4.02 – Environmental Action Plans	Borrowing governments are encouraged to prepare and implement an Environmental Action Plan which describes the country's major environmental concerns and mitigation actions and policies.
OP/BP 4.04 - Natural Habitats	The Natural Habitats policy prohibits World Bank support for projects that put native and vulnerable plant and animal species at risk. The policy takes into

Safeguard Policy	Policy Description
	consideration the conservation of biodiversity and natural resources essential to human society to minimize the impact on ecosystems.
OP/BP 4.36 - Forests	The Forests policy ensures that minimal deforestation is carried out during projects. Deforestation is assessed based on its impact on biodiversity, climate change, and importance to indigenous people.
OP/BP 4.11 - Physical Cultural Resources	Projects that may adversely impact physical cultural resources require the preparation of a physical cultural resources management plan within their respective environmental assessment that includes measures to avoid or mitigate potential damages to these resources.
OP/BP 4.37 - Safety of Dams	The Safety of Dams policy outlines the standards for dam projects. The Policy requires experts in engineering, hydrology, and geology to consult the project before its approval. Competent professionals should assess the environmental impact, cost estimates, construction schedule, and technical details to ensure maximum safety while minimizing costs and environmental impacts. Generic safety measures are published for smaller dams. Dedicated teams are required for larger dam projects to deduce safety and environmental standards to mitigate risks to the local population, fauna, and flora.
OP/BP 7.50 - International Waterways	For projects proposed on international waterways, borrowing countries are required to notify other riparian states for approval.

4.4 Institutional Framework

The national authorities currently managing the country's water sector are the MoEW and the public water investment institutions: the four RWEs and the LRA. Other governmental stakeholders include the CDR, the Ministries (Environment, Agriculture, Industry, Public Health, and Interior and Municipalities), and the Council for the South. Figure 6 illustrates the institutional setup of the water sector.

There are several other stakeholders which support the water sector but do not have direct responsibilities mandated by law, including international donor agencies, the academic and research sector, non-Governmental Organizations, and the private sector (such as private water providers).

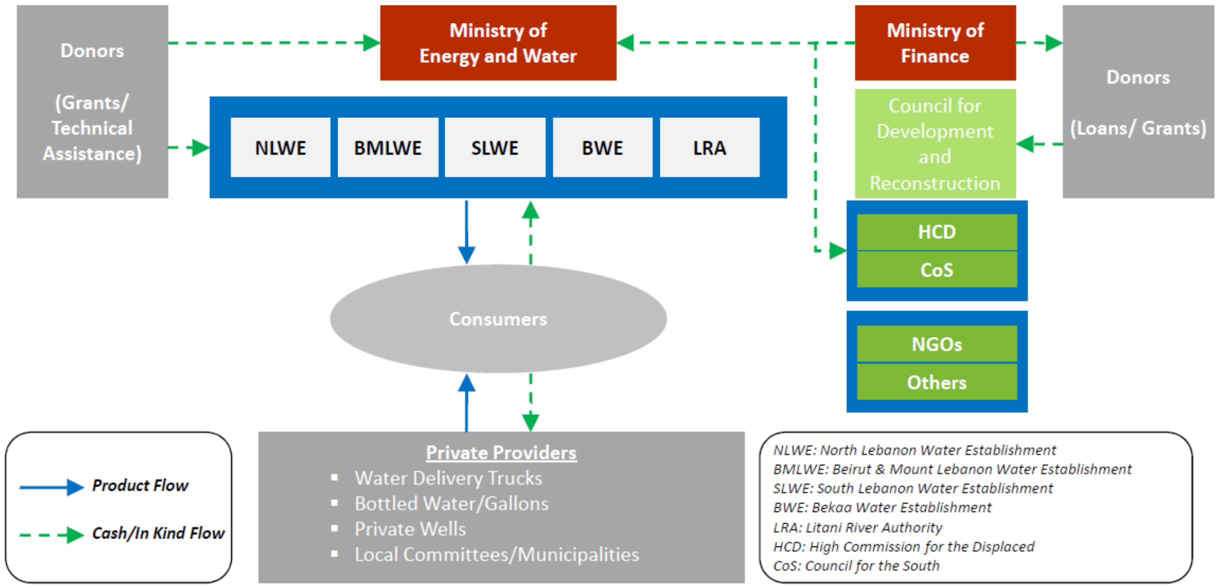


Figure 6. Current Institutional Setting and Commercial relations in the Water Sector in Lebanon (MoEW, 2012)

Responsibilities of all key authorities in the water sector are summarized in Table 11.

4.4.1 *Ministry of Energy and Water*

The MoEW is the apex of the water sector. Law 221/2000 (amended by Law 241/2000 and Law 337/2001) states that the MoEW is responsible for the following:

1. To collect, control, meter, establish statistics, and study water resources, as well as to evaluate water needs and areas of use all over the Lebanese territory.
2. To control the quality of surface and underground water and the identity standards to be applied.
3. To establish the general planning project for the allocation and reparation of hydraulic resources used for drinking and irrigation on the national level, as well as to prepare and continuously update the National Water and Wastewater General Master Plan and submit it through the Minister for approval by the CoM.
4. To design, study, implement, and operate large water installations and works, such as dams, artificial lakes, tunnels, water networks, and rectification of waterways.
5. To implement, when needed, artificial recharge of underground water reservoirs and to control underground water extraction.
6. To protect water resources from losses and pollution by elaborating legal texts and taking necessary measures and dispositions to avoid water pollution, as well as to restore the natural quality of these water resources.
7. To give licenses and permits for water prospecting, public water usage and temporary occupation of public properties, and to finalize all the necessary formalities according to the laws and by-laws in force.

8. To implement studies and hydraulic, geological, and hydrological research, to collect technical data relative to hydraulic matters, to establish technical maps concerning these studies, research, and data, and to update them regularly.
9. To carry out control and supervision over water-related public establishments and other relevant bodies in accordance with the present laws, texts and provisions pertaining to these establishments and institutions.
10. To ameliorate performances of the RWEs and to evaluate their performances on the basis of indicators mentioned in the action plans, which have been approved according to legal procedures.
11. To establish standards to be adopted in the conduct and implementation of studies by the Water Exploitation Public Establishments, and to establish the conditions and regulations for extraction and use of surface water, underground water, and management of wastewater, as well as quality standards and control.
12. To undertake public relations, provide the population with all necessary water-related information, and offer adequate orientation toward a rational usage.

The MoEW has three General Directorates (Article 2 of Law 20/1966 and amendment Law 247/2000): The Directorate of Water and Electrical Resources, the Directorate of Investment, and the Directorate of Oil. The Directorate of Water and Electrical Resources has the following missions (as stated in Article 9 of Decree 5469/1966):

a. To establish, execute or supervise the execution of water and electricity projects; and
b. To enforce laws and regulations pertaining to the protection and use of public waters.

4.4.2 *Regional Water Establishments*

Law 221/2000 and its amendments (Law 241/2000 and Law 337/2001) establish the four RWEs. According to Article 3 (amended by Article 1 of Law 241/2000), the RWEs have the following responsibilities and powers within their respective areas of jurisdiction (MoEW, 2020):

1. To study, execute, operate, maintain, and renew distribution projects for potable water and irrigation as well as wastewater collection and treatment projects in accordance with the General Water and Sanitation Master Plan or with the prior approval of the Ministry to use public water sources.
2. To propose (not set) tariffs for drinking water, irrigation, and sanitation services, taking into consideration the general socioeconomic conditions.
3. To monitor the quality of the distributed drinking water and irrigation water, as well as the quality of effluents entering and leaving WWTPs.
4. Oversee works, studies, and operation and maintenance of water installations by private service providers.
5. The listed establishments will operate in accordance with their own regulations.

Pursuant to Decision 118/2010, RWEs are also required to approve well license requests if:

a. The RWEs are unable to provide water services for the use specified in the licence request; and
b. The well does not pose a risk to any public water sources.

The RWE's rules of procedure, operating rules, financial regulations, staff rules and regulation, and administrative organization decrees were promulgated in 2005 in accordance with Article 5 of Law 221/2000. The RWEs operating rules stipulate that the RWEs are subject to a periodic governmental audit. The operating rules are identical for all regional water establishments except for SLWE: Articles 56 to 86 concerning irrigation in the operating rules were not incorporated into the operating rules of SLWE; SLWE is only responsible for potable water and wastewater management.

4.4.3 *Litani River Authority*

The LRA was established by law in 1954 and has the following missions (MoEW, 2020):

1. To carry out Litani River basin-related projects, involving irrigation, drinking water, land improvement, and electricity.
2. To create a connecting grid between power stations in Lebanon.
3. To build electricity distribution stations in various Lebanese regions.

Furthermore, the LRA has been assigned the following responsibilities by MoEW delegation (MoEW, 2020):

a. Surface flow monitoring in all rivers across the country; and
b. Water quality monitoring in the Litani river basin.

In 1962 the LRA was given the power to develop and operate all water systems connected to the Litani River and Awali Rivers in the area of Lebanon between the Beirut Damascus Highway and the Southern Lebanese border. Decree 9631/1996 assigned LRA with the additional responsibility of planning and managing of new irrigation schemes in the Litani River Basin and South Lebanon. Article 7 of Law 221/2000 further disposed that irrigation water schemes tied to the Litani River would remain under the control of the LRA, namely the irrigation schemes of South Beqaa (Canal 900) and South Lebanon (Canal 600). Law of 1954 grants the LRA administrative and financial autonomy, however, the LRA is also subject to a periodic governmental audit and is obligated to contract with an audit company in accordance with the provisions of Article 4 and Article 6 of Law 221/2000, respectively.

4.4.4 *Ministry of Environment*

The missions of the MoE stipulated by Law 690/2005 with regards to the water sector are the following (MoEW, 2020):

1. To prepare the general policy on short, medium, and long-term projects and plans in all that relates to the safeguarding and sustainability of natural environmental resources; to propose actions for the implementation of such projects and plans and to control their implementation (namely SEAs, EIAs/Initial Environmental Examination (IEEs), and Environmental Audits (EAs)).

2. To develop the strategy, work plans, programs, projects, activities, and studies needed to safeguard the environment, ensure the sustainability of natural resources, and control pollution from all sources.
3. To elaborate legislation, standards, and measures and to identify the standards and indicators necessary to guarantee the protection of the environment, the sustainability of natural resources, and control pollution from all sources.
4. To determine the environmental conditions for the protection of rivers, springs, marshes, and ponds to guarantee the protection of the environment, the sustainability of natural resources.

MoE is responsible for monitoring and regulating water pollution, including activities that may pollute the environment. Article 37 of the Environment Code (Law 444/2002) states that any facility carrying out water treatment operations must be subject to prior approval by the MoE. The Ministry of Justice designated environmental prosecutors and investigative judges as required by Law 251/2014 to prosecute environmental crimes. Moreover, Decree 3989/2016 establishes the environmental police, a department within MoE which regulates environmental crimes (including those pertaining to water) and enforces penalties; this provides the Ministry with means for law enforcement.

4.4.5 *Ministry of Agriculture*

The Ministry of Agriculture (MoA) is composed of: (a) The General Directorate, (b) The Directorate of Cooperatives, (c) LARI, and (d) Green Plan. Established by Decree 5246/1994, the MoA has the following missions (Article 1 of Decree-Law 31/1955 and its amendments):

1. Conducting technical studies for irrigation projects.
2. Supervising the execution of irrigation projects.
3. Organizing the distribution and use of irrigation water.

Although Green Plan has administrative and financial autonomy, it is under the authority of the MoA. Green Plan initiatives fall under the following two main areas of intervention:

1. National-level projects: construction of agricultural roads and the execution of small-scale irrigation projects – including water harvesting (hill lakes) and other sustainable water management projects.
2. Individual-level assistance: providing financial support and training of farmers and Municipalities.

4.4.6 *Ministry of Public Health*

The Ministry of Public Health (MoPH) was established in 1944 and is responsible for monitoring and ensuring the compliance of drinking water with local and international standards. More specifically, Article 35 of Decree 8377/1961 on the organization of the MoPH stipulates that the Sanitary Engineering Service is responsible for:

1. Conducting studies and proposing programs in accordance with the laws in force to ensure environmental health.
2. Proposing the technical specifications and conditions to be met for the construction of public and private sewers and drinking water network construction projects.

4.4.7 *Ministry of Interior and Municipalities (MoIM)*

Article 49 of Decree-Law 118/1977 gives the Municipal Councils the authority to implement water sector projects that address the needs within the Municipal area. Article 74 provides the president of the Municipality with the right to authorize water connections and the excavation of public streets to install water distribution pipes and sewers.

4.4.8 *Ministry of Industry*

The Ministry of Industry (MoI) was established in 1997 and has the responsibility of regulating and setting strategies for the industrial sector (Law 642/1997); this includes regulating industrial water use. MoI issues permits for the establishment and operation of industries and classifies industries in Lebanon according to the International Standard Industrial Classification (ISIC), which takes into consideration the industry’s water supply and sewerage. Moreover, MoI has the power to prepare and conduct inspection programs to verify the compliance of industries with regulations and environmental standards.

4.4.9 *Council for the South (Lebanon)*

The Council for the South was established by Decree 14649/1970, which stipulates that the Council has full authority to conduct any work with a view to fulfilling basic needs in the South province and to promote security and development. As such, the Council has the power to appoint any public authority or private company to implement any project, including water works, to address people’s needs in South Lebanon (MoEW, 2020). The Council for the South has developed many water supply systems that rely on boreholes for supply source in the South and West Bekaa region (ECODIT, 2015).

4.4.10 *Council for Development and Reconstruction*

The CDR has the following responsibilities pursuant to Decree-Law 5/1997:

1. Preparing a general plan and sector programs for development and reconstruction to be approved by the CoM.
2. Securing funding for the execution of the general plan and sector programs or other development and reconstruction projects.
3. Managing and supervising the implementation of projects in the general plan or sector programs or other development and reconstruction projects under the supervision of the CoM.

The CDR has administrative and financial autonomy, and Article 5 of Decree-law 5/1977 grants the CDR the authority to implement any infrastructure works in the water sector through any public authority or private entity. The infrastructure is then handed over to the respective ministries or establishments for operation given that infrastructure operation is not in their mandate.

Table 11. Responsibilities of Key Water Sector Authorities (UNDP *et al.*, 2020)

Description of Responsibilities		MoEW	RWEs	LRA	CDR	MoE	MoPH	MoA	MoI	MoIM	Munici-palities
Policy Making	Definition of sector policy, institutional roles, and structures.	•				•					
	Enactment of legislation and regulation.	•	•	•		•					
	Development of investment and subsidy policy.	•									
Planning and implementation	Establishment of long-term consolidated public plans for the utilization and distribution of water resources.	•		•		•					
	Water rationalization.	•	•	•				•			
	Evaluation of infrastructure and investment requirements.	•	•	•	•			•			•
	Designing, building, operating, and maintaining the potable and irrigation water transmission and distribution networks along with WWTPs and collection networks.	•	•	•				•		•	•
	Seeking funding and managing the execution of plans and investment programs.	•	•	•	•			•			•
	Environmental safeguarding for plans, programs, studies, and activities (SEAs, EIAs/IEEs, EAs).					•					
	Implementation of groundwater artificial recharge.	•	•	•							
	Allocation of resources across regions, e.g., water reuse.	•	•	•				•			
	Regulating water extraction.	•						•			
	Identification and promotion of water conservation campaigns.	•	•	•		•		•			

Description of Responsibilities		MoEW	RWEs	LRA	CDR	MoE	MoPH	MoA	MoI	MoIM	Munici-palities
Regulation and Enforcement	Issuance and enforcement of regulations and standards for water resources protection, cost recovery, service quality, water quality, and consumer relations.	•		•		•	•		•	•	
	Licensing wells and all water extractions from groundwater, rivers, and public water resources.	•									
	Tutelage and oversight of all public institutions working in the sector according to Law 2000/221 and the laws governing these institutions.	•									
	Ensuring compliance of drinking water with local and international standards.	•					•				
Operation and Distribution	Enhancing the operational performance of RWEs and monitoring their performance according to approved benchmarks.	•									
	Ensuring the quantity and quality of the supplied water.		•	•							
	Recommending tariffs on water and wastewater.		•	•							
	Billing and collection of tariffs.		•	•							•
	Maintenance and renewal of infrastructure.		•	•	•						
Control and Monitoring	Management of all information including data collection, analysis, and reporting.	•	•	•							
	Implementing service quality and contingency planning.	•	•	•							

Description of Responsibilities		MoEW	RWEs	LRA	CDR	MoE	MoPH	MoA	MoI	MoIM	Munici-palities
	Monitoring the quality of water resources and set relevant quality standards.	•		•							
	Monitoring drinking water quality.		•				•				

4.5 Other Relevant Plans and Programmes

ECODIT SESA team reviewed relevant existing national plans, strategies, and roadmaps developed by other Ministries, RWEs, as well as existing programs in the water sector. Annex 9.2 presents a summary of components of each of the reviewed documents.

4.5.1 *National Strategies and Plans Relevant to the Water Sector in Lebanon*

The national plans and strategies relevant to the water sector in Lebanon are summarized in Table 12 and

Table 13.

Table 12. Relevant RWE Visions, Strategies, and Master Plans

Title	Summary of Initiatives
SLWE 2020-2025 Strategy	The SLWE 2020-2025 strategy has a vision: To provide water for everyone in the South, and a mission: non-intermittent quality water supply at an optimized cost and environmentally friendly manner that allows for adequate human and infrastructure development and customer satisfaction. To achieve the aforementioned vision and mission, the strategy has 5 cornerstones, each with supporting proposed projects: Consistent water supply, improved drinking water quality, upgraded labs and quality procedures, cost optimization, and customer satisfaction.
EBML 2020-2025 Vision	The EBML 2020-2025 Vision has four objectives: Development of EBML Sectors, Development of Water Resources, Rehabilitation of Facilities, and Control of NRW.
BWE Vision	BWE vision delineates the following objectives: 1. Providing water, irrigation, and wastewater services for all areas under BWE jurisdiction in accordance with the best practices adopted globally. 2. Protecting the environment surrounding surface water and groundwater sources by coordinating with all stakeholders. 3. Improving water management and water treatment to protect natural basins in the Bekaa. 4. Conducting awareness campaigns which promote water conservation and the increase in subscription fees of services, as well as the importance of paying fees. 5. Developing sustainable development plans to secure water needs for future generations. 6. Rationalizing energy use and the use of renewable sources of energy. 7. Preserving water resources. 8. Maintaining skilled workforce and implementing technical capacity building. 9. Sustaining water services in light of the load shedding by Electricité du Liban (EDL).

Title	Summary of Initiatives
	10. Securing supplies and equipment for the maintenance of facilities. 11. Protection of the water establishment assets from theft.
NLWE Water Supply Master Plan for North Lebanon (2040)	The NLWE Master Plan updates the water Master Plans of each caza of North Lebanon. It describes the status of existing water systems and water reservoirs and forecasts populations for the horizon of 2040. The Master Plan proposes projects to address the water deficit calculated based on projected water demands for each caza; water demands are calculated based on water consumption estimates in the NWSS-MoEW (2012) for the horizon of 2040.

Table 13. National Strategies and Plans Relevant to the Water Sector in Lebanon

Title	Summary of Initiatives
Lebanon National Agriculture Strategy (NAS) 2020-2025 *– MoA*	The NAS proposes 5 key areas of intervention in the agricultural sector, each with corresponding programs: 1. Restoring the livelihoods and productive capacities of farmers and producers. 2. Increasing agricultural production and productivity. 3. Enhancing efficiency and competitiveness of agrifood value chains. 4. Improving climate change adaptation and sustainable management of agrifood systems and natural resources. 5. Strengthening the enabling institutional environment.
Strategic Development Plan for Industrial Zones in Lebanon (2019-2030) *– MoI*	The goal of the Strategic Development Plan is to enhance both existing and new industrial zones through the implementation of infrastructure, including: green areas and buffers, sewage, irrigation, and waste treatment infrastructure. There are four new industrial zones planned, three of which have national government priority (governmental Decision 75/2018) and are detailed as follows: • Tourbol – Koussaya, Beqaa (175 plots of area totaling 1,850,000 m^2); • Baalbek, Baalbek El Hermel (85 plots of area totaling 500,000 m^2); and • Al Qaa, Baalbek El Hermel (365 plots of area totaling 1,800,000 m^2).
Lebanon's 2020 Nationally Determined Contribution (NDC) *– Government of Lebanon (GoL)*	Lebanon's 2020 NDC serves as an update to its 2015 NDC in accordance with Lebanon's commitments under the Paris Agreement (UNFCCC). It entails policy and fiscal reforms – in line Lebanon's economic recovery – towards improving energy efficiency, sustainable use of land and water resources, reducing pollution across the agriculture, waste and industry sectors, and increasing the resilience of communities and infrastructure.
Updated Policy Paper for the Electricity Sector (2019) *– MoEW*	The Policy Paper aims to (1) reduce EDL's financial deficit and (2) improve the electricity supply. To achieve these targets, the Policy Paper has the following three objectives: 1. Improve collection and decrease technical and non-technical losses to 12% starting 2021. 2. Increase the generation capacity, improve efficiency, and reduce fuel cost by using natural gas. 3. Increase the tariff to eliminate EDL deficit and recover the costs of electricity generation, transmission, and distribution.
Renewable Energy Outlook Lebanon (2020) *– MoEW*	The Renewable Energy Outlook provides a roadmap to achieve Lebanon's renewable energy targets introduced in 2018: to generate 30% of the power demand from renewable energy.
Lebanon's National Biodiversity Strategy and	In accordance with Lebanon's obligations under the CBD, the NBSAP identifies 18 national targets in 13 priority areas that address key biodiversity challenges and aim to achieve the following vision:

Title	Summary of Initiatives
Action Plan (NBSAP) (2016-2030) *– MoE*	“By 2030, Lebanon’s biodiversity is valued and sustainably managed for the preservation and conservation of its ecosystems and habitats and the species they harbor in order to adequately respond to anthropogenic and natural pressures and to ensure Lebanese citizens equal access to ecosystem goods and services”.
Lebanon National Forest Program (NFP) (2015-2025) *– MoA*	The overall objective of the NFP is to “Restore degraded lands and increase Lebanese forest cover while meeting the ecological, social, and economic needs of sustainable forest management at a regional scale”.
Draft Strategy for Integrated Solid Waste Management (2018) *– MoE*	The Proposed strategy aims to achieve set waste recovery objectives for household solid waste and hazardous solid waste.
2005 National Physical Master Plan of the Lebanese Territory (NPMPLT) *– CDR*	The NPMPLT aims to define guidelines for land use and the development of regions, and sets regulations for urban planning in urban, rural, agricultural, and natural areas to promote the following three principles: unity of the country, balanced development, and rationalization of uses and resources.
Capital Investment Program (CIP) *– GoL*	The CIP proposes infrastructure projects which aim to strengthen all sectors of the national economy for the purpose of alleviating socio-economic inequalities across all districts. The CIP was approved by the Cabinet in 2018 and presented to the international community at the “Conférence Économique pour le Développement, par les Réformes et avec les Entreprises” (CEDRE) to seek funding. The program spans a period of 8 to 12 years and projects are prioritized based on their readiness for implementation and their expected positive impacts.
Lebanon Crisis Response Plan (LCRP) *– GoL*	The LCRP is a joint plan between the GoL and other national and international partners. It aims to respond to the challenges associated with the current humanitarian crisis in the country, further amplified by the economic crisis, COVID-19, and the Port of Beirut Explosion (2019).

4.5.2 *Relevant Projects and Programmes*

In Lebanon, there are several ongoing programmes and projects in the water sector. These include:

- Water, Sanitation, and Conservation (WSC) Project, funded by the United States Agency for International Development (USAID).
- Technical Assistance Program in the Water and Wastewater Sector in Lebanon, funded by the Delegation of the European Union (EU) and implemented by the Agence Française pour le Développement (AFD).
- Lake Qaraoun Pollution Prevention Project, funded by WB.
- Awali – Greater Beirut Water Supply Project, funded by WB.
- Climate Smart Agriculture: Enhancing Adaptive Capacity of the Rural Communities, funded by International Fund for Agricultural Development (IFAD).
- Improved Water Resources Monitoring and Integrated Water Resources Management in the North of Lebanon, funded by Swiss Agency for Development and Cooperation (SDC).
- Water Supply Augmentation Project, funded by WB, GoL, and Islamic Development Bank.

- WASH – Lebanon, funded through UNICEF.
- ReWater MENA, funded by International Water Management Institute (IWMI).
- 10,000 Rainwater Harvesting Systems, ACTED.
- Test the Water (TTW), American University of Beirut-Nature Conservation Center (AUB-NCC).

Annex 9.2 list all the projects and programmes relevant to the water sector in Lebanon with details on their objectives and components.

5 ASSESSMENT OF BASELINE CONDITIONS

This Chapter describes relevant baseline conditions, covering the years 2000-2022, based on which potential impacts resulting from the Updated NWSS- MoEW (2020) can be assessed. The Chapter is divided into physical, biological, and socioeconomic and cultural environments.

5.1 Physical Environment

This Section describes the physical environment - including water resources and wastewater management, climate change, land resources, and natural hazards.

5.1.1 *Water Resources and Wastewater Management*

5.1.1.1 Water Availability

5.1.1.1.1 Surface Water (Rivers and Dams)

There are 40 rivers – 16 perennials and 24 seasonal rivers – across Lebanon (FAO, 2016; MoEW & UNDP, 2014). The total length of rivers and streams in Lebanon is estimated at 730 km. River flows are often seasonal with an estimated total annual river flow ranging between 2,151 and 3,900 MCM (UNDP et al., 2020). According to the Updated NWSS -MoEW (2020), the total remaining available water from rivers is around 1,475 MCM/year, where only 14 MCM/year is being exploited due to the river water temporal variation throughout the year. Currently, the LRA monitors river flows through fixed monitoring stations distributed across the rivers of Lebanon (ECODIT, 2015).

In addition, seven wetlands, both coastal and inland, have been documented in Lebanon with a total surface area of 16 km^2 (Shaban, 2013). Out of the 7, only 3 wetlands, namely the Palm Islands (Law 121/1992), Tyre Beach (Law 708/1998), and Abbassiyeh Beach (Law 170/2020) are currently protected by law (Department of Ecosystems - MoE, 2020).

Over the past 10 years, the MoEW began constructing a series of proposed dams and lakes to augment water supply; several dams are currently under construction under the jurisdiction of EBML, NLWE, and BWE. Table 14 lists the existing dams in Lebanon that are either operational or under construction. After the completion of the dams which are under construction, the national static storage capacity will reach 409 MCM, compared to the current total of 232.5 MCM (MoEW, 2020). Figure 7 maps the existing and proposed dams across Lebanon.

Table 14. Existing Dams and Dams Under Construction in Lebanon

Dam	Static Storage (MCM)	Dynamic Storage (MCM/year)	Status	Usage
EBML				
Chabrouh Dam	9	11	Operational	Potable/Irrigation

Dam	Static Storage (MCM)	Dynamic Storage (MCM/year)	Status	Usage
Ballout Lake	0.5	0.5	Operational	Potable/Irrigation
Qaysamani Lake	1	1	Operational	Potable
Janneh Dam	38	95	Under Construction	Potable/Irrigation/Hydropower
Boqaata Dam	6	12	Under Construction	Potable
Bisri	125	125	Under Construction	Potable/Irrigation/Hydropower
NLWE				
Kouachra Lake Rehab.	0.4	0.4	Operational	Irrigation
Brissa Dam	0.8	0.8	Needs Repair	Irrigation
Mseilha Dam	6	12	Under Construction	Potable/Irrigation
Balaa Dam	1.2	2.2	Under Construction	Potable
BWE				
Yammouneh Lake	1.45	1.45	Operational	Irrigation
Qaraaoun Dam	220	300	Operational	Potable/Irrigation/Hydropower
Assi Phase I		63	Under Construction	Irrigation
Total Storage Capacity	409	624		

Source: MoEW, 2020

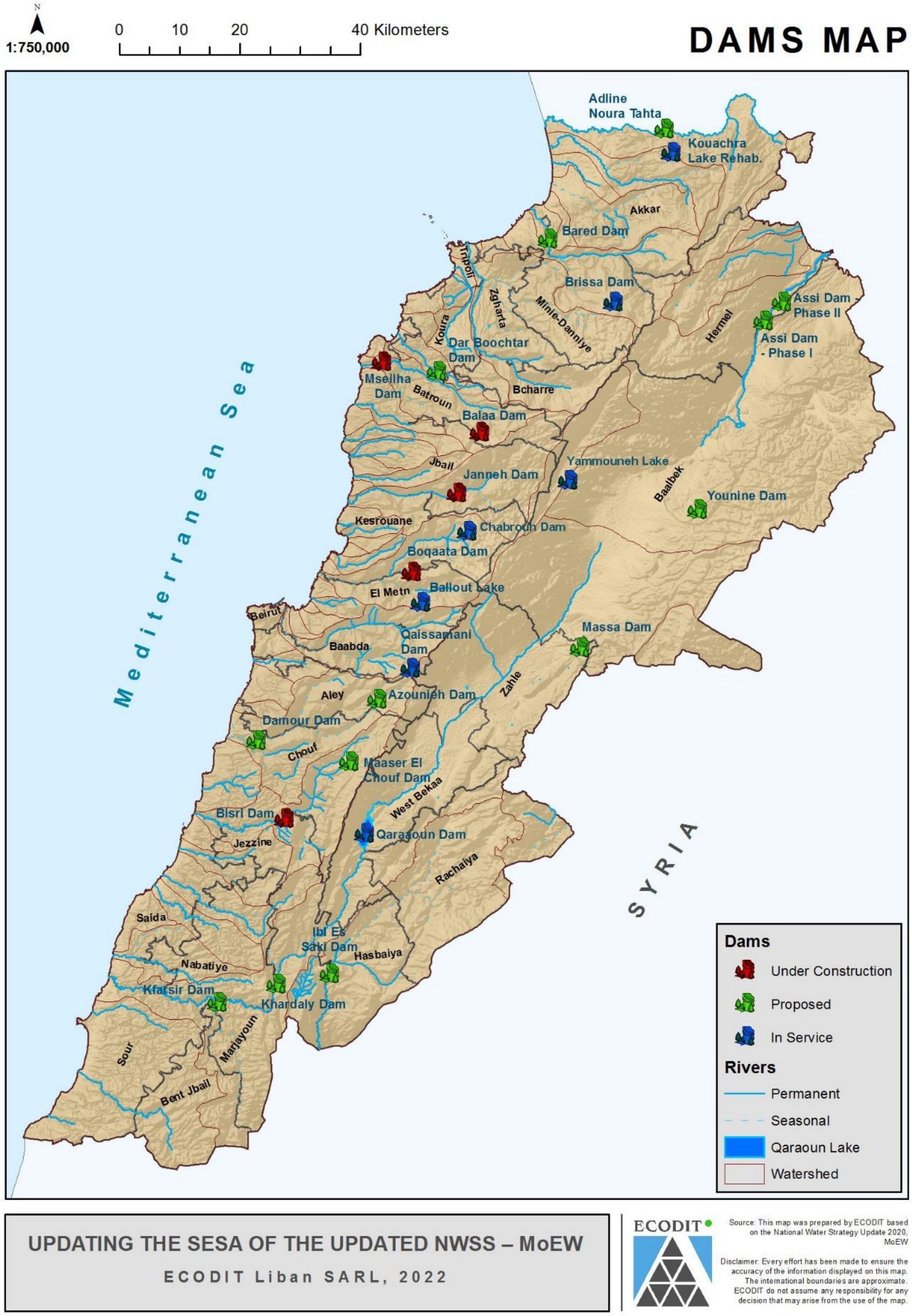


Figure 7. Operational, Under Construction, and Proposed Dams in Lebanon

5.1.1.1.2 Groundwater (Springs, Private Wells, and Public Wells)

The exact number and yield of springs in Lebanon is unknown. According to the State of the Environment Report (SOER) (2020), there are more than 5,000 springs identified in the topographic maps, of which only 409 have flow data. The MoEW estimates that the total number of springs exceeds 2,000 and the annual yield exceeds 2,050 MCM, which decreases to 200 MCM during dry season (MoEW, 2020).

Most of the water used for domestic supply comes from spring water. The MoEW estimates that there are 275 tapped springs, including small local springs. Due to increasing urbanization and groundwater misuse, small springs are subject to progressive dryness. Recently, the catchments of 22 springs have been rehabilitated to reduce outflows and pollution levels (MoEW, 2020). Figure 8 maps the water springs across Lebanon.

Around 83% of the total water supply in Lebanon is derived from groundwater (MoEW, 2020). Lebanon has 2 main aquifers – the Kesrouane Jurrasic (J4) and the Sannine-Maameltain (C4-C5) – which are mainly composed of karstic carbonate rocks covering around 5,600 km^2 of the country's territory. The four major tapped aquifers in Lebanon are as presented in Table 15.

Table 15. Most Tapped Aquifers in Lebanon

Aquifer	Served Areas
The Jurassic (J4-J7)	Niha-Barouk, Hermon, Keserwan, and Sir el Danniye-Ain Yaacoub
The Cenomanian-Turonian (C4-C5)	North Lebanon, Batroun-Jbeil, Hadath-Hazmieh, High Central Mount Lebanon, Mount Lebanon-Bekaa, Khaldeh, Sarafand, and Naqoura
The Miocene (m-mcg)	Tripoli-Koura
The Neogene-Quaternary	Bekaa and Akkar

Source: MoEW, 2020

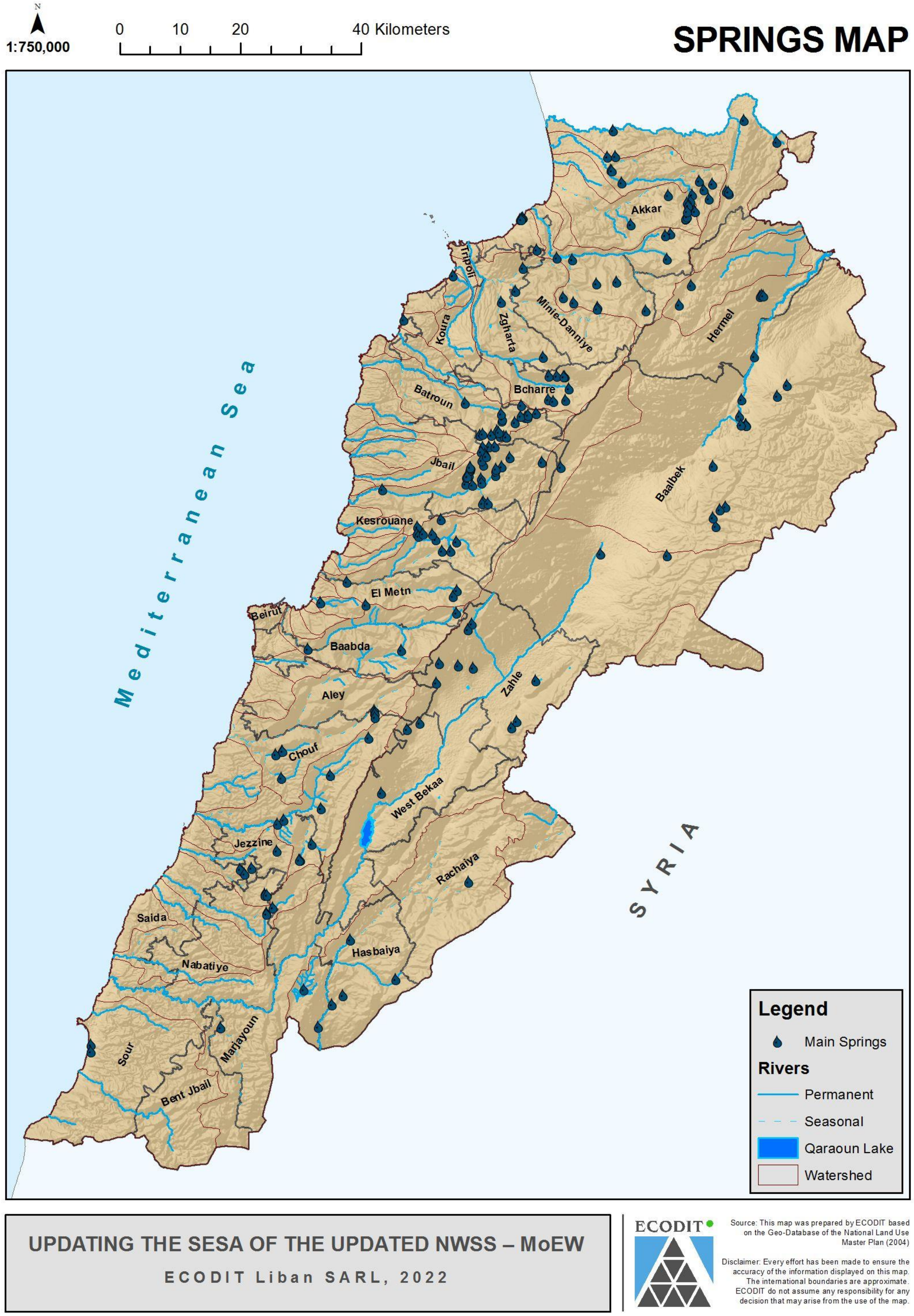


Figure 8. Main Springs in Lebanon

Given the absence of data concerning private wells and the volumes extracted from public wells, the exact number of wells and their annual yield are still unknown. According to the Updated NWSS-MoEW (2020), there are 1,615 public wells, of which 1,193 are in service. On the other hand, the MoEW & UNDP 2014 “Assessment of Groundwater Resources of Lebanon” report identified 841 public wells in the country. According to the Updated NWSS-MoEW (2020), around 25% of the existing wells are out of service (MoEW, 2020).

Lebanon also has a large number of private wells estimated to be around 85,000 (MoEW, 2020). The licensed wells were estimated at 20,537 (data up until 2012). The MoEW & UNDP (2014) report estimates the number of illegal wells to range between 55,000 and 60,000. Despite the absence of reliable records from RWEs, the annual withdrawal rate from both legal and illegal aquifers is estimated at around 990 MCM/year. RWEs withdraw a total of around 350 MCM/year. The overexploitation and over-pumping of groundwater aquifers in Lebanon has resulted in a drop in the groundwater level in most inland aquifers, and seawater infiltration in coastal aquifers. Many of the coastal and intensively cultivated groundwater aquifers have shown significant deficiencies in their water balance; with some basin deficits exceeding 150 MCM/year in dry years (UNDP et al., 2020). The levels of the water table of the Ain Yaacoub Basin in Sir ed Dannieh dropped by 27 m and by 20 m in the Southern Bekaa Neogene-Quaternary Basin in the Litani area (MoEW & UNDP, 2014).

<u>Water balance</u>

The Updated NWSS-MoEW (2020) estimates the annual rainfall in the country between 600 mm and 2,000 mm/year, which mostly falls in the form of snow that accumulates during the winter season and melts in spring.

Based on the National Council for Scientific Research (CNRS) data between 1950-2015, rainfall peaks in Lebanon between November and February, while the lowest rates are observed in May and August, as presented in Figure 9 (Shaban, 2020). In addition, the distribution of rainfall at different elevations is presented in Figure 10.

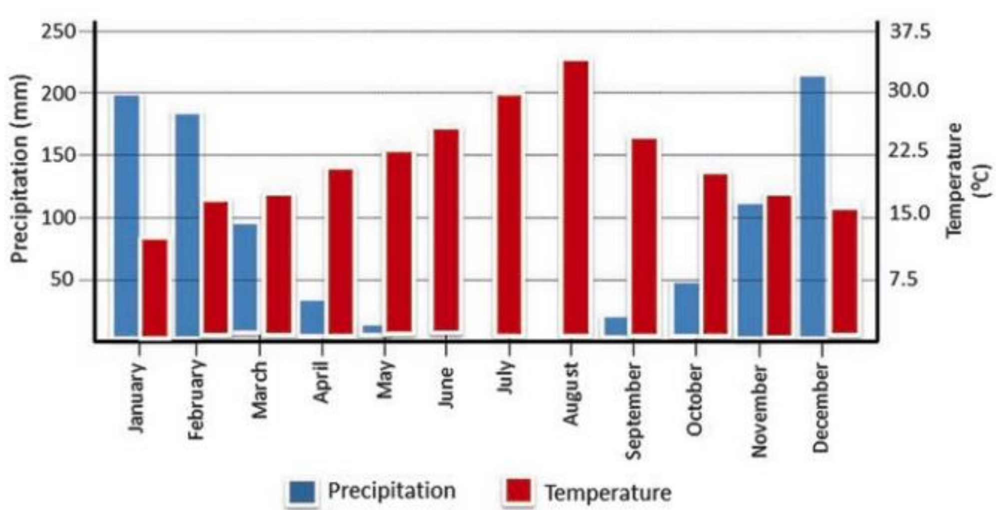


Figure 9. Average Annual Rainfall and Temperature Rate Across the Year (Shaban, 2020)

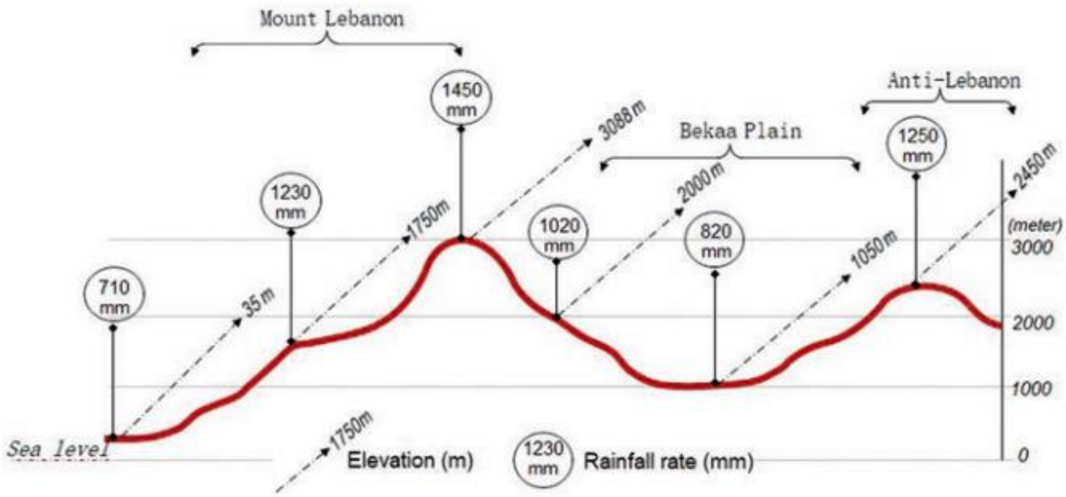


Figure 10. Distribution of Rainfall Amount by Elevation (Shaban, 2020)

Computing reliable national water balances in Lebanon is challenging for various reasons, including the absence of a unified database for long-term, high quality national meteorological and hydrological datasets. In addition, there are currently 136 meteorological stations and 138 hydrometric stations distributed across Lebanon, operated by various governmental establishments. However, these stations are not connected through an Integrated Information System. In 2014, MoEW & UNDP calculated the national water balance based on 2008-2012 hydrological data. The report found that (1) the precipitation per year ranges between 6,015 and 9,365 MCM, including snow, and (2) the annual groundwater recharge varies between 4,116 and 6,651 MCM/year (UNDP et al., 2020) (Table 16).

Table 16. Comparison of Annual Water Balance

	Amount (MCM/year)	
Source	MoEW & UNDP (2014)	Updated NWSS-MoEW (2020)
Precipitation (Including Snow)	9,365 – 6,015	8,559
Evapotranspiration	1,475 – 1,563	2,579
Surface Runoff	3,807 – 2,151	2,210[6]
Groundwater to Sea	400	3,770[7]

[6] Includes losses as rivers to adjacent countries (735 MCM)
[7] Includes losses to adjacent countries (280 MCM), seepage to the sea (740 MCM) and renewable reserves (700 MCM).

	Amount (MCM/year)	
Groundwater Recharge	4,116 – 6,651	

Despite all efforts, Lebanon still lacks a complete and inclusive long term annual average water balance that can be used for water management plans (MoEW, 2020). The most recent annual balance was conducted in the Updated NWSS-MoEW (2020) (Figure 11). It updates the NWSS-MoEW (2012) annual water balance to include the total losses as deficit of runoff (evapotranspiration and other losses) – estimated at 2,579 MCM (30% of total precipitation).

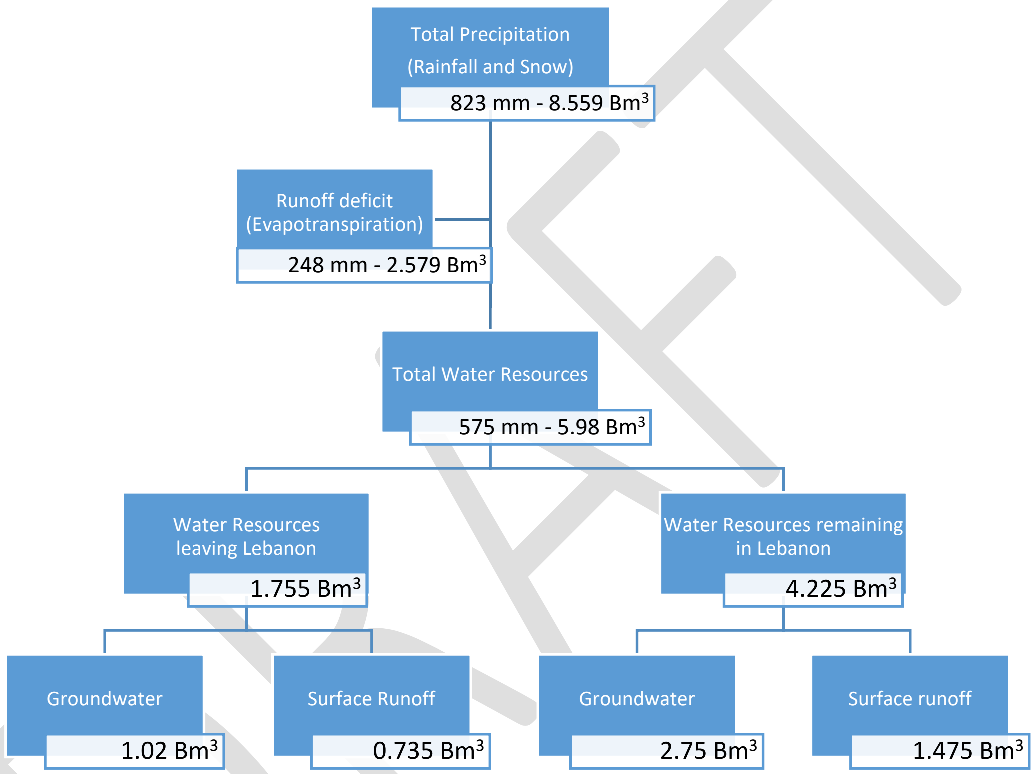


Figure 11. Annual Water Balance (Source: MoEW, 2020)

Table 17 provides a summary of the water resources in Lebanon; the table presents the most recent data and estimates adopted by MoEW.

Table 17. Water Resources in Lebanon (Source: MoEW, 2020)

Surface Water	Rivers	• Total available SW from rivers is around 1,475 MCM/year. • Existing volume exploited from rivers is 14 MCM/year.
	Dams	• Six operational dams/hill lakes: Chabrouh Dam, Ballout Lake, Qaysamani Lake, Kouachara Lake, Yammouneh Lake and Qaraoun Dam with a total dynamic capacity of around 314 MCM/year mainly concentrated in Qaraoun and Chabrouh dams.

Groundwater	Springs	• Total number of springs exceeds 2,000 with 275 tapped springs. • Spring discharge exceeds 2,050 MCM/year; maximum available discharge in dry months is 200 MCM/year. • Average actual extraction volume from springs is 594 MCM/year.
	Wells	• Total available GW volume (renewable groundwater resources) is 700 MCM/year. • Total number of public wells is 1,615 • Total number of private wells is 85,000. • Actual extraction volume from public wells is 350 MCM/year (based on 12 hours per day operation). • Actual extraction volume from private wells is 640 MCM/year. • Almost all existing public wells are used for potable water • An estimated 50% of extracted volume from private wells is used for irrigation.
Non-conventional Water	• Re-use is being practiced in Ablah WWTP in Beqaa for the irrigation of 20 ha. • Presence of minor hill lakes for irrigation and some household-level rainwater harvesting systems scattered across the territory.	

5.1.1.2 Water Demand and Supply

Reliable primary data on water consumption from water meters are absent (UNDP et al., 2020). Water metering is relatively new, and more efforts are being directed toward the installation of meters across Lebanon. As such, water demand estimates in Lebanon are based on assumptions related to population, per capita domestic and non-domestic water consumption, network efficiency, total irrigated area and irrigation consumption. The Updated NWSS-MoEW (2020) strategy estimates the water demand – referred to as “water need” – at 125 L/capita/day[8] for both urban and rural areas, and projects that the rate will remain the same between 2020 and 2035. The latter is significantly lower than the rates estimated in the NWSS-MoEW (2012): 180 L/capita/day in urban and 165 L/capital/day in rural zones. This revision was made due to the RWE’s commitment to decrease water consumption in 2035 by installing water metering, eliminating illegal connections, and reducing all types of non-revenue water. The current domestic drinking water demand in the Updated NWSS-MoEW (2020) was estimated at around 580 MCM/year, representing around 48% of the total water demand. Drawing on the Agricultural National Census (MoA, 2010), the Updated NWSS-MoEW (2020) concludes that there is gap between irrigation water demand and water use. It estimates that the current available water resources for irrigation can sustain around 75% of the present irrigation water requirements (630 MCM), where 50% are covered by surface water. The Updated NWSS-MoEW (2020)

[8] Growth rate assumed: 1.5% in rural areas; 0.75% in urban areas; 2% of districts under the jurisdiction of SLWE

estimates the irrigation water demand at around 842 MCM/year, equivalent to 55% of the total water demand.

Industrial and commercial (non-domestic) water demand is estimated at 5% of the total water demand. The Updated NWSS-MoEW (2020) estimates the total water demand in 2020 at 1,505 MCM/year, as presented in Table 18.

Table 18. Total Water Demand in 2020

Use	Demand in 2020 (MCM/year)	Distribution (%)
Domestic/Potable	580	40
Irrigation	842	55
Industrial and Commercial	83	5
Total Water Demand	**1,505**	**100**

See Section 5.3 for more information regarding water demand of the country's various sectors.

5.1.1.3 Water Quality

In addition to the challenges associated with the proper and sustainable management of water resources to meet the national water demands, high pollution levels in many of Lebanon's water sources have made them unusable or require high-cost treatment prior to use (UNDP et al., 2020). Many of the water resources are receiving pollution loads that exceed their carrying capacities. The current quality of the water resources and their rate of degradation or recovery is not possible to assess due to the absence of continuous times-series data on water quality.

Surface Water

The open discharge of untreated domestic wastewater is reportedly the main source of contamination of surface water; while other sources include point sources from industrial, healthcare, and touristic establishments, quarries, and agricultural run-off. Studies conducted in several rivers in Lebanon documented elevated levels of fecal and/or total coliform, including in Ibrahim River, Damour River, Beirut River, and the upper and lower Litani Basin (El Najjar et al., 2020; El-Nakib et al., 2020; Haydar et al., 2014; IDRC, 2007). The upper Litani River Basin and Qaraoun Reservoir are two of the most-studied freshwater systems in Lebanon that are characterized by high pollution loads. Untreated municipal wastewater with high levels of Biochemical Oxygen Demand (BOD) and agricultural runoff, contaminated with pesticides and herbicides, are directly discharged in the upper Litani River Basin (UNDP et al., 2011). The cost of water resource degradation in the Litani River Basin was estimated at USD 227 million/year (Afif and Doumani, 2013). In addition, due to high levels of pollution, eutrophication of the Qaraoun reservoir has been observed leading to further deterioration of the water quality. Heavy metal pollution has also been documented in the upper Litani River and El Kabir River (Haydar et al., 2014; Thomas et al., 2005). These high levels of pollution have impaired the use of these water resources.

Groundwater

Groundwater quality has been also deteriorating due to water contamination as a result of both over-pumping and human activities (UNDP et al., 2020). Sewage seepage and agricultural sources have been reported to cause nitrate pollution in groundwater sources. Elevated nitrate levels have been documented in most wells in the Bekaa plain and the Lucy well in the Litani basin (Amacha & Baydoun, 2018; Saadeh et al., 2012). In addition, microbiological contamination has been reported in groundwater aquifers due to wastewater leakage from faulty sewer systems or septic tanks used in some sub-urban areas. In addition, the karstic nature of the aquifers makes them vulnerable due to the large pore spaces. Elevated levels of total and fecal coliform have been reported in wells in Jal el Dib, Tripoli, Borj-Abou Haydar, Nweiri, and the upper Litani River Basin (IDRC, 2017; El-Fadel et al., 2014; Amacha & Baydoun, 2018; Nawas & Al Koussa, 2017). Seawater infiltration is another main problem for coastal aquifers, leading to high salinity levels in many wells (IDRC, 2017). The most vulnerable aquifers identified are the North Lebanon Cretaceous, the Jabal Terbol Miocene, the Batroun-Jounie Cretaceous and general Neogene-Quaternary aquifers (MoEW & UNDP, 2014). Seawater infiltration has been reported in several studies in the wells of Beirut, Choueifat, Jiyeh, Rmeileh, Jal El Dib, Tripoli and Zharani (Alameddine et al., 2018; Fayssal & Slim, 2015; Khadra and Stuyfzand, 2018; IDRC, 2017; Kalaoun et al., 2018; El-Fadel et al., 2018).

Coastal Marine Water

The Lebanese coastal marine water is also impacted by pollution due to the direct discharge of untreated domestic and industrial wastewater, the uncontrolled disposal of waste, agricultural runoff and reduced flushing capabilities due to poorly designed land reclamation projects (UNDP et al., 2020). Studies have estimated that the Lebanese coastal waters receive around 65% of the domestic wastewater through at least 53 outlets distributed along the coastline (Abboud-Abi Saab & Hassoun, 2017; Merhaby et al., 2020). The presence of trace metals, high nutrient levels leading to eutrophication, and Persistent Organic Pollutants was reported in coastal water (Abboud-Abi Saab & Hassoun, 2017; Merhaby et al., 2019; 2020).

Potable Water

Pollution of water resources has impacted the quality of water at a household level. The water quality at the household is also affected by the poorly managed and old water supply networks. A 2016 UNICEF and World Health Organization (WHO) report estimated that 65% of the population does not have access to a safely managed drinking water service (WHO & UNICEF, 2016). Households in Lebanon also rely on water delivered through tankers and private bottling companies, both of which are poorly regulated and monitored, which negatively impacts the quality of water delivered through those services. Studies have documented bacterial contamination in domestic bottled water brands and water used to fill water tankers (Semerjian, 2011; WHO & UNICEF, 2016; Constantine et al., 2017).

A study conducted by UNICEF found that 71% of the primary water sources of refugee communities in Baalbak-Hermel, Bekaa, Akkar, Mount Lebanon, North, Nabatieh, and South governates are safe to drink (primary sources of water for the surveyed community included mainly protected boreholes, water trucking, and public network reservoir). While the remaining 29% did not comply with the standards for drinking water due to fecal contamination, and high turbidity and nitrate levels (Bonel et al., 2021).

Two national standards for drinking water quality currently exist in Lebanon – LIBNOR Standard 161/1999 and its update developed in 2016; the latter is yet to be published as laboratories lack the necessary equipment and human resources to implement the standards. Generally, water quality monitoring in Lebanon is weak due to several reasons:

- The laboratories of the RWEs do not have the capacity to process large number of samples.
- Limited human, financial and physical resources to carry out water quality monitoring.
- Lack of historical data on water quality.
- Data from water samples are collected but not analyzed.

5.1.1.4 Wastewater Management

<u>Wastewater</u>

According to MoEW, 30% of the generated wastewater volume is being treated. Currently, 75 WWTP exist in Lebanon; 53 WWTPs are operational (the majority of which are small-scale). However, most WWTP are not yet or not fully connected to sewer lines leading to prolonged cocooning phase and reduced operational capacity (UNICEF, 2016). According to the Updated NWSS-MoEW (2020), the total operating capacity of the operational WWTPs is estimated at 292,918 m^3/day. Among the existing WWTPs, the most common type is Reed Bed. Other technologies include Activate Sludge and tricking filters. Moreover, 11 WWTP are currently under-construction with a design capacity of 130,000 m^3/day. A list of the existing WWTPs under the respective areas of jurisdiction of the RWEs is presented in Table 19.

Table 19. Existing WWTP under the Regional Water Establishments in Lebanon

	EBML	BWE	NLWE	SLWE	Total Number of WWTP
Existing	17	12	22	24	75
Under Construction	2	2	5	2	11
Total	19	14	27	26	86

<u>Sludge</u>

The quantity, quality, management, and disposal of sludge generated from the existing WWTPs are currently not being monitored in Lebanon and limited data is available at the national level. The CDR Sludge Management Plan estimated the quantities of sludge generated by the existing WWTP at 260 tons of dry material per day in 2010, assuming all WWTPs are operational, and projected a 306 tons of dry material per day in 2030 (World Bank, 2011). The MoEW (2019) estimates that municipal WWTP generate around 65,450 m^3 of dewatered sludge per day. In addition, with the WWTPs that are currently under construction and those proposed by the Updated NWSS-MoEW (2020), the amount of sludge generated is expected to increase drastically (UNICEF, 2016). Operating the existing WWTP at full capacity will also contribute to the expected increase in sludge generation (UNICEF, 2016). A European Bank for Reconstruction and Development (EBRD) 2019 study projected the generation of 86,514 tonnes/year of sludge in 2025 and 110,542 tonnes/year in 2030, excluding the sludge generated from Tripoli/Minieh WWTP and Beirut WWTP that are planning to treat their own sludge on-site (EBRD, 2019).

Currently, most of the operational WWTPs are small-scale and in rural areas that receive mainly domestic wastewater, which generates non-hazardous sludge. However, if large-scale plants (for example in costal urban areas) become operational, the risk of industrial wastewater being discharged in the WWTP is high, resulting in the generation of hazardous sludge.

There are several challenges that hinder the proper management and disposal of sludge in Lebanon, including the lack of plans or initiatives to treat and recover the resulting biomass from the sludge, thus reducing the need for disposal. In addition, there is a lack of collaboration between neighboring countries for the valuation/disposal of sludge, although a regional solution may be needed for sludge management.

Lebanon still lacks guidelines for wastewater effluent reuse and sludge management and reuse. Draft guidelines on sludge reuse in agriculture and wastewater reuse have been prepared by FAO in 2010. In addition, a National Master Plan for Sludge Recovery/Disposal was developed by CDR in 2003. Disposal methods of sludge such as incineration and landfilling have also been proposed (CDR et al., 2003). In 2021, and under a project funded by the World Bank, CDR prepared a Sludge Management Master Plan for the Bekaa region (refer to Box 6). Currently, LIBNOR, in coordination with concerned stakeholders and academics, is preparing standards for the reuse of wastewater in irrigation and sludge (MoEW, 2020).

Box 6. Feasibility Study for the Sustainable Sludge Management in the Beqaa Region

In 2021, CDR prepared a feasibility study for "Sustainable Sludge Management in the Beqaa Region" under the funds of the World Bank Lake Qaraoun Pollution Prevention Project (LQPPP): the objectives of which are to (1) mitigate pollution of the Litani river and (2) improve pollution management around Lake Qaraoun.

The feasibility study proposes five feasible scenarios for sludge disposal of the sludge generated by the 13 WWTPs in the Beqaa valley: a total sludge output without lime of 112,674 m^3/year at the 2040 horizon. Following a multi-criteria analysis based on selected technical and financial criteria, the following scenario was considered as the best option for the sustainable management of the sludge generated:

1. Adding solar dryers at the end of the sludge treatment lines of five WWTPs: Zahlé, Marj, Temnine, Iaat and Joub Janine.
2. Dispose 100% of the sludge in a dedicated landfill for each WWTP. Each WWTP will have its own dedicated landfill, where at a later stage the stakeholders will identify these plots and required areas.
3. Present a cost estimate for constructing sanitary cells.
4. Provide the operation & maintenance cost of handling/dumping the sludge in these landfills assuming the dedicated landfill is located at a 5 km radius from each WWTP.

The total investment cost for the scenario (without considering land acquisition) and O&M costs are around USD 20,870,000, and USD 2,080,000/year, respectively.

5.1.2 *Climate Change*

The UNFCCC defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC, 1992). This Section describes the existing and projected climate change trends in Lebanon and accordingly, its vulnerability to climate change effects. It also discusses Lebanon's Greenhouse Gas (GHG) emissions and international commitments to climate change mitigation and adaptation.

GHG concentrations are the primary driver of climate change; Lebanon contributes to about 0.06% of global GHG emissions (Ministry of Foreign Affairs of the Netherlands, 2018). The most significant GHG produced in Lebanon is CO_2 from the burning of fossil fuels. According to Lebanon's Fourth Biennial Update Report on Climate Change to the UNFCCC, Lebanon's net GHG emissions were estimated at 29,266 Gg CO_2eq in 2018. The largest contributor to GHG emissions is the Energy sector (fuel combustion activities), which constituted 82% of total GHG emissions in 2018. The "Energy industries", "Transport", and "Manufacturing industries and construction" sectors were the three biggest sources of emissions, each contributing to around 31%, 23%, and 15% of emissions, respectively. The domestic, and industrial wastewater treatment produced an estimated 669.92 CO_2eq. GHG emissions in 2018; and around 58% of these emissions are a result of discharge into the sea sea (MoE et al., 2021; MoE et al., 2016b).

Conversely, vegetation cover – including forest lands, croplands, and grasslands – is a primary GHG sink in Lebanon. Forest cover, followed by cropland, are a significant CO_2 sink, however, their sink capacity is decreasing due to deforestation, forest fires and urbanization. The loss in biomass from forested areas and cropland areas – mainly attributed to urbanization – has resulted in a decrease in CO_2 removals by an average of 2.47 Gg/year between 1994 and 2015 (MoE et al., 2019)

In total, Lebanon's GHG emissions increased by an average of 6% each year over the period of 1994-2018 (MoE et al., 2021).

5.1.2.1 Climate trends

Over the past 140 years, Lebanon has exhibited an increasing trend in the minimum temperature of about 3°C. However, there is contradictory research regarding annual precipitation trends in Lebanon. Shaban's 2009 report on "Indicators and Aspects of Hydrological Drought in Lebanon" states that precipitation witnessed a 12% decline between 1965 and 2005. However, precipitation data in the Updated NWSS-MoEW (2020) retrieved from the Issam Fares Institute at the American University of Beirut (AUB) suggests that Lebanon exhibited a stable precipitation trend over the years 1975-2018 (Figure 12).

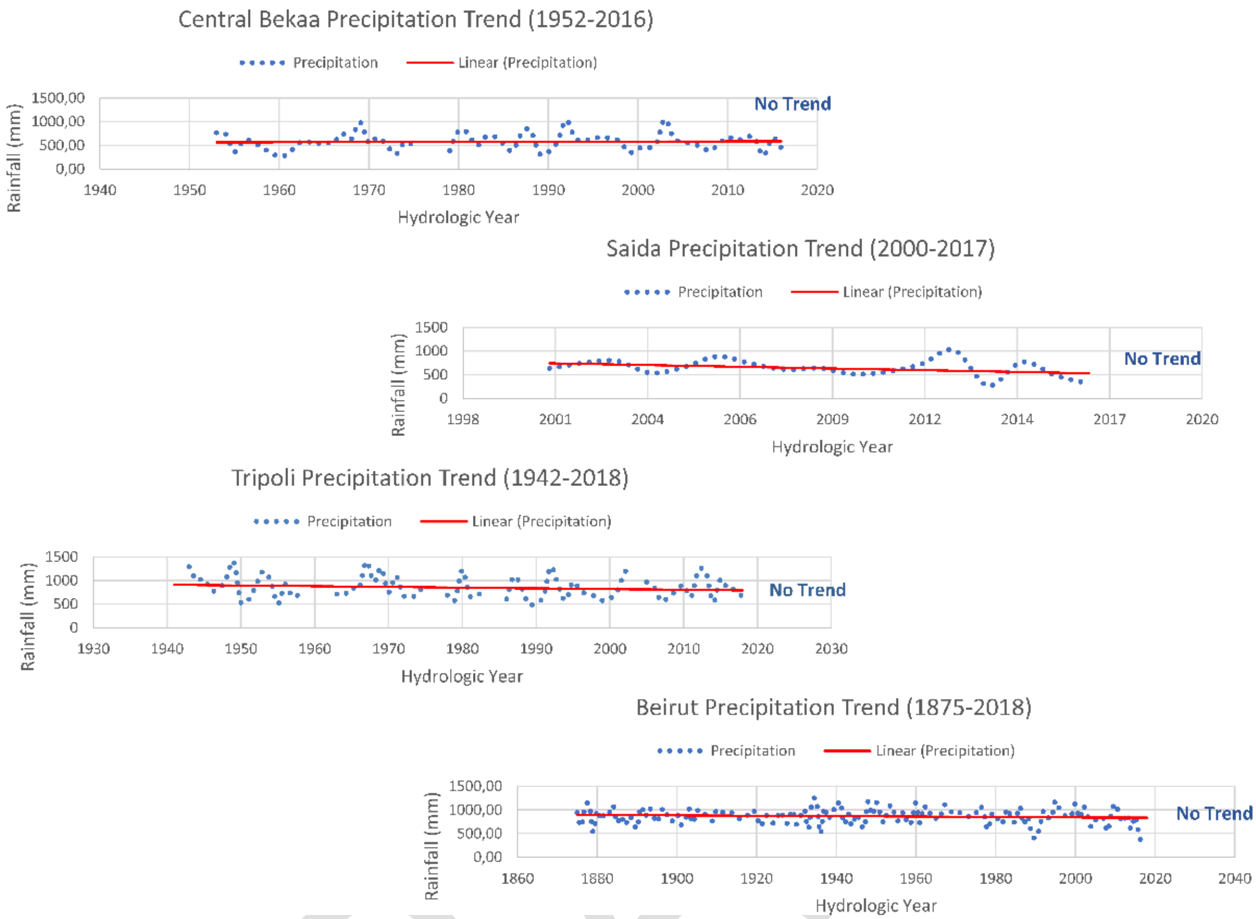


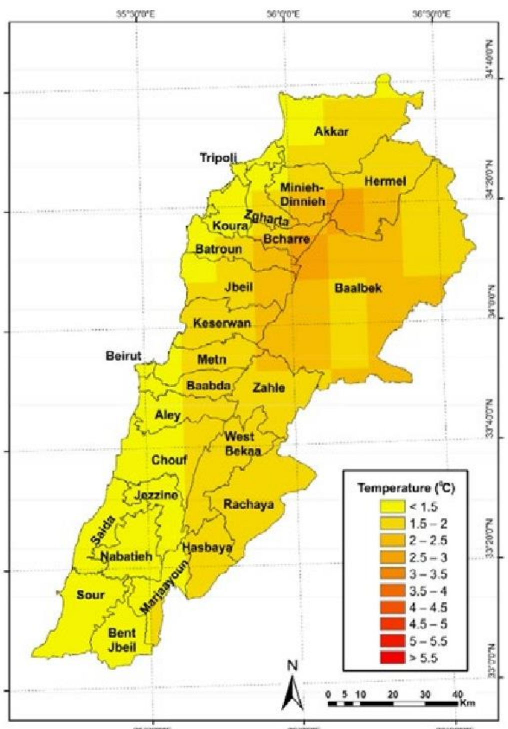
Figure 12. Annual Rainfall Trend (Source: MoEW, 2020)

As for snow cover, it was reported that the average time that dense snow covered the mountains decreased from 110 days/year to less than 90 days/year between 1965 and 2005 (Shaban, 2009). Moreover, a study conducted in 2018 at 'Université Saint Joseph' (USJ) suggests that the percentage of snowmelt as a water supply decreased by 12% since the 1960s and 1970s (Baaklini, 2018; UNDP et.al., 2020).

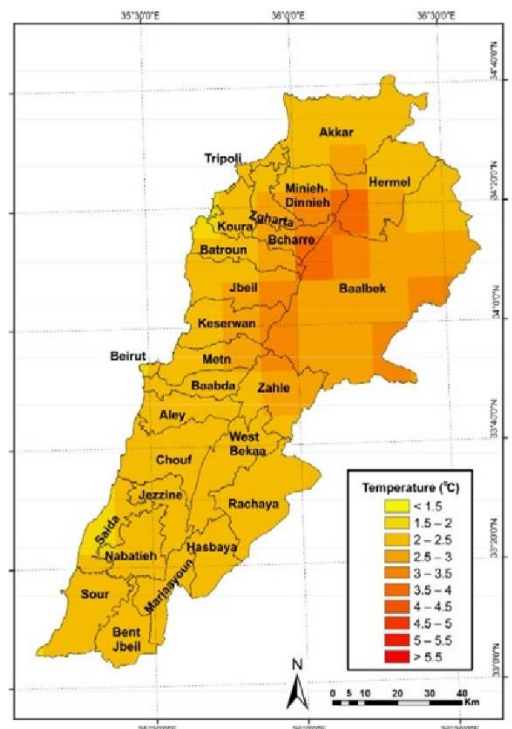
5.1.2.2 Climate Projections

According to 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 (UN-ESCWA), future climate change trajectories suggest a consistent warming and a general increase in the number of warm days (43 additional days) and longer summer seasons in the Arab region (MoE et.al., 2016). Results for Lebanon show an increase in temperature of 1.2°C and 1.7°C by 2046-2065 and up to 3.2°C by 2080-2100 compared to the baseline period of 1986-2005 (MoE et.al., 2016). Moreover, RICCAR projections suggest a decrease in precipitation by 4%-11% and an increase in the number of consecutive dry days (a maximum of 6 consecutive drought days by 2080-2100) resulting in a hotter and drier climate.

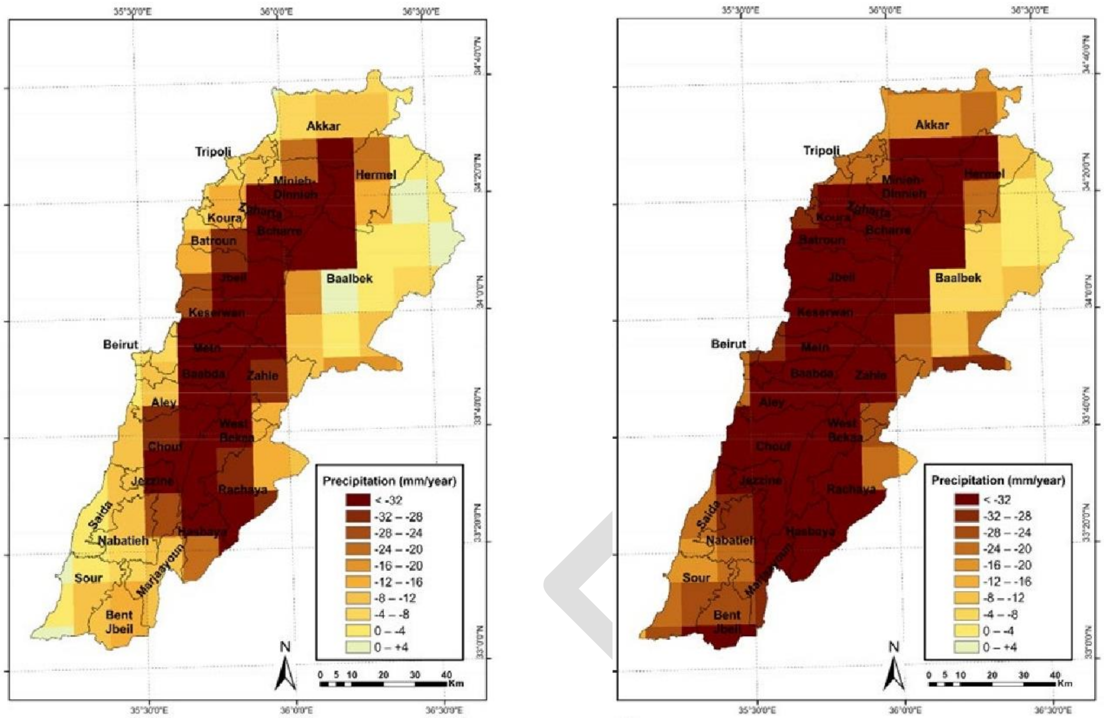
Comparatively, EURO-CORDEX RCP 4.5 "moderate case projection scenario" and RCP 8.5 "worst case projection scenario" (current scenario with the highest levels of potential GHG emissions) indicate that temperatures are expected to rise by an average of 2.7°C to 3.9°C by 2050 and 3.6°C to 6.6°C by 2100 when compared to the reference period of 1986-2005, with the largest increases projected in Northern Lebanon Mountains (ACSAD et.al., 2019). Moreover, decreases in precipitation by an average of 26 mm/year to 43 mm/year (5-9% decline) are projected by 2050, with largest decreases in the Lebanon mountains. Precipitation projections for the year 2100 suggest a decline in precipitation by 6-11% (ACSAD et.al., 2019). The EURO-CORDEX model captured local climatic effects; temperature and precipitation projections for RCP 4.5 are displayed geographically in Figure 13.



(a)



(b)



(c) **(d)**

Figure 13. EURO-CORDEX RCP 4.5 Temperature Projections for Mid-century (a) and End-century (b) and Precipitation Projections for Mid-century (c) and End-century (c) (ACSAD et.al., 2019)

5.1.2.3 Climate Vulnerability

Lebanon is considered to have a low vulnerability (78th least vulnerable country) and low readiness (59th least ready country) to climate change (Ministry of Foreign Affairs of the Netherlands, 2018). Nevertheless, climate change is projected to have significant adverse economic, environmental, and health impacts on Lebanon. According to Lebanon's 2020 Nationally Determined Contribution, studies show that for the years that exhibit low annual precipitation, the overall Gross Domestic Product (GDP) is estimated to have lost more than 60% as compared to years where the total precipitation is optimal (RoL, 2021). Lebanon's Third National Communication in 2016 provides an assessment of the adverse impacts of climate change on Lebanon based on the RICCAR results; key impacts are the following (MoE et.al., 2016; Ministry of Foreign Affairs of the Netherlands, 2018):

- Decrease in Snow Cover: a projected 40% reduction in snow cover with an increase in temperature of 2°C as well as a decrease in snow residence from 110 days to 45 days.
- Decrease in Water Availability: snow is projected to melt earlier in the spring, this will affect the recharge of springs and decrease the irrigation water supply during the summer. Moreover, reduced annual mean precipitation will increase water shortages and reduce annual water availability by 29% by 2080.
- Increase in Drought Period: extended drought periods will have the biggest impact on dryer regions (such as the Beqaa, Hermel, and the South of Lebanon). Moreover, there will be an increase in costs associated with irrigation due to an increase in groundwater pumping.

- **Decrease in Agricultural Activity:** higher temperatures and evapo-transpiration coupled with reduced precipitation will result in a decline in soil moisture. Soil erosion and topsoil loss on steep slopes will also be worsened by the increase in frequency of storms and High Precipitation Events (HPEs). Moreover, an increase in salinization of soil in coastal areas due to sea level rise poses a risk to banana and tomato production.
- **Sea Level Rise:** sea-levels are expected to rise by 30-60 cm in 30 years. This will exacerbate seawater intrusion into aquifers and increase the risk of coastal flooding.
- **Increased Risks to Forests:** climate change will further increase risks of forest fires and fragmentation.
- **Damage to Infrastructure:** current infrastructure cannot withstand climate-induced pressures and will suffer damages from changing precipitation patterns, sea level rise, and the increase in storms and HPEs.
- **Increased Mortality and Morbidity:** higher temperatures and more frequent extreme weather events will result in a reduced availability of clean water and increased malnutrition as a result of the effect of floods and droughts on agriculture.

5.1.2.4 International Agreements Related to Climate Change

Lebanon is party to the UNFCCC, ratified with Law 395/1994. The objective of the Convention is the "stabilization of GHG concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system". As a non-annex I country, Lebanon is required to submit National Communications (NC) on the implementation of the Convention to the Conference of the Parties (COP) and is obliged to reduce its greenhouse gas emissions. Since 1994, Lebanon has submitted three NCs (in 1999, 2011, and 2016).

Lebanon also became a signatory to the Paris Agreement in April 2016, ratified with Law 115/2019 (Box 4). The GoL submitted its most recent NDC to the UNFCCC on March 15, 2021. The 2020 NDC serves as an update to the 2015 NDC and commits to an unconditional GHG emission reduction of 20% relative to the Business-As-Usual (BAU) scenario in 2030 (amounting to 7,790 Gg. CO_2eq.) and a conditional GHG emission reduction of 30% by 2030. The 2020 NDC also provides adaptation priorities to increase Lebanon's resilience to climate change; Adaptation priority 3 – "Structure and develop sustainable water services, including irrigation, in order to improve people's living conditions" – aims to use renewable energy sources for irrigation and in drinking water supply to reduce GHG emissions. Other adaptation priorities include (RoL, 2021):

> <u>Box 3.</u> The Paris Agreement
>
> The Paris Agreement is a legally binding international treaty on climate change adopted on 12 December 2015 by 196 parties at the 21st COP. The aim of the treaty is to reduce the average global temperature rise to "well below 2°C" and "preferably to 1.5°C". To achieve the Agreement's goal, Parties are required to submit their plans for climate change mitigation and adaptation every five years in their NDCs, which communicate their national GHG inventories and the actions they will take to reduce GHG emissions.

- <u>Adaptation Priority 4:</u> Value and sustainably manage Lebanon's terrestrial and marine biodiversity in order to adequately respond to anthropogenic and natural pressures and to ensure Lebanese citizens equal access to ecosystem goods and services.

- Adaptation Priority 5: Reduce the vulnerability of climate change impacts on coastal zones, especially in cities.

5.1.3 *Land Resources*

5.1.3.1 Geomorphological Regions

Lebanon is mostly mountainous with rugged terrain, high mountain peaks and a fertile valley located between two mountains that extend from North to South Lebanon (UNDP et al., 2020). Geomorphologically, Lebanon is divided into 5 distinct regions (UNDP et al., 2020; Ministry of Foreign Affairs of the Netherlands, 2018) (Figure 14):

1. **The coastal Zone** (Region 1 in Figure 14): represents 13% of Lebanon's territory. It includes the shoreline and continental shelf, the coastal plain and the foothills of Mount Lebanon, which rise to 250 m. It extends around 230 km in length and is composed of two plains, one in the north (Akkar) and one in the south (Tyre), and a series of small narrow plains separated by rocky headlands in the center. This zone is at risk of degradation from natural events and anthropogenic activities.
2. **The Mount Lebanon Range** (Region 2 in Figure 14): represents 47% of the country's territory. It includes middle- and high-elevation zones, with an average elevation of about 2,200 m, extending from Akkar in the North to the hills of Jabal Amel in the South. The Mount Lebanon range is mainly composed of Jurassic thick carbonate sediments and is a vital source of freshwater for the country.
3. **The Bekaa Valley** (Region 3 in Figure 14): represents 14% of the Lebanese territory. It is a fertile land located between the Mount Lebanon and Anti-Lebanon chains and bordered by the Litani River to the South and the Assi River to the North. Most of the agricultural fields are located in this land.
4. **The Anti-Lebanon Range** (Region 4 in Figure 14): represents 19% of the country's territory. It extends across the Lebanese-Syrian border and includes Jabal El Cheikh (or Mt. Hermon) at its southern boundary, which distributes rainfall and snowmelt into at least three main watersheds across Lebanon, Syria, and Palestine. It has a relatively arid climate, and thus a low biodiversity value and limited presence of human activity.
5. **South Lebanon** (Region 5 in Figure 14): represents 7% of the territory. It is an elevated inland plateau that extends a short distance from the Western shores of South Lebanon to the Mount Hermon foothills in the East. It is characterized by intersecting seasonal streams flowing from East to West into the Mediterranean Sea. Agricultural fields and human settlements are equally distributed throughout the region.

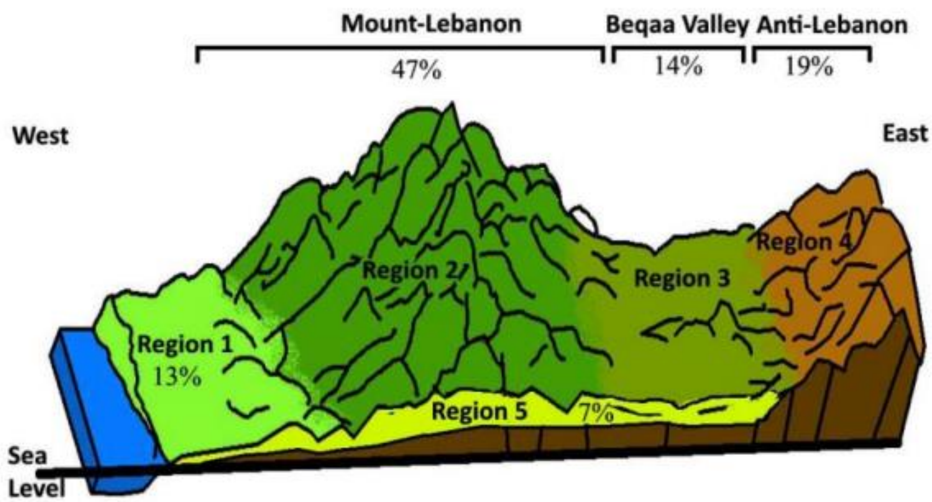


Figure 14. The Five Geomorphological Regions of Lebanon

Source: MoE et al., 2009

5.1.3.2 Geology and Soils

The country's geologic formation is predominantly sedimentary rocks, mainly Jurassic, Cretaceous and Tertiary Karstic Limestone (UNDP et al., 2020). More than two-thirds of Lebanon's territory consist of carbonated rock formations, which make up most of the mountain ranges, thus making them vulnerable to groundwater pollution and natural risks, such as landslides and earthquakes (CAS, 2010). Lebanon is also located in an active tectonic area with complex fault systems characterized by 3 major faults – Yammouneh, Roum, and Serghayand – and other minor faults (MoE et al., 2011). Figure 15 presents the risk of landslides and the location of the faults across Lebanon.

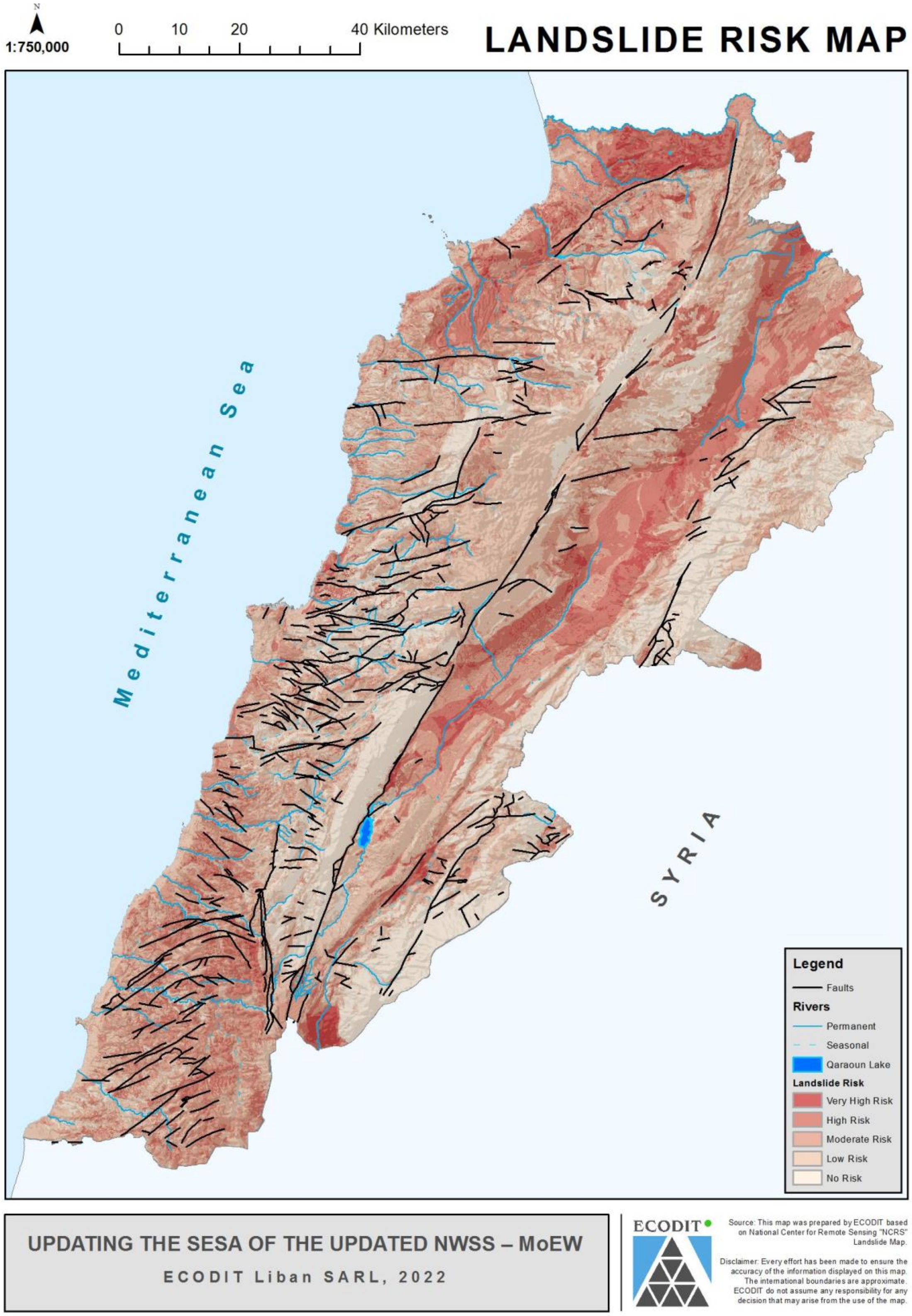


Figure 15. Faults and Land Slide Risk across Lebanon

In addition, Lebanon has witnessed 57 earthquakes with a magnitude of 3.5 or above on Richter's Scale, with the most active year recorded in 2008 with 27 earthquakes and the strongest earthquakes recorded with a magnitude of 5.5 (UNDP et al., 2020). Figure 16 represents the geological map of Lebanon and tectonic risk across Lebanon.

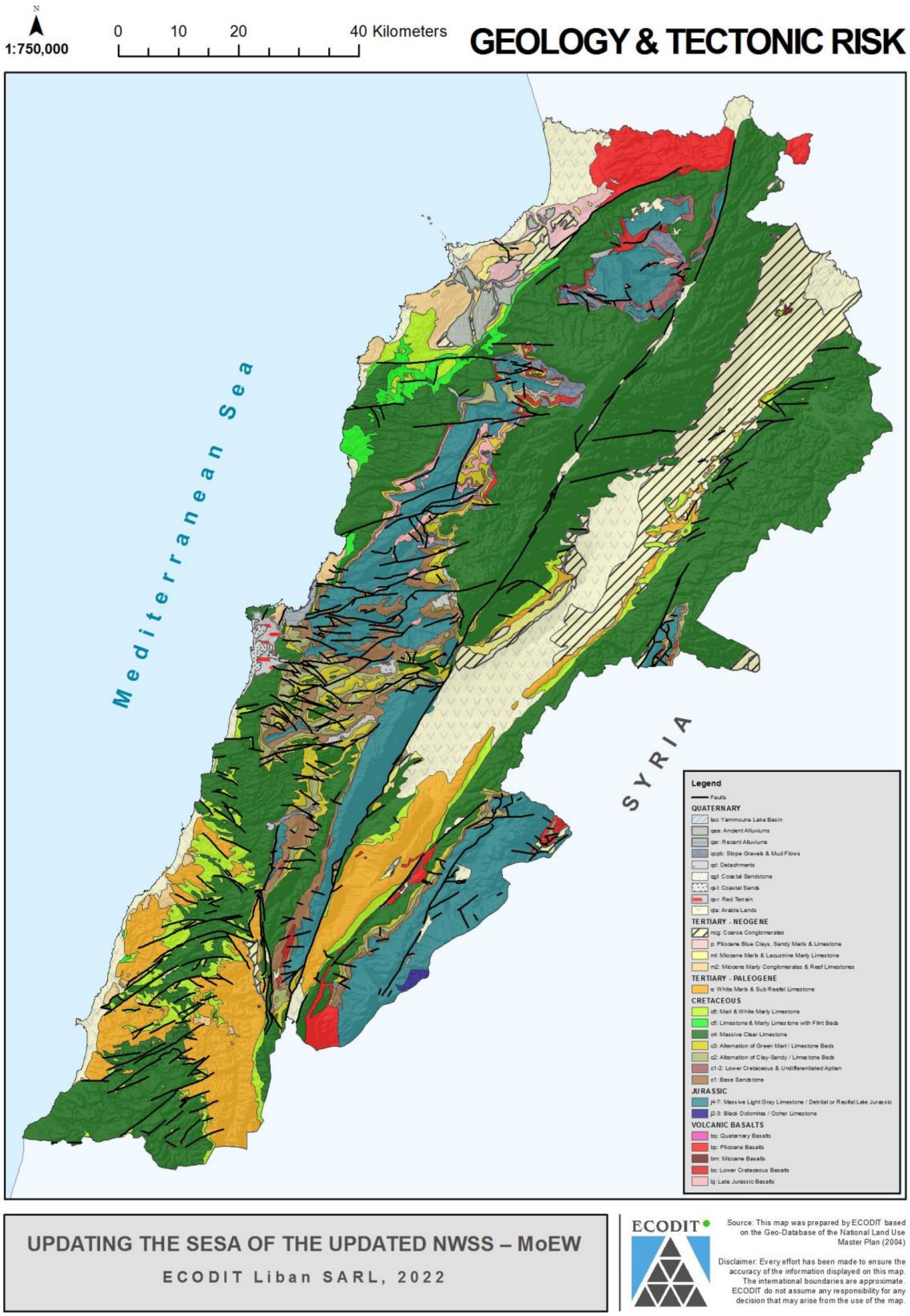


Figure 16. Geological and Tectonic Risk Map of Lebanon

According to “The Soil Map of Lebanon” Report published by the CNRS, the most common soils in Lebanon are the calcareous Terra-Rossa and Rendzinas that are located in agricultural plains, in addition to other types of soil including sandstone, basalts and similar older volcanic materials (Darwish & CNRS, 2006). Soils in Lebanon are generally fragile with poor consistency and shallowness (MoE et al., 2011). Natural and anthropogenic activities can result in soil erosion. However, the main factors influencing soil erosion are the texture and composition of the soil, topography of the land (slope orientation), climate (temperature, frequency of precipitation), surface cover and land use. Figure 17 maps the risk of erosion across Lebanon.

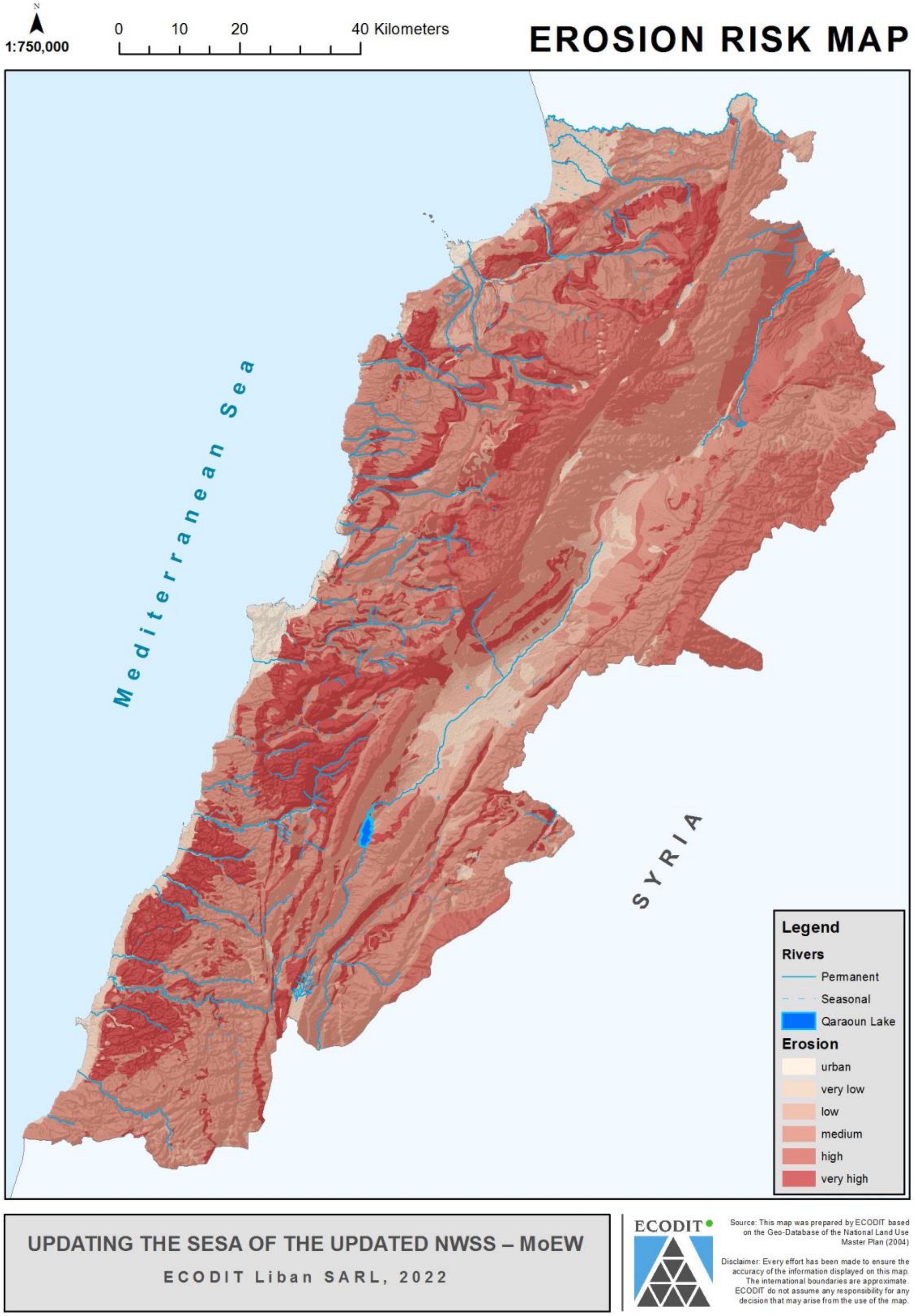


Figure 17. Soil Erosion Risk across Lebanon

5.1.3.3 *Land Cover and Land Use*

The most updated land use/land cover map was produced by the National Center for Remote Sensing affiliated with the CNRS in 2017. A comparison between 2005 and 2013 land cover suggests some significant changes over the years, mainly the increase of natural terrain with little or no vegetation and the decrease in herbaceous vegetation areas. Other minor changes in land cover include a slight increase in agricultural land and slight decrease in forested land. Figure 18 presents the latest land use/land cover map of Lebanon.

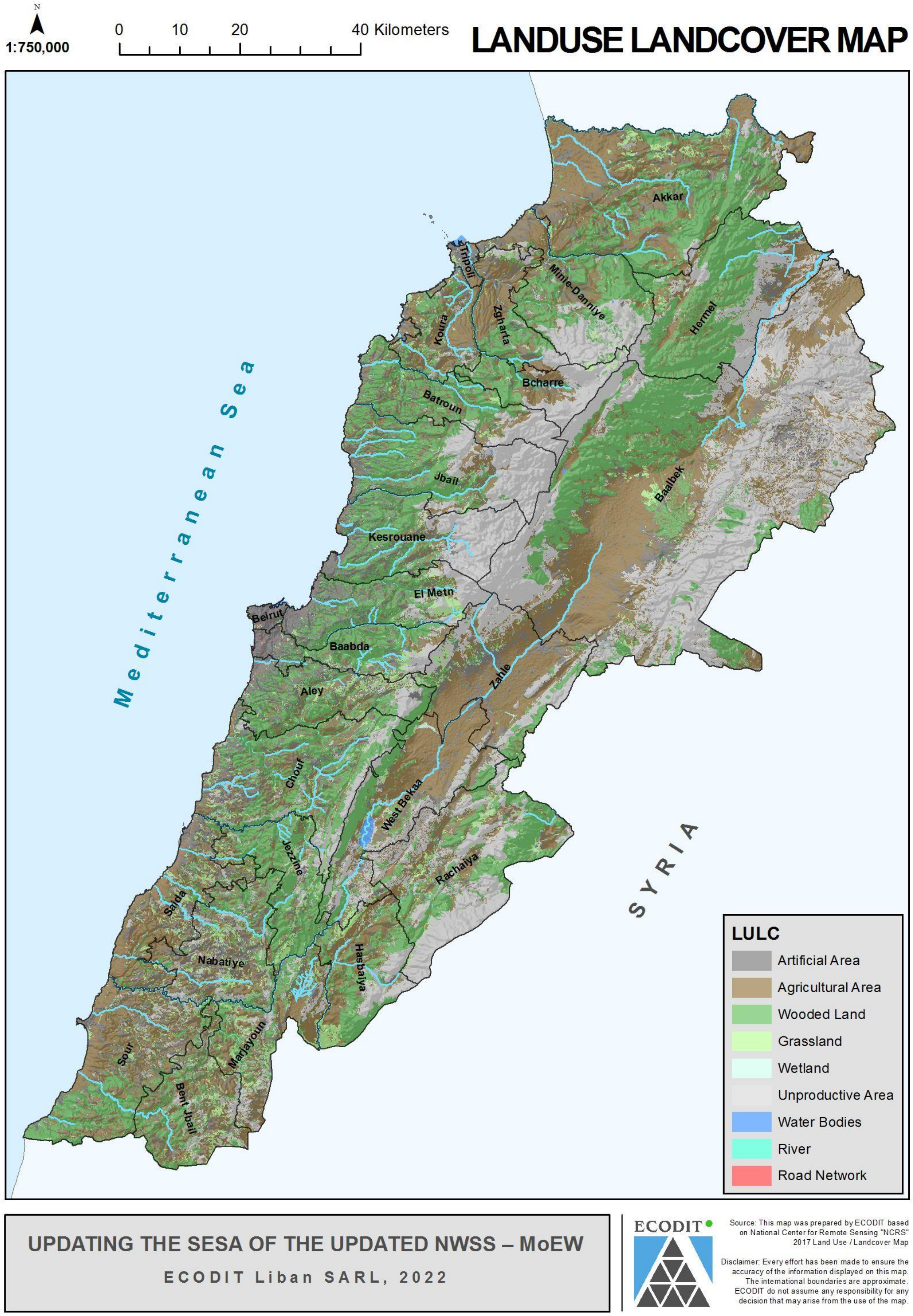


Figure 18. Land Use and Land Cover Map of Lebanon

Forest and Other Wooded Land

Forests and Other Wooded Land (OWL) cover 23% of the country's territory. According to the Association for Forests (AFDC), Development, and Conservation (AFDC) and FAO data for the years 2000, 2005, 2007, 2010, and 2015, no significant change in forest and other wooded land cover has been observed, as seen in Table 20.

Table 20. Coverage of Forests and Other Wooded Land 2000-2015

	Total Area (km^2)				
Year	2000	2005	2007	2010	2015
Forest	131	136	139	137	137.3
OWL	117	106	108	106	106

Source: AFDC, 2007; FAO, 2010; AFDC, 2019

However, CNRS data suggests a net loss of 38.9 km^2 of forests and other wooded lands between 2013 and 2017 (some attributed to forest fires) and the presence of 4.8 km^2 and 3.2 km^2 of newly burnt woodland areas and urban sprawl on forests, respectively (Faour & Abdallah, 2013; Faour & Abdallah, 2018). Forest fires are one of the main contributing factors to forest and OWL cover reduction in Lebanon. In October 2019, one of the largest forest fires in the country led to the loss of 1,214 ha (12.4 km^2) of forest land. Figure 19 illustrates the forest fire risk across Lebanon (UNDP et al., 2020).

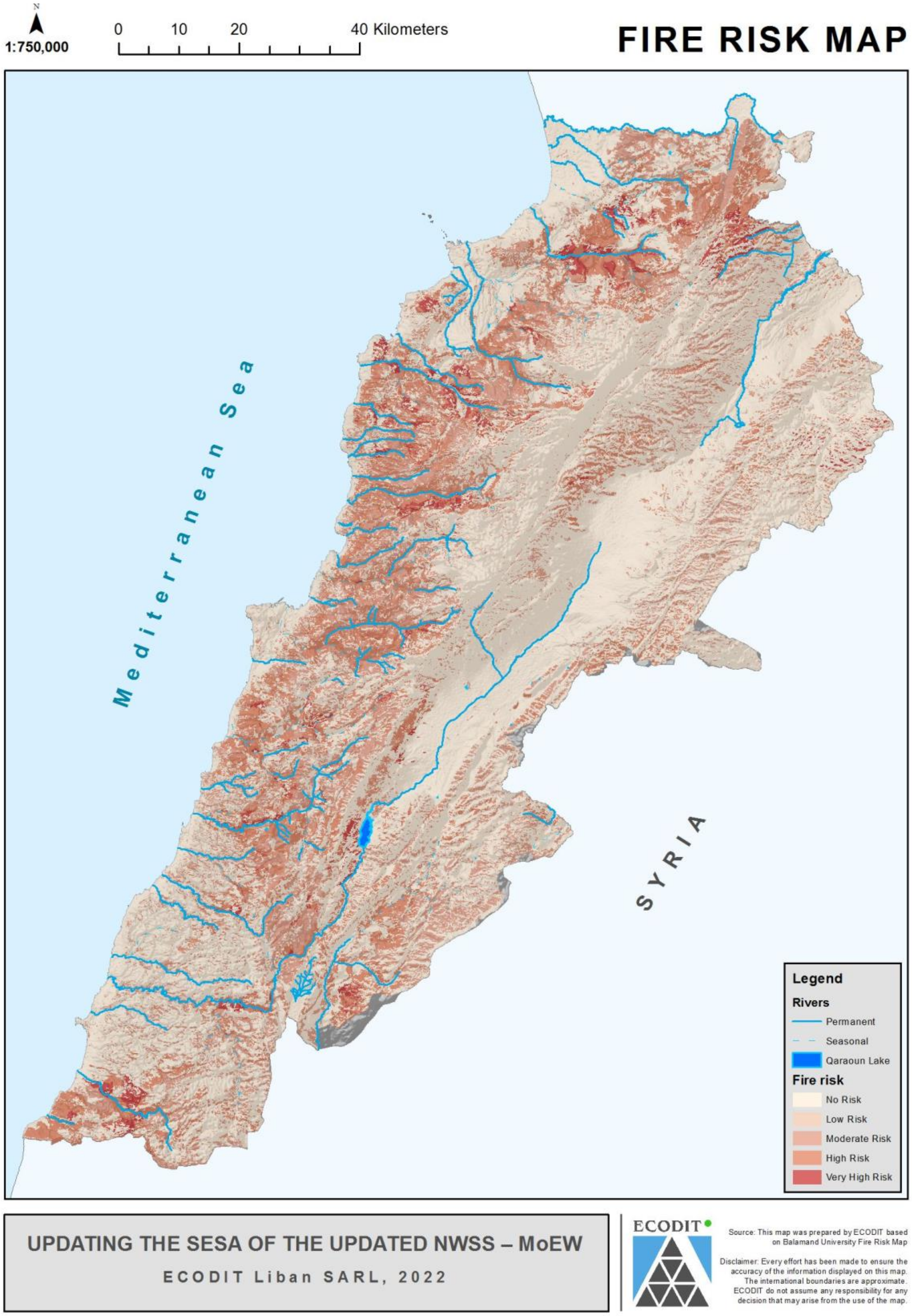


Figure 19. Forest Fire Risk across Lebanon

Built Areas

In 2018, only 14.4% of the Lebanese territory had a developed comprehensive master plan issued by decree detailing the main development principles of the zone and the land use, road network, building ratio, etc. These areas mainly correspond to urban agglomerations and their surroundings. In addition, around 4.3% were partially planned while the remaining 81% were unplanned (Legal Agenda, 2018). The current land governance situation in the country gives rise to various negative consequences including loss of forest lands and haphazard urbanization (UNDP et al., 2020).

Agricultural Land

The surface area covered by agricultural land in the country differs between various sources. The 2017 CNRS land use/land cover map indicates that it covers 3,084 km^2 while the FAO calculates a total of 2,580 km^2 of cultivated areas divided between 1,320 km^2 of arable land and 1,260 km^2 of permanent cropland (FAO, 2017). This figure is close to the 1,285 km^2 of permanent cropland estimated by the World Bank (UNDP et al., 2020), while the Copernicus Global Land Cover program estimates 1,617.1 km^2 of cropland (Buchhorn et al, 2020). Nevertheless, the main agricultural plains in Lebanon are located in Akkar, Bekaa, Hasbaya, Koura, Rachaya, Saida, and Tyre (UNDP et al., 2020).

5.1.3.4 Land Degradation

Land degradation has been accelerating in Lebanon due to natural factors, including poor drainage and weak lithology, and due to anthropogenic factors, such as forest fires, urban sprawl, and poor irrigation practices (Francis, 2012). A 2019 study classified 39% of the country's territory as being "very exposed" to land degradation (less than or equal to 90 Kg C/m^2). The report identified a loss of 2,257 ha of cropland, 1,783 ha of forests and 1,201 ha of grassland, as well as signs of loss of land productivity. Other factors that have impacted land degradation in Lebanon are the poorly managed and operated quarries, open solid waste dumps, land mines and the construction of dams.

Quarries

There is no data regarding the number of active quarries in the country due to the presence of a large number of unlicensed ones. Some sources estimate 760 quarries in the country, while other studies estimate the number of quarries as high as 2,400 (MoE et al., 2009). The MoE & UNDP report on the "Rapid Cost of Environmental Degradation" identified 1,330 active and passive quarrying sites covering 52.6 km^2 (MoE & UNDP, 2019). Quarries have several adverse environmental impacts; around 62% of quarries have disrupted the groundwater flow system by reaching the water table and either emptying or polluting aquifers (UNDP et al., 2020). Quarries have also affected many springs, especially in the Mayrouba/Wata area in Caza of Keserwan. The uncontrolled quarrying sector has also resulted in land degradation, valued at an estimated 350 to USD 770 million (MoE & UNDP, 2019).

Open Dump

Open dumps are highly prevalent in Lebanon as it is the most common method of waste disposal in the country (UNDP et al., 2020). A recent study identified 941 dumpsites in 2016 compared to 670 in 2011; these dumps are divided between Municipal Solid Waste (MSW) (Figure 20) and Construction and Demolition Waste (CDW) (Figure 21) (UNDP & MoE, 2017). In addition, many municipalities practice open dumping and burning of waste; waste in more than 150 dumpsites is burnt weekly (Khawaja, 2017).

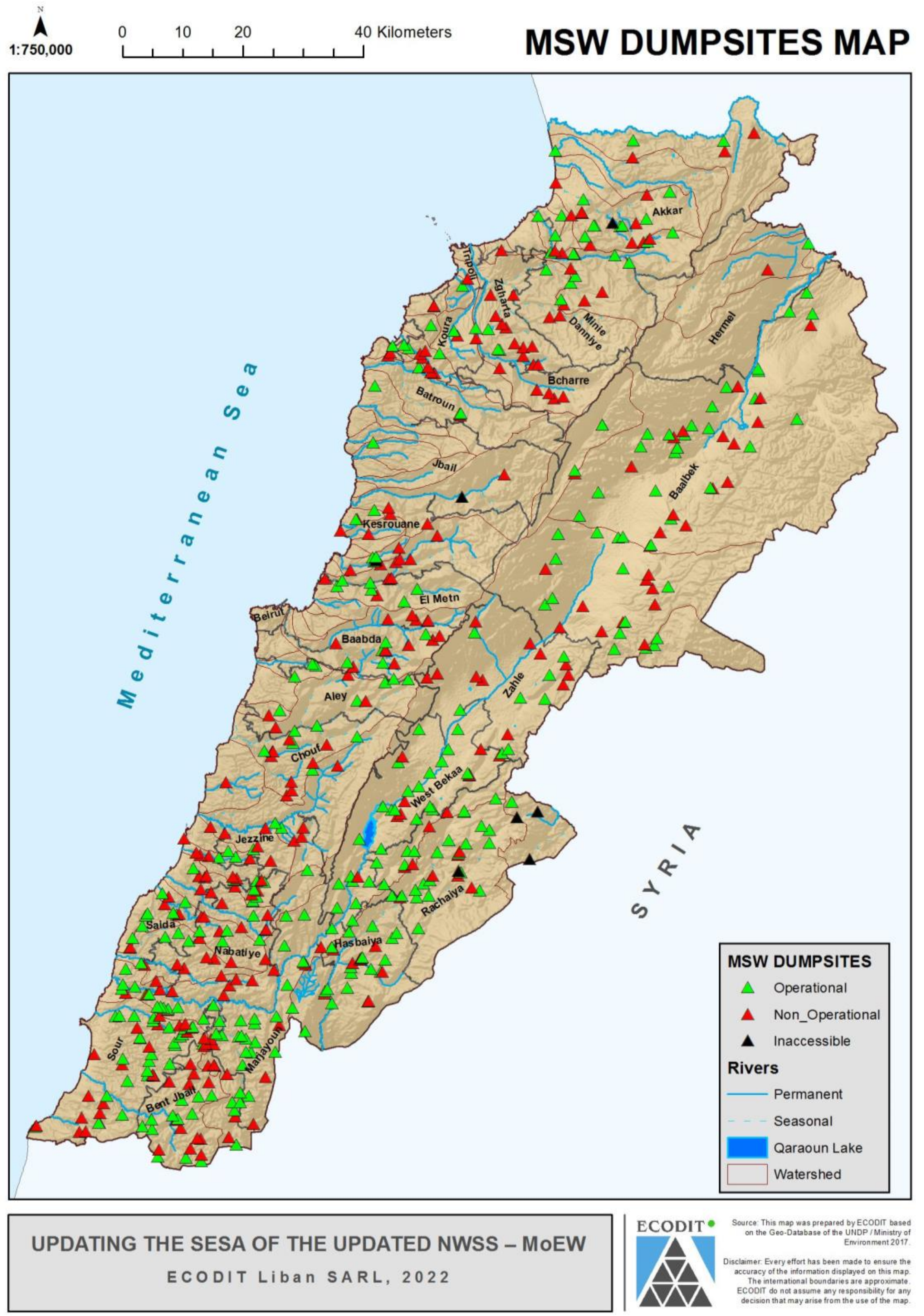


Figure 20. Location of MSW Dumpsites across Lebanon

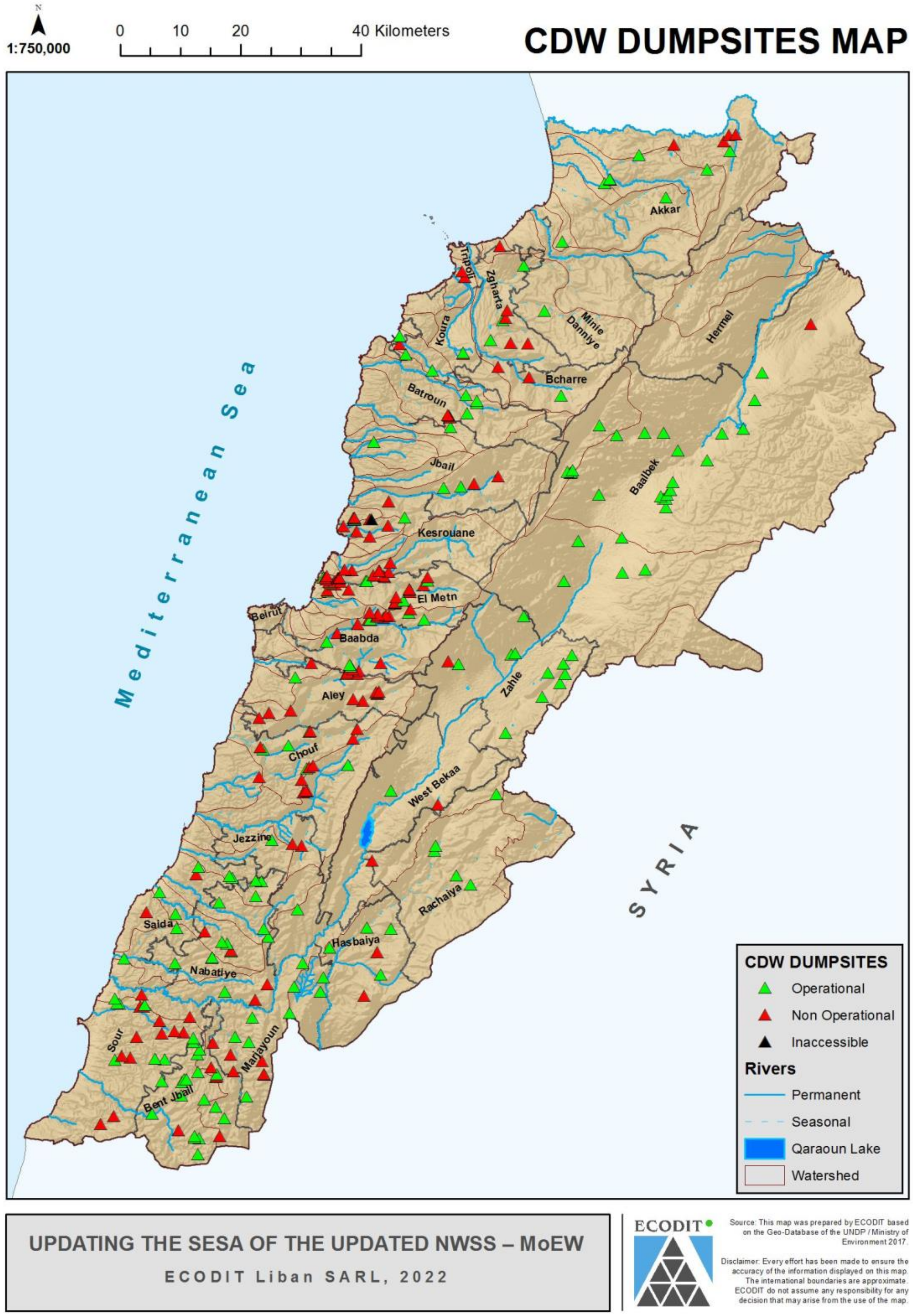


Figure 21. Location of CDW Dumpsites across Lebanon

Land Mines

Many landmines still exist in Lebanon due to the country's long history of conflicts and instability. By the end of 2017, a study estimated that land mines, cluster munitions and other explosive war remnants cover around 37.27 km^2 of confirmed hazardous areas and 21.8 km^2 of suspected hazardous areas (Landmine & Cluster Munition Monitor, 2016). The presence of landmines prevents the use of potentially useful and productive lands.

The above-mentioned factors contribute to land degradation in the county, which can have various impacts including increased risk of landslides, reduced agricultural output, droughts, floods, etc. (UNDP et al., 2020). If land degradation reaches the level of desertification, then additional health hazards are expected from the resulting lack of water, such as an increased risk of water-borne diseases (WHO, 2020).

5.1.4 *Natural Hazards*

Lebanon faces different types of natural risks from large-scale disasters such as earthquakes, tsunamis, storms and droughts to smaller scale events including landslides, floods, fires and torrential rain periods. These risks may cause physical damage or destruction, loss of life, or drastic change to the environment. Some of them are interrelated (i.e., storms and floods, torrential rain and landslides, droughts and fires) while others can have catastrophic consequences (i.e., earthquakes and tsunamis). Lebanon's mountainous morphology is transected by many faults including three major faults (Yammouneh, Roum and Serghaya). There are dozens of other minor faults.

Figure 22 illustrates the risk of floods in the country.

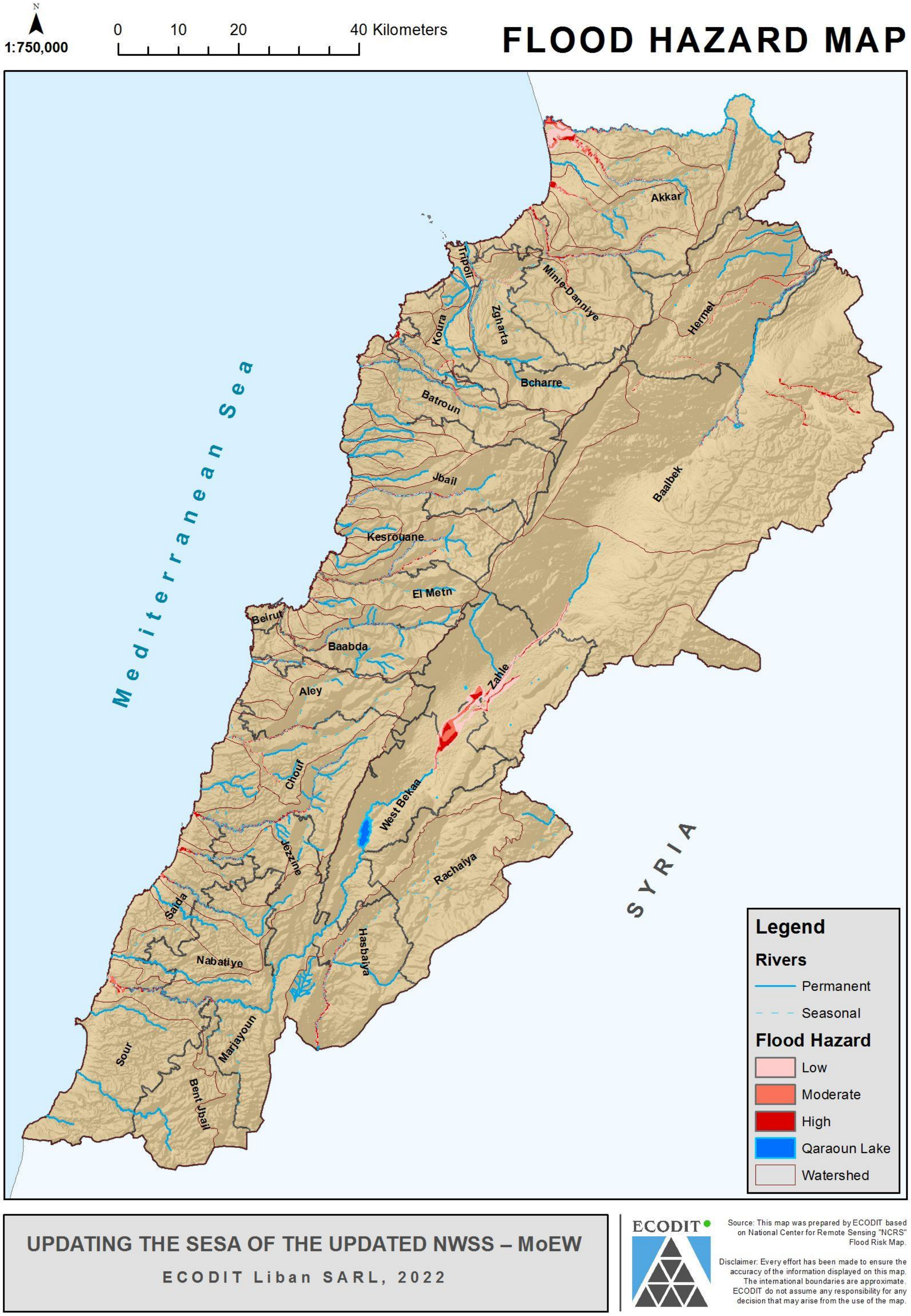


Figure 22. Flood Hazard Map

5.2 Biological Environment

This Section describes the baseline biological and natural environment that may be affected by the Updated NWSS-MoEW (2020).

5.2.1 *Terrestrial Ecosystems*

Terrestrial ecosystem encompasses forests, woodlands, grasslands, rock lands, etc., but also inland lakes, artificial lakes, hill lakes, marshes, ponds, and even rainwater harvesting ponds. This Section is divided into flora, fauna, protected areas of Lebanon, and hill lakes.

5.2.1.1 Terrestrial Flora

Taking into consideration the new botanical research, the terrestrial plants are c.2600 identified species (Tohmé & Tohmé, 2007). The freshwater flora comprises 284 known species (MoA et al., 1996).

According to the research of Dr. Ghassan Ramadan Jaradi, reported in the previous State of the Environment Report, 81% of the floral species are terrestrial; out of which 8.5% are regionally endemic (221 species), 3.5% are endemic to Lebanon only (91 species), 1.3% are rare (34 species), and 2.7% are threatened (69 species) (MoE et al., 2011).

5.2.1.2 Terrestrial Fauna

<u>Terrestrial Mammals</u>

The list of mammals of the terrestrial ecosystems is composed of 59 known species (MoE et al., 2011). The global conservation status of the species based on the International Union for Conservation of Nature (IUCN) Red List (retrieved in 2022) indicates a 'least concern' level of threat to all species occurring in Lebanon, with the exception of the near threatened Striped Hyena *(Hyaena hyaena)* (vulnerable at the Mediterranean level), and the vulnerable Marbled Polecat *(Vormela peregusna).*

<u>Terrestrial Avifauna</u>

Since the previous published checklist of the birds of Lebanon in 2008, many significant changes to the status and distribution of birds have been recorded. The recent checklist (2020) uses the standardized taxonomic list for the Ornithological Society of the Middle East (OSME) region. Of the 408 species recorded in Lebanon (Ramadan Jaradi, personal communication), eleven have been added since the 2008 list; 284 (70.3%) are passage migrants or winter visitors (or both); 69 (17.1%) are vagrants; 73 (17.8%) are summer breeders and 65 (16.1%) are breeding residents (some species fall into more than one category). The remaining birds are of uncertain status (Leach's Storm Petrel *Hydrobates leucorhous*, Western Brown Fish Owl *Bubo (zeylonensis) semenowi,* Eurasian Nuthatch *Sitta europaea,* and White-winged Snowfinch *Montifringilla nivalis*), have originated from escapes (Red Turtle Dove *Streptopelia tranquebarica* and Indian Silverbill *Lonchura malabarica*), were introduced (Mute Swan *Cygnus olor*, Rock Partridge *Alectoris graeca* and Common Pheasant *Phasianus colchicus*), or disappeared from Lebanon for over 120 and 70 years respectively but recently reappearing as vagrants (Lesser Crested Tern *Thalasseus bengalensis* and Blue-cheeked Bee-eater *Merops persicus*). We also described the first breeding records in Lebanon of five species (Squacco Heron *Ardeola ralloides*, Western Cattle Egret *Bubulcus ibis*, Little Egret *Egretta garzetta,* Black-winged Kite *Elanus caeruleus*) and European Robin *Erithacus rubecula*, in spring 2020 (Ramadan-Jaradi et al., 2020). Table 21 shows both the phenological and conservation statuses of the globally threatened species in Lebanon.

Table 21. Threatened Birds Species Observed in Terrestrial Ecosystems of Lebanon (Source: Ramadan-Jaradi et al., 2020)

	English Name	Scientific Name	Phenological Status	Conservation Status
	Globally Threatened			
1	Sociable Lapwing	*Vanellus gregarius*	PM, WV	CE
2	Egyptian Vulture	*Neophron percnopterus*	FB, PM	EN
3	Steppe Eagle	*Aquila nipalensis*	PM	EN
4	Saker Falcon	*Falco cherrug*	PM, WV	EN
5	Greater Spotted Eagle	*Clanga clanga*	PM, WV	VU
6	Eastern Imperial Eagle	*Aquila heliaca*	FB, PM, WV	VU
7	Great Bustard	*Otis tarda*	V	VU
8	Macqueen's Bustard	*Chlamydotis macqueenii*	V	VU
9	European Turtle Dove	*Streptopelia turtur*	SB, PM	VU
10	Syrian Serin	*Serinus syriacus*	SB, PM, WV	VU
11	Rustic Bunting	*Emberiza rustica*	V	VU
Legend: **CE:** Critically Endangered, **VU:** Vulnerable, **EN:** Endangered, **WV:** Winter Visitor; **PM**: Passage Migrant; **V:** Vagrant; **FB**: Former Breeder; **SB**: Summer Breeder				

Figure 23. Sociable Plover *(Sociable Lapwing)*, the most endangered bird species in Lebanon (© Fouad Itani)

Terrestrial Reptiles

The Reptile specialist, Souad Hraoui Bloquet, recorded in 2001 and 2002, 48 species of terrestrial reptiles in Lebanon. In 2017, Uetz has added 8 more species, raising the richness to 56 species. Three of them live in restricted habitats in the high altitudes of Mount Lebanon (Uetz, 2017).

5.2.1.3 Protected Areas of Lebanon

Lebanon has 18 legally established terrestrial Protected Areas (PAs) covering approximately 2.86% of the territory (Table 22). The management and operation of the PAs is a shared responsibility between the MoE, the Appointed PAs Committee and the Management Team of the Nature Reserve.

Several nature reserves have earned other designations such as Biosphere Reserves and Important Bird Areas. In total, Lebanon offers 3 Biosphere Reserves (Shouf Biosphere Reserve, Jabal Moussa, and Jabal El Rihane), 18 protected forests, 16 protected sites, 4 Ramsar Sites, 5 World Heritage Sites, 15 Important Bird Areas, and 26 Hima managed by municipalities. Some of those nature reserves and sites may be affected by the initiatives foreseen in the Updated NWSS-MoEW (2020). Additionally, there are other on-going efforts to establish "microreserves" in Lebanon. For example, the Critical Ecosystem Partnership Fund (CEPF) has approved a grant to setup three "micro-reserves" to conserve rare or endemic species in Lebanon. Located in Baskinta, Ehmej, and Sarada, these micro-reserves will help protect important species such as the Iris sofarana.

Table 22. Lebanon's 18 Nature Reserves (Source: MoE, 2021)

	Nature Reserve	Legal Instrument	Date of Creation	Caza	Area (ha)	Height Above Sea Level
1	Horsh Ehden	Law 121	March 09, 1992	Zgharta	1740	1200-1900
2	Palm Islands	Law 121	March 09, 1992	Tripoli	417,73	Sea level
3	Karm Chbat	Decision 14/1	October 06, 1995	Akkar	520	1400-1900
4	Al Shouf Cedars	Law 532	July 24, 1996	Shouf	15647	900-2000
5	Tyre Coast	Law 708	November 05, 1998	Tyre	3,889,25	Sea level
6	Bentael	Law 11	February 20, 1999	Jbeil	75,31	250-800
7	Yammouni	Law 10	February 20, 1999	Baalbeck	2100	1400-2000
8	Tannourine Cedars Forest	Law 9	February 20, 1999	Batroun	195,5	1300-1800
9	Wadi Al Houjeir	Law 121	July 23, 2010	Marjeyoun, Bent Jbeil and Nabatiye	3595	250-400
10	Mashaa Chnaniir	Law 122	July 29, 2010	Kesrouan	27	500-530
11	Kafra	Law 198	November 18, 2011	Bent Jbeil	40	650
12	Ramya	Law 199	November 18, 2011	Bent Jbeil	20	650

	Nature Reserve	Legal Instrument	Date of Creation	Caza	Area (ha)	Height Above Sea Level
13	Debl	Law 200	November 18, 2011	Bent Jbeil	25	600
14	Beit Leef	Law 201	November 18, 2011	Bent Jbeil	20	550
15	Jaj Cedars	Law 257	April 15, 2014	Jbeil	19,93	1650
16	Abbasiyeh	Law 170	May 5, 2020	Tyre	293,54	Sea level
17	Nmayriye	Law 169	May 5, 2020	Nabatiye	10,2	400
18	Mount Hermon	Law 202	December 30,2020	Rachaya	1260	800-2800

5.2.2 *Riparian Ecosystems*

Riparian zones are ecosystems located along the banks of rivers, streams, creeks, or any other water networks. Usually, riparian zones are narrow strips of land that line the borders of a water source. Riparian flora and fauna are often distinctly different from those found in adjacent communities because of the water-rich soils found in the riparian zone. Healthy riparian zones provide a variety of important ecosystem services including (1) sediment filtering, (2) bank stabilization, (3) water storage and release, and (4) aquifer recharge. Riparian habitats can be defined as transitional areas regularly influenced by fresh water. They extend from the edge of a water body to the edge of the upland community and constitute important habitats for wildlife.

The importance of riparian habitats to wildlife, in general, and birds, in particular, is a well-documented phenomenon. Riparian habitats are especially important to insectivores because flowing water is required for many insects' life cycles (Johnson & Jones, 1977). Riparian habitats are also critical to breeding birds. It provides a habitat for many more breeding birds than do surrounding uplands (Knopf et al. 1988). In Lebanon, about 75% of the breeding Water Bodies Dependent Species (WBDS) nest in riparian habitats (Ramadan-Jaradi et al., 2020).


Figure 24. Riparian Habitat in Lebanon (Source: Ali Chakas)

Riparian habitats are important because:

- The flow of water through riparian soils regenerates ground water.
- The riparian vegetation can remove excess nutrients and sediment from surface runoff and shallow ground water.
- The riparian vegetation shades streams to optimize light and temperature conditions for aquatic plants, fish, and other animals.
- The riparian areas provide important habitats for many endangered and threatened species and other wildlife and plants.

Riparian habitats are very diverse but offer similar ecological features including energy flow, nutrient cycling, water cycling, hydrologic function, and plant and animal population. Despite their ecological importance, riparian habitats in Lebanon are not listed among the country's known biological hotspots. There has not been a systematic survey of biological hotspots in Lebanon to date. Some references have determined that the Cedar corridor in Mount Lebanon and the Orontes Valley, including the upper Litani River and its watershed, are biological hotpots (Quezel et al., 1999). Lebanon offers many more biological hotspots but those have not been sufficiently assessed.

Moreover, estuaries (river mouths) host rich ecosystems in terms of biodiversity and ecological services. Estuaries filter out sediments and pollutants from rivers and streams before they flow into the sea, providing cleaner waters for humans and marine life. Estuaries (Figure 25) have been called the "nurseries of the sea" because their protected environment and abundant food provide an ideal location for fish and shellfish to reproduce. Many fishes and crustaceans migrate to river mouths to spawn or breed.

Table 23 shows the globally threatened species of the riverine and riparian ecosystem.

Figure 25. Example of an Estuary (River Mouth) Changing the Water Quality, Maintaining Reduced Coastal Salinity, Increasing Nutrients, Contributing to Building Beaches, Providing a Wide Range of Spawning and Breeding Areas to Wildlife (Source: UCSB, n.d.)

Table 23. Threatened Birds Species Observed in the Riverine and Riparian Habitats of Lebanon (Source: Ramadan-Jaradi et al., 2020)

	English Name	Scientific Name	Phenological Status	Conservation Status
	Globally Threatened			
1	White-headed Duck	*Oxyura leucocephala*	V	EN
2	Horned Grebe	*Podiceps auritus*	V	VU
3	Marbled Duck	*Marmaronetta angustirostris*	V	VU
4	Common Pochard	*Aythya ferina*	PM, WV	VU
5	Dipper of Lebanon (Figure 26)	*Cinclus cinclus rufiventris*	Resident	Endemic
Legend: **VU:** Vulnerable, **EN:** Endangered, **WV**: Winter Visitor; **PM:** Passage Migrant; **V:** Vagrant				

Furthermore, the 7 species of amphibians of the Lebanese riverine habitats were recorded by Souad Hraoui Bloquet in 2001 but are not threatened. As for the globally threatened Mammal species that live in the river (and the swamps), the European Otter was reported as Near Threatened (NT) in the IUCN RedList. It lives in Anjar and Ammiq swamps and their feeding rivers (Figure 26 and Figure 27).

Figure 26. The Dipper, an Endemic Resident that Swims Under the Water of Lebanese Rivers (© Fouad Itani)

Figure 27. The European Otter, a Swimming Mammal in Freshwater (Source: Animal Corner, n.d.)

5.2.3 *Coastal and Marine Ecosystems*

Except for a short (about 22 km) stretch from Tyre to Ras El Naqoura in South Lebanon, most of Lebanon's coastline is heavily impacted by human activities and infringements. River systems emptying into marine waters have very irregular flows and are almost non-existent in certain periods of the year. In the spring, sediment loads are heavy and often carry sewage waste, industrial, and agricultural pollutants. On another side, there are efforts to save the coast and the sea in Lebanon through the declaration of Palm Islands Nature Reserve (PINR), Tyre Coast Nature Reserve (TCNR), and Abbasieh "Nature Reserve" or "Marine Protected Areas (MPAs)" within the Mediterranean network of "MPAs". PINR is also an Important Bird Area (IBA), a Specially Protected Area of Mediterranean Importance (SPAMI), and a Ramsar Site; whereas TCNR is a Ramsar Site and a SPAMI site. Abbasieh is a third but new coastal Nature Reserve. However, about 15 new sites are proposed nature reserves to support the conservation and management of important marine habitats and species in Lebanon (MoE & IUCN, 2012) were explored and assessed but two of them were found of high priority to be declared as MPAs: Ras El Chekaa Ramsar Site and Enfeh Hima Site.

In Lebanon, most of the population lives in Beirut and Mount Lebanon, particularly along the coastal area and a narrow band of Mount Lebanon. This occupation generates a strong anthropogenic pressure on the water resources and threatens the life of sea birds, sea turtles, monk seals, dolphins, whales, and other globally threatened species.

The most globally threatened Mammal species in the eastern Mediterranean are shown Table 24.

Table 24. Threatened Sea Mammal Species Observed in the Waters of Lebanon (Source: MoE & IUCN, 2012)

	English Name	Scientific Name	Phenological Status	Conservation Status
	Globally Threatened			
1	Bottlenose dolphin	*Tursiops truncatus*	V	LC (Extremely rare)
2	Striped dolphin	*Stenella coeruleoalba*	V	LC (Extremely rare)
3	Sperm whale	*Physeter catodon*	Wv	VU
4	Monk Seal	*Monachus monachus*	R	EN
Legend: **VU:** Vulnerable, **EN:** Endangered, **WV:** Winter Visitor; **PM:** Passage Migrant; **V:** Vagrant; **R:** Uncommon resident; **LC**: Least Concern				

The most globally threatened sea bird species in eastern Mediterranean are shown in Table 25.

Table 25. Threatened Birds Species Observed in the Eastern Mediterranean Habitats of Lebanon (Source: Ramadan-Jaradi et al., 2020)

	English Name	Scientific Name	Phenological Status	Conservation Status
	Globally Threatened			
1	White-headed Duck	*Oxyura leucocephala*	V	EN
2	Horned Grebe	*Podiceps auritus*	V	VU
3	Leach's Storm Petrel	*Hydrobates leucorhous*	WV	VU
4	Yelkouan Shearwater	*Puffinus yelkouan*	PM, WV	VU
5	Marbled Duck	*Marmaronetta angustirostris*	V	VU
6	Common Pochard	*Aythya ferina*	PM, WV	VU
7	Velvet Scoter	*Melanitta fusca*	V	VU
8	Black-legged Kittiwake	*Rissa tridactyla*	WV, PM	VU
9	Dipper of Lebanon	*Cinclus cinclus rufiventris*	Resident	Endemic
Legend: **V:** Vulnerable, **EN:** Endangered, **WV:** Winter Visitor; **PM:** Passage Migrant; **V:** Vagrant				

The most globally threatened sea turtle species in eastern Mediterranean are shown in Table 26.

Table 26. Threatened Sea Turtle Species Observed in the Eastern Mediterranean Habitats of Lebanon (Source: Ramadan-Jaradi et al., 2020)

	English Name	Scientific Name	Phenological Status	Conservation Status
	Globally Threatened			
1	Green Turtle	*Chelonia mydas*	SB, WV	EN
2	Loggerhead Turtle	*Caretta caretta*	SB, WV, PM	VU
3	Leatherback Turtle	*Dermochelys coriacea*	Occasional	VU
4	Olive ridley sea turtle	*Lepidochelys olivacea*	V (A. Serhal 2018)	VU
Legend: **VU:** Vulnerable, **EN:** Endangered, **WV:** Winter Visitor; **PM:** Passage Migrant; **V:** Vagrant; **SB:** Summer Breeding				

5.3 Socio-Economic and Cultural Environment

Water is an important resource for economic and social development; it is an essential basic human need, and it is key to sustaining various economic activities i.e., agricultural, industrial, and touristic activities. Despite its importance, water resources in Lebanon are under various challenges related to the unsustainable use and management of water, and poor urban wastewater and sanitation services. The latter is exacerbating the water situation in Lebanon by jeopardizing the water quality and putting human health and the natural environment at risk.

This section presents a baseline description of the socio-economic and cultural environment in Lebanon including population growth and urbanization, poverty and socio-economic crises, water consumption and expenditure patterns, and the agricultural, industrial, and touristic activities in Lebanon.

5.3.1 *Population Growth and Urbanization*

The most recent official data on the Lebanese population was published in 2018-2019 (CAS, 2019) and detailed in Table 27. The total estimated Lebanese population is around 4.84 million habitants distributed across all eight governorates. Lebanon ranks amongst the top 20 most densely populated countries in the world, with a population density of 669 inhabitants/km^2 (World Bank, 2018).

Table 27. Population of Lebanon by Governorates (CAS, 2019)

	Distribution of Population		Distribution of Households	
Beirut	341,724	7.06%	100,049	7.90%
Mount Lebanon	2,032,573	41.97%	562,605	44.42%
Northern Lebanon	637,908	13.17%	153,172	12.09%
Akkar	323,966	6.69%	68,201	5.38%
Bekaa	297,659	6.15%	76,224	6.02%
Baalback-Hermel	245,081	5.06%	58,353	4.61%

	Distribution of Population		Distribution of Households	
Southern Lebanon	584,370	12.07%	147,807	11.67%
Nabatieh	379,183	7.83%	100,240	7.91%
Total Lebanon	**4,842,464**	**100.00%**	**1,266,651**	**100.00%**

Lebanon's population also includes an estimated 174,400 Palestinian refugees (LPDC et al., 2018) around 1.5 million Syrian refugees and 14,815 refugees from other nationalities (UNHCR, 2021), as well as 250,000 migrant domestic workers (UN News, 2021) . Currently, around 40% of the Lebanese population are refugees, representing the world's highest number of refugees per inhabitant (MoE et al., 2016a). Refugee populations, whether residing in host communities or ettlements, also require water and sanitation services and strain existing infrastructure.

Table 28. Non-Lebanese Population by Nationality

	Population
Palestinian (LPDC et al., 2018)	174,400
Syrian (UNHCR, 2021)	1,500,000
Other Nationalities and Migrant Domestic Workers	264,800
Total Non-Lebanese	**1,939,000**

The influx of refugees increased the population in Lebanon to around 6.7 million. As a result, the national water demand increased by 8-12% in 2014 and the wastewater generation rate by 8-14% by end of 2014 (MoE et al., 2016a). The population growth, including refugees and internal migration, constitute the main driving forces on the available water resources across the country in terms of water demand and consumption.

According to the recently published SOER (2020), the population growth rates in Lebanon have been reported to range between 1 and 2.5% per year. Yet, the MoEW in the 2020 National Water Sector Strategy, has estimated a population growth of 1.5% for rural areas and 0.75% for urban areas from 2020 to 2035, except for districts under the jurisdiction of SLWE (i.e., Saida, Jezzine, Zahrani, Tyre, Bent Jbeil, Nabatieh, Marjeyoun/Hasbaya) that were projected to grow at a rate of 2% per year (MoEW, 2020). Therefore, the MoEW might be underestimating the population growth which may impact the analysis of the projected water demand. Additionally, two factors are foreseen to also underestimate the current demographic projections in Lebanon: (1) the increase in emigration rates due to the multi-facet crisis and, (2) movement from urban to rural areas phenomena which has been noticeable during the Covid pandemic and economic crisis.

Lebanon is a highly urbanized country; more than 87% of the population lives in urban areas. Rates of urbanization in Lebanon have been increasing in the last 50 years due to various reasons including the influx of refugees into the country, sub-urbanization and rural exodus. The rates are expected to further increase by the year 2030 to cover more than 884 km^2 of the country.

The urbanization rates in Lebanon have exceeded the carrying capacity of large cities, especially in the capital city of Beirut. With the absence of urban planning and zoning, uncontrolled urban expansion is occurring without any consideration for access to services (i.e., water and wastewater infrastructure, electricity, etc.), and environmental standards and sustainability. The large agglomerations of concrete jungles have expanded to the peripheries creating large suburbs, mainly located around Beirut and Tripoli, with the majority being large slams or low-cost housing camps lacking proper wastewater services and infrastructure.

There are currently no accurate or recent data on the total zoning and urban expansion in Lebanon, as the latest figures published by the Higher Council of Urban Planning (HCUP) in 2014 show that only 1,693 km^2 or 12% of the total territory for urban areas was approved. However, a recent study by Faour, et al. (2016) has indicated that the total urban areas have almost doubled from 1994 to 2010 (Table 29). Also, the EU Copernicus Program gave an estimation of approximately 1,004 km^2 in 2019 for Lebanon's built-up area (UNDP et.al., 2020), reflecting that urban areas are in continuous increase since 1994.

Table 29. Urban Area in (km^2) of Major Urban Cities and the Whole Country, 1963–2005

Agglomeration	1994		2005		2010	
Akkar	20	3%	44	6%	55	7%
North Lebanon	49	4%	89	7%	101	9%
Mount Lebanon	226	11%	281	14%	312	16%
Beirut	21	95%	21	98%	21	98%
South Lebanon	35	4%	68	7%	92	10%
Nabatiyeh	30	3%	76	7%	99	9%
Bekaa	46	3%	67	5%	83	6%
Baalback-Hermel	45	2%	73	94	94	3%
Lebanon	**472**	**5%**	**719**	**7%**	**857**	**8%**

Urbanization remains a critical component in water and wastewater management planning, and it is necessary to take into account the projection rates of urban areas and the needs for population growth when planning for future water and wastewater infrastructure projects.

The population growth and urbanization rates projected to increase in the coming years will ultimately put pressure on the water resources and wastewater infrastructure across the country.

5.3.2 *Economic and Humanitarian Crises*

Lebanon is recently subject to an unprecedented economic, financial, monetary, and social crisis that is driving the country to a quasi-complete collapse. The World Bank has recently qualified the present Lebanese economic crisis as one of the three most severe crises registered in the world since the mid-nineteenth century. In addition to the economic collapse, Lebanon has recently been severely affected by the blast of Beirut Port that took place on August 4th, 2020 and the COVID-19 pandemic. Many other external shocks are still perpetrating their long-term negative outcomes, mainly the Syrian refugees' crisis.

At the macroeconomic level, the sharp and continuous decrease in yearly growth rates since 2018 is confirming the end of the rentier economic model that prevailed since the early nineties. As per the World Bank Economic Monitor, Lebanon's GDP fell by around 40% from USD 55 billion in 2017 to an estimated USD 31.7 billion in 2020, a contraction that never occurred in times of peace (World Bank, 2021). Unfortunately, within the framework of "free fall" policies expressly adopted by the Government, the decreasing growth trend is expected to continue in 2022, because the status of the major determinants of economic growth (namely public and private investment and consumption) is still worsening.

At the financial level, huge decreases have been registered in direct and indirect public revenues, accompanied by a growing public finance deficit. Also, a steady decline in capital inflows is still prevailing since 2011, due mainly to the tremendous decrease in exports of services and Foreign Direct Investment (FDI) in addition to the end of the "Paris conferences" process after 2008. The effects of this decline have been aggravated by the fact that Lebanon has heavily depended on imported consumption since the early nineties, as a result of the abrupt liberalization of foreign trade, and this has generated a huge cumulative deficit in the current account and the balance of payment.

At the monetary level, it is a matter of fact that the stabilization monetary policy that has been regularly implemented since the mid-nineties, has arrived at a dead end. Lebanon is presently witnessing the co-existence of at least 5 prices for the Lebanese pound varying from the official price of LBP 1,500 per USD and the free-market price that exceeds more than 20 times the official one. With this excessive devaluation, the Lebanese pound lost more than 95% of its pre-2019 value, and consequently paved the way towards an aggressive wave of high inflation rates averaging 131.9% over the first six months of 2021, increasing by more than 400% on average between 2018 and the first ten months of 2021 the total Consumer Price Index (CPI) and 550% the Food and beverage CPI.

At the social level this multidimensional crisis has severely affected the living conditions of the resident population (including the Syrian and Palestinian refugees): poverty rates and especially extreme poverty rates have more than doubled during the last two years, reaching successively 70% to 80% for the former and 25% for the latter, based on the findings of many UN organizations including World Bank, International Labour Organization (ILO), UN-ESCWA, World Food Program (WFP), etc.

The most recent study on poverty in Lebanon was conducted by the UN-ESCWA in 2019-2021 which assessed poverty in Lebanon per Governorate – in terms of households in extreme poverty and poor households – and their distribution as indicated (UN-ESCWA, 2021)

Table 30. Poverty Distribution in Lebanon (Source: UN-ESCWA, 2021)

Governorates	Households in Extreme Poverty		Poor Households	
	Number of Household	Distribution in %	Number of Household	Distribution in %
Beirut	25,000	28.90%	63,000	73.00%
Mount Lebanon	133,000	26.50%	382,000	75.00%
North Lebanon	50,000	32.60%	137,000	85.00%
Akkar	40,000	51.50%	76,000	92.00%
Bekaa	32,000	43.00%	69,000	91.00%
Baalbeck-Hermel	30,000	49.30%	57,000	92.00%
South Lebanon	50,000	35.30%	128,000	87.00%
Nabatieh	40,000	46.70%	88,000	92.00%
Total of Lebanon	**400,000**	**33.06%**	**1,000,000**	**82.64%**

The data presented in Table 30 suggests that the poorest households are dominant in the rural areas of Akkar, Baalbek-Hermel and Nabatieh, each with 92% of households considered poor, followed by Bekaa with 91% of its households considered poor. Moreover, 87% and 85% of households are considered poor in South Lebanon and North, respectively.

Around 82.64% of the Lebanese population were considered poor in 2021 (UN-ESCWA, 2021). This is primarily attributed to the economic and political crises that the country has been facing for the past 2 years. The data presented in Table 30 and Table 35 suggest that there is a positive correlation between the regions with poverty rates and distribution of agriculture activity; regions with the highest poverty rates (Baalbek-Hermel, Akkar and Bekaa) also display the highest agricultural activity, followed by Nabatieh, South Lebanon and then North Lebanon.

As for unemployment, preliminary estimates indicate unprecedented increases in unemployment rates up to 40% (against 11% in 2018 as per ILO and CAS survey 2018), knowing that the huge waves of recent migration have to a great extent tempered the severity of unemployment (FAO & UN-ESCWA, 2021). Most importantly, the purchasing power of wages – 80% to 90% of which were usually paid in Lebanese pound - dropped by at least 75% since 2018, taking into account that more than 55% of the total labor force are wage earners. The major pillars of the social protection schemes have been drastically weakened, and the Government – often described in these evolving economic and financial conditions as “kicking the can down the road” – becomes unable to ensure basic public services to the population through adequate coping strategies. It should be noted that all these indicators have been subject to further deterioration after the recent de-subsidizing of fuel during the last quarter of 2021, in addition to wheat and medication. Based on the new pricing system, the cost of 20 liters of gasoline becomes almost equal to 60% of the legal minimum monthly wage at around LBP 1.4 million in March 2022, making it increasingly unaffordable for employees to go to work or for children to attend school.

Lebanon has suffered historically from a lack of political will to develop reforms and build social policies. The very low level of investments in public infrastructure since the early ninetieth has drastically limited the capacity of the State to deliver and respond to crises. Key public investments undertaken did not follow socio-economic priorities but have rather tended to serve sectarian interests and affiliation. The heavy and multidimensional ties and connections between politicians and the private sector explains to a great extent why Lebanon ranks 149th out of 180 economies in Transparency International's Corruption Perceptions Index.

It should be recognized that the major components of a National Social Protection Strategy and welfare system are lacking in Lebanon. This is the case of pension schemes for workers in the private sector, unemployment insurance, old-age or disability pensions, and child benefits, bearing in mind that Lebanon is a country where the phenomenon of informality is predominant in many regards (residence, labor, civil status, etc.). In 2018, more than one third of the population was not protected by any kind of social protection measure, more than 40% were not affiliated with social insurance, and 62.6% were lacking coverage by either contributory, non-contributory, or humanitarian schemes. One of the major obstacles preventing the development of social protection in Lebanon resides in the nature of the taxation system which remains very regressive. Lebanon was ranked 117th of 158 governments worldwide with respect to the progressive taxation pillars. The country lacks an inheritance tax and a wealth tax, limiting the tax revenue collected through progressive schemes to only 11%, taking into consideration that the tax system is based on an archaic system where every income source is taxed separately, thus decreasing progressivity.

In conclusion, the current national and international economic crisis is increasing the households' vulnerability to secure their basic human needs from water, food, and electricity. The devaluation of the LBP and cut in minimum wages are reducing the purchasing power capacity, affecting the livelihoods of more than 75% of the population.

5.3.3 *Household Water Consumption and Expenditure*

In Lebanon, household water demand is estimated on a national level based on the relative domestic and non-domestic consumption per capita per day of freshwater required for daily household activities (i.e., cleaning, bathing, washing, etc.). Until today, there has been no reliable data on the exact water consumption rates; figures fluctuate between 125 l/c/day to 400 l/c/day as indicated in Table 31. According to the 2020 NWSS, the current water consumption rate in Lebanon is not reflective of the water need per capita given that the price of water supply is set below water demand levels. This had forged the way for households to unsustainably use and waste this resource. The new strategy had estimated a more realistic breakdown of a household water need per activity which resulted in a water consumption rate of 125 l/c/day less than what was estimated in the previous strategy and other pilot sites. As for the future drinking water demand per capita, the 2020 NWSS strategy estimated that drinking water needs will reach up to 200 l/c/d in 2035, which includes water for domestic consumption, non-domestic use, and physical losses.

Table 31. Estimated Water Consumption Rates

	2012 NWSS	2020 NWSS	Pilot Sites[9]	Hijazi et al. (2012)[10]
Water Consumption Rate (l/c/day)	160 (rural) to 180 (urban)	125	300-400	255

In addition to the Lebanese households' water consumption, the 2020 NWSS assessed the impact of the non-Lebanese population (displaced and refugees) on the national water balance, although their consumption is not accounted for in the water balances at district and system levels. The following assumptions were made:

- For displaced Syrians living in informal settlements, the allocated water supplied to on-site water tanks is: 50 l/cap/day
- For Palestinian refugees living in camps and displaced Syrians not living in informal settlements and benefitting from the public network, the allocated water is: 120 l/cap/day (including losses and non-domestic consumption).

Households in Lebanon receive public water through subscribing to the water public grid against an annual water tariff fee. A fixed annual fee is charged to each connected household. With very few exceptions on a pilot scale, there are no meters and the amount of water delivered is regulated by a gauge system. Most households have a one-cubic-meter gauge connection. The volume delivered depends both on the amount of time water flows through the pipes and on water pressure. Billing is based on a contractual fixed consumption regardless of the volume of water supplied, and it varies per water establishment, as indicated in Table 32.

Table 32. Annual Water Tariff Based on Water Establishments in 2019

	NWLE	BWE	EBML	SLWE
Annual Water Tariff for 1 m^3/day and Maintenance Fee (in LBP)	290,000	296,000	366,000	308,000

Nevertheless, there are big regional differences in terms of the network coverage, as shown in Table 33 (MoEW, 2020) with the highest supply rate recorded in EBML at 92% against NWLE where only 33% of the total population receives water, while unknown water sources account for 67%.

[9] JVC in the Beqaa; USAID in Jezzine District
[10] In Tripoli

Table 33. Total Population Connected to Public Water Grid vs. Unconnected (Source: MoEW, 2020)

	NLWE	BWE	EBML	SLWE
Estimated population of the service area	1,716,000	750,000	2,907,000	1,200,000
Official Number of Subscribers/Customers (2018)	124,793	86,761	592,835	176,000
Estimated Population Supplied	561,569	390,425	2,667,758	792,000
	33%	***52%***	***92%***	***66%***
Estimated Population Tapping Water from Unknown Origin	1,154,432	359,576	239,243	408,000
	67%	***48%***	***8%***	***34%***

Unconnected households to the water grid bridge their water needs by looking for other alternative water sources, such as: tapping into artesian water wells, or purchasing water from water tankers or, water in gallons or bottles for drinking purposes. This also applies to households who are connected to the grid but suffer from continuous disruption in water supply and inadequate water quality.

In practice, most households pay for the water provided by the public network in addition to other sources of service water and drinking water. Most households therefore pay the following:

- Public network annual fee.
- Other sources of service water (water trucks, private wells).
- Other sources of drinking water (water gallons and bottles).
- Maintenance costs and/or investment costs.
- Pumping costs. Due to the discontinued water supply, subscribers need to install water tanks in basements or ground level as well as tanks at a high level, typically on the roof, and interconnect these with a pumping system.

Although the connection to the public network reaches 92% in EBML, mineral water (gallons and bottles) remains a significant source of drinking water for both connected and unconnected households: about 40% of households buy mineral water in gallons and 12%-15% of them buy mineral water in bottles (Akkaya et.al., 2009) Artesian wells and delivery trucks are the main source of service water for unconnected households.

Table 34. Average Annual Expenditure on Water Products (in 2012 - Before the Financial Crisis) (in Thousands LBP)

Products	Average of Household's Expenditure	Average of Individual's Expenditure
Mineral Waters, Soft drinks, Fruit, and Vegetable Juices	299	75

Products	Average of Household's Expenditure	Average of Individual's Expenditure
Water Supply	234	59
Total Water Expenditure per Household	**533**	**134**
Total Water Expenditure	**675,124,983**	**648,890,176**

The total number of Lebanese Households is 1,266,651, therefore their total water expenditure would be LBP 675,124,983. Given that the Lebanese population was estimated in 2019 to be around 4,842,464, the total water expenditure for the entire population amounts to LBP 648,890,176.

Additionally, UNICEF estimates that the price of water purchased from private water suppliers could increase by 200% a month (UNICEF, 2021a). The study highlights that in May and June 2021, the following challenges have aggravated:

- More than 71% of people fall within “highly critical” and “critical” levels of vulnerability.
- Nearly 1.7 million people have access to only 35 liters a day, a decrease of almost 80% against the national average of 165 liters pre-2020.
- Blackouts and intermittent power supplies are threatening the capacity of the water system to treat, pump and distribute water.
- Public water utility providers can no longer afford essential spare parts for maintenance or fuel for their electricity generators as they had no access to hard currency due to the collapse of the Lebanese currency against the USD.
- On a national level, water that is unaccounted for due to system losses is about 40%, mostly due to the lack of maintenance and illegal connections.

5.3.4 *Farmers and Agricultural Activities*

According to a study conducted in 2017 by the Investment Development Authority of Lebanon (IDAL) and the FAO, Lebanon has the highest agricultural land area in the Middle East, constituting 64.3% of its total land territory. 14% of Lebanon’s land is composed of temporary crops, meadows, kitchen gardens and temporary fallow areas. The main agricultural clusters are located in 3 regions: Bekaa (40% of its land is cultivated), North- mostly in Koura and Akkar, and South-largely on the coastal region stretching from Sidon to Tyre. However, Baalbeck-Hermel and the Bekaa are the primary agricultural regions that produce wheat and the majority of cultivated crops in Lebanon. The coastal zone supports intensive production of citrus, fruits, bananas, and vegetables (IDAL, 2017). The agricultural sector constitutes 3% of the Lebanese GDP (MoA, 2020) and employs around 12% of the Lebanese Labor Force on a full-time basis and 13% on a part-time or seasonal basis (MoA, 2020). According to the 2019 CAS survey, the total active population rate was 47.4% of the 4.84 million total population; this is equivalent to a 2.3 million Lebanese labor force, out of which 575,000 people work in the agriculture sector.

The distribution of cultivated land share utilized agricultural areas, and irrigated areas across governorates are given in Table 35.

Table 35. Distribution of Cultivated Land Share, Utilized Agriculture Area (UAA), and Irrigated Area by Governorate (Source: MoA & FAO, 2010)

Governorate	Cultivated Land Share	UAA (ha)		Irrigated Area (ha)	
Baalback-Hermel	25%	57,625	24.9%	31,703	28%
Bekaa	18%	41,649	18.0%	29,866	26%
Aakkar	15%	35,352	15.3%	15,649	14%
South	11%	25,621	11.1%	12,203	11%
Nabatiyeh	11%	26,095	11.3%	4,939	4%
North	10%	24,065	10.4%	9,200	8%
Mount Lebanon	10%	20,588	8.9%	9,395	8%
Total Lebanon	**100%**	**230,995**	**100.0%**	**112,955**	**100%**

As shown in Table 36, the irrigated areas within the agriculture holdings represent almost half of the total UAA. According to the MoA & FAO report, half of the agriculture holdings are irrigated with surface water, and the other half with groundwater (deep wells, recharge wells and springs). It is difficult to determine the actual breakdown of water consumption in the agriculture sector due to the presence of:

1. System leakages of more than 50%, leading to losses and contamination, given that the water transmission and distribution networks (earth and concrete channels) are old;
2. Unlicensed wells (MoA & UNCWA, 2016).

Comparatively, the Updated NWSS-MoEW (2020) assesses the irrigation water needs based on the current irrigation schemes across Lebanon; it estimates the presently irrigated land areas at 100,000 ha, with irrigation efficiency reaching around 50 to 60%. The average irrigation water requirement for a representative ha at the country level is around 8,435 m^3/ha/year (Table 36).

Table 36. Irrigation Water Needs (Source: MoEW, 2020)

	Presently Irrigated Area (ha)	Adopted Requirements (m^3/ha/year)	MCM/year
NLWE	23,600	7,500 (Most of the area is coastal)	177
EBML	5,835	6,500 (Most of the irrigated area is at high altitude)	38
BWE	66,115	9,000 (Most of the irrigated area is inland /dry weather)	595

	Presently Irrigated Area (ha)	Adopted Requirements (m^3/ha/year)	MCM/year
SLWE	4,210	7,500 (Most of the irrigated area is coastal)	32
Total	~100,000	8,435 Average irrigation water requirements for one representative ha at country level	842

The agricultural sector in Lebanon relies primarily on water from rivers and springs, as well as groundwater resources from wells, many of which are illegally exploited. The most commonly adopted irrigation method is the traditional furrow irrigation of channeling water directly to crops. The second most adopted irrigation method falls between sprinkling and drip irrigation systems (Table 37).

Table 37. Distribution of Irrigated Areas Based on Irrigation Methods and Main Water Sources (Source: MoA, 2010)

Main Water Source	Primary Irrigation Method			
	Irrigated Area (in ha)	Furrow Irrigation	Sprinkling	Drip Irrigation
River / Spring	44,228.6	33,796.3	5,881.6	4,550.8
Well	55,607.8	15,954.8	19,554.7	20,098.3
Tank	7,975.7	4,333.3	1,359.7	2,282.6
Dirt Ponds	3,491.9	924.6	1,006.2	1,561.2
Other	1,650.6	922.5	443.2	284.9
Total	**112,954.7**	**55,931.5**	**28,245.4**	**28,777.8**

The productivity of the agricultural sector in Lebanon depends on the market demand; today with the high inflation rates of imported products and devaluation of the LBP, consumers are leaning towards buying local agriculture products. This has created a great opportunity for farmers to generate more revenues. However, this is not exactly reflected given that the farmers production costs have been increasing, i.e., the cost of fertilizers, pesticides, pumping water for irrigation, diesel to operate machinery and generators, etc. In some cases, the increasing costs of production have pushed farmers to look for cheaper sources to irrigate their crops, such as using untreated or contaminated water. This has been manifested in the number of waterborne diseases and food borne illnesses outbreaks, given that food safety is a critical issue determined by the quality of water used in agriculture activities.

5.3.5 *Industries and Industrial Activities*

According to the most recent available data, the industrial sector in 2018 contributed to 25% of Lebanon's GDP estimated at USD 53 Billion, i.e. USD 13.25 Million and employed around 134,000 workers (MoI & UNIDO, 2018). Industries in Lebanon are dispersed across the territory, the majority of which are located outside Industrial Zones and inside residential areas, including towns and cities. According to a study conducted in 2018 by the MoI and the United Nations Industrial Development Organization (UNIDO), there are 5,211 factories permitted by the Ministry of Industry in Lebanon (MoI & UNIDO, 2018). As shown in Table 38, more than half of these Factories are in Mount Lebanon (59.89%) followed by the Bekaa (11.38%). However, there are factories operating in Lebanon without any license which also put pressure on water resources. According to the Daily Star interview with the MoI in February 2018, there are at least 4,000 factories that employ 10 people or more and that operate without any licenses. In addition, there are 6,000 small workshops with less than 10 workers operating without any proper license (The Daily Star, 2018).

Table 38. Number of Factories Permitted by the Ministry per Region in 2018 (Source: MoI & UNIDO, 2018)

Governorates	Number of Factories	Distribution in %
Mount Lebanon	3121	59.89%
Beirut	218	4.18%
Nabatieh	270	5.18%
South of Lebanon	323	6.20%
Akkar	76	1.46%
North of Lebanon	377	7.23%
Baalbeck-el Hermel	233	4.47%
Bekaa	593	11.38%
Total	**5211**	**100.00%**

70% of all factories are concentrated in five manufacturing subsectors (Akl, 2016):

- Food products and beverages.
- Non-metallic mineral products.
- Fabricated metal products.
- Electrical machinery and chemicals.

More than 55% of registered manufacturing enterprises are in Beirut and Mount Lebanon, and are scattered over residential and agricultural areas, in addition to areas earmarked for commercial and industrial activity. Food products and beverages is the most predominant subsector, representing around 30% of total industrial establishments in the country (Akl, 2016). A study conducted by UN-ESCWA in 2016 states that the industrial sector in Lebanon consumes around 165 MCM of water per year, which is 11% of the total water consumption across all sectors. The ever-growing industrial demand for water is being covered by uncontrolled and unsustainable drilling of artesian wells, whereas the connected industrial establishment to the public water grid consumed volume is billed every three months (quarterly billing) at the rate of 1,200 LBP/m^3. According to the previous wastewater Strategy, the industrial sector in Lebanon produced in 2010 around 60 MCM of wastewater (UNDP et.al., 2020). Only 8% of the wastewater is treated and the rest is being directly discharged into water bodies without prior treatment.

Today the current economic crisis in Lebanon is seen as a two-edged sword in terms of productivity of the industrial sector. The demand for local products has increased given that their market prices are lower than imported products and they are less impacted by the fluctuating exchange rates; yet, the cost of energy and fuel crisis is affecting the supply side and jeopardizing the productivity of the industrial activity. In other terms, the current situation will depend on how public authorities might intervene to alleviate the current economic challenges, and the aftermath will then determine the impacts of the industrial sector on the water demand and wastewater discharge.

5.3.6 *Culture and Touristic Activities*

Lebanon's tourism sector has always been an important contributor to the local economy, representing a major source of income and employment. According to the Tourism Sector in Lebanon 2019 Factbook (IDAL, 2019), the direct contribution of travel and tourism to GDP reached USD 3.8 Billion in 2018, accounting for 7% of Lebanon's GDP, whereas the capital investments in the sector amounted to USD 1.3 billion (10.5% of total investments). The tourism sector generated around 144,300 direct jobs in 2018, and 394,399 jobs in total including indirect/induced jobs.

The tourist arrivals reached 1.9 million by the end of 2018 which was reflected in the average occupancy rate that reached 64% in Beirut hotels and 43% across Lebanon, due to lower occupancy in hotels outside Beirut (around 20-30%) (IDAL, 2019).

As for the cultural heritage importance, Lebanon has a wide range of cultural tourism choices, including 5 United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage sites. During the summer season, Lebanon hosts over 15 International music and entertainment festivals (i.e., Baalbeck and Byblos International Festivals – featuring local and world-acclaimed artists) (IDAL, 2019).

Lebanon has access to 225 km of the Mediterranean coastline; its beaches and favorable summer weather make it a perfect destination for "sun and beach" gateways. However, the lack of coastal tourism management and an integrated wastewater management plan has led to a decrease in bathing water quality across the Lebanese coastal beaches. Based on the survey conducted by the National

Center for Marine Sciences (NCMS) to evaluate bathing water quality and identify coastal sources of pollution; the bacterial contamination at 31 beaches for the years 2019 and 2020 was assessed. The results show high bacteriological contamination (from untreated wastewater and/or the presence of dumpsites) in selected locations. The assessment also reported the detection of chemical pollution at three beaches, namely Herri, Selaata, and Antelias.

Besides summer beach destinations, Lebanon hosts 6 ski resorts that attract local and international visitors during the winter season. Lebanon has 198 hotels with a capacity of around 12,300 rooms concentrated in the capital. The food and beverage sector is mainly dependent on tourists, the diaspora and the local population (IDAL, 2019).

With the current financial and economic situation, as well as travel restrictions from the COVID-19 pandemic, many Lebanese who traditionally holidayed abroad over the summer are now turning to domestic tourism. The latter has been seen as the more practical option because of travel restrictions, the dollars trapped in banks and a lack of functioning credit cards. Resorts in the main coastal cities of Batroun and Byblos, restaurants, pubs and rooftop bars are buzzing again, and some mountain guesthouses and boutique hotels are attracting a large number of local tourists (The Arab Weekly, 2021).

Nevertheless, the touristic sector in Lebanon is highly unstable and impacted by exogenous factors such as the Covid pandemic confinements, national insecurities, and economic crisis. The latter has drastically reduced the activity of this sector, including domestic and international tourism. However, the touristic and cultural activities in Lebanon remain one of the main driving pressures on the current water resources in the country. The latest available data indicated that water demand for the touristic sector reached 6 MCM in 2010 (MoEW, 2012).

5.3.7 *Investments in the Water and Wastewater Sector*

The total value (capital investment) of contracts implemented by CDR in the water sector in Lebanon from 2013 to 2021 reached around USD 1.24 billion, according to the annual progress reports published by CDR (CDR, 2022). The total contracts in all sectors amounted to USD 20.54 billion. Hence, the total investment in the water sector is only 6% of the total capital invested in all sectors.

The value of water supply contracts awarded between 2013 and 2021 amounted to USD 727.37 million, (59% of the total water and wastewater sectors), and wastewater contracts amounted to USD 514.23 million (41% of the total water and wastewater sectors). Foreign Funding was provided for 68% of the total investment in the water and wastewater sector (Table 39).

Table 39. Total CDR Contracts Value in the Water and Wastewater Sectors During 2013-2021 (Source: CDR, 2022)

	CDR Contracts from 2013 till 2021		Completed Contracts	Ongoing Contracts	
Basic Services	Value (USD)	Foreign Funds (USD)	Value (USD)	Value (USD)	Progress
Water Supply	727,370,908	548,404,517	218,803,817	508,567,091	49.79%
Wastewater	514,232,599	297,008,592	132,923,010	381,309,549	58.41%
Total Water and Wastewater Sectors	**1,241,603,467**	**845,413,109**	**351,726,828**	**889,876,640**	**54.10%**

As shown in Table 39, only 28.32% of previous projects have been completed, summing to USD 351.73 million of the total value of the investments in the water sector between years 2013 and 2021.

Given the prevailing political situation and economic and financial crises, the Lebanese Government has limited capacity to mobilize future required funds for capital investment purposes, including investments in the water sector, as Lebanon is facing an overall budget deficit. The future of the CEDRE capital investment plan, which proposes several water and wastewater sector projects, is pending until the government is able to implement the required reforms and reach an agreement with the International Monetary Fund (IMF).

5.3.7.1 Absorptive Capacity

For years, public capital investment, as a percentage of GDP, has been an insignificant proportion of total investment as compared to private capital investment.

As indicated in Section 3.3, the Updated NWSS-MoEW (2020) estimates an investment value of USD 8.04 billion until 2035 for the proposed projects listed in the strategy; this is almost seven-fold the total investment cost in the water sector from 2013 till 2021 (MoEW, 2020). Lebanon ranks among the top 5 countries of the world with the highest capital investment per capita on water, sanitation and hygiene (WASH) (Statica, 2019) with an average spend of 152 USD/capita/year. This value is higher than other developing countries in the world such as Hungary (119 USD/capita/year), Argentina (85 USD/capita/year), Jordan (55 USD/capita/year)[11], Tunisia (17 USD/capita/year) and lower than the Netherlands (307 USD/capita/year) and Trinidad and Tobago (301 USD/capita/year) (UN Water & WHO, 2019). It is noteworthy to highlight that although Lebanon has a lower expenditure rate per

[11] Value for 2018

capita on WASH infrastructure than the Netherlands, the total WASH expenditure as a percentage of GDP and per capita in Lebanon (1.7%) is much higher than those of the Netherlands (around 0.7%), Hungary (0.8%) and Argentina (0.6%). This implies Lebanon relatively spends on the water, sanitation and hygiene above its productivity level per capita.

5.3.8 *Land Expropriations*

Water and wastewater infrastructure projects in Lebanon require the acquisition of land area for the development of the project. The lands are mainly expropriated as part of the investment cost of the project from landowners. According to the reports published by the CDR, the total value of expropriation contracts in the water sector from 2010 to 2021 is estimated at around USD 226.27 million. Hence, the average annual investment in expropriations in the water sector is around USD 20.57 million which is equivalent to 15% of the annual investment costs spent in the water sector, as indicated in Table 40.

Table 40. List of Expropriations for the Water Sector (Source: CDR, 2021)

	Total Expropriation Contracts (2010-2021)
Wastewater	USD 7,839,035
Water Supply	USD 218,435,040
Total Water Sector	**USD 226,274,075**

Large infrastructure projects like dams make up the largest share of the total expropriation contracts given that they stretch over large areas. For example, the controversial project of Bisri Dam resulted in the expropriation of a total land area of 570 ha for a total resettlement cost of USD 170 million. These figures reflect the heavy environmental, social, and economic burden that the proposed dams can entail with varying impacts based on the dam reservoir capacity and land requirements.

6 STAKEHOLDER ENGAGEMENT AND CONSULTATION ACTIVITIES

In compliance with SESA Decree 8213/2012, ECODIT conducted an extensive stakeholder consultation process, through focused consultation meetings and public consultation meetings (refer to Section 2.3). The purpose of these consultations is to (1) gain key insights and opinions on the water sector in Lebanon and the Updated NWSS-MoEW (2020) (2) enhance strategic recommendations, and (3) solicit feedback on SESA outcomes.

This Section compiles all information gathered from the stakeholder engagement process conducted as part of the SESA study, which started November 2021.

Stakeholders fall under following categories (refer to Figure 3):

1. Central Administrations: including Ministries, RWEs and the LRA.
2. International Development and Funding Agencies
3. Research and Academia
4. NGOs and International Non-Governmental Organizations (INGOs)
5. Local authorities: including Municipalities and Union of Municipalities.
6. Media
7. Judicial body
8. Members of Parliament
9. Wastewater and Water Operators
10. Water users, including: farmers, industrialist, and citizens.

During the focused consultation meetings, the SESA team asked questions that were specific to each stakeholder category and that guided the discussions. In the meetings, the SESA team introduced the SESA study, its objectives, and provided a brief summary of the Updated NWSS-MoEW (2020). The discussions were kept open, flexible and dynamic with the aim of achieving a transparent dialogue. The following questions formed the basis of stakeholder discussions:

1. What are the top three challenges facing the water sector in Lebanon?
2. What should be the main objective of the Updated NWSS-MoEW (2020)?
3. What are the main ongoing projects in Lebanon that have direct impacts on the water sector?
4. How do you view the coordination between different actors in the water sector?
5. Do you think the environmental management initiatives in the strategy address the challenges and needs associated with the successful wastewater & sludge, and water quality management?
6. What are other national strategies that should be in line with the Updated NWSS?
7. What are the non-conventional sources of water that might have potential in Lebanon?
8. Do you believe the proposed initiatives in the Updated NWSS-MoEW (2020) will achieve objectives it sets out?
9. Do you have sufficient access to information related to the water sector?
10. What do you think about the restructuring of tariff rates?

11. What role should the civil society play in the management of the water sector?
12. Do you think there are alternative measures to achieve the objectives of the Updated NWSS-MoEW (2020)?

Annex 10.2 contains a summary table of stakeholder feedback. The following Sections provide an overview of feedback from Phase 1 stakeholder meetings.

6.1 General Stakeholder Feedback on the Water Sector

Stakeholders consulted in the focused consultation meetings outlined several common issues impeding the water sector in Lebanon. This section summarized the common issues raised by the different categories of stakeholders.

- RWEs and LRA are facing difficulties fulfilling their mandated responsibilities, they identified the following main challenges:
  - Lack of coordination between water sector authorities, including: MoEW, Ministries, funding and implementing agencies, and CDR.
  - Illegal tapping of networks and wells and the presence of technical losses in the system (NRW).
  - Lack of human resources (particularly engineers and management staff) needed to implement the amended water code (Law 192/2020) and fulfill their organizational decrees and provide the necessary water and wastewater services. The current legislative framework prevents RWEs from hiring permanent staff and the current wages are too low to hire the necessary expertise.
  - Presence of a poor controlled wells licensing mechanism. Well licenses are being granted haphazardly, resulting in the overexploitation of groundwater resources with the absence of monitoring and control of water pumped form wells.
  - As a result of the economic and financial crises, RWEs and LRA have entered a 'crisis mode'. Associated challenges amplifying existing difficulties with water service provision are primarily: (1) energy costs are very high and diesel is not readily available, and (2) operators are no longer applying to tenders due to the fluctuating value of the LBP, (3) key staff leaving the WE's for better paying opportunities, mainly abroad. LRA is also no longer able to collect hydrological data across the whole Lebanese territory.
- International development and funding agencies have stated that the water sector is generally poorly managed. More specifically, they identified the following key water sector challenges:
  - Lack of law enforcement (i.e., presence of illegal connections and the lack of collection of fees). This is affecting billing and service and the implementation of the tariff.
  - Lack of financial sustainability: The current financial /commercial framework is unsustainable and does not cover operation costs due to the current tariff structure. Moreover, the sector lacks a cost recovery model/financial recovery plan.
  - Economic and financial crises: The low RWE and LRA salaries are resulting in staff absenteeism and thus affecting their performance. RWEs are also focusing on emergency

response, which is halting development and affecting the future sustainability of the sector.
- Absence of sludge management planning: there are no regulations or standards on the reuse of sludge or plan for sludge disposal.
- Coordination in the water sector has improved over the years since the publication of the NWSS-MoEW (2012), mainly between donor agencies and water authorities, and between donor agencies themselves. However, there still exists insufficient coordination between all water sector actors. Given the above challenges, the involvement of international development and funding agencies in the water sector is focused on the following:
  - o Rehabilitation and upgrade of existing infrastructure;
  - o Interventions that reduce operation and maintenance costs of water and wastewater systems;
  - o Emergency response: maintenance and operation of facilities;
  - o Supporting in the implementation of water sector governance reforms.

- Experts from academic and research institutions also stated that there is an ineffective water management structure, and provided the following concerns regarding the water sector:
  - Climate change forecasts suggest that there will be a drastic change in water availability.
  - Lack of water sector monitoring: there is an absence of continuous data on surface water, groundwater, and wastewater quantity and quality.
  - Poor urban planning: this presents a challenge for identifying suitable locations for wastewater treatment plants and sludge disposal.
  - Absence of integrated water resources management in the sector
- Civil society, including NGOs and INGOs and local authorities stated the following common concerns:
  - The current centralized water sector institutional framework is ineffective and inflexible: water authorities are unable to provide the required services and fulfill their mandated responsibilities, yet, some Municipalities have the resources to carry out RWE responsibilities but cannot implement them as it is not under their mandate.
  - There is an absence of coordination and communication within the water sector, in particular between: (1) MoEW, the RWEs and LRA, (2) MoEW and other Ministries (MoI, MoA, MoF, MoE, and others), (3) RWEs and local authorities, and (4) water authorities and civil society/citizens. This has resulted in a lack of centralized decision making and the duplication of projects.
  - Water sector data is scattered, incomplete and unreliable: members of civil society, local authorities, and citizens are finding it difficult to access raw data and studies in the water sector due to long bureaucratic processes and a lack of data sharing.
  - Lack of monitoring over private water suppliers, particularly with respect to water quality.
  - Poor water quality: pollution loads on surface water and groundwater resources are affecting water availability.
- NGOs and INGOs highlighted the need to prioritize the following: (1) the rehabilitation of existing damaged infrastructure over the construction of new facilities, systems, and mega projects (2) the need to protect existing water sources by improving water quality, (3) demand management to increase efficiency on both a household and network level, and (4) Implement

the Lebanese access to information law (Law 28/2017) which obliges state administrations to publish financial and administrative data and permits citizens to request data from the state. The latter is necessary as one of the reasons for polarized public views towards water sector projects and which is a result of misinformation in the water sector. The majority of civil society stakeholders were not aware of the Updated NWSS-MoEW (2020); NGOs, INGOs, and media stakeholders stated that civil society representatives should ideally have a role in decision-making. They should be involved in early stages of discussions revolving around the water sector and review new policies and plans. The implementation of the aforementioned initiatives is reportedly a key step towards regaining citizens' trust in the water sector. Lastly, civil society members stressed the need to decentralize current water sector management, whereby local authorities carry out water services.

- Water users, including farmers and industrialists, stated that there is a complete absence of support from water authorities. Farmers voiced concerns that they are not being provided with water services or assistance with finding alternative water sources for irrigation. Farmers with private wells are burdened with the high costs of operation, due to the inflated prices of fuel; around 15% of their cost is now directed towards paying fuel. Farmers without access to water resources, especially in Akkar, are being denied well licenses, and as such, are having to resort to polluted surface water sources. Industrialists are experiencing similar difficulties; they are also relying on private wells for potable water due to the absence of the required water and wastewater infrastructure in industrial areas. As a result, water is a limiting factor in agricultural and industrial production and is reducing theses sectors' competitiveness as compared to neighboring countries.
- When asked about the tariff rate, there was a general consensus amongst NGOs, local water authorities, and water users that citizens are willing to accept an increased tariff rate, so long as water services are sufficiently provided in return or transparency regarding where the money from the tariff increase is going. Industrialists recommended the implementation of a separate subsidized tariff for the industrial sector to mitigate water-related challenges.
- Local authorities interviewed stated that they are ready to support with operating facilities and implementing projects, as many municipalities and unions of municipalities are already providing water to citizens within their respective jurisdictions, and law enforcement at the municipality level is more effective.

6.2 General Stakeholder Feedback on the Updated NWSS-MoEW (2020)

Stakeholders consulted in the focused consultation meetings provided diverse feedback regarding the Updated NWSS-MoEW (2020). Common technical concerns regarding the strategy were that it did not clearly tackle environmental components, particularly those related to the management of the wastewater sector and protection of resources. Out of the three strategy pillars, stakeholders tended to prioritize "Pillar 1: Implementing Reforms and Improving Sector Governance". Nevertheless, there was a common consensus that the three pillars of the strategy should be implemented in parallel, with focus on water resources management (data collection and storage, water demand management, and the protection of water resources) and institutional water sector reforms.

Considering that the Updated NWSS-MoEW (2020) was drafted during the challenging COVID-19 time, ministries, some of the RWEs, local authorities, and other stakeholders complained that they weren't involved in the strategy preparation.

- International development and funding agencies provided the following feedback regarding the Updated NWSS-MoEW (2020):
  - The strategy goals and objectives are not specific; it lacks higher-level strategic objectives.
  - Expansion of infrastructure projects should not be an immediate priority; cost recovery should be tackled before looking at infrastructure projects.
  - The strategy lacks a clear financing mechanism.
  - The water demand management strategy is not clearly defined.
  - The mismanagement of the wastewater sector is not well-tackled, including sludge management and standards for wastewater reuse.
- Central administrations and international development and funding agencies expressed that although the strategy should recognize the changes in the water sector since the start of the economic and financial crises in 2019, it should not lose sight of the long-term objectives and sector development. Given that the underlying challenges in the sector are the same, an emergency action plan developed should contain short-term actions that complement the strategy. International development and funding agencies also recommend that the strategy should focus on reforms that ensure the sustainability of proposed projects and accordingly, entail an adaptable cost recovery plan.
- Academia and research institutions provided the following feedback:
  - Absence of holistic approach for the development of the water sector: the strategy was not integrated with other Ministerial strategies or and does not interlink the different economic sectors of development.
  - IWRM is not integrated into the strategy approach; the strategy mainly focuses on projects and there is an absence of time management and interlinkages of water resources.
  - Climate change in the strategy is not explicit; particularly the effect of climate change on the seasonal distribution of rainfall and change in snow cover. The impacts of climate change on water availability should be quantified.
- Members of civil society noted gaps in the Updated NWSS-MoEW (2020) regarding the contribution/involvement of the youth in the water sector and advised on the following:
  - Given the presence of chronic youth un-employment, the Strategy should encourage student participation in the Updated NWSS-MoEW (2020) implementation. The water sector presents many work opportunities for young graduates in STEM fields that can contribute towards realizing the Strategy objectives.
- Despite an overall positive response regarding the proposed initiatives under Pillars 1 and 2 of the strategy, civil society stakeholders, including NGOs, INGOs, and water users are not optimistic that these initiatives will be implemented and have concerns that proposed infrastructure projects in the strategy will be prioritized over them. They prioritized the need for (1) implementing water governance reforms and (2) the protection of existing water resources, over other strategy initiatives. NGOs and INGOs also voiced the importance of aligning the strategy with other Ministerial strategies, and the translation of climate change

effects into measures. Several NGOs and INGOs stated that the strategy should focus on surface water supply, particularly through less-intrusive rainwater harvesting methods. They also reiterated that civil society should be informed and engaged throughout the strategy implementation process to increase transparency with the public. According to farmers, the strategy should prioritize the rehabilitation and maintenance of existing irrigation channels and combatting surface water pollution, which is preventing farmers from using surface water for irrigation purposes. Farmers and industrialists also voiced that the strategy should entail measures to support them with meeting their water needs.

7 ASSESSMENT OF POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS RESULTING FROM THE UPDATED NWSS-MOEW (2020)

This Chapter assesses potential impacts of the Updated NWSS-MoEW (2020) on the natural, and socio-economic environment. It is by no means an exhaustive list of impacts considering several were deemed to be localized and therefore better addressed at the project EIA level. The analysis of these impacts was based on a preliminary list of key SESA themes identified during the scoping phase, which are considered nationally and/or globally important, and are therefore major areas of concern. The preliminary list of SEA key issues was augmented and refined during the SESA analysis phase to produce eight key SESA Themes (previously described in Section 2.4). Annex 9.1 lists the SESA key themes with their associated objectives – based on national and global plans, policies, and goals – to which the Updated NWSS-MoEW (2020) will be benchmarked.

The Sections below describe the impacts of the Updated NWSS-MoEW (2020) on the Specific and Cross-Cutting Key Themes.

7.1 Specific Key Themes

7.1.1 *Water Conservation and Management*

Water conservation and management encompass the policies, strategies and activities made to manage water as a sustainable resource, and meet current and future demands. This section examines the extent to which the Updated NWSS-MoEW (2020) promotes water conservation through the adopted water resources management approach, treated wastewater effluent and sludge reuse, and improved water quality.

7.1.1.1 Sustainable Resources Allocation

The first step in sustainable water resources management is the establishment of water balances at the national/ regional/ watershed levels to estimate available water resources.

The annual average water balance in the Updated NWSS-MoEW (2020) considers the annual water resources available in Lebanon at 4,225 MCM (as compared to 2,700 MCM in the NWSS-MoEW (2012)), with 3,525 MCM from surface water and 700 MCM from groundwater (Figure 11). Furthermore, the Updated NWSS-MoEW (2020) also cited the available sources of potable and irrigation water which are mainly surface resources with a yearly average yield of 1,475 MCM/year from rivers, and an estimated total withdrawal of 2,750 MCM/year from groundwater (wells and springs).

The discrepancy between the numbers in the updated strategy versus the older one is to be noted. Hence, the absence of a well-founded water balance raises the question as to what extent the current water resources management in the country, and more specifically the proposed allocation of water to meet water demand, is preserving the sustainability of these available resources. The Updated NWSS-MoEW (2020) acknowledged these data limitations, especially regarding real evapotranspiration estimations, groundwater resources leaving Lebanon, and snow cover contribution, and considered the installation of new meteorological and hydrometric stations across Lebanon and the establishment of an IHIS a priority.

In terms of resource allocation, the Updated NWSS-MoEW (2020) states that surface storage is considered a strategic priority for the MoEW. It considers the construction of surface storage facilities as the first choice to compensate for water supply needs, provided it is financially, technically, and environmentally feasible. The Updated NWSS-MoEW (2020) further emphasizes that it is a strategic decision to keep groundwater resources as a strategic reserve for the future and use it only in areas where surface storage is not possible or is insufficient to cover the growing needs. The Updated NWSS-MoEW (2020) utilized existing data on surface and groundwater resources, while acknowledging its limitations, to calculate potable water balances for each distribution scheme throughout the Lebanese territory, allocate water by source, and propose water infrastructure projects to meet the deficits. The deficits between the water supplied and the water needs by RWE for the years 2020 and 2035, as calculated in the Updated NWSS-MoEW (2020), were projected to increase from 87.75 MCM/year in 2020 to 159.21 MCM/year in 2035 under the do-nothing scenario. These deficits were presented in the strategy at the level of water distribution systems in the various districts, justifying the proposed water source development projects, including rehabilitation projects, as well as new wells, reservoirs, or surface storage so that each distribution system evens out its own water balance deficit.

This detailed water balance study conducted at the water district level, led to reducing the number of proposed dams from 30 (in the NWSS-MoEW (2012)) down to 14. A total of 192 groundwater wells were proposed across Lebanon, with more than half being under the jurisdiction of the NLWE, especially Akkar, to meet the water deficit where there are no surface sources available. A summary of the proposed dams is presented in Table 7 in Section 3.3.3. Despite being well detailed, the water balances and proposed projects are not well optimized as they were built without adequate quantification of the available resources and demands; the first due to incomplete hydrometric metering coverage and the second due to the lack of supply networks metering and accurate population census.

With several dams mentioned previously in the NWSS-MoEW (2012) already completed or under construction (Qaissamani, Msailha, Boqaata, Janneh) but not yet in operation, several environmental and social effects of dams can now be confirmed and revised as lessons learnt for the rest of the planned dams in the Updated NWSS-MoEW (2020). These include:

- Dams will affect the water resources management at the river basin scale and at the national level and will impact water supply and availability. Planned dams and hill-lakes are expected to supply much-needed water to households, farmers and the economic sectors.
- Dams and impoundments are land greedy and will require extensive and expensive expropriations. Some dams will inundate forests and/or riparian ecosystems as well as rare species. Dams may potentially encroach on protected areas and sites.

- Dams have substantial effects on the hydrologic regime of affected rivers, both upstream, and more extensively downstream from the impoundment; therefore, it is crucial to address the environmental flow that would sustain the ecosystems in the river or streams downstream. The impact on hydrology is site-specific and will depend on local geology, fault lines, topography, and reservoir permeability.
- Dams will affect the underground water by inhibiting the natural replenishment of aquifers including caves. Conversely, reservoir leakage can help maintain water flows in springs located downstream.
- Dams and impoundments will require extensive excavation and will significantly alter landforms and landscapes.
- Dams will create man-made water bodies that require buffers zones and management.

The dams' programs must be reviewed and potentially framed and implemented to minimize their cumulative impact on Lebanon's ecology and natural heritage. Lebanon's dam experience to date provides invaluable learning opportunities. This knowledge should be harnessed to benefit the planning, investigation, design, construction, and operation of future dams.

As for groundwater as a resource, the MoEW estimates that the current total public (350 MCM/year) and private (640 MCM) withdrawal from the aquifers is around 990 MCM/year and recommended that the maximum allowable withdrawal should not exceed 500 MCM/year. This implies that current groundwater extraction rates are unsustainable as per the MoEW outlook. In fact, several studies have shown a drop in groundwater levels in inland aquifers, and saltwater intrusion in coastal aquifers (UNDP et al., 2020) because of this over-exploitation. Nevertheless, as mentioned above, the Updated NWSS-MoEW (2020) is still proposing to rely on 192 groundwater wells across Lebanon to provide an estimated additional 297 MCM/year. This may adversely impact sustainable groundwater use. However, it was difficult to assess the impacts of the proposed infrastructure projects on groundwater as the Updated NWSS-MoEW (2020) did not present (1) from which aquifers the withdrawals are anticipated, and (2) whether their impact on the already stressed groundwater aquifers was considered.

The Updated NWSS-MoEW (2020) presents the challenges related to sound groundwater management, particularly regarding poor data availability and proposes strategic recommendations for groundwater resources management. This includes establishing and staffing a Project Management Unit (PMU) to recommission the database center, follow up on geological, hydrogeological and water resources studies, refreshing and completing the detailed geologic mapping of Lebanon, exploring new potential deep aquifers, enhancing artificial recharge of some selected aquifers, enhancing the vulnerability studies in relation with the springs and the definition of their protection perimeters, refreshing the water budgeting of all aquifers progressively, performing gradually the modelling of the karstic, saline and porous aquifers, etc. While these recommendations are essential for better-informed management of the sector, the Updated NWSS-MoEW (2020) does not propose initiatives addressing the issue of uncontrolled groundwater extraction from private wells (20,537 licensed and the 55,000-60,000 illegal), which is estimated to be almost double that from public sources. It only mentions improving the licensing procedures for drilling and operating private wells, which would apply to new wells.

7.1.1.2 Efficient Water Use

With the absence of reliable primary data on water consumption generated from water meters, water demand data inputted into the detailed water balance was estimated based on assumptions related to population, per capita domestic and non-domestic water consumption, network efficiency, total irrigated area, and irrigation consumption. In the Updated NWSS-MoEW (2020), the term "water demand" was replaced with "water needs" and the strategy forecasts that the "water needs" will remain flat between 2020 and 2035, only increasing with population growth. Domestic water needs were estimated at 125 L/capita/day, and the non-domestic consumption (industrial and tourism) at 20% of the domestic needs (i.e., an additional 25 L/capita/day). Physical losses from the system were assumed to be 50 L/capita/day. As such, the total "water need" per capita, including industrial demands and network losses, was considered to be 200 L/capita/day. Revising down potable water demand will have a positive impact on resource exploitation and efficient water use, although it is not based on primary data. The estimation of demand across the various economic sectors (agricultural/ industrial/ tourism) does not seem to consider current and expected future sector productivity and the economic value derived from the productive uses of the available water, nor the plans and strategies of the concerned ministries for the development of their respective sectors at the national or district level, and consequently their projected water needs. The Updated NWSS-MoEW (2020) seems to be more focused on meeting domestic demand and achieving SDG 6.1 i.e., universal and equitable access to safe and affordable drinking water for all.

Unlike the industrial and tourism sector demands, the agricultural sector demand was considered separately. The Updated NWSS-MoEW-MoEW (2020) estimated the total irrigated areas at 100,000 ha with an average annual water requirement of 8,435 m^3/ha. It indicated that the irrigation sector also suffers from insufficient water resources, as currently, only 75% of the water demand (630 MCM/year of 842 MCM/year) is sustained for the irrigation of 105,000 ha; half of the available water is provided from surface water sources. Note that total irrigated areas were estimated at 112,000 ha in 2010 by the MoA and the FAO (MoA & FAO, 2010). Irrigation water demand was projected to increase to 927 MCM/year for 138,000 ha in 2035. However, these numbers do not take into account the strategy of the MoA and its corresponding water needs. The Updated NWSS-MoEW-MoEW (2020) mentions several initiatives to increase water availability including:

- Rainwater harvesting in hill lakes and small dams.
- Rehabilitating and modernizing existing irrigation infrastructure to reduce water losses and improve water efficiency
- Developing irrigation modernization plans through the gradual conversion of open channel systems into pressurized piped system; whenever topographical conditions allow for pump free, pressurized system development.
- Accelerating wastewater treatment strategies up to irrigation acceptable standards and in conjunction with crops selection adoption criteria.

- Performing detailed study for each existing irrigation scheme to assess in detail the existing condition all irrigation scheme components, and identify, select, quantify, and price all necessary actions and works needed to upgrade and modernize the selected scheme.

The proposed irrigation initiatives to increase irrigation water availability focus on water demand management rather than water supply augmentation, which will have a positive impact on water resources use, especially since the agricultural demand represents a significant proportion of the total water demand, and contributes a mere 3% to the GDP (MoA, 2020). However, while most initiatives (infrastructure rehabilitation and development) were clearly defined and priced, wastewater treatment reuse remains an abstract concept and is not linked to any tangible action (refer to Section 7.1.1.5).

7.1.1.3 Water Demand Management

As evident in Volume IV, the main focus of the Updated NWSS-MoEW (2020) is water supply augmentation. The Updated NWSS-MoEW (2020) was keen on meeting the increasing water demand of the growing population by proposing the exploitation of new water supplies. However, the experience in water scarce regions recommends that meeting the challenge of water shortage requires both a supply management strategy, involving highly selective development and exploitation of new water supplies (conventional and non-conventional) coupled with a vigorous demand management involving comprehensive reforms and actions to optimize the use of existing supplies. The appropriate mix of supply and demand management may vary depending on the level of development, the governance structure, and the degree of water scarcity in each country. However, as economies grow and the value of water increases, the benefits from and necessity for efficient demand management increase significantly (Thivet & Fernandez, 2012). Water Demand Management (WDM) is explained as part of IWRM, emphasizing the equitable, efficient and sustainable use of the finite water resources.

The WDM initiatives in the Updated NWSS-MoEW (2020) were mostly related to improving irrigation efficiency – as mentioned earlier – and consider water loss appurtenances as an integral part of the newly proposed supply and distribution infrastructure. Existing NRW was not actively addressed in the NWSS, although it is estimated at 40-50%. Reducing water losses (= reducing non-revenue water) in domestic water supply schemes was limited to investing in and improving infrastructure and revising tariffication. Yet, maximum gains in efficiency are only achieved when they are combined with better management practices. These include investing in water loss reduction systems (active leak detection, pressure management, etc.), strengthening regular maintenance programs, matching water supply to demand, encouraging recycling and reuse, etc. Such initiatives need to be proposed, budgeted and pegged to a timeline in the Updated NWSS-MoEW (2020).

Finally, ecosystem water demands were not considered in the Updated NWSS-MoEW (2020). Although this demand is difficult to quantify, some countries have already legislated to enforce minimum stream-flows in watercourses for sustaining wetlands, ecosystems, and wildlife habitats. Commonly, however, this demand for the environment is omitted from the water balance sheets. It tends to be treated as a limit on the exploitation of resources. However, maintaining minimum stream-flows also meets requirements to manage pollution by enhancing the self-purifying or dilution capacity of aquatic systems. It is recommended to commission studies to define the ecosystem water demand, or environmental flow of the major water bodies that are planned to undergo alterations as part of the strategy, to ensure that river, the "ecosystems and the human cultures, economies, livelihoods and well-being that depend on these ecosystems" are considered and preserved.

7.1.1.4 Non-Conventional Water Sources

Three non-conventional methods were elaborated in the Updated NWSS-MoEW (2020):

- Aquifer recharge either artificial or natural is the main alternative resource clearly described in the Updated NWSS-MoEW (2020). Due to climate change impact on water resources, aquifer recharge is a promising mitigation and adaptation measure that Lebanon can rely on to augment water resources for use during drought seasons, especially from early snowmelt. Aquifer recharge can also remediate saltwater intrusion in coastal aquifers especially due to overexploitation in urban areas. However, the main concern with aquifer recharge is the quality of the injected water and the risk of polluting the groundwater aquifer if it is not adequately monitored and controlled. Another issue is the energy required to pump the injected water out for use. The Updated NWSS-MoEW (2020) proposes the implementation of Artificial Aquifer Recharge at 3 sites (Berdaouni, Mejdlaya-Abou Ali, and Damour) and the assessment of the feasibility at 3 other sites (2 in Akkar and 1 in Hadath-Hazmieh aquifer) in the next 15 years.
- Rainwater harvesting is suggested to increase surface water resources through infrastructure like hill lakes, dams and ponds with the main purpose of irrigation. The Updated NWSS-MoEW (2020) proposed a rainwater harvesting program at the national scale, to be implemented as priority 1, which will be elaborated on separately. The program shall determine the harvesting methods and potential implementation sites.
- Treating wastewater effluents from existing and planned WWTPs was suggested for water conservation and reuse in irrigation and groundwater recharge. However, the focus of the strategy was on the absence of standards (Refer to Section 7.1.1.5).

Despite that these alternative resources were mentioned, the Updated NWSS-MoEW (2020) (1) did not set targets to pursue the development of non-conventional water resources for the period 2020-2035, (2) it did not incorporate the expected volumes of water within the national water balance as a production component, and (3) missed to discuss the needed volumes to be produced, for which use, in which location, and how are they going to be integrated with the proposed infrastructure projects, except for AAR which was subject to separate studies.

7.1.1.5 Reuse of Treated Wastewater and Sludge

<u>Treated Sewage Effluent</u>

The Treated Sewage Effluent (TSE) expected to be discharged from the planned 182 WWTPs and from the existing ones presents a good potential for increasing water availability, particularly during the dry season. In the NWSS-MoEW (2012), the MoEW set a target to increase the reuse of treated wastewater from 0% in 2010 to 20% in 2015 and then to 50% by 2020. The strategy estimated that up to 150 MCM/year of treated wastewater could be used for irrigation by 2020, while another 100 MCM could be used for AAR (UNDP et al., 2020). Unfortunately, these goals were never realized. The Updated NWSS-MoEW (2020) acknowledged this potential in irrigation, managed aquifer recharge, and industry, but shied away from setting targets, and limited its commitment to issuing an implementation decree for the Water Code on the reuse of treated wastewater and pushing for the adoption of standards and guidelines for wastewater reuse, using the FAO Lebanese Wastewater Reuse Guidelines as a starting point. Its recommendation for wastewater reuse remained high level, stating that "water conservation by reuse, aquifer recharge, or industrial reuse of treated effluent should be practiced where it is cost-effective and water resources are otherwise inadequate. Irrigation of agricultural lands by wastewater should be promoted provided that water quality is monitored and health standards are maintained".

It is recommended that MoEW adopts a proactive role in promoting TSE reuse. The agricultural sector water demand is expected to reach 58 percent of total water demand in 2030, with net irrigation demands reaching 1,050 MCM/year (UNDP et al., 2020). According to the Updated NWSS-MoEW (2020), should the proposed projects be implemented, the irrigation water demand in 2035 is expected to reach 53%. Accordingly, TSE reuse directly in irrigation or indirectly through AAR need to be studied as an important source of water within the national water balance. Wastewater reuse can help mitigate the current practice of using raw sewage for irrigation in some areas as well as reduce the stress on groundwater. The Updated NWSS-MoEW (2020) mentions the Rewater MENA project, implemented by the International Water Management Institute, which involves a national baseline assessment on reuse potential. It also aims to update and validate the reuse quality standards in association with the LIBNOR committee and to implement two local reuse plans. However, effort in this respect should not stop here. The MoEW and CDR should require that the planned WWTPs, particularly those in rural/ agricultural areas or in areas with significant water deficits, be reassessed in terms of the feasibility of TSE reuse and be redesigned accordingly, taking environmental costs and benefits into account. The MoE can also have a role in requiring an assessment of the potential of wastewater reuse in the WWTP EIA. It is not recommended to wait until all WWTPs are designed and constructed and then explore how to reuse the treated wastewater, but to rather optimize the design of the planned WWTPs in terms of location, treatment level, and adequate storage of the TSE, to promote its reuse. This should be coupled with stringent effluent quality control and monitoring conditions.

Sludge Management

Sludge is an inevitable by-product that will be generated by the proposed WWTPs, which will require proper treatment and disposal. The advancements in wastewater treatment technologies led to improved quality of wastewater effluent but considerably increased the quantities of sludge generated (Rorat et al., 2019). Based on the number of proposed WWTPs in the Updated NWSS-MoEW (2020) and those already existing and under construction, the total national capacity of treated wastewater for the year 2035 is estimated at 690.945 MCM/year. Thus, the expected amount of sludge generated (dry solids) is an estimated 171,822 tonnes/year[12]. As mentioned in Section 5.1.1, currently Lebanon faces several challenges in sludge management, due to the absence of national standards and monitoring systems.

The composition of sludge is highly variable, depending on several factors including the season, the wastewater treatment technology, the quality of the wastewater influent, etc. However, on average, dewatered sludge from domestic wastewater contains 50%–70% organic matter, 30%–50% mineral components, 3.4%–4.0% Nitrogen, 0.5%–2.5% Phosphorus, and significant amounts of other nutrients, including micronutrients (Rorat et al., 2019).

Due to its high nutrients and organic content, dried sludge is useful as a fertilizer in agricultural applications or as an organic amendment in the remediation of contaminated sites. The application of sewage sludge to agricultural lands has various benefits including the recycling of plant nutrients such as Phosphorus and Nitrogen and is an effective replacement for chemical fertilizers. However, sludge can also be a source of soil contamination due to the presence of organic and inorganic pollutants and pathogens, potentially toxic contaminants such as heavy metals (zinc, copper, cadmium, lead, silver, etc.), polycyclic aromatic hydrocarbons, polychlorobiphenyls, biocides, pharmaceuticals, personal care products, microplastics, and microorganisms (Rorat et al., 2019). Also, there are various types of microorganisms that could be present in sludge such as, viruses, bacteria, parasites, and fungi, which may be pathogenic and disrupt natural ecosystems during land applications (Fijalkowski et al., 2017), if the sludge is not treated and stabilized adequately.

There are several methods for the treatment and disposal of sludge generated from WWTPs; each with certain environmental repercussions. The most common environmental risks associated with application of sludge stabilized by aerobic digestion in land application include (1) atmospheric pollution such as ammonia and nitrous oxide emissions; (2) nutrient pollution due to excess nitrogen and phosphorous; and (3) biological and chemical soil contamination (Rorat et al., 2019).

The composting of sludge, although considered to be highly beneficial and cost-effective method of treatment, can also lead to high losses in nitrogen and release of greenhouse gas emissions. In addition, studies highlighted concerns with potentially toxic metal elements, chemical compounds, and some pathogens that can survive the composting process and cause soil pollution during land application (Fang et al., 2017; Rorat et al., 2019).

Alternatively, the disposal of sludge in landfills exacerbate the existing solid waste management problem in Lebanon. Landfilling of waste can lead to the release of toxins, generate high amounts of leachate and release greenhouse gases such as Methane and CO_2, which are the main contributors of

[12] Assuming the WWTPs are operating at their respective design capacities and wastewater treated is Municipal wastewater, and every 3.78 m^3 of Municipal wastewater produces 0.94 kg of dry solids (NRC, 1996).

climate change (Vaverková, 2019). Landfills can also lead to soil and groundwater contamination, if not properly constructed and operated (Vaverková, 2019).

According to personal communications with AFD, sludge management constitutes the second highest O&M costs (followed by energy costs), which is burdening the sustainable operations of existing WWTPs and affecting cost recovery.

Therefore, it is recommended to:

- Issue national standards for sludge recovery and reuse in agricultural applications to restrict its use under unfavorable conditions that may lead to pollution.
- Establish a monitoring system for the generation, treatment, and management of sludge generated from WWTPs in Lebanon to minimize the adverse environmental impacts of sludge.
- Enhance collaboration between relevant stakeholders. As discussed in Section 4, the MoE has a Solid Waste Management Draft Strategy that includes sludge management as one of its components. However, the Solid Waste Management Draft Strategy didn't account for the forecasted sludge to be generated after the establishment and operation of the proposed 181 WWTPs. MoEW should coordinate and collaborate with the MoE to ensure the sustainable management of sludge generated from the existing and proposed WWTPs.
- Ensure that sludge management is addressed in the planning and design phase of the proposed WWTPs. Provisions should be made to reduce the quantities of sludge generated and ensure that a sludge management unit is integrated in the design.
- Explore opportunities for regional collaboration on sludge management between different WWTPs. It should be one of the criteria for the site selection of the proposed WWTPs.

7.1.1.6 Water Quality

The open discharge of untreated wastewater continues to degrade water quality and thus compromise both the state of the environment and human health. Wastewater management is an important pillar of the Updated NWSS-MoEW (2020). Currently, eleven new WWTPs are under construction and are expected to treat 130,000 m^3/day. The MoEW is proposing the construction of an additional 182 WWTPs across the country, with a total additional treatment capacity of around 1,196,875 m^3/day (Figure 28). If all plants are constructed and operated, then the total national capacity will reach 690.3945 MCM/year, which is more than twice the estimated wastewater generation rate in the country in 2010 (310 MCM/year) (UNDP et al., 2020). This additional capacity will ensure that these plants can handle the projected growth in volumes during their projected service years.

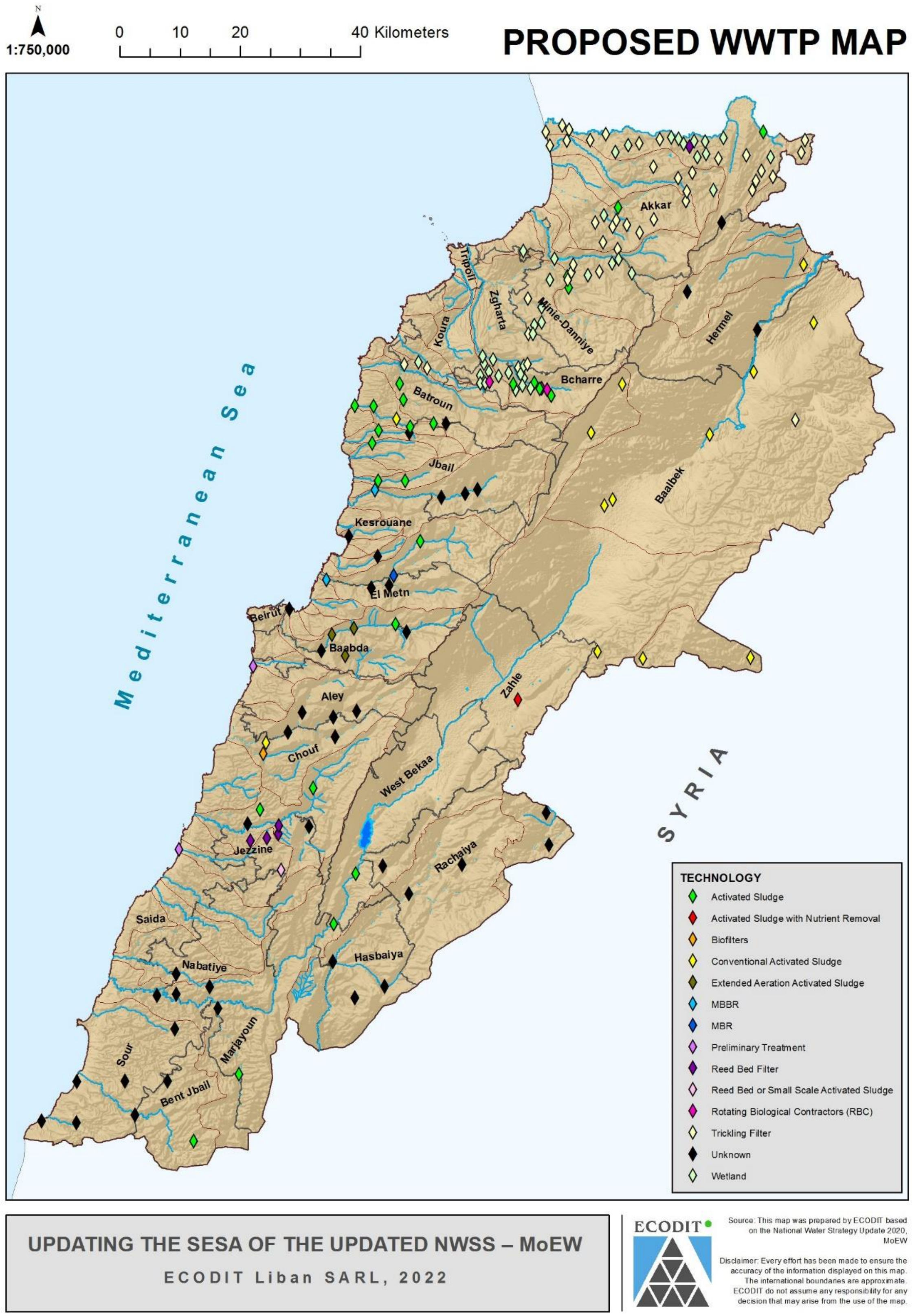


Figure 28. Existing and Proposed WWTPs (Sorted by Type of Technology)

Design and construction of WWTPs

Wastewater collection, treatment and disposal will have significant impacts on both the natural environment and public health. Inland WWTPs will help reduce surface and groundwater pollution and coastal WWTPs will also reduce land-based sources of pollution into the Mediterranean Sea. If all WWTPs are successfully implemented and adequately operated, as envisaged in the Updated NWSS-MoEW (2020), this means that 100% of the generated domestic wastewater will be treated. As most of the WWTPs are expected to achieve secondary treatment, this will result in an 85% reduction in the BOD load into the environment. This will be a major step for Lebanon in complying with the Barcelona Convention for the protection of the Marine Environment and Coastal Region of the Mediterranean. It will also allow Lebanon to achieve SDG 6.2, "by 2030, achieve access to adequate and equitable sanitation and hygiene for all" and partially achieve SDG 6.3, "by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally".

Improved quality of coastal water and rivers and lakes will stimulate the tourism industry and related economies. The wastewater program therefore will affect many key strategic areas including ecology, underground water, treated sewage effluent and sludge reuse, operation and maintenance, and the marine environment.

However, the wastewater sector has been facing several issues delaying the full operation of the constructed wastewater treatment plants and hindering the intended treatment of the generated wastewater. For example, as of 2018, out of eight medium to large WWTPs constructed along the Lebanese coast (EBRD, 2018), namely three in Tripoli, Chekka, and Batroun localities within North Lebanon Governorate, three in Jbeil, Ghadir and Nabi Younes-Jiyyeh localities within Mount Lebanon Governorate, and two others in Saida and Sour localities within South Lebanon Governorate, one is not operational yet (Jbeil) and three conduct only preliminary treatment (Ghadir, Saida and Tripoli), with Tripoli WWTP being designed for secondary treatment unlike the ones in Ghadir and Saida. Many of these WWTPs were completed before the completion of the sewage networks connected to them and were left cocooning for several years (Sour, Jbeil and Tripoli) and/ or were operated at low capacity and not as per the designed treatment level (Tripoli) (UNICEF, 2016). Similarly, for medium-scale inland treatment plants, several are still either non-operational or partially operational (EBRD, 2018; UNICEF, 2016). Hence, the true indicator for pollution reduction from domestic wastewater is not the number of WWTPs that are constructed or planned to be constructed but the number of WWTPs that are operational, and the volume of wastewater treated up to a secondary level, and hence the actual quality of the treated effluent discharged into the environment. Accordingly, it is recommended to prioritize the adequate operation of the constructed treatment plants and to abstain from the construction of additional treatment plants if the networks connecting to them are not complete and if their long-term operation and maintenance is not sorted out. It is important to mention that the cocooning of many treatment plants and their operation at subpar capacities has important cost implications on the GoL, hence this should be avoided. For instance, the design and construction costs of the Sour WWTP (55,000 m^3/day capacity) amounted to around USD 26 million. After completion of the construction, the Sour WWTP cocooned for 7 years for a total cost of USD 2.625 million (375,000 USD/ year) and an additional USD 460,000 as rehabilitation cost before being finally put into operation (Personal communication with Dr. Charafeddine, CDR). Hence, this delay for one WWTP cost the GoL an additional 3 million USD.

Furthermore, to ensure that wastewater treatment is achieving the desired improvement to the natural environment and public health, adequate control measures should be in place for the discharge of the TSE. International practice stipulates that TSE discharged into water courses or bodies should meet two conditions: (1) quality criteria and (2) the right balance between the volume of TSE discharged and the volume of the receiving water. If the WWTPs are operating to a level that produces the TSE to the right quality, the TSE can be discharged into water courses or bodies, provided the volume of receiving water is at the appropriate level. This volume of receiving water and TSE is determined on a case-by-case basis. Accordingly, the following actions are recommended with regards to TSE being released into Lebanon's water courses or bodies:

(1) TSE meet the minimum acceptable quality criteria set by international best practice or provided by Lebanese law and regulations (MoE Decision 8/1 of 2001). WWTPs Environmental Management Plans set daily sampling of TSE to monitor quality. MoE and MoEW must enforce it on the RWEs or WWTP operators.
(2) MoEW and MoE should verify the conditions of the receiving water to ascertain if it is in a state to receive the volume of TSE to be discharged. This could be part of the EIA for the WWTP in question.
(3) Holding tanks should be considered in WWTPs to hold untreated sewage in case of operations shutdown or malfunction. Raw sewage bypasses should be approved by MoE and MoEW as part of the EIA process and should be addressed within the Emergency Response Plan of the facility.
(4) Water courses containing TSE should be sampled immediately upstream of lakes or dams (baseline) to ensure the quality criteria for the lake or dam in question are being met downstream. Again, MoE and MoEW should be empowered to enforce the RWE to conduct this sampling. Furthermore, this should be part of the Environmental Management Plan for both the WWTP discharging the WWTP or dams or lakes receiving the water.
(5) An appropriate buffer zone be established for inland WWTPs either through MoEW/MoE/Directorate General of Urban Planning (DGUP) regulations or through the WWTP EIA process to ensure that no seepage of contaminated material during construction or untreated sewage seepage from any of the WWTP tank structures is allowed into nearby water bodies.

Operation and Maintenance of WWTPs

Currently, most treatment plants are operated by private operators through service contracts that are managed either by CDR or the concerned municipalities. Few operational WWTPs are managed by the RWEs, also through service contracts with private operators. Although wastewater management services, including the operation and maintenance of WWTPs, are mandated to the RWEs as per Law 221/2000, the current organizational chart of the RWEs has no wastewater department and the staffing plan defined by the organizational decrees does not include these services. Accordingly, they have no dedicated qualified staff to perform the needed tasks. Furthermore, when they outsource some of their tasks to private operators, they lack an efficient and effective contracting framework and internal technical skills to properly supervise them. Lastly, the absence of a wastewater tariff scheme and the associated lack of an efficient cost recovery system at the WWTPs hinder the provision of the appropriate skilled personnel, human capacity, as well as equipment and other operating costs. These challenges are acknowledged in the Updated NWSS-MoEW (2020), which lists several actions in this respect, as part of a priority and short-term action plan including:

- Revise and update all RWE organizational and operating decrees to (1) grant RWEs the freedom to develop the most appropriate service management model and to develop their organizational charts in line with their evolving needs, (2) simplify the recruitment process and enhance recruitment outside the public service procedures; (3) define guidelines for procurement management and the management of performance-based contracts and raise expenditure and procurement validation thresholds.
- Conduct a customer and user census.
- Revise the tariff structure for sanitation services. Introduce wastewater fee proportionally to the water consumed and define a specific wastewater fee for households that are not subscribing to the RWEs.
- Improve operating cost control by reducing the energy bill.
- Enhance private sector involvement by reviewing existing contracts with private operators and developing a new contracting framework and performance-based contracts.
- Adopt a shared wastewater management framework including financial arrangements for O&M in coordination with RWEs, MoEW, CDR, donors, and partners.

The aforementioned actions are very much needed to ensure the adequate management of the sector and subsequently, true compliance with the Barcelona Convention and the achievement of SDG 6.2 and 6.3. While the Updated NWSS-MoEW (2020) gives these actions high priority, it is well known that governance-related initiatives have a high tendency of being politicized in Lebanon and hence might take a longer time and a political will to be achieved. For example, the need to ratify the Water Code was raised in the NWSS-MoEW (2012). However, it was not until 2018 that it was promulgated under Law 77, and it is believed that it was adopted hastily, with the political will to accommodate the holding of CEDRE conference. Law 77/2018 was later amended and issued as Law 192/2020. Accordingly, it is recommended to not only treat the governance-related initiatives as high priority, but to set the infrastructure initiatives, particularly the construction of WWTPs to be contingent on achieving some progress on the governance end and successfully operating the existing WWTPs.

7.1.1.7 Governance

Volume II of the Updated NWSS-MoEW (2020) detailed the gaps and challenges faced by the sector at the institutional level and highlighted the need for legal and institutional strengthening to ensure better management of the water and wastewater sectors. The strategy identified various actions at the water governance level, to be completed within the first five years of strategy implementation.

The timely implementation of these actions is expected to promote sustainability and IWRM through, (1) the Water Code executive bylaws that emphasize integrated water resources management and the management of water resources at the catchment level (2) institutional building at the MoEW to enhance its monitoring and supervisory roles (3) restructuring and capacity building at the level of the Water Establishments to enhance their capability in performing the services assigned to them by Law 221 and Law 192. Furthermore, the proposed actions related to tariffication (water user census, consumption-based tariffs for water services, tariff structure for sanitation), as well as enhancing the operation and maintenance of water and wastewater facilities (reducing energy costs, reviewing contracts with private operators, etc.) will help ensure the sustainability of present and future initiatives. However, the main concern with the governance measures is the timeliness of their implementation as they can be highly influenced and significantly delayed by political bickering, as has been the case for the past 20 years. One example is the issue of RWE staff recruitment, which is imperative for their proper functioning, but the no-recruitment policy of successive governments halted the integration of new skilled personnel. Hence, linking the implementation schedule of infrastructure projects to that of Water Sector Governance is imperative.

7.1.2 *Biodiversity and Ecosystems*

The Updated NWSS-MoEW (2020), through its intervention, should promote the conservation and protection of biodiversity and ecosystems, helping Lebanon achieve its national and international commitments and obligations (*See Section 4.4.2*). These include:

- Achieving SDG 6.6: Protect and restore water-related ecosystems.
- Meeting the obligations of the multilateral environmental agreements related to biodiversity and ecosystems, namely:
    - AEWA – Law 412/2002
    - Convention on wetlands of international importance, especially as Waterfowl habitat (RAMSAR) – Law 23/1999
    - CBD – Law 360/1994
- Alignment with the national targets in Lebanon’s National Biodiversity Strategy Action Plan (2016-2030) which addresses Lebanon’s obligations under the CBD and aims to protect and conserve ecosystems and habitats in order to respond to anthropogenic and natural pressures.

Infrastructure projects, if not sustainably planned and managed, may cause the loss of entire ecospheres, including endangered and undiscovered species. Although Lebanon now has 18 Protected Areas (PAs) covering 2.8% of the territory, these don’t represent all possible ecosystems and habitats in the country. Many unique ecosystems (i.e., juniper forests and karst ecosystems) remain unrepresented in the present network of PAs and without any form of regulatory protection. If not scientifically assessed and managed, infrastructure projects may therefore cause the irreversible loss of rare and/or endemic species of national and/or international importance.

This Section focuses primarily on the effects of dams, reservoirs, hill lakes and ponds on ecology and natural ecosystems.

7.1.2.1 Impacts of Dams

Dams and their associated reservoirs impact flora and fauna by:

- Changing river flows and hence water temperature and natural conditions. This affects some species, such as sturgeon (*Acipenser sturio*) that is native in Lebanon and hinders the development of fish larvae. For example, the sturgeon fish is currently classified as a critically endangered species due to: (1) the use of its eggs for caviar and (2) the deterioration of its continental habitat because of gravel extraction from riverbeds. Elsewhere in France and Spain, the damming of the Dordogne and Garonne Rivers resulted in a reduction in the number of available spawning sites and in changes of the water conditions surrounding the eggs and young. The species requires conservation in accordance with the CBD. As such, the design volume of water released from the proposed dam and the timing of release into the rivers should consider the water conditions required for local/native fish and create a hostile environment for invasive fish.

- Blocking movement of migratory water bird species (i.e., White throated water Dipper bird of Lebanon that swims under river water) up and down rivers. Impoundments can also block altitudinal migration of mammals (e.g., Otter), and many species of fish, namely those breeding in the rivers and spending the remaining life cycle in the sea (anadromous fish, like sturgeon), or breeding in the sea to spend the other parts of life cycle in the rivers (catadromous fish, like eels in Lebanese rivers).
- Reducing the presence of anadromous fish in the sea due to the impact of dams on their breeding habitats (rivers). This will ultimately impact sea fishery; high costs are associated with the transport of this fish downstream. Consider designing passageways through and along the side of the dams, to allow fish and aquatic animals to move upstream and downstream unobstructed (Figure 29).

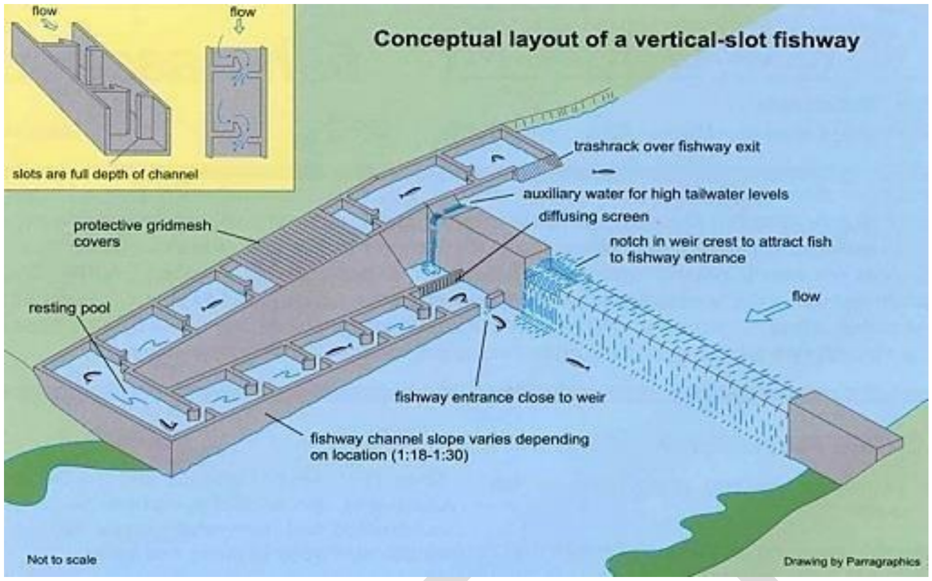


Figure 29. Pool Type Fish Ladder (Source: Ravichandran et. al., 2016)

- Changing turbidity/sediment levels to which species and ecosystems are adapted. Trapping silt in reservoirs deprives downstream deltas and estuaries of maintenance materials and nutrients that help make them productive ecosystems. In Lebanon several bird species of waders (stilts, plovers, stints, sandpipers, shanks, lapwings, snipes, curlews, whimbrels, egrets, bitterns, herons, etc.) that frequent river outfalls may be affected and subsequently desert the impacted area. The potentially affected species in Lebanon include: Marbled Duck (*Marmaronetta angustirostris*), Common Pochard *(Aythya ferina)*, Velvet Scoter *(Melanitta fusca)*, Horned Grebe (*Podiceps auratus)* and Black-legged Kittiwake *(Rissa tridactyla)*. These species are globally threatened and ranked as 'Vulnerable' by IUCN and BirdLife International, and protected by the CBD, Convention of Migratory Species (CMS), AEWA, Convention of Barcelona for the Protection of the Mediterranean Sea, and Ramsar Convention.

To mitigate the effects of changing turbidity/sediment levels, the following considerations can be adopted, among many others:

- Install an aeration system in the deepest part of the lake near the dam wall to cause mixing and thus prevent the development of a pool of anoxic water in the bottom of the lake.
- Install sediment control measures (i.e., scour valve at the base of the dam) that will enable periodic removal of accumulating sediment.
- Use an appropriate or specific water quality model to allow prediction of water quality in the newly filled lake and the probable changes in water quality over the next few years as the lake establishes an equilibrium state and the organic matter left in the lake when it was filled decomposes.
- Consider operational options such as flushing, sluicing, dredging, and hydro-suctioning to reduce sediment deposit in the artificial lake.
- Ensure that water released from the reservoir comes from all levels of the reservoir, rather than just the bottom (which is the coldest and has the lowest dissolved oxygen).

Flood plains provide vital habitat to diverse river biota during high-water periods in many river basins. This is the case of the Assi River, where the flooded sides are used by the Whiskered Tern species as a breeding ground (Ramadan-Jaradi et al., 1999). Dam management that diminishes or stops normal river flooding of these plains will impact biodiversity. Regular and natural high and low river causes flooded sides of the river to host many insectivorous aquatic species. In Lebanon, the floods beyond the Qaraoun Lake are artificially created but not during the seasons which birds breed. This deprives many bird species from the appropriate nesting habitats and from the adequate food. It is recommended to maintain scheduled downstream floods between late April and late May to provide the appropriate breeding habitat which offers protection and plenty of food to various species of birds and herptiles.

- The importance of riparian habitat to wildlife in general and birds in particular is a well-documented phenomenon. Studies show that riparian habitats contain up to 10 times as many migrant passerines (songbirds) per hectare compared to adjacent, non-riparian habitats. The occupation of the riparian vegetation by an impoundment and a dam could result in a loss of 63 bird species that breed in that area in Lebanon (Ramadan-Jaradi et al., 2008; 2015; 2019; 2020). The riparian habitat acts as a fire barrier and regulates water flow and sedimentation; it plays several roles in maintaining and conserving ecosystem functioning. Accordingly, the following threats can impact riparian areas: dams' construction and modes of functions, resulting pollution, and groundwater pumping.
- Modifying water quality and flow patterns downstream. In Lebanon, the post-dam portion of Litani River has lower richness in birds than the pre-dam portion (Ramadan-Jaradi, 2013). In addition, the Kingfisher bird that uses its beak and feet to excavate nesting tunnel in wet walls of the river's sides loses this ability when the water level is low during breeding season. Similarly, normal passing ways of territorial animals are hindered since the dam works as a barrier. Meanwhile, the upstream fish movement is prevented and thus fish population decreases significantly (Stott & Smith, 2001). Subsequently, all fish-eating bird species (piscivorous) like kingfishers are fewer in number downstream compared to upstream (Ramadan-Jaradi, 2013).
- Songbirds breeding in riparian habitats within valleys where hydroelectric power generation regulates water levels may suffer increased nest mortality or reduced survival if rising water levels flood active nests or reduce food availability (Green & Quinlan, 2008) or destroy riverbanks and their associated vegetation, forcing species like Lesser Whitethroat, Graceful Warbler, Cetti's Warbler, Mustached warbler, Marsh Warbler, etc., to desert the area. For hydro-electric power generation, it is recommended to install turbines in streams and rivers to generate electricity without disturbing the water flow.
- Some impoundments are built with steep slopes. This prohibits shore birds from landing and feeding on what is rejected by the water body surface to the edges. Some birds may land due to thirst in hot summer times but can also drown due to the slippery steep slopes. In this case, the constructed slopes are considered a deadly trap to birds.
- Large water bodies attract several species of waterfowl for resting, feeding, and roosting; especially duck species that agglomerate in the center of the water surface area to protect

themselves away from enemies and human beings. In Lebanon, this phenomenon is observed in many water bodies ranging from small agricultural ponds to high dams with large impoundments.

- Fish can be damaged while passing throughout the floodgates, turbines, and pumps of the high bodied dams. The floodgates can also block the passage of fish and create low-oxygen zones in which certain non-native species can survive. To facilitate the passage of fish, the following is recommended:
  - Integrate gentle-sloped channels.
  - Cage turbines and pumps.
  - Ensure that dissolved oxygen in all floodgate sites does not subceed the minimum standard for protection of aquatic life.
  - Reduce the impact of floodgate modifications on water quality in acid sulphate soil terrains through acid neutralization.
- In dry season, dams contribute to the increased salinity of the coastal area at and near the estuaries, depriving the river mouths from nutrients that are necessary to many species of brackish and saltwater. Downstream habitats up to estuaries are severely impacted by changes in salinity and oxygen levels. Due to the high rate of evaporation and growth of aquatic vegetation within the reservoir itself, water that travels downstream from a dam usually has a higher salinity content and a lower oxygen concentration than normal. The salinity due to the growth of aquatic flora can be mitigated by uprooting 50% of the plants once a year in the summer (i.e. after the end of the waterbird breeding season).

Potential Encroachment on Protected Sites and Important Bird Areas (IBAs)

Lebanon has many PAs including nature reserves (enacted by parliament), Biosphere Reserves (UNESCO), protected sites (MoE and Ministry of Tourism), and protected forests (MoA). Some of these sites may be affected and/or inundated by proposed dams and hill lakes. As revealed in **Error! Reference source not found.**, the proposed Maaser El Chouf dam may be located in the Chouf Biosphere Reserve (UNESCO-MAB Programme). Consequently, it is recommended to review the legal instruments of the Reserve before any action is taken; the vegetation at the location of the dam is limited to a riparian area and will be impacted. The same case is for Azzounieh Dam (See *Section 7.1.2.4* for associated impacts).

Inundation will inevitably destroy plants and displace animals, including undiscovered species. Lebanon's valleys are steep and often inaccessible which increases the likelihood that not all species have been identified and inventoried. The only way to verify the presence of new species and/or important species such as endemics and threatened species is to physically inspect and survey the valleys before project implementation, and during different seasons. This is supported by the Lebanon Law of Environment (444) which imposes EIA reports for any project in or near protected areas.

Strategically, inundation can impact the ecological heritage value of natural sites by:

- Land modification.
- Fragmentation or destruction of habitats.
- Loss of rare or endangered endemic specie.
- Stress on already stressed ecosystems causing irreversible damage.

- Breach in ecological connectivity.
- Impacts on migratory birds.

Accordingly, the project design maps of any proposed water, wastewater, or irrigation infrastructure projects, including networks, should be overlayed on a map of protected areas, reserves, and IBAs in their respective EIAs. Alternatives should be proposed for projects encroaching on protected areas or sites and the design should be revised accordingly.

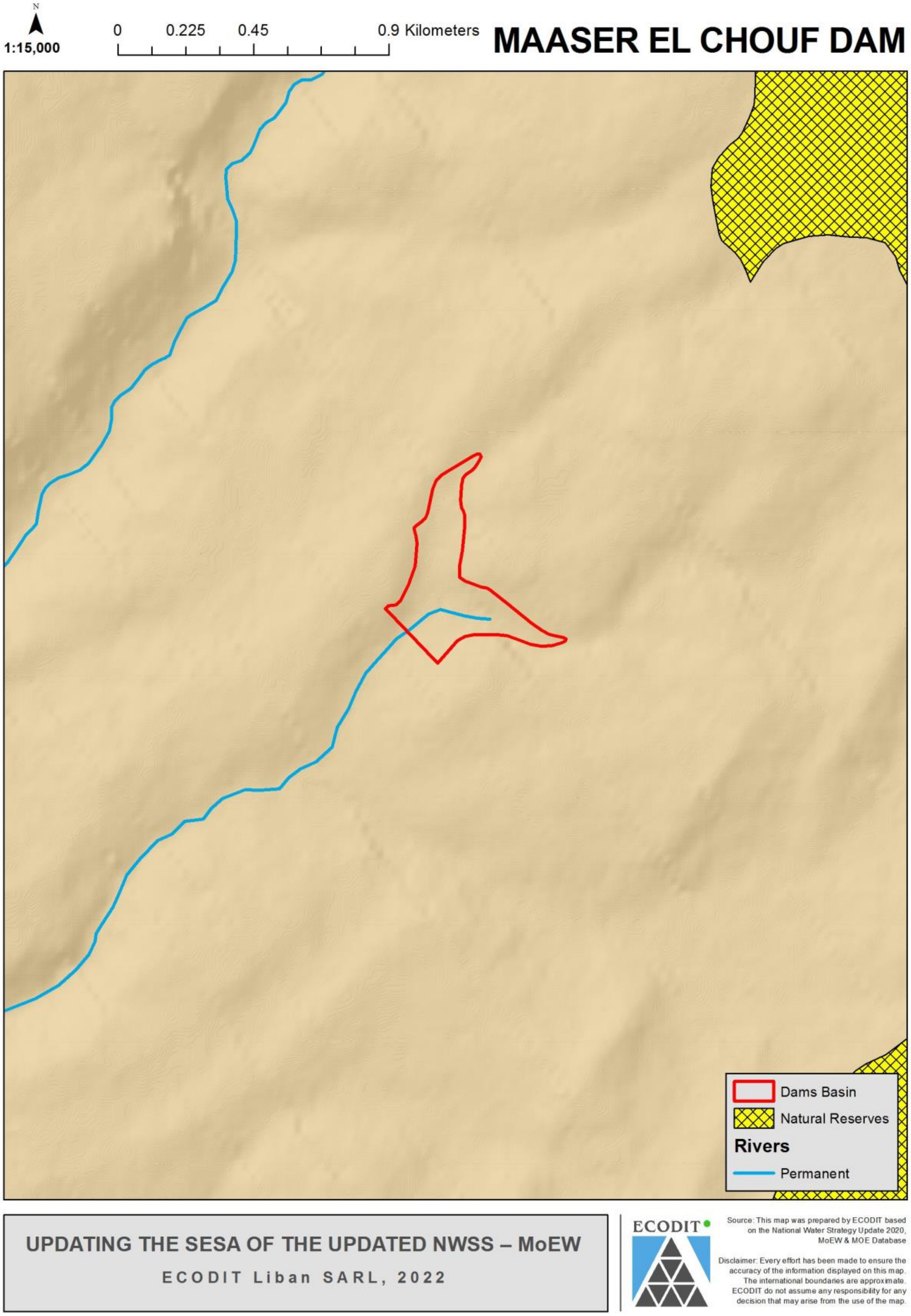


Figure 30. Map of Maaser El Shouf Proximity to Arz El Chouf Nature Reserve and Chouf Biosphere Reserve

Potential Inundation of Forests

Several dams will inundate forests especially dams located on river systems. Inundation will transform the land cover from a forested valley to an open man-made water body.

Besides Maaser El Chouf, Younine, Azzounieh, and Massa dams, eight dams (Noura El Tahta, El Bared, Dar Baachtar, Damour, Kfarsir, Khardali, Assi I-II and Ibl El Saqi) are located within the Thermo-Mediterranean (<700m ASL) scrub zone (Eunice Habitat Classification). All the rivers are bordered by riparian vegetation within this Thermo-Mediterranean zone; it is typically abundant in *Pistacia lentiscus*, *Myrtus communis*, *Styrax officinalis*, *Calicotome villosa*, *Sarcopoterium spinosum,* mixed with batha and degraded garrigue of oak *Quercus spp*. trees. After damming, many species of high dynamic rates as well as many trees of specialists of dry forests will die, but some typical species of riparian forests will enhance forest richness in deciduous forests. In general, the deciduous forest communities may change to a typical riparian forest, but many seasonal specialist species will maintain the seasonal traits – such as dispersion by wind and deciduousness in the forests – where an entire transformation does not occur. These impacts of damming and consequent changes cannot provide the same functions as a riparian forest. Subsequently, a potential remedy-mitigation is to create two narrow effluents on the sides of the dam and its impoundment ('Femur-Tibia ligaments model'), bordered by the same specialist species of the previously existing main riparian habitat.

Azzounieh and Maaser dams are both located in the meso-Mediterranean zone (700-1300m asl) where *Pistacia lentiscus,* wild *Olea europaea, Smilax aspera* grow. Poor sandy soils have few species with the Oak (*Quercus spp.*), *Juniperus drupacea, Daphne gnidium* and *Lonicera estrusca*; the maquis of oaks, and pine trees predominates. Massa and Younine dams – located within the same zone – differ from by nature of their surroundings: barren areas at the western feet of Anti-Lebanon. Consequently, there are Massa and Younine have fewer adverse impacts. Vegetation in Azzounieh is limited to the riparian area; mitigation of adverse impacts is possible by diverting part of the river flow to side streams (as with the Thermo-Mediterranean zone).

It is difficult to estimate the extent of forest damage without site specific baseline for each proposed project. However, recent experience shows that dam contractors have had to compensate for tree losses to the MoA Agriculture, as part of MoA's "alternative trees" policy. In brief, the MoA, prior to construction, inspects the site, assesses the number of trees that will be flooded, and then requests the contractor to supply young replacement trees equivalent to at least six times the number of trees lost or damaged.

Accordingly, MoA will determine the number and type of alternative trees including:

- Size of forest seedlings.
- Species (for landscaping or reforestation).
- Total number of replacement seedlings.
- Destination nursery for new forest seedlings.

The noticeable deficiencies in this "alternative trees" policy include:

- There is no control over the origin (and quality) of the forest seedlings delivered by the project contractor.
- Normally, the most common replacement seedlings are pine and cypress trees because those are readily available; the notion of riparian habitat restoration is absent.
- The replacement seedlings may not benefit the region that was affected by the project.
- Mortality during storage and transplanting can be high.
- Poor monitoring of the process.

7.1.2.2 Impacts of Hill Lakes and Ponds

The main impacts of hill lakes and ponds on biodiversity are summarized below:

- Hill lakes and ponds act as natural reservoirs to store water. In addition, ponds can also store rainwater, and this self-sustaining cycle of hydrations can be used to keep nearby plants and vegetation alive. Moreover, the creation of a hill lake or pond on a commercial site like a farm, also provides water for livestock.
- Hill lakes and ponds promote wildlife. The water features attract several species of birds, frogs, and insects, and provide a breeding ground for indigenous wildlife. The ecosystem is further sustained as algae and insects near the pond provide a food source for frogs and tadpoles. Even small-scale ponds can support beautiful fish, like Carp and Tilapia.
- Hill lakes and ponds rarely develop riparian areas because the borders of the water are either cemented or covered by plastic sheets, as such, lowering the attractiveness of birds.
- Most of the inclined walls of the small hill lakes and ponds are steep and slippery, causing the drowning of granivorous birds (which need to drink water on a daily basis), and mammals as well as reptiles.
- Hill lakes and ponds constructed on simply compacted or unstable soil may collapse and harm the surrounding local communities. This occurred in Akoura in 2015 whereby a poorly designed hill lake collapsed and caused damages to Apple orchards and to some houses (Figure 31).
- Hill lakes and ponds are useful in providing helicopters and fire trucks with water to extinguish forest fires (Figure 30). Dams provide similar services; however, the number and distribution of dams is much smaller compared to that of lakes and ponds.

Figure 31. Torrent of Mud Following the Explosion of One 50,000 m^3 Water Capacity Pond at Aqoura in 2015

Figure 32. A Helicopter Using Water from a Pond at Shouf Biosphere Reserve to Fight Forest Fires

7.1.2.3 Potential Impacts of Proposed WWTPs

As mentioned in Section 5.1.1.1, only 8% of the wastewater generated in Lebanon is being treated. The rest is being discharged in streams, rivers, valleys, and the sea, or used directly in irrigation. This creates major impacts on natural ecosystems. For example, Lebanon's fresh and marine water bodies are currently facing alarming pollution levels that are severely threatening native flora and fauna

(UNDP et al., 2020). The Updated NWSS-MoEW (2020) is proposing new WWTPs that, if implemented properly, will reduce the growing pressure on natural ecosystems caused by the haphazard discharge of untreated wastewater.

On the other hand, the proper site selection and design of the WWTPs are key to ensuring that any potential negative impacts on biodiversity are prevented and mitigated (if any). WWTPs should be sited away from sensitive areas (i.e., protected areas) to prevent any impacts on biodiversity. It is important to:

- Avoid damage to nearby sensitive areas, abstain from passing transport pipeline or mobile decanting units through the sensitive area and its buffer zone.
- Avoid transporting treated and untreated wastewater through sensitive areas and their buffer zones.
- Avoid flooding of decantation tanks after heavy or stormy rain as the flooded wastewater can run to the sensitive area and induce major impacts.
- Maintain the infrastructure of the WWTPs to prevent any leakage or discharge from impacting sensitive areas.
- Strictly prohibit the discharge of treated wastewater in water bodies within sensitive areas.

Each proposed WWTPs as part of the Updated NWSS-MoEW (2020) should be assessed separately as part of the EIA process to ensure the proper site selection of the facility and that all potential impacts are mitigated. However, it is worth mentioning that two of the proposed WWTPs, in Chakra and Froun, are located within Wadi Al Houjeir Nature Reserve. As part of the EIA process, project location alternatives need to be assessed. The minimum distance between the PAs and the proposed WWTPs should be at least 1,000 m.

7.1.3 *Climate Change Adaptation and Mitigation*

7.1.3.1 Climate Change Adaptation

Climate change has led to high intra- and inter-annual climate variability in Lebanon, leaving a high level of uncertainty regarding projected changes in water availability and water quality. It threatens the assumptions and predictions used as a basis for proposing projects in the water and wastewater sector.

Projected climate change impacts are numerous as discussed in Section 5.1.2, including a decrease in snow coverage, an increase in the frequency of hydrometeorological disasters (e.g. floods, landslides, droughts and forest fires), an increase in extreme weather events, and sea level rise. Moreover, according to our communications with the Climate Change Unit at MoE, although annual precipitation levels are relatively constant in Lebanon, the spatio-temporal precipitation patterns are varying significantly. Consequently, climate change is anticipated to have alarming impacts on the country's water resources. SWAT models conducted by Saade et,al. (2021) that simulate the impact of climate change on the streamflow of El Kalb river in Lebanon indicate that the average annual discharge of El Kalb river for the years 2021-2040 will decrease by around 28-29%. Moreover, Assessments of climate change impacts on springs discharge in Lebanon suggest that springs are sensitive to changes in precipitation, which is associated with longer dry periods and decreasing flow rates (Dubois et al., 2020; Doummar et al., 2018). Dubois et al. (2020) found that a decrease of rainfall by 10% to 30% annually will decrease flow rates by 34% and increase recessions by 1 month.

Below are some examples of the impacts of climate change on the proposed projects and water resources:

1. <u>Changes in Precipitation Levels</u>

   Changes in precipitation levels can impact the operation of existing and proposed infrastructure. For example, the capacity of impoundment projects, such as hill lakes and dams, is highly dependent on the volume and frequency of precipitation. However, the design of the infrastructural projects proposed in the Updated NWSS-MoEW (2020) is currently based on annual historical weather data.

   Frequent extreme precipitation events induced by climate change will increase the risk of floods, thus affecting the safety of impoundment projects and their operation and, in the case of dams, may cause damage in the spillway of the structures. An increase in extreme precipitation events and rainfall intensity presents risks for combined sewage network systems (wastewater and stormwater). High volumes of stormwater runoff may overload the combined networks leading to the breakage of pipes and outflow of wastewater into water sources, thus impacting water quality (Hughes et al., 2021).

   Extreme rainfall events can also lead to the flooding of drainage channels and adversely impact the operation of the proposed WWTPs. The design capacity of current and proposed WWTPs do not account for the resulting increased inflow of diluted wastewater. Diluted wastewater inflow reduces the BOD load and consequently impacts the treatment process efficiency in biological WWTPs. An example would be the existing Ablah and Ferzol activated sludge WWTPs; the systems are deactivating during the winter due to the uncontrolled inflow of stormwater following high precipitation events and require at least 5-7 days to reactivate. Frequent extreme precipitation events can also put proposed irrigation schemes at risk of flooding and liquefaction (UNDP, 2021).

2. <u>Temperature Variations</u>

   Continued increase in minimum and maximum temperatures is predicted to shrink snow cover and accelerate snow melt (Somma & Abou Chakra, 2018; Doummar et.al, 2018). Snow cover in Mountainous areas in Lebanon acts as a water reservoir for the dryer months of the year with Mount Lebanon and Anti-Lebanon in particular serving as major water reserves (Fayad, 2017). Snow melt replenishes coastal springs and aquifers, and feeds surface water storages such as artificial lakes, ponds, and dams. However, the predicted continued increase in temperature suggest that mid elevation regions (1200-2000 m above sea level) will progressively shift from snow dominated to rain dominated hydrologic regimes (Fayad, 2017). With the majority of

Lebanon's mountains in the medium elevation range, the country will lose its primary source of freshwater during the dry season. To compensate, water retention systems are required to maximize water collection and storage during the dry season.

3. <u>Increased Evapotranspiration</u>

   Increased evapotranspiration rates resulting from anticipated higher temperatures will reduce lake levels, reduce the volume of water stored in reservoirs as compared to anticipated design levels, and increase irrigation water demand. Overall, climate change can introduce a high level of uncertainty regarding changing flows within the life span of reservoirs and increase the risk of dam structural and operational failure (Jari, 2020).

4. <u>Sea Level Rise</u>

   Sea level in the along the Mediterranean coast is expected to increase by 7-12 cm by 2050 (Nader et. al., 2020). According to trends in long-term relative sea level changes, coastal areas in the Eastern Mediterranean region, particularly the Lebanese coastline, which extends over 220 km from The North (Arida) to the South (Ras Al-Naqoura), are most vulnerable to significant wave height and sea level rise, and thus submersion and beach erosion (Nader et. al., 2020). Given these impacts, it is recommended to account for technical measures during the design of dams that ensure a constant flow of sediments and nutrients into coastal areas to reduce the loss of beaches and maintain coastal populations (Nader et al., 2020).

   Sea level rise is also expected to decrease the hydraulic capacity of downstream sewage networks, which impacts the quality of the wastewater influent and thus the efficiency of coastal WWTPs. Rising downstream water levels due to sea level rise can also lead to higher energy demands than anticipated to pump the wastewater to the WWTPs. This will impact around 18 coastal WWTP (existing and proposed by the Updated NWSS-MoEW (2020)).

Climate change can influence the hydrologic processes of watersheds by adversely impacting river flow and groundwater recharge (Alameddine et. al., 2018). Climate change models on the Upper Litani river basin, for example, predict deficits consistently exceeding 200 MCM/year after 2050 and surpassing the basin's annual renewable resources (Alameddine et.al., 2018).

A national adaptation framework to implement measures to increase the resilience of existing water resources and infrastructural projects proposed by the Updated NWSS-MoEW (2020) in the face of climate change is critical. According to the UNDP report on "Climate-Proofing Lebanon's development plans" (2021), water and irrigation infrastructure projects in Lebanon's development plans (the CIP in particular) are not sufficiently climate change resilient and have high vulnerability scores. Climate proofing interventions also have economic benefits, with USD 3.2 delivered for every USD 1 invested in mitigation and adaptation improvements (UNDP, 2021). The Updated NWSS-MoEW (2020) proposes the following initiatives in alignment with the adaptation measures recommended in the assessment:

1. Increasing surface water storage (i.e., hill lakes) and artificial aquifer recharge,
2. Rehabilitation and upgrade of existing water resources,

3. Increasing wastewater collection and treatment, and
4. Improving water efficiency.

The following additional recommendations ought to be considered:

1. Choose construction materials for proposed water, wastewater, and irrigation infrastructure projects that are more resistant to extreme temperatures, precipitation and floods;
2. Assess potential climate impacts when rehabilitating/upgrading existing infrastructure;

Given the above, improving knowledge on climate change impacts on water resources, including data on precipitation levels and patterns, snowfall coverage, evapotranspiration, recharge rate, etc. is essential and should be used to make informed decision regarding project implementation and the design of infrastructural projects. To address data availability, the Updated NWSS-MoEW (2020) has suggested the implementation of the IHIS which aims to collect hydrological data to help make informed decisions about the water sector's needs and plans and can also help in setting the annual national water balance, monitor the availability of resources and demand and plan its annual budget ahead for early decision making.

In parallel, MoE can support with the implementation of the Updated NWSS-MoEW (2020), particularly with data management reforms such as drought and flood management plans, by providing MoEW with the following decision-making tools in the adaptation planning process:

1. Update regional/sub-regional climate change projections, including drought and flood projections.
2. Conduct regional/sub-regional climate change vulnerability assessments to identify most vulnerable areas and the greatest risk factors to habitats, systems, and natural resources.

The Third National Communication (TNC) to the UNFCCC re-affirms that a key measure towards climate change adaptation in Lebanon is the development of climate-based watershed management plans. However, despite the predicted impact of climate change on water resources, the Updated NWSS-MoEW (2020) does not consider climate change projections in the water balances for the proposed projects under Pillar 3. Nevertheless, the Updated NWSS-MoEW (2020) proposes the development of WEAP models to conduct water balances. Drawing from the Al Ostuan river basin IWRM study (see Box 5), it is recommended to conduct high resolution physical-based distributed water resources management models that assess the availability of water resources to integrate them into management plans and projects in the water sector. Accordingly, WEAP models that adopt an IWRM approach ought to:

1. Consider intra-annual (seasonal) changes in climate.
2. Consider intra-watershed climate variations and climate change projections.
3. Simulate combinations of proposed measures through different scenarios to evaluate their effectiveness and deduce optimal measures; this can be used to re-prioritize both macro and micro-level proposed projects in the Strategy.

Following the implementation of proposed measures, it is recommended to perform assessments of implemented measures based on monitored data following their implementation to evaluate their actual effectiveness and redesign or improve them if needed (Kossida & Tsoukalas, 2021).

Box 4. IWRM of the Al Ostuan River Basin Considering Future Climatic Scenarios

In 2021, ACTED published a report on 'Future scenarios of water availability and demand in the Al Ostuan River Basin, including the performance of different demand management measures' that investigates measures that aim to save water and thus reduce water demand in the Al Ostuan river basin. The study simulates potential response measures in a physical-based Distributed Water Resources Management Model (WRMM) to assess their effectiveness and impact prior to their implementation. Future climatic conditions were modelled using anySim and assume annual population increase and climate change based on stochastic simulation of the past 2003-2018 climatic variables (Nataf-based model).

Prior to the simulation of response measures, results of the climate change models suggest that the average annual unmet water demand in the Al-Ostuan river basin increases under all climatic scenarios of the 2019-2035 period to reach an average unmet demand of 20-27 MCM per year. The study simulated domestic/urban and agricultural response measures derived from the proposed projects in Volume V of the Updated NWSS-MoEW (2020).

The response measures were simulated in a WEAP21 model and compared with their CAPEX to determine the most effective combination of measures. Results suggest that the most optimal solutions require a mix of urban and agricultural water saving measures that can reach cumulative water savings of up to ~7 MCM/year. The solution that delivers the maximum reduction in unmet demand (30% reduction) is the combination of installing on-site rainwater harvesting systems, water saving fixtures and increasing the irrigation efficiency through converting to closed pipes and drip irrigation systems. The most expensive and sub-optimal solution is the combination of the installation of all water saving fixtures as well as implementing rainwater harvesting and a greywater reuse system in households, which resulted in a 9.4% reduction in total unmet demand. The cheapest solution, which involves only the installation of water saving fixtures, reduces unmet demand by around 3.2-4.3%.

In addition, water governance reforms under Pillar 1 of the Strategy should be part of the adaptation framework, as augmenting water storage without addressing governance issues will compound the challenges of the water sector in the face of climate change. Finally, and in anticipation of rising uncertainty due to climate change, it is recommended that the plans and projects of the Updated NWSS-MoEW (2020) remain flexible and adaptive to accommodate changes which may arise in the future, thus minimizing the risk and cost of maladaptation.

7.1.3.2 Climate Change Mitigation

Although Lebanon does not contribute significantly to global GHG emission, Lebanon has declared its intention to reduce GHG emissions by 20% by 2030 as an unconditional target and by 30% as a conditional target following the UNFCCC Conference of the Parties COP21 and as part of the new Paris Agreement. Therefore, a thorough assessment of the GHG contributions and savings expected from each proposed projects, particularly mega-projects, should be conducted and used to guide the decisions regarding implementation and prioritization.

The Updated NWSS-MoEW (2020) has proposed the construction of several WWTPs to improve the collection and treatment of wastewater and reduce associated environmental pollution. As mentioned in Section 5.1.2, the unregulated discharge of untreated wastewater is responsible for emitting 555 Gg of CO_2. However, the MoE Lebanon's Third National Communication to the UNFCCC report estimates that the waste and wastewater sector's emissions can be reduced by 32 to 38% by 2040. The latter can be accomplished by increasing the rate of wastewater collection and treatment and consequently reducing discharges in septic tanks and surface waters, in addition to introducing and increasing the rate of use of waste-to-energy technologies (MoE et al., 2016b). Moreover, the proposed projects involving the rehabilitation and upgrade of water networks will significantly decrease water lost as NRW and thus decrease the energy consumption needed to pump water to household and establishments, reducing associated GHG emissions.

On the other hand, the construction activities and resulting land-use changes or deforestation activities of the proposed infrastructural projects, including the WWTPs, WTPs, dams, hill lakes, and networks, will lead to an increase in GHG emissions and will require a significant energy demand to operate.

Once operational, man-made reservoirs contribute to CH_4, CO_2 and N_2O emissions. Studies have estimated that GHG emissions from reservoirs may vary between 873 to 2,733 g CO_2 eq./m^2/year depending on reservoir surface area, nature of the dam (powered vs. hydroelectrical dam), and climate zone (Song et al., 2018). A recent study based on data from 223 dams distributed globally, estimates the GHG emissions from the operation of dams to be around 1,076 Tg CO_2 eq./year (328 Tg CO_2 eq./year for CO_2 and 748 for CH_4), which is around 3,074 Mg CO_2 eq./year of CO_2 and CH_4 per Km_2 of the surface area of the dam. According to the IPCC (2003), the primary causes of GHG emissions from flooded lands in climatic conditions similar to that of Lebanon can occur via the following processes:

1. Diffusive Emissions: Molecular diffusion across the air-water interface for CO_2, CH_4 and N_2O.
2. Bubble Emissions: Bubbles of CH_4 from the sediment through the water column.
3. Degassing Emissions: Emissions resulting from the process of water passing through turbines and spillways.

Studies suggest that large dams contribute to 4% of global CH_4 emissions annually (Chow et al., 2018). Using the Tier 1 method in the IPCC guidelines to estimate CH4 emissions from flooded lands, the projected emissions from the 14 proposed reservoirs in the Updated NWSS-MoEW (2020) based on average daily diffusive emissions for similar climatic zones is estimated to be around 0.059 Gg CH_4/year. This emission rate would constitute a negligible fraction of Lebanon's methane emissions, which was recorded to be 69.28 Gg in 2018 (MoE et al., 2021). This low emission rate can be attributed to the small, estimated surface areas of proposed dams in the Updated NWSS-MoEW (2020).

However, low flow circulation and improper O&M of reservoirs can result in water body eutrophication, which increases CH_4 emissions in reservoirs (Jari, 2020). Eutrophication is characterized by heavy algae bloom and creates an anoxic environment in the water body (Jari, 2020). Studies suggest that eutrophic systems emit more CH_4 than oligotrophic systems by approximately one order of magnitude (Deemer et.al., 2016). It is therefore important to develop models to predict the eutrophication process during the design phase of dams and regularly test the water quality for water eutrophication indicators as part of the O&M of reservoirs. Guidelines to assess water eutrophication should be detailed in the EMPs.

On the other hand, the construction of impoundment projects will reduce the need for groundwater use, thus reducing GHG emissions from regulated and unregulated pumping processes. The generation of power from the proposed dams, mainly the proposed Assi Phase II Dam, can also reduce reliance on fossil fuel burning and can help achieve Lebanon's target to generate 30% of the power demand from renewable energy, which includes hydroelectricity, as discussed in Section 4. Hydroelectricity is a low-carbon source of renewable energy and a cost-effective alternative to electricity generation by fossil fuels and can generate 4 to 18 g CO_2 eq./kWh.h, compared to 690 to 890 g CO_2 eq./kWh.h from the burning of fossil fuels (Temblay et al., 2004).

Given the above, it is critical to integrate a climate change component into the EIAs of man-made reservoirs and associated mitigation measures in the EMP. The EMP should consider climate change mitigation and adaptation measures during the construction and O&M of the projects and the MoE should ensure that the execution of the EMP measures is regularly monitored.

7.1.4 *Land Use and Conservation*

7.1.4.1 Impacts on Land Use

The construction of the proposed infrastructural projects, particularly dams and hill lakes, require large areas of land, altering the land use of certain areas. For instance, several of these projects, which are proposed to be constructed on wooded lands and forests, will inundate these areas especially those located on river systems (See Table 7 for proposed dams, and Annex 9.3 for WWTPs overlayed on Land Use/Land Cover map). The latter will transform the land cover from a forested valley to an open man-made water body, thus changing the land use in these areas. In addition, the construction of water reservoirs influences the landscape of the river valleys, including the proportion of land to water area. The proposed dams and hill lakes are also expected to limit access to the land where construction will take place and other surrounding lands. Experience from Lebanon shows that the lack of urban planning regulations and enforcement near existing and future impoundments will attract construction activities and other forms of urban development. These will impact the proposed project and thus require regulation to safeguard public safety and ensure pollution prevention. As such, the construction of dams and hill lakes often requires the establishment of a buffer zone ranging between 30 to 100 m (depending on international standards adopted), thus impacting the land use of adjacent lands. Land activities in adjacent lands may need to be shifted to low impact activities in order to protect the proposed water reservoirs. Moreover, the construction of these proposed projects may infringe on existing and/or planned protected areas and sites which normally carry statutory setback and land use restrictions.

On the other hand, providing additional irrigation schemes as proposed by the Updated NWSS-MoEW (2020) will provide water to water-scarce areas which may increase the agricultural land cover and diversify crops. Increasing the availability of water for irrigation can foster agricultural expansion and intensification of agricultural land use (Thomas and Adams, 1999).

Given the significant impacts of such projects on land use, the MoEW should require an extensive land use and management plan to be submitted for approval along with the proposed infrastructural project, especially for dams and hill lakes. The land use plan should define buffer zones, protected waterside habitats, pollution point and non-point sources, agricultural and industrial activities, residential agglomerations in the project area, heritage sites and recreation/touristic areas. The MoEW, in collaboration with MoE, should ensure that the plan is focused on protecting the designated buffer zones by managing land use activities and sedimentation and restoring the native trees and vegetation in the buffer zone. The submitted plan should also include a land restoration and enhancement plan for the restoration of native habitats. In addition, as the construction of such projects will generally be built on private lands, having a participatory approach, and engaging the community in such projects is key. Having public acceptance and providing a sense of ownership for these projects can ensure effective implementation and operation (further discussed in Section 7.3).

In addition, several of these infrastructural projects are proposed to be constructed in areas with high risk of soil erosion (See Figure 44 in Annex 9.3). As seen in Figure 44, there is a high concentration of proposed projects in the Chouf area, which is characterized by high risk of soil erosion, including among others, the Maaser El Chouf and Damour Dam, the Deir El Qamar and Mristi hill lakes, and the Bkifa and Mazraet El Chouf WWTPs. In addition, a number of WWTPs and dams are proposed to be constructed in areas with faults and high risk of landslides. As seen in Figure 46 in Annex 9.3 the Deir Janine and Ras Baalbek hill lakes are located in areas with a high risk of landslides; along with a concentration of WWTPs that are proposed to be constructed in high-risks areas in Akkar, including Chikhlar, Menjez, Ain Tanta, Mazraat En Nahriye and other WWTPs.

As such, conducting an EIA at the design phase of these projects is fundamental to:

- Reduce associated environmental impacts.
- Reduce the risk of exacerbating natural hazards (such as soil erosion and landslides).
- Ensure the design of these infrastructures is resilient to natural hazard shocks and can withstand harsh conditions. This should be part of a geotechnical study conducted at the design phase and included in the EIA.
- Develop a natural disaster emergency plan detailing actions to be taken in case of emergencies to minimize environmental impacts and safeguard public safety.

It is also recommended to propose other sites for the construction of such projects in the Analysis of alternatives section of the EIA and assess the feasibility of relocating them to other lands with reduced risks of natural hazards.

<u>Raw Material Extraction and Generation of Construction and Demolition Waste (CDW)</u>

The construction of the proposed infrastructural projects, particularly dams and hill lakes, in addition to water and irrigation networks, WWTPs, and WTPs, requires various types of raw materials. Of particular significance, is the large volumes of aggregates used to produce cement and concrete, which are needed in large quantities particularly for the construction of dams. These aggregates will be extracted from other sites and quarries by blasting or by ripping using heavy machinery, which may significantly alter landforms and landscapes. Increasing the quarrying activities in Lebanon requires careful considerations due to the highly unregulated nature of the sector, as mentioned in Section 5.1.3. In addition, blasting and other similar operations to extract the aggregate often have various adverse impacts on the environment, including impacts on biodiversity, and generation of large amounts of fumes and dust. Experience in Lebanon also shows that excavation practices can cause irreversible change to landforms if the cut-and-fill procedures are not optimized.

Furthermore, the unregulated disposal of CDW generated from the construction of the proposed projects will also affect landscapes and natural water courses. The construction of such projects will lead to the generation of large amounts of construction and excavated waste. If not properly managed, the waste will end up on the side of the roads and in water streams and can damage landscapes and landforms.

As such, the MoEW, in coordination with the MoE, should promote sustainable resource use and management, and ought to adopt a Life Cycle Assessment framework for the construction of infrastructural projects, taking into consideration the raw material production, transportation, construction, operation, demolition, and disposal phases. This framework shall be used to optimize all environmental aspects of the construction and operation of these projects and reduce their carbon footprint.

7.1.4.2 Impacts on Land Conservation

The Updated NWSS-MoEW (2020) has also proposed the establishment of protection zones for the springs' catchment areas and their immediate buffer zones. With the establishment of these protection zones, a plan delineating the spring catchment areas is required. The latter is defined based on the identification of main pollution sources in the catchment area, which may include agricultural and farming practices, waste disposal activities, and industrial establishments. Establishing these protection zones may alter the land use activities in these areas, reduce the land use intensity, or completely halt some of the activities that are identified as major sources of pollution in this area. The MoEW, in coordination with the MoE and DGUP, should take a proactive approach to developing and using land use regulations to make informed land use decisions concerning areas affecting watersheds. Having sound land use plans can be the most pervasive force in protecting catchment areas

Changes in land use induced by the construction and operation of impoundment projects, such as dams and hill lakes, can have direct and indirect impacts on water resources and the hydrological cycle. Land use changes, induced by these activities, can affect temperature patterns which ultimately impact the global hydrological cycle (Chase et al. 2000) and can also impact the volume of water available for both ecosystem functions and human uses (Jarosz et al. 2009, Kumar et al., 2017).

Furthermore, these land use changes and their effects and interactions, along with the construction activities itself, can lead to land degradation including soil erosion, change in agricultural productivity, etc. In turn, land degradation not only impacts the land surface itself, but also affects freshwater systems in terms of both quality and quantity. For example, soil erosion has been linked to the pollution of nearby water bodies and wetlands (Issaka and Ashraf, 2017; Shi et al., 2012). The soil that has eroded can transport with it nonpoint nutrient contaminants, heavy metals, and chemicals, causing higher sediment levels in water bodies leading to high pollution loads, water eutrophication, and disturbance of aquatic ecosystems (Bing et.al., 2013; Wilson, Cullum, & Römkens, 2008). The soil erosion process can also impact how much water the soil can hold, the water flow rate over the soil, and its movement below the surface, thus impacting the quantities of water reaching these water bodies (Issaka and Ashraf, 2017).

7.1.4.3 Sustainable Urban Planning

In 2005, a National Physical Master Plan of the Lebanese Territory (NPMPLT) was developed (as discussed in Section 4.5.2). However, with the lack of clear institutional framework, and enforcement of law, the plan is not being implemented, leading to haphazard urbanization and development and unregulated construction activities.

The development and implementation of an updated comprehensive strategic urban plan is currently needed. The national urban plan should have a holistic vision and should enhance and harmonize land uses in Lebanon while ensuring the protection of natural and cultural resources. Strategic urban planning should also be in line with all the national sectoral strategies, including the Updated NWSS-MoEW (2020). As such, having a participatory approach and engaging all concerned stakeholders including the public, is key to having an integrated approach to land use; strategic sustainable urban planning is one of the fundamental pillars of sustainable development.

<u>Urban Stormwater Management</u>

The construction and development of urban cities has required the conversion of vegetated, pervious, “green” terrain to man-made, impervious, “grey” landscapes that disrupt the area’s natural hydrology (UACDC, 2010). In urban environments comprised of increased impervious area in the form of roadways, sidewalks, and building roofs, precipitation is incapable of penetrating the impervious surfaces and, thus, reduces the precipitation losses and increases stormwater runoff (Sun & Lockaby, 2012).

Additionally, these grey landscapes generate urban pollutants such as heavy metals, E. coli, oil and grease, nutrients, pharmaceuticals, and suspended sediments that are picked up by storm water flows and carried downstream, without mitigation that would have naturally been provided in undisturbed landscapes by vegetation and infiltration (Steinman et al., 2009; UACDC, 2010). As a result, the flow regimes of stormflows from urban watersheds are characterized by increased total runoff volumes, greater peak flows, flashier hydrographs with rapidly rising and receding flows, and poorer water quality (Walsh et al., 2005).

Uncontrolled storm water runoff has many cumulative impacts on humans and the environment including:

- Flooding - Damage to public and private property;
- Aesthetics - Dirty water, trash and debris, foul odors;
- Public Health threats- Contamination of drinking water, fish/shellfish;
- Public Safety threats - Drownings occur in flood waters;
- Economic Impacts – Impairments to fisheries, shellfish, tourism, recreation related businesses.

An understanding of urban watershed hydrology and water quality, including the quantity and movement of storm water runoff, sources and locations of contaminants, and the degree of downstream water body impairment is required to effectively design and plan green infrastructure (Carey et al., 2013; Lathrop et al., 1998; UACDC, 2010). In that respect, it is important that governmental agencies, public works, and other concerned entities work together to provide these understandings by conducting field hydrologic and water quality monitoring studies that model and quantify downstream pollutant levels and stormflow volumes to estimate overall contaminant loads across land-areas and regions (Leitz, 1999).

After an assessment of human and natural factors, such as city climate and location and urbanization rates, land-use, and the observed water quality conditions, storm water pollution reduction goals and more effective storm water management strategies can be created (EPA, 1993; NRC, 2008). In order to begin solving the complex issue of urban storm water pollution, cities are developing and implementing storm water management plans that are unique to each location which would ensure flood and pollution control by committing to separate collection systems and utilization of novel management practices which mimic the natural water cycle.

Improvement of availability of data, manual/guidelines, and technical standards, as well as adoption of novel management practices along with effective collaboration at all levels with all the stakeholders will enhance efficiency of urban storm water management in Lebanon. Introduction of Improvements in the legal and institutional frameworks should be implemented in order to ensure the effective implementation of urban management plans measures.

Urban Stormwater Better Management Practices (BMPs)

BMPs include conserving natural areas and vegetation, reducing hard and/or impervious surface cover, and retrofitting urban areas with Low Impact Development (LID) features that effectively hold and treat storm water instead of conveying it downstream with no treatment (NRC, 2008). An increasingly popular BMP technique is Green Infrastructure (GI), which mimics the natural water cycle by harvesting, infiltrating, and evapo-transpiring storm water, while promoting climate regulation and ecological functioning, such as sediment retention and nutrient cycling that is lost in urban "grey" landscapes (UACDC, 2010). Moreover, urban planners have worked to incorporate Green Infrastructure, such as green roofs, bioretention facilities, bioswales, wetlands, retention ponds, recharge of aquifers, and porous pavements, into city design schemes due to their effectiveness in reducing and mitigating storm water and providing economy and aesthetic enhancements to communities and their citizens' life quality (Tzoulas et al., 2007).

7.1.5 *Water-Energy Nexus*

Providing utility water and wastewater treatment services in Lebanon is an energy intensive activity, especially when the RWEs/service providers need to generate their own electricity through localized generators which is the dominant form of energy used in this sector. A study over a three-year period (2016-2019) covering 62 water and wastewater facilities (39 water pumping stations and 23 wastewater treatment plants), mostly operated by the four RWEs, has shown the considerable burden the energy bill has on their overall as well as on their O&M budgets (Farajalla et. al., 2021).

Energy expenditures ranged from 20% of the annual budgets of both NLWE and EBML to nearly 36% for the BWE. For the EBML, this represented 33.6% of its O&M outlays while for the BWE it was equivalent to 47% of the overall O&M expenses (Farajalla et. al., 2021). According to MoEW, the percentage of the energy expenditure reached 70% of the overall O&M expenses after the economic crisis and the increase in EDL tariff rates. Moreover, the utilities are currently compelled to generate their own electricity most of the time due to the near total utility electricity black-outs. In Lebanon, in-house generated electricity costs much more than utility electricity based on the present utility tariffs and fuel cost.

Worldwide, energy costs are usually between 5 and 30% of total operating costs among water utilities. The share is usually higher in developing countries and can go up to 40% or more in some countries. Such energy costs translate into high and often unsustainable operating costs, which directly affect the financial sustainability of water utilities and put strains on public/municipal budgets. This may directly result in increased tariffs on subscribers or a reduction in the level of water quality and the reliability of the water supply.

In the case of Lebanon this conundrum, which is at the root of the water energy nexus, translates for most subscribers into a double tariffication regime for water supply services. First is the official tariffication as subscription to the water utility based on a fixed lumpsum paid annually, and second is the disguised tariffication which itself may consist of three components. It is worthwhile mentioning that there are plans in the future to base the official tariffication on actual water use after the completion of the installation of water meters at the subscribers' premises.

The tariffication in disguise arises once citizens try to make up for the shortages in the water supply infrastructure whether in the quantity of water supplied or its quality. Subscribers may face three kinds of expenses related to the disguised tariffication each with its own water energy nexus and associated energy footprint. These include:

1. Due to a full or partial shortcoming in the quantity of water delivered, especially during the summer and fall seasons, subscribers and non-subscribers are:
    1.1. Hauling water by trucks to their premises. It is estimated that in 2018, 46,000 households relied mostly on water trucks to meet their domestic water demand and 205,000 relied on private water wells. The amount of water trucked to supply industries and tertiary sector facilities (hotels, hospitals, malls, etc.) is estimated to be slightly less than that of water trucked to households. The yearly cost burden of trucked water to the different users is estimated to exceed USD 70 million while the energy used is estimated to exceed 12 million KWhr equivalent to some 1.4 million liters of gasoline which amount to nearly USD 1.8 million in 2018.
    1.2. Drilling water wells, although it is currently outlawed except in very particular cases. The estimated number of buildings using private wells is estimated to be around 20,000 (based on the figure of 205,000 households mentioned above assuming an average of 10 households per building). The cost burden of water treatment installations, assuming 10% of these buildings have installed such equipment, may exceed USD 20 million while the yearly maintenance outlays may exceed USD 3 million. The primary energy needed for water extraction from such wells and its treatment is estimated at 30 million KWhr/year equivalent to around 3.3 million liters of fuel needed to generate the electricity on a yearly basis. The outlays on electricity are estimated at USD 5 million assuming 50% of the electricity is supplied by EDL at 2018 prices.
2. Due to the low pressure in the distribution networks / due to the intermittent supply of water, many subscribers' water hardly reaches the taps year-round even for dwellings situated on the

lower floors of a building. In this case, subscribers need to install water tanks in basements or ground level as well as tanks at a high level, typically on the roof, and interconnect these with a pumping system. Utility water fills the tanks at a low level then water is pumped to the high-level tanks which feed dwellings by gravity. The expenses born by households till 2019 to implement such installations are estimated to exceed USD 3 billion. The primary energy intensity to lift the water 3 floors (the average number of floors in a building) using electrical pumps is estimated at around 0.44 KWhr/m^3. The financial burden or disguised tariff born by households to pay for electricity to lift water in buildings using electrical pumps is estimated at USD 700,000/year at 2018 prices and much more in 2022 considering that electricity is mostly provided by private generators due to the near total black outs.

3. Because of interruptions in the water supply which result in seepages into the water networks, the low network pressure which prevents utility water to directly reach the consumer taps, as well as the questionable quality of the water being supplied to consumers, a great percentage of subscribers do not consider tap water fit for drinking purposes. In 2018, some 874,000 households (69% of primary residences) used treated or mineral water for their potable water consumption. The bottled water market was estimated at around USD 500 million in 2015 equivalent in volume to some 900 million liters of water. Assuming the market remained at the same level in 2018, the energy footprint of this market at the stated volume of production is estimated to be 150 million KWhr of electricity for bottled water production and 32,500,000 KWhr of gasoline for distribution. The energy cost in 2018 for the first component is estimated at USD 27 million and USD 3.5 million for the second.

Most of the costs and energy requirements shown above have been displaced from the RWEs/service providers to the households due to the shortcomings in the utilities' infrastructure. Consequently, the share of energy in the utilities' budget should have been higher than what was stated further above if water reached the subscribers' taps in the required quantity and quality.

The wastewater sector suffers even deeper shortcomings, where only 8% of the wastewater generated in Lebanon is being treated. The indirect costs borne by society in what relates to wastewater are reflected in the environmental damage whether as land degradation or water pollution which results in a marked decrease in the quality of life in the country. From a water energy nexus perspective, if Lebanon had implemented the necessary infrastructure to carry out the secondary treatment of no less than 70% of the generated wastewater, this would have absorbed no less than 100 million KWhr/year of electricity at a cost estimated at USD 18 million at 2018 prices.

Box 5. Integration of Indirect Tariffication – The Case Study of EBML

EBML covers a population of around 1.9 million (more than 50% of the population connected to public water networks) of whom 350,000 reside in low-income neighborhood. The household connection rate in its area 90% compared to a national average of 70%. It has 600 employees out of a total authorized of 1124 due to employment freeze by the government. EBML has the highest water bill collection rate (75%) and thus the largest revenues which could support its operating budget. Its electricity outlays for 2018 amounted to USD 18.2 million of which USD 14.8 million as electricity bill and USD 3.5 million as diesel fuel for generators.

As a comparison, the energy cost of the three components of the indirect water supply tariffication discussed further above, including only 50% of the energy needed for bottle production, amounts nearly to USD 24 million. Assuming 60% of this cost arises in the regions covered by EBML, which is a conservative estimate, the resulting energy outlays of the indirect tariffication amount to nearly 70% of EBML 2018 energy outlays shown in the referenced study. Consequently, if the share of indirect tariffication is integrated into the utility operation, the energy share of EBML budget could exceed 30% for that year, instead of the stated 20%, which is a better reflection of the importance of energy use in that utility. The same approach could be applied to the other three water establishments.

Concerning wastewater management, again if 50% of this cost was borne by EBML, assuming that the water utilities were in charge of operating the wastewater treatment plants, then the estimated energy budget of that utility related to water supply and wastewater treatment would have reached no less than USD 45 million in 2018.

Based on the above discussion, any water sector strategy aiming to expand the water and wastewater infrastructure should carefully consider the additional energy demand needed to operate the new facilities and, of course, the billing system needed to recover the energy cost. This is critical for a country like Lebanon where the electricity infrastructure cannot provide for the basic needs of the country and where energy costs represent an unbearable burden on the economy. The current efforts undertaken by Lebanon to solicit the goodwill of neighboring and other influential countries to help assist in securing a few hours of electricity per day to avoid a total black out should be sobering reminders that proper water and energy supply and demand management should be at the forefront of any well thought out water strategy at the national level.

The Updated NWSS-MoEW (2020) proposes numerous strategic objectives to enhance the water and wastewater sector governance and management and improve the water availability and sanitary services in Lebanon. The Updated NWSS-MoEW (2020) corresponding initiatives and proposed projects will translate into positive and negative socio-economic externalities. In Section 7.1.7, we will briefly discuss these impacts and will suggest policy recommendations.

7.1.6 *Water-Food Nexus*

This section features the interdependencies that exist between water and food resources and highlights the need to pursue and optimize integrated management across them. The Water–Food Nexus is necessary to reach equitable, balanced, and sustainable access to water and food resources in the face of the mounting pressures caused by population growth, and exacerbated by climate and land use change, resource depletion, etc.

According to the latest WFP Country Brief Report (February 2022), the profound economic crisis the country is facing, in addition to the prolonged Syrian refugee crisis, has made food security a major concern. Food insecurity reached 46% of Lebanese people by the end of 2021. With the increasing inflation rates and international fuel prices, the latest WFP market assessments show that the price of the minimum food basket increased by 1,140% since October 2019, reaching a record-high of LBP 660,000 (USD 22) in January 2022 (WFP, 2022). Considering that Lebanon imports 80% of its food needs, the mentioned crises caused serious impacts on food security and increased poverty levels.

In addition to the impacts of the increase of prices in food supply, Lebanon's capacity to produce food was also affected by the financial crisis. For instance, the cost of producing vegetables in 2020 has increased by an estimated 40% since 2019. The costs of new investments (i.e., irrigation systems or greenhouse equipment) have increased by 80% in 2020. Farmers have reported a 40% average decrease in sales, leading to cancelling planned investments, decreasing cultivated areas, or increasing areas dedicated to lower-cost crops (Hamadeh, 2020).

The crises since 2011 (starting with the Syrian crisis) also had a positive impact on agricultural productivity where the real value of agricultural output increased by 10 percent compared to the pre-crisis level. To respond to rising food demand, people started investing in agriculture. Moreover, since the economic crisis, an increasing trend of investing in agriculture and planting essential crops was witnessed in Lebanon. Political parties even asked their allies to return to their land. Satellite pictures of the coastal Akkar show the expansion of agricultural land after 2011 (Figure 33) (Google Earth, 2022).

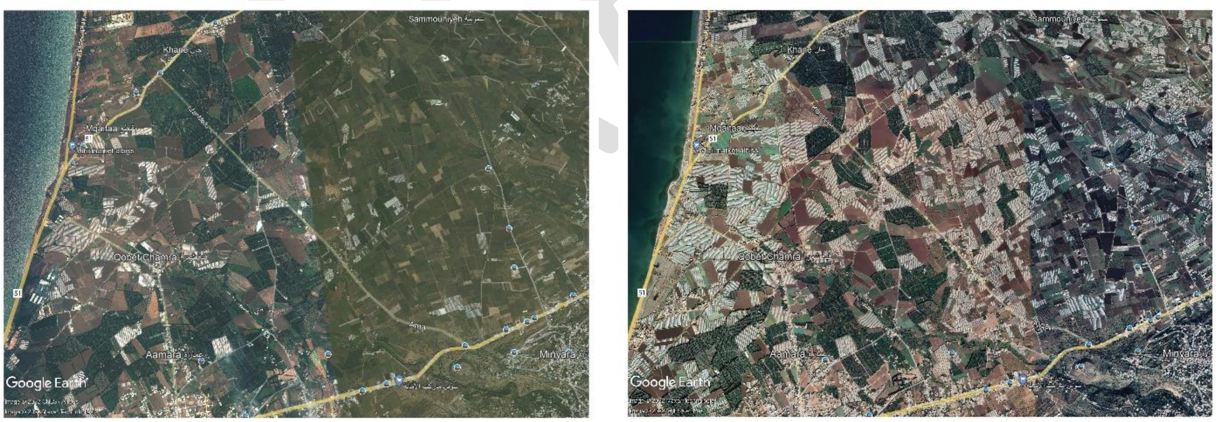


Figure 33. Satellite Images Showing Increase in Agricultural Greenhouses since 2010 (Left Image: 2010, Right Image: 2022)

Increasing food security and improving agricultural productivity is heavily dependent on water sources. The MoA published in September 2020 its strategy for 2020–2025, tackling food security for the first time. MoA listed the rising water stress and increasing water use competition as the main challenge facing food security in the country. As mentioned earlier, the agricultural sector in Lebanon remains a significant consumer of available freshwater.

Moreover, the challenges in the agricultural sector and food security are likely to be compounded by climate change effects. The "Vulnerability Assessment Application on the Lebanese Agricultural Sector" study conducted by ACSAD et.al. in 2019 suggests that cultivated areas have a low to moderate adaptive capacity to projected climate change impacts, with areas most impacted being South Lebanon (agricultural areas in Marjeyoun, Nabateyye, Bent Jbeil), Zgharta and Akkar. Based on EURO-CORDEX climate change projections, critical areas with the highest vulnerability are Southeastern Akkar, Hasbaya, Rachaya – characterized by limited irrigation capacity, shortage of groundwater resources, and high sensitivity to flooding events and soil erosion – as well as Baalbek, Zahle, Zgharta and Bcharre (ACSAD et.al., 2019) (Figure 34).

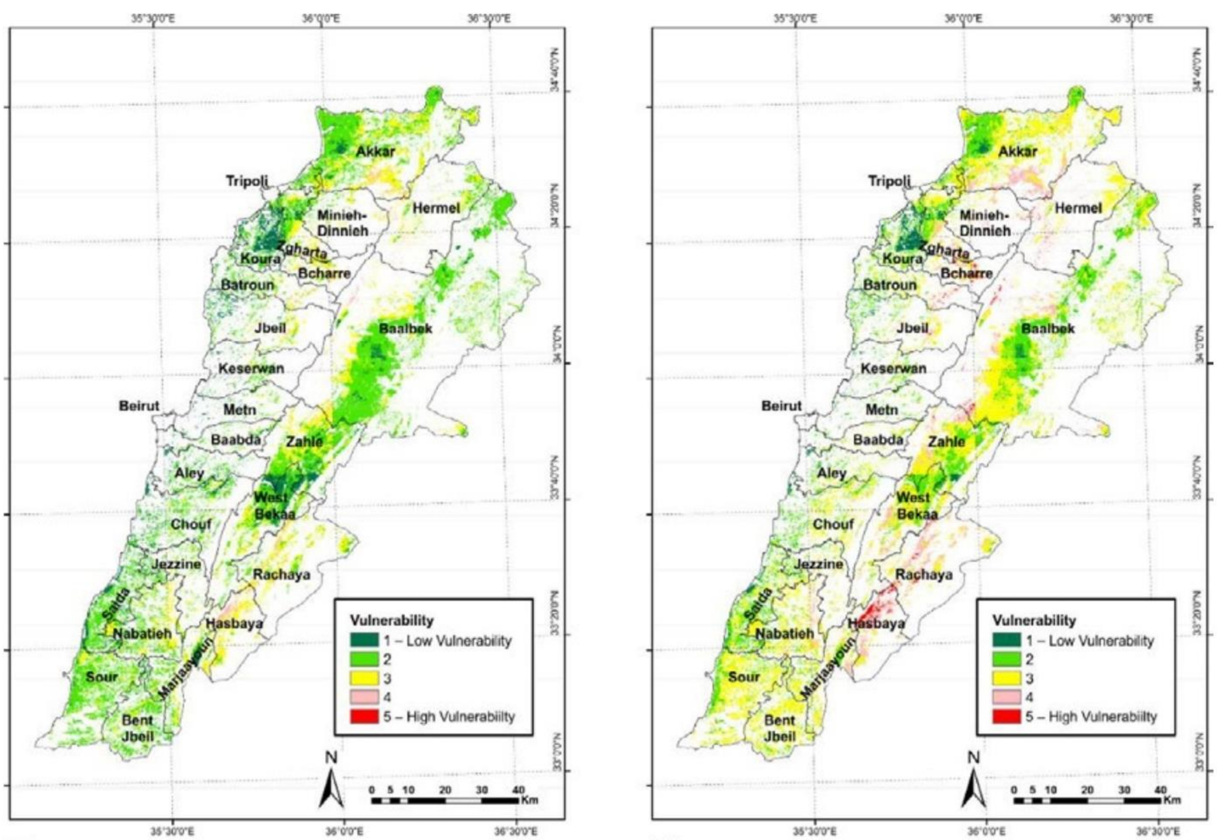


Figure 34. Vulnerability at 2100 for (a) RCP 4.5 and (b) RCP 8.5. (Source: ACSAD et. al., 2019)

The Updated NWSS-MoEW (2020) mentions several initiatives, mainly related to water demand management rather than water supply augmentation, to increase water availability (i.e., rainwater harvesting, improving irrigation infrastructure, studying existing irrigation schemes, etc.). The strategy projected an increase in the irrigated areas and hence irrigation water needs, while taking into account the proposed improvements in efficiencies (Table 41).

Table 41. Projected Increase in Irrigation Water Needs (MoEW, 2020)

Date	Irrigated lands	Water Use (per ha)	Irrigation Water Requirement

2010	100,000 ha	8435 m^3/ha	842 MCM/year
2035	138,000 ha	6,720 m^3/ha	927 MCM/ha

However, these numbers do not take into account MoA strategy and its corresponding water needs. It also does not consider the spatial distribution of the projected increase in irrigated lands to consider water allocation per region. Moreover, the prioritization criteria for irrigation projects do not consider the sub-regional disparities in cropland sensitivity to natural and physical environmental changes, including the effects of projected changes in climate.

An integrated system of coordination among the main stakeholders, mainly MoEW and MoA, is very much needed to assess the Water-Food nexus based on reliable data and make the appropriate decisions concerning the allocation of resources and the required trade-offs needed between the various development priorities of different stakeholders. Accordingly, there is a need for MoEW to coordinate with MoA to establish regional irrigation plans that aim to (1) increase sustainable food production (2) maximize water efficiency on the level of the farmer and the water system, and (3) outline adaptation measures to reduce climate change vulnerability, with focus on areas that are most vulnerable in accordance with the available vulnerability assessments.

7.1.7 *Social and Socio-Economic Environment*

The Updated NWSS-MoEW (2020) is expected to create numerous social and socio-economic benefits. These are summarized below:

- **Improved water quality for domestic and irrigation use and enhanced health conditions[13]:** The Updated NWSS-MoEW (2020) aims to improve and rehabilitate the existing water networks across Lebanese governorates, which will result in securing water for a larger number of households and agricultural lands. Additionally, the strategy's largest proposed investments will be in the provision of wastewater services. The efficient collection, conveyance, and treatment of wastewater, followed by continuous monitoring will minimize contamination of freshwater, soil and agriculture products, as well as result in overall improved water quality. Therefore, the cases of waterborne diseases outbreaks will be expected to be reduced which will alleviate the financial burden related to the health bill. Limiting water pollution and ensuring good quality of domestic and irrigation water is essential given that today in Lebanon 44% of the residents do not benefit from any form of healthcare or social protection system (CAS, 2019).

Box 6. Savings on Healthcare Bill related to decrease in Waterborne Diseases

According to the MoPH, the food and waterborne diseases cases registered in Lebanon in 2022 amounted to 162 cases, and the current out-of-pocket cost of healthcare per person per year ranges between LBP 486,000 to LBP 2,510,000. Assuming that 88% of these cases were linked to unsafe or contaminated water, the total cumulative savings from improved wastewater and sanitary facilities is estimated to reach USD 1.5 million in 2035.

(USD 1 = LBP 1,500).

[13] Assumptions: (1) Waterborne diseases are based on the registered cases across Lebanese regions as per the MoPH reports and it is not computed proportionally to the population, (2) in 2035, the percentage increase in treated WW will reach 81%, (3) the number of food & waterborne diseases in Lebanon vary yearly at a 1% CAGR, (4) Cumulative 2035 savings are calculated as a sum of yearly savings from avoided waterborne diseases cases linked to poor sanitary and hygiene

- **Increased households' savings on private water purchase and other indirect costs:** As discussed in Section 7.1.4.3, the absence of reliable freshwater quality has pushed households to buy water from the private sector (e.g., water bottles and gallons, water tankers) or invest in water services (e.g., pumping cost, maintenance, filters, etc.), in addition to paying their public network water subscription fee. This has led to increasing the financial burden on households, who are facing a greater challenge to secure their basic food and beverage needs with the current national and global economic crises[14]. Around 40% of Lebanese households buy mineral water in gallons and 12%-15% buy mineral water in bottles. The implementation of the Updated NWSS-MoEW (2020) initiatives will aim to reduce the costs of purchasing water from private suppliers by ensuring access to sufficient and safe water for households.

> Box 7. Given the yearly scenario proposed to increase the number of subscribers, the incremental increase in water supply will forge the future water deficit and result in cumulative savings of USD 2.55 billion in purchasing private water by 2035. This value is derived assuming that a yearly population growth of 2%, with approximately 4 capita per household and average expenditure on private water resources of 135 USD/month/household (USD 1 = LBP 1,500).

- **Improved agricultural and industrial productivity and revenues:** The Updated NWSS-MoEW (2020) proposes to increase irrigated lands by an additional 38,000 ha at the country level and improve irrigation efficiency to 75%. The availability of water for irrigation might enable the diversification of crops and increased productivity, which will translate into the following benefits: (1) higher revenues and income for farmers, (2) more local agricultural crops on the market ensuring food security given the current economic crisis and peak in imported goods, and (3) boosting the agriculture sector in terms of GDP contribution. However, for the abovementioned benefits to materialize, the NWSS strategy will need to be coupled with other economic reforms and cross-sectoral strategies involving different stakeholders such as Ministry of Agriculture, Ministry of Economy and Trade, etc. On the other hand, enhancing continuous water supply will also advance the productivity of industries that rely on water in their production such as textiles factories. Water shortages and deteriorating water quality can result in tremendous costs for industries, as it jeopardizes their production process putting at risk their business continuity. Therefore, the increase in water availability, after implementing

> Box 8. The productivity per additional irrigated lands is estimated to generate **USD 580 million per year in revenues.** Additionally, the reduction in irrigation system losses as proposed in the Updated NWSS-MoEW (2020) will result in saving 1,680 m^3/ha/year of freshwater, which translates into 232 MCM/year of total freshwater savings for total projected irrigated area of 138,000 ha.

[14] The price of bottled water in Lebanon has skyrocketed since 2019. Prices of water bottles have increased by four to five folds (Chehayeb, 2021).

the proposed projects of the Updated NWSS-MoEW (2020), will result in improved productivity and revenues for the private sector as well.

- **Enhanced coastal tourism and fisheries:** Based on the World Bank study (2004)[15], the adjusted average value of coastal damage is estimated at USD 357.8 Million, assuming two scenarios (1) minimum range: 25% of the damage is directly attributable to wastewater, and (2) maximum range where 75% of the damage is linked to wastewater.

  Enhanced wastewater management will improve the coastal marine water quality and attract a larger number of domestic and international tourists to beaches and coastal resorts. The growing number of visitors to coastal touristic areas will contribute to the national GDP and will offer recreational benefits to society from a well-being perspective. Given that the coastal water quality will affect the quality and quantity of fish catch and species, reducing the marine pollution will support the fishermen by improving their livelihood, especially since they are considered one of the most vulnerable social working class in Lebanon. Also, it will ensure that good quality fish is being offered to households while limiting the risk of food contamination. The estimated benefits as a result of an increase in treated wastewater from the status-quo is estimated to range between USD 271 million and USD 814 million between 2020 and 2035, given that 100% of wastewater will be treated in 2035 instead of being discharged into coastal bodies.

- **Developed and improved job opportunities:** The Updated NWSS-MoEW (2020) focuses on enhancing staff capabilities within the water establishments and increasing the number of human resources to improve efficient procurement, management and operations of water and wastewater projects. The strategy highlighting the importance of financing staff recruitment will create new job opportunities in the water sector improving the livelihood of people or households. This is much needed given that the national unemployment rate in Lebanon is on the rise reaching 40% in 2021. In addition to the jobs that will be directly created in the water sector, other indirect and induced jobs will emerge from the improvement of the agriculture, industrial and touristic sectors which are directly or indirectly impacted by the water availability and quality.

[15] Based on the World Bank study conducted in 2004 that estimate the impact of the improvements in water quality on the coastal economic sectors such as tourism, these values are extrapolated to account for the inflation in 2020 and consider international tourism losses, intrinsic values, and domestic travel costs as proxy to estimating damages related to wastewater discharge into coastal water bodies.

Box 9. Based on ECODIT's rapid economic assessment conducted as part of this SESA Report, the total estimated number of jobs that can be potentially created once the strategy is implemented is around 31,564 jobs, generating **USD 170 billion** of income return sustaining families/individuals across 13 years. This value includes: (1) the direct and indirect jobs from investing in water and wastewater projects, and (2) filling the vacant staff positions in the RWEs.

The direct and indirect jobs from investment in wastewater infrastructures are based on US benchmark ratios 2,125 USD/m^3/day, taking into account the procurement cost of wastewater treatment plants in Lebanon.

(1 USD = 1,500 LBP)

- **Reduced reliance on freshwater and costs savings from abstracting groundwater:** Improved management of the water and wastewater sector will reduce the reliance on groundwater abstraction. This will limit the sea water intrusion caused by over pumping and depletion of groundwater resources, and result in financial savings in terms of costs of pumping groundwater for irrigation and buying diesel to operate pumps, or even buying water tankers from private providers. The latter will translate into significant economic savings in the long-run.

- **Increased revenues for RWEs and secured funds for water investments (benefit on an institutional level):** The Updated NWSS-MoEW (2020) suggests improving collection rates of water bills and introducing wastewater fees proportionally to the water consumed. It forecasts an increase in the number of subscribers and the number of metered connections and collection rate to 90% in EBML, 67% in BWE, 85% in NLWE and 77% in SWLE. These proposed reforms can bridge the RWEs deficit allowing it to financially recover, once an economy recovery plan is set on a national scale. Additionally, the revenues collected by the RWEs can translate into positive impacts on the national GDP by securing funds that can be invested in new water infrastructure and development projects, and allow them to employ skilled experts and middle management staff, preventing them from emigrating.

- **Increased environmental social awareness within the population while reducing the household water footprint**: The proposed shift in water tariff from a gauge-system flat billing to a rate based on consumption will incentivize users/consumers to reduce their water footprint. The new tariff coupled with extensive environmental awareness campaigns will create a sense of social responsibility among the population to apprehend the true cost of water and drive them to conserve this natural resource.

Despite the numerous benefits of the Updated NWSS-MoEW (2020), several issues on the socio-economic environment need to be taken into consideration. These issues are summarized in the following subsections.

7.1.7.1 Purchasing Power Capacity of Water Users

> **Box 10. Reduced Purchasing Power of Water Users**
>
> The purchasing power of Lebanese wages – 80% to 90% of which were usually paid in Lebanese pound - dropped by at least 75% since 2018, considering that more than 55% of total labor force are wage earners and the minimum wage today is equivalent to about USD 50 at the black-market dollar exchange. This situation is currently aggravated by the global inflation of food prices reaching 21% in 2022. Therefore, around 75% of the Lebanese people living in poor conditions cannot afford to buy basic food and beverage needs.

The Updated NWSS-MoEW (2020) suggests the implementation of a new water tariff based on the consumption rate per household. Given the current consumption behavior trends in Lebanon reaching 300-400 liters per capita per day in some regions, the new tariff system will mainly result in higher bills. This will put pressure on underprivileged people whose income are low to cover the proposed water tariff and additional wastewater tariff, especially since these households are today relying more on the public grid water than the private bottled industry to secure their basic daily needs. Additionally, today the poverty rate in Lebanon has reached more than 85%, and people are not being able to afford paying for their basic food and beverages needs. This global economic crisis is weighing harder on the Lebanese population whose situation has already reached rock bottom given the devaluation of the LBP, the hyperinflation, and the collapse of the banking sector. Therefore, proposing higher water and wastewater tariffs will worsen the socio-economic crisis in Lebanon if it is not coupled with a national social protection system to alleviate poverty rates and subsidize basic human needs. The volumetric tariff will be based on blocks that take into account the most vulnerable populations in the lower blocks, and will charge higher fees on higher consuming households.

7.1.7.2 Land Expropriations

The majority of the proposed water and wastewater projects such as dams, lakes, wastewater treatment plants, conveyance and network will require the expropriation of lands. The latter requires significant capital per project depending on the area of land needed. Land expropriation is a very controversial topic as it affects landowners and changes the type of land use and landscape.

History shows that the expropriation process (from determining the public interest to compensating the affected people whose lands have been expropriated) is a protracted process that, in some cases, can extend for many years. Delays occur at different junctures in the process which have important repercussions for landowners:

- Landowners essentially lose the right to dispose of their property as soon as the “public interest” has been decreed by the CoM. The period from a declaration of public interest until effective compensation can extend for up to 20 years. Hence, a landowner will incur an opportunity cost equivalent to the potential profit that would have accrued to him/her by the development of that property.
- Delays between the valuation and actual disbursement of compensation may cause a landowner to lose the actual appreciation in the value of the property. Delays therefore can result in socio-economic impacts.

- Long delays may occur between disbursing the compensation to the landowner and the implementation of the project, translating into a misplacement of public funds. Indeed, there have been many cases in Lebanon whereby a public interest project was decreed, compensation was disbursed to affected individuals, but the project was subsequently suspended and/or never implemented.

The delays outlined above may lead to additional dysfunctions in implementing the process as such:

- Evaluations may be over- or under-evaluated: There may be cases when the land may be over- or under-evaluated depending on the parties involved and commercial interests. When lands are over-valuated (or just handsomely valuated), this tends to expedite the process by minimizing protests.
- Land delimitations may be inflated: The project consultant may have incentives to vary the boundaries of the land parcels affected by the project.
- Land speculation: Insider trading may occur whereby certain landowners sell the land without informing the buyer that it had been earmarked for expropriation. Alternatively, a potential investor with insider information decides to purchase adjacent parcels from their owners who may be unaware of the "public interest" project and/or its impact on land appreciation.

It is important to note that today some of the expropriated lands for major water projects are not directly affecting the livelihood of landowners who are in most cases absent[16] and are ending up with valuable compensation. The most affected people from expropriations are those who live on the land and make their living out of it. They are either farmers or families that informally settle in lands and practice cultivation or cattle herding activities. These vulnerable people in most cases are the most affected and are rarely compensated through expropriation.

7.1.7.3 Absorptive Capacity

In the Updated NWSS-MoEW (2020), the MoEW estimates an investment value of USD 8.24 billion over 15 years almost 1/3 of the current GDP estimated by the World Bank in 2021 at USD 21.8 billion (World Bank, 2022). This is almost six times more than the total investment cost in the water sector from 2013 to 2021 (MoEW, 2020).

For years, the Lebanese government secures the majority of its capital investment for water infrastructure projects from the private sector investors and international financing. Today, many water projects that are under planning or construction have been delayed, paused, or cancelled due to the current financial situation hindering the absorptive capacity of new planned projects. Investors or lenders have lost trust in the Lebanese banking sector and the government is unable to cover public sector investments affecting a great number of projects that hardly reach implementation stages. Additionally, the Lebanese government is still in the consultations and negotiations phase with the IMF

[16] Landowners who completely do not have any direct use of their land, either leaving their land deserted or accepting families to informally settle and work the land against a return (monetary or agricultural crops)

to set a rescue plan for the country's financial situation. If the latter has not been settled, the government will not be able to secure international funds for the proposed water projects.

Noteworthy, in the history of Lebanon there has been no proof of the capacity of the Lebanese economy to absorb this amount of investment i.e., 8.24 billion in a duration of 15 years.

Beside the financial challenges, there exist also some political problems that limit the absorptive capacity for new planned projects in the water sector as such:

- Delays in contract signings and in investment mobilization by the government entities.
- Tendency for the government to study and restudy contracts paralyzing the decision-making process and projects implementation, resulting in most cases in sunk costs and great waste in public funds.
- Monopoly of few players in the PPP concentrating economic powers to few groups within the country.

7.1.7.4 Resilience to Economic Crisis

With the current political instability, high inflation rate, depreciation of the LBP, fuel shortage and power shortage as well as the pandemic, the water sector in Lebanon is at great risk of collapsing. From one end, many water bottling companies are cutting their production and distribution by more than half leading to a shortage in bottled drinking water in the market. This is mainly caused by the fuel crisis where water factories depend on diesel to power their generators, which in the absence of state electricity are essential to pump water and manufacture plastic bottles. On another hand, the RWEs are warning of continuous water shortage as they also have been suffering from blackouts and intermittent power supplies threatening the capacity of their water systems to treat, pump and distribute water. They can also no longer afford essential spare parts for maintenance or fuel for their electricity generators as they have no access to financial resources due to the collapse of the Lebanese currency against the US dollar. In addition to the shortage in water supply, the Beirut port explosion has impacted a great number of water networks and connections which will require great investment to replace or restore the damages in the capital and its suburbs.

The abovementioned external shocks have highly impacted the water sector and put public health at risk, especially that water is a basic need for survival and hygiene. This series of events have showcased the weakness of the water sector's resilience to adapt to economic shocks and implement efficient and responsive mitigation and contingency measures.

7.1.8 *Disaster Prevention and Management*

Lebanon is subjected to a range of natural hazards (i.e., earthquakes, tsunamis, floods, forest fires, landslides, and droughts), as well as man-made hazards (i.e., contamination of water resources, infrastructure failures, etc.). With the absence of proper national contingency planning, these hazards can turn into unmanageable disasters.

Although the Updated NWSS-MoEW (2020) did not allocate a specific section on water sector disaster management with a strategic approach and a holistic overview that can prevent hazards and mitigate the impacts of disasters, several valuable related ideas were mentioned, which include:

- The water sector governance, Vol. II, stressed the importance of the resilience of the water sector to disasters especially floods, droughts, and climate change as per SDG 6 on clean water and sanitation for all and SDG 11 on sustainable cities and communities.
- Surface water management in Vol. III stressed the necessity of a flood risk management plan for each of the 20 major rivers and a drought mitigation plan on a national scale and included them as priority 1 within the required assessments and studies. It suggested the establishment of a "disaster risk monitoring unit" responsible for monitoring, prediction and management of floods and droughts, and that the hydrological and meteorological monitoring networks should be upgraded for better flood risk prediction and real time monitoring.
- As part of groundwater management, Vol. III of the Updated NWSS-MoEW (2020) discussed the need for groundwater vulnerability mapping and pollution hazard and risk mapping for surface and groundwater protection, which are necessary for a holistic view of the water sector disaster management plan at the national scale.

The implementation of the above-mentioned decisions and actions will have a positive impact on floods and droughts risk management in the water sector, especially if they are taken a step further, towards the development of specific hazard and risk assessment reports for the identified high-risk regions, associated with local level risk maps. These can be used to improve resilience and reduce societal exposure.

However, it was not clear in the Updated NWSS-MoEW (2020) how the "disaster risk monitoring unit" will integrate with the water sectoral unit at the MoEW, as per the requirements of the National Disaster Risk Management Strategy that is currently being updated by the Disaster Risk Management (DRM) unit of the Presidency of the Council of Ministers (PMC). Furthermore, the Updated NWSS-MoEW (2020) does not mention the National Disaster Risk Management Strategy and what other activities are still required at the MoEW to ensure preparedness for any identified disaster in the water sector.

The Updated NWSS-MoEW (2020) acknowledged natural disasters, mainly floods and droughts, and man-made ones such as groundwater contamination, but it did not mention other hazards, such as dams and hill lakes failures, or forest fires that appear to be frequent during the last years.

7.1.8.1 Forest Fires

Upon the devastating forest fires that ravaged Lebanon in 2007 and in response to the call of the Prime Minister, the MoE and AFDC have been in charge of developing and implementing a recovery plan to restore the damaged forest areas and to put into action a forest fire management plan in cooperation with an inter-ministerial committee (MoE, MoA, MoIM, and Civil Defense, Ministry of Defense, and Lebanese Army) which later led to the development of Lebanon's National Strategy for Forest Fire

Management in 2009. It establishes a comprehensive Risk Management Framework for forest fire management known as the 5Rs and identifies the relevant stakeholders for each key dimension.

However, the MoEW and RWE's which were not included in the inter-ministerial committee, need to be involved as a support entity in the readiness and direct response (Figure 35) to forest fires to report on the availability of water resources at the nearest surface storage and reservoirs, and work on establishing new infrastructure (reservoirs, fire hydrants, etc.) in high risk areas, to decrease the response time resulting in fewer damages and losses. This can be done through the update of the National Strategy for Forest Fire Management to include the roles of the MoEW and RWEs.

Figure 35. Comprehensive Risk Management Framework for Forest Fire Management Known as the 5Rs (IFI, 2019)

7.1.8.2 Dam Breaks and Hill Lakes Failure

Although no dam breaks have occurred to date in Lebanon, there is always a likelihood that they might occur, and such disasters may result in a high environmental, social, economic, and financial impact on the national scale. On the other hand, hill lakes failures have been frequently occurring, as hill lakes lack proper design and annual maintenance or overflow provisions in the case of heavy precipitation.

However, the failure of dams or hill lakes do not usually occur suddenly, but rather after several weeks of clear indications (pore pressure, cracks, leakage, etc.). Accordingly, response actions can be taken. For example, the reservoir could be emptied in a few days, hence removing any risk of downstream inundation. Two methods are usually globally used to mitigate dam break or failure, namely (1) a dam safety program including dam monitoring and (2) dam break analysis.

- Dam safety assurance program must be consistent with the dam safety management principles related to operation, maintenance, surveillance, and emergency action planning as per national and international standards. It shall include requirements for frequency of surveillance, routine visual inspections, annual dam safety reviews, comprehensive dam safety reviews, testing of gates and valves, instrument monitoring, data evaluation, and reporting to the dam owner.

- Dam break analysis and flood inundation mapping consists of simulating the flood wave caused by the dam breach or dam overtopping resulting in the dam failure and illustrating how the flood wave propagates and attenuates along the river valley downstream of the dam. Dam break analysis shall be carried out at the EIA phase as they help in determining the Potential Impact Category (PIC) of the dam, based on the assessment of the possible downstream effects in terms of potential losses, as well as damage to infrastructure. The inundation maps will assist dam owners, regulators, and emergency agencies in the preparation of warning systems for dam failure, and flood and hazard classification of affected areas. A general mitigation measure would involve the development of an emergency flood control procedure.

7.2 Cross-Cutting Key Themes

The Sections below describe the impacts of the Updated NWSS-MoEW (2020) on the Key Specific and Cross-Cutting Themes.

7.2.1 *Data Management*

The limitation in data availability is a cross-cutting issue affecting all the Key Themes mentioned above. The Sections below describes the importance of data for the sustainable management of the water sector.

7.2.1.1 Integrated Hydrological Information System

The Updated NWSS-MoEW (2020) discussed in Volume I the challenges facing the water sector governance of which challenge 3: Tutelage, Administrative Supervision, Monitoring and Reporting in the Water Sector, which described the limitations of the MoEW and RWE's to *carry out monitoring actions across the entire sector and the country, as there is no specific body dedicated to conducting this activity.* Thus, to overcome this challenge, the strategy proposed is to set up a monitoring department within the MoEW and RWE's.

A monitoring system of all the water sector including administrative (ministerial and RWEs), projects implementation, resources, and infrastructure is necessary to assess the performance of the water sector, real production, demand, usage and quality, at both water system and user level and accordingly optimize the resources management. The Updated NWSS-MoEW (2020) presented an assessment of the existing meteorological and hydrological networks and proposed the installation of an additional 113 meteorological stations and 135 hydrometric stations, in the next five years, to reach an average density of 1 station per 50 km^2. Without a complete monitoring system, the evaluation of water resources stays random and the sector management theoretical.

It has also suggested improving the surface water monitoring and management through the implementation of an IHIS for the monitoring of all hydrological resources with all supporting studies. The proposed IHIS is an information system for all public and private water sector stakeholders to manage, publish, share their data, products, and services. This intervention is paramount as it will provide public and private stakeholders with access to reliable information and management services upon data validation and analysis and will help support informed decision-making in the water sector. The IHIS is expected to be implemented in the next 10 years. It is imperative to start making use of the generated data as soon as practicable to revise the adopted water flow numbers, re-assess the calculated water balances at the national and river basin levels as well as to reconsider the need for some of the proposed projects and their impact on the sustainability of the water resources. These proposed improvements and upgrades to the sector monitoring are a necessity and a priority as they will have a direct positive impact on the management of the sector if they are properly implemented and if the collected data is adequately processed and analyzed to inform decision-making.

7.2.1.2 Water Quality Monitoring

Many rivers, springs, wetlands, and groundwater resources of Lebanon receive uncontrolled pollutant loads from point and non-point sources that are orders of magnitude higher than their carrying capacities. As such, many systems are impaired, and their ecosystem functions are disrupted. Without a long-term time-series dataset on the evolution of water quality in these systems, the assessment of their current state and the rate of their degradation or recovery, it is difficult to propose practical measures to protect these resources.

Water quality needs to be managed at two levels (1) water resources (rivers, springs, groundwater) and (2) water supply and distribution. Monitoring water quality is an important first step in managing water resources. It enables authorities to assess how the quality of these resources is changing, analyze trends and inform plans and strategies that improve water quality and ensure that water meets its designated use. The MoEW, RWEs, and the LRA are responsible as per Article 31 of Law 192/2020 for water quality monitoring at the water resources level and the water supply level.

<u>Surface and Groundwater Monitoring</u>

As mentioned above, surface water monitoring in the Updated NWSS-MoEW (2020) focused on water quantity monitoring with no mention neither of water quality monitoring stations along the rivers nor the development and implementation of water quality monitoring programs. This will hinder the effective management of the quality of the surface water resources and hence maintaining ecosystem health and livelihood of the population. In the Updated NWSS-MoEW (2020), water quality management is restricted to "domestic water sources (aquifers, springs, wells, or surface-water) will be protected against contamination by wastewater, and conditions for water-based recreation (swimming, boating, and fishing) will be enhanced by improvements in water quality and control of marine disposal".

Alternatively, the Updated NWSS-MoEW (2020) proposed the following for groundwater monitoring:

- Monitoring continuously the flows and the water quality of springs with flows higher than 80 l/sec with the assistance of the Water Establishments.

- Performing groundwater vulnerability mapping and delineation of protection zones 1 and 2 for springs.

This will eventually have a positive environmental and public health impact if the collected data and the mapping results are used for the protection of groundwater resources.

<u>Supplied Water Quality Monitoring</u>

The Updated NWSS-MoEW (2020) focuses more on the quality of the supplied water. This is crucial as studies have shown that 64% of the population in Lebanon does not have access to a "safely managed" drinking water service (WHO & UNICEF, 2016), whereby bacterial contamination and low levels of residual chlorine were detected across all regions (UNICEF, 2021b), posing significant health risks. Accordingly, the Updated NWSS-MoEW (2020) is proposing the adoption of an operational water quality monitoring program (including parameters, locations, and frequency of testing), the publishing of the updated 161:216 LIBNOR drinking water quality standards, and the implementation of Water Safety Plans by the WEs which also consider the water sources and manage the pollution risks at the catchment level. However, these initiatives are neither given a priority of implementation, nor pegged to a timeline, or included in the overall budget. This weakens their much-needed implementation, which will require serious capacity building at the WE and MoEW levels in terms of trained staff, laboratory facilities, equipment, material, etc.

7.2.1.3 Infrastructure Monitoring

The Updated NWSS-MoEW (2020) also missed to mention an infrastructure monitoring system that shall complete the sector monitoring. The infrastructure monitoring shall be managed by the water establishment at the first level and then at a national level. The RWE's shall dispatch the daily, monthly and annual monitoring reports and timeseries to the suggested monitoring department in the MoEW which in its turn assesses the resources, estimates the water balances and manages the sector at a river basin and national level. The infrastructure monitoring system shall cover the following infrastructures:

- Dams and hill lakes: surface storage shall be monitored at the water inlet and outlet of the reservoirs. Water quality shall be also monitored in dams and main hill lakes for potable water.
- Water supply: springs intakes, wells and pumping stations, distribution network metering system.
- Wastewater collection network and treatment plants.
- Stormwater drainage network.

7.2.2 *Achieving Integrated Water Resources Management*

The Updated NWSS-MoEW (2020) has committed to strengthening IWRM to meet the SDG6 targets, namely the right to safe and affordable water for all. It adopts IWRM as one of its objectives and a main background framework of the strategy, with its implementation principles being the core principles of the Water Code (Law 77/2018, amended by Law 192/ 2020). Achieving IWRM as a managing concept/ philosophy will optimize the use of water resources and infrastructure. It will promote harmony and synergy within the sector and across sectors, while considering the interdependence between all types of storage and uses, implying water storage increase, sustainable withdrawals and supply, water-use efficiency, water quality improvement, etc.

Implementing IWRM will allow for the balancing of competing social, economic, and environmental demands and impacts on water resources, while working towards broader sustainable development objectives and climate resilience. IWRM as a holistic approach influences the allocation and management of all surface water resources and infrastructures (i.e., dams, lakes, etc.), groundwater resources (i.e., wells and springs), irrigation schemes, ecosystems, and the marine environment through improving water quality (i.e., wastewater treatment plants). It also allows the assessment of the climate change impacts on water resources and suggests adaptation methods through better planning and infrastructure implementation.

In 2021, Lebanon reported to Integrated Monitoring Initiative for SDG 6 on the IWRM SDG 6.5.1 indicator by completing a survey that covers the four main dimensions of IWRM: (1) Enabling Environment (laws, policies, and plans); (2) Institutions and Participation; (3) Management Instruments; and (4) Financing[17] (Table 42). The overall score amounted to 25 out of 100, which means that "implementation of elements of IWRM has generally begun, but with limited uptake across the country, and potentially low engagement of stakeholder groups". The lowest score pertained to the adequacy of the finance available for water resources development and management from various sources.

Table 42. Indicator 6.5.1 for Lebanon (2021)

Section	Average Scores (All Values Rounded to Nearest Whole Number)
Section 1: Enabling Environment	37
Section 2: Institutions and Participation	29
Section 3: Management Instruments	24
Section 4: Financing	13
Indicator 6.5.1 Score = Degree of IWRM Implementation (0-100)	25

Some of the challenges to achieving IWRM that were identified in the report were addressed in the Updated NWSS- MoEW (2020). These, which are expected to have a positive impact on achieving IWRM, include the following:

[17] http://iwrmdataportal.unepdhi.org/countrydatabase

- Issuing implementing decrees for the Water Code which recognizes IWRM at the basin level as the basis for water resources management and which promotes multi-sectoral coordination through the establishment of the National Water Council.
- Improving monitoring, data- and information-sharing capabilities and the establishment of the IHIS.
- Building capacity related to public private partnerships and more specifically, management of performance-based contracts.

However, one recommendation that was not addressed in the Updated NWSS-MoEW (2020) was IWRM-specific training and capacity building, including the creation and functioning of River Basin Organizations, other collaboration platforms as well as the communication with citizens and users, with due consideration of gender aspects and particularly vulnerable groups.

Furthermore, the Updated NWSS-MoEW (2020) does not specify how IWRM shall be implemented/ achieved, except for the intention of setting up a unit to coordinate and supervise the implementation of the strategy. Achieving IWRM requires first the exact knowledge of all the infrastructures, their status, operation, with clear resources allocation per usage type and water balance (available resources, demands, projections, shortage, losses, etc.) and per specified geographical/spatial distribution unit, at the water establishment level, the river basin, or point-based systems. This level of knowledge also requires that resources and infrastructure monitoring units shall be established at the RWEs, connected to a central monitoring unit at the MoEW to be also connected in its turn to other related ministries (MoA, MoE, MoF). This network of monitoring units shall be strengthened by interactive monitoring tools such as GIS, Water Evaluation and Planning (WEAP) software and the suggested IHIS in the Updated NWSS-MoEW (2020). Their implementation (GIS, IHIS, WEAP) allows the simulation of management scenarios for smarter project planning and new infrastructure implementation based on user needs for optimized water allocation and conservation at the river basin scale. The impact of future climate change RCP scenarios on water resources allocation could be also simulated for optimized adaptation plans.

Achieving IWRM requires real-time long-term data on the existing water resources which the MoEW is currently proposing to collect in the Updated NWSS-MoEW (2020). The Updated NWSS-MoEW (2020) is also prioritizing the IHIS - the first step in the right direction towards a well-informed and improved management of the water resources. Furthermore, the updated strategy suggests developing WEAP models for Lebanese river basins, that shall help assessing the actual status of water resources and water balance and simulate several future scenarios to improve the water management at the river basin level. WEAP models include the demand and supply elements of the system/basin, integrated into the model, and connected via natural or manmade conduits. WEAP models shall validate, verify, justify, and optimize the deficit and/or excess of each system including the proposed projects, in an integrated way to come up with a holistic plan at the river basin scale. However, before the implementation of these initiatives, when it came to allocating water resources to meet the current and projected water deficits, the Updated NWSS-MoEW (2020) proposed supply augmentation projects at the level of municipal supply systems using a simplified and unified demand across all geographic areas without showing considerations to socio-economic systems, nor showing the link between the proposed withdrawals and the basins/ catchment areas, nor looking at interlinkages with groundwater aquifers. Hence, it is recommended to ensure that the results of the WEAP exercises that will be conducted in the future, feed promptly into the strategy and that the proposed projects are updated accordingly to ensure the optimization of water resource use and the sustainability of water resources. The Updated NWSS-MoEW (2020) (water balance, proposed projects, etc.) should be treated as a live document that is continuously revised and updated based on the collected and analyzed data.

Table 43 includes the implementation steps of the IWRM as per the United Nations Environmental Programme (UNEP) (2012)[18] and how they were approached and detailed in the Updated NWSS-MoEW (2020). Table 43 also describes the missing actions that shall also be applied to achieve IWRM.

Table 43. IWRM Implementation Steps, NWSS Proposed Actions, and Identified Gaps

IWRM Implementation Steps	Updated NWSS-MoEW (2020) Approach and Proposed Actions	Missing Actions/ Additional Needed Actions
1. Understanding the system (study area, geographical features, socio-economic conditions, and legislation)	• Presentation of the actual status of the water sector and infrastructure with challenges facing it • Knowledge of surface and groundwater resources with detailed water balance at the distribution system level • IWRM endorsed in the Water Code (Law 77/2018) with implementation principles	• Description of the socio-economic conditions and variability across the country. • Water balance estimation at the river basin and interlinkage with groundwater aquifers. • Quantitative impact of climate change on water availability.
2. Distinguish potential areas of improvement 3. Development of improvement targets	• Hydro-meteorological monitoring systems, IHIS implementation and WEAP modeling • Legal and institutional strengthening • Additional infrastructure projects • Additional studies (Hydrogeological, geological, NLUMP, water resources, etc.) • Water governance reform with recruitment of staff and creation of project management unit	• Improving the Infrastructure monitoring system. • Surface water quality monitoring. • Considering the socio-economic system, the people living in the area, their water uses and related economic, social and cultural axes. • Water needs by economic sector. • Integrating climate change adaptation and mitigation measures.
4. Planning the strategy (budget, schedule, role and	• Cost estimation for all proposed studies and projects	• Detailed timeline including all the proposed activities.

[18] The UN-Water Status Report on the Application of Integrated Approaches to Water Resources Management. Disclaimers.

IWRM Implementation Steps	Updated NWSS-MoEW (2020) Approach and Proposed Actions	Missing Actions/ Additional Needed Actions
responsibilities, targets, and indicators)	• Separate timescale/timeline for some activities (Groundwater activities, IHIS studies)	• No specific staff for IWRM implementation except for IHIS. • No Key Point Indicators to follow up the IWRM implementation.
5. Implementation of plan		• No IWRM implementation plan
6. Monitoring, evaluation, and documentation		• No monitoring, evaluation, or documentation to follow on up IWRM implementation.

7.2.3 *Stewardship and Stakeholder Engagement*

The Updated NWSS-MoEW (2020) has committed to strengthening water stewardship and promoting environmentally sustainable water use through the implementation of the water code and enhancing information sharing, communication, and coordination between the concerned stakeholders and the public. Through the SDGs, world leaders have publicly acknowledged the importance of water stewardship in using and managing water sustainably. The approach and the actions proposed in the Updated NWSS-MoEW (2020) are outlined in Table 44.

Table 44. Approach and Actions Proposed to Strengthen Water Stewardship and Identified Gaps

The Updated NWSS-MoEW (2020) Approach	Actions Proposed in the Updated NWSS-MoEW (2020)	Missing Items and Required Actions
1. Considering users as key actors for implementing sustainable services	• Establishing non-profit irrigation water users' associations to assist in the management of public irrigation utility *(Article 75 of the Water Code).*	• The strategy does not directly address the citizens and primary users of the water sector, including farmers and industrialists.
2. Integrating Information, Education, and Communication (IEC) as a fundamental strategy component, in which all actors are informed of their position in the sector's organization as well as the position of other actors to fulfil their roles	• Involving all concerned stakeholders, including the MoE, Ministry of Education and Higher Education, Ministry of Information, and the private sector to collaborate on educating citizens on water right and water conservation culture. • *(Article 101 of the Water Code).*	• A clear plan on achieving financial and operational transparency in the water sector is needed. • A clear strategy/plan to reinstate the trust of the public in the government's water governance and sector's plans is needed. • The roles and responsibilities of the citizens and the civil society representatives in achieving the objectives of the strategy should be clearly outlined.
	• Publishing all information pertaining to potable and irrigation water to consumers on a regular basis. • *(Article 100 of the Water Code).*	
	• Publishing RWEs annual reports, financial reports, main sector indicators, and breakdown of the water bill.	
	• Developing E-governance and publishing all procedures online.	
	• Assessing and improving existing tools and communication strategy of the MoEW and RWEs.	
	• Defining the main indicators and messages to be communicated to the public and channels of communication.	
	• Developing social media platforms and websites.	
	• Designing and launching a national communication campaign on the water sector.	

The Updated NWSS-MoEW (2020) Approach	Actions Proposed in the Updated NWSS-MoEW (2020)	Missing Items and Required Actions
	• Establishing the IHIS database.	
3. Improving coordination and communication between governmental and non-governmental water sector stakeholders	• Proposing legal possibilities for PPPs with Municipalities.	• The roles and responsibilities of the private sector in supporting governmental mandates and responsibilities in the proposed PPPs should be clearly outlined.
	• Defining guidelines and a framework for private sector engagement.	
	• Establishing the National Water Authority (council) at the Prime Minister's Office *(Articles 14 and 15 of the Water Code).*	

To enhance stewardship in the water sector, the strategy should outline the roles and responsibilities of the citizens in achieving the objectives of the strategy. The strategy should directly address the citizens, who are the primary users of the water sector. For instance, the strategy can highlight the duties of the citizens in (1) applying water conservation practices, (2) implementing water efficient initiatives such as installing water efficient fixtures and rainwater harvesting systems; (3) monitoring water resources, (3) promoting subscription and paying water bills to ensure sustainable service delivery, (4) promoting responsibility to monitor and report illegal connections, water pollution practices, etc. National Social Behavioral Change Campaigns and awareness sessions may be needed to promote sustainable water use/management and water conservation among all users.

Keeping an open line of communication between the citizens and the concerned stakeholders and providing them with a platform to voice their concerns is needed. Most importantly, the strategy should capitalize on ways to regain the trust of the public. Water stewardship cannot be achieved without establishing trust within and between stakeholders involved in the water sector and the public. Lack of confidence and mistrust in the government's actions have led to public opposition that have hindered the implementation of proposed projects. In order to regain this trust, having a strong and transparent water governance is primitive, which includes having a transparent financial and operating system in the sector. Sharing of information and annual reports in a systematic and timely manner, which has been proposed in the strategy and the Water Code, can enhance the trust of the public and can provide the water users with the information needed to objectively assess the plans and projects of the Updated NWSS-MoEW (2020) and be part of the decision-making process. With the proper and transparent dissemination of information, the civil society can have an active role in monitoring the implementation of the strategy and assessing the performance of all actors. In addition, the role of the private sector in supporting the government's mandates and responsibilities should be clearly outlined, while ensuring that their activities do not infringe upon and overlap with the responsibilities of the government. Overall, the key message of the strategy should highlight the importance of collective action and meaningful partnerships among all parties involved in the sector, including users, to achieve responsible and sustainable water use and safeguard water resources.

7.2.4 *Achieving SDGs and International Commitments*

In 2017, Lebanon endorsed the SDGs issued by the UN, and in 2020, the updated Water Code emphasized the sustainable management of water resources. In its introductory volume, it is mentioned that the updated NWSS is developed in the context of the new Sustainable Development Goals, and in particular Goal 6, which aims to ensure access to water and sanitation for all.

Table 45 summarizes the proposed initiatives in the Updated NWSS-MoEW (2020) by SDG 6 target.

Table 45. Summary of the Proposed Initiatives in the Updated NWSS-MoEW (2020) by SDG 6 Target

Target		Proposed Activities	Comment
6.1	By 2030, achieve universal and equitable access to safe and affordable drinking water for all;	• Infrastructure projects to meet all water deficits at the national level. • Projects to meet current (2020) deficit in the water balance are prioritized. • Updated drinking water quality standards to be published. • Compliance and operational water quality monitoring proposed.	• Focus is more on providing water rather than "safe" water.
6.2	By 2030, achieve access to adequate and equitable sanitation and hygiene for all, paying special attention to the needs of women and girls and those in vulnerable situations;	• Infrastructure projects to ensure 100% sewage collection and wastewater treatment.	
6.3	By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally;	• Treating wastewater is the main activity to meet this goal.	• Wastewater reuse mentioned but not given needed focus.
6.4	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity;	• The proposed infrastructure projects will reduce the number of people suffering from water scarcity. • Water-use efficiency tackled mainly at the level of the agricultural sector. • IHIS system will provided a good basis for the sustainable management of the resources. • WEAP will help in IWRM.	• Sustainability of withdrawals is not clear in the strategy. • Water allocation is at the administrative district level rather than the basin/ catchment level. • Groundwater withdrawal appears to be unsustainable. • Withdrawals by other sectors (industry,

Target		Proposed Activities	Comment
			tourism, etc.) not considered separately. • Climate change consideration not elaborated.
6.5	By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate;	• The establishment of the IHIS is an important first step to collect the needed data to pave the way for IWRM.	• The implementation of IWMR is in its infancy. Refer to section on IWRM.
6.6	By 2030, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.	• Protection zones for springs are to be delineated. • Wastewater treatment is expected to help reduce pollution into water-related ecosystems.	• No serious actions on this front. Surface water resources quality monitoring absent.

As evident above, many of the proposed initiatives will help Lebanon in moving towards achieving the SDG targets, provided the necessary governance-related initiatives are successfully implemented. The initiatives appear to be more focused on achieving SDG targets 6.1 and 6.2 and less on the remaining targets. More details are presented under the specific key issues. It would have been beneficial, particularly for monitoring purposes, to estimate quantitatively the percent contribution of these initiatives to the achievement of the SDG targets, along with a realistic timeline.

8 ANALYSIS OF ALTERNATIVES TO THE PROPOSED STRATEGIC ACTION

In theory, the SESA should review and assess proposed alternatives that have been identified and studied by MoEW during the preparation of the Updated NWSS-MoEW (2020). However, in the absence of formal alternatives to the Updated NWSS-MoEW (2020), this chapter focuses instead on highlighting potential alternatives that may enhancing the scientific dialogue on Lebanon's water sector, and to narrow the gaps between policy making and public opinion.

The SESA team assessed the following scenarios:

1) "Do Nothing" Alternative: A description of the future baseline (2035 status) without the implementation of Updated NWSS-MoEW (2020)
2) Water Supply Mix Alternatives, which consist of the following scenarios:
   - ***Current Status 2020*** which Represents the baseline scenario; the general status of 2020.
   - ***Scenario 1: "Updated NWSS-MoEW (2020) Scenario"*** represents the general status of 2035 with the implementation of the Updated NWSS-MoEW (2020)
   - ***Scenarios 2: "Updated NWSS-MoEW (2020) Scenario with the Addition of Non-conventional Water Sources"*** represents a duplicate of Scenario 2 of the general status of 2035, but includes the use of non-conventional resources as a water supply source
   - ***Scenario 3: "Updated NWSS-MoEW (2020) Scenario with increase in supply from SW sources"*** which increases supply from SW sources, considering that all the proposed dams in the Updated NWSS -MoEW (2020) will be completed by 2035
   - ***Scenario 4: "Updated NWSS-MoEW (2020) Scenario with increase in supply from GW sources"*** which considers that only the dams under construction will be completed and operational by 2035 (Janneh Dam, Mseilha Dam and Boqaata Dam), and considers increasing supply from GW sources to meet the demand.

8.1 "Do Nothing" Alternative

The "Do Nothing" alternative, also known as the "null variant" or "business as usual", is required under the MoE SEA Decree 8213/2012, and international laws related to SESA. The "Do Nothing" alternative is a description of the future baseline without the implementation of Updated NWSS-MoEW (2020).

Currently, the population relies the most on groundwater supply, constituting 83% of the total supply and 58% of the total available GW (2,750 MCM/year) on the national scale, exceeding the cap on groundwater extraction. Private wells (PrW) provide the highest percent supply (33%), followed by springs (31%) and public wells (PuW) (18%). The total supply (1,912 MCM/year) barely covers the total demand (1,837 MCM/year) at the current network efficiency of 50% (Figure 36).

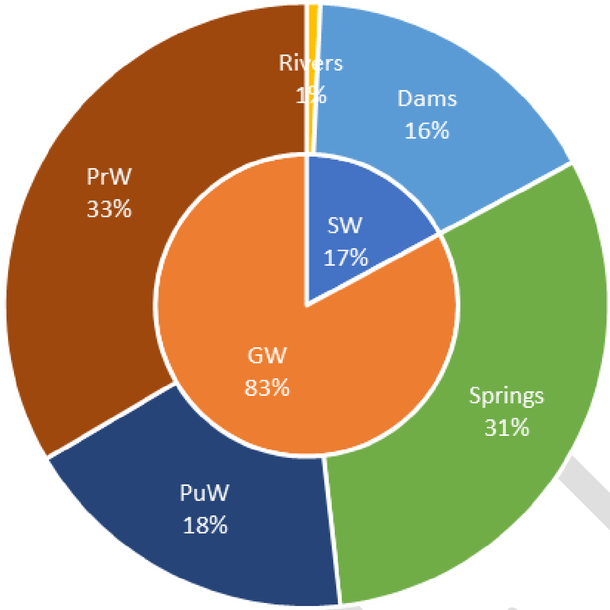


Figure 36. Current Water Supply Mix (2020)

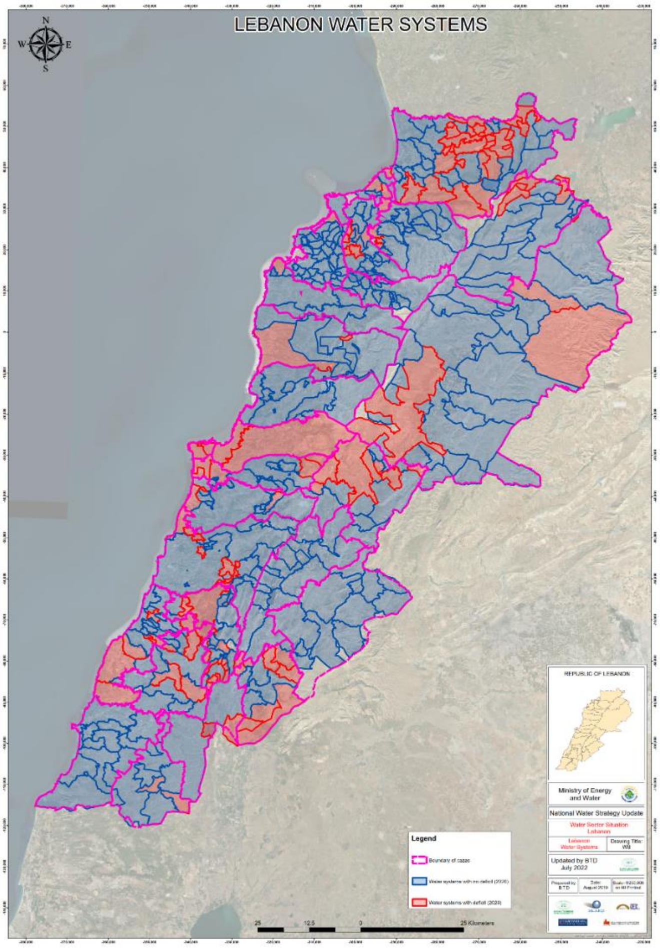
In addition to the challenges associated with the proper and sustainable management of water resources to meet the national water demands, high pollution levels in many of Lebanon's water sources have made them unusable or require high-cost treatment prior to use (UNDP et al., 2020).

The open discharge of untreated domestic wastewater is reportedly the main source of contamination of surface water; while other sources include point sources from industrial, healthcare, and touristic establishments, quarries, and agricultural run-off. Groundwater quality has been also deteriorating due to water contamination as a result of both over-pumping and human activities (UNDP et al., 2020). Sewage seepage and agricultural sources have been reported to cause nitrate pollution in groundwater sources.

In addition to the above-mentioned challenges, the water sector has also been impacted by the multitude of crises facing the country that began late 2019 and have been gradually exacerbating; these include the economic collapse, fuel shortages, and the COVID-19 pandemic. UNICEF warns that the water sector in Lebanon is on the verge of collapse and projects that more than 71% of people residing in Lebanon, including refugees, are at immediate risk of losing access to safe water (UNICEF, 2021a).

Figure 37 and Figure 38 show a comparison of the regions expected to face water shortages in the case of "Do Nothing" Scenario.

Based on the above, it clear that without effective action to increase supply and improve water quality, Lebanon would be in danger of facing severe water shortages in the near future.



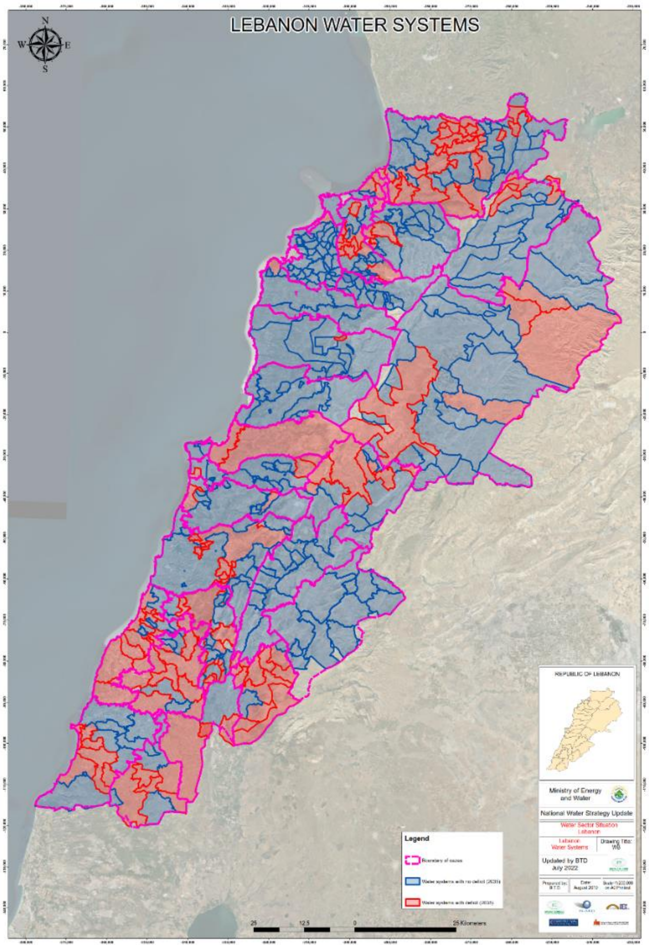


Figure 37. Water Systems with Deficit 2020

Figure 38. Water Systems with Deficit 2035

8.2 Water Supply Mix Alternatives

The MoEW and RWEs rely on different water sources (surface and groundwater) to supply water to users (domestic, agriculture, industry, etc.). The combination of water sources and supply schemes results in a national water supply mix (WSmix). However, the MoEW and RWEs face many challenges to supply water to the different users (domestic, agriculture, industry) during the entire year. In addition to the challenges described in Section3.2, the MoEW and RWEs must address seasonal scarcity and human and ecosystem need fluctuations by combining different local conventional water sources (surface and groundwater), including alternative water sources in some limited cases. Moreover, matching the geographical location of the abstracted water with the water needs, selecting the appropriate schemes for water production and supply, and assessing resulting environmental impacts shall also be considered.

In this section, the SESA team analyzed different WSmix scenarios. The scenario development was based on the estimations and assumptions summarized in Table 46. In all alternatives, the percent reliance on GW is higher than that of SW knowing that not all available resources could be exploited as temporal distribution is not aligned with irrigation/agricultural season. On an international level, countries are implementing policies towards the sustainable use of water, reflected through the management of groundwater over-exploitation and increase in surface water exploitation and storage to meet domestic, industrial and agricultural water demand[19].

Table 46. Summary of Assumptions Used for WSmix Scenario Development

		Estimations/ Assumptions
Water Sources		
Surface Water (SW)	Rivers	1- Public water supply directly from rivers is limited as (1) it is used for irrigation purposes and (2) river flow decreases in summer during the irrigation season, when it is needed the most. Supply is estimated in the Updated NWSS -MoEW (2020) at 14 Mm^3/year and is projected to increase to 21 Mm^3/year. 2- The total available SW is estimated in the Updated NWSS -MoEW (2020) at 1,475 Mm^3, however not all of it is exploitable due to its temporal variation throughout the year. Hence, it is in non-alignment with the demand during the irrigation season.
	Dams	1- Although dams are usually filled during winter and spring seasons, with 50% contribution directly from rainwater runoff to rivers and 50% from springs discharge or snowmelt during the spring season, the dynamic capacities of the dams were considered as surface water resources. 2- As per the Updated NWSS -MoEW (2020), the dynamic capacity of all existing dams is 314 Mm^3 and will increase to 625 Mm^3 when the under construction and on-hold dams are put into operation. This additional dynamic volume is divided as follows: - 240 Mm^3 for potable water (125 Mm^3 from Bisri Dam; 90 Mm^3 from Janneh Dam, 11 Mm^3 from Mseilha Dam and 12 Mm^3 from Boqaata Dam) - 70 Mm^3 for irrigation (63 Mm^3 from Assi Dam -Phase 1, 5 Mm^3 from Janneh Dam, 1 Mm^3 from Mseilha Dam and other) 3- The construction of all the proposed dams is not expected to be achieved before 2035.
Groundwater GW	Springs	1- The annual spring flow is estimated at 2,050 Mm^3/year as per the Updated NWSS -MoEW (2020). Spring flow is either used by direct tapping for potable water and irrigation supply, or indirectly through filling of dams. 2- The actual volume extracted from springs in 2020 is 594 Mm^3/year, as per the Updated NWSS -MoEW (2020): 315 Mm^3/year for irrigation and 280 Mm^3/year for potable water. This volume is projected to increase in 2035 to 656 Mm^3/year with the additional volume used for potable water only as per the Updated NWSS -MoEW (2020).
	Public Wells	1- Almost all the existing and proposed public wells are used for potable water. 2- The actual extracted volume from public wells is 350 Mm^3 for 12h Operation as per the Updated NWSS -MoEW (2020). 3- The extracted volume from public wells is projected to increase to 635 Mm^3 for 24h Operation as per the Updated NWSS -MoEW (2020).

[19] (Semi)-Arid but also temperate example countries include:
Spain ~ 78% SW; 22% GW (OECD,2011),
Morocco ~ 80% SW; 20% GW (Hssaisoune et. al., 2020),
Greece ~ 58% SW; 42% GW (EASAC, 2010), and
France ~ 50% GW, 50% SW (Marechal & Rouillard, 2020)

		Estimations/ Assumptions
	Private Wells	1- The actual extracted volume from 85,000 private wells is estimated at 640 Mm^3/year as per the Updated NWSS -MoEW (2020). 2- The extracted volume for irrigation is estimated at 315 Mm^3/year as per the Updated NWSS -MoEW (2020). 3- It is assumed that the extracted volume from private wells for domestic and non-domestic use is expected to decrease to a minimum or null in 2035, when the total demand for potable water is ensured from public supply sources. Private wells can be used to meet irrigation demand in case no public facility was conceived.
Non-Conventional water sources	TSE Reuse	1- The reuse of TSE is expected to be applied for irrigation purposes only, during the irrigation season extending from June to September. 2- The quantities of available TSE for reuse were calculated based on the list of existing and proposed WWTPs presented in the Updated NWSS -MoEW (2020), and their proximity to nearby agricultural schemes. TSE reuse from most WWTPs located along the coast and discharging into the sea was not considered. Accordingly, the total TSE that can be reused following the completion of all the proposed WWTPs was estimated to be around 80 Mm^3/year.
	AAR	AAR will be limited to four pilot sites until 2035, as per the Updated NWSS -MoEW (2020), which were selected based on the UNICEF feasibility study. As recharge happens during the wet season, mostly in winter, water pumping from recharged aquifers will be limited to the summer season. Hence, a limited volume of a maximum of 50 Mm^3/year was estimated for this scenario analysis, to be recharged and reused, mainly for domestic purposes.
	Rainwater Harvesting	RH is geographically limited to hill lakes and other minor storage facilities used mainly for irrigation purposes. An approximate volume of 10 Mm^3/year from hill lakes was estimated for the scenario analysis.
Water Demand and Supply by Sector		
Domestic and non-domestic		1- Potable water shall be totally ensured from public facilities only (dams, springs, and public wells). 2- As per the Updated NWSS -MoEW (2020), the actual domestic and non-domestic water demand is 995 Mm^3/year for a current network efficiency of 50% (663 Mm^3/year in 2020 for a network efficiency of 75%). The demand is projected to decrease gradually to reach 807 Mm^3/year in 2035 due to improvements in network efficiency - reaching 75% in 2035. 3- The Updated NWSS -MoEW (2020) ensures water supply for domestic and non-domestic use mainly from dams, tapped springs and wells as follows: - Dams: 15 Mm^3/year in 2020 increasing to 255 Mm^3/year in 2035 upon the completion and operation of Bisri, Janneh, Mseilha and Boqaata dams - Tapped springs: 280 Mm^3/year in 2020 increasing to 342 Mm^3/year in 2035 - Public wells: 325 Mm^3/year in 2020 increasing to 635 Mm^3/year in 2035 from public wells for 24h operation 4- The deficit in supply in 2020 for domestic and non-domestic use, as per the above, is approximately 375 Mm^3/year, as only 620 Mm^3/year are available from public facilities with 50% network efficiency. This explains why the population currently resorts to private wells, water tankers and other local initiatives to meet their current water demand.

	Estimations/ Assumptions
Agriculture	1- As per the Updated NWSS -MoEW (2020), the current irrigation water need is 842 Mm^3/year, of which only 75% (630 Mm^3/year) is met, with 50% (315 Mm^3/year) coming from springs and the remaining 50% from private wells. 2- The projected irrigation water demand is expected to increase to 927 Mm^3/year. 3- To meet the required current deficit (212 Mm^3) and future deficit in 2035 (297 Mm^3) for irrigation, the Updated NWSS -MoEW (2020) relies on newly constructed dams or private wells as follows: - 70 Mm^3/year from dams (63 Mm^3 from Assi Dam- Phase 1, 5 Mm^3 from Janneh Dam, 1 Mm^3 from Mseilha Dam and other) - 152 Mm^3/year increasing to 227 Mm^3/year from springs and/ or private wells 4- Private wells will still be needed for irrigation in certain areas, as per the geographic distribution of agricultural schemes. The MoEW will need to regulate the public use of these private wells.
Network Efficiency	
1- The Updated NWSS -MoEW (2020) assumes that the network efficiency in 2020 is 50%, including all physical losses and non-accounted for water. 2- The Updated NWSS -MoEW (2020) projects an increase in network efficiency to reach 75% in 2035.	

8.2.1 *Description of WSmix Scenarios*

Current Status 2020 represents the general status of 2020 with currently available supply of 1912 Mm^3/year and required demand of 1837 Mm^3/year, adopting a network efficiency of 50%.

Scenario 1: represents the general status of 2035 with a network efficiency of 75%, i.e., the Updated NWSS-MoEW (2020). This scenario, similar to the Updated NWSS-MoEW (2020), does not include non-conventional water resources as a supply source. Furthermore, it considers only the dams that are currently under construction (namely Janneh Dam) or on-hold (namely Al Assi-Phase 1 Dam, and Bisri Dam) to be completed by 2035.

Scenario 2: "Updated NWSS-MoEW (2020) Scenario" represents a duplicate of Scenario 2 of the general status of 2035, but includes the use of non-conventional resources as a water supply source, replacing supply from GW as follows:

- For irrigation: TSE reuse and RH instead of extraction from Private Wells
- For domestic and non-domestic: AAR in proposed pilot locations to optimize supply from public wells

Scenario 3:" Updated NWSS-MoEW (2020) Scenario with increase in supply from SW sources" maintains a constant total water supply equal to 2,257 Mm^3/year in 2035, as per the Updated NWSS -MoEW (2020). However, it increases supply from SW sources, considering that all the proposed dams in the Updated NWSS -MoEW (2020) will be completed by 2035, without the use of non-conventional resources, to reach a total supply of 985 Mm^3 from dams. This increase was matched with a decrease in supply from spring water (- 200 Mm^3/year) and private well water (- 160 Mm^3/year) both for irrigation and domestic and non-domestic uses. Extraction from public wells was kept the same, corresponding to 24hr pumping.

Scenario 4: "Updated NWSS-MoEW (2020) Scenario with increase in supply from GW sources" maintains a constant total water supply equal to 2,257 Mm^3/year in 2035, as per the Updated NWSS -MoEW (2020). However, it considers that only the dams under construction will be completed and operational by 2035 (Janneh Dam, Mseilha Dam and Boqaata Dam), providing a supply of 435 Mm^3/year, and that non-conventional resources will not be used. This scenario considers increasing supply from GW sources to meet the demand, mainly private wells that will be used for irrigation, to compensate for the absence of surface water in dams, as springs and public wells are already providing their maximum capacity envisaged by the Updated NWSS -MoEW (2020). This scenario is only feasible if extraction from private wells is regulated by the MoEW.

Table 47 below presents the different WSmix scenarios described above to meet the demand estimated in the Updated NWSS -MoEW (2020), while maintaining a constant total water supply equal to 2,257 Mm^3/year in 2035. Note that this exercise should be considered with caution as it was conducted at the national level. The geographical distribution and temporal availability are main challenges for water supply and for the distribution between resources, hence, the importance of water management at the river basin/ watershed scale.

- *Current Status 2020* shows that currently, the population is relying the most on GW supply, constituting 83% of the total supply and 58% of the total available GW (2,750 Mm^3/year) at the national scale. Private wells provide the highest percent supply (33%), followed by springs (31%) and public wells (18%). Total supply (1912 Mm^3/year) is barely covering the total demand (1837 Mm^3/year) at current network efficiency of 50%. Increasing network efficiency to 75% will reduce the demand to 1505 Mm^3.

- *Scenario 1: "Updated NWSS-MoEW (2020) Scenario"* shows that if the dams that are on-hold and under construction are completed by 2035, the public supply will most likely increase to cover all potable water demand and the population will mostly rely on private supply for irrigation purposes. SW supply (646 Mm^3/year) will still constitute a low percentage (29%) of the total supply and 44% of the total available SW (1,475 Mm^3/year) at the national scale. GW supply (1611 Mm^3/year) is 71% of the total supply and 59% of the total available GW (2,750 Mm^3/year) at the national scale.

- *Scenario 2: "Updated NWSS-MoEW (2020) Scenario with Addition of Non-conventional Water Sources* shows that non-conventional resources are projected to be limited in Lebanon, and they can reach a maximum of 6% of total supply. However, this does not forgo the need to develop them, particularly AAR, which was included in this analysis at the pilot scale proposed in the Updated NWSS- MoEW (2020).

- *Scenario 3: "Updated NWSS-MoEW (2020) Scenario with increase in supply from SW sources"* shows that an increase of SW supply (45%) through the construction of all the proposed dams in the Updated NWSS- MoEW (2020), will reduce reliance on GW (55%), specifically private wells, from 14% in Scenario 2 to 7%, mostly to meet irrigation demand. Public wells are considered to be pumping at full capacity, on a 24hr basis.

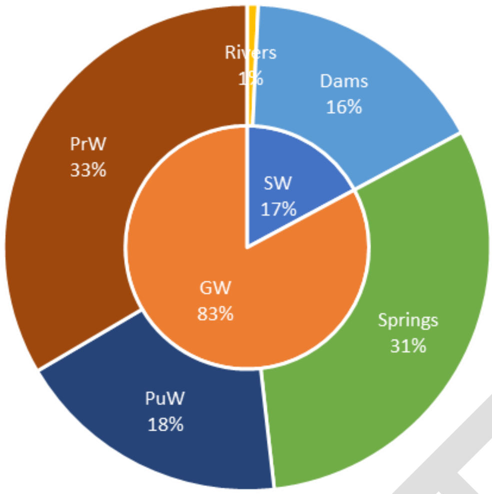
- *Scenario 4: "Updated NWSS-MoEW (2020) Scenario with increase in supply from GW sources"* shows that a decrease of reliance on SW (20%) by only proceeding with Janneh Dam, will increase the need for water supply from GW sources (80%), mainly private wells, as water from public wells is already being pumped at full capacity, on a 24-hour basis. This will result in over-pumping (1052 Mm^3/ year) of groundwater resources.

Table 47. WSmix Scenarios

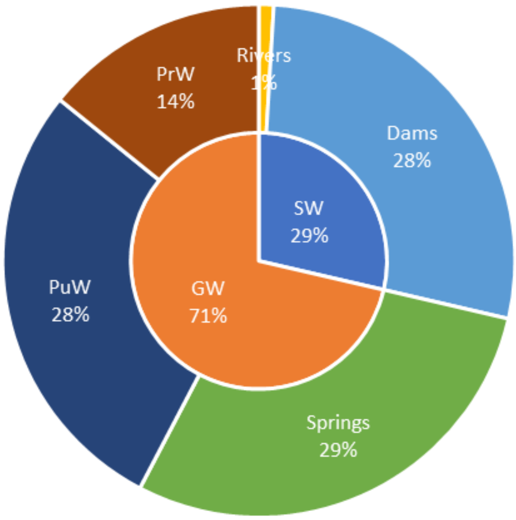
Scenario #	Scenario Description	Total Demand in Mm^3: Network Efficiency 50%	Total Demand in Mm^3: Network Efficiency 75%	Total Supply in Mm^3	Total Supply by Source: Surface Water (SW) Mm^3 (% supply by source) (% of available resource) [a]	Total Supply by Source: Ground Water (GW) Mm^3 (% supply by source) (% of available resource) [a]	Total Supply by Source: Non-Conventional Mm^3 (% supply by source)
Current Status 2020	General status of 2020 with currently available supply and required demand	1837	1505	1912 PuS 1272 PrS 640	328 (17%) (22%) Rivers: 14 (1%) Dams [b]: 314 (16%)	1584 (83%) (58%) Springs: 594 (31%) PuW: 350 (18%) PrW: 640 (33%)	0
1	General status expected in 2035 without non-conventional resources, and with dams under construction/ on-hold completed (Janneh, Al Assi-Phase 1, and Bisri Dams)	2138	1734	2257 PuS 1937 PrS 320	646 (29%) (44%) Rivers: 21 (1%) Dams [b]: 625 (28%)	1611 (71%) (59%) Springs: 656 (29%) PuW: 635 (28%) PrW: 320 (14%)	0
2	Scenario 2 with the use of non-conventional resources to substitute private wells for irrigation (from WWR and RH) and public well for domestic/ non-domestic (from AAR)	2138	1734	2257 PuS 2027 PrS 230	646 (29%) (44%) Rivers: 21 (1%) Dams [b]: 625 (28%)	1471 (65%) (53%) Springs: 656 (29%) PuW: 585 (26%) PrW: 230 (10%)	140 (6%) TSE Reuse: 80 (4%) AAR: 50 (1.3%) RH: 10 (0.7%)
3	Increase of SW supply through the completion of all proposed dams in the 2020 NWSS by 2035	2138	1734	2257 PuS 2097 PrS 160	1006 (45%) (68%) Rivers: 21 (1%) Dams [b]: 985 (44%)	1251 (55%) (45%) Springs: 456 (20%) PuW: 635 (28%) PrW: 160 (7%)	0
4	Increase of GW supply through pumping from private wells to substitute SW from dams. Janneh, Msielha, and Beqaata Dams are only completed over and above the existing dams of Scenario 1	2138	1734	2257 PuS 1740 PrS 517	449 (20%) (30%) Rivers: 14 (1%) Dams [b]: 435 (19%)	1808 (80%) (66%) Springs: 656 (29%) PuW: 635 (28%) PrW: 517 (23%)	0

PuS: Public Supply; PrS: Private Supply; PuW: Public Wells; PrW: Private Wells; AAR: Artificial Aquifer Recharge; TSE: Treated Sewage Effluent; RH: Rainwater Harvesting;
[a] The percentage from available GW (2,750 Mm^3) or SW (1,475 Mm^3) resource at the level of the national water balance scale, knowing that not all available resources could be exploited as temporal distribution is not aligned with irrigation/agricultural season

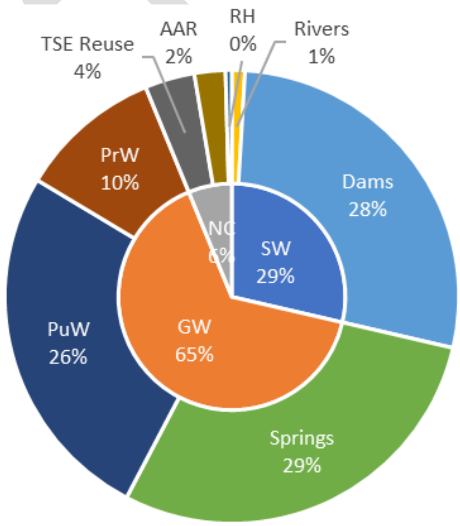
[b] Although dams are filled from surface runoff (50%) and springs and snow melt (50%), they are considered in this table as filled 100 percent from surface water.



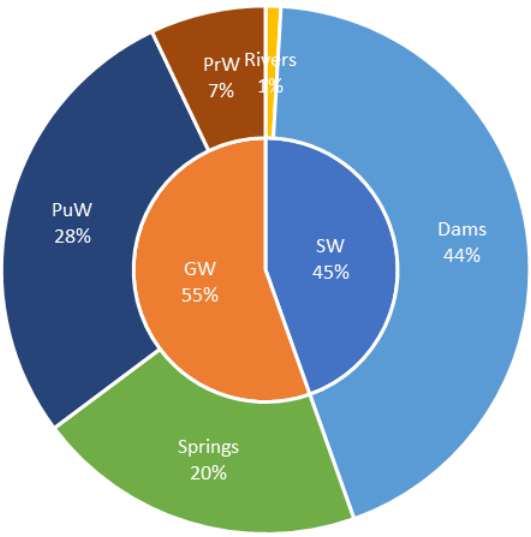
Current status 2020



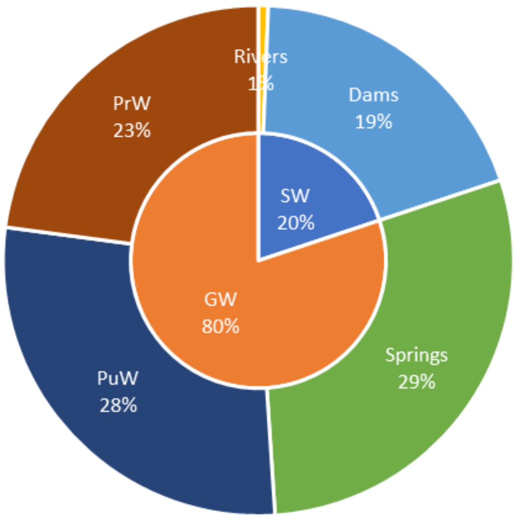
Scenario 1 WSMix- Updated NWSS-MoEW (2020)
Scenario



Scenario 2 WSMix- Updated NWSS-MoEW (2020)
Scenario with Addition of Non-conventional Water Sources



Scenario 3 WSMix- Updated NWSS-MoEW (2020)
Scenario with increase in supply from SW sources



Scenario 4 WSMix- Updated NWSS-MoEW (2020)
Scenario with increase in supply from GW sources

Figure 39. Illustration of WSMix Scenario Results

8.2.2 *Analysis of WSmix Alternatives*

Each scenario described above will have positive and negative economic, social and environmental externalities. A qualitative comparative assessment of the relevant impacts of these scenarios was conducted in Table 48. This was supplemented with a monetary assessment of selected impacts of *Scenarios 3* and *4*, as compared to *Scenario 1*, which is considered as the baseline, representing the Updated NWSS-MoEW (2020) scenario (Table 49).

Scenario 2 was not considered in the economic assessment due to lack of monetary data on non-conventional sources. Yet, even though non-conventional sources are projected to reach a maximum of 6% of total supply by 2035, this scenario is an improvement to *Scenario* 1 on various fronts and is worth considering. The incorporation of non-conventional water into the overall supply will mainly release the stress on groundwater abstraction for irrigation through TSE reuse and hill lakes. AAR will also help reverse seawater intrusion in coastal aquifers. However, abstracting water from recharged aquifers needs to be considered in terms of pumping energy costs and carbon emissions. As the AAR potential included in *Scenario 2* is limited to pilot projects, this potential needs to be explored further, and its feasibility assessed on a case-by-case basis, taking environmental, social, and economic impacts into consideration.

The increase of surface water supply through the completion of all proposed dams in the 2020 NWSS by 2035 as suggested in *Scenario 3*, will reduce the reliance on groundwater by half, specifically private wells, as compared to *Scenario 1*. This will result in estimated savings on private water sources (i.e., tankers, bottled water, and private wells) that can reach around 2.23 Bn USD/year (Table 49). Also, the reduction of groundwater pumping will imply less energy consumption, and thus reduction of carbon emissions estimated at 50,00 $mtCO_2e$ per year, equivalent to around 10,800 cars. The reduced emissions will result in savings of 2.55 Mn USD/year on social cost. As for the seawater intrusion, with the implementation of *Scenario 3*, reliance on private wells will be reduced to 160 Mm^3/year, which will decrease coastal seawater intrusion with averted costs estimated at USD 800 Mn. On the other hand, and as discussed in the impact assessment chapter, dams are associated with several direct environmental costs including loss of biodiversity at the species level, destruction and/or fragmentation of habitats, loss of topsoil, disposal of excavation material, disturbance to environmentally sensitive areas (such as protected or rare geological formations, reduced/ dry up of environmental water/flows, etc. Direct social costs of dams include expropriation of lands affected by the water dam, loss of agricultural output in submerged lands, loss of known/unknown cultural heritage, disruption of grazing patterns, etc.

Scenario 4 proposes the completion of only Janneh (95 Mm^3/year), Boqaata (12 Mm^3/year), and Mseilha (11 Mm^3/year) dams. The loss of surface water supply from Bisri and Al Assi dams, as per *Scenario 1*, will have to be compensated by an increase in groundwater extraction from groundwater sources (80%), mainly private wells, as water from public wells is already being pumped at full capacity, on a 24-hour basis. Thus, *Scenario 4* will create social cost overruns as such: increase in household expenditure on private water sources (tankers, bottled water, and private wells) specially groundwater pumping (USD 1,280 Mn USD), increase in carbon emissions and its cost on the society (USD 3.13 Mn), and increase in seawater intrusion from over-pumping of groundwater aquifers in coastal areas and deterioration of water quality (USD 442 Mn). Furthermore, increased reliance on private wells is of concern for two main reasons, (1) the control of abstraction of groundwater from private wells is challenging, and (2) groundwater resources are already heavily exploited (990 MCM/ year in 2020) whereby the maximum allowable withdrawal limit is set by the MoEW at 500 MCM/year. On the other hand, the construction of less dams as per this scenario will forgo the negative impact of dams on biodiversity and ecosystems, land use and conservation, and land acquisition and expropriation, among others, as illustrated in Table 48.

Table 48. Qualitative comparative assessment of the major relevant environmental, social, and economic impacts of the WSMix scenarios

Major relevant impacts		Scenario 1	Scenario 2	Scenario 3	Scenario 4
Biodiversity & ecosystems	Loss of biodiversity (species level)/ Destruction and/or fragmentation of habitats/ Loss of topsoil	- -	- -	- - -	-
	Disturbance to environmentally sensitive areas (such as protected or rare geological formations)	- -	- -	- - -	- -
Land use & conservation	Landscape enhanced (due to the water body)/ Water body becomes an important bird area	+ +	+ +	+ + +	+
	Grazing patterns disrupted	- -	- -	- - -	-
	Loss of known/unknown cultural heritage (archaeological finds)	- -	- -	- - -	-
	Water bodies attract undesired urban development (resorts, restaurants, activities, etc.)	- -	- - -	- - -	-
	Disposal of excavation material	- -	- -	- - -	-
Water conservation & management	Unsustainable water use (Environmental flows dry up/ Over pumping/ Water pollution)	-	+/ -	- -	- - -
	Reduced surface water runoff (and increased surface storage)	+ +	+ + +	+ + +	+
Climate change mitigation	GHG emissions during construction	- -	- -	- - -	-
	GHG emissions during operation (pumping, hydropower generation, biomass decomposition in reservoirs)	-/ +	-/ + +	- -/ +	- - -/ +
Socio-economics	Expropriation of lands/ Land acquisition/ Reduced land access	- -	- -	- - -	-
	Loss of agricultural output in submerged lands (e.g., orchards uprooted)	- -	- -	- - -	-
	Improved prospects for economic development in agricultural community	+ +	+ + +	+ + +	+
	Supply reliability (access to irrigation water/ reliance on bottled water/ tanker trucks/ private wells)	+ +	+ + +	+ + +	- -
	Infrastructure works (CAPEX)	- -	- -	- - -	-
	O&M costs of water body and ancillary treatment facility	-	- -	- -	- - -

- low negative impact
- - medium negative impact
- - - high negative impact
0 neutral impact

+ low positive impact
+ + medium positive impact
+ + + high positive impact

Table 49. Economic analysis of proposed scenarios

Water Supply	Scenarios Assessment[1]	
	Scenario 1 vs 3	Scenario 1 vs 4
Water Supply from Dams (Mm^3/year)	+360	**-190**
Water Supply from Groundwater (Private Wells in Mm^3/year)	**-160**	+197
Savings/(Costs)	**Scenario 1 vs 3**	**Scenario 1 vs 4**
Private Water Sources (in Million USD)	**$2,221**	**$(1,280)**
Tankers	$1,078	$(569)
Bottled Water	$986	$(521)
Groundwater Pumping	$157	$(190)
Carbon Emissions (mtCO2e)	**50,538**	**(61,456)**
Equivalent to cars emissions (# of cars)	10,986	13,360
Carbon Emissions Social Cost (in Million USD)	**$2.58**	**$3.13**
Coastal Seawater Intrusion (in Million USD)	**$838**	**$(442)**

[1] *Scenario 2* was not considered in the economic assessment due to lack of monetary data on non-conventional sources

Box 12. Assumptions adopted for economic analysis of alternatives

1- Cost of water from dams is borne at the community level by the public facilities whereas private wells are costly on a household level
2- The capacity of potable water to be supplied by dams will have to be compensated by groundwater pumping and purchase of water from private suppliers (i.e., tankers, bottles)
3- The deferral of Bisri dam proposed to serve 124 Mm^3 of potable water for Beirut and Greater Beirut region, would exacerbate the reliance on groundwater to compensate the water supply needed in 2035
4- Reduced reliance on private wells - i.e. less groundwater over-pumping especially in coastal regions will decrease saline intrusion in Beirut, Damour, and Saida, and improve water quality
5- Saltwater intrusion drives household to either install desalination units and filters (RO brackish water systems), or to purchase freshwater for household use
6- Household consumption per day of freshwater is equivalent to 1 m^3
7- Estimated electricity consumption needed per m^3 of pumped water is 0.44 kWh
8- Estimated carbon emissions per kWh of burned fuel is equivalent to 7.09×10^{-4} metric tons of CO_2 emissions
9- Average household expenditure on bottled water per year is around USD 600 (in 2018)
10- Cost of water tankers per m^3 ranges between 3.75 to 7.55 USD (in 2018)
11- Median annual cost incurred from coastal seawater intrusion is estimated at 850 USD/HH/year based on the published study of I. Alameddine, R. Tarhini & Mutasem El-Fadel (2018)

Conclusion

The scenario analysis showed that increasing supply from groundwater will exacerbate over pumping from aquifers. Supply from groundwater, currently estimated at 990 MCM/year at 50% network efficiency, can be reduced to a minimum of 795 Mm^3 in the case of Scenario 3 with network efficiency of 75% and the construction of all proposed dams. This is still over and above the recommended maximum abstraction of 500 MCM/ year, which justifies to a certain extent the need for water storage in dams at the national scale (but does not justify the proposed dam locations or engineering design). Furthermore, the construction of dams (Scenario 3) opts to significantly reduce direct costs incurred by the society in terms of securing water supply from private sources, specifically private wells, where estimated savings on household expenditure reach around USD 2.2 Bn. On the other hand, if the supply from groundwater sources was increased (Scenario 4), additional private costs borne by the society can reach USD 1.3 Bn. However, this does not necessarily indicate that dams, which are highlighted in the Updated NWSS- MoEW (2020) to compensate for the water supply in 2035, appear with no cost overruns. Moreover, large dam projects are heavy on the government treasury (USD 2.12 Bn excluding Bisri Dam), and they result in ecological, economic, and social costs (as listed in Section 7.1) that need to be assessed at granular level by conducting more sophisticated cost-benefit analysis models. The latter will validate whether dam construction projects have economic benefits that are large enough to justify various kinds of environmental damage.

In fact, the irreversible nature of many ecosystem impacts makes it difficult to accurately assess or quantify the benefits or losses from dams, such as the loss of biodiversity through the extinction of yet-undiscovered fauna and flora species in riverine systems and forests. For example, in an attempt to value the loss of ecosystem services from Janneh Dam in Lebanon, around 45 Mn USD/year in ecological, economic, and social losses, were estimated, excluding cost of land expropriation. However, this value cannot be extrapolated to other dam projects given that it is a conservative value that only reflects a specific project, noteworthy that each dam scale and location will play a vital role in its magnitude of impacts. Furthermore, the human costs of dams range from the most direct, property loss submergence by the reservoir, and extend to loss of economic livelihood due to displacement, break-up of community and its resulting negative effects, a loss of culture and identity, deterioration in health (especially the reservoir related spread of schistosomiasis, devastating waterborne disease parasite that thrives near dams), and social marginalization and conflicting there settled area.

Nevertheless, regardless of the adopted scenario, it is crucial to:

- Develop an integrated watershed management strategy prior to the implementation and completion of proposed dams in the Updated NWSS -MoEW (2020). This will allow to minimize and mitigate risks and damages and reduce the costs on the society.

- Focus on increasing network efficiency to 75%, as this is a main assumption in the Updated NWSS -MoEW (2020), which has a great impact on water demand and is a main condition for sustainable water management. It keeps a safety margin between the total demand (1,734 Mm^3) and total supply (2,257 Mm^3). Increasing network efficiency will also reduce over pumping from aquifers and corresponding energy consumption.

- Regulate abstraction from groundwater wells, including private ones. Furthermore, under the current circumstances, water supply from private wells cannot be reduced to null as several agricultural schemes will still be relying on it.

- Promote additional R&D efforts to assess the potential of increasing the reliance on non-conventional resources. The upscaling of AAR following pilot testing may provide a good potential that is worth exploring, particularly that the problem of over-abstraction will not be solved by 2035 as per the Updated NWSS-MoEW (2020).

9 SELECTION OF THE «MOST SUITABLE STRATEGIC OPTION »

The requirement to select the most suitable strategic action in the SESA report is based on the assumption that the SESA study takes place in an ideal situation, i.e. where a number of alternative strategic plans are being considered before implementation has started. In such a case, the strategic alternatives would have been defined, at least in outline, and the key factors affecting their feasibility and operational characteristics would have been developed to an extent sufficient to determine their broad environmental, social, and economic effects.

In the case of Updated NWSS – MoEW (2020), implementation has already begun and no complete alternatives for achieving the same strategic objectives have been systematically set out in the strategy itself or in the documentation supporting the strategy. It is clear from interviews with staff and independent experts that some alternatives to individual components of the strategy were considered but were rejected – usually on the grounds of cost, as it became clear that preferable solutions, i.e. those presented in the Updated NWSS-MoEW (2020) itself, were available. It is also the case that the Updated strategy remains flexible, in that it allows for adjustment of the elements and targets of the strategy as time progresses and more information becomes available.

The above notwithstanding, it is possible to draw some useful conclusions about the environmental and social suitability of the Updated NWSS (2020) against the No Action Scenario and some of the alternatives that have been discussed in Section 8. Namely:

- The Updated NWSS (2020) provides a coherent strategy in an area where action is vital. This is because of the future potential for severe water shortages, over-exploitation of groundwater and pollution of water courses coupled with potential economic disruption associated with small farmers who are reliant on irrigation water. The No-Action alternative is risky to human health and well-being as well as to economic growth and even the future social and political stability of the nation and there are no tested affordable alternatives that can meet future water demand.
- There are several potentially significant negative environmental and social impacts that may be associated with implementation of the Updated NWSS-MoEW (2020) (land take, ecological effects, risk associated with larger storage dams) but all of these can either be satisfactorily addressed through well-designed management measures and/or, the impact would not be significantly lessened by adoption of an available alternative.
- Where alternative approaches have been identified that might yield better environmental and social outcomes, including water management at the river basin/ watershed scale and the consideration of non-conventional water sources (for example reuse of TSE, AAR, RH, etc.), these are not precluded by adoption of the Updated NWSS-MoEW (2020), which can be adapted and enhanced to accommodate more effective approaches as they become available. For example, the implementation of newly proposed dams could be slightly delayed allowing for better assessments at the river basin/ watershed scale as more data becomes available following the implementation of the proposed IHIS and other monitoring programs.

With the above in mind, it is reasonable to conclude that the Updated NWSS-MoEW (2020) is "the most suitable strategic option" from an environmental and social perspective, in that it is a necessary strategy which does not have irremediable negative impacts and for which there are no clearly superior available alternatives. However, the Updated NWSS-MoEW (2020) must remain flexible and can be greatly enhanced by researching and adopting other options and/or complementary measures for achieving the same goals. More importantly, the strategy can be best improved by prioritizing the governance-related initiatives to strengthen the institutional capacities and ensure sustainability of projects. For these measures to unfold, it is important that MoEW continues to moderate an open-minded and transparent discourse on Lebanon's water strategy with all relevant stakeholders. In other words, water planning must not end in 2020 when the Updated NWSS (2020) was compiled but, rather, should adapt to the growing uncertainties and emerging opportunities in the water sector.

10 A FRAMEWORK TO OPTIMISE THE ENVIRONMENTAL AND SOCIAL EFFECTS OF THE STRATEGY

This Chapter presents a framework to optimize the environmental and social effects of the Updated NWSS-MoEW (2020). Rather than focusing on activity level mitigation measures, which are best addressed in site-specific Environmental Management Plans, this SESA addresses policy responses required for the Updated NWSS-MoEW (2020) implementation. It also outlines other required responses such as advancing IWRM Implementation, prioritizing projects, strengthening EIA and EMP system, implementing adaptation strategies, establishing financial mechanisms, and enhancing public and stakeholder engagement.

10.1 Policy Responses

This section retraces the effects of the Updated NWSS-MoEW (2020) on key themes (see Chapter 7) and summarizes the most important policy responses represented in Table 50.

10.2 Advance IWRM Implementation

To achieve IWRM, the MoEW should lead on the following actions:

- Strengthening political will for IWRM implementation by clearly communicating and demonstrating the value of implementing IWRM for achieving multiple sustainable development objectives to key stakeholders at all levels and across sectors.
- Enhancing coordination between the different actors in the water sector.
- Strengthening the legal framework by issuing implementing decrees for the Water Code which recognizes IWRM at the basin level as the basis for water resources management and which promotes multi-sectoral coordination through the establishment of the National Water Council
- Encouraging effective stakeholder participation in the decision-making process. Stakeholders such as academia, media, private sector, water users' associations, NGOs, etc.
- Improving data and information to (1) provide a deeper understanding of the current conditions of the existing water and wastewater systems/services and how to improve them; (2) allow the sustainable allocation of water resources at the watershed basin level, as discussed in the water code; and (3) help set targets for the Updated NWSS (2020) and indicators that can be monitored on a continuous basis to assess improvements in the sector. A data sharing protocol should be established. It is important to ensure that the monitoring and modelling results will feed promptly into the strategy and that the proposed projects are updated accordingly to ensure the optimization of water resource use and the sustainability of water resources.
- Building capacities through securing IWRM-specific training and capacity building, including the creation and functioning of River Basin Organizations and other collaboration platforms, as well as the communication with citizens and users.

10.3 Prioritize Projects

The Updated NWSS-MoEW (2020) requires USD 3,129 Million for the implementation of Priority 1 projects, 2,556 M USD for Priority 2 Projects, and 1,485 M for Priority 3 Projects. However, given the current situation of the country and the economic turmoil, acquiring funds to implement all Priority 1 projects may not be possible. As such, sub-prioritization of the projects classified as Priority 1 is needed in order to identify the projects which have the most significant impact and are required to achieve the projected development in the sector.

In addition, each proposed activity in the Updated NWSS-MoEW (2020) should undergo a cost-benefit analysis to assess its feasibility, prioritize implementation plans and identify potential funds. This approach will allow comparison between proposed projects and will provide an initial estimate of the return on investment for these projects. The analysis should analyze both the financial and economic perspectives separately. The financial evaluation assesses the revenue generated by a project, based on tariffs and the amounts of water supplied or saved, or wastewater treated. While the economic evaluation assesses how much water is supplied or saved or wastewater is treated and their benefits to the economy.

10.4 Strengthen EIA and EMP System

The EIA process is essential to ensure environmental compliance of infrastructural projects proposed in the strategy. However, in general, the EIA process in Lebanon needs to be strengthened to ensure effective assessment and monitoring of projects' environmental compliance. The EIA process continues to face critical limitations including:

(1) EIA consultants. MOE Decision 7/1 (dated 6/3/2003) stipulates that EIA consultants must be prequalified by the CDR to conduct "environmental studies". The list of pre-qualified firms at CDR also includes dozens of "conventional" engineering firms that design roads, bridges, and dams. The result is that many EIAs are prepared by the same firm that designed the project, putting EIA consultants in a situation of conflict of interest. Equally important, the MoE should become the custodian of the list of pre-qualified EIA and EMP consultants.

(2) EIA Review. The MoE is currently understaffed and under-resourced. Effective and timely review of EIA studies is therefore hampered by the occasional lack of technical resources and skills in several project domains. Although technical skills will accrue at the ministry with each EIA, multiple EIAs for several projects in the same sector will be reviewed by different employees at the ministry. The benefits of accumulating subject-matter experience and knowledge are lost if the members of the EIA review committee change.

(3) Environmental Management Plans. (Article 11 of Decree 8633/2012). MoE requires that all EIA studies include a detailed EMP. EIA consultants prepare effective EMPs and typically request the client to endorse the EMP in the form of a commitment letter. Once the MoE is satisfied with the Final EIA report and has issued its final opinion, the client can proceed with the project. The role of the EIA consultants has ended unless the Client reappoints the consultant to ensure application of the EMP by the contractor. Currently, MoE has no resources or means to monitor EMP compliance as prescribed in the EIA decree (Article 11.2). EMP monitoring is essential to ensure environmental compliance of the proposed projects.

(4) Seeking the Position of MoE in relation to an EIA Study is Mandatory. Article 10.4 of Decree 8633/2012 stipulates that public institution shall not implement or operate new projects prior to seeking the (environmental) position of the Ministry of Environment regarding the EIA report; and

(5) Retroactive application of the EIA decree. Article 15 (on violations and penalties) stipulates that project owners must prepare an EIA study (or IEE) if the EIA decree was issued **before** the project started. If the EIA decree was issued **after** the project started, then the minimum requirement is to submit to the MOE an Environmental Management Plan for the project. [Experience to date has revealed some deficiencies in the Article; is the project start date determined based on contract signature with the lending agency or contract signature with the contractor or effective commencement of works on site].

See EIA process flowchart in relation to the date of the EIA decree in Figure 40.

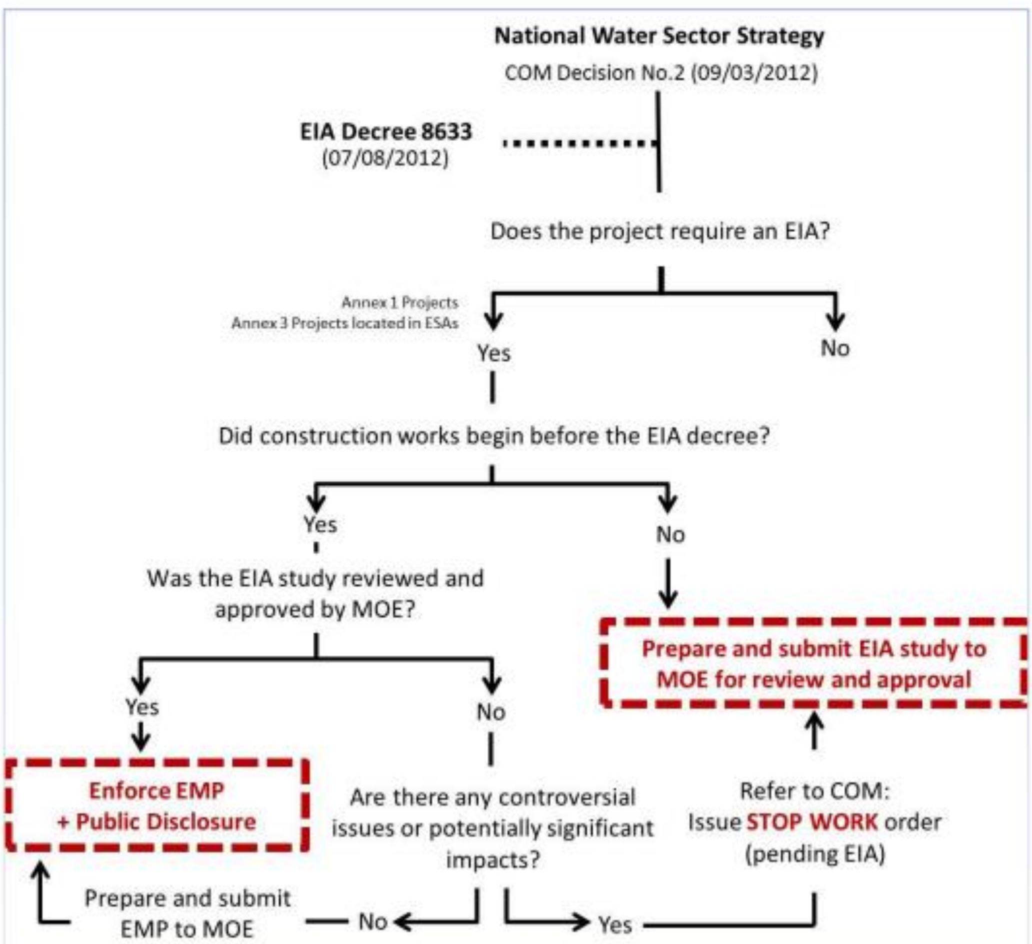


Figure 40. EIA decision flowchart in relation to the Updated NWSS-MoEW (2020) and the EIA Issuance Date

The EIA sector would greatly benefit from issuing guidance notes for dams, STPs, large-scale irrigation schemes, and artificial recharge –to serve as minimum requirements for EIA studies.

10.5 Implement Adaptation Strategies

The ability to adapt to foreseen and unforeseen changes is paramount to the long-term effectiveness of the Updated NWSS-MoEW (2020) and its ability to ensure water supply, irrigation, and sanitation services on a continuous basis and at optimal service levels, with a commitment to environmental, economic and social sustainability. As such, water resource allocation regime and water demand management must take into consideration not only gradual changes in water availability due to climate change, but also sudden changes due to unexpected climatic shifts.

10.6 Establish Financial Mechanisms

The MoEW should develop a sector investment program, to ensure that viable financing is available for the implementation of the Updated NWSS-MoEW (2020) proposed projects and their operation. The investment program should identify the infrastructure investments that are needed to achieve the projected development, while also taking into consideration the sustainability of services and priorities within the local context, in addition to socioeconomic factors. The program should set a framework for MoEW and relevant stakeholders to secure the funds for its implementation.

10.7 Enhance Public and Stakeholder Engagement

MoEW should enhance information sharing, communication, and coordination between the concerned stakeholders, including the public, on issues related to the water sector. Transparency and stakeholders' engagement is crucial for the successful implementation of the strategy. Coordination between all stakeholders is necessary to address actions that require broad cross-sectoral co-operation including (a) data sharing, (b) catchment protection, (c) climate change adaptation, and (d) Water Demand Management. In addition, this is also required to ensure that strategic development plans and national strategies set by other sectors are aligned with the water strategy, especially those for the industrial and agricultural sector.

Moreover, donor-funded projects and external support to the water sector (whether traditional, new, bilateral, multilateral, financial, etc.) should be carefully monitored to ensure alignment with the Updated NWSS-MoEW (2020). All donor projects must be coordinated by the MoEW, to ensure that project benefits are maximized and that there are no overlapping projects.

Table 50. Policy Framework for Optimizing the Environmental and Social Effects of the Updated NWSS -MoEW (2020)

Mitigation Strategies and Policy Recommendations to Optimize Environmental and Social Impacts	ID	Responsibility
KT1. Water Conservation and Management		
Sustainable Resources Allocation and Efficient Water Use		
• Identify existing available water resources in each watershed basin based on best available scientific evidence (i.e., data collected from the IHIS proposed in the Strategy).	KT1.1	MoEW, RWE's, LRA
• Revise the national water balance based on updated data following the implementation of initiatives under Pillars 1 and 2.	KT1.2	
• Improve the inter-ministerial coordination to optimize current and future sectoral demands: - Align current and future Ministerial strategies/vision, particularly those of the MoI, MoA, and MoT.	KT1.3	
• Develop a well-designed water allocation regime with the following objectives: - Economic efficiency, by allocating resources to higher value uses, according to a National Economic Plan once set by the GoL. - Water use efficiency through innovation and investment in the sector. - Environmental performance by securing adequate flows to support ecosystems services. The allocation regime should utilize international frameworks such as the Ecological Limits of Hydrologic Alteration (ELOHA) by Poff et al. (2009) to assess the environmental flow needs required to sustain water bodies to foster development and implement environmental flow standards. - Equity by sharing the risks of shortage among water users fairly, which include: o Equity among water users and between existing users and new entrants. o Equity in the process of allocation and re-allocation. o Fair distribution of costs and benefits. o Equitable sharing of risk of shortage.	KT1.4	
• Assess the impact of the proposed infrastructural projects (dams, hill lakes, wells, etc.) on water availability and aquifers and optimize the management accordingly (i.e., extraction rates, etc.).	KT1.5	
* **Empower and define the role of the Lebanese Center for Water Conservation and Management within the MoEW to promote policies that aim to develop and implement water conservation initiatives in the sector.**	**KT1.6**	
* **Review Lebanon's dam experience to-date to inform the planning, design, construction, and operation phases of dam implementation.**	**KT1.7**	MoEW
• Amend Building Regulations to include a requirement for a minimum standard of water efficiency in new facilities.	KT1.8	DGUP, OEA
Water Demand Management		
* **Develop a long-term national strategy to promote social behavior change and encourage consumers to efficiently use water. As part of the strategy development, MoEW should have an improved understanding of consumer attitudes and behavior and the motivations and barriers to individual and community action across different environmental issues. This will help link**	**KT1.9**	MoEW

	water saving to other behaviours on energy, environmentally friendly products, etc.		
*	**Propose initiatives to curb the uncontrolled groundwater extraction from private wells.**	**KT1.10**	
*	**Propose initiatives – with a defined budget and timeline – to reduce NRW.**	**KT1.11**	
*	**Prioritize rehabilitation of the distribution networks to minimize losses.**	**KT1.12**	
*	**In addition to district and household metering (which were proposed in the Updated NWSS-MoEW (2020)), encourage investment in water loss reduction systems (i.e. active leak detection, pressure management, etc.).**	**KT1.13**	
*	**Strengthen regular network maintenance programs**	**KT1.14**	
*	**Direct new funds towards installation, reading and maintenance of bulk and district meters, and ensure the availability of continuous funding for calibration and maintenance**	**KT1.15**	
•	Promote the installation of water saving devices for domestic use.	KT1.16	
•	Assess the potential of government subsidies, rebates and other financial incentives to encourage residents and business owners to make an investment in water efficiency.	KT1.17 (KT1.9)	
•	Develop programs to promote water efficiency at the household level, through partnerships with manufacturers, retailers and distributors, homebuilders, and contractors and develop branding labels similar to EPA's "WaterSense" for water efficient products.	KT1.18 (KT1.17) (KT1.9) (KT1.8)	
•	Establish minimum water efficiency specifications through codes and standards which will require builders to make water efficient investments at the time of construction or product purchasing. Local governments can work to improve compliance and enforcement, or to establish specifications that go beyond the code or standard.	KT1.19 (KT1.8)	
•	Develop programs to build the capacity of contractors to retrofit facilities for water savings, which can start with water audits to help identify problems and solutions for improving water efficiency.	KT1.20 (KT1.18) (KT1.17) (KT1.19)	
•	Provide technical support for industries to improve water efficiency and wastewater management.	KT1.21	MoEW, MoI
*	**Establish monitoring frameworks to track the quantities of water used per industrial sector. Accordingly, tailored water conservation programs can be developed.**	**KT1.22**	
•	MoEW to collaborate with MoA to induce changes to agricultural practices to reduce the demand for water (i.e., shift to more water-efficient bundles of crops to optimize yield per unit of water, adopt conservation tillage and agroforestry.)	KT1.23	MoEW, MoA
•	MoA to produce irrigation best practices guide and water management toolkit for field crop growers.	KT1.24	
•	Improve on-farm irrigation systems and efficiency of bulk irrigation water delivery.	KT1.25 (KT1.23)	
*	**Introduce appropriate water tariffs and incentives in order to promote water efficiency in irrigation and higher economic returns for irrigated agricultural products.**	**KT1.26**	
*	**MoEW to collaborate with and encourage MoA to consider the use of targeted adaption funds or temporary technological subsidies to support**	**KT1.27** (KT1.25) (KT1.23)	

farmers in adopting on-farm measures to enhance water efficiency (such as crop rotation, adjusting planting times, etc.)		
Non-Conventional Water Sources		
• Assess the potential contribution of non-conventional water resources to the water balance as an available water source and set a realistic target for 2035 accordingly.	KT1.28	MoEW, MoE, MoA, DGUP, OEA
• Promote alternative technologies such as rainwater harvesting to improve irrigation supply.	KT1.29	
• Amend Building Regulations to include a requirement for rainwater harvesting in new facilities.	KT1.30	
∗ **Prioritize the exploration of the potential for AAR and ensure that pilots are designed and implemented in areas where upscaling is needed to meet water deficit.**	**KT1.31**	
Reuse of Treated Wastewater and Sludge		
• Identify realistic targets for increasing TSE reuse and work towards achieving them.	KT1.32	MoEW, CDR
∗ **Require that the planned WWTPs, particularly those in rural/ agricultural areas or areas with significant water deficits, be reassessed in terms of the feasibility of TSE reuse and redesigned accordingly, taking environmental costs and benefits into account.**	**KT1.33**	
∗ **Study TSE reuse directly in irrigation or indirectly through AAR as an important source of water within the national water balance.**	**KT1.34** (KT1.28)	
∗ **Require an assessment of the potential of wastewater reuse in the WWTP EIAs and regulate TSE reuse in different sectors.**	**KT1.35** (KT1.33)	MoE, MoEW
• Develop necessary procedures to monitor TSE and sludge reuse in agriculture and land reclamation and put in place the necessary monitoring system to respond to any incompliances.	KT1.36	MoA, RWEs, Municipalities
Water Quality		
∗ **Set the infrastructure initiatives, particularly the construction of WWTPs, to be contingent on achieving some progress on the governance end and successfully operating the existing WWTPs.**	**KT1.37**	MoEW, CDR
∗ **Prioritize putting into operation the existing treatment plants at their design treatment levels over the construction of new WWTPs.**	**KT1.38**	MoEW, CDR, RWEs
∗ **Abstain from the construction of additional WWTPs if the networks connecting to them are not complete and/ or if their long-term operation and maintenance are not secured by the concerned RWEs.**	**KT1.39**	
∗ **Develop a National Plan for the Operation and Maintenance of wastewater treatment plants.**	**KT1.40**	
• Develop contingency plans for wastewater treatment plants, such as building holding tanks in WWTPs to store untreated sewage in case of operations shutdown or malfunction. Allow raw sewage bypasses only upon approval from the MoE and MoEW as part of the EIA process.	KT1.41	MoE, MoEW
• Verify the conditions of the receiving water to ascertain if it is in a state to receive the volume of TSE to be discharged.	KT1.42	
• Ensure that the storm water network is separated from the wastewater network during the design of the WWTPs. If not, ensure that storm water runoff is accounted for in the WWTP design and capacity.	KT1.43	

∗ **Ensure EMPs of the WWTP EIAs include:** - **Daily testing of TSE to ensure that it meets the minimum acceptable quality criteria set by international best practice or provided by Lebanese law and regulations (MOE Decision 8/1 of 2001).** - **Sampling of water courses containing TSE immediately upstream from any lakes or dams (baseline) to ensure the quality criteria for the lake or dam in question are being met downstream.**	**KT1.44** (KT1.41) (KT1.35)	
∗ **Empower MoE and MoEW to enforce the measures of the EMP on the RWE/WWTP operator.**	**KT1.45**	
∗ **Establish an adequate buffer zone for inland WWTPs either through MoEW/MoE/DGUP regulations or through the WWTP EIA process to prevent the seepage of contaminated material during construction or untreated sewage from any of the WWTP tank into nearby water bodies.**	**KT1.46**	
• Implement the "Polluter Pays Principle" of Law 444/2002 to reduce the point and non-point sources of pollution affecting water resources.	KT1.47	MoE, MoIM
• Continue with the efforts to ensure environmental compliance of industries, other classified establishments, health care centers etc., where wastewater is treated at the establishment level.	KT1.48	MoI, MoIM, MoPH, MoE
• Develop a national plan/framework for agriculture point and nonpoint sources pollution prevention.	KT1.49	MoA, MoE
Governance		
∗ **Interlink the implementation schedules of proposed water governance reform initiatives and infrastructure projects in the Updated NWSS-MoEW (2020).**	**KT1.50** (KT1.37)	MoEW
∗ **Aim to adopt the international frameworks for good governance, which includes principles of good water governance for the OECD Twelve Principles of Good Water Governance.**	**KT.1.51**	
• Support the design and implementation of policies that are consistent with the long-term goals of water security, in a sustainable, integrated and inclusive way, at an acceptable cost, and in a reasonable time frame.	KT1.52 (KT1.51)	
• Assess the possibility of public-private partnerships (PPPs) to make water services more efficient and commercially oriented and enhance the creditworthiness of their public partner and the latter's ability to raise finance – and thus contribute indirectly to financing. In assessing the PPPs, governments should focus on evidence of the actual or likely performance of PPPs, including their value-for-money, impact on tariff levels, affordability, and quality of services to poor consumers and those previously unserved	KT1.53	
• Urge donors, and businesses to promote adequate funding for R&D and innovation in water, using research grants, challenge funds, prizes, support of pilot ventures, venture capital, and other means.	KT1.54 (KT1.4)	
KT2. Biodiversity and Ecosystem		
Potential Impacts of man-made water bodies		
• Develop and implement a program for monitoring the ecological effect of dams prior to their construction (pre-monitoring) and after dam completion (post-monitoring): - Pre-monitoring: conduct an ecological risk assessment of the dam's construction activities on the surrounding biodiversity (mainly endemic, threatened and rare aquatic and terrestrial species). The assessment should feed into the EIA baseline study. The assessment should monitor	KT2.1	MoE

and evaluate regional climatic conditions, hydrological conditions, riparian conditions, and biological conditions). - Post monitoring: monitor upstream and downstream ecological changes, environmental flows, including water discharge volume, water quality and downstream flow, and changes in anthropogenic activities.		
• Develop guidelines for the preparation of EIAs of dams projects in Lebanon. The guidelines should require EIA consultants to assess the potential effects of the construction of man-made water bodies on the downstream environment, adjacent properties, and groundwater.	KT2.2	
• Identify biodiversity hotspots, determine vulnerabilities and trends, and provide guidelines on the management of water bodies that include minimum environmental flows, turbidity/sediment levels, water quality patterns, and erosion-control measures.	KT2.3	
• Prepare restoration plans for degraded man-made water bodies and lakes.	KT2.4	
* **Consider the ecosystem water demand and water quality requirement when allocating water resources in the Updated NWSS-MoEW (2020).**	**KT2.5** (KT1.4)	MoEW
* **Prepare guidelines for the construction, operation and maintenance of water and wastewater networks to prevent/reduce potential adverse impacts to surrounding biodiversity (i.e., from leakages or flooding).**	**KT2.6**	
• Increase household connectivity to the wastewater treatment networks to prevent ecological exposure to contamination.	KT2.7	
• Assess alternatives to infrastructure projects located in Important Biodiversity Areas.	KT2.8	
• Specify activity restrictions for recreational water users of water bodies.	KT2.9	MoEW, MoE, MoT
* **Develop guidelines for the construction of dams and hill lakes, including buffer zones, requirements to facilitate the migration of animals and birds (upstream to downstream), system requirements for aeration and the removal of accumulating sediment.**	**KT2.10** (KT2.2)	MoEW, MoE, MoA
• Prepare guidelines for the restoration of riparian habitats around man-made water bodies.	KT2.11 (KT2.4)	MoE
• Coordinate with MoEW to review the dams program, particularly dams encroaching on protected areas or sites, to minimize the program's cumulative impact on Lebanon's ecology and natural heritage.	KT2.12	
• Review with MoA policy on "alternative trees" to consider the restoration of riparian habitats and seedling requirements (including storage and transplanting requirements). - Require EMPs to include this policy; the EMP should also assign an agency responsible for the monitoring of this activity.	KT2.13	MoA, MoE
Potential Impacts of Proposed WWTPs		
* **Prepare guidelines for the construction and O&M of WWTPs that include requirements for discharged wastewater and WWTP buffer zones, to be used as minimum requirements for EIAs, to reduce potential adverse impacts on the ecosystem.**	**KT2.14** (KT1.46) (KT1.40)	MoEW
• Abstain from discharging treated wastewater into water bodies located in sensitive areas.	KT2.15 (KT1.42)	MoEW, CDR, RWEs
• Ensure the regular maintenance of the infrastructure of the WWTPs to prevent leakages.	KT2.16 (KT1.46)	RWEs, CDR
• Abstain from constructing WWTPs in protected areas or their respective buffer zones; maintain a minimum distance between the protected areas and	KT2.17	MoE

the WWTPs of at least 1,000 meters to prevent damage to the surroundings from potential WWTP flooding or leaking.		
• EIAs should assess project location alternatives to the proposed WWTPs located within sensitive areas.	KT2.18	MoE
KT3. Biodiversity and Ecosystem		
Climate Change Adaptation		
* **Develop basin management plans in accordance with the Water Code that take into consideration climate change to achieve climate-resilient water resource management. Accordingly, the Strategy's proposed WEAP models that adopt an IWRM approach ought to:** - **Consider seasonal climatic changes** - **Consider intra-watershed climate variations**	**KT3.1**	MoEW
• Disseminate the proposed drought and flood management plans with the Climate Change Unit in the MoE to consider climate change forecast models.	KT3.2	
• Take into consideration seasonal fluctuations in water resources during planning and calculation of water balance, which are expected to worsen due to climate change.	KT3.3	MoEW, MoE
• Take into account climate change impacts on projected water availability in the proposed infrastructural projects.	KT3.4	
• Conduct climate change risk assessment to be used as a tool to inform development policies and activities.	KT3.5	MoE
• Develop a national adaptation framework to increase the resilience of existing and proposed water and wastewater infrastructure, i.e. promotes the implementation of robust and flexible climate-proof infrastructure: - Consider quantitative impacts of spatiotemporal precipitation patterns (e.g. inter-annual precipitation variability) and temperature variations at the planning and design phases of proposed infrastructure projects. - Consider quantitative climate change forecasts in hydrological studies at the design phase of proposed hill lakes and water reservoirs and wastewater systems (WWTPs and networks) and integrate them into management plans.	KT3.6	MoEW, CDR, MoE
Climate Change Mitigation		
• Prepare and adopt a Life Cycle Assessment for the proposed infrastructure projects to reduce GHG emissions.	KT3.7	MoEW
• Measures to reduce GHG emissions should be identified at a project level.	KT3.8 (KT3.7)	
* **Develop a national-level solar water pumping plan:** - **Identify and prioritize areas suitable for solar water pumping (for potable water and irrigation use).** - **Allocate a budget for the implementation of solar water pumping systems.**	**KT3.9**	MoEW
KT4. Land Use and Conservation		
Land Use		
* **Coordinate with DGUP to ensure that the proposed initiatives under the Updated NWSS-MoEW (2020) are in line with the national land use and management plans (i.e., buffer zones, protected waterside habitats, pollution point and non-point sources, agricultural and industrial zones, residential agglomerations, heritage sites and recreation/touristic areas).**	**KT4.1**	MoEW, MoE, DGUP

Land Conservation		
• Prepare and adopt Life Cycle Assessment for the construction of the proposed infrastructure projects to use as a decision-making tool and to inform EIAs.	KT4.2 (KT3.7)	MoEW, MoE
• Regulate and monitor raw material extraction throughout the duration of the projects' implementation.	KT4.3	MoE
• Develop the delineation of buffer zones for man-made water bodies and springs in coordination with the Directorate General of Urban Planning.	KT4.4 (KT4.1)	MoEW, MoE, DGUP
• Develop land use regulations for watersheds to protect catchment areas, specifying which activities are sanctioned, delineating buffer zones for man-made water bodies and springs, implementing erosion-control measures, and others.	KT4.5 (KT4.4)	
Sustainable Urban Planning		
• Develop updated strategic National Land Use Master Plan that is aligned with all national sectoral strategies, including the Updated NWSS-MoEW (2020) and in coordination with other relevant parties.	KT4.6	MoEW, MoE, DGUP, CNRS, MoPW, MoA, MoT
* **Promote water-sensitive urban and building design practices. Practices include the following:** - **At the building level: Implementation of green roofs, rain gardens and rainwater harvesting units.** - **At the neighborhood level: Implementation of water-permeable pavements/roads, tree pits to drain roads and water street trees by runoff.** - **At the city level: implementation of swales to collect and convey stormwater.**	**KT4.7** (KT1.30)	DGUP, MoEW, MoE, MoPW, MoIM, Municipalities
KT5. Water-Energy Nexus		
• Establish management information system to collect energy consumption data at RWE level by the water sector.	KT5.1	MoEW
• Align hydropower (dams) initiatives in the Updated NWSS-MoEW (2020) with the hydroelectricity target in the 2020 Renewable Energy Outlook and review Lebanon's hydropower production potential.	KT5.2	
• Remove barriers to hydropower production and clear-up the legal framework to incentivize the private sector.	KT5.3	
• Assess the energy needs of the proposed infrastructural projects and identify energy efficient and sustainable methods for powering them.	KT5.4	
• Improve energy efficiency in water facilities and further promote renewable energy technology. Improve energy efficiency through: o Improving cost recovery through financial restructuring. o Targeting functional and technical inefficiencies in sector energy use. o Improved operations and maintenance and replacement/rehabilitation of equipment in distribution and treatment systems.	KT5.5 (KT1.11) (KT1.12) (KT1.14)	
* **Adopt strategic energy management in RWEs and other water utilities.**	**KT5.6**	MoEW, RWEs
KT6. Water-Food Nexus		
* **Enhance coordination between MoEW and MoA to ensure that the National Agriculture Strategy (NAS) and the Updated NWSS – MoEW (2020) are aligned. For instance, the Updated NWSS should consider the potential increase in regional irrigation water requirements, and its spatial distribution, due to the projected increase in cultivated areas as per the NAS.**	**KT6.1** (KT1.23)	MoEW, MoA

• Enhance coordination between MoEW and MoA to prioritize the implementation of NAS initiatives that aim to reduce agricultural pollution at the farm-level in groundwater and surface water pollution-vulnerable regions.	KT6.2 (KT1.49)	
∗ Develop regional irrigation plans that aim to achieve more sustainable food production and that maximize water efficiency: **- Consider introducing water-friendlier or drought-resistant crops;** **- Consider Implementing programs for improving water use efficiency (i.e. promoting water-efficient irrigation practices and providing incentives).** **- Consider pilots for the use of treated wastewater for the irrigation of targeted crops; build on existing pilots, such as Ablah WWTP.**	**KT6.3** (KT1.23) (KT1.25)	
KT7. Social and Socio-Economic Environment		
Cost Recovery		
∗ Set a framework to control and monitor the water bottling industry in Lebanon (i.e., ensure all suppliers are licensed, monitor quality of bottled water, and ensure sustainable water resources management at the level of the industries)	**KT7.1**	MoEW, MoPH, MoE
• Promote research and development in the water sector to implement innovate solutions for productive sectors to collect, use and re-use water.	KT7.2 (KT1.4) (KT1.54)	MoEW, MoA, MoI, MoE
∗ Prioritize the planned WWTPs and WTPs in the Updated NWSS-MoEW (2020) based on their impacts on the coastal areas and rivers that will generate greater economic benefits.	**KT7.3**	MoEW
• Develop a financing strategy for the water establishments enabling them to recruit highly qualified permanent staff to run water projects and oversee the operations.	KT7.4	MoEW, MoF
• Introduce the water footprint tool on a household-level and on a national scale. This will allow for the identification of major water-consuming activities and accordingly address specific solutions.	KT7.5 (KT1.9) (KT1.17) (KT1.18)	MoEW, MoE, MoIM
• Enforce regulations to limit the illegal abstraction of groundwater and depletion of groundwater resources.	KT7.6 (KT1.10)	
• Introduce special tariffs charged for groundwater exploitation and use as part of the permitting scheme for drilling wells.	KT7.7 (KT7.6) (KT1.10)	MoEW, MoPW, MoIM, WEs
• Strengthen monitoring and metering to eliminate illegal water connections.	KT7.8	
• Implement accountability measures: for example, the accountability of administration at every level (regarding implementation of plans and their achievement or shortcoming) needs to be strengthened.	KT7.9	
• Strengthen the operation and maintenance of water infrastructure by developing systems that can enhance operational management, planning, or emergency response.	KT7.10 (KT1.40)	
• Use digital water conservancy through the application of information and communication technology in infrastructure such as in monitoring stations, data centers, telecommunication, decision support systems, etc.	KT7.11	
• Enforce regulations and impose penalties for water-usage payment violations.	KT7.12	
• Use of water allocation model to calculate water pricing.	KT7.13	MoEW
• Use a life-cycle assessment tool to determine the best options for domestic water conservation method.	KT7.14 (KT1.18) (KT1.17)	

	(KT1.9)	
• Calculate shadow prices and integrate the environmental and social cost of water use in water pricing	KT7.15	
• Raise the priority of water in national investment and financing programs through the following: - Develop a communications strategy for spreading evidence of the link from water to growth; the targeted group should be development financing institutions and donors. - Build professional and advocacy links with other key sectors and issues including energy, industry, agriculture, environment, climate change SDGs, etc, to create joint initiatives that add weight to the case for water investment. - Engage corporate businesses in water development in communities, e.g. direct investment in, or co-funding of, projects of concern in order to secure their resource, customer or operational base - Engage civil society as they have a role to play, to voice the level of security they deem appropriate, how much they are willing to pay for it, to ensure an acceptable distribution of risks. - Develop indicators of "water risk" to the businesses' operations, including Value At Risk metrics to help quantify their dependence on water, for the information of their shareholders, customers and other stakeholders.	KT7.16 (KT7.2) (KT1.54) (KT1.4)	
• The new Green Climate Fund should maintain a good balance in its operations between climate mitigation and adaptation, in order to assure water investments a fair share of the funds.	KT7.17	MoE
Public Health & Livelihood Conditions		
• Promote awareness building and education in proposed public awareness campaign regarding water conservation culture, water issues, and their interrelation, as well as water eco-environmental protection among the wider public, including businesses and industries. The campaign should also inform citizens and water users on their rights and responsibilities.	(KT7.18) (KT1.18) (KT1.17) (KT1.9)	MoEW, MoI, MoEHE, MoE, NGOs and Local Community
• Implement a monitoring and management program for surface water and wastewater across all Lebanese regions to minimize the risk of water and soil contamination on public health.	KT7.19	MoEW, MoPW, MoA, MoPH
* **Monitor cases of waterborne diseases to reflect the efficiency of wastewater treatment projects and keep track of outbreaks' numbers.**	**KT7.20**	
Purchasing Power Capacity of Water Users		
• Advocate for transparency between users/consumers and the water establishments to attain common responsive grounds in understanding the link between water scarcity and new proposed tariffs.	KT7.21	MoEW, MoSA, MoE, MoEW
* **Assess the possibility to implement subsidized programs to help unprivileged households access drinking water supply at reduced costs (e.g., water filters, pumps, etc.).**	**KT7.22**	
* **Align Updated NWSS-MoEW (2020) with national social protection programs to help underprivileged people afford to buy water or paying for water tariffs, given that more than 75% of the Lebanese population are living in poverty conditions.**	**KT7.23**	
* **Align Updated NWSS-MoEW (2020) with other national strategies, such as the NAS, to collaborate on initiatives and projects that would help the farmers reduce their water consumption while maximizing their productivity.**	**KT7.24** (KT6.1) (KT1.23)	

Land Expropriations		
• Integrate requirement to optimize land-use in large scale water projects in guidelines for the construction of dams and hill lakes; this will reduce the costs of expropriation.	KT7.25	CDR, WEs, MoEW
Absorptive Capacity		
* **Distribute the total estimated investment value in the Updated NWSS-MoEW (2020) across priority projects and different short, medium and long-term timeframes for an efficient allocation of investments, giving enough time for projects to be completed and operational.**	**KT7.26**	MoEW, CDR
Economic Resilience		
* **Develop a water emergency fund to support the implementation of mitigation measures and adaptation plans in case of external unpredictable shocks affecting the water sector.**	**KT7.27**	MoEW, MoF, CDR
• Plan restoration and rehabilitation programs for the areas impacted by the Beirut Port blast that were not taken into consideration in the Updated NWSS-MoEW (2020), particularly proposed wastewater infrastructure, water networks, etc.	KT7.28	
KT8. Disaster Prevention and Management		
• Set up a holistic plan at the MoEW to address the main types of water-related disasters (floods, droughts, dam breaks, fire) in alignment with the National Disaster Risk Management Strategy.	KT8.1	MoEW, MoIM, MoD, CNRS, DRMU, MoE, MoPH
• Ensure the proposed disaster risk monitoring unit is aligned with the National Disaster Risk Management Strategy.	KT8.2	
• Establish a dam safety program and dam break analysis.	KT8.3	
• Consider strategic locations of hill lakes and water reservoirs to support in the response to forest fires in coordination with the Lebanese Army and Green Plan.	KT8.4 (KT2.10) (KT2.2)	
• Include the MoEW in the inter-ministerial committee for forest fire management as a support institution.	KT8.5	
• Establish a communication protocol between the DRM and the disaster monitoring unit of the MoEW and other institutions in the National Strategy for Forest Fire Management.	KT8.6	
• Develop guidelines for hill lake monitoring. - Ensure guidelines are integrated into the EMP.	KT8.7	MoEW, MoE
• Define and allocate responsibility for hill lake water quality, quantity, and infrastructure monitoring for both public and private hill lakes. - Coordinate with Green Plan to provide adequate training for agencies responsible for hill lake monitoring.	KT8.8 (KT8.7)	
KT9. Data Management		
• Develop technical assistance for data management. - Include staff training in the IHIS studies and timescale. - Elaborate inter-institutional coordination for better integrated management - Establish a system that ensures the integration of the collected data as part of the IHIS into the decision-making process, to refine the proposed activities and improve water resources management.	KT9.1	MoEW, MoA, MoPH, MoE, LRA, CNRS
• Establish water quality monitoring within the IHIS for water resources (rivers, wells, springs) and water supply and distribution.	KT9.2 (KT7.19)	MoEW, RWEs, LRA,

• Prioritize building the capacity of the RWE laboratories to perform the needed water quality monitoring (human resources, equipment, QA/QC systems, reagents and other consumables, etc.).	KT9.3 (KT7.4)	LARI, MoPW – LMS, MoE
• Automation of water resources monitoring system	KT9.4 (KT7.11)	
• Establish an infrastructure monitoring system within the RWE's and link it to the IHIS within MoEW.	KT9.5	MoEW, RWEs, LRA
• Establish water sector data collection standards and codes to be adopted across all institutions (e.g. ArcGIS requirements) to ensure consistent database formats. Set a framework for IHIS data collection: - Develop mechanism to update data; - Develop a legal framework for data sharing.	KT9.6	MoEW
• Develop data-sharing protocols to harmonize and standardize data collection and sharing methods and develop management and exchange protocols to allow subnational data to be interpreted and collated at the national level.	KT9.7	
KT10. Achieving IWRM		
• Strengthen political will for IWRM by clearly communicating and demonstrating the value of implementing IWRM for achieving multiple sustainable development objectives to key stakeholders at all levels and across sectors.	KT10.1	MoEW
• Dedicate budgeting for IWRM activities and more efficient use of existing resources in a coordinated manner are needed to address the financing gap. - Develop and enforce revenue-raising mechanisms.	KT10.2	MoEW, CoM, MoA, MoE, MoI, MoT, etc.
• Coordinate budgeting across sectors for more efficient and transparent use of existing resources.	KT10.3	
• Integrate IWRM throught: - Considering the socio-economic system, the people living in the area, their water using activities and related economic, social and cultural axes; - Water balance estimation at the river basin and interlinkage with groundwater aquifers; - Considering the quantitative impact of climate change on water availability as well as climate change adaptation and mitigation measures.	KT10.4 (KT1.1) (KT1.2) (KT3.1) (KT3.6)	MoEW
• Dedicate a unit at the MoEW (with dedicated staff and developed KPIs) to follow up on the progress towards achieving IWRM and ensure that the data collected and WEAP modelling conducted is feeding back into the strategy to refine the proposed projects. - WEAP models should simulate combinations of proposed measures through different scenarios to evaluate their effectiveness and deduce optimal measures this can be used to re-prioritize both macro and micro-level proposed projects in the Strategy. - Perform assessments of implemented projects based on monitored data following their implementation to evaluate their actual effectiveness and redesign or improve them if needed.	KT10.5	MoEW
• Enhance and retain institutional and human capacity for IWRM planning, implementation, and enforcement. In conjunction with funded capacity development programs, it is important to create incentives to keep staff in government agencies and provide practical experience-sharing opportunities.	KT10.6 (KT10.5)	MoEW, RWEs
• Prioritize issuing Water Code executive decrees related to the National Water Council and to watershed plans, to promote cross-sectoral coordination and management activities, particularly at the basin and aquifer levels, for sustainable and efficient water management.	KT10.7	MoEW, MPs, CoM

KT11. Achieving SDGs and International Commitments			
•	Establish a task force for coordinating and leading activities to work towards the achievement of SDG 6. This would bring together the key institutions and national focal points responsible for different elements of water resources management such as wastewater treatment and reuse, pollution control, ecosystems, clean water and sanitation, water-use efficiency, and water scarcity.	KT11.1	MoEW, RWEs, MoE, MoA, MoIM, MoT, MoI…
KT12. Stewardship and Stakeholder Engagement			
•	Ensure that the data related to the water sector is accessible to the public and all stakeholders at no cost.	KT12.1	MoEW
•	Enforce Law 28/2017 (Access to information law) across water sector state administrations.	KT12.2	
*	**Propose water conservation and water-use optimization guidance actions directed towards water users, i.e. citizens (household/individual-level), industrialists and farmers in the Updated NWSS-MoEW (2020).**	**KT12.3**	MoEW, RWEs
*	**Delineate the roles and responsibilities of citizens, civil society, local authorities and private sector for achieving strategy objectives in the Updated NWSS-MoEW (2020).**	**KT12.4**	
•	Engage civil society in strategy initiatives: - Organize and conduct regular meetings with a committee of selected civil society representatives, academic and non-academic experts, and media representatives to inform stakeholders on water sector updates and solicit feedback and concerns. - Collaborate with educational institutions to engage youth in the implementation of proposed projects by providing learning opportunities through internships and site visits. Interns are also a useful human resource that can help facilitate the implementation of Updated NWSS-MoEW (2020) initiatives at the MoEW or RWEs.	KT12.5 (KT7.21)	
•	Establish a functional and efficient system for public-private partnership in the sector.	KT12.6 (KT1.53)	
*	**Outline public awareness campaign steps and goals in the Updated NWSS-MoEW (2020); it should target the following major user groups: households, industry, large consumers (tertiary sector: schools, government buildings, etc.) and farmers.** - **Coordinate and collaborate with the public and private sector (e.g. civil society organizations, local authorities and academia) to implement national behavioral change and targeted awareness campaigns.** - **Endorse and build on existing community engagement initiatives, public awareness campaigns, and platforms in the water sector.** - **Awareness campaigns should be interactive, and make use of all available media, including modern multimedia channels and other applications.** - **Develop a platform that can be used by the community to check ongoing projects and their status.**	**KT12.7** (7.18) (KT1.18) (KT1.17) (KT1.9)	MoEW, MoEHE, MoE, MoI in collaboration with RWEs, NGOs, academic institutions, and Local Authorities
•	Conduct regular local workshops and information sessions to inform the public on water sector developments and to engage with water users. - Conduct targeted awareness campaigns for educational institutions that provide youth with insights on current and future career opportunities in the water sector.	KT12.8 (KT12.5) (KT7.21)	MoEW, MoEHE, academic institutions

* Mitigation Strategies/Policy Recommendations for preliminary implementation *(See Recommendations for Integrating SESA Findings in the Updated NWSS-MoEW (2020))*

11 RECOMMENDATIONS FOR INTEGRATING SESA FINDINGS IN THE UPDATED NWSS-MOEW (2020)

This Report identified 10 specific and cross-cutting key themes potentially affected by the Updated NWSS-MoEW (2020). It also presented several policy responses that would help mitigate or alleviate the environmental, social, and economic burden of the Updated NWSS-MoEW (2020). In this Chapter, the Consultant attempts to highlight a handful of priority recommendations for integrating SESA findings in the Updated NWSS-MoEW (2020).

1. **Integration of Mitigation Strategies/Policy Recommendations into Updated NWSS-MoEW (2020):** It is advised to begin with the integration of the "priority" SESA policy responses and mitigation measures20 into the Updated NWSS-MoEW (2020) and continue with the integration of all other SESA policy responses and mitigation measures in the upcoming revised/updated strategies.
2. **Oversight and Monitoring:** There is an urgent need to clearly assign responsibility for oversight and monitoring of the Updated NWSS-MoEW (2020). The Minister of Energy and Water will be in charge and would be required to report yearly to the Council of Ministers, as per the Water Code. Continuous monitoring and reporting would improve communication with other agencies (Agriculture, Environment, Urban Planning, etc.) and immunize the strategy from political and partisan interference.
3. **Research and Development:** Promote additional R&D efforts to assess the potential of increasing the reliance on non-conventional resources.
4. **National Water Dialogue:** MoEW should enhance information sharing, communication, and coordination between the concerned stakeholders, including the public, on issues related to the water sector. Transparency and stakeholders' engagement is crucial for the successful implementation of the strategy.
5. **Appraisal of the Updated NWSS-MoEW (2020) Implementation:** There is a strong case for a "mid-term appraisal" of the NWSS through which lessons from experiences could be learned, targets and methodologies could be re-assessed, and SESA safeguards could be implemented.
6. **Iterative process for Revisions:** As stipulated in the Water Code, the strategy should be revisited every 5 years. The MoEW shall review the Updated NWSS-MoEW (2020) and consider scaling-back the implementation of newly proposed dams and other large infrastructure projects to allow for better assessments at the river basin/ watershed scale as more data becomes available following the implementation of the proposed IHIS and other monitoring programs. The Updated NWSS-MoEW (2020) should be viewed as an iterative process whereby appraisals and externalities bring about modifications and/or variances to the original strategy.

[20] ECODIT has highlighted from the mitigation measures/policy recommendations listed in the table above the "priority" responses that could be integrated immediately into the Updated NWSS-MoEW (2020).

12 REFERENCES

Abboud-Abi Saab, M., & Hassoun, A. E. R. (2017). Effects of organic pollution on environmental conditions and the phytoplankton community in the central Lebanese coastal waters with special attention to toxic algae. *Regional Studies in Marine Science*, *10*, 38–51. https://doi.org/https://doi.org/10.1016/j.rsma.2017.01.003

AFDC. (2007). *State of Lebanon's Forests*.

AFDC. (2019). *State of Lebanon's Forests 2018*. AFDC, MoA, MoE, UNDP, IUCN and LRI.

Akkaya, S., Junge, N., & Mansour, W. (2009). Lebanon, Social Impact Analysis – Electricity and Water Sectors. Beirut-Lebanon. In *MENA Knowledge and Learning Quick Notes Series*. World Bank.

Akl, C. (2016). *Strategic Development Plan for Industrial Zones in Lebanon 2019-2030*. http://www.industry.gov.lb/getattachment/PublicationsAndStudies/STRATEGIC-DEVELOPMENt-PLAN-(1).pdf?lang=en-US

Alameddine, I., Tarhini, R., & El-Fadel, M. (2018). Household economic burden from seawater intrusion in coastal urban areas. In *Water international* (Vol. 43). Routledge. https://doi.org/10.1080/02508060.2017.1416441

Alameddine, I., Fayad, A., Abou Najm, M., & El-Fadel, M. (2018). Sustainability of basin level development under a changing climate. *International Journal of Sustainable Development and Planning*, *13*, 394–405. https://doi.org/10.2495/SDP-V13-N3-394-405

Amacha, N., & Baydoun, S. (2018). Groundwater Quality in the Upper Litani River Basin. In A. Shaban & M. Hamze (Eds.), *The Litani River, Lebanon: An Assessment and Current Challenges* (pp. 87–105). Springer International Publishing.

Animal Corner. (n.d.). *List of Animals that Live in Lakes*. https://animalcorner.org/blog/animals-that-live-in-lakes/

Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), MoA, CNRS, & UNESCWA. (2019). *Integrated Vulnerability Assessment Application on the Lebanese Agricultural Sector*. E/ESCWA/SDPD/2019/RICCAR/TechnicalReport.6

Arif, A., & Doummani, F. (2013). *Cost Assessment of Water Resources Degradation of The Litani Basin*. http://www.swim-sm.eu/files/Assessment_Litani_EN.pdf

Baaklini, S. (2018). Penurie d'eau au Liban : cet ete s'annonce infernal, L'Orient Le Jour. *L'Orient-Le Jour*. https://www.lorientlejour.com/article/1117098/cet-ete-grave-penurie-deau-en-perspective.html

Bedient, P. B., Huber, W. C., & Vieux, B. E. (2013). *Hydrology and Floodplain Analysis: International Edition*. Pearson Education. https://books.google.com.lb/books?id=0pypBwAAQBAJ

Bing, H., Wu, Y., Liu, E., & Yang, X. (2013). Assessment of heavy metal enrichment and its human impact in lacustrine sediments from four lakes in the mid-low reaches of the Yangtze River, China. *Journal of*

Environmental Sciences, *25*(7), 1300–1309. https://doi.org/https://doi.org/10.1016/S1001-0742(12)60195-8

Bonel, K., Wehbi, M., & halabi, S. (2021). *WaSH Assessment Platform Report 2021*. https://reliefweb.int/report/lebanon/wash-assessment-platform-report-2021

Buchhorn, M., Smets, B., Bertels, L., Lesiv, M., Tsendbazar, N. ., Masiliunas, D., Linlin, L., Herold, M., & Fritz, S. (2020). *Copernicus Global Land Service: Land Cover 100m: Collection 3: epoch 2019: Globe (Version V3.0.1)*. Zenodo. https://doi.org/10.5281/zenodo.3939050

Carey, R. O., Hochmuth, G. J., Martinez, C. J., Boyer, T. H., Dukes, M. D., Toor, G. S., & Cisar, J. L. (2013). Evaluating nutrient impacts in urban watersheds: Challenges and research opportunities. *Environmental Pollution*, *173*, 138–149. https://doi.org/https://doi.org/10.1016/j.envpol.2012.10.004

Carpenter, S. R., Caraco, N. F., Correll, D. L., Howarth, R. W., Sharpley, A. N., & Smith, V. H. (1998). Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen. *Ecological Applications*, *8*(3), 559. https://doi.org/10.2307/2641247

CAS. (2019). *LFHLCS_2018_2019_Demography*. http://cas.gov.lb/index.php/demographic-and-social-en/population-en

CAS. (2019). *LFHLCS_2018_2019_Labor force*. http://cas.gov.lb/index.php/demographic-and-social-en/laborforce-en

CDR. (2022). *Annual Progress Report of the CDR*.

CDR. (2021). *List of Expropriations for Water Sector*.

CDR, Techswat, & KREDO. (2003). *Plan directeur de valorisation ou de disposition des boues d'épuration*.

Chase, T. N., Pielke Sr., R. A., Kittel, T. G. F., Nemani, R. R., & Running, S. W. (2000). Simulated impacts of historical land cover changes on global climate in northern winter. *Climate Dynamics*, *16*(2), 93–105. https://doi.org/10.1007/s003820050007

Chehayeb, K. (2021). Lebanon's fuel crisis is causing a drinking water crisis. *Middle East Eye*. https://www.middleeasteye.net/news/lebanon-fuel-water-crisis-drinking

Chow, M. F., Bakhrojin, M. A. bin, Haris, H., & Dinesh, A. A. A. (2018). Assessment of Greenhouse Gas (GHG) Emission from Hydropower Reservoirs in Malaysia. In *Proceedings* (Vol. 2, Issue 22). https://doi.org/10.3390/proceedings2221380

Constantine, K., Massoud, M., Alameddine, I., & El-Fadel, M. (2017). The role of the water tankers market in water stressed semi-arid urban areas:Implications on water quality and economic burden. *Journal of Environmental Management*, *188*, 85–94. https://doi.org/10.1016/j.jenvman.2016.11.065

Darwish, T., & CNRS. (2006). *Soil map of Lebanonma natta: 1:50 000*. CNRS, Remote Sensing Center.

Deemer, B. R., Harrison, J. A., Li, S., Beaulieu, J. J., DelSontro, T., Barros, N., Bezerra-Neto, J. F., Powers, S. M., Dos Santos, M. A., & Vonk, J. A. (2016). Greenhouse Gas Emissions from Reservoir Water Surfaces: A New Global Synthesis. *Bioscience*, *66*(11), 949–964. https://doi.org/10.1093/biosci/biw117

Doummar, J., Hassan Kassem, A., & Gurdak, J. J. (2018). Impact of historic and future climate on spring recharge and discharge based on an integrated numerical modelling approach: Application on a snow-governed semi-arid karst catchment area. *Journal of Hydrology*, *565*, 636–649. https://doi.org/https://doi.org/10.1016/j.jhydrol.2018.08.062

Dubois, E., Doummar, J., Pistre, S., & Larocque, M. (2020). Calibration of a lumped karst system model and application to the Qachqouch karst spring (Lebanon) under climate change conditions. *Hydrology and Earth System Sciences*, *24*(9), 4275–4290. https://doi.org/10.5194/hess-24-4275-2020

European Academies Science Advisory Council. (2013). *Groundwater in the Southern Member States of the European Union: an Assessment of Current Knowledge and Future Prospects Country Report for Greece (2010)*. 37. https://easac.eu/fileadmin/PDF_s/reports_statements/Greece_Groundwater_country_report.pdf

EBRD. (2019). *Hazardous Waste Preliminary Inventory Study*.

EBRD. (2018). *Lebanon Daoura/ Bourj Hammoud Wastewater Treatment Plant Feasibility Study Terms of Reference*.

ECODIT. (2015). *Strategic Environmental Assessment for the New Water Sector Strategy for Lebanon*.

El Najjar, P., Pfaffl, M., Ouaini, N., Abdel Nour, A., & El Azzi, D. (2020). Water and sediment microbiota diversity in response to temporal variation at the outlet of the Ibrahim River (Lebanon). *Environmental Monitoring and Assessment*, *192*(3), 201. https://doi.org/10.1007/s10661-020-8139-z

El-Fadel, M., Deeb, T., Alameddine, I., Zurayk, R., & Chaaban, J. (2018). Impact of groundwater salinity on agricultural productivity with climate change implications. *International Journal of Sustainable Development and Planning*, *13*, 445–456. https://doi.org/10.2495/SDP-V13-N3-445-456

El-Fadel, M., Tomaszkiewicz, M., Adra, Y., Sadek, S., & Abou Najm, M. (2014). GIS-Based Assessment for the Development of a Groundwater Quality Index Towards Sustainable Aquifer Management. *Water Resour Management*, *28*, 1–17. https://doi.org/10.1007/s11269-014-0683-2

El-Nakib, S., Alameddine, I., Massoud, M., & Abou Najm, M. (2020). Nutrient pollutant loading and source apportionment along a Mediterranean river. *Environmental Monitoring and Assessment*, *192*(5), 274. https://doi.org/10.1007/s10661-020-8220-7

EPA. (1993). *Handbook: Urban Runoff Pollution Prevention and Control Planning*. Center for Environmental Research and Development.

Fang, W., Delapp, R. C., Kosson, D. S., van der Sloot, H. A., & Liu, J. (2017). Release of heavy metals during long-term land application of sewage sludge compost: Percolation leaching tests with repeated additions of compost. *Chemosphere*, *169*, 271–280. https://doi.org/10.1016/j.chemosphere.2016.11.086

FAO. (2017). *AQUASTAT Database*. http://www.fao.org/aquastat/statistics/query/results.html

FAO. (2016). *Aquastat*. FAO.

FAO. (2010). Global Forest Resources Assessment 2010 - Main report. In *FAO Forestry Paper* (Issues 0258–6150). FAO.

FAO, & UN-ESCWA. (2021). *Lebanon: Falling Into The Abyss*.

Faour, G., & Abdallah, C. (2013). *Land Use Land Cover Map of Lebanon. 1: 20 000*. CNRS Remote Sensing Center.

Faour, G., & Abdallah, C. (2018). *Land Use Land Cover Map of Lebanon. 1: 20 000. [Vector map]*. CNRS Remote Sensing Center.

Faour, G., Verdeil, E., & Hamze, M. (2016). *Atlas of Lebanon: New Challenges* (p. 111). Presses de l'Ifpo, CNRS Liban. https://doi.org/10.4000/books.ifpo.10709

Farajalla, N., El Hajj, R., Ayoub, M., Zgheib, L., Chehadeh, A. H., Hanna, F., & Karam, N. (2021). *Water-Energy Nexus of Water and Wastewater Services in Lebanon*.

Fayad, A. (2017). *Evaluation of the snow water resources in Mount Lebanon using observations and modelling*.

Fayssal, N., & Slim, K. (2015). *The impact of urban growth on ground water salinity rates on the Lebanese coast N. Fayssal1 & K. Slim2*. https://doi.org/10.2495/WS150211

Fijalkowski, K., Rorat, A., Grobelak, A., & Kacprzak, M. J. (2017). The presence of contaminations in sewage sludge - The current situation. *Journal of Environmental Management*, *203*(Pt 3), 1126–1136. https://doi.org/10.1016/j.jenvman.2017.05.068

Francis, R. (2012). *Status of Soil Resources in Lebanon*.

Gaucher, C., Domingues-Hamdi, É., Prin-Mathieu, C., Menu, P., & Baudin-Creuza, V. (2015). Interaction of recombinant octameric hemoglobin with endothelial cells. In *Comptes Rendus - Biologies* (Vol. 338, Issue 2). https://doi.org/10.1016/j.crvi.2014.11.004

Government of Lebanon, & United Nations. (2019). *Lebanon Crisis Response Plan 2017-2020*. http://www.un.org.lb/library/assets/67780-035714.pdf

Green, D. J., & Quinlan, S. P. (2008). *Reservoir operation impacts on survival of Yellow Warblers in the Revelstoke Reach Wetlands, BC* (Vol. 6).

Hamade, K. (2020). Lebanon's Food Insecurity and the Path Toward Agricultural Reform. *Carnegie MEC*. https://carnegie-mec.org/2020/11/13/lebanon-s-food-insecurity-and-path-toward-agricultural-reform-pub-83224

Haydar, C., Nehme, N., Awad, S., Koubayssi, B., Fakih, M., Yaacoub, A., Toufaily, J., Villieras, F., & Hamieh, T. (2014). Physiochemical and microbial assessment of water quality in the Upper Litani River Basin, Lebanon. *Journal of Environment and Earth Science*, *4*(9), 88–97.

Hijazi, F., Halwani, J., Daye, M., & Baroudi, M. (2012). Hydrogeology and Contamination of the Basin of Tripoli. *Hydrogeology of Arid Environments*, 230.

Hraoui-Bloquet, S., Sadek, R., & Geze, R. (2001). *Amphibians of Lebanon: Inventory, Geographical and Altitudinal Distribution*.

Hssaisoune, M., Bouchaou, L., Sifeddine, A., Bouimetarhan, I., & Chehbouni, A. (2020). Moroccan groundwater resources and evolution with global climate changes. *Geosciences (Switzerland)*, *10*(2). https://doi.org/10.3390/geosciences10020081

Hughes, J., Cowper-Heays, K., Olesson, E., Bell, R., & Stroombergen, A. (2021). Impacts and implications of climate change on wastewater systems: A New Zealand perspective. *Climate Risk Management*, *31*, 100262. https://doi.org/https://doi.org/10.1016/j.crm.2020.100262

IDAL. (2017). *Agriculture Sector 2017 Factsheet*. https://www.investinlebanon.gov.lb/Content/uploads/SideBlock/171010012459018~Agriculture factsheet 2017.pdf

IDAL. (2019). *Tourism Sector In Lebanon 2019 Factbook* (Issue May). http://samarth-nepal.com/sites/default/files/resources/Sector brief_Tourism_Issue %2313.pdf

IDRC. (2007). *Towards an ecosystem approach to the sustainable management of the Litani watershed - Lebanon*.

IDRC. (2017). *Climate change and saltwater intrusion along the Eastern Mediterranean: Socio-economic vulnerability and adaptation*.

IFI. (2019). *Forest fires in Lebanon: a recurring disaster, Legal and institutional framework for forest fire management in Lebanon*. https://www.aub.edu.lb/ifi/Documents/publications/infographics/2019-2020/20191220_october_forest_fires.pdf

IPCC. (2003). LUCF Sector Good Practice Guidance. In *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. e Institute for Global Environmental Strategies (IGES).

Issaka, S., & Ashraf, M. (2017). Impact of soil erosion and degradation on water quality: a review. *Geology, Ecology, and Landscapes*, *1*, 1–11. https://doi.org/10.1080/24749508.2017.1301053

Jari, J. (2020). *Investigating water infrastructure mitigation mechanisms to reduce impacts on climate change: The case of El-Azzounieh dam (Lebanon)*. AUB.

Jarosz, N., Béziat, P., Bonnefond, J. M., Brunet, Y., Calvet, J. C., Ceschia, E., Elbers, J. A., Hutjes, R. W. A., & Traullé, O. (2009). Effect of land use on carbon dioxide, water vapour and energy exchange over terrestrial ecosystems in Southwestern France during the CERES campaign. *Biogeosciences Discussions*, *6*, 2755–2784. https://doi.org/10.5194/bgd-6-2755-2009

Johnson, R. R., & Jones, D. A. (1977). *Importance, preservation, and management of riparian habitat : a symposium*. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Kalaoun, O., Jazar, M., & Al Bitar, A. (2018). Assessing the Contribution of Demographic Growth, Climate Change, and the Refugee Crisis on Seawater Intrusion in the Tripoli Aquifer. In *Water* (Vol. 10, Issue 8). https://doi.org/10.3390/w10080973

Khadra, W. M., & Stuyfzand, P. J. (2018). Simulation of saltwater intrusion in a poorly karstified coastal aquifer in Lebanon (Eastern Mediterranean). *Hydrogeology Journal*, *26*(6), 1839–1856. https://doi.org/10.1007/s10040-018-1752-z

Knopf, F. L., Johnson, R. R., Rich, T., Samson, F. B., & Szaro, R. C. (1988). Conservation of Riparian Ecosystems in the United States. *The Wilson Bulletin*, *100*(2), 272–284. http://www.jstor.org/stable/4162566

Kossida, M., & Tsoukalas, I. (2021). *Report on future scenarios of water availability and demand in the Al Ostuan River Basin, including the performance of different demand management measures and the results of an optimisation process. Project Deliverable No. 4, Consultancy to Facilitate In*.

Kumar, N., Tischbein, B., Kusche, J., Beg, M. K., & Bogardi, J. J. (2017). Impact of land-use change on the water resources of the Upper Kharun Catchment, Chhattisgarh, India. *Regional Environmental Change*, *17*(8), 2373–2385. https://doi.org/10.1007/s10113-017-1165-x

Landmine & Cluster Munition Monitor. (2016). *Lebanon Cluster Munition Ban Policy*. http://www.the-monitor.org/en-gb/reports/2019/lebanon/view-all.aspx#

Lathrop, R. C., Carpenter, S. R., Stow, C. A., Soranno, P. A., & Panuska, J. C. (1998). Phosphorus loading reductions needed to control blue-green algal blooms in Lake Mendota. *Canadian Journal of Fisheries and Aquatic Sciences*, *55*(5), 1169–1178. https://doi.org/10.1139/f97-317

Legal Agenda. (2018). *The General Directorate of Urban Planning: Arbitrary Practice Between the National Master Plan, General Master Plans, Exceptions, and Decisions*. https://www.legal-agenda.com/en/article.php?id=4948

Lietz, A. C. (1999). *Methodology for Estimating Nutrient Loads Discharged from the East Coast Canals to Biscayne Bay, Miami-Dade County, Florida. . U.S. Geological Survey, Water-Resources Investigations Report 99-4094*.

LPDC, CAS, & PCBS. (2018). *The Population and Housing Census in Palestinian Camps and Gatherings - 2017, Key Findings Report*.

Maréchal, J. C., & Rouillard, J. (2020). Groundwater in France: Resources, Use and Management Issues. In *Global Issues in Water Policy* (Vol. 24, Issue March). https://doi.org/10.1007/978-3-030-32766-8_2

Merhaby, D., Ouddane, B., NET, S., & Halwani, J. (2020). Assessment of persistent organic pollutants in surface sediments along Lebanese coastal zone. *Marine Pollution Bulletin*, *153*, 110947. https://doi.org/10.1016/j.marpolbul.2020.110947

Merhaby, D., Rabodonirina, S., Net, S., Ouddane, B., & Halwani, J. (2019). Overview of sediments pollution by PAHs and PCBs in mediterranean basin: Transport, fate, occurrence, and distribution. *Marine Pollution Bulletin*, *149*, 110646. https://doi.org/https://doi.org/10.1016/j.marpolbul.2019.110646

Ministry of Foriegn Affairs of the Netherlands. (2018). Climate Change Profile Lebanon. In *Ministry of Foriegn Affairs of the Netherlands*.

http://sdwebx.worldbank.org/climateportalb/doc/GFDRRCountryProfiles/wb_gfdrr_climate_change_country_profile

MoA. (2020). *Lebanon National Agriculture Strategy 2020-2025*.

MoA. (2010). *Distribution of the Irrigated area according to Irrigation methods and the main water source*.

MoA, & FAO. (2010). *The Core Module of the Census of Agriculture 2010 Lebanon*. https://data.unhcr.org/en/documents/details/44733

MoA, UNEP, & GEF. (1996). *Biological Diversity of Lebanon Country Study Report*.

MoE. (2004). *List of Protected areas in Lebanon between 1982 and 2020*.

MoE, EU, & UNDP. (2016). *Lebanon Environmental Assessment of the Syrian Conflict & Priority Interventions*.

MoE, & IUCN. (2012). *Lebanon's marine protected area strategy supporting the management of important marine habitats and species in Lebanon*.

MoE, & UNDP. (2019). *Rapid Cost of Environmental Degradation 2018*.

MoE, UNDP, & ECODIT. (2011). *Lebanon State of the Environment Report (SOER) 2010*.

MoE, UNDP, & GEF. (2016). *Lebanon's third national communication to the UNFCCC*.

MoE, UNDP, & GEF. (2021). *Lebanon's Fourth Biennial Update Report to the UNFCCC*.

MoE, UNDP, & GEF. (2019). *Lebanon's Third Biennial Update Report to the UNFCCC*.

MoEW. (2012). *National Water Sector Strategy*.

MoEW. (2020). *Updated National Water Sector Strategy – Ministry of Energy and Water (2020)*.

MoEW, & UNDP. (2014). *Assessment of Groundwater Resources of Lebanon*.

MoI, & UNIDO. (2018). *Lebanon Industry 2025*.

Nader, M. R., Bou Nassar, M., El Indary, S., & Abou Dagher, M. (2020). *Assessment of Climate Change Impact on Lebanon Coastal Zone*.

National Research Council. (1996). Use of Reclaimed Water and Sludge in Food Crop Production. *The National Academy of Sciences*, 192. https://doi.org/10.17226/5175

Nawas, T., & Al Koussa, H. (2017). Bacterial Contamination of Urban Water Wells in the Nuwayri Region of Beirut - Lebanon. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, *11*, 81–85. https://doi.org/10.9790/2402-1105038185

NRC. (2008). *Urban stormwater management in the United States.* (p. 529). The National Academies Press. https://www.epa.gov/sites/production/files/2015-10/documents/nrc_stormwaterreport1.pdf

OECD. (2011). Policies Towards a Sustainable Use of Water in Spain. *OECD Economics Departament Working Papers*, *840*, 0–30.

Quezel, P., Médail, F., Loisel, R., & Barbero, M. (1999). Biodiversity and conservation of forest species in the Mediterranean basin. *Unasylva*, *50*, 21–23.

Ramadan-Jaradi, G., Bara, T., & Ramadan-Jaradi, M. (1999). *Revised checklist of the birds of Lebanon 1999-2007. Sandgrouse 30 (1)*.

Ramadan-Jaradi, G. (2013). *Distribution and size of the Waterbird populations in wetlands of Lebanon.*

Ramadan-Jaradi, G. (2021). *Annotated Checklist of the Marine and Coastal Birds of Lebanon*.

Ramadan-Jaradi, G., & Bara, T. (2008). Revised checklist of the birds of Lebanon 1999-2007. *Sandgrous*, *30*(1), 22–69.

Ramadan-Jaradi, G., Itani, F., Hogg, J., Serhal, A., & Ramadan-Jaradi, M. (2020). *Updated checklist of the birds of Lebanon, with notes on four new breeding species in spring 2020*.

Ramadan-Jaradi, G., Serhal, A., & Itani, F. (2015). *First two records of Eurasian Bullfinch Pyrrhula pyrrhula for Lebanon and first records of Marbled Duck Marmaronetta angustirostris and Little Bustard Tetrax tetrax for over 14 and 56 years respectively. Sandgrouse 37 (2).*

Ravichandran, S., & Student, O. (2016). *Effects of Dams and barriers – A Mini Review*. https://doi.org/10.13140/RG.2.1.1058.6007

RoL. (2021). *Lebanon's Nationally Determined Contribution Updated 2020 Version*.

Rorat, A., Courtois, P., Vandenbulcke, F., & Lemiere, S. (2019). *8 - Sanitary and environmental aspects of sewage sludge management* (M. N. V. Prasad, P. J. de Campos Favas, M. Vithanage, & S. V. B. T.-I. and M. S. Mohan (eds.); pp. 155–180). Butterworth-Heinemann. https://doi.org/https://doi.org/10.1016/B978-0-12-815907-1.00008-8

Saade, J., Atieh, M., Ghanimeh, S., & Golmohammadi, G. (2021). Modeling Impact of Climate Change on Surface Water Availability Using SWAT Model in a Semi-Arid Basin: Case of El Kalb River, Lebanon. In *Hydrology* (Vol. 8, Issue 3). https://doi.org/10.3390/hydrology8030134

Saadeh, M., Semerjian, L., & Amacha, N. (2012). Physicochemical Evaluation of the Upper Litani River Watershed, Lebanon. *The Scientific World Journal*, *2012*, 462467. https://doi.org/10.1100/2012/462467

Semerjian, L. A. (2011). Quality assessment of various bottled waters marketed in Lebanon. *Environmental Monitoring and Assessment*, *172*(1), 275–285. https://doi.org/10.1007/s10661-010-1333-7

Shaban, A. (2013). *Geomorphological and geological aspects of wetlands in Lebanon.*

Shaban, A. (2020). *Water resources of Lebanon*. Springer.

Shaban, A. (2009). Indicators and Aspects of Hydrological Drought in Lebanon. *Water Resources Management*, *23*(10), 1875–1891. https://doi.org/10.1007/s11269-008-9358-1

Shi, Z. H., Fang, N. F., Wu, F. Z., Wang, L., Yue, B. J., & Wu, G. L. (2012). Soil erosion processes and sediment sorting associated with transport mechanisms on steep slopes. *Journal of Hydrology*, *454–455*, 123–130. https://doi.org/https://doi.org/10.1016/j.jhydrol.2012.06.004

Somma, J., & Abou Chakra, C. (2018). *Snowfields Monitoring on Mount Lebanon High Plateaus. Effects of Snowpack Inter Annual Fluctuations on the Drought Period*. Saint Joseph University.

Song, C., Gardner, K. H., Klein, S. J. W., Souza, S. P., & Mo, W. (2018). Cradle-to-grave greenhouse gas emissions from dams in the United States of America. *Renewable and Sustainable Energy Reviews*, *90*, 945–956. https://doi.org/https://doi.org/10.1016/j.rser.2018.04.014

Statica. (2019). *Annual per capita expenditure on water, sanitation, and hygiene worldwide in 2019, by select country (in U.S. dollars)*. Statica. https://www.statista.com/statistics/1098366/water-sanitation-hygiene-spending-per-capita-by-country/

Steinman, A., Chu, X., & Ogdahl, M. (2009). Spatial and temporal variability of internal and external phosphorus loads in Mona Lake, Michigan. *Aquatic Ecology*, *43*(1), 1–18. https://doi.org/10.1007/s10452-007-9147-6

Stott, R., & Smith, L. (2001). *River Recovery Project Restoring Rivers and Streams through Dam Decommissioning and Modification*.

Sun, G., & Lockaby, B. G. (2012). Water quantity and quality at the urban-rural interface. *Urban-Rural Interfaces: Linking People and Nature*, *27606*, 29–48. https://doi.org/10.2136/2012.urban-rural.c3

The Arab Weekly. (2021). *Battered with crises, Lebanon hopes tourism will bring some relief*.

The Daily Star. (2018). *Thousands of unlicensed factories operating in Lebanon*.

Thivet, G., & Fernandez, S. (2012). *Water Demand Management: The Mediterranean Experience*. http://www.gwp.org/Global/ToolBox/Publications/Technical Focus Papers/01 Water Demand Management - The Mediterranean Experience (2012) English.pdf

Thomas, D. H. L., & Adams, W. M. (1999). Adapting to Dams: Agrarian Change Downstream of the Tiga Dam, Northern Nigeria. *World Development*, *27*(6), 919–935. https://doi.org/https://doi.org/10.1016/S0305-750X(99)00041-8

Thomas, R. L., Shaban, A., Khawlie, M., Kawass, I., & Nsouli, B. (2005). Geochemistry of the sediments of the El-Kabir River and Akkar watershed in Syria and Lebanon. *Lakes \& Reservoirs: Science, Policy and Management for Sustainable Use*, *10*(2), 127–134. https://doi.org/https://doi.org/10.1111/j.1440-1770.2005.00267.x

Tremblay, A., Varfalvy, L., Roehm, C. L., & Garneau, M. (2004). *The Issue Of Greenhouse Gases From Hydroelectric Reservoirs : From Boreal To Tropical Regions*.

Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kaźmierczak, A., Niemela, J., & James, P. (2007). Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landscape and Urban Planning*, *81*(3), 167–178. https://doi.org/https://doi.org/10.1016/j.landurbplan.2007.02.001

UACDC. (2010). *Low Impact Development: a design manual for urban areas*. University of Arkansas Press. https://s3.amazonaws.com/uacdc/LID-Manual_Excerpt.pdf

UC Santa Barbara (UCSB). (n.d.). *A river delta in East Aceh, on the island of Sumatra, Indonesia.* https://www.news.ucsb.edu/file/delta-east-aceh-sumatrapng-0

Uetz, P. (2017). *Parvilacerta fraasii (LEHRS, 1910)*. www.reptile-database. org

UN News. (2021). *Lebanon crises increase suffering of migrant domestic workers*. UN News. https://news.un.org/en/story/2021/12/1108332

UN Water, & WHO. (2019). *National Systems to Support Drinking Water, Sanitation and Hygiene: Global Status Report 2019*.

UNDP. (2021). *Climate-Proofing Lebanon's Development Plans.*

UNDP, & MoE. (2017). *Updated master plan for the closure and rehabilitation of uncontrolled dumpsites throughout the country of Lebanon. Volume A*.

UNDP, MoE, & ELARD. (2011). *Business plan for combating pollution of the Qaraoun Lake*.

UNDP, MoE, & GEF. (2009). *Fourth National Report of Lebanon to the Convention on Biological Diversity*.

UNDP, UNHCR, & UNICEF. (2020). *Lebanon State of the Environment and Future Outlook: Turning the Crises into Opportunities*.

UNEP. (2012). *The UN-Water Status Report on the Application of Integrated Approaches to Water Resources Management*. https://www.unwater.org/publications/un-water-status-report-application-integrated-approaches-water-resources-management-rio20/

UN-ESCWA. (2016). *Strategic review of Food and Nutrition Security in Lebanon*. https://archive.unescwa.org/sites/www.unescwa.org/files/page_attachments/escwa_food_and_nutrition_security_in_lebanon_final_version_high_res_en.pdf

UN-ESCWA. (2021). *Multidimensional poverty in Lebanon (2019-2021) Painful reality and uncertain prospects*. https://www.unescwa.org/sites/default/files/news/docs/21-00634-_multidimentional_poverty_in_lebanon_-policy_brief_-_en.pdf

UNHCR. (2021). *Lebanon Fact Sheet 2021*. Relief Web. https://reliefweb.int/sites/reliefweb.int/files/resources/Lebanon factsheet September 2021.pdf

UNICEF. (2021a). *Drying Up- Lebanon's Water Supply System: on the Verge of Collapse.*

UNICEF. (2016). *Rapid Assessment for Large & Medium Scale Wastewater Treatment Plants across the Lebanese Territory*.

UNICEF. (2021b). *Water Quality Mapping North, South and Bekaa: Spatial seasonal variation of water quality parameters, Beirut, Lebanon.*

UNICEF. (2020). *Water Sector Lebanon end-year 2020 Dashboard*. http://www.3rpsyriacrisis.org/wp-content/uploads/2021/05/WATER_SECTOR_LEBANON-end-Year-Dashboard-2020.pdf

United Nations Framework Convention on Climate Change, (1992).

Walsh, C. J., Roy, A., Feminella, J., Cottingham, P., Groffman, P., & Morgan II, R. (2005). The Urban Stream Syndrome: Current Knowledge and the Search For A Cure. *Am. Benthol. Soc*, *24*, 706–723. https://doi.org/10.1899/0887-3593(2005)024\[0706:TUSSCK\]2.0.CO;2

WFP. (2022). WFP Lebanon Country Brief February 2022. *World Food Programme*.

WHO. (2020). *Climate change: Land degradation and desertification*. https://www.who.int/news-room/questions-and-answers/item/climate-change-land-degradation-and-desertification

WHO, & UNICEF. (2016). *Lebanon Water Quality Survey*.

Wilson, G. V, Cullum, R. F., & Römkens, M. J. M. (2008). Ephemeral gully erosion by preferential flow through a discontinuous soil-pipe. *CATENA*, *73*(1), 98–106. https://doi.org/https://doi.org/10.1016/j.catena.2007.09.008

World Bank. (2011). *Republic of Lebanon Country Environmental Analysis Sustainable Development Department (MNSSD) Middle East and North Africa Region*. http://documents1.worldbank.org/curated/en/360011468265768992/pdf/622660ESW0Gray0c060601100BOX361480B.pdf

World Bank. (2022). *World Bank berates Lebanon's elite for "zombie" economy*. Reuters. https://www.reuters.com/world/middle-east/lebanese-govt-revenues-fell-by-nearly-half-2021-world-bank-says-2022-01-25/

World bank. (2021). *Lebanon Economic Update*. World Bank. https://thedocs.worldbank.org/en/doc/90f36d3399fac59746ac2f3a44fa612a-0280012021/original/Lebanon-Economic-Update-October-2021.pdf

World Bank. (2018). *World Bank Open Data*.

13 TECHNICAL ANNEXES

13.1 SESA Key Themes in Relation to National Objectives

Table 51. Specific SESA Key Themes in Relation to National Objectives

Specific SESA Key Themes	Link to NWSS	National Objectives[1]
Water Conservation and Management	1.a.; 2.a; 2.b; 2.c; 2.d; 3.a; 3.b; 3.c; 3.d.	• Achieving SDG 6.1: Universal and equitable access to safe and affordable drinking water for all. • Achieving SDG 6.5: Implement IWRM at all levels. • Achieving SDG 6.4: Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity. • Achieving SDG 6.B: Support and strengthen the participation of local communities in improving water and sanitation management. • Meeting the obligations of the multilateral environmental agreements on the Protection of the Marine Environment and the Coastal Region of the Mediterranean, namely The Barcelona Convention and Protocols – Laws 126/1997 & 292/1994. • Achieving SDG 6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all. • Achieving SDG 6.3: By 2030, improve water quality by reducing pollution, eliminating dumping… halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally. • Achieving SDG 6.A: By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes.
Biodiversity and Ecosystems	2.d; 3.d; 2.c.	• Achieving SDG 6.6: Protect and restore water-related ecosystems. • Meeting the obligations of the multilateral environmental agreements related to biodiversity and ecosystems, namely: o Agreement on the Conservation of African-Eurasian Migratory Water Birds (AEWA) – Law 412/2002 o Convention on wetlands of international importance, especially as Waterfowl habitat (RAMSAR) – Law 23/1999 o Convention on Biological Diversity (CBD) – Law 360/1994 • Alignment with the national targets in Lebanon's National Biodiversity Strategy Action Plan (2016-2030) which addresses Lebanon's obligations under the CBD and aims to protect and conserve ecosystems and habitats in order to respond to anthropogenic and natural pressures.
Climate Change Mitigation and Adaptation	1.a; 1.b; 3.a; 3.c; 3.d.	• Achieving SDG 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and

Specific SESA Key Themes	Link to NWSS	National Objectives[1]
		substantially reduce the number of people suffering from water scarcity. • Achieving SDG 13: Climate Action • Meeting the obligations of the Paris Agreement, signed in 2016 and ratified by virtue of Law 115/2019 and Decree 5599/2019. • Contributing to meet the NDCs to the UNFCCC on the development of low-carbon mitigation and adaptation strategies: • Lebanon commits to unconditionally increase its greenhouse gas emission reduction target relative to the Business-as-Usual (BAU) scenario from 15% to 20%.
Land Use and Conservation	3.c; 3.d;	• Achieving SDG 11.3: By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
Water-Energy Nexus	1.e; 3.d; 2.a.	• Contributing to meet the NDCs to the UNFCCC, specifically: o Lebanon commits to unconditionally generate 18% of the power demand from renewable energy sources in 2030. o Lebanon commits unconditionally to a 3% reduction in power demand through energy-efficient measures in 2030. • Achieving SDG 7: Ensure access to affordable, reliable, sustainable, and modern energy for all.
Water-Food Nexus	3.c; 2.d.	• Alignment with goals and objectives of Lebanon's National Agriculture Strategy (NAS) 2020-2025 which aims to increase agricultural production and the sustainable management of agricultural resources and systems. • Achieving SDG 2.4: By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.
Social and Socio-Economic Environment		• Achieving SDG 6.4: to substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity • To implement integrated water resources management (IWRM) at all levels, considering that water is a cross-sectoral social and economic good. • Achieving SDG 3.9: By 2030 substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination. • Achieving SDG 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related

Specific SESA Key Themes	Link to NWSS	National Objectives[1]
		disasters, with a focus on protecting the poor and people in vulnerable situations.
Disaster Prevention and Management	1.a; 2.a; 3.d;	• Achieving SDG 11.B: By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels • Achieving SDG 3.D: Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks. • Achieving SDG 15.3: By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world

13.2 Legal and Institutional Framework

13.2.1 *Relevant Legislations*

Table 52. Relevant Legislations

Legislation	Description
Technical and Financial	
Law 77/2018 and its amendment Law 192/2020	The Amended Water Code: addresses the legal, financial, and institutional aspects of the water sector.
Law 48/2017	The PPP Law: Organization of the PPP in the water sector for joint projects implemented by public institutions (except for Municipalities and the federation of Municipalities).
MoE Decision 589/1 of 2015	Review process for SEA Scoping and SEA Reports.
Decision 32/2014	Approval for establishment of committee to oversee the execution of the 2013 Roadmap for Combatting Pollution of the Lake Qaraoun and the Litani River.
Law 210/2012	Treatment, bottling, and selling of drinking bottled water: requirements/conditions for authorization to sell bottled drinking water.
Decree 8213/2012	Strategic Environmental Assessment of Policy, Plan and Program Proposals in the Public Sector.
Decree 8633/2012	Fundamentals of EIAs.
Decree 8471/2012	Requirements for environmental compliance of establishments (including Class I, Class II, and Class III industries): obtaining an environmental compliance certificate in accordance with the provisions of the Environmental Protection Law (Law 444/2002).
MoEW Decision 118/2010	Administrative procedures/requirements to obtain authorization to drill wells.
Decree 8018/2002	Determination of the permitting essentials, procedures, and conditions to establish and operate industrial institutions or enterprises. Stipulates required distances of industries from water bodies (i.e., Class I and II industries must be 1,000 m distant from springs).
Law 444/2002	Environmental Protection Law which sets the basic principles and general provisions to regulate environmental protection and participation in terms of management, preservation, and maintenance of environmental media (resources), to assess the effects of projects on the environment. It also defined the responsibilities and the penalties imposed on those who abuse the resources or cause environmental damage or pollution. *Notable Relevant Articles*: • Article 35: Provides legislative support for the protection of Lebanon's water resources. • Article 36: The establishment of water procedures, standards, and measures for water quality monitoring and management, by decree. • Article 37: Any facility carrying out water treatment operations must be subject to prior approval by the Minister of Environment with an implementing decree.

Legislation	Description
MoE Decision 8/1 of 2001	National Standards for Environmental Quality that covered air emissions and liquid discharges (partly updating Decision 8/1 dated 30/1/2001).
Decree 1039/1999	Establishes drinking water standards: adopting the potable water Standardizations No. 161/1999 and the bottled water standardizations No. 162/1999 concerning the bottled potable water as the Lebanese Standardizations.
Decree 681/1998	The preservation and protection of boreholes.
Law 623/1997	Implementation of penalties for vandalism of water (as well as telephone and electricity) infrastructure.
MoE Decision 52/1 of 1996	Environment quality standards and criteria for air, water, and soil pollution.
Decree Law 108/1983	Monitoring of Drinking Water Industry sector: compliance of bottled drinking water with drinking water quality standards/conditions.
Decree 9132/1974	Marine Shelf of territorial waters are part of public domain.
Decree 8735/1974	Public Cleanliness Law, which sets regulations for maintaining the cleanliness of public properties, including regulations for the collection and disposal of waste and wastewater. *<u>Notable Relevant Articles:</u>* • Article 3: Prohibits the discharge of wastewater from the public domain. • Article 4: Prohibits the use of wastewater for direct irrigation. • Article 13: Prohibits the discharge of unfiltered wastewater from the industrial establishments.
MoPH Decision 67/1972	Methodology for bacteriological analysis of water: water quality testing.
Decree 14438/1970	Restrictions on the depth of unlicensed boreholes: Regulates the granting of or exemption from prospecting permits according to whether the drilling depth is superior or inferior to 150 m and according to the nature of the use of underground water.
Decree 10276/1962	Protection Zones for Water Sources and Recharge Areas.
Decree 340/1943	The Penal Code *<u>Notable Relevant Articles:</u>* • Articles 745 to 749: Outline criminal provisions concerning public waters: provides penalties in case of infringement on water resources.
Decree 639/1942	Protection of Nabaa Al Assal Spring, Faraya.
Decree Law 16L/1932	Mandates the establishment of buffer zones for the protection of all surface and groundwater resources from any type of activity/potential source of pollution.
High Commissioner Decision 320/1926	Conservation and use of public water, addresses the following: • Prohibitions with regards to the protection of catchment areas and buffering requirements. • Acquired rights of public waters (i.e. exclusive property over water resources), particularly underground water. • Other criminal provisions relating to the violations of water policing.
Order No. 144/1925	Protection of Surface and Ground Water Resources.
High Commissioner Decision 144/1925	Public Property Law, which determines state ownership of water resources with respect to the protection and utilization of the water resources.
Law dated 1913 (The Ottoman Megelle)	Ottoman irrigation Code: Regulation of Agriculture use of water. *<u>Notable Relevant Articles:</u>*

Legislation	Description
	• Title 4, Chapter 10: Articles 1234 to 1328: definition of waters, utilization of water, and the maintenance of waterways.
Institutional	
Law 28/2017	Access to Information Law: Obligates state administrations to publish financial and administrative data and allows citizens to request information from the state.
Decree 3989/2016	Establishing the Environmental Police: department within the MoE which regulates environmental crimes (including those pertaining to water) and enforces penalties. The Law specifies its organization and mandates.
Law 251/2014	Establishing the Public Environmental Prosecutor.
Decree 14596/2005, Decree 14598/2005, Decree 14600/2005, and Decree 14602/2005	EBML, BWE, SLWE, and NLWE Rules of procedure, respectively. Rules of procedure articles entail the water establishment authorities and governance.
Decree 14597/2005 (amended by Decree 1759/2009), Decree 14599/2005 (amended by Decree 1756/2009), Decree 14601/2005 (amended by Decree 1758/2009), and Decree 14603/2005 (amended by Decree 1757/2009)	EBML, BWE, SLWE, and NLWE Operating rules, respectively. Articles entail water establishment operating rules provisions with respect to drinking water subscriptions, wastewater subscriptions, and irrigation water subscriptions.
Decree 14637/2005, Decree 14636/2005, Decree 14638/2005, and Decree 14639/2005	EBML, BWE, SLWE, and NLWE Financial regulations, respectively. Financial regulations articles entail the budget of the establishments, contracts for work and services, and auditing of accounts.
Decree 14877/2005, Decree 14875/2005, Decree 14639/2005, and Decree 14874/2005	EBML, BWE, SLWE, and NLWE Staff rules and regulations, respectively.
Decree 14915/2005, Decree 14916/2005, Decree 14914/2005 Decree 14913/2005	EBML, BWE, SLWE, and NLWE Administrative organization, respectively.
Article 2 of Law 690/2005 (which revoked Law 260/1993 and its amendments)	Defining the missions and organization of the MoE. *Relevant Notable Articles:* • Article 2: Rights and missions Defines the responsibilities of the MoE, of the MoE– including those with respect to water.
Law 221/2000 (and its amendments Law 241/2000 and Law 337/2001)	Water Sector Reform Law: Institutional reform of the water authorities, addresses the organization of the water sector and establishes the four public water establishments for water use.
Decree 9631/1996	Additional Responsibilities of the LRA.
Decree Law 5/1977	Establishment of the CDR *Notable Relevant Articles:* • Article 5: CDR has the authority to execute any works related to the water sector in any urban area.
Decree Law 118/1977	Municipalities' Law *Notable Relevant Articles:* • Article 49: the Municipalities can implement projects in the water sector within their associated city boundaries.
Decree 7432/1974	Transfer of Responsibilities of the Qasimiyah and Ras al-Ain Irrigation Departments to the LRA.

Legislation	Description
Decree 4517/1972	Public Law on Public Institutions *<u>Notable Relevant Articles:</u>* • Article 10: the Board of Directors of RWEs decide tariffs and fees of services provided by water establishments.
Decree 14649/1970	Establishment of The Council for the South *<u>Notable Relevant Articles:</u>* • Article 1: the Council is authorized to conduct any project, including water works, to address people's needs in South Lebanon.
Law 20/1966 (Amended by Law 247/2000) and implementation Decrees 5469/1966 and 6650/1973	Establishment of the MoEW and its composition, organization, and missions.
Decree 8377/1961	Organization of the MoPH. *<u>Notable Relevant Articles</u>*: • Article 35: the MoPH is responsible for proposing the technical specifications and conditions to be met for the construction of public and private sewers and drinking water network construction projects.
Decree Law 31/1955	Organization of the MoA.
Law dated 04/08/1954	Establishment of the LRA: it is responsible for the execution and implementation of works on the Litani basin, including key dams and power stations.

13.2.2 *Relevant RWE Visions, Strategies, and Master Plans*

Table 53. Relevant RWEs Visions, Strategies, and Master Plans

Title	Summary of Initiatives
SLWE 2020-2025 Strategy	The SLWE 2020-2025 strategy has a vision: To provide water for everyone in the South, and a mission: non-intermittent quality water supply at an optimized cost and environmentally friendly manner that allows for adequate human and infrastructure development and customer satisfaction. To achieve the aforementioned vision and mission, the strategy has 4 cornerstones, each with supporting proposed projects: 1. Consistent water supply: • Rehabilitation of water networks and increasing storage capacity. • Shifting from groundwater to surface water resources (rivers and springs). • Water demand management (to reduce NRW). • Automation: optimizing water resources and water distribution and monitoring water flow. 2. Drinking water quality: • Upgrading labs and quality procedures. • Control of pollution sources. • Enforcement of laws. • Automation of water quality monitoring processes. 3. Cost optimization: • Automation of networks. • Implementation of water and maintenance management systems. • Implementation of SCADA systems. • Decrease of power costs (replacing pumps and introducing renewable sources of energy). • Reduction of NRW (e.g. through smart metering). 4. Customer satisfaction: • Introduction of a call center. • Development of a customer interface. • Implementation of mobile application. As such, the strategy sets the following targets for 2025: • 308,000 m^3 of expected billed water. • 95% collection of bills.
EBML 2020-2025 Vision	The EBML 2020-2025 Vision has four objectives: 1. Development of EBML Sectors: • Building, developing, and equipping the establishment's buildings. • Implementation of SCADA systems. • Automating the establishment's archiving system. 2. Development of water resources: • Janneh and Bekaata Dam completion. • Drilling wells for areas in-need of water resources. • Establishment of desalination plants for Greater Beirut wells. 3. Rehabilitation of facilities: • Expansion, rehabilitation, and renewal of all water networks in the region. • Expanding and rehabilitating the Dbayeh, Nahr Ibrahim, and Jbeil water treatment stations. • Cleaning, rehabilitating and constructing reservoirs. 4. Control of NRW: • Prepare regulation and enforcement plan that ensures all citizens are paying for services and control violations

Title	Summary of Initiatives
	• Installing meters for al subscribers. • Organizing water confined areas (DMA) in coastal Matn, South Beirut, and Keserwan.
BWE Vision	The BWE crafted a vision: A modern establishment that aims to reach global standards in: • Managing the drinking water, irrigation, and wastewater sectors. • Providing the highest quality services throughout the Bekaa Valley. In a comprehensive and sustainable way, to become a pioneer in its field and a reliable reference point for citizens. Although the core objective of the BWE remains to secure drinking water, irrigation, and wastewater services for all areas in the Bekaa Valley, the priority of the BWE is to maintain the continuity of public facilities so as to mitigate the effects of the current crises in the country and minimize associated losses. As such, the BWE delineates the following objectives: 12. Providing water, irrigation, and wastewater services for all areas under BWE jurisdiction in accordance with the best practices adopted globally. 13. Protecting the environment surrounding surface water and groundwater sources by coordinating with all stakeholders. 14. Improving water management and water treatment to protect natural basins in the Bekaa. 15. Conducting awareness campaigns which promote water conservation and the increase in subscription fees of services, as well as the importance of paying fees. 16. Developing sustainable development plans to secure water needs for future generations. 17. Rationalizing energy use and the use of renewable sources of energy. 18. Preserving water resources. 19. Maintaining skilled workforce and implementing technical capacity building. 20. Sustaining water services in light of the load shedding by EDL. 21. Securing supplies and equipment for the maintenance of facilities. 22. Protection of the water establishment assets from theft.
NLWE Water Supply Master Plan for North Lebanon (2040)	The NLWE Master Plan updates the water Master Plans of each caza of North Lebanon. It describes the status of existing water systems and water reservoirs and forecasts populations for the horizon of 2040. The Master Plan proposes projects to address the water deficit calculated based on projected water demands for each caza; water demands are calculated based on water consumption estimates in the NWSS-MoEW (2012) for the horizon of 2040. In addition to the dams proposed in the NWSS-MoEW (2012), proposed new water resources in the Master Plan are as follows: • Tripoli Caza: Abou Halka and Hab springs, drilling of wells, and the Al Bared dam. • Minieh and Dannieh Cazas: drilling of new wells and Al Bared construction. • Bcharre Caza: Qadisha spring • Batroun Caza: Rahwe spring, drilling of new wells, and the construction of Balaa and Mseilha dams. • Kaoura Caza: El Asfour spring and the drilling of new wells. Additional actions are as follows: • Construction of new WTPs and expanding existing WTPs capacities to cover the water demand of all cazas. • A gradual increase in water tariff, paid through monthly or quarterly bills, as suggested by the results of a socio-economic study conducted for the purpose of the Master Plan. • Installation of water meters in regions where water is supplied for 24 hours to meet the NWSS-MoEW (2012) target of "30% unaccounted for water by 2035". • A five-year water resources monitoring and gauging campaign • The update of the river gauging data base (in coordination with LRA) and marine springs gauging in Batroun.

Title	Summary of Initiatives
	• Conduct public campaigns that aim to advertise reforms, reduce water consumption, and gain the trust of consumers. Projects are prioritized according to the following criteria (higher to lower level of importance): 1. Locality or a group of localities don't have water supply systems. 2. System with the greater amount of water balance in the same water Branch. 3. Springs as water resources that need protection from contamination risks. 4. Water leakage attenuation. As such, projects of immediate importance are: • The construction of Sahel Akkar water supply systems. • The rehabilitation of the Safa system pumping system in the Wadi Khaled region.

13.2.3 *National Strategies and Plans Relevant to the Water Sector in Lebanon*

Table 54. National Strategies and Plans Relevant to the Water Sector in Lebanon

Title	Summary of Initiatives
Lebanon National Agriculture Strategy (NAS) 2020-2025 – *MoA*	The NAS proposes 5 key areas of intervention in the agricultural sector, each with corresponding programs: 1. Restoring the livelihoods and productive capacities of farmers and producers, programs include: • Providing financial assistance to farmers. • Developing a subsidized loan system for farmers. • Developing a platform to attract funding. 2. Increasing agricultural production and productivity, programs include: • Increasing cultivated areas (for cereals and legumes in particular). • Supporting and training farmers on pesticide and livestock management practices. • Promoting modern agricultural techniques. • Enhancing food quality and safety assurance system. • Enhancing efficiency and competitiveness of agrifood value chains. 3. Improving climate change adaptation and sustainable management of agrifood systems and natural resources, programs include: • Promoting smart-climate agriculture techniques, including: conservation agriculture, smart planting, afforestation and reforestation. • Introducing more sustainable farming, food processing and logistics practices. • Management of water harvesting and storage: constructing of hill lakes and water tanks, and promoting the adoption of modern irrigation techniques. • Reducing agricultural pollution at farm level. 4. Strengthening the enabling institutional environment.
Strategic Development Plan for Industrial Zones in Lebanon (2019-2030) – *MoI*	The goal of the Strategic Development Plan is to enhance both existing and new industrial zones through the implementation of infrastructure, including: green areas and buffers, sewage, irrigation, and waste treatment infrastructure. There are four new industrial zones planned, three of which have national government priority (governmental Decision 75/2018) priority and are detailed as follows: • Tourbol – Koussaya, Beqaa (175 plots of area totaling 1,850,000 m^2). • Baalbek, Baalbek El Hermel (85 plots of area totaling 500,000 m^2). • Al Qaa, Baalbek El Hermel (365 plots of area totaling 1,800,000 m^2). • Fourth Industrial Zone is unknown.
Lebanon's 2020 Nationally Determined Contribution (NDC) – *GoL*	Lebanon's 2020 NDC serves as an update to its 2015 NDC in accordance with Lebanon's commitments under the Paris Agreement (UNFCCC). It entails policy and fiscal reforms – in line Lebanon's economic recovery – towards improving energy efficiency, sustainable use of land and water resources, reducing pollution across the agriculture, waste and industry sectors, and increasing the resilience of communities and infrastructure. The 2020 NDC commits to the following unconditional targets by 2030: • A GHG emission reduction target of 20%. • Generate 18% of the power demand and 11% of the heat demand (in the building sector) from renewable energy sources in 2030. • A 3% reduction in power demand through energy-efficient measures in 2030. Moreover, the 2020 NDC commits to the following conditional targets: • A GHG emission reduction target of 31%.

Title	Summary of Initiatives
	• Generate 30% of the power demand and 16.5% of the heat demand (in the building sector) from renewable energy sources in 2030. • A 10% reduction in power demand through energy-efficient measures in 2030.
Updated Policy Paper for the Electricity Sector (2019) – *MoEW*	The Policy Paper aims to (1) reduce EDL's financial deficit and (2) improve the electricity supply. To achieve these targets, the Policy Paper has the following three objectives: 4. Improve collection, and decrease technical and non-technical losses to 12% starting 2021. The measures proposed to achieve this objective are the following: • Implementation of transmission and distribution initiatives. • Organization and execution of a national campaign to remove illegal grid connections, issue infringement notices, and the quick processing of claims of theft of electricity. • Improve bill collection. • Increase in the collection of arrears' payments. Dues of the water establishments and public administrations can be paid back through yearly installments over five years. 5. Increase the generation capacity, improve efficiency and reduce fuel cost by using natural gas. 6. Increase the tariff to eliminate EDL deficit and recover the costs of electricity generation, transmission, and distribution.
Renewable Energy Outlook Lebanon (2020) – *MoEW*	The Renewable Energy Outlook provides a roadmap to achieve Lebanon's renewable energy targets introduced in 2018: to generate 30% of the power demand from renewable energy. Key measures include: 1. Establish the electricity regulatory authority to provide a single access point to the electricity sector. 2. Reinforce the transmission grid and conduct grid impact assessments. 3. Technology-specific renewable energy targets: 1000 MW of wind, 601 MW of hydro-electricity, 2500 MW of centralized solar photovoltaic, 500 MW of decentralized solar PV, and 13 MW of biogas.
Lebanon's National Biodiversity Strategy and Action Plan (NBSAP) (2016-2030) – *MoE*	In accordance with Lebanon's obligations under the CBD, the NBSAP identifies 18 national targets in 13 priority areas that address key biodiversity challenges and aim to achieve the following vision: 'By 2030, Lebanon's biodiversity is valued and sustainably managed for the preservation and conservation of its ecosystems and habitats and the species they harbor in order to adequately respond to anthropogenic and natural pressures and to ensure Lebanese citizens equal access to ecosystem goods and services.' To accomplish the targets it sets out, a key objective of the NBSAP is to mainstream biodiversity into other national strategies, plans and programs. NBSAP National Targets include the following: • National Target 4: By 2030, at least 20% of natural terrestrial and marine ecosystems are protected and all types of ecosystems are represented in the Protected Area (PA) network. • National Target 5: By 2030, the total percent coverage of nature reserves is increased to reach at least 5% of Lebanon's area. • National Target 6: By 2030, 50% of all natural ecosystems are sustainably managed and properly considered in spatial planning implementation. • National Target 7: By 2030, the gap between Lebanon's ecological footprint and biocapacity is alleviated to reach an equal state. • National Target 11: By 2030, effective measures are in place to control the introduction and diffusion of Invasive Alien Species into the environment.

Title	Summary of Initiatives
	• National Target 14: By 2030, vulnerable ecosystems to climate change are identified and adaptation plans are developed and implemented.
Lebanon National Forest Program (NFP) (2015-2025) *– MoA*	The NFP is the main instrument of the national forest policy for the years 2015-2025 and provides a framework for the development of the forestry sector in Lebanon. It identifies the governments interventions in the forest sector and beyond it, and aims to sustainably manage the Lebanese forest resources and define forest-related coordination and cooperation mechanisms among all public and private sectors. The overall objective of the NFP is to “Restore degraded lands and increase Lebanese forest cover while meeting the ecological, social and economic needs of sustainable forest management at a regional scale”. Key objectives are: 1. Establish and update national data on forest and rangeland sector; promote research through the establishment of partnerships between the different sectors 2. Setting up sustainable management in forests; establishing restoration and rehabilitation plans in degraded lands to counteract soil erosion and desertification. 3. Enhancing ecosystem resilience in forestland to mitigate the impact of climate change and other natural hazards, which includes measures related to prevision, prevention and fire fighting in forests. 4. Supporting small enterprises through the development of value chains standards, for sustainable production of forests and rangelands value added goods. This includes developing and applying national schemes on sustainable rangelands management. 5. Launch and support green economic opportunities through the establishment of the needed infrastructure. This includes setting up a framework for the development of ecotourism activities in public and private forests.
Policy for Integrated Solid Waste Management (2018) *– MoE*	The Proposed policy aims to achieve the following waste recovery objectives for household solid waste and hazardous solid waste: • Years 2019-2024: material recovery 25%, energy recovery 35%, sanitary landfill 40% • Years 2025-2035: material recovery 35%, energy recovery 50%, sanitary landfill 15% The policy is founded on the following key principles: 1. Alignment with the principles of the Environmental Protection Law (Law 444/2002). 2. Recovery of as much waste as possible through adopting the hierarchy of integrated solid waste management approach (reduce waste production, re-use, sort at source, and sweeping and collection). 3. Adoption of administrative decentralization of waste management; the Municipalities are delegated the initial stages of waste management. 4. Coverage of all provinces under the proposed policy. 5. Implementation of a communications program to spread a culture of shared responsibility for Integrated Solid Waste Management.
2005 National Physical Master Plan of the Lebanese Territory (NPMPLT) *– CDR*	The NPMPLT aims to define guidelines for land use and the development of regions, and sets regulations for urban planning in urban, rural, agricultural, and natural areas to promote the following three principles: • The unity of the country. • Balanced development. • Rationalization of uses and resources. Accordingly, the NPMPLT proposes facilities and sites for planned activities and specifies their location and size restrictions based on land use regulations, taking into consideration water resource vulnerability, ecological and geological heritage, major landscapes,

Title	Summary of Initiatives
	environmentally sensitive and protected areas, as well as hazards, including: landslide risk, desertification, and flood-risk. The guidelines of the Master Plan include: 6. Structure the territory around the major urban centers; 7. Distribute the major public facilities in an effective and integrated manner; 8. Unite the territory with an efficient and developed transportation network; 9. Ensure an urban development of good quality, respecting the characteristics of each region; 10. Highlight and benefit from the natural wealth of the country; 11. Exploit the water resources in a sustainable way; 12. Resolve efficiently the problems of quarries, wastewater and solid wastes For the water and wastewater sector, the Master Plan stresses that external funding should only concern projects of low priority and should not be a determining criterion for identifying projects. It presents the following priorities: • Data collection and management. • Prioritization of the reducing leakages and NRW in distribution networks over the exploitation of new water resources. • Establishing within each WE a plan for illegal well management. • Rehabilitation of existing sewage networks. • Construction of WWTPs in regions where wastewater threatens groundwater resources.
CIP – *GoL*	The CIP proposes infrastructure projects which aim to strengthen all sectors of the national economy for the purpose of alleviating socio-economic inequalities across all districts. The CIP was approved by the Cabinet in 2018 and presented to the international community at CEDRE to seek funding. The program spans a period of 8 to 12 years and projects are prioritized based on their readiness for implementation and their expected positive impacts. The program details water, irrigation, and wastewater projects that aim to address infrastructure challenges – further exacerbated by the country's refugee crises – and are in-line with the targets of the NWSS-MoEW (2012). Water and irrigation capital investment projects aim to increase water supply, and are of two categories: • Expansion and improvement of water supply systems. • The development of additional water resources through the construction of dams or hill lakes. Wastewater projects tackle overloaded wastewater infrastructure and low connection rates to networks. Projects are divided under six categories: • Completion of on-going wastewater projects. • Protection of planned dams. • Protection of major surface and groundwater resources. • Upgrade of the coastal treatment plants for secondary treatment and Expansion of existing WWTPs to meet future demand (2040). • Upgrade of the collection networks in Beirut and its neighborhoods. • Small-scale municipal-level works (completion and rehabilitation of existing systems).

Title	Summary of Initiatives
Lebanon Crisis Response Plan (LCRP) *– GoL*	The LCRP is a joint plan between the GoL and other national and international partners, and aims to respond to the challenges associated with the current humanitarian crisis in the country, further amplified by the economic crisis, COVID-19, and the Port of Beirut Explosion (2019). Since commencing in 2017, the yearly appeal has been directed towards achieving the following strategic objectives: 1. Ensure protection of vulnerable populations. 2. Support service provision through national systems. 3. Provide immediate assistance to vulnerable populations. 4. Reinforce economic, social, and environmental stability.

13.2.4 *Relevant Projects and Programs*

Table 49. Relevant Projects and Programs

Title	Summary of Initiatives
Water, Sanitation, and Conservation (WSC) Project *Agency: USAID* *Duration: 2022 - 2026*	The WSC is a five-year project and draws on the work done in the USAID Lebanon Water Project (2015-2020). Expected results of the project are the following: • Interventions that lead to treatment of 14,000 m^3/day of wastewater, including: - The construction and rehabilitation of facilities to benefit 200,000 people for the first 3 years. - Improve water and wastewater services to around 600,000 people. • Reduce NRW by 10% in selected areas. • Decrease O&M per m^3 of water or wastewater by 20%. • Increase hours of water supply by 5%. • Help LRA to detect and absolve cases contributing to pollution: - Five cases are targeted within the first 3 years. • Increase water, wastewater, and irrigation fees by 5%. • Increase subscriptions to water and wastewater services by 25%. • One pilot initiative for reuse of treated wastewater effluent. • One private sector engagement initiative using performance-based contracts. • Implement at least two community-led engagements that result in sustainable water protection.
Technical Assistance (TA) Program in the Water and Wastewater Sector in Lebanon *Agency: Delegation of the EU and AFD* *Duration: 2020 – 2025*	The objective of the TA is to shift the paradigm in the water sector from an investment-based approach to a service-based approach through improving service operation, strengthening tutelage, and supporting institutional and sectoral dialogue. The TA will pilot new managerial approaches to tackle water demand management at the local level. The TA has three pillars: 1. Water sector reform: activities under this pillar include: • Prioritizing and drafting high-priority implementation decrees for the water code. • Improving the performance and capacities of the RWEs: organizational, technical, and financial audits for each RWE will be conducted to produce action plans specific to each RWE. The tools and methodologies of the RWEs will be revised to include performance indicators in the reporting of activities. • Improving the tutelage function at the MoEW: an organization audit at the MoEW will be conducted. • Creating a tariff restructuring plan for water and wastewater. 2. Technical maturity of investment projects in the strategy: this pillar involves reviewing the investment projects in the Updated NWSS-MoEW (2020) and other master plans in the water sector to re-prioritize projects and generate an investment roadmap that takes into consideration the crises in the country. 3. Supporting sectoral coordination and institutional dialogue.
Lake Qaraoun Pollution Prevention Project *Agency: CDR- funded by WB* *Duration: 2016 - 2023*	The aim of this project is to mitigate the pollution of the Litani River and to improve pollution management around Qaraoun Lake. The project targets four sources of pollution (municipal and industrial wastewater, solid waste and agriculture) through three key interventions: • Investments: reduction of municipal wastewater by extending sewage networks for municipal water and connecting them to WWTPs through investments. • Technical Assistance (TA): Capacity building for the BWE and LRA and preparatory studies addressing agriculture and solid waste pollution of water resources and the establishment of a PMU.

Title	Summary of Initiatives
	- Assessments under the TA include the SESA of the Updated NWSS-MoEW (2020) (ongoing), and the "sustainability of wastewater systems in the Upper Litani basin" assessment (planned). The latter aims to assess how to improve the sustainability of the systems that connect to the Zahle, Anjar, and Aitanit WWTPs (Beqaa). • Lebanon Environmental Pollution Abatement Project (LEPAP): This project addresses industrial wastewater pollution and aims to incentivize industries to reduce their pollution in all of Lebanon (including the area upstream to the Lake Qaraoun).
Awali – Greater Beirut Water Supply Project *Agency: WB*	The Awali project will convey treated water from the Awali river to supply water for the city of Beirut. A water treatment plant with a capacity of 250,000 m^3 is designed to treat the conveyed water. The treated water will be stored at a reservoir in Hadath, Mount Lebanon. Project implementation is expected to begin within the next 2-3 years.
Climate Smart Agriculture: Enhancing Adaptive Capacity of the Rural Communities in Lebanon (AgriCAL) *Agency: Green Plan – funded by IFAD* *Duration: 2013 – Ongoing*	The AgriCAL project objective is to support the implementation of climate change adaptation measures in the agriculture sector in three focus areas: Akkar-Danniyehh, North Baalbek and Hermel, and South Litani below Lake Karaoun. Project outputs are the following: 1. Water Management: Increase water availability and efficient use through water harvesting (rainwater harvesting from greenhouse rooftops and roads) and irrigation technologies. 2. Adaptation Techniques Roll-out: Increase adaptation to climate change for rangeland 3. Rangeland management: Prepare Community-based sustainable rangeland management plan, restore degraded rangeland areas and reduce flood risks. 4. Climate index-based insurance, 5. Policy and Knowledge Management.
Improved Water Resources Monitoring and Integrated Water Resources Management in the North of Lebanon *Agency: FAO – funded by SDC* *Duration: 2017-2022*	The objective of this project is to improve surface water resource monitoring and integrated water resource management in North Lebanon. The project initiatives are the following: • NLWE Capacity building: this includes installing SCADA systems for management-level decision making. • Training farmers on water-efficient irrigation methods and agricultural practices that increase production and yield. • Providing farmers with subsidies and on-the-job training. • Providing NLWE with the necessary infrastructure for water testing and monitoring.
Water Supply Augmentation Project *Agency: CDR – funded by WB, Government of Lebanon (GoL) and Islamic Development Bank* *Duration: 2014 – Ongoing*	The Water Supply Augmentation Project consists of constructing a dam in the Bisri River to store 125 MCM of water to secure water for the Greater Beirut and Mount Lebanon area and provide residents with continuous water supply services. The project will relieve pressure on groundwater by reducing reliance on wells for water supply. Following partial suspension, the WB cancelled the funds under the project on September 5th, 2020, due to delays in project implementation.
WASH – Lebanon *Agency: UNICEF and GoL* *Duration: 2011 – Ongoing*	In response to the refugee crisis, the UNICEF WASH program addresses the water, sanitation, and hygiene needs for the most vulnerable populations in Lebanon, prioritizing Syrian refugees in Informal Settlements (IS) and the Lebanese host populations. When the crisis escalated, the WASH program shifted towards sustaining services in villages that host the highest number of refugees; interventions include repairing systems to prevent failure and increasing capacity. As such, the WASH response includes:

Title	Summary of Initiatives
	• Humanitarian interventions: Provision of WASH services to mitigate public health hazards in IS and improve access to drinking water and wastewater services to those most in-need. • Stabilization: this component supports with the implementation of the MoEW National Water and Wastewater strategies, and has two pillars: - Emergency Response: with the help of donors, the program aids with covering the necessary maintenance to sustain the services of the RWEs. - Job Creation through labor-intensive modalities: creating labor modalities through the construction of new water infrastructure in vulnerable Lebanese populations. • Supporting the national and regional government with improving water and wastewater management through the implementation of inclusive interventions.
ReWater MENA *Agency: IWMI* *Duration: 2018 – 2022*	The ReWater MENA project aims to expand water reuse in the Middle East and North Africa (MENA) and promote reuse practices in the region to meet the water demand. The project targets three countries: Egypt, Jordan, and Lebanon. To achieve its objective, the project equips key stakeholders of the respective countries to implement sustainable water reuse models. Key outputs in Lebanon include (MoEW, 2020): 1. Building on national policies: • National baseline assessment of reuse potential • Update & validation of reuse quality standards through the support to LIBNOR committee. 2. Development of two local water reuse plans at identified sites. 3. Stakeholders' capacity building for safe water reuse through training and network building.
10,000 Rainwater Harvesting Systems *Agency: ACTED* *Duration: 2018 – Ongoing*	In line with the National Guideline for Rainwater Harvesting Systems created by the MoEW in 2016, ACTED is promoting the installation of rainwater harvesting systems to increase water availability and decrease pressure on groundwater and networked supplies. The objective of the project is to "promote an effective, simple, and scalable decentralized solution to Lebanon's water scarcity". In 2019, ACTED installed 44 rainwater harvesting systems in residential and institutional buildings. To achieve its' 10,000 rainwater systems' campaign, ACTED plans to implement the following key infrastructure and management initiatives: • Launch the campaign with the MoEW. • Create online database of existing RWH systems in Lebanon, including those installed by ACTED. • Train communities and local NGOs to design and install RWH systems and water efficient fixtures and host demonstration days. • Install additional systems for vulnerable households and institutions relying on unsustainable water sources. • Increase awareness about RWH and water efficient fixture with municipalities who provide building permits. • Promote training of plumbing installation of RWH systems and water efficient fixtures through technical schools, increasing green jobs.
Test the Water (TTW) *Agency: AUB-NCC* *Duration: Ongoing*	TTW addresses the social, technical, and management issues behind poor water quality by providing a digital platform, water quality testing kits, and solution co-creation workshops to improve citizen water quality testing through a participatory approach.

Title	Summary of Initiatives
Irrigation canals (cash for work) financed by KFW ; implemented by KFW	Rehabilitation of canals across the country; grants over 60 MUSD, water conservation and improved efficiency.

13.3 GIS Analysis Maps

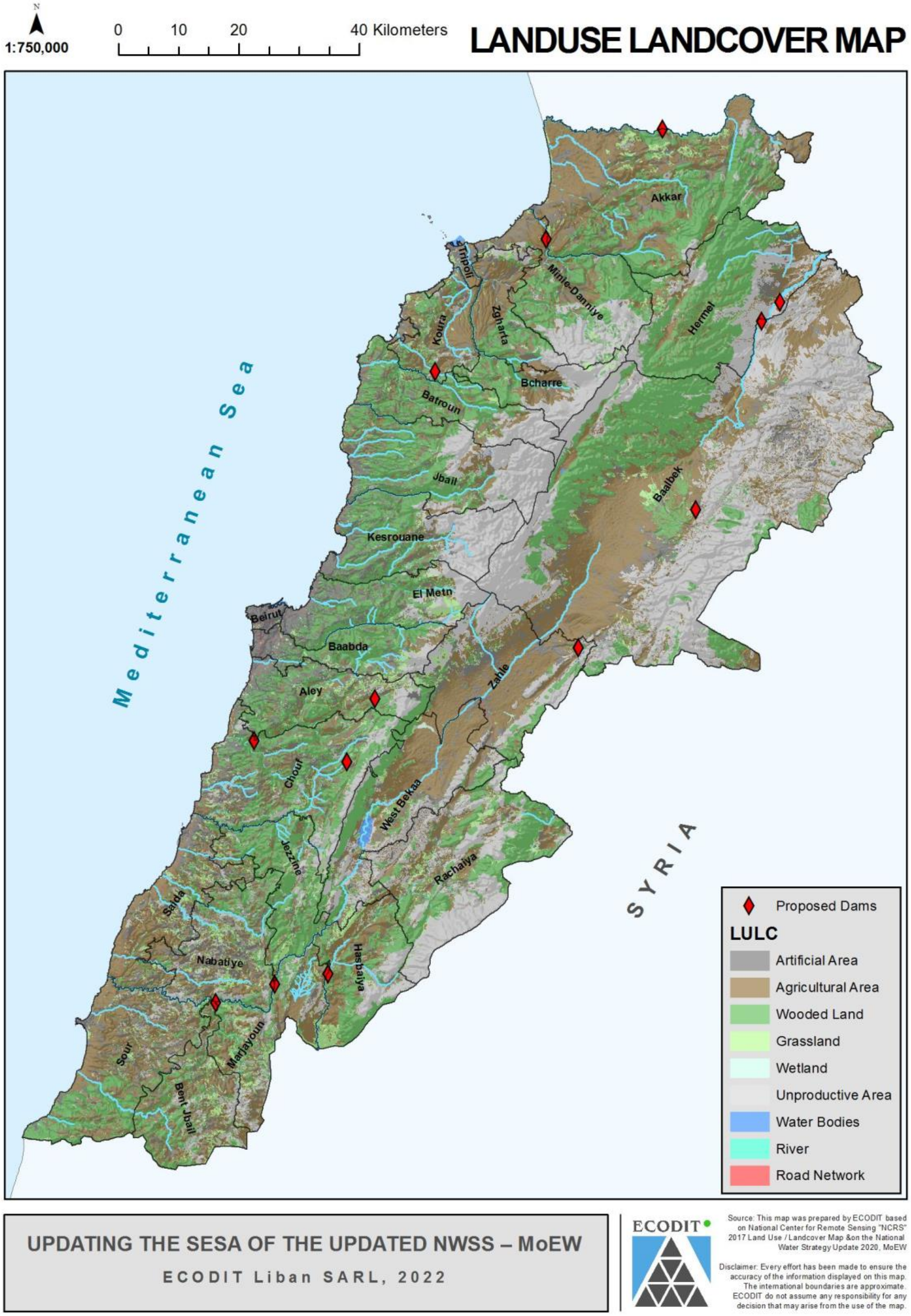


Figure 41. Proposed Dams Map Overlayed on Land Use/Land Cover Map

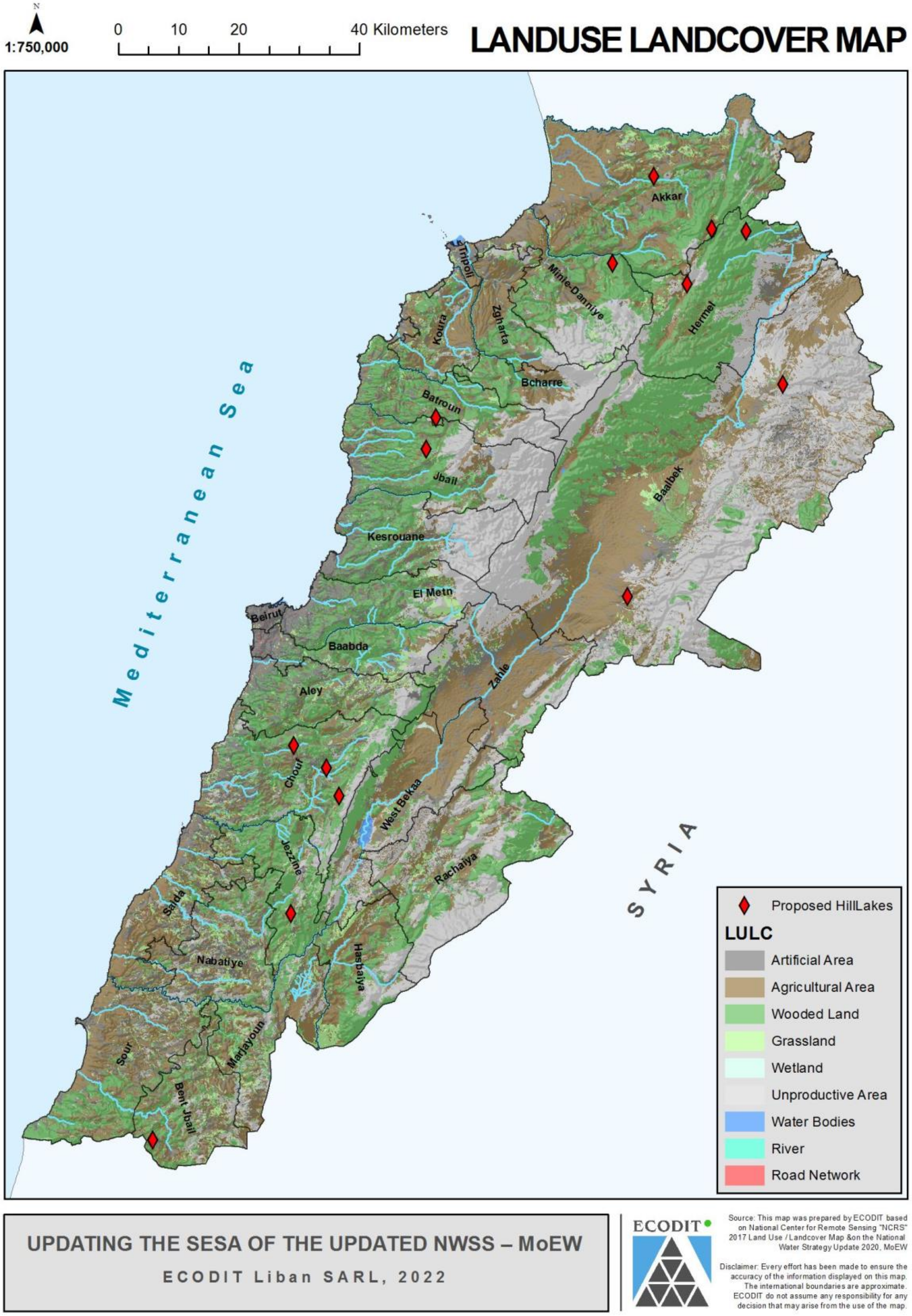


Figure 42. Proposed Hill lakes Map Overlayed on Land Use/Land Cover Map

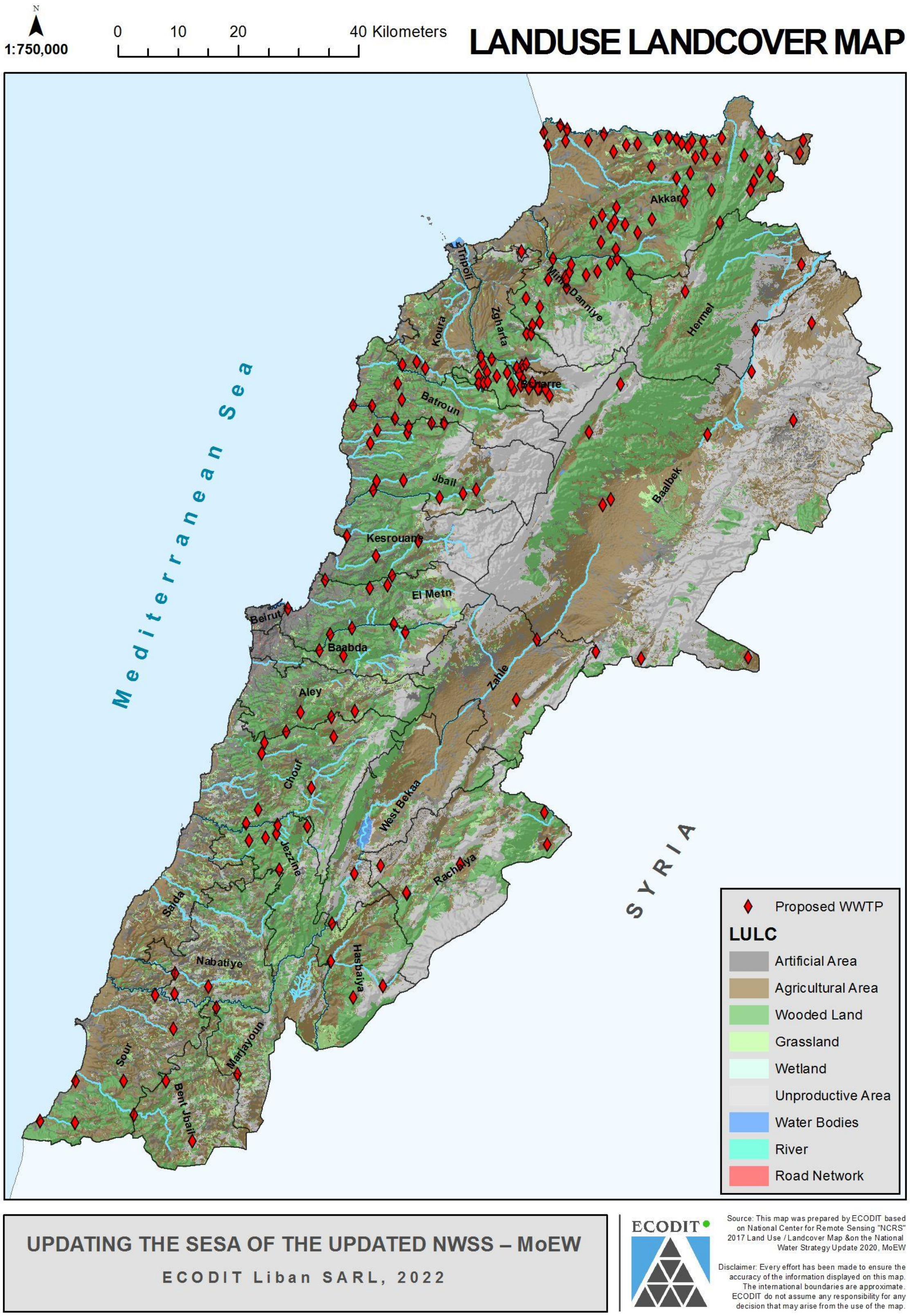


Figure 43. Proposed WWTPs Map Overlayed on Land Use/Land Cover Map

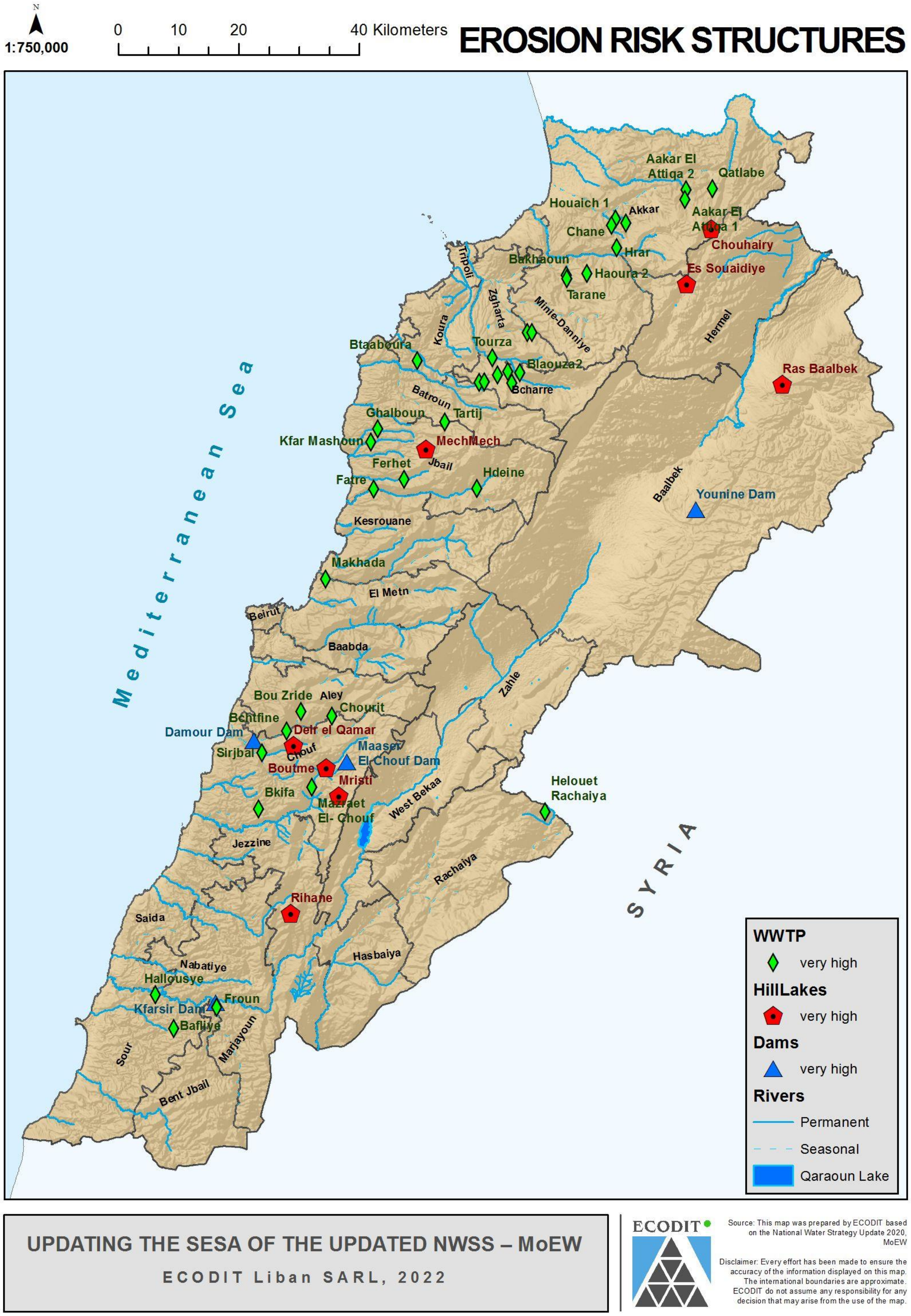


Figure 44. Proposed Projects located on Areas with High Risk of Erosion

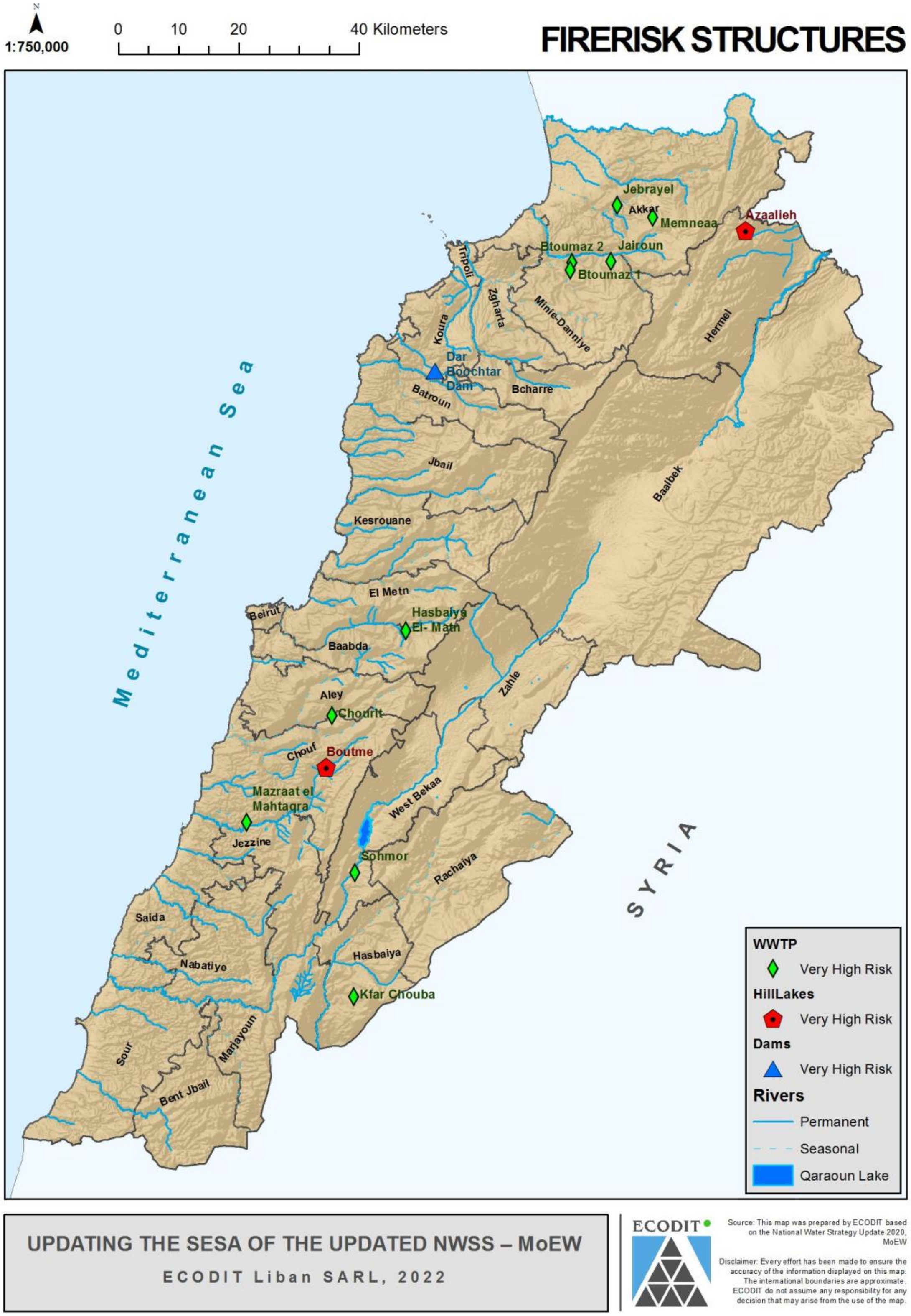


Figure 45. Proposed Projects located on Areas with Very High Risk of Fire

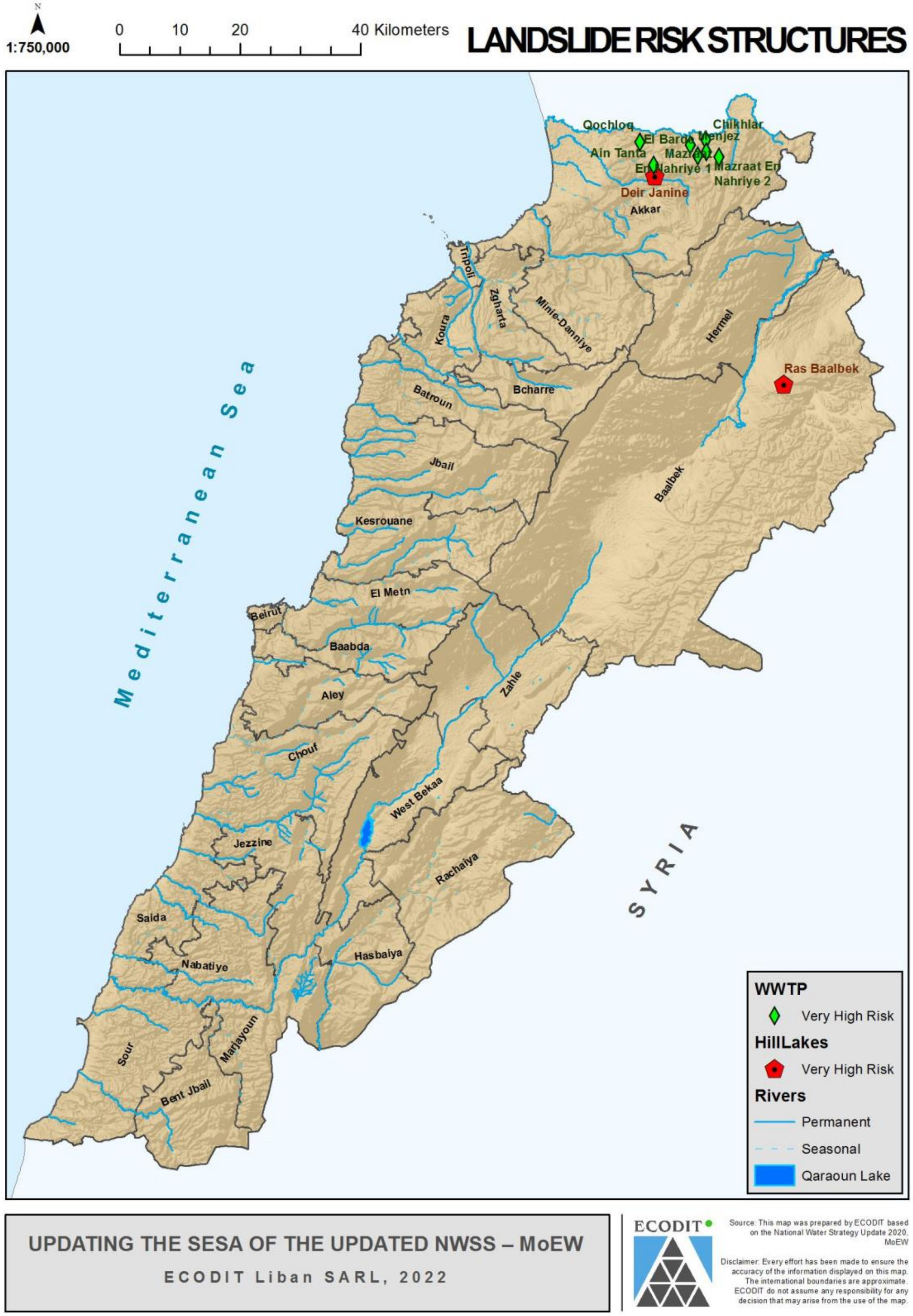


Figure 46. Proposed Projects located on Areas with Very High Risk of Landslides

13.4 Strategic Energy Management in Water Utilities

Strategic Energy Management (SEM) is a holistic approach to manage energy use. It is holistic in the sense that it acts at the level of an organization's strategic directions, it involves commitments from all levels of an organization's hierarchy and uses a multi-criteria approach to the water energy nexus. In the case of water utilities, water management is a key component of SEM, which unfolds as an integrated management of water and energy in the context of their activities.

An SEM adopts a continuous improvement approach based on the Plan-Do-Check-Act (PDCA) model, which is at the root of ISO 50001[21] energy management standard. PDCA is an effective SEM tool which could be used by a water utility. This standard aims to make energy efficiency and energy productivity improvements key components of organizational culture.

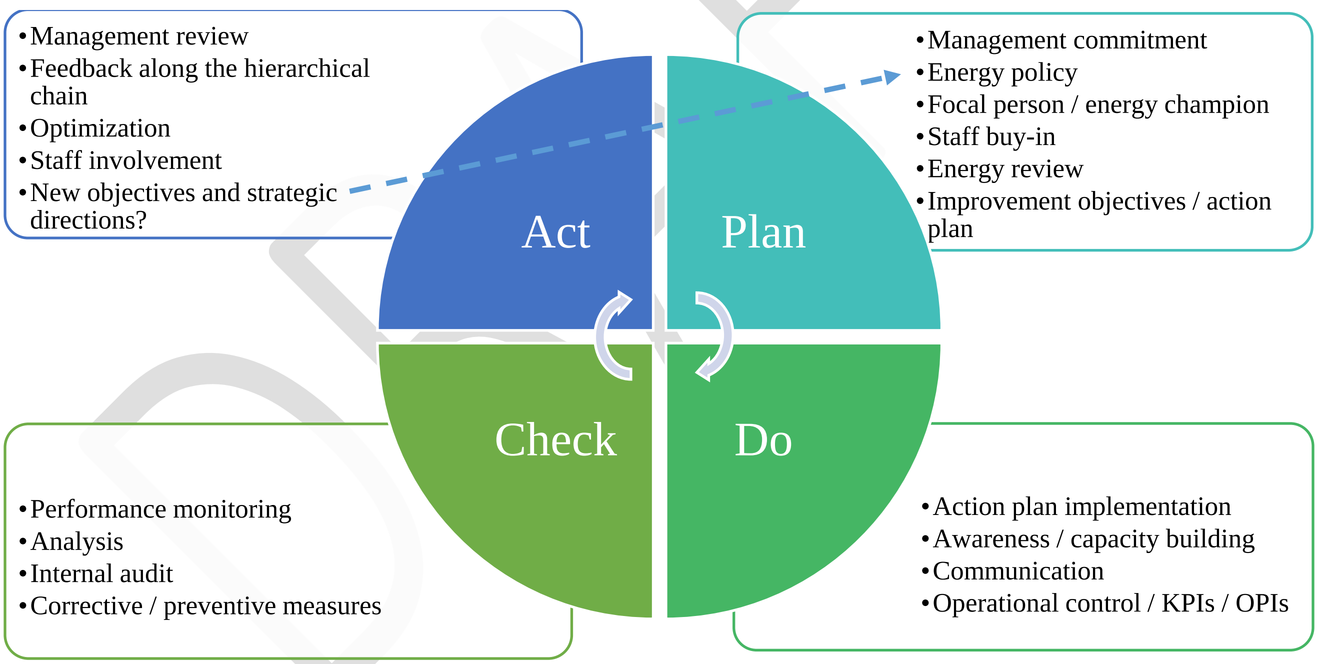


Figure 47. ISO 50001 PDCA Model

The main benefits of implementing SEM at a water utility are as follows:

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[21] ISO 50001 is a certification standard, whereby an accredited certification company will deliver a certificate proving that the organization has achieved the requirements stated in the standard. ISO 50001 requires the demonstration of continual improvement through the reduction in utilization of energy, or in the case of water utilities. ISO 50001 could be applied to part of an organization or to its full operations.

- Reduced energy footprint (incorporation of energy saving),
- Reduced water footprint,
- Reduced greenhouse gas emissions,
- Reduced operating costs which may have a positive impact on water rates.
- Reduced risk to energy price fluctuations,
- Better management practices and stronger company culture (embedded energy awareness),
- Improved operational control (reporting, monitoring, follow-up),
- Increased employee motivation, empowerment and engagement.

These benefits are of strategic importance for water utilities operating in environments where on top of the economic crisis, water scarcity, variability, and uncertainty are becoming more prominent, as is the case in Lebanon, potentially leading to increased vulnerabilities of water operators. One good example of stress factors on water is the increase of 37% in the country population in a matter of few years due to the influx of Syrian refugees.

Roadmap for a water utility to adopt SEM

In many instances, small and medium-sized organizations with limited resources opt for a phased approach to achieve good energy governance. This phased approach is intended to support and simplify the implementation of an SEM by an organization to (1) achieve a level of energy management appropriate to its objectives and (2) build a strong foundation, which can subsequently be extended towards meeting the requirements of ISO 50001 at the organizational level. ISO 50005 has been devised specifically to help organizations implement a stepwise approach to SEM.

Considering that water supply by pumping is the largest consumer of energy in a water utility in Lebanon, a phased approach could start by applying SEM to a major pumping station. It is more effective to include the water network (thus the region or area served by this pumping station) in the process.

Planning activities

To ensure the success of the SEM process, management should undertake the following activities:

1. Define an energy policy that reflects the vision, strategic directions and objectives towards responsible energy use. Objectives should be specific and measurable, for example: an “x” percent improvement in pumping efficiency within a 5-year period, or a “y” percent reduction in Non-Revenue Water (NRW) losses (a considerable source of energy wastage).
2. Hire a member of staff in charge of ensuring the implementation of the energy policy on the ground: an “Energy Champion”. This individual could be supported by an appointed Water-Energy Technical Team consisting of qualified, actively-involved personnel from across the organization.
3. Communicate and discuss the intent to embark on an SEM with all levels within the organization to ensure the consensus and engagement of all company employees in the process, particularly operating personnel.

4. Carry out an energy assessment of the selected facility to determine the significant energy users and its current performance, and to establish a baseline with respect to which future improvements are evaluated.
5. Devise an action plan following the assessment that includes quantifiable and measurable improvement targets to be achieved within a specified time frame (usually one year). Apart from the specific improvements to be undertaken in the selected facility, the action plan could include interventions at different levels within the organization, such interventions could address:
   - Improved metering, data monitoring, logging and analysis (hydraulic modelling),
   - Improved reporting,
   - Improved determination of "controlled point" location,
   - Improved pumping efficiency,
   - Improved maintenance practices,
   - Improved determination of true value of water including the embedded energy component,
   - Reduction in equipment unplanned downtime due to malfunctions,
   - Awareness and capacity building among staff on different technical and non-technical subjects,
   - Reduction in NRW,
   - Improved determination of Sustainable Economic Leakage Levels (SELL),
   - Increase in length of old pipe runs replaced in the network,
   - Reduction in frequency of pipe bursts,
   - Decrease in response time to repair pipe bursts or leaks,
   - Improved water network metering and at subscribers' premises,
   - Improved SCADA systems,
   - Improved operational control including water demand control through metering,
   - Reduced impact of energy cost on company financial performance,
   - Improved water quality supplied to subscribers,
   - Improved wastewater treatment and consequently reduced environmental pollution,
   - Improved communication with stakeholders (subscribers),
   - Reduced water demand by subscribers,
   - Increase in renewable energy share in utility energy demand,

In order to assess the success of the interventions suggested in the action plan, and thus the improvements achieved with respect to the baseline – which reflects the business-as-usual conditions – a set of performance indicators need to be devised. These indicators are divided into three categories one for each type of suggested interventions.

1. Key Performance Indicators (KPIs): These are used to assess the improvement in technical performance of equipment and systems in relation to SEM.
2. Operational Performance Indicators (OPIs): These are used to assess the improvement in service and business performance of the organization in relation to SEM.

3. Management Performance Indicators (MPIs): These are used to assess the improvement in performance at the human resources and administrative processes levels within the organization in relation to the SEM.

The indicators can also be evaluated with respect to selected benchmarks to establish distance to targets. The table below presents a list of recommended KPIs, OPIs and MPIs which could be included in an action plan, thus constructing a dashboard for performance tracking.

Table 55. Recommended SEM Action Plan Indicators

Indicator	Formula	Description
Key Performance Indicators		
Pump efficiency	$KW_{hydraulic}/KW_{elect}$	• Assesses the true efficiency of individual electric motor pumps from wire to water. • Used to evaluate any improvements made on the pump or due to pump replacement at similar duty.
Pumping system energy index	KWh_{actual} / $KWh_{optimum}$	• Assesses the additional energy use of a pump or a pumping system operating at suboptimal conditions compared to a pump or pumping system of similar duty operating at optimum performance. • This indicator is applied at the individual pump level or pumping system in the same pump house. It cannot be used to compare two different pumps or two different pumping systems. • Used to evaluate any improvements made on the pump or the pumping system.
Pumping system in-house normalized energy use	KWh/(m³.m/100m) Where: m³= volume of water m = pumping head	• Assesses the average pumping energy use at a given pumping head per unit volume normalized at 100 m of head. • Provides information on the impacts of energy management measures for the pumping system. • Allows to compare the performance of pumping systems operating at different operating pressures due to topography or required service pressure. Could be used to compare pumping energy use between two facilities in a utility or between pumping energy use between different utilities. This indicator could be also used to calculate pumping efficiency. • Does not consider NRW control measures.
Pumping system energy use per unit volume pumped	KWh/m³	• Assesses the energy use per unit of volume pumped. • Provides information on the impacts of energy management measures for the pumping system. • Should not be used to compare between two pumping systems operating at different pressures. • Does not consider NRW control measures.
Pumping system energy use per unit volume of revenue water	KWh/m³	• Assesses the energy use per unit of volume delivered to subscriber (revenue water). • Allows for assessment of impact of leakage control measures on the energy demand.
NRW ratio	m³ (lost) / m³ (pumped) (%)	• Assesses the leakage rate of networks. • Allows for assessment of impact of leakage control measures.
Water treatment plant volumetric energy use	KWh/m³ (treated)	• Assesses the energy use per unit volume of water treated

Indicator	Formula	Description
Wastewater treatment plant volumetric energy use	KWh/m³ (treated)	• Assesses the energy use per unit volume of wastewater treated
Wastewater treatment plant pollution removal energy use	KWh/kg BOD (removed)	• Assesses the energy use per unit mass of organic pollution removed
Pumping system specific CO_2 emissions	Kg CO_2 / m³ (pumped)	• Assesses GHG emissions per unit volume pumped.
Water treatment plant specific CO_2 emissions	Kg CO_2 / m³ (treated)	• Assesses GHG emissions per unit volume treated water.
Wastewater treatment plant volumetric specific CO_2 emissions	Kg CO_2 / m³ (treated)	• Assesses GHG emissions per unit volume wastewater treated.
Wastewater treatment plant pollution removal specific CO_2 emissions	Kg CO_2 / kg BOD	• Assesses GHG emissions per unit mass of organic pollution removed.
Operational Performance Indicators		
Total budget Energy share	Energy expense (LBP) / total budget (LBP)	• Assesses the importance of energy in the overall utility budget
O&M expenses energy share	Energy expense (LBP) / O&M budget (LBP)	• Assesses the importance of energy in the overall utility budget
Energy cost of water pumped	Energy expense (LBP) / m³ (pumped)	• Assesses the energy cost per unit volume pumped water
Energy cost of revenue water	Energy expense (LBP) / m³ (at subscriber tap)	• Assesses the energy cost effectiveness for revenue water. It also helps determine the water tariffication
Energy cost of NRW	Energy expense (LBP) / m³ (lost)	• Assesses the energy cost per unit volume lost to leakages
Energy cost of treated water	Energy expense (LBP) / m³ (treated)	• Assesses the energy cost per unit volume treated
Energy cost of treated wastewater	Energy expense (LBP) / m³ (wastewater treated)	• Assesses the energy cost per unit wastewater volume treated
Systems monitoring coverage	Number of measuring points installed / total number of measuring points needed to monitor all systems at the level of the utility	• Assesses the progress in installing measuring points to control systems performance. • This indicator is important to evaluate the extent of operational control in the utility
Water network Specific NRW	m³ (lost) / km of network / day	• Assesses the leakage rate per unit length of network over a specific time period
Subscribers metering coverage	Number of subscribers metered / total number of subscribers	• Assesses the progress of water meters installation at subscribers' premises • This indicator is important to evaluate the progress done towards controlling the NRW and billing based on consumption
Network metering coverage	Number of meters installed at strategic nodes in the network / total number of meters needed to fully monitor the network	• Assesses the progress of water meters installation in the water network • This indicator is important to evaluate the progress done towards controlling the NRW and billing based on consumption
District metering coverage	Number of districts fully equipped with water meters / total number of districts served by the utility	• Assesses the progress of fully equipping districts with water meters at subscribers' premises and water networks • This indicator is important to evaluate the progress done towards controlling the NRW and billing based on consumption

Indicator	Formula	Description
Bacteriological Water quality compliance at point of delivery	Average of the 10% lowest values of free chlorine at the point-of-delivery/Minimum recommended value of free chlorine	• Assesses the bacteriological quality of water at subscriber tap at different locations. Allows to measure improvements in water treatment as well as water network integrity
High chlorine water quality compliance at point of delivery	Average of the 10% highest values of free chlorine at the point-of-use/Maximum recommended value of free chlorine	• Assesses the maximum chlorine content of water at subscriber tap for safe use at different locations. Allows to measure improvements in water treatment as well as water network integrity
Potable water index	Tests complying with national criteria for potable water /Tests carried out)	• Assesses the suitability of tap water for potable water use. Allows to measure improvements in water treatment as well as water network integrity
Management Performance Indicators		
Staff capacity building activities index	Man-hours of capacity building workshops attendance by company staff / number of staff	• Assesses the efforts made by company management to upgrade employee competence related to SEM
Staff awareness activities index	Man-hours of awareness workshops attendance by company staff / number of staff	• Assesses the efforts made by company management to upgrade employee awareness related to SEM

Usually, the "Energy Champion" – assisted by the Water-Energy Technical Team – is responsible for preparing the planning phase (energy policy, communication within the organization, energy assessment and action plan). The following are some recommended measures which could be included in an action plan:

1. Install metering systems at all facilities to monitor energy use and volumes of water handled. Typically, the most needed measurements and sensing devices are:
    - Electricity consumption for significant energy users like pumps, air blowers, aeration bridges, etc.,. Typically, all electrical loads having a rating equal-to or higher than 5 KW should be have individual electrical energy meters;
    - Water flow measurements (instantaneous and cumulative) downstream from pumps discharging water to the network;
    - Pressure readings at the inlet (if applicable) and discharge side of pumps;
    - Water meters at critical nodes in the water network serving the different districts;
    - Water meters at the subscribers' premises;
    - Pressure readings at critical nodes in the network;
    - Leak detection at critical nodes in the network.
2. Replace old, inefficient equipment with modern machines, especially in what concerns significant energy users. Note that the inability to meet full operational cost coverage may hinder or delay the maintenance of aging infrastructure, especially pumps and motors, and hence, their operational efficiency.
3. When replacing equipment or designing new installations, select new equipment to operate at its best efficiency duty point, as much as possible. Equipment oversizing should be avoided.

4. Considering that the reliance on in-house electricity generation will most probably persevere for a long period to come, it is recommended to replace generators that have varying loads with new ones that have proportional fuel use characteristics (i.e. fuel consumption varies with the load).
5. Install variable frequency drives for all electric motors above 3 KW that operate equipment with different load regimes (pumps, air blowers, ventilation fans, mixers).
6. Install soft starters for motors above 7.5 KW operating at constant load.
7. Instill among staff an ethic of regular data acquisition, monitoring and analysis.
8. Utilize hydraulic modelling to simulate the different operating conditions of the water networks.
9. Improve O&M procedures.

Note that Capacity building is a critical requirement for recommendations 7, 8, and 9.

10. Reduce the NRW to the Sustainable Economic Leakage Levels.
    NRW represents a wasted high value resource; it embodies energy expended in the sourcing, treatment and distribution of water, and thus, carries a high energy footprint. NRW reflects the interrelationship at the core of the water energy nexus: any wastage of water has direct implications on energy wastage, and improvements made in water systems have a direct impact on energy utilization. However, effectively reducing the NRW to zero is not feasible from both an operational and economic point of view. NRW is rarely lower than 15%, even in countries with modern water infrastructure. In Lebanon, it is estimated to be at a national average of 50%. Indeed, some improvements a utility can undertake on a network can cancel each other. A good example is the objective of placing all subscribers within the 'controlled point' (The subscriber location whose water pressure is most difficult to reach) which determines the water pressure in the system and consequently the energy use. This is a challenge in areas with hilly topography and mountainous regions as is the case for the water utilities in Lebanon. Thus pushing further the 'controlled point' will imply higher pressures in the system which will negatively affect the NRW as these will increase water losses and pipe bursts thus negatively affecting the service provided to subscribers. Conversely, higher system pressures increase pumping inefficiencies and energy use, which negatively impacts the energy performance of the utility. Consequently, finding the optimum operating conditions for a water utility considering the SELL, the "controlled point" and energy use, with the aim of providing services at the most advantageous rates to subscribers, is a tedious balancing act between different operating parameters. This can only be achieved through the implementation of a well-thought-out SEM program.
11. Establish a program of water re-use or water table replenishment.
12. Separate the rainwater network from the sewage network, or make the sewage network as water-tight as possible against rainwater infiltration. This will drastically reduce energy costs related to sewage handling.

13. Establish a demand-side water management program through effective communication with subscribers to instill in them water conservation culture. The demand side management could include incentive programs such as:
    - Installation of water saving fixtures at subscriber premises (faucets, WC, shower heads, washing machines);
    - Rainwater harvesting installations at subscribers' premises;
    - Separate grey and black water plumbing systems at subscribers' premises.

    Demand-side management could also imply an active involvement of water utilities in urban planning. This is a critical issue in developing countries like Lebanon, where skyscrapers are becoming more prevalent. In many streets, two or three-story buildings housing a maximum of six households have been demolished and replaced with high-rise buildings housing 30 households or more. As such, utility water does not reach most households in the city. High rise buildings require more system pressure, which increases leakages and energy required for pumping. In a typical utility, pumping absorbs 85% of energy use. Hence, establishing an optimum average network water pressure in urban areas could influence the city skyline.

<u>Implementation activities</u>

Following the completion of the action plan, implementation activities conducted under the supervision of the "Energy Champion", assisted by the Water-Energy Technical Team, include the following;

- Interventions on the significant energy users (Upgrading, refurbishment, replacement), whether equipment or processes. Incidentally the significant energy users are also closely related to hot spots in water use.
- Installation of measuring equipment (KWhr meters, flowmeters, etc.) and system control and data acquisition.
- Capacity building for the following purposes:
    - Upgrading O&M practices,
    - Upgrading competencies for analytical assessment (software simulation),
    - Upgrading competencies for hydraulic system design.
- Awareness events in issues related to SEM and the environment.
- Communication activities directed to internal and external stakeholders.

The aim of the implementation phase, and consequently the SEM, is to reinforce operational control in the organization based on four main integrated components, namely:

- Improved data acquisition, monitoring and preventive actions,
- Improved O&M practices,
- Improved management practices,
- Improved communication.

Checking activities

Conduct a periodic assessment of the action plan that evaluates its effectiveness in achieving the objectives and targets of the energy policy. In particular, evaluate the actual versus expected energy performance of significant energy users at planned intervals. All results of monitoring activities should be duly recorded.

The assessment should periodically review (1) the relevance, suitability, and effectiveness of the performance indicators, (2) the measurements required to evaluate these indicators, and (3) the accuracy and repeatability of the measuring data. Records of instruments' calibration must be properly maintained. Deviations in energy performance of significant energy users should be duly investigated and corrective actions undertaken.

As part of the assessment, the utility must conduct internal audits at planned intervals in order to ensure the following:

- The objectives and targets are in conformity with the energy policy and the action plan is effectively implemented and updated.
- Devise corrective actions and review their effectiveness.

Management review

Top management, supported by the "Energy champion" and the Water-Energy Technical team, should periodically review the energy policy to ensure its suitability, adequacy and effectiveness.

As part of this process, top management should evaluate energy performance using the performance indicators, and review the internal audits and the corrective actions undertaken.

The energy review could result in (1) modifications to the energy policy, including the energy targets and objectives, (2) changes to the performance indicators, or (3) changes to the allocation of resources needed to ensure the sustainability of the continual improvement process.

13.5 Preliminary Economic Assessment of WSmix Scenarios

I Economic Assessment of Alternatives - Water Supply – Lebanon

A	Scenario 2 General status expected in 2035 without non-conventional resources, and with dams under construction/ on-hold completed (Al Assi-Phase 1, Janneh and Bisri Dam)
B	Scenario 3 Increase of SW supply through the completion of all proposed dams in the 2020 NWSS by 2035
C	Scenario 4 Increase of GW supply through pumping from private wells to substitute SW from dams. Janneh Dam is only completed over and above the existing dams of Scenario

INPUTS / ASSUMPTIONS

Groundwater		
Water supply from private wells (scenario 2)	320	Mm3/year
Water supply from private wells (scenario 3)	160	Mm3/year
Water supply from private wells (scenario 4)	517	Mm3/year
Dams		
Water supply from dams (scenario 2)	625	Mm3/year
Water supply from dams (scenario 3)	985	Mm3/year
Water supply from dams (scenario 4)	435	Mm3/year
Bisri Dam capacity	125	Mm3 of potable water
Assi Dam Capacity	63	Mm3 of irrigation water
Janneh Dam Capacity	90	Mm3 of potable water
	5	Mm3 of irrigation water
Boqaata Dam Capacity	12	Mm3 of potable water
Mseilha Dam Capacity	11	Mm3 of potable water
Groundwater pumping cost		
Average fuel consumption per liter/m of depth/m3	0.004	liters of diesel
Estimated electricity consumption needed/m3 of pumped water	0.44	kWh/m3[1]
Price of diesel per liter in Lebanon 2022	0.998	USD/liter[2]
Carbon Emissions		
Equivalent 1 gallon of diesel	20	liters

[1] Source: Energy-nexus Expert Report - Updated SESA
[2] Source: www.globalpetrolprices.com/Lebanon/diesel_prices

Carbon emissions per gallon of diesel	0.0102	metric tons of CO2 emissions[3]
Carbon emissions per KWh	0.000709	metric tons of CO2 emissions[4]
Gallons of fuel needed per KWh	0.11	gallons of fuel/kWh
Emissions from one 500MW coal power plant	4,497,354	tCO2e[5]
Emissions from one typical passgenger car	4.6	tCO2e/year[6]
Social Cost of Carbon (in Feb 2021)	51	$/tCO2e[7]

Private water purchase

Household water consumption from public grid	1	m3/day
Water consumption per capita per day	165	liters[8]
Average Expenditure on Private water sources (tankers, bottled water, wells)	135	USD/month[9]

<u>Assumptions</u>

Average household demand for water tanks	1	water tank/week
	52	water tankers/year
Price of water tanker (full)	1500000	LL
	52	$ (black market exchange rate 1$=29000)
Average household expenditure on bottled water	600	$/year
Range of bottled water annual expenditure	260 - 850	$/year
ye	850	$/year/HH[10]

[3] Source: https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references
[4] Source: https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references
[5] Source: https://www.ciel.org/wp-content/uploads/2019/05/Plastic-and-Climate-Executive-Summary-2019.pdf
[6] Source: https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle#:~:text=typical%20passenger%20vehicle%3F-,A%20typical%20passenger%20vehicle%20emits%20about%204.6%20metric%20tons%20of,8%2C887%20grams%20of%20CO2.
[7] Source: https://recyclingpartnership.org/wp-content/uploads/dlm_uploads/2021/05/Paying-It-Forward-5.18.21-final.pdf
[8] Source: https://www.intechopen.com/chapters/64413
[9] Source: https://today.lorientlejour.com/article/1304598/the-water-informality-trap.html
[10] (Conservative value, as this excludes health costs and pipe replacements costs from water quality deterioration)

Brakish water RO system range cost	200 - 1050	$/year/HH	625[11]
	3.75 - 7.55	$/m3	in 2018[12]
Average cost of water from tankers per m3	5.65	$/m3	
Household water subscription (flat rate per year per HH)			

Source: https://www.tandfonline.com/doi/pdf/10.1080/02508060.2017.1416441?needAccess=true

[11] (costs include regular operation and maintenance as well as amortization over 10 years)
Source: https://www.tandfonline.com/doi/pdf/10.1080/02508060.2017.1416441?needAccess=true

[12] Source: https://www.tandfonline.com/doi/pdf/10.1080/02508060.2017.1416441?needAccess=true

III Economic Assessment of Alternatives - Water Supply - Lebanon

A Scenario 2: General status expected in 2035 without non-conventional resources, and with dams under construction/ on-hold completed (Al Assi-Phase 1, Janneh, and Bisri Dam)

B Scenario 3: Increase of SW supply through the completion of all proposed dams in the 2020 NWSS by 2035

Scenario 2 vs Scenario 3 (A+B)

Argument: The increase of SW supply through the completion of all proposed dams in the 2020 NWSS by 2035 will reduce the reliance on GW specifically private wells by half compared to scenario 2
This will result in economic savings such as household savings from expenditures on private water sources (bottles, tankers, private wells)

Economic and Social Metrics

Household Savings from Expenditures on Private Water Sources

Incremental water supply from dams - scenario A to B 360 Mm3/year

Savings from Reduced Pumping Costs of Groundwater		
Reduction of water capacity from private wells	162	Mm3/year
Estimated electricity to pump groundwater	71,280,000	KWhr
Estimated gallons of fuel consumed	7,840,800	Gallons of fuel
Estimated savings cost for pumping water from private wells	157	Mn USD/year
Estimated water supplied by tankers	191	Mm3/year
Estimated cost savings of water supplied by tankers	1,078	Mn USD/year
Estimated water supplied by bottled water	7.2	Mm3/year
Estimated drinking water per household	1,643,836	HH/year

Split assumption of private water supply	
Private wells	45%
Bottled water	2%
Tankers	53%

3	liters/c/day	4c/HH
12	liters/HH/day	
4380	liters/HH/year	
4.38	m3/HH/year	

Estimated cost savings on bottled water	986	Mn USD/year
Total annual household savings from private water supply	2,221	Mn USD/year
Carbon Emissions Reduction		
Carbon emissions from reduced pumping groundwater	50,537.52	mtCO2 emissions
Equivalence in number of car emissions	10,986	cars/year
Savings in terms of social carbon cost	2,577,414	USD/year
	2.58	Mn USD/year
Savings from improved quality from reduced coastal seawater intrusion		
Incremental water supply from dams from scenario A to B	360	Mm3/year
Bisri dam - serving coastal areas of Beirut & Greater Beirut	125	Mm3/year
Replacement cost if the same Bisri water capacity was covered through GW pumping and treatment using brakish RO water system	214	Mn USD/year
Savings on annual cost incurred from coastal seawater intrusion	838	Mn USD/year

Note: This is considered a conservative value as it excludes health costs and pipe replacements costs from water quality deterioration

Economic Assessment of Alternatives - Water Supply – Lebanon

A	Scenario 2: General status expected in 2035 without non-conventional resources, and with dams under construction/ on-hold completed (Al Assi-Phase 1, Janneh, and Bisri Dam)
C	Scenario 4: Increase of GW supply through pumping from private wells to substitute SW from dams. Janneh Dam is only completed over and above the existing dams of Scenario 1

Scenario 2 vs Scenario 4 (A+C)

Argument: If we would to only complete only Janneh, Mseilha, and Baqaata Dams (118 Mm3/year), we would still be forced to continue our reliance on GW to meet our demand of freshwater.

This will result in over pumping of aquifers, increase in seawater intrusion in coastal areas, increase costs on household to secure water from private wells and private water sources such as tankers, bottled water.

Economic and Social Metrics

Household Expenditures on Private Water Sources		
Reduced SW supply from dams - scenario A to C	-190	Mm3/year
Additional Pumping Costs of Groundwater		
Incremental water capacity to be covered from private wells	197	Mm3/year
Estimated electricity to pump groundwater	86,680,000	KWhr
Estimated gallons of fuel consumed	9,534,800	Gallons of fuel
Estimated cost for pumping water from private wells	190	Mn USD/year

Split assumption of private water supply	
Private wells	45%
Bottled water	2%
Tankers	53%

3	liters/c/day	4c/H
12	liters/HH/day	
4380	liters/HH/year	
4.38	m3/HH/year	

Estimated water supplied by tankers	100,700,000	m3/year
Estimated cost of water supplied by tankers	569	Mn USD/day
Equivalent annual bottled water supply for drinking purposes	3,800,000	m3/year
Estimated cost of water bottles given (1HH=4.38m3)	521	Mn USD/year
Annual Total Household Costs	**1,280**	**Mn USD/year**

Additional Carbon Emissions

Carbon emissions from increased reliance on groundwater	61,456	mtCO2 emissions
Equivalence in number of car emissions	13,360	cars/year
Savings in terms of social carbon cost	3,134,262	USD/year
	3.13	Mn USD/year

Costs from increased coastal seawater intrusion

Reduced SW supply from dams - scenario A to C		-190	Mm3/year
Increase in GW capacity from private wells to offset SW reduced supply		197	Mm3/year
Replacement cost if the same water capacity supplied from dams was covered through GW pumping and treatment using brakish RO water system	337		Mn USD/year

Median annual cost incurred from coastal seawater intrusion from pumping equivalent amount of water for HH use	442	Mn USD/year

Note: This is considered a conservative value as it excludes health costs and pipe replacements costs from water quality deterioration)

13.6 OECD Twelve Principles of Good Water Governance

Enhancing the effectiveness of water governance	1.	Allocate and distinguish roles and responsibilities for water policymaking, operational management and regulation, and foster coordination across these responsible authorities.
	2.	Manage water at the appropriate spatial scale(s) within integrated basin governance systems to reflect local conditions, and foster coordination among the different scales.
	3.	Encourage policy coherence through effective cross-sectoral co-ordination, especially between policies for water and the environment, health, energy, agriculture, industry and land use.
	4.	Adapt the level of capacity of responsible authorities to the complexity of water challenges to be met, and to the set of competencies required to carry out their duties
Enhancing the efficiency of water governance	5.	Produce, update, and share timely, consistent, comparable and policy relevant water and water-related data and information, and use it to guide, assess and improve water policy.
	6.	Ensure that governance arrangements help mobilise water finance and allocate financial resources in an efficient, transparent and timely manner
	7.	Ensure that sound water management regulatory frameworks are effectively implemented and enforced in pursuit of the public interest.
	8.	Promote the adoption and implementation of innovative water governance practices across responsible authorities, levels of government and relevant stakeholders.
Enhancing the trust and engagement of water governance	9.	Mainstream integrity and transparency practices across water policies, water institutions and water governance frameworks for greater accountability and trust in decision-making.
	10.	Engage with stakeholders for informed and outcome-oriented contributions to water policy design and implementation.
	11.	Ensure that water governance frameworks foster equity across water users, rural and urban areas, and generations
	12.	Conduct regular monitoring and evaluation of water policy and governance, share the results with the public, and make adjustments when needed.

14 ADMINISTRATIVE ANNEXES

14.1 SESA Team Composition

The SESA team consists of the following team members, each of which will lead the analysis of specific SESA issues, as summarized in Table 56.

Table 56. Team Members' Responsibilities and Scope of Work

Name	Position	Responsibilities and Scope of Work in the Analysis of SESA Issues
Rana Tabcharani	Project Director	• Lead the contracts, administrative, and financial relations of the project
Nour Mucharafieh	Team Leader/Environmental and Energy Specialist	• Lead/Manage the preparation of project deliverables • Lead the: o Description of the baseline environmental conditions o Evaluation and selection of the SESA key issues o Analysis of environmental impacts o Analysis of alternatives • Assess coherence with national policy; objectives and institutional frameworks • Conduct stakeholder consultation meetings and public consultation sessions
Melissa Dahdouh	Project Coordinator/Environmental Specialist	• Contribute to the: o Description of the baseline environmental conditions o Evaluation and selection of the SESA key issues o Analysis of environmental impacts o Analysis of alternatives • Conduct stakeholder consultation meetings and public consultation sessions
Dana Halawani	Project Coordinator/Environmental Health Specialist	• Contribute to the: o Description of the baseline environmental conditions o Evaluation and selection of the SESA key issues o Analysis of environmental impacts o Analysis of alternatives

Name	Position	Responsibilities and Scope of Work in the Analysis of SESA Issues
		• Conduct stakeholder consultation meetings and public consultation sessions
Nay Ghorayeb	Project Coordinator/Civil and Environmental Engineer	• Contribute to the: o Description of the baseline environmental conditions o Evaluation and selection of the SESA key issues o Analysis of environmental impacts o Analysis of alternatives • Conduct stakeholder consultation meetings and public consultation sessions
Karim El Jisr	SESA Advisor	• Provide senior advice to SESA team on: o Evaluation and selection of the SESA key issues o The stakeholders outreach strategy o The development of recommendations for integrating SESA findings in the Updated NWSS-MoEW • Review the project deliverables (internally)
Ghassan Jaradi	Ecology Expert	• Describe the baseline biological environment • Assess the potential significant impacts on the environment associated with the implementation of the Updated NWSS focusing on: o Solid waste impact on freshwater, seawater, and wildlife o Impact of wastewater effluent in freshwater and seawater bodies on biodiversity o Overexploitation of water vs biodiversity sustainability o Management of man-made water bodies towards increasing their support to beneficial services o Loss of biodiversity due to water resource mismanagement and destruction of ecosystems

Name	Position	Responsibilities and Scope of Work in the Analysis of SESA Issues
		○ Impact of irrigation systems on biodiversity of habitats ○ Benefits from the creation of sub-natural water reservoirs (Hill lakes)
Redha Hamdan	Social Expert	• Describe the baseline socio-economic conditions • Assess the potential socio-economic impacts associated with the implementation of the Updated NWSS focusing on: ○ Household water consumption and expenditure ○ Economic activity and water consumption ○ Impact of the economic crisis on households and economic actors: poverty, local development, economic sectors (in relation to water sector) • Conduct Macro-economic analysis: economic absorption capacity of investments • Assess the direct and indirect socio-economic impact of the NWSS
Sara Safi	Economist	• Estimate the value of selected benefits of the Updated NWSS (e.g. value of coastal water quality improvements from wastewater treatment, value of reduced salinity/saline intrusion of coastal aquifers, potential recreational benefits associated with increased bird watching opportunities, and others); • Conduct a preliminary assessment of cost and benefits of alternative options
Naji Tannous	Energy Expert	• Provide analysis of specific water-energy issues (expected energy consumption for the strategy initiatives, impacts of hydropower, impacts of strategy initiatives on energy security and national energy supply and demand, shift to natural gas and renewable energy etc.) • Assess and evaluate the environmental and social impacts of

Name	Position	Responsibilities and Scope of Work in the Analysis of SESA Issues
		the Updated NWSS, namely impacts related to water-energy nexus
Antoine Allam	Hydrology Expert	• Describe the baseline environmental conditions • Assess and evaluate the environmental and social impacts of the Updated NWSS, namely impacts related to: o Hydrology o Dams' operation and monitoring o Water resources monitoring o Safety and risk assessment o Emergency planning and implementation
Rania Maroun	Water Resource Management Expert	• Describe the baseline environmental conditions • Assess and evaluate the environmental and social impacts of the Updated NWSS, namely impacts related to: o Water resources availability and management o Water resources monitoring o Climate change adaptation o Wastewater and sludge management o Water governance (institutional, organizational, operation and maintenance) o Safety and risk assessment o Emergency planning and implementation
Ali Koumaiha	GIS Expert	• Prepare required GIS maps, including but not limited to: o Water and Wastewater Infrastructure in Lebanon o Water Resources (river watersheds, dams, etc.) o Geology and Tectonic Risk of Surface Water Infrastructure o Location of Environmental Sensitive Areas and Large Water Infrastructure in Lebanon o The strategy's proposed projects and activities • GIS analysis

Name	Position	Responsibilities and Scope of Work in the Analysis of SESA Issues
Lamia Chamas	Environmental and Social Specialist	• Conduct stakeholder consultation meetings with civil society
Capricia Chabarekh	QA/QC Manager	• Check coherence and proofreading for the deliverables • Review draft deliverables (internally)

14.2 Phase I Stakeholders' Meetings Notes

14.2.1 *Summary of Meeting Notes*

<table>
<tr><th>Stakeholder</th><th>Key Comments from Meetings</th></tr>
<tr><td rowspan="4">BWE</td><td>Comments on Updated NWSS-MoEW (2020)</td></tr>
<tr><td>
Water sector governance actions in the strategy are fairly covered.
Water governance, proposed projects, and water resources management actions in the strategy should be implemented in parallel.
An emergency response plan at the Ministerial level should be included in the strategy.
Activities and projects listed in the Updated NWSS are in-line with the strategies of the BWE, as they were provided to the consultant during the drafting of the Updated NWSS.
All projects in the strategy are needed; however, projects can be better prioritized taking into consideration the current situation.
The strategy should be revised periodically.
Reuse of wastewater and AAR are not needed as BWE can provide 50% of needs through spring tapping and gravity networks.
</td></tr>
<tr><td>Comments on Water Sector</td></tr>
<tr><td><u>Challenges:</u>
Lack of coordination between the government and WEs.
The WWTP projects are being implemented without taking into consideration the local context (implemented based on international experience).
Illegal tapping of wells and technical losses in the system:
There are areas in Bekaa where BWE does not have the authority to enter in order to address the problem of NRW.
BWE only has the authority to refuse well tapping if it interferes with activities of BWE.

The country's financial crisis: Devaluation of the currency has resulted in a significant reduction in tariff value.
WEs lack flexibility in employment.
Absence of civil service council.
BWE is in debt.
</td></tr>
<tr><td rowspan="4">EBML</td><td>Comments on Updated NWSS-MoEW (2020)</td></tr>
<tr><td><u>Challenges with proposed projects:</u>
Difficult to get the necessary funds for the proposed projects in the strategy.
</td></tr>
<tr><td>Comments on Water Sector</td></tr>
<tr><td><u>Challenges:</u>
The country's financial crisis:
EBML are in 'survival mode'
Operators are no longer applying to tenders due to fluctuating value of the LBP

Lack of Availability of Water Resources in Beirut and Mount Lebanon
Lack of public trust in WEs
</td></tr>
</table>

Stakeholder	Key Comments from Meetings
	● Lack of metering, which leads to the problem of Non-revenue Water (NRW) ● Capacity: WEs lack staff and engineers. Current wages too low to hire necessary expertise. ● Coordination: actors in the sector (including donors) do not work in parallel and projects are not complimentary.
SLWE	**Comments on Updated NWSS-MoEW (2020)**
	● Absence of holistic approach: ○ The strategy should consider the different Ministerial strategies and address the challenges and needs of the different sectors that interlink with the water sector. ○ The strategy focused mainly only compilation of WE strategies. ● The re-use of wastewater (and sludge) for irrigation is not addressed effectively. ● The projects in the strategy are realistic in terms of the management and resources capacities at the SLWE. ● AAR should not be a priority: it can affect the quality of water in aquifers, which is an additional burden on the WEs. ● Infrastructure and demand management actions are of equal priority; they should be implemented in parallel as they are interlinked.
	Comments on Water Sector
	<u>Challenges:</u> ● Legal framework/structure: ○ SLWE lacks management staff and human resources to implement the amended water code (Law 192/2020), fulfill the WE organizational decrees, and operate infrastructure. ○ Responsibilities of the key players in the water sector are not clearly defined, particularly with regards to wastewater. ○ Law prevents WEs from hiring permanent staff and engineers are hired on a contract-basis (غب الطلب). ● Cost recovery: there are not enough subscribers to the WEs. ● High energy costs: Fuel (diesel) is not always readily available and is very costly due to the country's current fuel crisis. ● Lack of centralized decision making and planning, as such: ○ Projects in the sector are overlapping and redundant – particularly donor projects. ● No revenue associated with wastewater treatment. <u>Recommendations:</u> ● Legal framework should provide the WEs with the ability to develop projects/infrastructure and build capacity.
NLWE	**Comments on Updated NWSS-MoEW (2020)**
	<u>General Comments:</u> ● The role of SDGs in the strategy is unclear. ● The country's current economic crisis is not an indicator in the strategy and is not considered in the financing of the action plan and proposed projects; the strategy should take into consideration the current situation. ● The link between the different sectors (agriculture, industry, etc.) is not evident. <u>Wastewater and water quality management:</u>

Stakeholder	Key Comments from Meetings

	● The management of the collection, transmission, and treatment of wastewater processes are unclear.
	● Wastewater data collection and collection of subscription fees are not addressed.
	● There is no plan for how treated wastewater can be utilized, e.g. for irrigation.
	● There is no plan to tackle water pollution.
	<u>Proposed projects:</u>
	● Values used for population and growth rate for NLWE proposed projects are unjustified and are different to those currently adopted and used by the NLWE.
	● This number of wells proposed in the strategy is too high, particularly in Akkar:
	    o Controlling groundwater exploitation is a major concern and drilling additional wells will add to this problem.
	● It is unclear why regions such as Batroun and Bcharre don't have projects, despite there being a Master Plan for Bcharre funded by AFD.
	● The strategy proposed more wells than recommended in the Water Resources Master Plan conducted with EU and CISEF for NLWE.
	<u>Demand management:</u>
	● NRW in the strategy have been reduced by around 20% from figures currently adopted by NLWE.
	● Private wells/illegal wells and their effect on demand and groundwater depletion were not considered.
	<u>Groundwater management:</u>
	● Absence of strategic thinking for groundwater management:
	    o The strategy does not have a plan for groundwater monitoring and control, performance monitoring, and associated roadmap, players, and steps towards achieving these goals.
	● Absence of plan for the replacement of groundwater resources with alternative water resources.
	<u>Irrigation strategy:</u>
	● Management of irrigation activities not effectively tackled, specifically:
	    o Groundwater pollution from fertilizers as a result of agricultural activity.
	    o Presence of open soil channels.
	    o Forecasting for the future: particularly with regards to water conservation and demand control.
	<u>Other comments:</u>
	● Key Performance Indicators (KPIs) for climate change are not specified.
	● Absence of clear plan for the audit of the strategy and strategy financing.
	    o Lack of employees to conduct audits.
	● It will take more time than predicted in the strategy for capacity building actions to be implemented due to the current situation in the country.
	● Some projects listed in the strategy have already been implemented.

	Comments on Water Sector
	<u>Challenges:</u> ● NLWE lacks human resources and funds. ● Donors' projects are not targeting the key needs of the sector.

Stakeholder	Key Comments from Meetings
	● Lack of water resources planning. Recommendations: ● Shift towards surface water to save around 50-60% of the water pumped from the groundwater.
LRA	**Comments on Updated NWSS-MoEW (2020)**
	General Comments: ● The strategy is not aligned with the amended water code and lacks the following requirements: o The strategy is required to be conducted in coordination with the Ministries (environment, agriculture, etc.) and the water authorities, as outlined in Article 17 of the Amended Water Law. o The strategy fails to pass the water sector strategy content requirements listed in Article 18 of the Amended Water Code. o The strategy fails to include (and accordingly plan for) the requirement of classifying the country's water basins and conducting water basin management plans, as outlined in Articles 21, 22, and 23 of the Water Code. A plan for water basin classification as well as the creation of water basin management plans should serve as a basis for the water sector strategy. o The strategy proposed projects and associated budget are unjustified; it does not align with the priorities of the water sector. ● The following priority areas in the water sector were not considered in the strategy: o Hydro-electric potential of water and hydroelectricity projects. o Water resources pollution: Projects for improving water quality and combatting pollution in the Litani basin were not tackled or prioritized.
	Comments on Water Sector
	Challenges: ● Maintaining efficient hydroelectric power generation during the country's current crises: o Absence of cost recovery as EDL are not paying due fees: LRA is unable to pay O&M costs or employee salaries. ● Operation and maintenance of irrigation infrastructure is too costly; this was amplified by the country's economic crisis. o Low efficiency irrigation water networks due to lack of modern irrigation infrastructure. ● Absence of coordination between water sector actors ● Presence of severe water pollution; this is the primary cause of water loss: o Treated wastewater effluent is of poor quality and is polluting water basins. ● Poor well licensing mechanism: o Well licenses are being given randomly o Absence of monitoring and control of quantity of water pumped from wells o Over exploitation of groundwater resources ● LRA are no longer able to collect hydrological data across the whole Lebanese territory. Recommendations: ● Prioritization of surface water sources over other non-conventional sources of water, particularly projects that combat surface water pollution.

Stakeholder	Key Comments from Meetings
	● Decentralization of water sector management; centralized authorities are no longer effective. ● Establish mechanism to control groundwater exploitation/well pumping and licensing. ● Water demand management and water supply should be addressed in parallel ● Implementation of Choumariye/Kfarsir dam to provide water for irrigation purposes. ● Modernization of irrigation infrastructure, systems and practices.
MoE Advisors	Comments on Updated NWSS-MoEW (2020) General comments: ● The strategy does not have a clear vision for the development of the water sector. ● IWRM and water resources assessment are not integrated in the strategy approach. Focus of the strategy is mainly on projects. ● The strategy focuses on water quantity and not on water quality. ● Absence of mechanisms for stakeholder engagement. ● The strategy does not consider the ecosystem as one of the users. ● The strategy should be revisited to include an emergency response plan to address the country's developments after 2019. ● Fire management should be taken into account in the strategy. Water sector governance: ● The strategy recommends the improvement of transparency through monitoring and sharing of information, however, there is a lack of trust between the public and the decision makers which will impede the implementation of this recommendation. ● The strategy does not set out a system for quality control in Public Private Partnership (PPP). Climate change: ● The strategy should consider the impact of dams on climate change (strategy focuses mainly on impact of climate change on dams). ● The strategy only considered precipitation water availability in terms of volume and does not consider timing/seasonality: o The strategy does not consider seasonal variations in the precipitation trend; this is important, from a climate perspective, to link water resources to agricultural cycles and to understand the expected volume at dam level. ● Modern methods (including new research in the field of climate change and new climate scenarios) have not been considered in the strategy, e.g. climate proofing. ● It is unclear if the proposed surface water projects (e.g. rainwater harvesting) take into consideration climate change. ● The strategy fails to mention the Nationally Determined Contribution under the UNFCCC. Demand management: ● The updated strategy is driven more towards meeting demand, not managing demand: o Absence of demand management plan: there should exist a component in the strategy for cutting on demand. o Industrial sector was not discussed

Stakeholder	Key Comments from Meetings
	o The strategy does not provide a clear link between the sectors of development (agriculture, domestic, industrial, etc.). ● It is unclear whether the strategy is meeting water demand with groundwater or surface water; a justification should be provided.
	Comments on Water Sector
	<u>Challenges:</u> ● Financial sustainability: o Water sector is highly dependent on donors. o Absence of cost recovery. o Ineffective management structure. ● Monitoring: o Absence of continuous data on surface water, groundwater, and wastewater quantity and quality; this information is required for better policy making and should be publicly available. ● Communication: o There is a gap between water supply and demand. o Lack of communication between actors in the sector. ● Lack of Enforcement: o Presence of illegal connections and the over-pumping of groundwater by farmers and citizens. o Industries are constructing wastewater treatment plants that are not operational. ● Site Selection: o The size of the country and poor urban planning present a challenge for identifying suitable locations for wastewater treatment plants and sludge disposal. ● Emergency preparedness is being neglected due to inefficient management. <u>Recommendations:</u> ● Devise clear plan for cost recovery in proposed projects. ● Consider the privatization of the sector. ● Effective communication of alternative solutions to dams.
Green Plan	**Comments on Updated NWSS-MoEW (2020)**
	● Irrigation elements in the updated NWSS were not drafted in collaboration with Green Plan.
	Comments on Water Sector
	<u>Challenges:</u> ● Absence of direct communication and transparency between the stakeholders in the water sector. ● Presence of climate change: this is creating a change in rainfall patterns. ● Inefficient water systems which are resulting in the presence of 50-60% NRW. ● Presence of water pollution due to a lack of law enforcement. ● Absence of control mechanisms for the implementation of non-conventional sources of water. <u>Recommendations:</u>

Stakeholder	Key Comments from Meetings
	● Regular meetings should be conducted with the MoEW (or committees for the purpose of communication can be established) to improve coordination in the water sector. ● The maintenance of existing networks.
MoA	**Comments on Updated NWSS-MoEW (2020)**
	● Absence of alignment of the Updated NWSS with the MoA 2020-2025 strategy.
	Comments on Water Sector
	<u>Challenges:</u> ● Lack of coordinated Ministerial-level decision making and planning. ● Regarding the supply of water from dams for irrigation purposes: o There is a variation in quantity between seasons; the flow provided is not constant. o Although WE are mandated to distribute water for irrigation purposes, they lack the human resources and are financially unable to provide water for irrigation. ● Causes of irrigation inefficiencies are the following: o Presence of earth channels which should be converted either to concrete channels or pipes to increase efficiency (distribution inefficiencies) o Lack of water tariffing/water metering. As such, there is an overconsumption of water by farmers. The MoA is waiting for the water metering/volumetric tariffing law to be implemented, given that this is not the responsibility of the MoA. o Inefficient irrigation systems: Sprinkler and drip irrigation systems are not widespread, despite the fact that they reduce inefficiencies. o Lack of overall management. ● Use of treated effluent for irrigation: o Farmers that use wastewater for irrigation purposes have opposed the diversion of wastewater for treatment. o Irrigation systems constraint: only drip irrigation system can be used with treated wastewater. <u>Recommendations:</u> ● Conducting awareness campaigns for farmers. ● Capacity building for farmers. ● Providing farmers with alternative water sources for irrigation.
MoI	**Comments on Water Sector**
	<u>Challenges:</u> ● Challenges associated with the mismanagement of industrial wastewater: o Corruption; lack of law enforcement o Non-compliance of industries because of low technical and financial capacity o Lack of cooperation of Municipalities. <u>Recommendations:</u> ● MoE should provide more technical support to industries to improve their environmental compliance and treat their wastewater effluent.
CDR – *Funding Division*	**Comments on Updated NWSS-MoEW (2020)**
	● SDG 6 targets 6.1, 6.2, and 6.5 and 6.6 are very ambitious targets for 2035. ● The strategy should reflect the economic situation of the country. ● Proposed projects that require expropriation and that are not currently financially feasible should be reconsidered.

Stakeholder	Key Comments from Meetings
	● Short term financing of the strategy should depend on donations. The strategy should propose the following long-term financing mechanism guidelines: o A balance sheet for the WEs (for the next 5 years), o Calculation of technical losses, o Improvement of the collection rate to increase the revenue of the RWEs, o Increase the water tariff and reduce NRW. ● Projects should be conducted in coordination with local institutions to improve implementation and coordination.
	Comments on Water Sector
	<u>Challenges:</u> ● WEs have small budgets for O&M. ● Some WEs do not have correct balance sheets. ● Donors are cancelling projects due to delays in implementation; delays are occurring because of political interference, expropriation, and other challenges specific to the context of the country. <u>Involvement of donors in the sector:</u> ● Technical key areas of all donor-funded projects are: o Increase in collection rates, o Technical losses, o RWE Balance sheets.
CDR – *Water, Wastewater, and Infrastructure Division*	**Comments on Updated NWSS-MoEW (2020)**
	<u>General comments:</u> ● The strategy resembles a Master Plan more; this is a positive element as it centralizes decision-making, which provides more direction of donor-funded projects. ● The strategy focuses more on surface water storage; this is important as there are shorter periods of precipitation and consequently, increased runoff. ● The data present is enough for the implementation of necessary high priority projects, including dams. ● Water sector governance and infrastructure projects should be implemented in parallel.
	Comments on Water Sector
	<u>Challenges:</u> ● Inconsistent and low-quality wastewater influent of WWTPs; this is damaging the facility and increasing O&M costs. o Contamination resulting from the ad-hoc discharge of wastewater into WWTPs from unknown entities due to lack of law enforcement. ● Anaerobic techniques in WWTPs for electricity generation requires a lot of expertise and is not suitable for implementation in Lebanon. ● Absence of adequate labs for the testing of water and wastewater samples. Labs are ill-equipped and results are inaccurate. ● Lack of implementation of Law 221/2000: o WEs lack human resources to fulfill organizational structures o WEs lack funds to fulfill responsibilities ● Absence of WE strategies: WEs require master plans to improve decision making. ● Present tariff does not allow for cost recovery, especially for wastewater services.

Stakeholder	Key Comments from Meetings
	● There is good coordination between the CDR and MoEW, but there is no coordination between MoEW and other Ministries. Recommendations: ● Implementation of activated sludge WWTPs for large-scale facilities. ● Implementation of RBC and reed bed WWTPs for small-scale facilities. ● To address demand management, pressure gauges should be installed rather than water meters: o Water meters have a larger initial investment o Water meters require regular checking which presents additional costs.
Municipalities	**Comments on Updated NWSS-MoEW (2020)**
	● Protection/cleaning existing water resources, water sector governance reforms, and the rehabilitation of existing infrastructure are priorities. ● Absence of ultimate achievable vision
	Comments on Water Sector
	Challenges: ● Lack of law enforcement: citizens are continually breaching their water rights and polluting water resources. Lack of 'water culture' awareness among citizens. ● Inadequate water sector management and water resources management; presence of unused/wastewater water resources. o Centralized establishments are unable to meet citizens' needs: RWEs lack the capacity and/or budget to fulfill responsibilities. o Municipalities are assuming water sector responsibilities. o Absence of operation and maintenance of existing infrastructure. ● Haphazard and unorganized wells management. ● Water and wastewater infrastructure is damaged and requires rehabilitation. ● Presence of failed impoundment projects that do not collect water due to the lack of studies prior to construction. ● Absence of coordination between all water sector stakeholders: o Lack of coordination between RWEs and Municipalities. Recommendations: ● Cease the drilling of wells in polluted groundwater. ● Water sector decentralization: o Allocate to Municipalities/Municipal Unions a larger role in the water sector: i.e. the management of water resources and services for citizens under their jurisdiction. This will aid with law enforcement and improve urban planning, i.e. lower water tariffs to support the development of areas planned for expansion. o Provide Municipalities with the authority to carry out water services and implement water projects for citizens under their jurisdiction ● Involve civil society in decision-making as part of the participatory approach.
OXFAM	**Comments on Updated NWSS-MoEW (2020)**
	● There should exist an adaptable, scalable cost recovery model included within the workplan of activities; it should keep up with the context of the country. ● The mismanagement of the wastewater sector and its impacts are not clearly addressed in the strategy.

Stakeholder	Key Comments from Meetings
	● The strategy should recognize emergency response, however, the focus should be on the long-term rather than the short term.
	Comments on Water Sector
	<u>Challenges:</u> ● Financial/commercial framework: cost recovery model is absent. ● Data gaps in the water sector ● HR and Capacity Building: staff absenteeism and those that are reporting to work are overworked. ● Legal and regulatory framework: laws are outdated, overlapping and unclear. ● Ministerial processes are long which might cause delay in strategy implementation.
USAID	**Comments on Updated NWSS-MoEW (2020)**
	● The strategy should be amended to reflect the current situation. The focus of the strategy should be on setting specific short-term targets for the next 3 to 5 years within the context of the current situation. Moreover, all projects should be prioritized based on clear criteria, specifically: o What are the vital sectors? o What are the vital resources needed? o What are the funds required considering what funds are available? ● The strategy needs to consider interventions that reduce O&M to create more sustainable projects and ensure the sustainability of the sector as a whole. ● Improvement and expansion should not be an immediate priority. ● The water sector should be sustainable and not dependent on donors. As such, the following should be considered: o Proposed actions should tackle cost recovery before looking at infrastructure projects. o A plan for financing the strategy should be developed (financing mechanisms).
	Comments on Water Sector
	<u>Challenges:</u> ● Lack of enforcement: this is affecting billing and service and the tariff. ● Poor coordination between all actors in the water sector: coordination between donors is better. <u>Recommendations:</u> ● Main focus of the sector should be on reducing non-revenue water, before considering the potential of non-conventional sources of water. <u>Involvement in the Sector:</u> ● USAID is conducting a 45 million dollar 5-year program: Water, Sanitation, and Conservation (WSC) in Lebanon: o USAID would prefer if the MoEW are able to compile interventions that reduce O&M.
UNDP	**Comments on Updated NWSS-MoEW (2020)**
	<u>General comments:</u> ● Irrigation in the strategy should target surface water. ● The Strategy should focus on upgrading irrigation canals before looking at water supply augmentation.

Stakeholder	Key Comments from Meetings
	● Budget should be allocated for collection purposes in hill lake projects. ● The strategy should focus on demand management for ecosystem services, not just for humans. ● Climate change should be mentioned in terms of reduction and supply in the strategy; it should be more explicit. ● The strategy should not be revisited to consider the new challenges in the water sector as a result of the country's current crises; the underlying challenges remain the same. ● There was mention that the water data of the groundwater study conducted by UNDP in 2014 was not integrated into the strategy; this should be checked. Wastewater and Sludge Reuse management: ● The strategy should promote wastewater standards for reuse. ● The strategy should target upgrading existing septic tanks or implement low-tech wastewater treatment technologies to mitigate WWTP operation and maintenance issues. Discrepancies in the Strategy: ● Maps for irrigation canals proposed by the Updated NWSS are inaccurate; locations of the canals are incorrect.
	Comments on Water Sector
	Challenges: ● Water consumption cannot be controlled with solar-powered irrigation pumping. ● Pollution loads on ecosystems is impacting water quality and in-turn water availability. ● There is a lack of coordination in the sector as a result of a general lack of personnel and capacity in the sector. Recommendations: ● Facilities for sludge treatment should be centralized; regional if possible. Involvement in the Sector: ● UNDP is focusing on projects that upgrade irrigation infrastructure (irrigation canals).
EU	**Comments on Updated NWSS-MoEW (2020)**
	General comments: ● Unclear financing mechanism. ● The strategy lacks a timeline. ● A crisis response plan will dilute the strategy: a short-term crisis response plan should be included as an annex in the strategy. Wastewater and sludge management: ● Industrial pollution and its effect on the quality of sludge was not addressed.
	Comments on Water Sector

Stakeholder	Key Comments from Meetings

	Challenges:
	● Projects are not sustainable due to water tariff structure.
	    o Inability to cover operational costs.
	● Lack of human resources and capacity of WEs.
	● Lack of law enforcement: WEs are not collecting fees in some areas due to impunity.
	● Privatization:
	    o Difficulty with monitoring and control due to lack of law enforcement.
	    o Private sector may be reluctant to be involved in the sector due to the political situation and resulting uncertainty regarding the safe return on investment.
	● Coordination between water sector stakeholders is not sufficient:
	    o Absence of clear strategy: as such, projects between donors are not complementary.
	    o Financial crisis: communication is improving between stakeholders in the sector due to lack of funding available.
	Recommendations:
	● Introducing a National Water Council: this will provide a point of contact with other governmental actors and consequently facilitate the approval of certain key reforms.
	● Water tariff restructuring.
	● Implementation of the water code.
	Involvement in water sector:
	● The EU is adapting their strategy to 'crisis mode' due to collapse of system.
	● Future EU intervention is focused on demand management and water resource management.

SDC	**Comments on Updated NWSS-MoEW (2020)**
	● The strategy should include achievable outputs and indicators: e.g. tackling the water and irrigation tariff by shifting to a volumetric tariff to reduce illegal connections. ● The strategy should not address the issue of vulnerable communities, rather the strategy should tackle water and wastewater on a national scale. ● The strategy should be in line with all Ministerial strategies. ● Sector reforms should be prioritized in the strategy. ● The strategy should not be revised to reduce delays with implementation. ● The infrastructure and water governance components of the strategy should be implemented in parallel.
	Comments on Water Sector

	Challenges:
	● Coordination in the water sector
	● Water governance:
	    o Lack of qualified staff at the MoEW.
	● Inefficient irrigation practices:
	    o Farmers do not have the financial means to install efficient irrigation systems
	    o Farmers rely on traditional irrigation methods that over-exploit water.
	● Mismanagement of the water sector due to lack of effective law enforcement.
	Recommendations:
	● Digitizing and archiving data.
	● Implement solar pumping stations to reduce O&M costs.

Stakeholder	Key Comments from Meetings
	<u>Involvement in the sector:</u> ● Direct action projects involve improving water and sanitation services in the Beqaa and integrated water resource monitoring tackling surface water in North Lebanon.
AICS	**Comments on Updated NWSS-MoEW (2020)** ● The infrastructure and water governance components of the strategy should be implemented in parallel. ● The strategy should focus on ensuring the sustainability of services for the successful implementation of projects: e.g. restructuring of tariff, improving maintenance, and improving collection. **Comments on Water Sector** <u>Challenges:</u> ● WEs lack the capacity and qualified staff to take over the O&M of wastewater treatment facilities. ● High operation and maintenance costs of facilities. ● Sludge management: absence of landfills to dispose of sludge. ● Absence of adequate water tariff. ● The country's economic crisis: o Absence of local financing, o Contractors are not being paid, o Absence of funds for new infrastructure projects. <u>Recommendations:</u> ● The Lebanese government should implement policies to restructure the tariff and improve collection rates. ● The sector needs a quick solution to address sludge management: landfilling is a financially feasible solution. <u>Involvement in the sector:</u> ● AICS interventions focus on constructing and rehabilitating wastewater treatment plants, as well as technical capacity building and the training of water sector institutions.
UNICEF	**Comments on Updated NWSS-MoEW (2020)** ● The proposed water resources management studies are necessary for proper decision making. ● The strategy should not cover the country's economic crisis; the purpose of the strategy should be to cover the development of the water sector only. ● The strategy covers the social dimension by acknowledging the total population of the country to cover the actual water needs. ● Performance-based contracts as well as the polluter-pays principle are addressed in the strategy and are important measures towards improving control in the water sector. ● The infrastructure and water governance components of the strategy should be implemented in parallel. <u>Recommendations:</u> ● The strategy should be updated to include a plan for project prioritization: o O&M of facilities at the current service level may need to be prioritized over the implementation of the proposed studies and infrastructure projects due to the country's current crises.

Stakeholder	Key Comments from Meetings
	Comments on Water Sector

	● Sector coordination is comprehensive due to the presence of regular national sector meetings involving all NGOs and activity information reporting by all donors at the sector level.
	<u>Challenges:</u>
	● The country's economic crisis:
	    ○ Low WE employee salaries are affecting their performance.
	    ○ Lack of commitment of on-demand labor operators due to the fluctuating Lebanese Pound exchange rate.
	    ○ There are several cases of equipment theft from water stations.
	● Design levels of wastewater treatment plants are insufficient:
	    ○ The level of treatment of most wastewater treatment plants are not at an adequate environmental standard (absence of secondary-level treatment).
	● WEs lack financial schemes and internal structures required for the takeover of wastewater treatment plants.
	● Lack of water management and tariffication (absence of water metering and the presence of NRW)
	● Lack of protection of water resources.
	<u>Involvement in the water sector:</u>
	● UNICEF interventions are centered around the following:
	    ○ Emergency response: Maintenance and services of facilities.
	    ○ Job creation through labor intensive modalities: building reservoirs, spring catchments, and diverting stormwater runoff from wastewater lines.
	    ○ Providing WASH services for vulnerable communities.

AFD	**Comments on Updated NWSS-MoEW (2020)**
	<u>Comments:</u> ● Challenges associated with the roles and responsibilities of actors are not tackled. ● The strategy goals are not specific. ● The proposed MoEW PMU tasks overlap with that of the AFD/EU TA project. ● Absence of concrete measures for strategy monitoring and implementation. <u>Demand management:</u> ● The strategy lacks a section on performance improvement. ● Plans to manage water demand are not well-defined. <u>Wastewater and sludge management:</u> ● Recommendations for sludge management in the strategy are sufficient and are not over-ambitious. <u>Recommendations:</u> ● The strategy should include an emergency plan with short and medium cost recovery objectives that address the country's current crises. ● The strategy objectives should be well-defined with targeted figures. ● Mandates of actors (MoEW, WEs, and the National Water Council) should be defined and analyzed to identify overlapping roles and responsibilities and resolve institutional problems. ● The strategy should promote the establishment of guidelines (energy efficiency, sludge management, reuse potential, return on investment, and socio-economic impact etc.).

Stakeholder	Key Comments from Meetings
	Comments on Water Sector
	Challenges: ● Weak water sector management: absence of corrective maintenance, data collection, and adequate planning. ● Absence of urban planning of land use. ● There are no plans, regulations or standards on the reuse of sludge on a Ministerial level. ● Civil society (specifically citizens and other water users) are not included in the decision-making process in the water sector, rather, only the views of NGOs are captured. Involvement in the water sector: ● AFD is interested in water governance reforms. ● AFD's primary intervention in the sector is the 5-year TA project, which focuses on three pillars: Supporting the implementation of reforms, technical maturity of investment projects in the strategy, and supporting sectoral coordination and institutional dialogue.
WB	**Comments on Updated NWSS-MoEW (2020)**
	Comments: ● Lack of policy planning: the strategy does not define the required policies or prioritize the proposed policies (i.e. prioritize their implementation into long, medium, and short-term). ● Absence of a connection strategy: the strategy should address the pricing of connections and should link to the different economic levels of citizens. ● Operation and Maintenance is not adequately covered, including the financial elements and the maintenance of connections. ● The strategy is more of an action plan and lacks a higher strategic vision/goals. ● The strategy does not consider the major developments in the country following 2019. Recommendations: ● The strategy should be periodically revised and updated based on changes in the situation of the country; this timeframe should be defined in the strategy. ● Develop an emergency plan with short-term actions for the water sector that addresses the current country's current crisis to complement the strategy. ● Develop a strategy to tackle NRW: 1. Collect data on NRW and create databases for each WE 2. Implement pilot projects then expand on pilots.
	Comments on Water Sector
	Challenge: ● Absence of financial sustainability: there should exist a financial sustainability roadmap and financial statements should be audited at the entity level. ● Lack of wastewater management and treatment: previously constructed wastewater treatment plants are not functional or are not operating effectively. ● Delays at the level of implementing agencies. ● The country's current economic and financial crises: ○ WEs experiencing challenges with paying contractors.

Stakeholder	Key Comments from Meetings
	○ WEs are in need of emergency support: the WEs are focusing on emergency response and this is affecting the sustainability in the sector in the future. ○ Implementing innovative development projects is no longer a priority. <ins>Involvement in the water sector:</ins> ● WB are working on 3 primary projects: Lake Qaraoun Pollution Prevention Project, Awali - Beirut Water Conveyor Project, and the Greater Beirut Water Supply Project. ● Future activities in the Lake Qaraoun Pollution Prevention Project involve assessing the sustainability of wastewater systems in the Upper Litani basin.
IFI	**Comments on Updated NWSS-MoEW (2020)** <ins>General Comments:</ins> ● The strategy is a significant improvement from the 2010 NWSS: The strategy has updated data and research, and includes supporting projects. ● The strategy addresses the tariff and service challenges to tackle demand effectively. ● The strategy should not be revised to integrate a disaster management roadmap. The emergency response plan should be a short-term document which should complement the strategy. ● Climate and environmental aspects should be more explicit/prominent. ● Environmental aspects include those related to dams, reforestation, and their effect on runoff are not explained. ● Absence of integration of the strategy actions with different Ministries and Ministerial strategies; e.g. the integration of the financial dimension of the strategy with the Ministry of Finance. ● The social aspect in the strategy is not evident and requires elaboration: e.g. how to implement the tariff and the role of water in livelihood. ● AAR is a necessary measure; however, karst aquifers present a challenge in AAR. **Comments on Water Sector** <ins>Challenges:</ins> ● Water storage/capacity: climate change trends suggest a reduction in rainfall and snow cover. ● Water quality/wastewater treatment: Farmers are using wastewater for irrigation purposes. ● High energy expenses; high O&M costs. ● Tariff and service: WEs lack capacity and human resources. ● There is a lack of trust and coordination between the Municipalities and the WEs. ● WEs (particularly BWE) are experiencing issues with tribes and refugees; they are not paying subscriptions and are preventing projects from being implemented. <ins>Recommendations:</ins> ● Switching to performance-based contracts for outsourcing ● KPIs: energy should be a performance-based indicator ● The water code is great; its implementation is a key step; the National water council should play a strategic role, in that it should review strategy progress to ensure it is conducted in a cooperative manner, and study if the strategy addresses/relates to current scientific outlook. ● WEs should be more autonomous with regards to the appointment of personnel.

Stakeholder	Key Comments from Meetings
	● Wastewater treatment plants should be located near agricultural area for the use of treated wastewater for irrigation.
LARI	**Comments on Water Sector**
	<u>Challenges:</u> ● Lack of coordination with other data collection entities. o There are discrepancies in the data collected between different institutions. ● Some institutions that are collecting data in the sector usually do not have the data freely available. ● Lack of capacity at LARI: o Shortage of staff o Equipment requires maintenance. ● Urbanization: not all locations in the country are suitable for the installation of meteorological stations. ● Water quantity used for irrigation is more than the needed amount, due to: o Low efficiency irrigation systems: this results in technical losses and reduction in distribution efficiencies. o Lack of awareness of farmers. <u>Recommendations:</u> ● Around 300 stations are required to achieve good agro-meteorological coverage in Lebanon. If the strategy is able to provide funds for the expansion of these stations; this will help provide more recorded points in Lebanon. ● Technical training of farmers.
	Comments on Updated NWSS-MoEW (2020)
	● Water sector governance actions in the strategy are fairly covered. ● Water governance, proposed projects, and water resources management actions in the strategy should be implemented in parallel. ● An emergency response plan at the Ministerial level should be included in the strategy. ● Activities and projects listed in the Updated NWSS are in-line with the strategies of the BWE, as they were provided to the consultant during the drafting of the Updated NWSS. ● All projects in the strategy are needed; however, projects can be better prioritized taking into consideration the current situation. ● The strategy should be revised periodically. ● Reuse of wastewater and AAR are not needed as BWE can provide 50% of needs through spring tapping and gravity networks.
Wadih Najem - *USJ*	**Comments on Updated NWSS-MoEW (2020)**
	● The financial mechanisms should be aligned with Lebanese policies. ● First priority should be actions that improve water governance, to improve the implementing and monitoring bodies. ● Absence of links between projects.
	Comments on Water Sector
	<u>Challenges:</u> ● Key challenge in the water sector is with water sector governance:

Stakeholder	Key Comments from Meetings
	o Lack of human resources and technical experts in the Ministries.
CNRS	**Comments on Updated NWSS-MoEW (2020)**
	● SDG 6 and its indicators are not mainstreamed in the strategy. ● The water-energy-food nexus is not integrated into the strategy. ● Centralized national strategies are not effective in Lebanon: general objectives of the strategy should be on a national-scale, and the sub-objectives/projects should be specific to each watershed/region (bottom-up approach)
	Comments on Water Sector
	<u>Challenges:</u> ● Lack of capacity in the sector: o WEs and the MoEW lack human capacity to operate WWTPs. o Lack of human resources capacity and the budget necessary for the update of data present. ● Lack of coordination between water sector stakeholders: o The responsibilities of each actor are not well defined. o Lack of unified vison, strategies and objectives between the different actors in the sector. o Individual donor-funded projects are fragmenting the sector and reducing coordination between institutions. <u>Recommendations:</u> ● Creation of a consumption-based tariff and the mainstreaming of water metering. o This economic policy will create control and mitigate the unethical use of water ● Improving data collection; the following is suggested: o Create a platform for data sharing. o Create a mechanism to update data. o Use common standards and codes for data between institutions. o Set a legal framework for data sharing, with clearly defined mandates.
Joanna Doummar - *AUB*	**Comments on Updated NWSS-MoEW (2020)**
	<u>Water resources management</u>: ● The interdependency of springs, groundwater, and surface water resources was not adequately addressed in terms of water governance and proposed studies: o Groundwater is being treated as a standalone source, despite it being the main source of rivers and springs. o The tasks and responsibilities of water sector governing bodies are assigned without considering the interlinkages between water resources. ● The methodology for water resource monitoring is unclear (i.e., what water resources should be monitored and for what purpose). ● Absence of comparison of proposed infrastructure with other alternatives. ● Absence of time management of water resources: o The strategy considers an annual water balance; this is unadvisable given that there are discrepancies between the monthly water availability. ● The QA/QC process during the processing of data and the frequency of data collection is absent from the water monitoring recommendations in the strategy. ● AAR is a promising and should be used for the purpose of mitigating the deficit that exists during summer time

<table>
<tr><th>Stakeholder</th><th>Key Comments from Meetings</th></tr>
<tr><td rowspan="3"></td><td>Climate Change:
● The climate change element in the strategy should not be theoretical: climate change impacts on water availability should be quantified:
o The strategy should downscale regional global circulation models to the climatic data of Lebanon.
o Proposed infrastructure should forecast the projected water availability.
Wastewater and Sludge Management:
● The implementation of wastewater treatment plants should be prioritized over water infrastructure projects to improve water quality.
Recommendations:
● The first step towards water resources management should be to define whether to proceed with watershed management or groundwater management units:
o To determine this, a starting point would be to benchmark on groundwater-dependent countries.
● Projects should not be proposed at a national-level given the absence of data: projects should be proposed based on hydrological studies conducted on a pilot-level at specific catchments of interest with deficits.
● The strategy should propose pumping tests of wells (aquifer testing) to determine water table changes with time.
● There should be a PMU at the level of the WEs for the purpose of monitoring indicators and addressing operating procedures.</td></tr>
<tr><td>Comments on Water Sector</td></tr>
<tr><td>Challenges:
● The roles and responsibilities of the water sector actors overlap and are not well-defined.
● Water establishments adopt more conventional methods for service, rather than looking at the redistribution of water within a watershed through inter-basin exchange.
● Improper distribution of water across the country: some areas have higher water availability than others.
● During the summer season there is a significant water deficit; this will become more severe due to climate change.
● Anthropogenic challenges: increase in water consumption and lack of water recycling.
o Water should be prioritized for each sector.
● Climate change:
o Snow cover is decreasing,
o Periods of rainfall are becoming shorter,
o Forecasts suggest that there will be a drastic change in groundwater availability.</td></tr>
<tr><td rowspan="2">Naji Kodeih – WASH Expert</td><td>Comments on Updated NWSS-MoEW (2020)</td></tr>
<tr><td>General Comments:
● The protection of existing water resources and the implementation of water governance reforms should be prioritized over other Strategy initiatives.
● Addressing pollution in the Litani basin should be a priority action, specifically the management of household and industrial wastewater.
● Prior to restructuring the tariff rate, the following should be prioritized:
o Rehabilitation and upgrade of existing networks</td></tr>
</table>

Stakeholder	Key Comments from Meetings
	o Reducing waste and wastewater pollution of water resources
	Comments on Water Sector
	<u>Challenges:</u> ● Lack of reliable data: o Existing data suggests Lebanon should rely on groundwater resources; surface water is not sufficient as it is subject to various sources of pollution; it is more costly. ● Lack of coordination between Ministries/sectors with regards to water and wastewater management. <u>Recommendations:</u> ● Conduct studies that monitor the quality of water resources. ● Implement water resource protection policies in coordination with other Ministries, including: o Policies to address pesticide pollution of surface and groundwater resources o Policies to address industrial wastewater treatment ● Considerable investments in groundwater (specifically renewable groundwater) required to cover the needs of both the people and the economy.
	Comments on Updated NWSS-MoEW (2020)
IAAF	<u>General comments:</u> ● Absence of collaboration between Ministries: o Water demand should include other sector requirements, including agriculture, industry, and climate change strategies. ● The strategy should be a longer-term, adaptive and flexible strategy: adaptive management can be used and based on different scenarios. ● The link between the actions and targets is not evident. ● Transboundary waters were not clearly addressed in the strategy. ● The strategy is not well-organized and structured; the information is not presented clearly and is difficult to navigate through. ● The budget provided for a monitoring network is a good recommendation. <u>Social considerations:</u> ● There is not enough focus on the environmental and social considerations. ● The local community should have a certain extent of ownership for the proposed projects. ● The approach of the communication campaign that is proposed in the 'water governance' section of the strategy should be clearly defined: o It should include a mechanism for addressing the role of media and social media in spreading correct information. <u>Water Resources management:</u> ● The modeling of karst aquifers should be of a higher priority, given that most of the aquifers in Lebanon are karstic. ● Climate change analysis is too simple and requires more elaboration. ● Growth factor may need to be revised, given the reduction in the population of the country over the past couple of years. ● Sections on using groundwater recharge are feasible. <u>Wastewater and water quality management</u>:

Stakeholder	Key Comments from Meetings

	● Limited information is derived from the Litani pollution prevention project.
	Water Sector Governance:
	● The strategy should take into consideration the country's economic crisis, and address the following:
	    o Reduction in the efficiency of governmental establishments given that the employees' salaries have not increased and many employees have left.
	    o Governmental establishments lack the tools and training to conduct technical tasks.
	● Absence of plan on how to enhance the coordination and collaboration with civil society: universities, international institutions, etc.
	● The committee that will follow up on the strategy implementation should include non-technical members of civil society and citizens.

	Comments on Water Sector
	Challenges: ● Water supply is non-consistent. ● Financial access to water: many citizens cannot afford the cost of water. ● Lack of financial mechanisms ● The country's economic crisis: the efficiency of governmental establishments will diminish given that the employees' salaries have not increased and many more employees are resigning. Recommendations: ● Involvement of local community: o During the inception phase of the large-scale proposed projects, diverse members from the local community should be consulted.
Terre Liban	**Comments on Updated NWSS-MoEW (2020)**

	General Comments:
	● The strategy needs to be in Arabic.
	● The strategy is too large.
	● Strategy does not take into consideration IWRM:
	    o The strategy focuses on infrastructure projects that are not aligned with IWRM principles.
	    o Approach of strategy – movement of water from one watershed to another – is not an IWRM approach.
	● Strategy does not take into consideration the impacts of climate change and sustainable development.
	● Absence of coordination of water strategy with other Ministries and non-governmental institutions.
	● Presence of discrepancies in values for irrigated land.
	● The following should be considered given the country's current crises:
	    o Computation of new water balance;
	    o Management of groundwater resources;
	    o Revisiting the proposed infrastructure projects and budget for proposed projects;

Stakeholder	Key Comments from Meetings
	○ Assessing existing infrastructure to determine methods to reduce wastage of water; ○ Propose renewable energy (i.e. solar energy) for water pumping. <u>Water resources management:</u> ● Insufficient demand management: ○ The strategy proposes new wells instead of working on the demand management. ○ The strategy proposes the installation of only 120,000 water meters in the Beirut area only, which is not enough. ○ The domestic water balance was calculated on the basis of the water distribution system (area/district scale). ● Absence of an alternative options in case the proposed projects are not effective as anticipated. ● Unclear whether groundwater is sufficient to meet the water needs, given the absence of groundwater data. ● Water demand for the industrial sector was not addressed. ● The Environmental/Ecological demand was not addressed. ● The strategy did not adequately cover wastewater and sludge management; these sectors should be given priority. <u>Proposed projects:</u> ● There is no workplan for the mega-projects proposed. ● Energy needs for proposed projects were not considered. <u>Integration of studies in the strategy:</u> ● Some studies were not taken into consideration in the strategy: ○ BGR water strategy for Jeita ○ Study conducted by UNDP in 2014 on groundwater ○ Study conducted by Mohamad El Serje on the use of marine springs as a source of water
	Comments on Water Sector
	<u>Challenges:</u> ● Pollution of water resources from lack of wastewater treatment. ● Poor water consumption management and monitoring ● Water sector governance: ○ Breach in water code ○ Lack of implementation of laws ○ Lack of environmental studies: mega-projects lack baseline studies ● Lack of coordination between all stakeholders involved in the water sector ○ Absence of communication approach between MoEW and the public.
Waterlution – WIL	**Comments on Updated NWSS-MoEW (2020)**
	● Actions to improve governance in the strategy should take priority to address the current management challenges and ensure the sustainability of projects. ● Addressing informal settlements: The number of refugees should be monitored in order to have a clear overview and understanding of the challenges, given that they constitute a significant percentage of the water demand.
	Comments on Water Sector

<table>
<tr><th>Stakeholder</th><th>Key Comments from Meetings</th></tr>
<tr><td></td><td><u>Challenges:</u>
● Domestic and industrial wastewater are a key burden on the water system.
● Lack of sustainability of projects
● The country’s financial crisis has affected the citizens motivation which has in turn hindered the implementation of projects.
● Lack of data collection and monitoring.
● The mandates of water sector key actors are unclear: responsibilities are overlapping and fragmented:
o International organizations are finding challenges with implementation due to tension between stakeholders.
o Lack of coordination and unified objectives/strategies of the different stakeholders in the water sector.
o The existing structure in the water sector is ineffective; introducing a new entity (National Water Council) will not solve this core issue.</td></tr>
<tr><td rowspan="4">ACTED</td><td>Comments on Updated NWSS-MoEW (2020)</td></tr>
<tr><td><u>General Comments:</u>
● Implement governance reforms alongside infrastructure projects.
● Prioritize the rehabilitation of infrastructure over the construction of new infrastructure.
● Increase awareness on water use while implementing a volumetric tariff.
● Prioritize measures derived from integrated resource management plans:
o Evaluating and monitoring laws and regulations concerning water resource protection.
o Encourage water conservation in the industrial and agricultural sectors.
o Identify violations pertaining to the misuse of ground water resources.
● The strategy should outline a coordination mechanism; identify the roles and responsibilities at each decision-making level.
o Assign a steering committee for this purpose.</td></tr>
<tr><td>Comments on Water Sector</td></tr>
<tr><td><u>Challenges:</u>
● Poor water governance structure
● Absence of data and existing data is scattered; difficult to access date and data is unavailable or incomplete.
● Incomplete RWE subscription databases and absence of effective subscription collection.
● Lack of human resources and discrepancies in decision-making; this is delaying the implementation of projects.
<u>Recommendations:</u>
● Decentralization of current water governance structure:
o Allocate larger roles to RWE sub-offices and Municipalities.
● International community should attend meetings with local decision-makers, key stakeholders and CSOs to discuss the outcomes of projects funded and priorities for upcoming projects.</td></tr>
</table>

Stakeholder	Key Comments from Meetings
	● RWEs should improve their district water management: fees collection and maintenance interventions. ● Civil society should play a role in bridging the knowledge gap across all levels. Involvement in the water sector: ● ACTED is integrating a 'soft component' to projects that involve the implementation and/or rehabilitation of infrastructure, i.e. governance reforms, awareness/education campaigns and sessions, and technical training.
LEWAP	**Comments on Updated NWSS-MoEW (2020)**
	General Comments: ● The strategy does not take into consideration the current conditions in the country; this is a hindering factor for implementation. ● Infrastructure projects are of lowest priority: o Establishing a clear institutional framework and database are more of a priority o Strong governance required in order to ensure the successful implementation of infrastructure projects. Recommendations: ● Any restructuring of the tariff rate should take into consideration the social/financial profile of households.
	Comments on Water Sector
	Challenges: ● Water authorities are in 'emergency mode'; it is difficult to implement development projects. ● Inflexible institutional framework o Water authorities lack the capacity to carry out their responsibilities o Some Municipalities have the resources to take on water sector responsibilities, but the legal framework does not permit them to do so. ● Lack of data sharing and availability (particularly raw data). ● RWEs lack the capacity for water/wastewater fees collection. Recommendations: ● Municipalities can play a larger role in the water sector: o They can apply a system to follow up on water violations.
Green Mind	**Comments on Updated NWSS-MoEW (2020)**
	General Comments: ● Initiatives in the strategy should be clearly prioritized. o Prioritization criteria should consider costs – derived from a cost-benefit analysis. ● Prioritized actions should be those that are the least environmentally intrusive. o Consider the value of riverine ecosystems when implementing impoundment projects; these are important biodiversity areas that large potential for nature tourism. o Implementing less-intrusive projects at first will result in less public opposition. ● The strategy lacks an exploration/analysis of alternative solutions. ● Water governance is the biggest priority in the strategy. Climate Change:

Stakeholder	Key Comments from Meetings
	● The strategy should consider the effect of the increase in evo-transpiration on surface water storage. ● The strategy did not consider the impact of climate change on sea level rise; this will result in salt-water intrusion and will affect sewage infrastructure. <u>Recommendations:</u> ● Put forwards a clear process for strategy implementation with due diligence: o Ensure transparency with the public; inform the public on implementation progress and steps. ● Prioritize water re-use over the construction of dams. ● Prioritize the implementation of solar energy over the rehabilitation of existing systems. ● Outline measures to increase water-use efficiency on a citizen-level.
	Comments on Water Sector

	<u>Challenges:</u>
	● Presence of contradictory/varying technical perspectives regarding scientific facts and studies across members of civil society and the public.
	● Presence of significant water network losses.
	● Absence of water metering.
	● RWEs lack financial and human resources to achieve cost recovery:
	    o RWEs cannot cover operation and maintenance costs.
	● On a governance level, the water sector is addressed in silos; there is a lack of collaboration between the Ministries.
	<u>Recommendations:</u>
	● Conduct a scientific, open debate to discuss the different scientific perspectives/studies in the water sector.
	● Maximize the use of rainwater harvesting in urban areas.
	● Separate rainwater and sewer networks
	● Implement a tiered tariff system:
	    o Tariff should differ across social groups.
	    o Allocate a unique tariff for irrigation; this tariff can be contingent on the implementation of water-efficient technology; this can act as an incentive for farmers.
	● Engage civil society groups in discussions and decision-making surrounding the water sector and the Updated NWSS-MoEW (2020):
	    o MoEW should create an open space for civil society to review policies and the Strategy.

IAH – Lebanese Chapter	**Comments on Updated NWSS-MoEW (2020)**
	<u>General Comments:</u> ● Water governance reforms and water resources management should be prioritized over the implementation of new infrastructure projects. o Prioritize water resources management over the increase in water resources availability.
	Comments on Water Sector
	<u>Challenges:</u>

Stakeholder	Key Comments from Meetings

	● Absence of demand management.
	● Inadequate institutional management: RWEs lack financial autonomy and independency.
	  o RWEs should determine the water tariff.
	● Lack of modern legislation
	● Lack of national-scale monitoring of water resources:
	  o RWEs lack the budget and capacities to conduct monitoring.
	● Several water sector studies and data are not being used by decision-makers.
	<u>Recommendations:</u>
	● Conduct demand management on a regional level to identify the problems in each region.
	● Implement the Law of access to information (Law 28/2017).

ODDD	**Comments on Updated NWSS-MoEW (2020)**
	<u>General Comments:</u> ● Information, Education and Communication (IEC) is not applied in all strategy components, despite it being a Strategy pillar. ● Given the controversy of dams, the strategy should provide a justification for the implementation of dams as compared to alternatives. ● The strategy does not consider issues related to urban planning, e.g. stormwater runoff and sewerage, sustainable urban tree planting activities. <u>Capacity building:</u> ● Initiatives requiring human resources can provide work opportunities for youth in the country. <u>Water resources management:</u> ● The strategy does not tackle the issue of solid waste pollution of aquifers. <u>Recommendations:</u> ● Outline a clear mechanism for strategy implementation; this a step towards regaining the public's trust.
	Comments on Water Sector
	<u>Challenges:</u> ● Lack of public trust in governmental entities ● Disparity between what water authorities tell the public and what is implemented on the ground. ● Difficulty with accessing data. <u>Recommendations:</u> ● Implement a volumetric tariff to build citizens' awareness on water culture and reduce their water consumption. ● Involve civil society members in the National Water Authority (as per the Amended Water Code) ● Implement information/awareness campaigns at the level of the household to promote water conservation practices. ● Increase communication and transparency with the public.
BIAT	**Comments on Updated NWSS-MoEW (2020)**

<table>
<tr><th>Stakeholder</th><th>Key Comments from Meetings</th></tr>
<tr><td rowspan="3"></td><td><u>General Comments:</u>
● Prioritize water governance reforms actions followed by water resources management:
  ○ Existing infrastructure is inadequately managed and non-operational.
  ○ Collect and update water sector data and make available/accessible to all.
● The strategy should emphasize on the monitoring and evaluation of proposed projects, including lessons learned from previous projects.
<u>Tariffication:</u>
● Industries will no longer be competitive if the tariff is not differentiated for the industrial sector.
  ○ Consider initiatives for water subsidies in industrial zones, otherwise, industries may resort to ‘illegal’ water source alternatives.</td></tr>
<tr><td>Comments on Water Sector</td></tr>
<tr><td><u>Challenges:</u>
● Water availability is an obstacle for industries, especially startups.
● Water quality is an obstacle for industries:
  ○ It is a restricting factor for exportation
  ○ It is a restricting factor in agriculture (i.e. obtaining an organic certification)
● Lack of data and difficulty with accessing existing data
  ○ Data is scattered and all local actors are struggling with accessing existing information.
● Absence of coordination between different sectors and/or stakeholders, particularly in the absence of funding organizations.
<u>Recommendations:</u>
● Implement the access to information law (Law 28/2017).
● Public-private partnerships.
● Involve NGOs/CSOs in early discussions of the Strategy; NGOs have on-the-ground experience.</td></tr>
<tr><td rowspan="4">LEM</td><td>Comments on Updated NWSS-MoEW (2020)</td></tr>
<tr><td><u>General comments:</u>
● Any dams implemented should not block the flow of water to the sea and estuaries so as not so as not to destroy the coastal biodiversity.
<u>Recommendations:</u>
● Prioritize the rehabilitation of existing wastewater infrastructure over the implementation of new WWTPs.
● Invite experts, activists, and citizens to a meeting to discuss the Strategy.</td></tr>
<tr><td>Comments on Water Sector</td></tr>
<tr><td><u>Challenges:</u>
● Absence of political will
● Lack of citizens’ awareness regarding environmental sustainability and the importance of water resources.
● Absence of adequate wastewater management.
● Significant increase in unmonitored private water suppliers.
● Absence of coordination between water sector actors.</td></tr>
</table>

Stakeholder	Key Comments from Meetings
	Recommendations: ● Consider the re-use of treated wastewater for agricultural purposes. ● Role of civil society should be to closely monitor the strategy's implementation.
RAED	**Comments on Updated NWSS-MoEW (2020)**
	General comments: ● Strategy pillars should be implemented in parallel, however: o Prioritize the rehabilitation of infrastructure o Prioritize the issue of irrigation o Water sector governance reforms take longer to achieve (due to the requirement for legislation); as such, they should take second priority. ● Restructuring of water tariffs is a key initiative. Water sector governance: ● Implement proposed awareness campaign in parallel with strategy implementation. ● Prioritize improving coordination between water establishments and Municipalities. Water resources management: ● Industrial sector water demand should be a strategy pillar.
	Comments on Water Sector
	Challenges: ● Absence of good sector governance: o Lack of good communication between water sector actors. ● Lack of thorough studies and scientific reviews. ● High cost of large infrastructure projects, such as dams Recommendations: ● Raise public awareness on sustainable water use ● Municipalities should play a role in the implementation of water infrastructure. ● Decentralization of the water sector; work on smaller administrative levels. ● Regarding challenges associated with water demand in the agricultural sector: o Lands not connected to direct water sources should shift to rain-fed agriculture. ● Infrastructure maintenance. ● Implement and mainstream water metering
LYWP	**Comments on Updated NWSS-MoEW (2020)**
	General comments: ● The water governance reforms in the strategy will help alleviate challenges experienced on behalf of water sector authorities associated with project implementation. ● The priority is to improve water sector governance and coordination as well as protecting existing resources. Prioritize the following over the implementation of large-scale impoundment infrastructure projects: o Protection and rehabilitation of existing water resources o Reduce NRW and system inefficiencies. o Reduce stress on groundwater sources by using non-conventional sources of water, i.e. treated wastewater for irrigation.

Stakeholder	Key Comments from Meetings
	● Absence of integrated water resource management approach: the strategy should consider the water, energy and food sectors. ● The Strategy lacks measures and/or plans that address climate change adaptation and mitigation. ● The strategy does not consider the country's developments after 2019.
	Comments on Water Sector
	<u>Challenges:</u> ● Lack of public trust in water authorities; this presents difficulties with public acceptance of the restructuring of tariffs. ● Lack of public awareness on water conservation culture. ● On a governance level, the water sector is addressed in silos: o There is a lack of collaboration between the Ministries: the strategy should be aligned with other sectoral strategies ● Inflexible water sector institutional framework: o Stakeholder mandates and associated responsibilities are unclear. o Water establishments lack the capacity to fulfill responsibilities. o Municipalities lack the legislative power required to assist with water sector responsibilities, despite having the resources to do so. ● Difficulty with accessing data: o Data available is not published or shared. o Tedious bureaucratic processes associated with accessing water sector data. <u>Recommendations:</u> ● Ideal solution to the water sector is to implement watershed/basin-level water sector governance (i.e. the Litani River Authority). ● Standardize watershed activities and improve monitoring and data collection: o Water establishments should be responsible for the data collection on water quality and quantity. This could be done with the assistance of research institutions/academia. ● To improve the capacities of water authorities and institutions: o Engage and involve the youth in water sector projects and activities o Generate a 'youth employment map' to provide employment opportunities for the youth in the water sector in collaboration with the Ministry of Education and Higher Education. ● Increase transparency with respect to financial reporting; use social media as a tool for sharing information: o Implement tracking system for money (fees) collected and share with the public
Farmers	**Comments on Updated NWSS-MoEW (2020)**
	<u>Water Sector Governance:</u> ● Regarding the creation of the 'irrigation water users' associations' in the water code: o Concerns that such associations may leave room for corruption; i.e. an unequal/dishonest distribution of water by cooperatives. o Some farmers believe that they should be involved in local water management. <u>Proposed Projects:</u>

Stakeholder	Key Comments from Meetings
	● For irrigation purposes, prioritize proposed surface water infrastructure projects. o Hill lakes will help reduce dependency on wells, particularly in the Beqaa where a large area can be irrigated by gravity. ● Prioritize the rehabilitation and maintenance of existing water and wastewater infrastructure of the construction of new infrastructure.
	Comments on Water Sector
	<u>Challenges for farmers:</u> ● Surface water pollution from wastewater: o Farmers are irrigating crops with polluted surface water, particularly in Akkar where MoEW has stopped providing well licenses. o Overflow of polluted rivers into agricultural land (i.e. Al Kabir river in Akkar) ● Inadequate management of the water sector: o Water authorities are not providing support to farmers; they lack the capacity to provide support and provide water for irrigation. ● High cost of pumping water from private water wells dur tp the current inflated fuel costs. o Agricultural sector is no longer competitive with neighboring countries because of high water costs. o High operation and maintenance fees of private wells. ● Challenges associated with obtaining well licenses: o Topographers have inaccurate/outdated hydrogeological data; investments made by farmers are lost on drilling wells with no water. o Difficulty with acquiring licenses legally: MoEW are not providing farmers with licenses, despite the absence of any alternative source. o In areas where MoEW are not provided well licenses: ▪ An individual is assigned (either by the Municipality or collectively by farmers) to organize and regulate water for irrigation use; this individual distributes the water to farmers. This person is responsible for opening the dams to direct the flow of water to irrigate specific land, maintenance, and the collection of fees from farmers ▪ Farmers are shifting to low water consumption crops. ● Lack of coordination between water authorities resulting in a lack of sector sustainability: o Projects/plans discontinue following a change in governance. <u>Recommendations:</u> ● Implement basin-level water sector governance (i.e. the Litani River Authority) ● Prioritize updating hydrological and hydrogeological maps: o Centralize hydrologeological data o Ensure maps are accessible to the public. ● Implement the re-use of treated wastewater for irrigation purposes as an alternative water source for farmers. ● Support farmers with shifting to solar-energy powered water pumping.

Stakeholder	Key Comments from Meetings
	● Water sector decentralization through the empowerment of local authorities; this will help with law enforcement and fees' payment.
WWTP Operator	**Comments on Updated NWSS-MoEW (2020)**

	<u>Proposed WWTPs:</u>
	● Regarding reed beds:
	  o Reed beds are suitable for small towns/villages that are remote and distant from wastewater networks. They are suitable for household sewage only.
	  o There are concerns regarding treatment efficiencies of proposed reed beds during the winter:
	    ▪ The reed bed is ineffective in cold climates, particularly in mountainous areas (i.e. 0ºC temperatures); the reeds will die. In the winter, the reeds have to be cut in cold areas.
	    ▪ In coastal areas, reed beds are more plausible due to the climate.

	Comments on Water Sector

	<u>Challenges with the operation of WWTPs in Lebanon:</u>
	● Standards for the safe re-use of treated wastewater:
	  o Some WWTPs are using FAO international standards; these are not tailored to Lebanon.
	● Lack of electricity; prolonged power outages are affecting the efficiency of the wastewater treatment process.
	  o Trickling filters are sensitive to temperature and power outages.
	● Lack of materials and equipment required to conduct tests
	● Variability of inflow; in the winter, river water/stormwater is diluting the inflow sewage and resulting in low BOD loads.
	● RWEs lack the required budget, expertise, and capacity to take over the operation of WWTPs.
	● The same WWTP standard designs are being adopted for all proposed WWTPs in the country:
	  o CDR are not willing to implement new technologies/treatment processes despite having the budget to do so.
	<u>Recommendations:</u>
	● Adopt the following to mitigate costs associated with sludge management:
	  o RWEs can build centralized sludge treatment plants for all treatment plants in the area to collect the dried sludge and ferment it with organic matter and sell as fertilizer. This can generate a source of revenue. For WWTPs with no sludge press, a portable sludge press (on a truck) can collect the sludge from WWTPs and haul it to a central sludge processing plant.
	  o This is feasible so long as WWTPs agree to provide the centralized plant with the sludge. RWEs should monitor this to ensure that the WWTPs are providing the sludge to the centralized WWTP.

Industrialist -	**Comments on Updated NWSS-MoEW (2020)**
	<u>Water resources manage management:</u>

<table>
<tr><th>Stakeholder</th><th>Key Comments from Meetings</th></tr>
<tr><td rowspan="3">ALI</td><td>● The agro-food industries are top-priority industries that should be provided with water to ensure economic growth.</td></tr>
<tr><td>Comments on Water Sector</td></tr>
<tr><td><u>Challenges in the industrial sector:</u>
● There is no focus/direction for the industrial sector and its development; absence of sector planning.
● Industrial areas are not connected to the required water infrastructure; e.g. absence of water and wastewater networks in industrial areas.
● High cost of electricity and energy for the operation of water and wastewater systems.
● Industries are experiencing challenges with the availability of water; private water wells are the main water sources.
<u>Recommendations:</u>
● Differentiate the water tariff from the domestic water tariff for industrial areas; it should be appropriate for industries.
● Conduct an assessment of the industrial sector water needs.</td></tr>
<tr><td rowspan="4">WASH Sector Reporter</td><td>Comments on Updated NWSS-MoEW (2020)</td></tr>
<tr><td>● Priority is to rehabilitate existing infrastructure and protect existing water resources prior to the construction of new infrastructure due to the absence of data:
o It is challenging and risky to implement large-scale projects, especially those that consider the effects of climate change, as they may result in significant damages to the environment and ecosystem.
● The strategy seems to still be heavily infrastructure-based despite the new and improves water management and water sector governance initiatives.</td></tr>
<tr><td>Comments on Water Sector</td></tr>
<tr><td><u>Challenges:</u>
● The public is not feeling heard:
o E.g. criticism was directed from the public towards dams, but decision makers did not seem to consider/address this criticism seriously; there is a absence of communication from the MoEW/government to the public.
● Absence of data:
o The media struggles with gathering accurate and valid information regarding events in the sector as it is either not available or not being provided to them. as such, not information published by the media is objective and scientific; it is politically driven.
<u>Recommendations:</u>
● The water sector is interconnected with all sectors and should be approached holistically.
● Steps to gain public trust:
o Serious commitment on behalf of the MoEW towards legitimate and constructive change in the water sector; this should be clearly expressed to the public.
o Present success stories to the public.
● Involve civil actors in decision making:
o E.g. include them in the 'water council' sessions, etc.</td></tr>
</table>

Stakeholder	Key Comments from Meetings
	o Civil actors should form committees (composed of objectively chosen experts) with decision making role. o Sami Alaweyye, LRA director general, has placed civil society members and experts on a social media messaging group (Whatsapp) to provide information frequently, answer questions, and inform them of developments; this is successful example of civil society involvement. ● Public hearings should include experts in the fields and essential NGOs; they be taken seriously and should not be just for show.