

PHASE I

Water-Energy-Food-Ecosystems Nexus Assessment for Lebanon



NEXUS



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Mediterranean
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2.2

Mediterranean Coastal Zones:
Managing the Water-Food-Energy
and Ecosystem NEXUS

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LIST OF ACRONYMS



AFDC	Association for Forests, Development and Conservation
BDL	Banque Du Liban
BMLWE	Beirut and Mount Lebanon Water Establishment
BOD	Biological oxygen demand
CAFU	Concentrated animal feed units
CDR	Council for Development and Reconstruction
CEDRO	Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon
CNRS	National Council for Scientific Research
CoM	Council of Ministers
CoS	Council for the South
CSP	Concentrated solar power
DGUP	Directorate General of Urban Planning
DO	Dissolved oxygen
DRE	Distributed renewable energy
EDF	Electricité de France
EDL	Electricité du Liban
EIA	Environmental impact assessment
ERA	Electricity Regulatory Authority
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FEV	Fuel-efficient vehicles
FSLC	Food Safety Lebanese Commission
GDP	Gross domestic product
GEF	Global Environment Facility

GHG	Greenhouse gas
GWP-Med	Global Water Partnership Mediterranean
ICZM	Integrated coastal zone management
IDAL	Investment Development Authority of Lebanon
IFI	International financial institution
IHIS	Integrated hydrological information system
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
ITS	Informal tented settlements
IUCN	International Union for Conservation of Nature
IWRM	Integrated water resource management
LARI	Lebanese Agricultural Research Institute
LBP	Lebanese pound
LCEC	Lebanese Center for Energy Conservation
LCWMC	Lebanese Center for Water Management and Conservation
LEA	Lebanese Environmental Action
LEPAP	Lebanon Environmental Pollution Abatement Project
LEV	Lebanon Economic Vision
LIBNOR	Lebanese Standards Institution
LPA	Lebanese Petroleum Administration
LRA	Litani River Authority
MEHE	Ministry of Education and Higher Education
MENA	Middle East and North Africa
MINARET	MENA Region Initiative as a Model of Nexus Approach and Renewable Energy Technologies
MoA	Ministry of Agriculture
MoD	Ministry of Defence
MoE	Ministry of Environment
MoET	Ministry of Economy and Trade
MoEW	Ministry of Energy and Water
MoF	Ministry of Finance

MoFA	Ministry of Foreign Affairs
MoI	Ministry of Industry
MoIM	Ministry of Interior and Municipalities
MoJ	Ministry of Justice
MoL	Ministry of Labour
MoPH	Ministry of Public Health
MoPWT	Ministry of Public Works and Transportation
MORES	Management Of Resources and Environmental Solutions
MoSA	Ministry of Social Affairs
MoT	Ministry of Tourism
MSW	Municipal solid waste
NARP	National Afforestation and Reforestation Programme
NAS	National Agriculture Strategy
NBSAP	National Biodiversity Strategy and Action Plan
NCE	National Council for the Environment
NDC	Nationally Determined Contributions
NEEAP	National Energy Efficiency Action Plans
NEEREA	National Energy Efficiency and Renewable Energy Action
NFE	National Fund for the Environment
NGO	Non-governmental organisation
NPMPLT	National Physical Master Plan for the Lebanese Territory
NREAP	National Renewable Energy Action Plan
NRP	National Reforestation Programme
NWSS	National Water Sector Strategy
O&M	Operation and maintenance
RDF	Refuse derived fuel
RWE	Regional water establishment
SEA	Strategic environmental assessment
SME	Small and medium enterprises
SOER	State of the Environment Report
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

UNESCWA	United Nations Economic and Social Commission for Western Asia
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Fund
USAID	U.S. Agency for International Development
USD	United States dollar
WE4F	Water and Energy for Food
WEFE	Water-Energy-Food-Ecosystems
WtE	Waste to energy
WWTP	Wastewater treatment plant
%	Percent
°C	Degree Celsius
Bm ³	Billion cubic metres
Gg	Gigagrams
ha	Hectares
km	Kilometres
km ²	Square kilometres
kWh	Kilowatt-hours
L	Litres
m	Metres
m ²	Square metres
m ³	Cubic metres
mg	milligrams
Mm ³	Million cubic metres
mm	Millimetres
MW	Megawatts
MWp	Megawatts peak
pkm	Passenger kilometres
TWh	Terawatt-hours
W	Watts
Wh	Watt-hours

Executive summary

The “Assessment of the Water-Energy-Food-Ecosystems Nexus in Lebanon”, or “the Assessment”, is being conducted as part of the **WEFE Nexus National Policy Dialogue** launched in Lebanon by the Global Water Partnership – Mediterranean (GWP-Med) in spring 2022. This initiative is part of the **Mediterranean Sea Programme: Enhancing Environmental Security** (MedProgramme), a multi-programmatic effort funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme Mediterranean Action Plan (UNEP MAP).

The activities are being carried out under MedProgramme Child Project 2.2¹ titled **“Mediterranean Coastal Zones: Managing the Water-Energy-Food and Ecosystems Nexus.”**

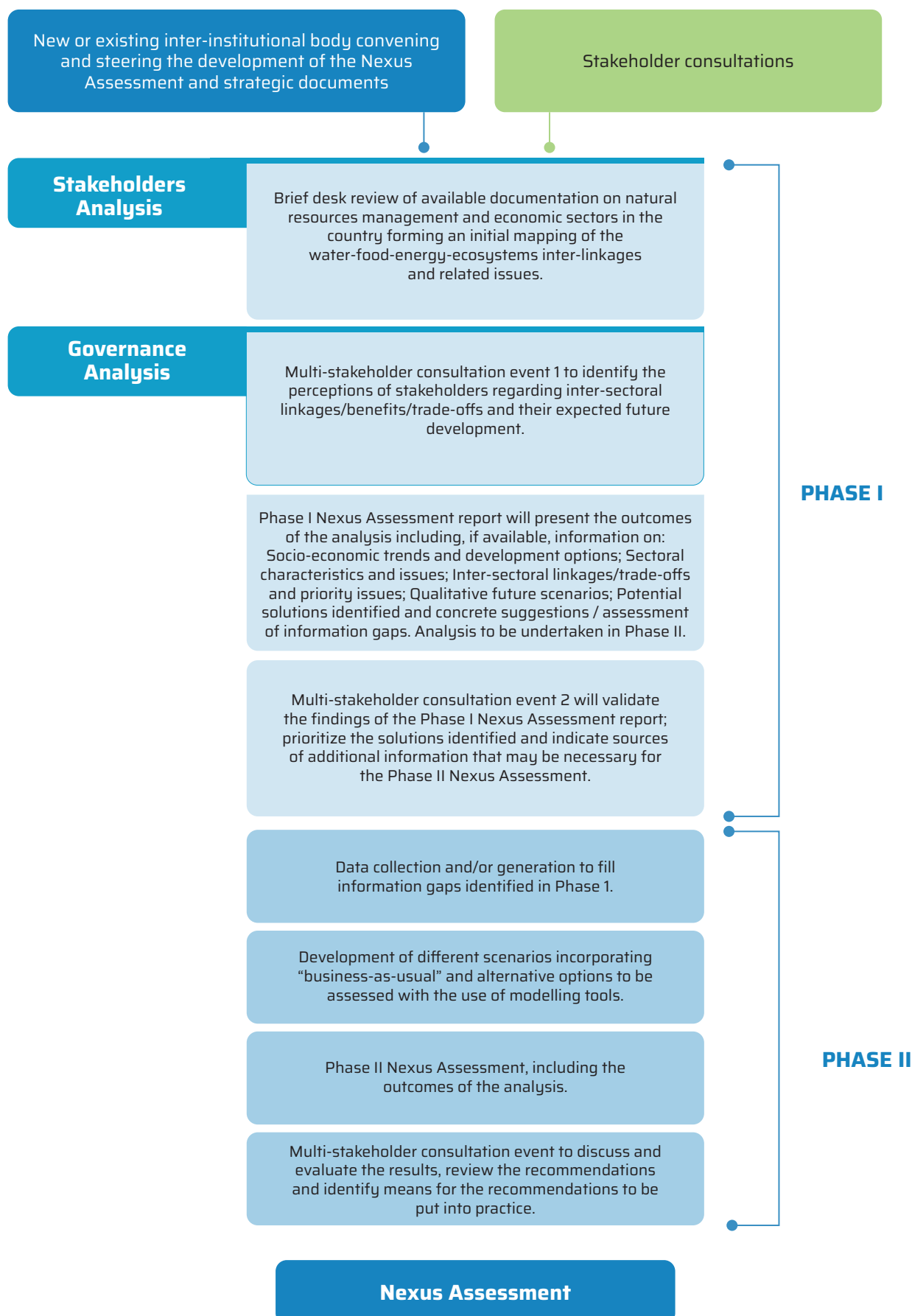
The project aims to balance competing water uses by integrating governance of water, energy, food and ecosystems, and to improve environmental security and benefit-sharing.

The WEFE Nexus approach provides opportunities for multisectoral coordination. In Lebanon, the river basin is used as a spatial reference and the approach is applied within the **source-to-sea continuum**. This makes it possible to address the interconnected challenges faced within and beyond the basin, coastal zone and marine areas, by identifying the root causes of interlinked issues and the corresponding solutions.

The figure below illustrates the process used to prepare the Assessment, comprising two distinct but complementary phases: Phase I and Phase II.

¹ Child Project 2.2 is one of the eight child projects carried out under MedProgramme.

FIGURE I Phases I and II of the Nexus Assessment.



This report has been prepared by MORES s.a.r.l (Management Of Resources and Environmental Solutions) and offers an overview of the outcomes from the Phase I analysis (scoping phase, 2022–2023). It is based on the findings from the following documents, developed by the consultant within the same framework:

- ▶ An “Assessment of the water, energy, food (agriculture), and ecosystems (WEFE) sectors in Lebanon”, examining the status and trends within each of the WEFE sectors in Lebanon and highlighting crucial policy and thematic areas for further development and improvement.
- ▶ A “Brief overview of the strategic and decision-making frameworks in the policy/thematic areas of priority and assessment of how cross-sectoral interlinkages are addressed”.
- ▶ A “Governance analysis”, providing an overview of the institutional frameworks pertaining to the Nexus sectors and evaluating their effectiveness and the extent of cross-sectoral coordination. The report also analysed the underlying factors contributing to inadequate management in these sectors.
- ▶ An “Overview of national and international financing schemes and instruments, of strategies and priorities of donors and international financial institutions (IFIs) active in Lebanon and relevant to WEFE sectors and Nexus projects”, undertaken to gain deeper insights into the feasibility of providing support for Nexus interventions.

This executive summary provides an overview of the outputs from the Assessment conducted, which are described in further detail in the report that follows.

A highly participatory and consultative approach was used to prepare the Phase I Assessment, enhancing the validation of its outcomes. The process involved a series of bilateral meetings with representatives from different institutions, administrations and other stakeholders including non-governmental organisations (NGOs), donors and implementing agencies. Two multi-stakeholder consultations on the WEFE Nexus in Lebanon were also held at key stages.

The process also contributed to the formation of a **WEFE Inter-Ministerial Group**, serving as the governing body for the WEFE Nexus Dialogue in Lebanon. The regular meetings of this group are currently hosted by the Ministry of Energy and Water and facilitated by GWP-Med. Its members consist of nominated representatives from various WEFE-related institutions. Other ministries and high-level national authorities have also expressed their interest in participating in a dialogue focused on the WEFE Nexus, with a view to facilitating effective coordination between sectors.²

Main findings of the Phase I WEFE Nexus Assessment

a. Current status and trends of WEFE Sectors in Lebanon

Water: Despite its access to relatively abundant natural water resources in comparison with other countries in the water-scarce Middle East region, Lebanon is currently facing challenges in this area due to over-exploitation and pollution. The public water infrastructure is outdated and ineffective, and incurs considerable operational and maintenance expenses, which are currently beyond the financial capacity of the responsible administrations. Furthermore, it is unable to meet demand, thereby fostering the emergence of a supplementary market (both legal and illegal)

² The current members of the WEFE Nexus Inter-Ministerial Group represent the following Lebanese institutions: Ministry of Energy and Water, Ministry of Agriculture, Ministry of Environment, Ministry of Public Works and Transport, Ministry of Industry, Ministry of Tourism, Ministry of Interior and Municipalities, National Council of Scientific Research. The Council for Development and Reconstruction and the Office of the Prime Minister have also expressed interest in joining the group.

to compensate for the inadequacy in supply. This scenario not only intensifies the strain on resources but also exacerbates the disparities in access to clean water among disadvantaged communities and residents. Moreover, there are comparable limitations in the coverage and efficiency of the wastewater infrastructure, leading to pollution, increased stress on natural resources, and heightened risks to public health.

Energy: Lebanon has consistently faced challenges related to energy security, primarily driven by the significant disparity between demand and supply, and its heavy reliance on fuel imports. Furthermore, energy generation and transmission are inefficient as a result of the inadequate condition of the existing infrastructure and transmission network, as well as the deterioration of facilities and insufficient maintenance practices.

Privately owned diesel generators, strategically placed within residential areas, supplement the public system, making up **80%** of the deficit resulting from the public system's inability to supply energy to meet needs. However, this parallel market has imposed an additional financial strain on the population, making energy inaccessible for a considerable portion of the community, and generating negative impacts on human health and the environment through increased pollution.

Renewable energy resources hold considerable potential for enhancing Lebanon's energy security. These abundantly available resources can play a crucial role in advancing the development of the energy sector. Exploration activities and the successful discovery of commercially viable quantities of oil and gas resources could further strengthen the country's energy security.

Food/agriculture: Food insecurity is a significant issue in Lebanon, primarily due to its heavy dependence on imported food products and production inputs. There is a significant disparity between food imports and exports, primarily because domestic production cannot meet the

demand for essential commodities such as wheat and vegetable oils. The presence of large refugee and displaced populations further exacerbates the situation, as they require sustenance that exceeds the capacity of the local agricultural sector. The high cost of food production further contributes to the challenge at hand.

Ecosystems: Lebanon is situated within the Mediterranean Basin biodiversity hotspot and boasts an incredibly rich biodiversity. Despite occupying a mere **0.007%** of the world's land surface area, it harbours **1.11%** of the world's plant species and **2.63%** of reptile, bird and mammal species. Nevertheless, Lebanese ecosystems face various challenges including pollution, over-exploitation and encroachment.

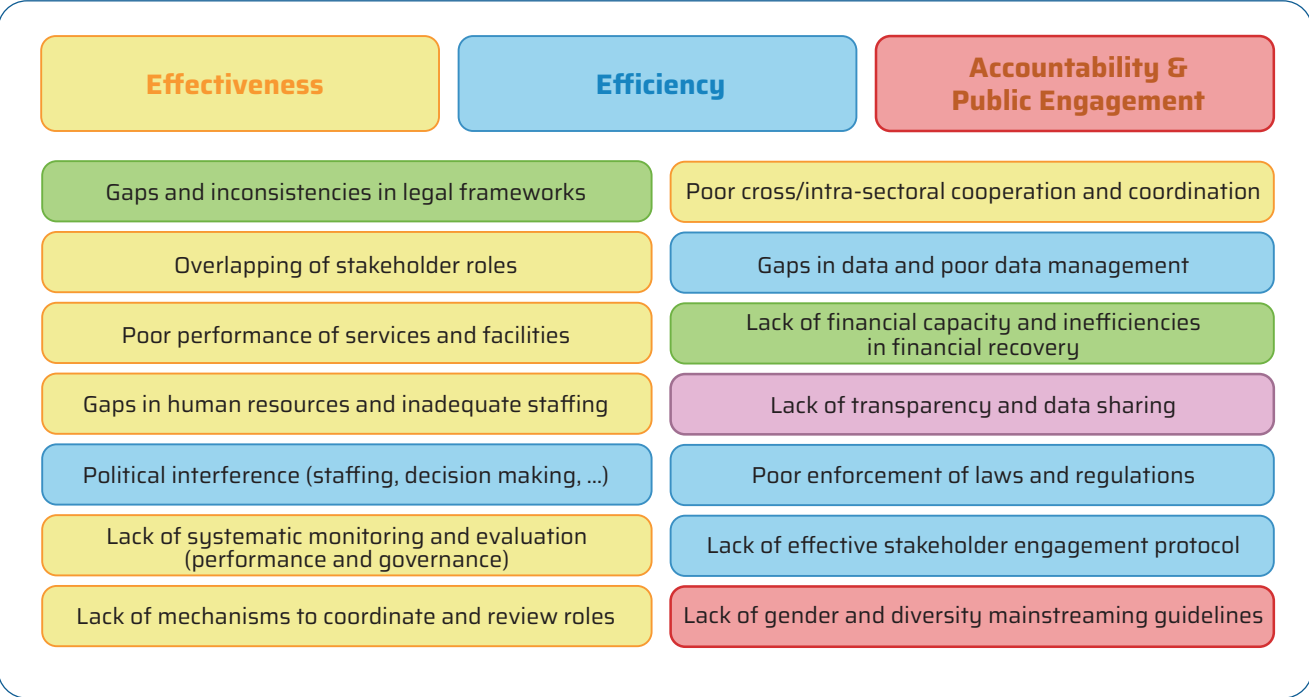
Cross-sectoral challenges: Climate change, haphazard urban development and ineffective solid waste management have been identified as key factors in the poor performance of WEFE sectors. These challenges have notable consequences for the long-term sustainability of water resources, food production, ecological balance and associated services.

b. Sectoral and intersectoral governance analysis

The WEFE sectors face similar governance challenges that impact their efficiency, effectiveness, accountability and public engagement. These challenges encompass a range of issues, including gaps and inconsistencies in legal and institutional frameworks; overlapping mandates among relevant administrations, leading to duplication or inadequate enforcement of rules and regulations; gaps in human resources; insufficient financial capabilities and inefficiencies in cost recovery; the absence of guidelines and modalities for inclusive approaches, such as gender mainstreaming and assessing the needs of vulnerable populations; the limited availability and sharing of data, and inadequate mechanisms for collecting and exchanging data. Political interference further amplifies these challenges.

The figure below illustrates the key challenges surrounding WEFE sector governance in Lebanon.

FIGURE II Summary of WEFE sector governance challenges.



To address these challenges, sectoral national strategies have evaluated the weaknesses in governance and formulated action plans. However, the implementation of needed reforms is being hindered by factors such as limited financial resources, political paralysis, breakdown of trust and a lack of coordination or support among relevant actors.

Like many other countries, Lebanon does not have a well-established framework to enable the integration of policies, strategies and action plans for the four WEFE sectors, which are predominantly managed independently. Moreover, the above-mentioned structural challenges significantly impact the effectiveness of cross-sectoral management initiatives, such as the proposed committees within the draft integrated coastal zone management (ICZM) Strategy, the Water Code (77/2018) and its amendments, the

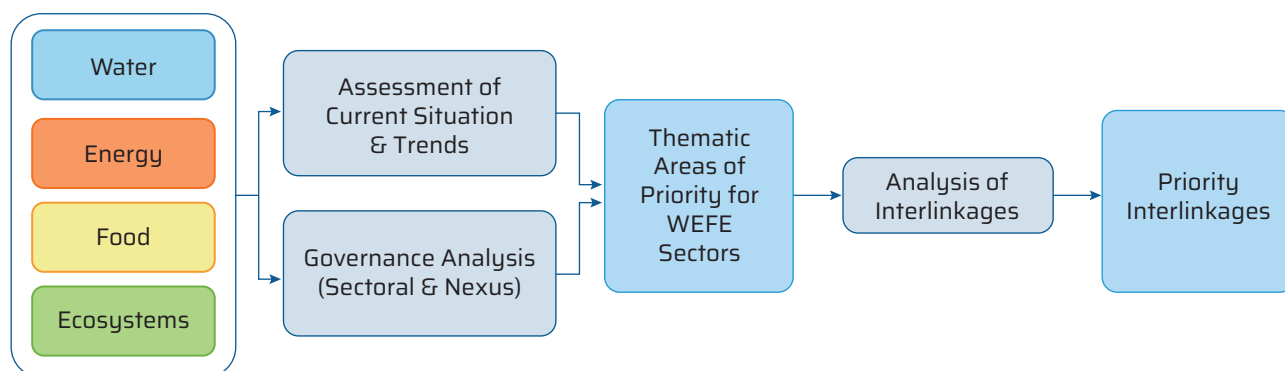
Nationally Determined Contributions (NDCs) (2020), the National Agriculture Strategy (NAS 2020-2025), the Ministerial Committee for Food Security (established in March 2022) and the National Council for the Environment (NCE) (Law 444/2002).

The WEFE Inter-Ministerial Group established as part of this project has the potential to facilitate coordination among the authorities responsible for the Nexus sectors.

c. High-priority interlinkages among WEFE sectors in Lebanon

The figure below illustrates the process used to identify priority thematic areas for each sector and, subsequently, four high-priority interlinkages among the WEFE sectors in Lebanon.

FIGURE III Identification of high-priority interlinkages.



The process began with an **assessment of the status of the WEFE sectors**, including an examination of **governance practices**. The analysis focused on identifying barriers and challenges, and revealed a series of issues. Some of these were unique to specific sectors, while others were common across all sectors. The governance analysis also highlighted the degree of integration among the WEFE sectors, taking into consideration legal frameworks, sectoral strategies, policies, plans and existing obstacles to intersectoral coordination.

Through this initial step, specific priority issues for each of the WEFE sectors were identified. These **thematic areas of priority** were then thoroughly examined, considering their interdependencies with the other sectors, as well as with key concerns in Lebanon, such as climate change, urbanisation, public health and solid waste management.

This step helped to identify **four priority interlinkages** among the WEFE sectors, highlighting the key trade-offs that need to be addressed to overcome obstacles, leverage synergies and produce substantial improvements:

1. An adequate energy supply to support water and food security: the adverse effects of energy shortages, high prices and unreliable energy sources have had significant implications on the performance and status of other sectors, highlighting their reliance on a consistent and

accessible energy supply. To operate water and wastewater facilities, ensure the stability of agricultural activities and enhance water and food security, it is imperative to establish a secure energy provision framework. This approach will also contribute to safeguarding and improving conditions for ecosystems.

2. Integrated water management to enhance food security and preserve ecosystems: water resources and wastewater must be effectively managed to increase water availability to produce high-quality food, reduce energy requirements, support healthy ecosystems and safeguard public health.

3. Promotion and mainstreaming of sustainable food production to enhance water safety and security and preserve ecosystems: agriculture is the primary consumer of water resources, responsible for a significant portion (at least **55%**) of overall demand, and a major contributor to water pollution. The adoption of sustainable practices within this sector can greatly improve performance across all WEFE Nexus sectors.

4. Management and regulation of human activities to preserve ecosystems and natural resources: human activities have significant impacts on natural resources, often causing irreversible damage. The challenges outlined below are particularly relevant to the Lebanese context, leading to harmful consequences for the WEFE sectors:

► **Urbanisation and its impact on natural resources:** the rapid and unregulated expansion of urban areas, coupled with unsustainable practices, has resulted in the detrimental loss of valuable ecosystems and agricultural land. Furthermore, haphazard urbanisation has disrupted groundwater recharge and increased the risks to precious natural resources.

► **Solid waste management and its impact on natural resources:** inadequate solid waste management practices play a pivotal role in negatively impacting ecosystems, natural resources and overall public health.

By addressing these priority interlinkages, major improvements could be achieved in the WEFE sectors.

The approach of this project is to tackle these interlinkages through interventions targeting four main goals:

- **Enhance planning in the energy sector and close the energy gap (Goal 1)**
- **Protect and enhance water resources management in Lebanon (Goal 2)**
- **Enhance the sustainability of agricultural production and food security (Goal 3)**
- **Protect ecosystems from anthropogenic pressures (Goal 4)**

An additional goal to **enhance WEFE Nexus governance (Goal G)** and coordination among relevant stakeholders was also highlighted, as a means to enable, strengthen and facilitate implementation.

WEFE Nexus solutions with significant cross-sectoral relevance and benefits were thus identified as effective means to achieve the goals.

Finally, general recommendations on addressing the varying circumstances faced by individuals based on their gender and societal roles were set out. These recommendations aim to integrate such considerations into the detailed design and planning of the proposed solutions so that they better cater to the needs of beneficiaries and have increased chances of success.

d. WEFE Nexus solutions for Lebanon

The tables below provide an overview of the WEFE Nexus solutions that have been identified for each goal, and are vital to achieving water, energy and food security within the Lebanese context, while protecting and conserving natural resources and ecosystems. The tables also set out how these solutions align with and potentially contribute to national plans and strategies.

The solutions were proposed based on Lebanon's current situation, taking into consideration political, economic and financial crises, by experts in the four sectors with extensive experience in their fields.

The solutions include short-term activities to meet urgent gaps and needs, as well as medium- and long-term activities aimed at establishing a sustainable system for managing the four sectors and related services. Due to the lack of accurate, up-to-date baseline data and proper data management systems in the various fields, the project has focused on data collection, mapping and planning at a national and river basin level.

These solutions have been thoroughly discussed, informed and approved by numerous relevant stakeholders who were actively involved in the consultation process.

Goal 1: Enhance planning in the energy sector and close the energy gap

Objective 1: Promote renewable energy use and energy conservation	
WEFE Nexus solutions	Alignment with national plans and strategies
1.1 Strengthen the renewable energy legislative and policy framework - Approve the Distributed Renewable Energy Law and the Energy Conservation Law - Prepare implementing decrees for Distributed Renewable Energy and Energy Conservation Laws	- NREAP 2016-2020 - NEEAP 2016-2020
1.2 Enhance the energy security of the food sector Implement solar installations for food production and enhance the energy efficiency of systems	
1.3 Design and develop novel agro-energy cooperative models and replicable business models	- NREAP 2016-2020 - NEEAP 2016-2020 - NDC 2020 - NWSS 2020 - NAS 2020-2025
1.4 Enhance the energy security of the wastewater sector - Increase the use of renewable energy, mainly solar, to operate wastewater treatment plants (WWTPs) - Enhance the energy efficiency of the facilities and rely on low energy consuming technologies	
1.5 Enhance the energy security of the water sector - Increase the use of solar energy to operate water supply facilities - Enhance the energy efficiency of the facilities and rely on low energy consuming technologies, such as transmission by gravity, where possible	
1.6 Increase the energy efficiency of various facilities (public sector)	

Objective 2: Support transparency and integrated planning in the energy sector	
WEFE Nexus solutions	Alignment with national plans and strategies
1.7 Develop guidelines and a methodology for energy-related data collection	▶ Law 462/2002 ▶ NREAP 2016-2020 ▶ NEEAP 2016-2020
1.8 Create an energy indicator database platform to enhance transparency in the Lebanese energy sector	
1.9 Develop an integrated energy-water master plan ▶ In MoEW plans (renewable energy/power production), integrate the Nexus approach specifically when water resources are used either for utilities or hydro production ▶ Consider energy needs and opportunities to increase efficiency and renewable energy use in water sector projects	▶ NREAP 2016-2020 ▶ NEEAP 2016-2020 ▶ NDC 2020 ▶ NWSS 2020

Goal 2: Protect and enhance water resources management in Lebanon

Objective 1: Promote groundwater recharge and protection	
WEFE Nexus solutions	Alignment with national plans and strategies
2.1 Develop groundwater recharge master plans ▶ Map sensitive groundwater recharge areas, including area delineation and classification based on the water quality expected within these areas ▶ Assess aquifers, including an estimate of available quantities, recharge rates and water quality ▶ Establish protection zones for aquifer recharge areas ▶ Issue recommendations on stormwater management	▶ NWSS 2020
2.2 Adjust building permit process to regulate stormwater management	
2.3 Develop guidelines and national standards for public green infrastructure that prioritise groundwater recharge and better stormwater management	
2.4 Green and retrofit existing infrastructure and build new facilities/ services to enhance stormwater management	
2.5 Create stormwater recharge projects within coastal and high-density cities	
2.6 Implement recharge galleries wherever possible	
2.7 Promote reintroduction of traditional terraces throughout the Lebanese landscape	

Objective 2: Prepare basin management plans for the rivers of Lebanon	
WEFE Nexus solutions	Alignment with national plans and strategies
2.8 Develop river basin management plans - Develop water safety plans for water sources within river basins - Conduct hydrological and hydrogeological analysis of basins, taking into consideration climate change trends and projections	- NWSS 2020 - Water Law (77/2018 & 192/2020)
2.9 Calculate water balance at river basin and national levels - Assess water availability and water production by monitoring water points (water supply facilities) - Monitor water consumption by end users	
2.10 Identify opportunities to use surface water sources instead of groundwater where and when possible	

Objective 3: Adopt water-saving measures and non-conventional water resources use	
WEFE Nexus solutions	Alignment with national plans and strategies
2.11 Upgrade water distribution networks to reduce leakage and waste	NWSS 2020
2.12 Raise awareness about water scarcity and saving	- NWSS 2020 - NDC 2020 - NAS 2020-2025
2.13 Promote water-saving technologies in various sectors (agriculture, education, industry, tourism, healthcare, domestic use, cleaning, etc.) including through the development of guidelines targeting each sector	
2.14 Install meters to monitor water consumption, create database for water consumption (by area, sector and user) and set goals for specific sectors to incentivise water-saving	
2.15 Promote rainwater harvesting in rural and urban areas (for reuse at domestic level and for irrigation)	- NWSS 2020 - NDC 2020
2.16 Reuse treated wastewater in agriculture provided that the treatment results in suitable effluent quality	
2.17 Separate grey- and blackwater; treat and reuse greywater where possible	

Goal 3: Enhance the sustainability of agricultural production and food security

Objective 1: Develop agricultural planning at river basin level	
WEFE Nexus solutions	Alignment with national plans and strategies
3.1 Develop sustainable agriculture master plans at river basin level	▶ NAS 2020-2025
3.2 Develop national agriculture baseline maps identifying available resources for agriculture, and recommending crops to be grown at the river basin level	
Objective 2: Promote sustainable agricultural practices and enhance food security	
WEFE Nexus solutions	Alignment with national plans and strategies
3.3 Promote agricultural practices that minimise negative impacts on the environment, enhance climate change resilience and improve farmers’ livelihoods	▶ NAS 2020-2025
3.4 Promote various water-saving techniques and practices in agriculture (crop selection, agro-forestry, zero tillage, winter cover crops, integration with animal production, etc.)	
3.5 Recycle agricultural waste for fertiliser production	
3.6 Recycle agricultural waste, including forest biomass, to produce alternative fuel	
3.7 Promote sustainable pest management techniques	
3.8 Adopt sustainable animal farming and production with high productivity and health and safety standards	
3.9 Elaborate a holistic strategy that creates linkages between aquaculture, fish feed production and agriculture	
3.10 Train fishers on sustainable fishing practices and how to add value to their products	
3.11 Train fishers on using new sustainable gears and targeting new fishing grounds, releasing pressure on shallow coastal areas	
3.12 Promote the upscaling of sustainable agriculture (rather than keeping it at the level of small farms)	

Objective 2: Promote sustainable agricultural practices and enhance food security	
3.13 Build farmers' capacity on sustainable agriculture and food production	NAS 2020-2025
3.14 Integrate agriculture into urban development programmes and utilise smart urban concepts	
3.15 Support and encourage farmers to grow cereals/fodder crops	
3.16 Recycle agricultural waste to produce animal feed	
3.17 Deliver training and capacity-building for farmers, cooperatives and research centres on seed production and conservation	

Goal 4: Protect ecosystems from anthropogenic pressures

Objective 1: Enhance forest and landscape restoration and management	
WEFE Nexus solutions	Alignment with national plans and strategies
4.1 Develop sustainable forest and landscape management plans	- NAS 2020-2025 - NDC 2020
Objective 2: Control pollution sources	
WEFE Nexus solutions	Alignment with national plans and strategies
4.2 Adopt and raise awareness about integrated solid waste management (ISWM)	ISWM Law (80/2018)
4.3 Identify and remove pollution sources affecting natural resources and ecosystems, including the control of solid waste and liquid waste generated by healthcare and industrial facilities, closure and rehabilitation of open dumpsites, and remediation of polluted areas	- Law 444/2002 Environmental Protection - MoE decisions related to pollution control - NWSS 2020-2035
4.4 Increase coverage of wastewater collection networks and extend/enhance wastewater treatment plant services (in terms of covered areas and level of treatment, including sludge management)	Water Code

Objective 3: Prioritise environmental protection in policies, plans and projects, and raise public awareness	
WEFE Nexus solutions	Alignment with national plans and strategies
4.5 Encourage community-based activities related to ecosystem protection and conservation	- Environmental legislation - Law 444/2002 Environmental Protection - NAS 2020-2025 - NBSAP 2016-2030 - National Afforestation and Reforestation Programme (NARP) 2014-2028 - Lebanon National Forest Program 2015-2025
4.6 Appoint environmental prosecutors and investigating judges, and activate environmental inspection and environmental police (to enforce laws on natural resources and environmental protection)	
4.7 Strengthen and enforce the implementation of EIA Decree 8633/2012 and SEA Decree 8213/2012	
4.8 Ensure the resumption of the National Environment Council and hold periodic meetings in compliance with the requirements of Decree 8157/2012	
4.9 Support the adoption and issuance of the draft legislation and strategy on ICZM, and integrate the WEFE Nexus recommendations that benefit ecosystem protection, raise awareness and build the capacities of various stakeholders on related issues	
4.10 Integrate the findings of the WEFE Nexus Assessment that reduce pressure on natural resources and ecosystems in the update of the National Physical Master Plan of the Lebanese Territory (NPMPLT/SDATL)	
4.11 Update and implement/adopt the National Strategy for Environmental Education developed by AFDC and adopted by the MEHE (2012)	

Goal G: Enhance WEFE Nexus governance

The following governance solutions pertaining to the WEFE Nexus will help to integrate this approach into national strategy and project planning:

G1 - Set up and sustain a WEFE Nexus intersectoral body

G2 - Develop measures to facilitate access to financing for WEFE Nexus projects

G3 - Develop land-use planning and zoning that prioritises the protection of natural resources.

The establishment of the **WEFE Inter-Ministerial Group** is a promising initiative in this direction. This technical group enables the collective engagement of relevant institutions towards common priority solutions. It also incentivises **other actors and financial institutions** to invest in these interventions.

Moreover, as haphazard urban expansion remains a significant issue impacting natural resources

and ecosystems, it is essential to implement a strategic **land-use planning and zoning approach that prioritises the safeguarding of these resources**. This approach should focus on protecting water resources, sensitive recharge areas, soil, agricultural lands and ecosystems. By prioritising the conservation of natural resources, the trade-offs and synergies between urbanisation and preserving these resources can be effectively balanced. Adopting a Nexus approach will also facilitate the integration of sectoral policies and programmes.

Coordinating the planning of urban communities and natural resources necessitates effective communication among the diverse stakeholders tasked with managing different sectors. It is crucial to develop guidelines and regulations, including implementing decrees for laws, to encourage or enforce the adoption of sustainable urbanisation practices. This is imperative if adverse impacts on natural resources are to be minimised.

e. WEFE Nexus solutions prioritisation and financing

A prioritisation exercise was conducted for the solutions presented above, based on evaluation criteria agreed with key stakeholders. The aim was to achieve the maximum possible benefit for all four sectors, while also ensuring the sustainable use and protection of natural resources, as well as adopting climate change mitigation and adaptation measures.

Opportunities for financing were also assessed based on a screening of the main financial institutions and development organisations active in Lebanon and their funding mechanisms for interventions related to the WEFE Nexus sectors.

Further work on the interconnections among WEFE Nexus solutions is under way and will be included in a WEFE Nexus Action Plan for Lebanon alongside a projected timeline.

1. Introduction

1.1 Project background

In Lebanon, the water, energy, food and ecosystems (WEFE) sectors face multiple challenges that hinder their effectiveness and ability to meet the diverse needs of the country's population. Governments worldwide are increasingly recognising the urgency of addressing climate change and its potential repercussions, a pressing issue that also confronts Lebanon. Climate change has far-reaching implications across the WEFE sectors and must therefore be considered as part of future planning efforts.

Lebanon has been affected by various crises in recent times, namely the COVID-19 pandemic, economic and fiscal difficulties, and the devastating Beirut port explosion. These crises have also greatly impacted the WEFE Nexus sectors, which must now deal with several fresh challenges, including obstacles to the import of foreign goods, supply chain disruption, elevated input costs for agriculture and other economic activities, and notably, the lack of robust financial instruments that are crucial to sustaining positive growth trajectories within these sectors.

Lebanese policymakers have traditionally addressed issues pertaining to WEFE-related resources separately, failing to reflect their interdependencies in sectoral governance and management frameworks. Action to resolve

conflicts was only taken when these conflicts became evident. By developing a process to facilitate effective communication among stakeholders from different sectors, it is possible to foster collaboration that optimises resource utilisation, enhances water, energy and food security, and safeguards ecosystems.

Consequently, by comprehensively grasping the local context and tailoring appropriate measures, the WEFE Nexus approach can be customised to match the specific attributes of Lebanon and propose solutions that effectively address the unique hurdles the country faces.

1.2 Report objectives and structure

This report provides a comprehensive evaluation of the current status and trends of the WEFE sectors in Lebanon. It examines governance systems, explores connections between these sectors, analyses trade-offs and highlights possible opportunities from synergies. Building on this thorough analysis, which has been corroborated by input from numerous relevant stakeholders involved in the consultation process, the report proposes specific Nexus solutions. These solutions aim to enhance the overall effectiveness, efficiency and management practices of WEFE sectors to improve the security of the related natural resources.

The report is divided into the following chapters:

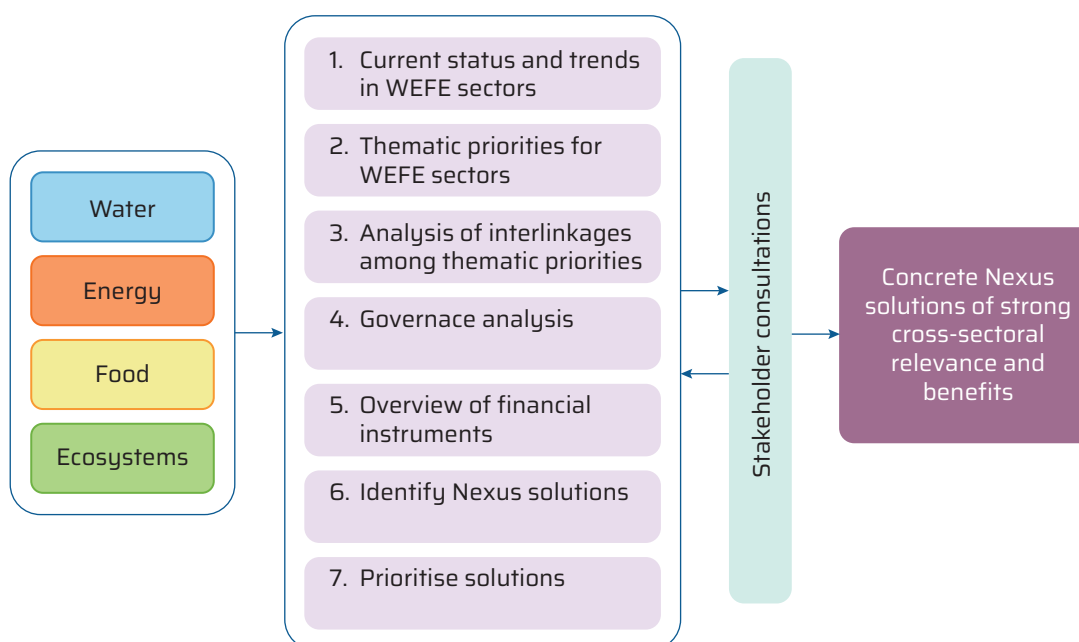
- ▶ Chapter 1 (this chapter): Introduction, providing information about the project background and report objectives, and outlining the methodology employed
- ▶ Chapter 2: Current status and trends in WEFE sectors in Lebanon, also including the findings from the governance analysis
- ▶ Chapter 3: Proposed WEFE Nexus solutions
- ▶ Chapter 4: Overview of national and international financing schemes and instruments and of IFIs' strategies and priorities
- ▶ Chapter 5: Shortlist of concrete Nexus interventions

1.3 Approach and methodology

A participatory approach was employed for the development of the Phase I Nexus Assessment. This approach, which is an essential component of the interactive, multi-stakeholder national dialogue on the WEFE Nexus launched in the country by this project, was facilitated by the stakeholder analysis conducted at the beginning of the assignment and, subsequently, by the establishment of a WEFE Inter-Ministerial Group, comprising representatives from various pertinent institutions and administrations.

Figure 1-1 is a schematic representation of the adopted methodology.

FIGURE 1-1 Schematic representation of methodology.



To initiate the process, an evaluation was conducted on the status and trends of the WEFE sectors. This evaluation encompassed a comprehensive analysis of published literature and studies (included in **Sources**), legislation, sectoral strategies, plans and interviews

conducted with various stakeholders, including members of the WEFE Inter-Ministerial Group.

A governance analysis was carried out simultaneously to gain an understanding of how the WEFE sectors are governed under current legal and institutional frameworks, plans, strategies

and policies. This analysis also explored how interconnections among sectors and issues that span multiple sectors are managed and resolved within the Lebanese context. The analysis included an initial examination on a sector-by-sector basis, followed by an assessment of interlinkages among these sectors.

Drawing on the findings of the above assessments, **priority policy and thematic areas** were identified for each of the WEFE sectors. These areas were carefully selected to strengthen the development and performance of each sector.

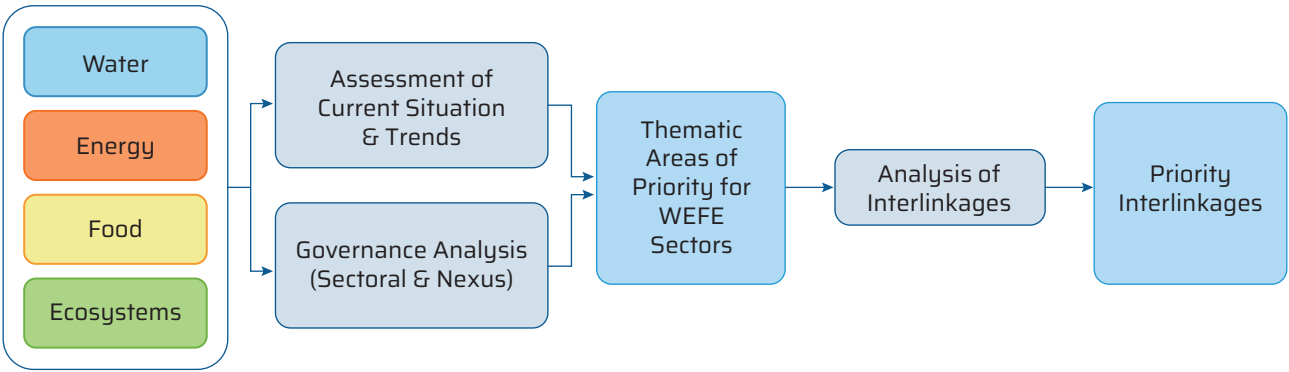
An in-depth analysis was then conducted to explore interdependencies across these thematic areas and the security of resources pertaining to the other WEFE sectors. This work led to the identification of **“high-priority interlinkages”** (see Fig. 1-2). Considerations related to climate change, urbanisation, solid waste, public health and more were also mainstreamed in the analysis,

as these are of key importance for Lebanon. These high-priority interlinkages highlight the main trade-offs that should be addressed to overcome obstacles, leverage synergies across sectors and produce substantial improvements in the situation and performance of the WEFE sectors, resulting in an enhanced standard of living for the residents of Lebanon by effectively addressing their urgent needs.

Considering the country’s current circumstances, **ensuring an adequate energy supply to support water and food security** was identified by stakeholders as the key trade-off or priority interlinkage to address.

However, the analysis and consultations highlighted three additional interdependencies that should be addressed in parallel **to guarantee water and food security** for the country’s residents, while **safeguarding the ecosystems upon which these resources depend.**

FIGURE 1-2 Identification of high-priority interlinkages.



Identifying the means to address these four priority interlinkages thus directed the subsequent stages of analysis, ultimately resulting in the formulation of **five goals for the WEFE Nexus Policy Dialogue in Lebanon and, finally, of specific WEFE Nexus solutions.**

The solutions were evaluated and prioritised using criteria discussed with members of the WEFE Inter-Ministerial Group (refer to section 1.3.4). This comprehensive process led to the proposal of

“Concrete WEFE Nexus solutions of cross-sectoral relevance and benefits”. These solutions were further validated during a dedicated consolidation exercise involving a range of relevant actors.

Finally, an overview of national and international financing schemes and instruments, as well as the strategies and priorities of donors and international financial institutions (IFIs) actively involved in Lebanon, was carried out to achieve a better understanding of the potential for

supporting WEFE Nexus interventions in the country.

1.3.1 Stakeholder consultations

Stakeholder consultations played a crucial role in this assignment to foster a sense of ownership throughout the entire process. The objective was to ensure that the methodology and outcomes of this Assessment were in line with national priorities, strategies and policies.

Individual meetings were held with representatives of national authorities,

public institutions, donor organisations, non-governmental organisations (NGOs) and other stakeholders. These meetings aimed to introduce the project, present methodologies and interim results, and gather information and feedback as the work progressed. Members of the WEFE Inter-Ministerial Group were actively involved throughout the project. In addition, two multi-stakeholder WEFE Nexus consultation meetings were held, one in August 2022 and another in February 2023. The feedback and input received during these consultations were crucial in shaping the recommendations and selecting and prioritising the Nexus solutions.

PHOTO 1-1 Second multi-stakeholder workshop, Beirut, 27-28 February 2023.



1.3.2 Data collection and analysis

Data pertaining to different aspects of each of the WEFE Nexus sectors were collected from credible online sources, published documents and stakeholder interviews. A thorough analysis of the data was then conducted to evaluate the current status of the WEFE sectors, including governance and management issues, as well as the factors that impact the sectors, the challenges they face and associated risks, in both the pre-crisis and post-crisis periods.

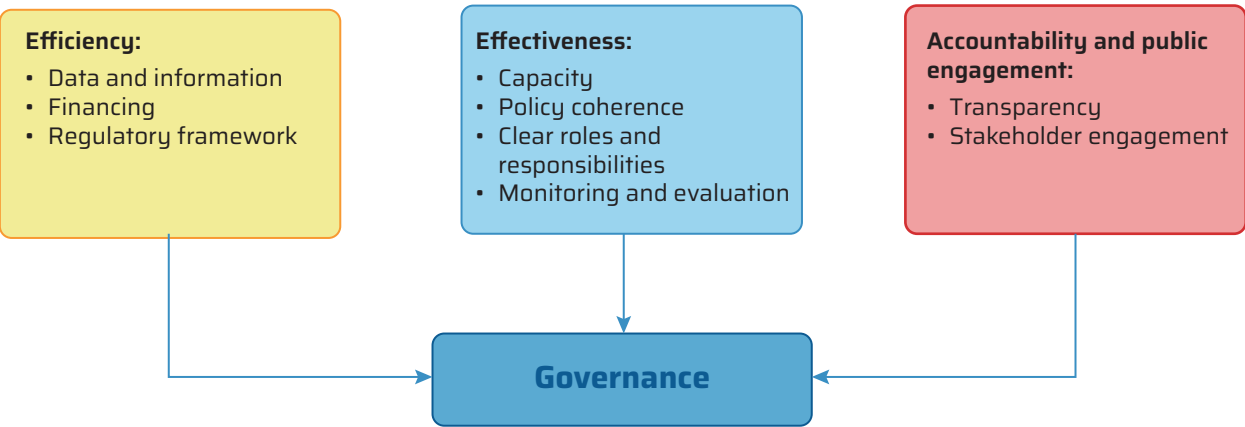
1.3.3 Governance analysis methodology

1.3.3.1 Sectoral governance analysis

The governance analysis first focused on evaluating the challenges and issues that hinder the efficient delivery of services and security of resources **pertaining to the WEFE Nexus sectors**.

This analysis was carried out following a conceptual framework that aligns with international guidelines and is based on the Organisation for Economic Co-operation and Development (OECD) Water Governance Indicator Framework (OECD, 2015). Governance was assessed against three main principles: effectiveness, efficiency and engagement (see Fig. 1-3).

FIGURE 1-3 Conceptual framework for WEFE governance analysis.



1.3.3.1.1 Efficiency

The assessment of efficiency evaluates how well the governance of different sectors maximises their performance. Specifically, it examines: a) the regulatory framework of these sectors; b) access to updated and reliable data and information; c) financing arrangements for these sectors.

1.3.3.1.2 Effectiveness

The assessment of effectiveness examines whether the governance of a sector enables consistent and sustainable policy tracks and targets across the different levels of government. This includes evaluating: a) the clarity of roles, responsibilities and jurisdiction of the institutions involved; b) the sector management capacity of these institutions; c) the coherence of the sector’s policy framework; and d) the monitoring and evaluation processes for both sector policies and the governance structure.

1.3.3.1.3 Accountability and public engagement

The evaluation of accountability and public engagement assesses the level to which the sector’s governance ensures accountability,

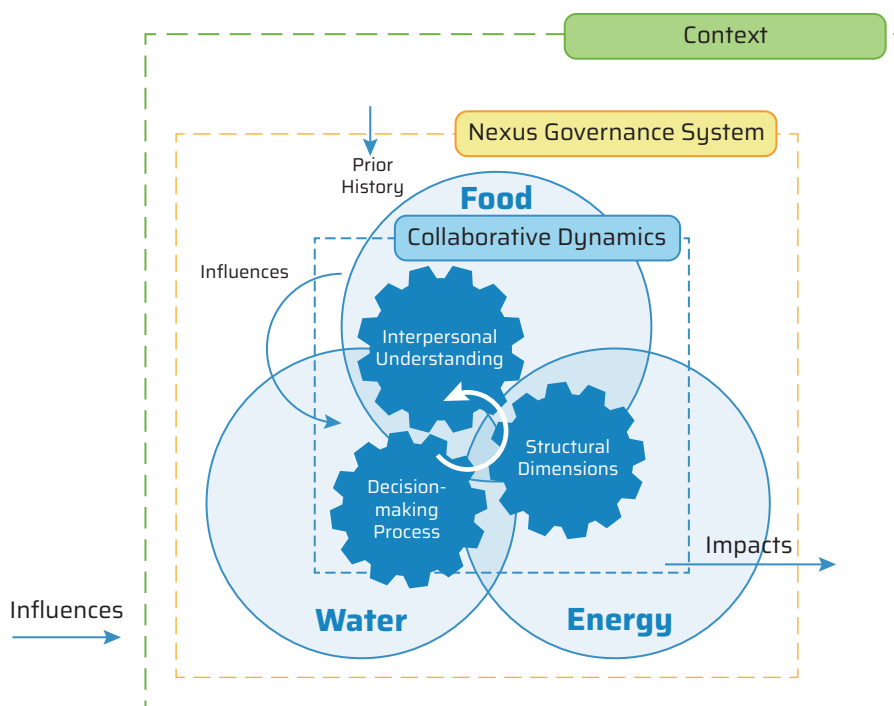
integrity, public scrutiny and inclusive stakeholder engagement to foster public confidence.

1.3.3.2 Integrated WEFE governance analysis

The analysis next assessed the **extent of integrated governance among sectors** by examining the alignment of priorities and conditions outlined in legal texts, sectoral strategies, policies and action plans, and the approaches adopted to address trade-offs among the sectors.

It also evaluated the **level of collaborative interactions** among the relevant stakeholders, particularly the existence of established and well-operating structures to facilitate multisectoral communication and coordination on priority issues of concern.

In fact, the success of the overall governance of the Nexus relies heavily on collaborative governance concepts (Jones-Crank *et al.*, 2022). This framework considers the specific circumstances of the case at hand, as well as historical developments within and between sectors (see Fig. 1-4).

FIGURE 1-4 Conceptual framework for assessing collaborative Nexus governance (Jones-Crank *et al.*, 2022).

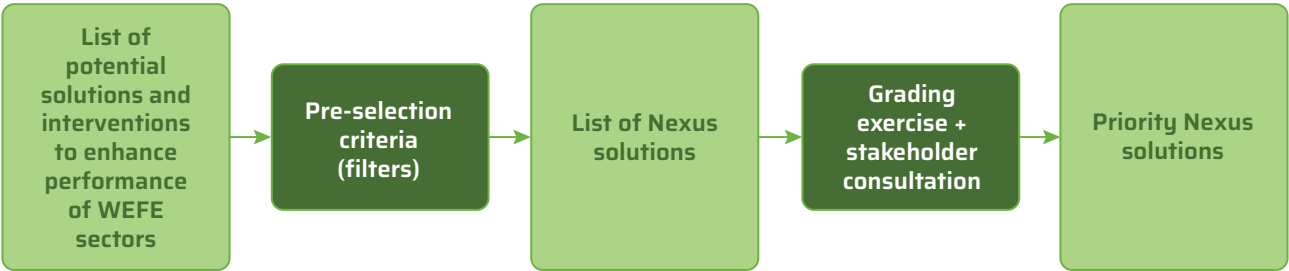
1.3.4 Solution selection and prioritisation

A range of solutions has been proposed to address the priority challenges identified throughout Phase I of the WEFE Nexus Policy Dialogue in Lebanon. These solutions were prioritised based on criteria discussed and agreed with members of the WEFE Inter-Ministerial Group and other key stakeholders. Governance-related interventions and technical solutions were evaluated separately.

The criteria encompassed pre-selection “filters” that, if not met, led to the rejection of a proposed solution, and prioritisation criteria to evaluate approved solutions (see Fig. 1-5).

In other words, to avoid conflict with the project objectives, even if a solution would lead to improved performance in one sector, it was rejected and removed from the analysis if it would not 1) ensure environmental protection and conservation of natural resources and ecosystems; 2) help to address interlinkages between WEFE sectors; 3) create a positive impact on WEFE sectors (projects with potential negative impacts on any sector were rejected); 4) contribute to climate change resilience; and 5) be technically feasible.

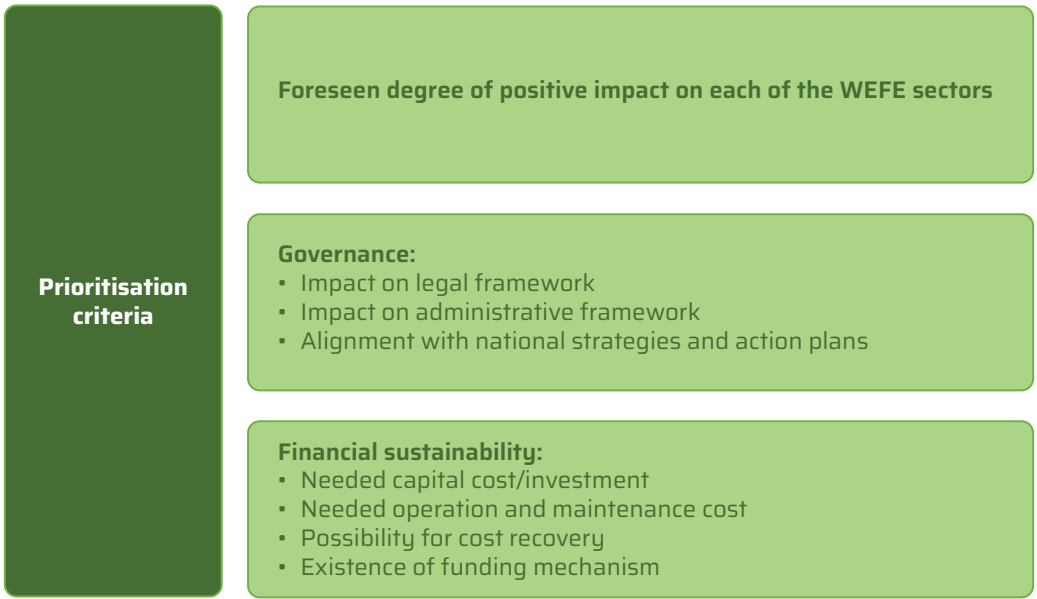
FIGURE 1-5 Schematic representation of priority Nexus solution selection and prioritisation.



Solutions were then graded using the following prioritisation criteria (see Fig.1-6): a) ability to effectively resolve important trade-offs and generate positive impacts for WEFE sectors; b) alignment with the goals set in the relevant legal and administrative frameworks, strategies

and action plans; and c) financial sustainability, including the required capital investment, operation and maintenance costs, potential for cost recovery and the existence of funding mechanisms.

FIGURE 1-6 WEFE solutions prioritisation criteria.



2. Current status and trends in WEFE sectors in Lebanon

2.1 General context

2.1.1 Governance in Lebanon

Lebanon's governance structure is highly centralised. In addition to its legislative and executive responsibilities, the national Government historically maintained authority over the planning and supervision of local and regional operations (EU CoR, 2023). The country also faces a range of challenges, such as limited public investment, inequitable distribution of resources across the country and mismanagement of taxpayer and international donor funds (Atallah, 2020). The ongoing financial crisis and substantial devaluation of the Lebanese pound have depleted national government resources, leading to reduced quality and reliability of public services delivered by governmental entities. The private sector and decentralised authorities possessing the necessary resources have the potential to play a prominent role in addressing this gap.

Corruption is a significant challenge that affects all sectors, and has become widespread in the public sector due to its ability to facilitate administrative procedures, procurement advantages, tax exemptions and the accumulation of wealth by political figures and influential individuals (DRI, 2020).

The results of the sectoral governance analysis performed during preparation of the Assessment are presented in the following sections. These sections aim to clarify the extent to which existing legislative texts, strategies, policies and plans in

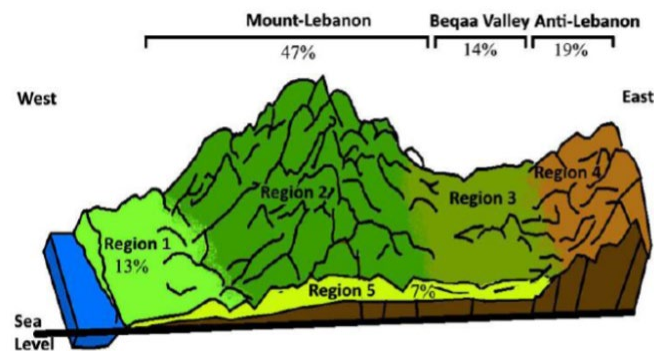
each WEFE sector integrate and align with the priorities outlined in corresponding documents from the other sectors. They also assess the availability of adequate human and financial resources to successfully implement these priorities. The state of collaborative governance, represented by the presence and operational effectiveness of inter-institutional entities tasked with addressing shared concerns for the WEFE sectors, is also discussed.

2.1.2 Lebanon's geography and climate

Lebanon's climate is influenced by its geographical position on the eastern coast of the Mediterranean Sea and is characterised by four seasons. Winters are mild and rainy, summers hot and dry with little to no precipitation, autumn and spring are transitional seasons with gradual changes in temperature and limited rainfall (U.S. Library of Congress, 2016). The majority of precipitation occurs between October and May, while the period from June to September is generally dry.

Lebanon's topographic variations (see Fig. 2-1) result in different microclimates, which can be classified into three key climatic patterns: coastal, mountainous and inland (MoPWT, 1966). The coastal and western areas of the Mount Lebanon range exhibit maritime features and receive more rainfall compared to the Anti-Lebanon range, which experiences a more continental, drier climate. These conditions produce rich ecosystems and biodiversity, and give rise to various bioclimatic zones and agroclimatic zones.

FIGURE 2-1 The five geomorphological zones of Lebanon³ (MoE/GEF/UNDP, 2009).



2.2 Water sector overview

Lebanon is relatively rich in water resources when compared to neighbouring countries, however, it has long suffered from water scarcity.

2.2.1 Water resources

The country receives estimated average annual precipitation of approximately **8,559 Mm³** (MoEW, 2022 (a)). Precipitation varies geographically across different climatic zones, with the driest areas experiencing around **200 mm** of rainfall, while certain areas of Mount Lebanon receive up to **2,000 mm**. Additionally, about **3,000 Mm³** of precipitation fall as snow (MoEW, 2020), which reaches its highest cover areas in March.

Lebanon’s geological features and varied sedimentary formations, including karstic formations, fissures, fractures, depressions and sinkholes, promote the efficient percolation and infiltration of rainwater and snowmelt deep into the ground. This water then feeds aquifers or emerges at lower elevations as springs that flow into rivers, constituting the main sources of water supply in the country.

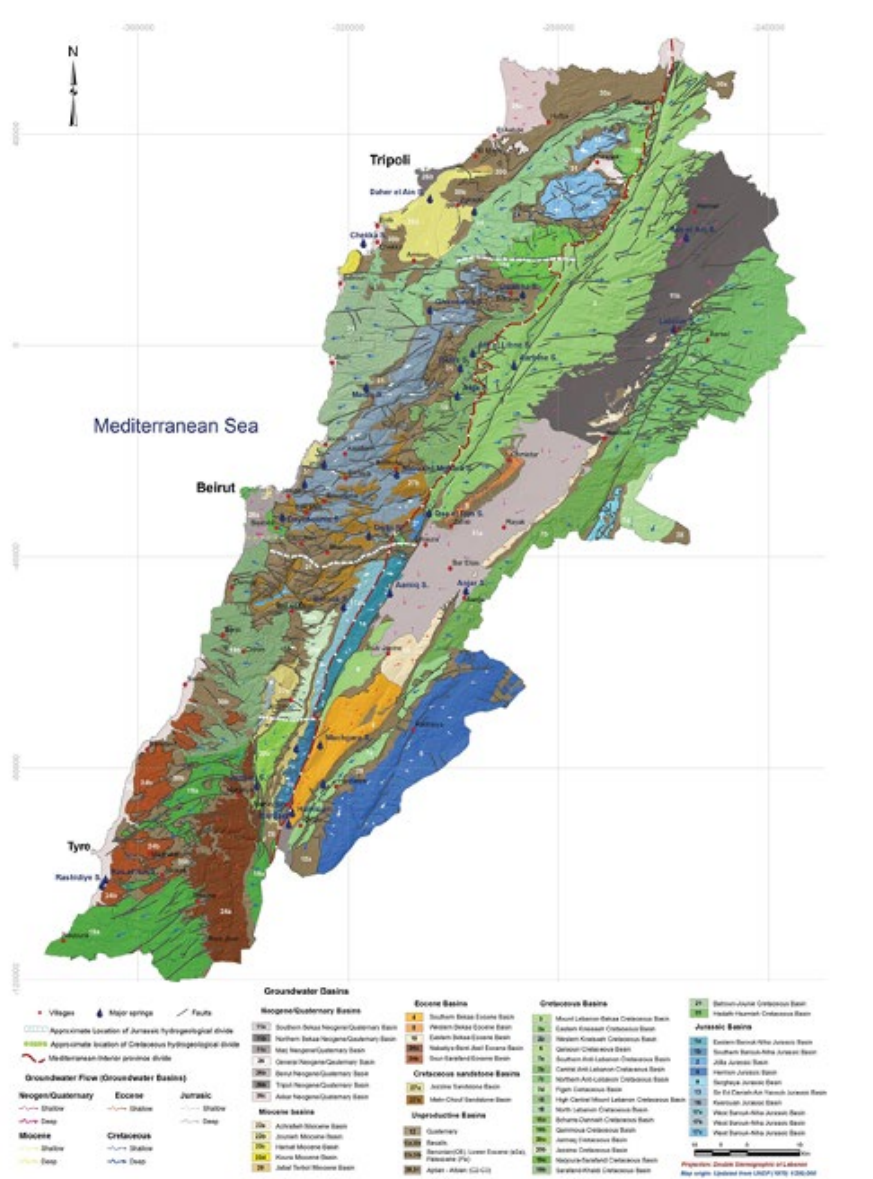
Exploitable groundwater resources are estimated at **2,750 Mm³** (MoEW, 2022 (a)). Most of the interior groundwater basins not directly connected to the sea have experienced a decline in groundwater levels since 1970. In contrast, coastal groundwater basins have maintained relatively stable levels due to seawater intrusion (see Fig. 2-2) which compensates the pumped water (MoEW/UNDP, 2014).

³ Region 1: coastal zone, Region 2: Mount Lebanon range, Region 3: Bekaa Valley, Region 4: Anti-Lebanon range, Region 5: South Lebanon

FIGURE 2-2 Saltwater intrusion along coastal aquifers (MoE/UNDP/UNHCR/UNICEF, 2021).

Region	Saltwater Intrusion Status In Sampled Wells	Studies
Beirut	- Median chloride levels Increased up to 4,453 mg/L in 2014 - Out of 170 wells sampled between 2012 and 2013, only 14% were categorized as fresh or slightly saline	Alameddine <i>et al.</i> , 2018; Rachid <i>et al.</i> , 2017
Choueifat, Jiyeh and Rmeileh	- Most wells had salinities in excess of 2 deciSiemens/m - In 2014, salinity levels in the area between Naameh and Rmeileh were found to have doubled or tripled as compared to their levels in 1989 - Freshwater/seawater interface intruded > 2 km inland	Fayssal and Slim, 2015; Khadra and Stuyfzand, 2018
Jal el Dib	90% of wells experienced SWI year-round - Total Dissolved Solids (TDS) levels: 222 - 4,400 ppm	IDRC, 2017
Tripoli	- TDS levels: 209 - 3,460 mg/L - Freshwater/seawater interface expected to move by 103 m further inland over the next 25 years as compared to its current location in 2018	El-Fadel <i>et al.</i> , 2014; El-Hoz <i>et al.</i> , 2014; Kalaoun <i>et al.</i> , 2018
Zahrani	The plain appears to be in the early stages of SWI	El-Fadel <i>et al.</i> , 2018; IDRC, 2017

FIGURE 2-3 Groundwater basins of Lebanon (MoEW/UNDP, 2014).

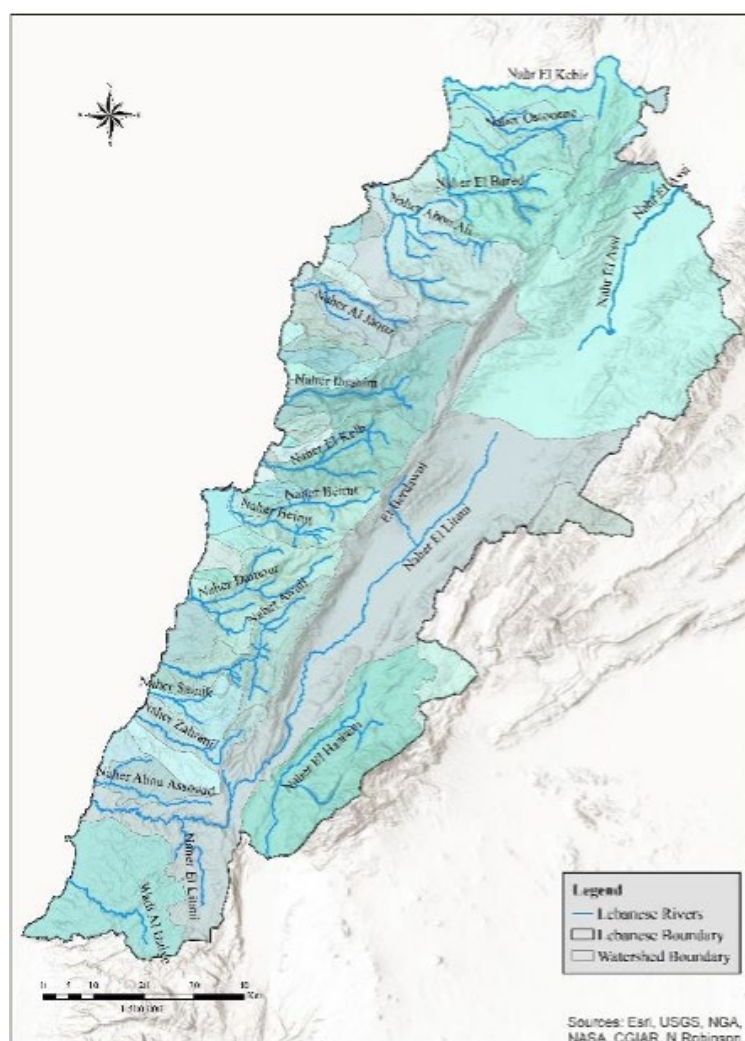


Lebanon has **40** rivers, **17** perennial and **23** seasonal (see Fig. 2-4), with an average annual flow estimated at **3,400 Mm³** (MoEW, 2022 (a)). About **75%** of the flow occurs between January and May, **16%** between June and July, and the remaining **9%** between August and December (FAO, 1997)).

Most of the rivers in Lebanon originate from the Mount Lebanon range and flow into the coastal areas of the country, ultimately entering the Mediterranean Sea, generally moving from east

to west. The Litani River, on the other hand, originates in the country's interior, specifically the Bekaa region, and also discharges into the coastal areas. This directional flow of the rivers connects the mountainous and interior regions of Lebanon to the sea.

It is worth noting that the Assi (Orontes) River and the Hasbani River, two transboundary rivers originating in Lebanon, discharge their waters outside the boundaries of the country.

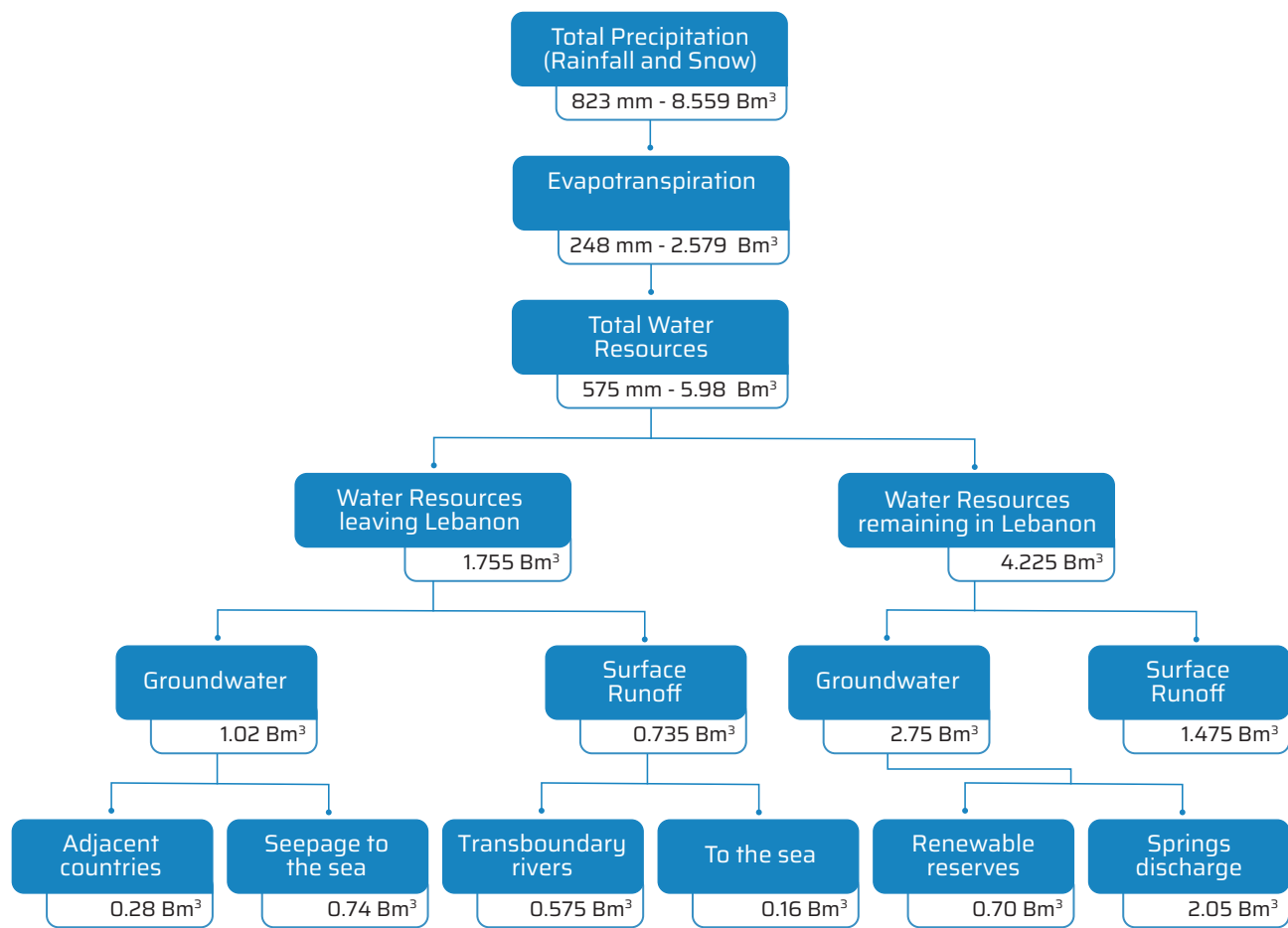
FIGURE 2-4 Map of Lebanon showing major rivers and related watersheds (MoEW, 2022 (a)).

Different studies report varying numbers of springs in Lebanon. According to the State of the Environment Report (SOER) 2020, approximately **5,000** springs have been documented (MoE/ UNDP/UNHCR/UNICEF, 2021), while the National Water Sector Strategy (NWSS 2020-2035) estimates **2,000** springs, **275** of which have been tapped (MoEW, 2022 (a)). The level of water flow

and quality monitoring differs significantly among the springs, making it challenging to estimate the total resources from all of them. The NWSS estimates the total annual flow from tapped springs to be **2,050 Mm³** (MoEW, 2022 (a)).

The annual water balance included in the NWSS is presented in Fig. 2-5.

FIGURE 2-5 Detailed annual average water balance (MoEW, 2022 (a)).



It is worth noting that the above water balance was based on estimations and calculations rather than actual data collected from monitoring and measurement of water resources (public wells, springs and river flows, as well as extraction volumes from both licensed and unlicensed private wells), due to the lack of infrastructure and mechanisms for collecting the required data in the country. The limited availability of dependable data regarding the resources hinders the development of an accurate national water balance.

The updated NWSS 2020-2035 (MoEW, 2022 (a)) has highlighted these limitations and stressed the need for further knowledge and studies, “especially regarding real evapotranspiration estimation, groundwater resources leaving Lebanon either to adjacent countries or to the

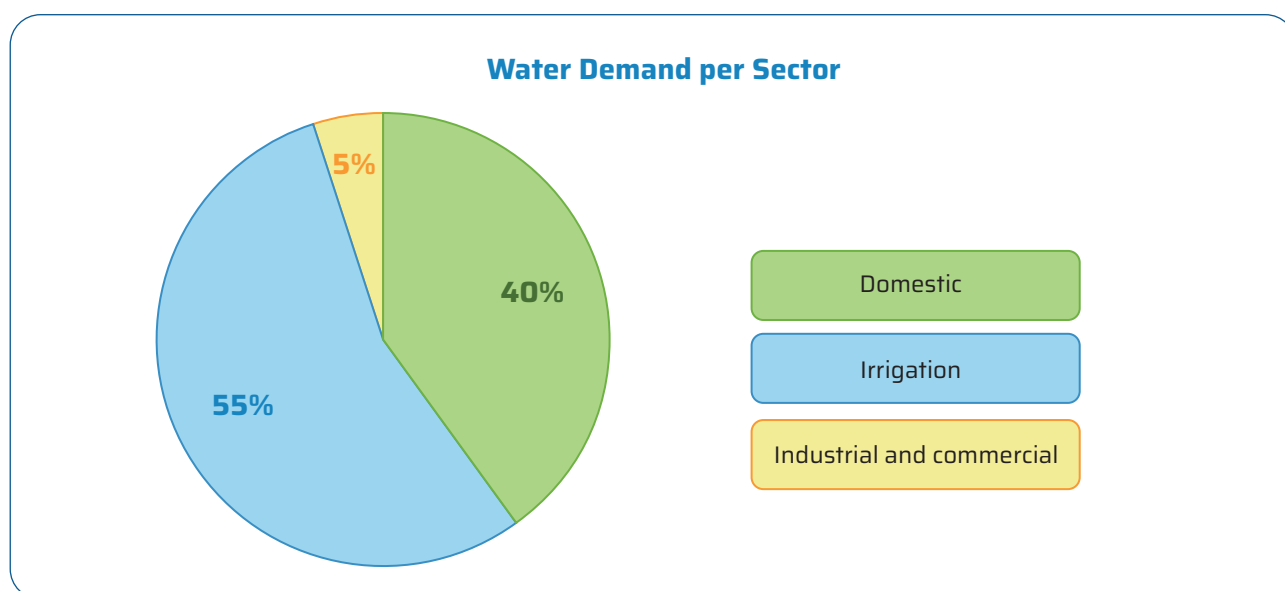
sea through submarine springs with estimations dating back to the 1970s.” The strategy also stresses that information collected on snow cover contribution during the last decade should be integrated into the annual water balance.

The NWSS further states that “the annual water balance was included for information only and should not be adopted for water management plans on a national scale. Rather, water management plans should be based on water balances estimated at the watershed scale as part of the integrated water resources management (IWRM) approach” and highlights the fact that “among other impediments, the lack of data results in estimated/approximated projections of supply and demand” (MoEW, 2022 (a)).

2.2.2 Water demand and supply

The figure below illustrates the estimated water demand for each sector as per the NWSS (MoEW, 2022 (a)).

FIGURE 2-6 NWSS 2020-2035 estimates of annual water demand by sector in Lebanon (based on data from MoEW, 2022 (a)).



Water supply is the responsibility of the regional water establishments (RWEs). These operate under the auspices of the Ministry of Energy and Water (MoEW). However, it is worth noting that most water supply facilities and the associated infrastructure are outdated and inefficient. This has resulted in significant leakage, which accounts for approximately **50%** of the water supply, leading to resource wastage and an increased risk of contamination. The public water system has thus failed to consistently provide a safe and reliable water supply across the country (Government of Lebanon and United Nations, 2021), and complementary supply to meet demand has been provided by private water companies (water bottling), private wells and private cisterns. This situation presents health and safety challenges, risks the over-exploitation of groundwater and raises issues concerning transparency, as described in the governance sections.

The majority of public water distribution networks lack meters for monitoring water consumption by users. As a result, data on domestic water use are also based on estimations, giving an average of **5,244 litres** per household per week (household size is assumed to be **5.8** persons) (MoEW, 2022 (a)). The NWSS estimates annual water demand in Lebanon to be **1,050 Mm³**, with irrigation accounting for the largest share (**55%**) of this demand (see Fig. 2-6).

About **50%** of the water needed for irrigation and **80%** of potable water is obtained through wells and boreholes, which include both public and private wells (MoE/UNDP/UNHCR/UNICEF, 2021). It is also worth noting that a considerable number of private wells are unauthorised and not properly recorded (MoEW, 2022 (a)), leading to the over-exploitation of aquifers (MoEW/UNDP, 2014).

In 2017, only **36%** of the total Lebanese population had access to safe drinking water (UNHCR, 2018). The financial and economic crisis that started in 2019 has had a significant impact on the water sector, resulting in an increased supply deficit. Approximately **1.5 million** Lebanese citizens now face limited access to safe water, as do **66%** of the refugee population residing in Lebanon (Government of Lebanon and United Nations, 2021).

2.2.3 Wastewater

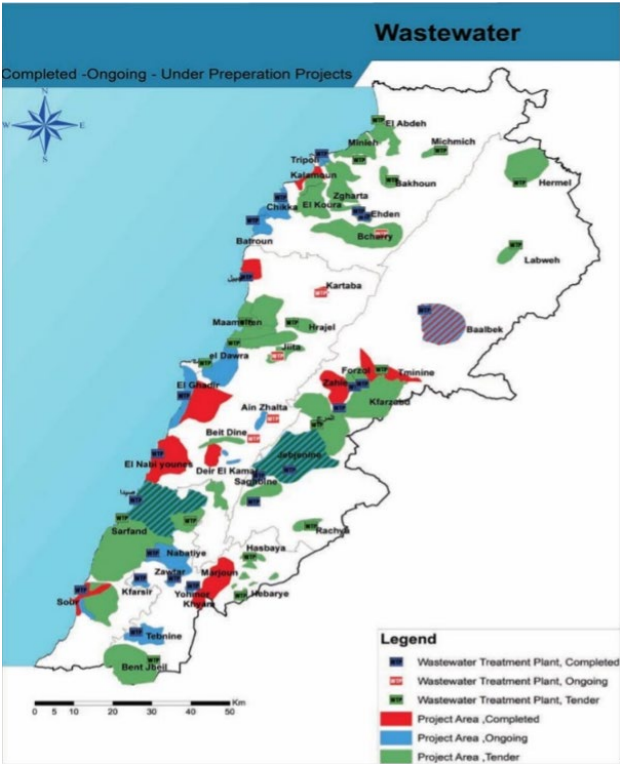
Lebanon generates approximately **248 Mm³** of domestic wastewater per year (MoE/UNDP/GEF, 2017). It is estimated that the influx of refugees and displaced persons has contributed to an **8-14%** increase in the wastewater generation rate (MoE/UNDP/GEF 2021). However, it is important to note that data on wastewater generation and treatment are also based on estimations that vary between different studies:

- ▶ The NWSS 2020-2035 estimates that about **30%** of generated wastewater is treated, **25%** of which is treated to secondary and tertiary levels (MoEW, 2022 (a)).
- ▶ Lebanon’s Fourth Biennial Update Report to the UNFCCC (2021) estimates that **68%** of generated wastewater is collected and only **19%** is treated (**13%** to primary level and **6%** to secondary level), while **28%** is discharged into septic tanks or cesspools without treatment and **53%** is untreated and discharged to rivers, lakes or the sea (see Fig. 2-8). About **4%** of domestic wastewater is uncollected, untreated and disposed in situ (MoE/UNDP/GEF 2021).

Despite the discrepancy in the values provided by these studies, both highlight the urgent need to improve wastewater management.

Figure 2-7 shows the areas covered by WWTPs that are completed, ongoing and being put to tender.

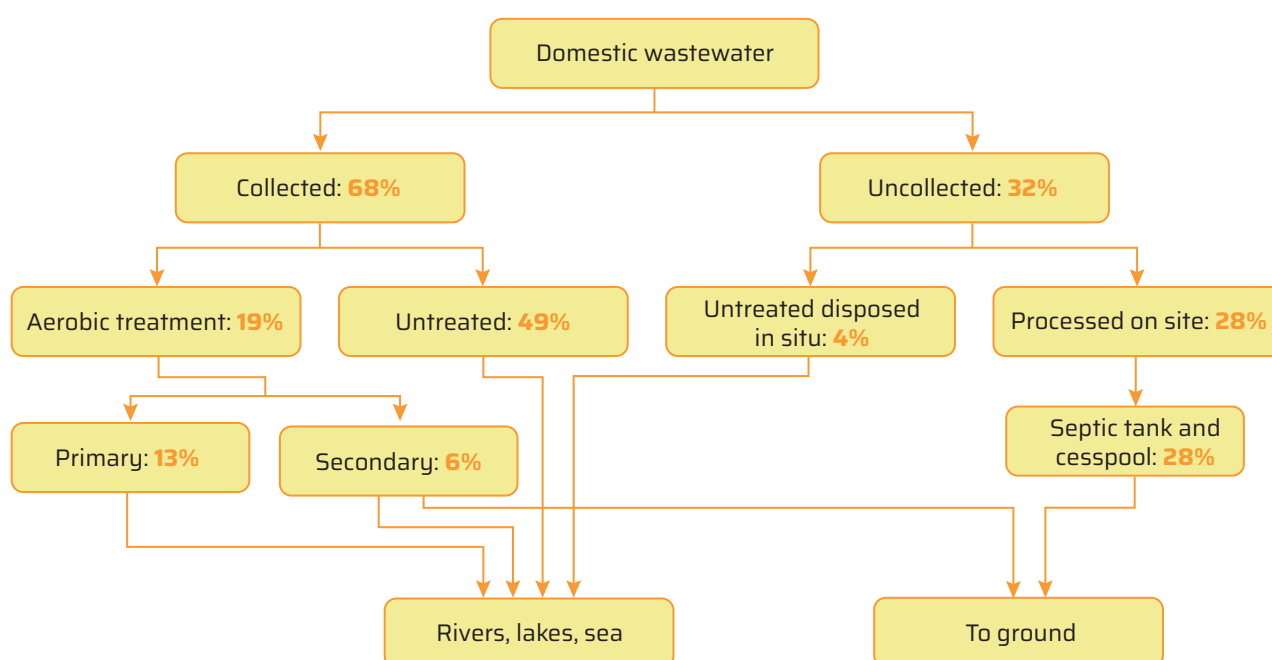
FIGURE 2-7 Areas covered by WWTPs (completed, ongoing and put to tender) (Eid-Sabbagh, 2023).



There are no recent estimations of the amount of industrial wastewater generated in Lebanon. The latest available estimate is **60 Mm³/year** in the NWSS 2010 (MoE/UNDP/UNHCR/UNICEF, 2021). Generated industrial wastewater is rarely treated at the industry level prior to being discharged into

the environment or to the public sewer network (MoE/UNDP/GEF 2017). The situation is similar in healthcare facilities, where generated wastewater is in many cases discharged into the network without prior treatment (MoEW/UNDP/GEF 2021).

FIGURE 2-8 Domestic wastewater treatment systems in Lebanon and discharge pathways in 2018 (MoEW/UNDP/GEF 2021).



2.2.4 Challenges and threats affecting the water sector in Lebanon

While the available water resources are considered to be enough to cover the needs of the country “well beyond the NWSS horizon (2035)” (MoEW, 2022 (a)), the water sector has been facing various challenges that have affected the performance of related services, including availability of resources and access to safe water. In other words, water service providers have been struggling to provide sufficient quantities of good quality water that meets domestic water standards. This situation is primarily linked to ineffective governance mechanisms. These are described in detail in Section 2.2.5, and were having an impact on the sector even before the start of the economic and financial crisis in 2019. These crises have, however,

compounded the situation and intensified pre-existing challenges.

2.2.4.1 Inequitable access to water resources in Lebanon

Water accessibility in Lebanon has been inequitable due to a variety of reasons:

- ▶ The quality and availability of infrastructure varies greatly between rural and urban areas, and across different regions in Lebanon.
- ▶ The lack of funding for RWEs and their varying financial capacities have created unequal opportunities for development projects.

- ▶ The significant role of the profit-driven private sector. This is a parallel market that is unregulated, therefore the quality of the water it supplies is not assessed or assured, posing risks to public health from waterborne and pollution-related diseases.
- ▶ The illegal drilling of wells, threatening groundwater quality and availability.
- ▶ Underinvestment in water and wastewater infrastructure and services.
- ▶ Overdesign of facilities, making it difficult to properly manage and monitor them in terms of optimised operation and energy use (Issam Fares Institute, 2015).
- ▶ A lack of proper operation and maintenance procedures for water sector facilities, and a failure to enforce these procedures where they do exist.
- ▶ The limited capacities and skills of staff responsible for managing facilities.

Most of the public facilities operated by RWEs depend on power supplied by Electricité du Liban (EDL) with diesel-powered back-up generators. Following the economic, financial and fuel crises and the decrease in power supply from EDL, these facilities have been relying mostly on generators, which are cost-intensive to operate and maintain and environmentally harmful. Facilities have therefore faced drastic increases in operational costs, due to a high dependence on diesel, higher oil prices (locally and internationally), devaluation of the Lebanese pound and reduced public funding.

These factors have been instrumental in the deterioration of services provided by the water sector administrations, exposing the vulnerability of the system and intensifying water insecurity and environmental risks. Addressing these issues, especially those related to facilities' energy consumption have been identified by stakeholders as a priority for enhancing water supply and

wastewater treatment in the short term. They should also be taken into consideration as part of long-term planning, a key element of the NWSS 2020–2035.

2.2.4.2 Pollution of water resources

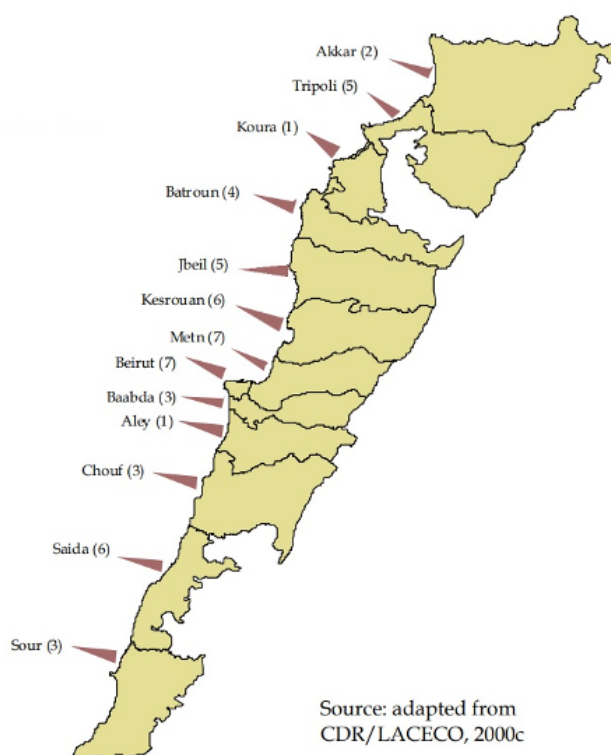
Surface water: The quality of surface water varies across Lebanon and throughout the year: while pollutant concentration is higher in the dry months (due to low dilution), the higher flow witnessed in winter drags along solid waste, together with surface water run-off (MoE/UNDP/UNHCR/UNICEF, 2021). Some of the detected pollutants have a significant impact on the environment and public health. Most polluted sources exhibit high levels of biological contamination, biological oxygen demand (BOD), dissolved oxygen (DO), and nitrogen and phosphate (MoE/UNDP/UNHCR/UNICEF, 2021). Microbial contamination has been documented in all assessed rivers, highlighting that the discharge of untreated domestic wastewater remains the principal source of freshwater pollution at the national level. Meanwhile the understanding of riverine pollution by heavy metals and micropollutants across Lebanon is still limited and based on a few sporadic studies (MoE/UNDP/UNHCR/UNICEF, 2021).

Groundwater: The quality of groundwater resources in Lebanon also varies across the country. Salinity levels are much higher in coastal areas, while high nitrate concentrations have been reported in wells in the Bekaa region, making them unsuitable for potable water and irrigation purposes (MoE/UNDP/UNHCR/UNICEF, 2021). Groundwater contamination by microorganisms is also a concern, as karst aquifers are porous and therefore unable to prevent infiltration. In urban areas, microbial contamination is mainly attributed to the open discharge of wastewater, sewer system leakage and poorly constructed septic tanks. As is the case for surface water, there are limited studies addressing heavy metals and micropollutants in groundwater (MoE/UNDP/UNHCR/UNICEF, 2021).

Coastal and marine waters: River discharge is considered the major land-based source of pollution affecting the marine and coastal environment of Lebanon. Most urban, domestic, industrial and agricultural effluents find their way to waterways and eventually to coastal waters. Moreover, these waters receive around **65%** of

the total domestic wastewater generated, through at least **53** outfalls along the coastline, due to the fact that the coastal zone hosts about **70%** of the country's population. **Figure 2-9** is a map from the year 2000 showing the distribution of sea outfalls by *caza* (district).

FIGURE 2-9 Map showing sea outfalls in Lebanon (MoE/Lebanese Environment and Development Observatory, 2001).



The NWSS notes that if the operational WWTPs functioned at maximum or design capacity, they would exceed the volume of total wastewater generated by **30%**. Upgrading them to secondary treatment stages and ensuring their proper and sustainable operation are crucial to meeting the requirements of the international conventions to which Lebanon has signed up, such as the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution, as well as to achieving Sustainable Development Goal (SDG) 14, which calls for the conservation and sustainable use of the oceans, seas and marine resources for sustainable development (MoEW, 2022 (a)).

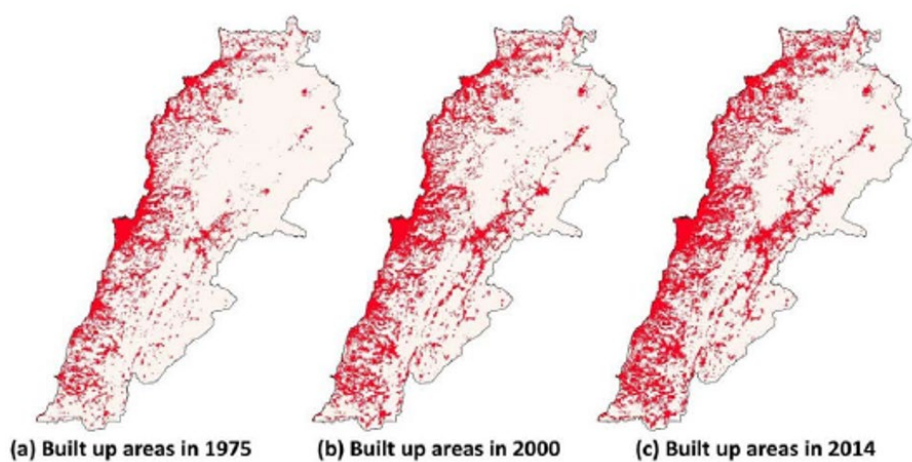
The Strategic Environmental Assessment (SEA) related to the previous NWSS predicted that if all WWTPs (planned and existing) were operated properly, pollution into the Mediterranean Sea would be reduced by up to **80%** (MoE/UNDP/UNHCR/UNICEF, 2021). The concentration of industrial facilities along the coast, which discharge their water either into the municipal wastewater network or directly into the sea with minimal to no treatment, further increases the stresses on seawater quality (MoE/UNDP/UNHCR/UNICEF, 2021).

2.2.4.3 Haphazard urbanisation

Urban sprawl has led to the loss of agricultural land, ecosystems and habitats, and has affected the availability and quality of natural resources, including water. Landscapes have been

substantially altered, and construction methods that reduce soil permeability are in widespread use, reducing vegetation cover and raising the risk of flooding in many areas (MoE/UNDP/UNHCR/UNICEF, 2021).

FIGURE 2-10 Urban expansion in Lebanon between 1975 and 2014 (MoE/UNDP/UNHCR/UNICEF, 2021).

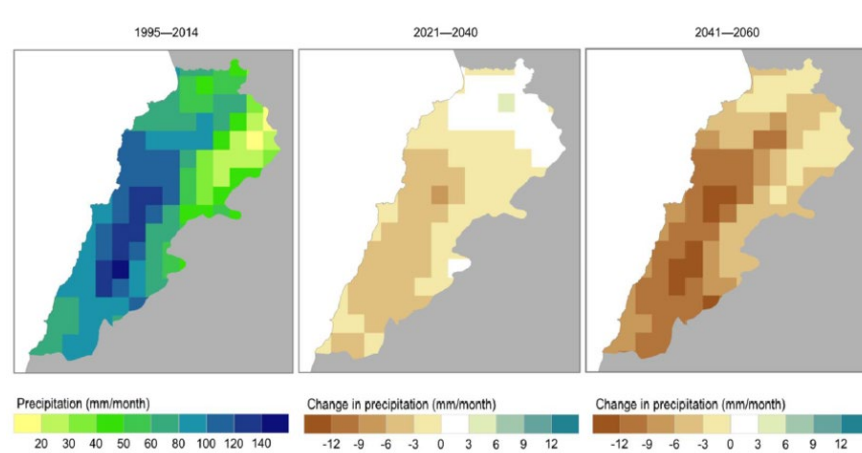


Moreover, construction in remote areas without access to a sewer network can contribute to groundwater pollution. In these areas, septic tanks are commonly used to dispose of wastewater, and this can also cause pollution if proper standards are not adhered to (MoE/UNDP/UNHCR/UNICEF, 2021). Mountain resorts, for example, are usually located in untouched natural surroundings, meaning that they lack fundamental infrastructure, such as access roads, water supply networks, sewage collection and treatment systems, and electricity. These resorts require significant quantities of water for various purposes, but also generate substantial amounts

of wastewater and solid waste (MoE/UNDP/UNHCR/UNICEF, 2021).

2.2.4.4 Climate change

The impacts of climate change threaten to reduce the availability of water resources and significantly alter Lebanon's microclimatic zones. The most recent projections have shown a higher increase in average temperatures compared to previous projections, indicating a greater degree of threat, and more noticeable results in the short term, including an intense increase in temperature over a shorter timeframe, more frequent extreme weather events, etc. (UNDP, 2022 (b)).

FIGURE 2-11 Projected variations in precipitation in Lebanon (MoE/UNDP/GEF, 2022).


In addition, climate events in Lebanon show a considerable level of variation in terms of type and intensity, as illustrated in Table 2-1.

TABLE 2-1 Climate events in Lebanon (adapted from Verner *et al.*, 2018)

Date	Climate events
2007	Severe heatwaves where temperatures exceeded the 90th percentile during the summer months. Heatwaves reached temperatures above 40°C for five days in June and seven days in July. This led to large local forest fires. Rainfall was also 50% lower that summer.
2008	Well-below-average temperatures and drier-than-average conditions.
2009	Warmer-than-average temperatures prevailed throughout the country followed by severe rainfall causing flooding.
2010	The average air temperature ranged from 2°C to 4°C higher than normal, with November being very dry. Lebanon received less than 40% of normal precipitation. Heatwaves were recorded over the Bekaa Valley (September). In December, an extratropical cyclone brought heavy rainfall and strong winds to the eastern Mediterranean. Along the costs of Lebanon, waves reached ten metres tall.
2011	Temperatures and rainfall levels were normal. Flood damage in the Akkar, Danieh and Hasbani areas.

Date	Climate events
2012	Summer was significantly warmer than normal with anomalies between +1°C and +3°C, reaching +4°C. Despite some extreme precipitation events, 2012 was slightly drier than normal especially during the warm season. Precipitation surplus resulted in a wetter-than-normal winter with rainfall reaching 125% to 140% of long-term mean precipitation, especially in January. Spring was dominated by mostly dry conditions. Lebanon received 50 mm less precipitation than normal, or 40% of the long-term mean.
2013	The Middle East was +1°C to +2°C warmer than normal, during both the winter and summer months. In the first days of January, snow, frost and thunderstorms affected parts of Lebanon and the surrounding areas. In March, a heatwave hit with maximum temperatures reaching 40°C. Flash floods were recorded in North Bekaa and East Lebanon (November).
2014	Temperatures in the Middle East were +1°C to +2°C above the long-term mean and annual precipitation was below normal. Lebanon had a dry year with high temperatures and low rainfall. Major frost events in the Central and Northern Valley and North Lebanon (March) and heat and water shortages (September).
2015	In the Middle East, temperatures were +1°C to +2°C warmer than the long-term mean. Windstorms and frost were recorded in the coastal areas of South Lebanon (January), snow, wind and frost in Mount Lebanon (March) and the Nahr El Kabir River in Akkar flooded (February).
2016	Heavy rain and snow caused a landslide in Chouf, Mount Lebanon.
2017	Heatwaves and strong winds caused forest fires in several areas in North Lebanon (Akkar).
2018	Snow, heavy rain and some flooding were observed in Tripoli in February, with 81 mm of rain recorded in 24 hours. In December, Storm Norma caused torrential rain, freezing winds and snow, resulting in damage to infrastructure, roads and homes across the country.
2019	Heavy rain caused flooding (December). Heatwave with temperatures in coastal and inland areas exceeding 36.5°C (July).
2020	Heatwave for two weeks in July and August; temperatures reached more than 40°C.

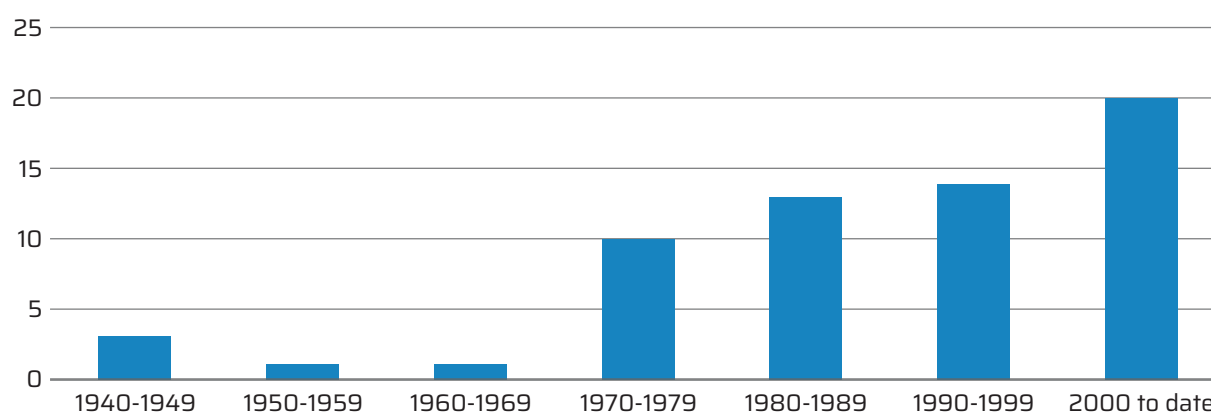
The consequences of such drastic changes in Lebanon include more stress on water resources, including groundwater supplies, increased water scarcity and reduced agricultural output (MoE/

UNDP/UNHCR/UNICEF, 2021), (UNDP, 2022 (b)). The expected short periods of intense rainfall may lead to destructive flooding with the potential to cause damage amounting to millions of pounds

annually that the Government will have to tackle (see Fig. 2-12). The threat of more severe droughts is similarly alarming, since between these periods

of intense precipitation, long dry intervals are expected to become the norm.

FIGURE 2-12 Number of major flooding events in Lebanon in the last seven decades (MoE/UNDP/UNHCR/UNICEF, 2021).



The anticipated climate risks and climate-related vulnerability of water resources in Lebanon are described in the Fourth National Communication to the UNFCCC as follows:

Snow cover: Several studies have consistently shown a decrease in snowfall in the periods 1967–2009 and 2012–2018. This has been accompanied by a reduction in the duration of snow coverage from **110 to 85 days**. These changes are attributed to higher rates of melting and a decrease in annual snow cover, with a significant difference of **70%** between 2013 and 2018. It is also anticipated that snow will begin to melt earlier over time. As snowfall plays a significant role in total precipitation and water availability, climate change will have a substantial impact on groundwater recharge and surface water availability during the dry months of the year (MoE/UNDP/GEF, 2022).

River basins: Research on the effects of climate change and extreme events, such as severe droughts and floods, has been conducted in several river basins, including the Nahr El Kabir, Nahr El Kaleb, Upper Litani and Nahr Ibrahim basins. Projections indicate that these areas will experience drier conditions, more droughts and shifts in precipitation patterns as a result

of climate change. For instance, the Nahr El Kabir basin is expected to experience more dry days and an increase in peak flow and flood frequency. The Nahr Ibrahim basin will witness changes in drought occurrences, discharge and peak flow timing due to shifts in precipitation and temperature. The Upper Litani basin is also facing significant impacts, including a projected water supply deficit and increased demand, putting government plans for agricultural expansion at risk. It is imperative to engage in integrated and strategic adaptation planning to address these vulnerabilities effectively (MoE/UNDP/GEF, 2022).

Groundwater: Recent studies have revealed a significant decline in groundwater volume in major aquifers in Lebanon over the last four decades, amounting to a reduction of **35–40%**. As a result, the water table has dropped by about **30 to 35 metres**. Generally, the occurrence of drought and alterations in snowfall or snow cover duration due to climate change are expected to have substantial consequences for groundwater use and water quality (MoE/UNDP/GEF, 2022).

Coastal aquifers: The extraction of groundwater, driven by population growth and increased water consumption rates, poses a greater threat to

coastal aquifers in Lebanon than rising sea levels caused by climate change. Despite projections that sea levels will rise **20-65 cm** by 2032, the observed impact on saltwater intrusion is roughly equivalent to just a **2%** increase in extraction rates. To mitigate saltwater intrusion, the primary focus of any adaptation strategy or management

measure should therefore be on controlling groundwater extraction (MoE/UNDP/GEF, 2022).

Table 2-2 provides an illustration of climate change impacts along with the associated climate stressors and projected risks.

TABLE 2-2 Impacts, climate stressors and projected risks (MoE/UNDP/GEF, 2022)

Impact	Climate stressors	Projected risks
Reduced water availability	- Increased temperatures - Reduced rainfall and snow cover - Increased incidence of drought - Rise in sea level	- Altered seasonal water regimes; up to 30% increase in winter flooding - Reduced river flows leading to increased strain on limited groundwater sources in the dry season - Increased evaporation of surface water - Increased saltwater intrusion/salinisation of coastal aquifers
Less snow	- Increased temperature - Reduced snowfall	- Reduction of 40-70% in snow cover - Shift in snow fall from 1,500 m to 1,700 m by 2050, and to 1,900 m by 2090 - Decrease in snow residence time from 110 to 45 days
Reduced agricultural productivity	- Increased temperature - Reduced rainfall and snow cover - More frequent droughts - More frequent heatwaves and fewer frost days - Rise in sea level	- Reduced land productivity (especially for wheat, cherries, tomatoes, apples and olives; the quality of grapes may also be affected) - Reduced fruit tree yields (up to 50% through blossom pollination and fecundation of mountainous fruit trees) - Decline in soil moisture (high temperatures/ reduced precipitation/higher evapotranspiration), impacting agricultural yields - Migration of mountain fruit production to higher elevations - Decreased crop quality (particularly wine grapes) - Increased infestation (fungi and bacterial diseases) - Shift in livestock grazing areas and periods - Increased pumping for irrigation needs

Impact	Climate stressors	Projected risks
High energy demand	Increased temperatures	Increased demand for cooling (1.8% increase in electricity consumption for a 1°C increase, and 5.8% for a 3°C increase)
Sea level rise	Increased rise (30–60 cm in 30 years, up to 2 mm/year)	- Increased seawater intrusion into aquifers - Increased risk of coastal flooding and inundation - Increased coastal erosion altering coastal ecosystems in natural reserves and elsewhere
Forests at risk	Increased temperatures	Increased adverse effects on forests suffering from fragmentation, pest outbreaks, forest fires and harmful practices
Increase in morbidity and mortality	- Increased temperatures - More intense and frequent heatwaves - Increased extreme weather events	- More frequent outbreaks of infectious diseases - Increased morbidity and mortality from heat and other extreme weather events - Increased malnutrition from droughts and floods - Increased rates of waterborne, rodent-borne and vector-borne diseases
Impacts on tourism	- Increased temperatures - More intense and frequent heatwaves - Rise in sea level - Reduced precipitation	- Impact on winter outdoor tourism - Shortened skiing season - Increased losses of natural attractions (e.g. sandy public beaches) - More structural damage to the country's archaeological heritage

2.2.5 Water sector governance analysis

This section presents the findings from the governance analysis conducted for the water sector.

2.2.5.1 Efficiency

The regulatory framework

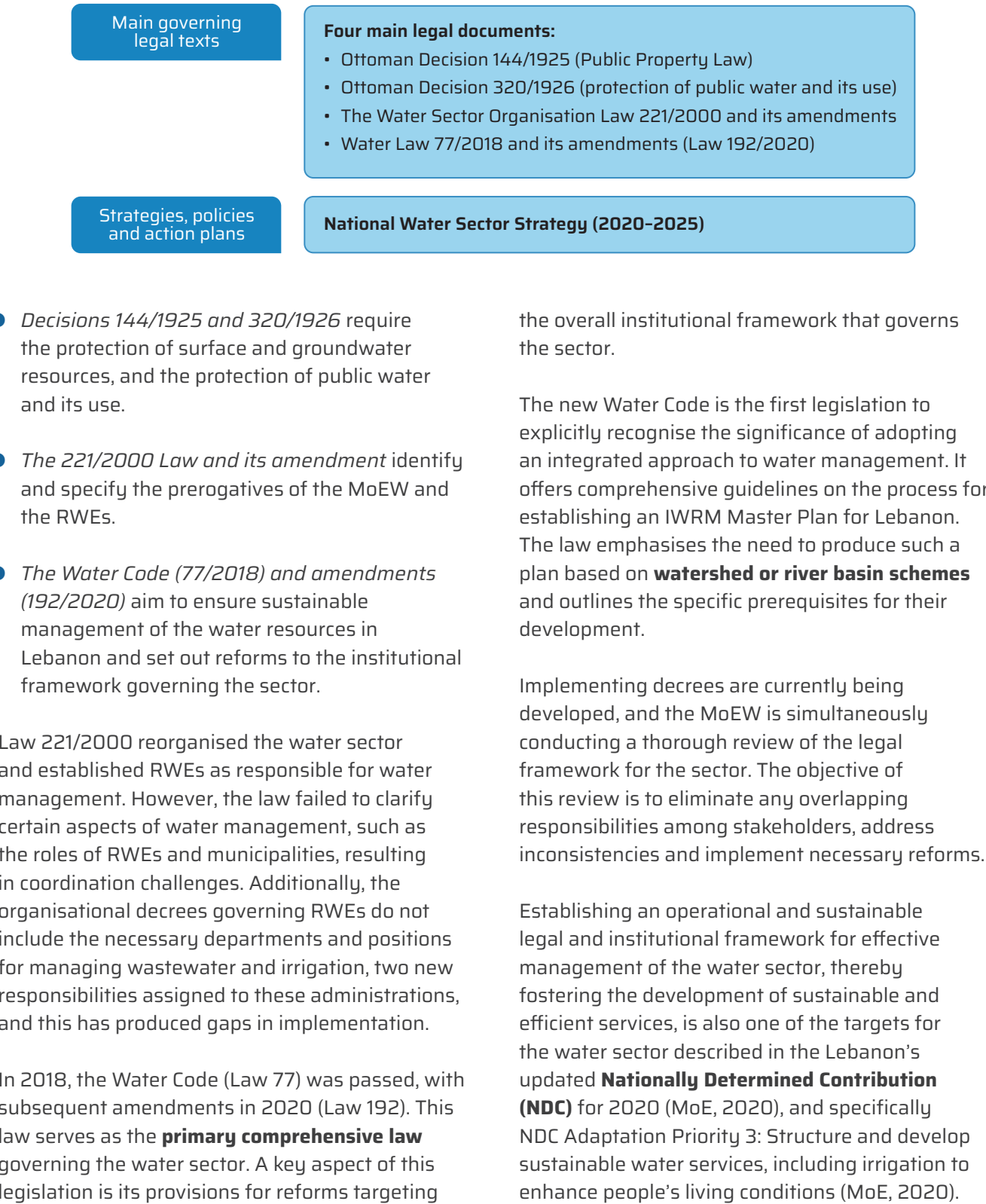
The water sector in Lebanon is regulated by a series of legislative texts, some of which are very old and in **need of updating**. One example is the 1913 Ottoman Irrigation Code, which governs the agricultural use of water. This Code has been

mistranslated from Turkish to Arabic, and is incoherent and outdated, requiring comprehensive redrafting (MoEW, 2022 (a)).

Furthermore, there are **gaps when it comes to governing specific aspects of water management**. For example, there is no legislation regulating domestic water use, except for provisions under a specific decree (320/26) regarding the delimitation of space needed for drinking water piping, the prohibition of tree planting in these spaces and compensation for equipment that obstructs the works. There is also a lack of specific legislation addressing **municipal water use**, which is governed by general provisions for municipalities.

The water sector is currently regulated by four main legal documents, as shown in Fig. 2-13.

FIGURE 2-13 Legal documents and strategies governing the water sector.



There are two factors that may present challenges during the implementation of the new Water Code. The Water Code establishes that water, in all its forms, is a national resource owned by the State, while also recognising the historical water rights of individuals for specific purposes. However, there is growing concern regarding the lack of enforcement, monitoring and implementation of these rights, leading to disparities in water allocation.

At a different level, as mentioned above, the IWRM Master Plan divides the country into watersheds and is overseen by the MoEW, while responsibility for water services lies with the respective RWEs, delineated by cadastral limits. This could lead to situations where watersheds are under the jurisdiction of two RWEs, requiring more complex collaboration processes.

Status of data and data-sharing mechanisms

There is a considerable **lack of reliable data pertaining to most hydrological and hydrogeological** parameters, such as evapotranspiration, water quality, the quantities of groundwater resources leaving Lebanon (either to neighbouring countries or through submarine springs into the sea) and extraction levels from private wells, both licensed and unlicensed. Obtaining accurate information on the latter is challenging due to the very high number of such wells and their unpredictable locations, compounded by inadequate law enforcement.

As previously noted, this data uncertainty results in several obstacles, including approximate projections of supply and demand, and prevents the development of a thorough national water balance and planning in the sector (NWSS 2020–2025) based on the IWRM requirements of the Water Code, as well as the preparation of water safety plans and other strategic documents.

The MoEW and the RWEs have limited human technical capacity to produce technical reviews and accurate reports or to monitor activities

throughout the sector and the country, as there is no dedicated organisation for this task.

Moreover, despite there being many institutions responsible for overseeing water resources, there is unfortunately no established mechanism for effectively exchanging information among them. There is also a clear need for a data management protocol that unifies the methodology and reliability of data-sharing. Currently, the lack of a framework designed to facilitate this exchange means that accessing information is a time-consuming bureaucratic process. Furthermore, the absence of a shared national water statistics database hampers transparency and restricts access to comprehensive data.

The NWSS 2020–2035 has emphasised the importance of establishing an integrated hydrological information system (IHIS) to address the numerous studies and estimations relating to the water sector. The IHIS would serve as a strategic decision-making tool for the water sector, providing relevant stakeholders with reliable and scientific information to inform planning (MoEW, 2022 (a)). It is vital that funding is secured to establish and maintain this system successfully.

Financial constraints and funding mechanisms

The public administrations responsible for overseeing water resources have consistently faced challenges resulting from **limited financial resources**. These have been exacerbated by recent economic and fiscal crises.

Even prior to these crises, RWEs struggled with energy costs and accumulated debt with EDL (Eid-Sabbagh *et al.*, 2021). The cost of electricity constituted a significant proportion (**68%**) of their overall operational costs (MoEW, 2022(c)), impeding their capacity to enhance services by completing necessary upgrades and improvements (Eid-Sabbagh *et al.*, 2021).

Moreover, the sector faces **financial losses** arising from inadequate infrastructure and unauthorised drilling. The lack of appropriate metering systems

also makes it difficult for the MoEW and RWEs to accurately monitor losses and consumption, hindering the potential for increased revenue. Furthermore, the existing billing system for water services provided by the Government has proven insufficient, leading to low revenue and significant losses (MoEW, 2020).

Investment in Lebanon's wastewater sector is also inefficient. Continuing **restrictions on government recruitment and inadequate salaries** make it challenging to attract qualified professionals, leading to a scarcity of technical and managerial expertise within both the MoEW and RWEs, hindering their ability to effectively execute their mandated responsibilities.

Developing financial tools and mechanisms that enable the sustainability and financial balance of services is another target for the water sector described in Lebanon's updated **NDC** for 2020 (MoE, 2020) under NDC Adaptation Priority 3: Structure and develop sustainable water services, including irrigation to enhance people's living conditions (MoE, 2020).

Due to the previously described financial constraints and limitations, the water sector in Lebanon is **highly dependent on foreign funding** (NWP, 2022). The funds are often foreign loans, some of which are then used to contract mostly foreign companies and experts. As a result, a significant share of this funding makes no contribution to the Lebanese economy (Eid-Sabbagh *et al.*, 2021). International funding has played a crucial role in supporting infrastructure design, implementation and operation, in addition to addressing governance-related issues in the sector and capacity-building programmes for relevant stakeholders. Loan repayment results in additional hidden costs, despite the fact that the interest rates are concessional (Eid-Sabbagh *et al.*, 2021).

2.2.5.2 Effectiveness

Policy coherence status

As previously noted, the implementation of the new Water Code (Law 77) is expected to lead to **reforms targeting the overall institutional framework that governs the sector**. Moreover, the new law makes provision for the National Water Council (NWC) to establish a robust institutional framework through a comprehensive approach and the involvement of all relevant institutions. However, some of the Council's responsibilities were recently removed following an appeal. This gives it a consultative role (MoE/UNDP/ UNHCR/UNICEF, 2021), and impacts the level of collaborative governance structure originally foreseen for this body.

Implementing decrees for the Water Code, including the NWC, are currently being developed, and a **thorough review of the legal framework in the sector** is being undertaken simultaneously to eliminate overlapping responsibilities among stakeholders, address inconsistencies and introduce the necessary reforms.

Regarding the interlinkages between **water and energy**, the NWSS 2020-2035 emphasises two main concerns. Firstly, there is a lack of legislative documentation addressing technical and legal regulations for hydroelectric projects, with the exception of those under the responsibility of the Litani River Authority (LRA). Secondly, the strategy recognises that water and wastewater facilities consume a significant amount of energy, leading to higher operational expenses. It therefore proposes formulating a targeted strategy to manage the energy costs of these facilities and establishing a national plan to integrate renewable energy sources into energy-intensive water and wastewater facilities.

Moreover, encouraging and **supporting the use of renewable energy in irrigation and drinking water supply** is one of the activities or objectives proposed in Lebanon's updated NDC for 2020 (MoE, 2020) under NDC Adaptation Priority 3: Structure and develop sustainable water services, including irrigation to enhance people's living conditions (MoE, 2020).

Another activity under the same NDC Priority relates to enhancing **efficient use of irrigation water** and **expanding the supply of surface water sources for irrigation**. These NDC activities are in line with one of the key guiding principles, namely "the achievement of **food and water security** through sustainable management of resources, enhancing infrastructure resilience and incorporating nature-based solutions."

Regarding **food security** and the potential challenges posed by diminished water resources for agricultural activities due to climate change, the NWSS has also developed the following proposals. Firstly, it advises the Government to focus on identifying the crops that are vital for ensuring the country's food security. Secondly, it suggests that the Ministry of Agriculture (MoA) designate

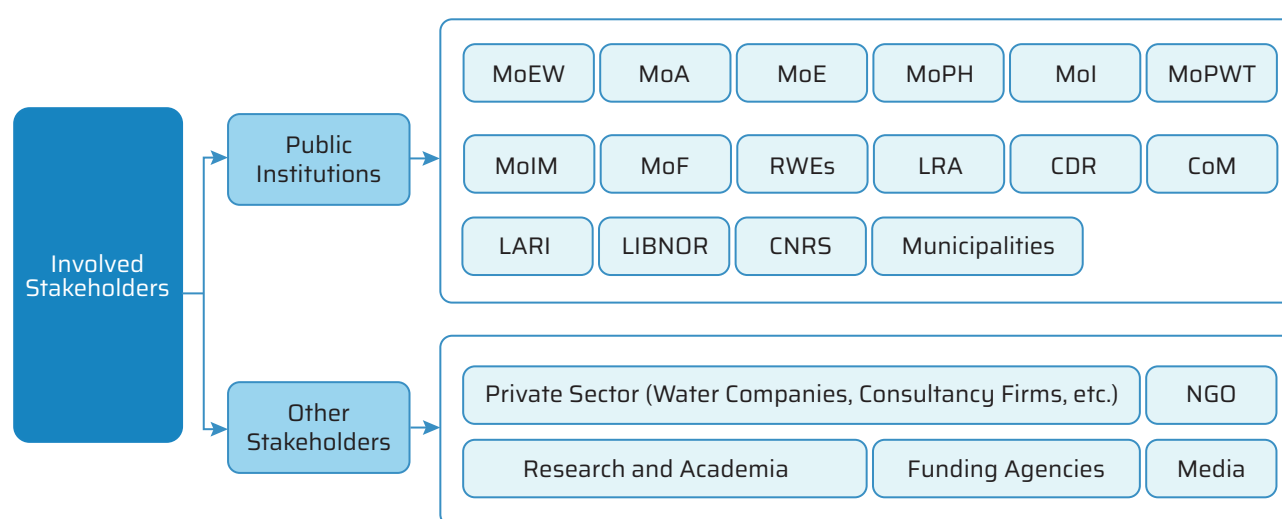
specific land suitable for cultivating such crops. These strategic steps would facilitate effective resource and infrastructure planning by the MoEW and RWEs to adequately address food security needs.

Furthermore, the **utilisation of treated wastewater for irrigation** is considered by both the NWSS and the National Agriculture Strategy (NAS 2020-2025) to be a strategic action to enhance **water, food and energy security**. The Lebanese Standards Institution (LIBNOR), along with other stakeholders, is currently formulating standards and guidelines for the safe utilisation of treated wastewater and has already issued standards on the reuse of sludge (biosolids). Building upon these standards, the MoEW intends to collaborate closely with the MoA and the Ministry of Environment (MoE) to develop tailored plans for agricultural use or aquifer recharge.

Stakeholder roles and responsibilities

The water sector in Lebanon involves various institutions, whose functions and initiatives are poorly integrated, leading to ineffective water governance (Tegoni *et al.*, 2016).

FIGURE 2-14 Stakeholders involved in the water sector.



The main factors contributing to this situation are **overlapping responsibilities** and a considerable

gap between mandated roles and implementation capacity.

For instance, Law 221 clearly defines the remits of the MoEW and the RWEs. The MoEW is responsible for policy, general planning, regulating access to public resources, water policing and monitoring the water conservation performance of public operators. The RWEs are tasked with operating and managing public drinking water, sanitation and irrigation services. However, as previously noted, the organisational decrees governing RWEs do not include the necessary departments and positions for wastewater and irrigation management, two additional responsibilities assigned to these administrations. This has resulted in implementation gaps.

Moreover, regulations governing other institutions involve similar responsibilities relevant to the water sector. For example, the Council for Development and Reconstruction (CDR) holds significant authority in terms of planning, advising, providing guidance and implementing projects related to water and wastewater. This authority stems from an earlier law (Decree-Law 5, dated 31 January 1977), which grants the CDR the power to implement any works, including those in the water sector, through public authorities, private companies or mixed companies. Similarly, the Council for the South, established by Decree 14649 dated 12 June 1970, has been granted full authority to appoint public authorities or private companies to carry out various projects, including water works, to meet the needs of the population in South Lebanon. Furthermore, according to Decree-Law 118 dated 30 June 1977, municipal councils can implement local water and wastewater projects within their respective boundaries based on local needs.

To effectively address the current situation, the responsibilities, roles and capacities of the different institutions and authorities involved in water resource management must be clarified and streamlined. This is the objective of the ongoing review of the water-related legal framework, which also aims to address the bottlenecks of Law 221/2000.

It is also important to acknowledge that the informal private sector involved in water supply (see the following sections), despite not being recognised as having decision-making capacity, has a significant influence over the health and welfare of people in Lebanon, due to its substantial role in covering the gaps in water supply by the Government from non-monitored sources.

Status of human capacity in the sector

The four **RWEs are severely understaffed**, with only half of all available positions occupied. RWE staff members are recruited through the formal channels of the Civil Service Council or Civil Service Board. However, the existing staff-to-management ratio within the organisation restricts the capacity of managers to effectively fulfil their strategic responsibilities (MoEW, 2022 (a)).

To address the staffing gaps, RWEs resort to employing **temporary staff** in the form of daily contractors. All RWEs have more temporary employees than permanent staff. Unfortunately, due to limited financial resources, RWEs face challenges in recruiting highly qualified individuals for senior positions (MoEW, 2022 (a)). Furthermore, the inadequate technical capacities at the MoEW and RWEs mean that increased CDR involvement has been required in planning and project implementation. This has resulted in a top-down planning approach and a shift towards large-scale projects, without due consideration for the capacity of RWEs to effectively take over these projects (Eid-Sabbagh *et al.*, 2021). The prevailing economic crisis and its repercussions have also prompted many skilled public sector employees, particularly those employed by RWEs, to leave their positions, exacerbating the human resource challenges faced by these institutions (Eid-Sabbagh *et al.*, 2021).

Capacity-building programmes have also encountered various challenges, such as the absence of tool ownership (e.g. software) at the RWEs and the associated difficulties regarding software usage (lack of qualified staff to manage

certain software) and staff allocation (the operation requires full-time staff to adequately use and benefit from the software, and these staff are not available in RWEs). It has also proved difficult to mobilise staff to actively participate in training sessions, and staff lacking the necessary training pre-qualifications have been involved. Another limiting factor is the scarcity of competent professionals with the required knowledge in the respective field. Instead, the Director General is often directly involved, rather than a specialist engineer or technician (MoEW, 2022 (a)).

Multinational corporations and local monopolies have derived substantial advantages from the malfunctioning public services, stepping in to fill the gaps. **Private water suppliers** provide households with water using cisterns for domestic use. This parallel market is not regulated and poses significant risks to public health and resource sustainability. Water accessibility is therefore contingent upon household finances, thus intensifying the financial burden on local people, who receive three separate water bills: government fees for water supply subscriptions, potable water (in bottles and gallons) and water for non-potable domestic use from private suppliers or cisterns.

Some of the responsibilities assigned to RWEs have been outsourced to private operators. However, there is a “lack of an efficient and effective contracting framework” as well as the required technical skills to supervise these operators (MoEW, 2022 (a)).

Inter-ministerial coordination and collaborative planning

The MoEW acknowledges the need for enhanced coordination with all water resource management stakeholders and, as part of the NWSS implementation process, intends to establish dedicated platforms to effectively address technical concerns, prioritise investments within the sector and ensure effective governance.

Benefiting from the outcomes of the WEFE Nexus Policy Dialogue in Lebanon launched by GWP-Med, the WEFE Inter-Ministerial Group has been established. This group, which is led by the MoEW and facilitated by GWP-Med, is dedicated to prioritising and addressing matters of mutual concern within the pertinent sectors.

Moreover, the new Water Code created the NWC to establish a strong institutional framework involving relevant institutions. However, recent changes have reduced the Council's responsibilities from a decision-making to a consultative role, affecting the level of collaborative governance that it was intended to have (MoE/UNDP/UNHCR/UNICEF, 2021).

Lack of efficient monitoring and evaluation

The monitoring of water resources in Lebanon is suboptimal, leading to significant reliance on estimated **hydrological and hydrogeological parameters**, among others, in the planning process within the sector.

As previously outlined, the MoEW and RWEs have limited capacity to effectively monitor activities across the entire sector and to produce technical reviews. The NWSS also acknowledges deficiencies in the periodic monitoring of needed data and the absence of a dedicated entity or staff assigned to these duties as key challenges.

The inadequate availability of data and the lack of financial reporting also hinder the MoEW's ability to evaluate the performance of RWEs. This situation contributes to the dilution of responsibilities, fosters a lack of confidence between citizens and institutions and results in low rates of fee collection.

2.2.5.3 Trust and engagement

Transparency and stakeholder engagement

As has already been noted, the limited availability of data and lack of coordination between relevant institutions in the water sector contribute to a **lack of transparency**. Authorities overseeing the water sector have not demonstrated a strong commitment to the Access to Information Law (28/2017) (Gherbal Initiative, 2023), although the level of data-sharing varies (Sleiman, A., 2022). A failure to apply international financial reporting standards or conduct external audits further hinders transparency in financial statements.

The **lack of effective communication with users**, particularly with regards to water institutions (especially RWEs, who are the service providers), erodes trust. This lack of trust partially explains the low water bill recovery rate.

Furthermore, incomplete customer databases within the commercial sector, particularly concerning potable water services, exacerbate this issue. There is a significant discrepancy between the number of listed official customers in the databases and the actual population utilising the network. The current situation indicates that numerous households and dwellings receive their water supply from unidentified sources, including private wells, multiple connections or even incorrect entries within the database, extending to unauthorised connections.

Databases providing details about users of the wastewater management services have not been developed yet. Identifying and registering users in dedicated databases is vital, as there are instances where not all individuals receiving wastewater services, particularly households connected to sewage networks and treatment plants, subscribe to water establishments. In accordance with the Water Code, non-connected households are required to pay a wastewater fee, essentially a form of “pollution tax”, to address the environmental impact caused.

Engaging all stakeholders in the service delivery process and establishing sustainable mechanisms for collaboration and coordination to improve sector monitoring and transparency, is one of the targets for the water sector described in the NDC. As previously noted, as part of the NWSS implementation process, the MoEW is establishing dedicated platforms to address key concerns within the sector and ensure effective governance through enhanced coordination with all stakeholders involved in water resource management. Once created, the NWC will also offer an opportunity to enhance collaborative governance despite the setbacks following the recent appeal that removed some of the Council's responsibilities.

The NWSS has also recommended several initiatives and projects to enhance stakeholder involvement, including communicating with users, creating a coordination platform for projects in the water sector to prevent duplication, structuring and enhancing private sector involvement and developing a new contracting framework and performance-based contracts.

2.2.6 Thematic areas of priority for the water sector

Following the assessment of the current status and governance of the water sector, key thematic areas for prioritisation have been identified. These are outlined below.

2.2.6.1 Prioritise groundwater recharge and replenishment and mitigate pollution

An integrated cross-sectoral approach is required to prioritise groundwater recharge and replenishment and address groundwater pollution. This policy would enable the establishment of regulations on groundwater recharge, identifying suitable areas for recharge projects, developing potential measures to mitigate over-exploitation and pollution, and setting frameworks for implementation.

2.2.6.2 Enhance stakeholder awareness of cross-sectoral issues affecting groundwater

The lack of awareness and mandates regarding WEFE resources when making decisions on infrastructure projects, land-use planning and urbanisation, specifically road planning and design, has resulted in rainwater and stormwater that naturally replenishes aquifers being diverted to discharge directly into sewer networks, surface water courses and the sea.

This diversion, coupled with excessive groundwater extraction, is causing springs and rivers fed by groundwater to dry up, and increasing saltwater intrusion into aquifers as the withdrawn water is not being replaced naturally. It is crucial to raise stakeholder awareness about the importance of green infrastructure and the role of agricultural land, especially traditional terraces in mountainous areas, in replenishing and recharging aquifers, and thus the importance of their conservation.

2.2.6.3 Protect sensitive natural groundwater recharge areas to facilitate natural infiltration and prevent contamination

When designing and implementing infrastructure projects, measures should be taken to protect sensitive natural groundwater recharge areas to allow for natural infiltration and prevent groundwater contamination. Additionally, there is an urgent need to monitor and control groundwater extraction from private wells. It is also imperative to adopt scientific principles in engineering and urban planning to ensure the conservation and protection of natural resources, enhance groundwater replenishment and protect geologically sensitive areas, while monitoring and preventing hazardous practices by engineering firms, real estate developers and contractors that may pollute aquifers.

2.2.6.4 Implement waste management solutions that protect water and other natural resources from pollution

The proliferation of illegal and polluting waste management practices such as open dumping, waste burning and so on has resulted in the pollution of soil, surface water and groundwater. Proper management of solid waste is essential if the quality of water resources is to be protected. While there is a legal framework in place for waste management, the current situation in Lebanon presents challenges due to insufficient funding and the absence of reliable solutions in many areas. Controlling improper waste disposal has thus become extremely difficult.

2.2.6.5 Improve the performance and efficiency of water and wastewater services

The poor performance of water and wastewater facilities can be attributed to a combination of various factors, which have been previously discussed and acknowledged by stakeholders and included in their strategic plans. Enhancing the performance of these facilities is a priority to ensure that the population has access to safe water, prevent and reduce pollution from improper wastewater management and ultimately facilitate better governance of the water sector.

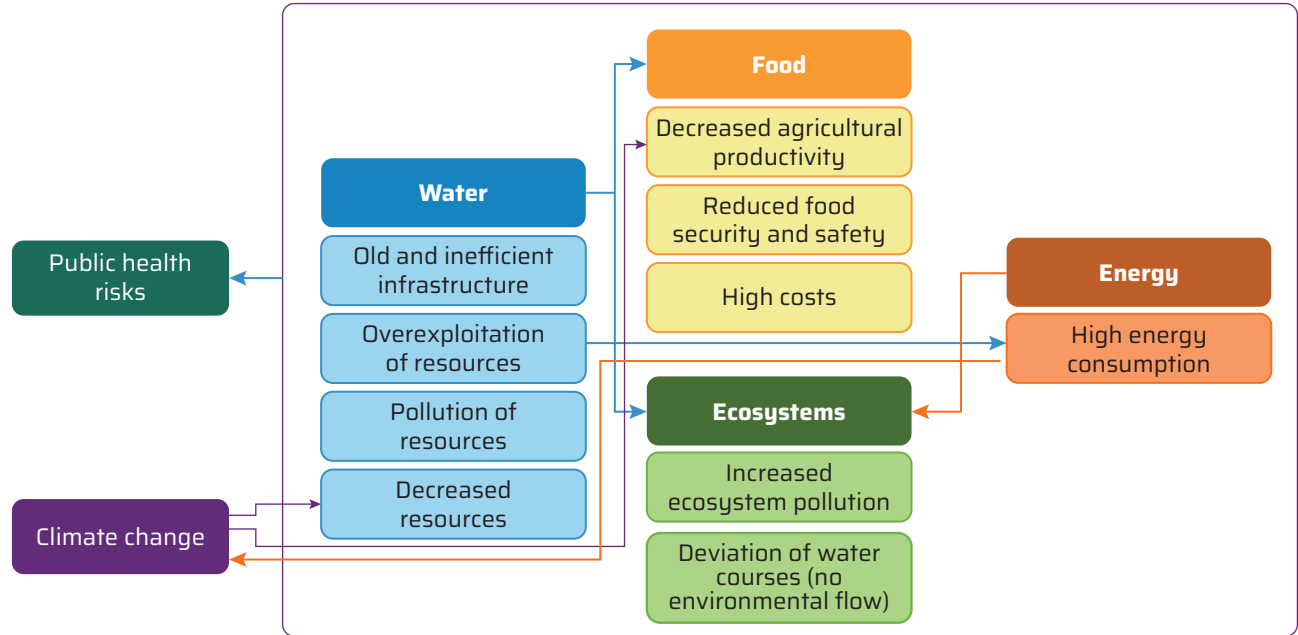
2.2.7 Water in the Nexus

Table 2-3 and Fig. 2-15 present the key findings from an assessment of interdependencies between the water sector thematic areas and resource security in the other WEFE sectors. This analysis has identified **IWRM for food security and ecosystem preservation** as a **key priority** in increasing water availability to produce high-quality food, reduce energy requirements, support healthy ecosystems and safeguard public health.

TABLE 2-3 Interlinkages between water security and energy, food and ecosystems security in Lebanon

Interlinkage	Description of direct and indirect impacts
Water-Energy	▶ Inefficient water resources management and wastage increase energy needs in the sector ▶ Overdesign of water and wastewater facilities requires higher energy consumption than is actually needed, resulting in energy being wasted
Water-Food	▶ Lack of water supply for irrigation due to declining water services affects agricultural and animal production thus increasing food insecurity, production costs and farmers' vulnerability, and discourages investment and development in the sector ▶ Water quality affects agricultural production quality and threatens public health ▶ Lack of data for prioritising investment in irrigation/food security
Water-Ecosystems	▶ Overextraction of water might limit availability of resources for environmental flows ▶ Diversion of water courses and modification of flows affect ecosystems ▶ Pollution of water resources and poor management of wastewater and sludge increases ecosystem stress and vulnerability

FIGURE 2-15 WEFE interlinkages.



The key governance and technical barriers already described in the previous sections, which affect the efficient management of trade-offs and

synergies between water and the other sectors, are summarised in Table 2-4.

TABLE 2-4 Barriers to addressing water-related intersectoral trade-offs and benefiting from synergies

Barrier type	Description
Governance	▮ Gaps in legal framework ▮ Failure to implement existing legislation ▮ Lack of needed human resources at the relevant institutions ▮ Lack of needed funds to implement reforms proposed by the Water Code and NWSS ▮ Lack of an efficient system for sharing and exchanging information and expertise ▮ Lack of efficient monitoring, data collection and information systems, resulting in poor data availability and reliability ▮ Crises and shifting of management to cover short-term emergencies rather than long-term plans ▮ Poor communication and coordination between stakeholders ▮ Lack of transparency ▮ Limited policy coherence (refer to governance section)
Technical	▮ Old infrastructure with high operating and maintenance costs ▮ High losses within the water network ▮ Low coverage of wastewater collection network and treatment ▮ Lack of meters and monitoring of groundwater consumption ▮ Lack of control over groundwater pumping due to widespread wells (legal and illegal) ▮ Lack of irrigation projects and schemes, etc. ▮ Lack of efficient treatment of effluents from industrial and medical establishments, failure to enforce laws on pollution, etc.

Based on the WEFE Nexus analysis conducted and extensive stakeholder consultation, it has been determined that actions to develop more effective and integrated management of water resources should be planned so as to:

- ▮ consider the interconnectedness between water and the other sectors
- ▮ focus on optimising and enhancing water efficiency, and reducing wastage across sectors

- ▮ ensure equitable resource allocation
- ▮ enhance the proper treatment of wastewater for possible reuse, where applicable.

To achieve proper management and planning in the water sector, a comprehensive evaluation of the water budget at the national level and at the river basin/watershed level is necessary. This must be based on the monitoring of real data rather than assumptions and estimations. Additionally, the quality of water resources and the anticipated

impacts of climate change should be considered, in line with Pillar 2 of the NWSS, which is dedicated to the practical application of IWRM.

Once the assessment is completed, water resources management planning can be developed at the watershed level, with the involvement of various stakeholders and consideration of their specific needs. This process should also identify sources of pollution and pollution remediation measures, and prioritise groundwater recharge. Implementing these plans would increase water resource availability, enhance overall water quality and ensure long-term sustainability.

Improved management of the water sector based on IWRM principles at the watershed level has been one of the main objectives of the Water Code (Law 77/2018 and the amendments in Law 192/2020), for which implementing decrees

are currently being developed. The Water Code addresses the management of trade-offs and synergies through the NWC, the adoption of IWRM plans at the watershed level, the enforcement of regulations on water rights, the elimination of outdated regulations and the remediation of pollution through coordinated action between the MoEW and the MoE. On the other hand, the committee described in the NAS 2020-2025 also has the potential to facilitate coordinated actions, in addition to other initiatives aimed at enhancing the sustainability of the agricultural sector.

Furthermore, enhancing governance in the water sector and the performance of facilities, monitoring water quality and water safety planning, and addressing the challenges posed by climate change are crucial aspects of the NWSS and Lebanon’s updated NDC for 2020.

BOX 2-1 How water security contributes to the UN SDGs

The enhanced management of water resources at the national level results in the provision of a sufficient and safe water supply for domestic use and agriculture, and helps to maintain the balance of ecosystems. This contributes to the SDGs by promoting food security and improving public health and well-being through access to clean water and appropriate sanitation. It also helps to reduce inequalities, mitigate and adapt to climate change, and support the preservation of healthy ecosystems.



2.3 Energy sector overview

The energy sector has been identified as a significant burden for the Lebanese economy, and reform of this sector has been acknowledged as a critical priority for the International Monetary Fund (IMF) and potential donors who may support Lebanon in addressing its current crises.

2.3.1 Electricity and heat generation

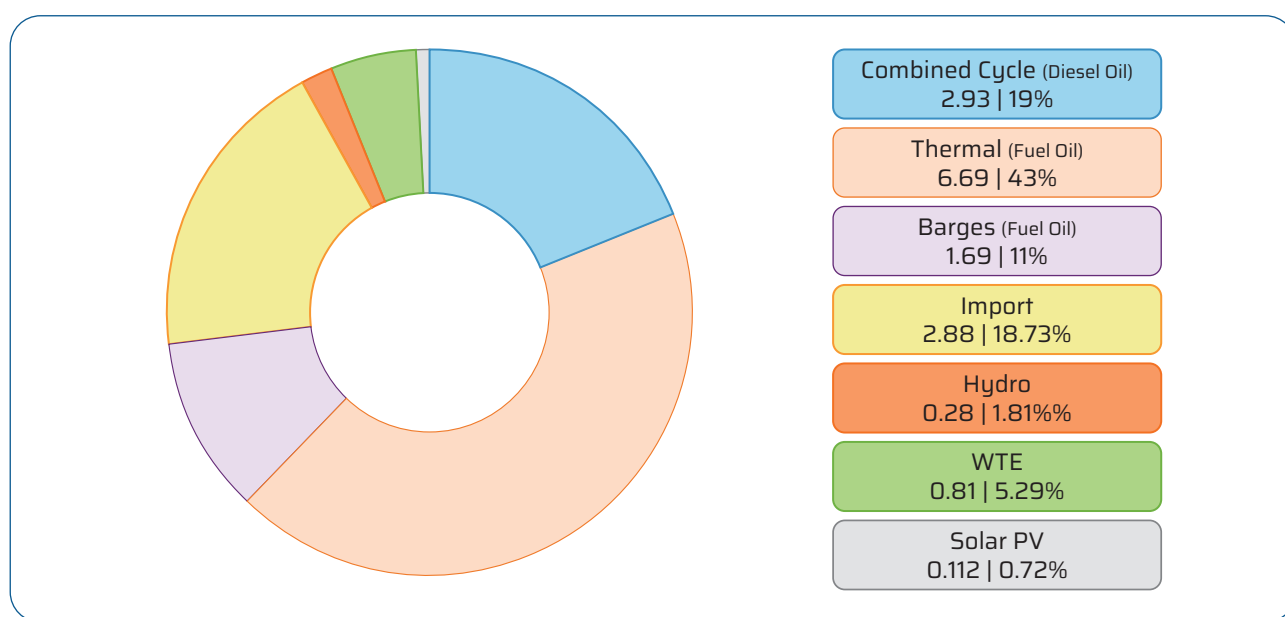
Lebanon has been plagued by a “chronic electricity crisis since the end of the Lebanese Civil War (1975–1990)”, and a significant gap between supply and demand. The country relies almost entirely on imported fuel to generate electricity,

and this accounts for **3.5%** of its gross domestic product (GDP) (MoE/UNDP/UNHCR/UNICEF, 2021).

Most of the electricity produced in Lebanon comes from thermal power plants, with a much smaller proportion generated by hydropower stations

(see Fig. 2-16). Three of the country's seven thermal power plants run on heavy fuel oil and four on gas diesel oil (MoE/UNDP/GEF, 2017). To supplement its power supply, Lebanon purchases electricity from neighbouring countries (MoEW, 2022 (b)) (Jaoude *et al.*, 2020).

FIGURE 2-16 Electricity generation in Lebanon in 2019⁴ (LCEC, 2021).



Privately owned diesel-powered generators have addressed **80%** of EDL's supply deficit, resulting in a significant rise of **2,500%** in overall fuel consumption between 1994 and 2015. Although a few generators are situated in industrial facilities or commercial institutions, the majority are distributed throughout residential areas, providing electricity to residential buildings and small retailers (MoE/UNDP/GEF, 2017).

The recent crises have amplified the situation, leading to increased supply deficiencies caused by fuel shortages and resulting in "extended rolling blackouts and power outages" (MoEW, 2022 (b)), including recurrent national blackouts.

The suboptimal performance of electricity generation and transmission can primarily be attributed to the poor condition of existing infrastructure, decline in facilities, lack of proper maintenance and the need for improvements to the transmission network (MoE/UNDP/UNHCR/UNICEF, 2021).

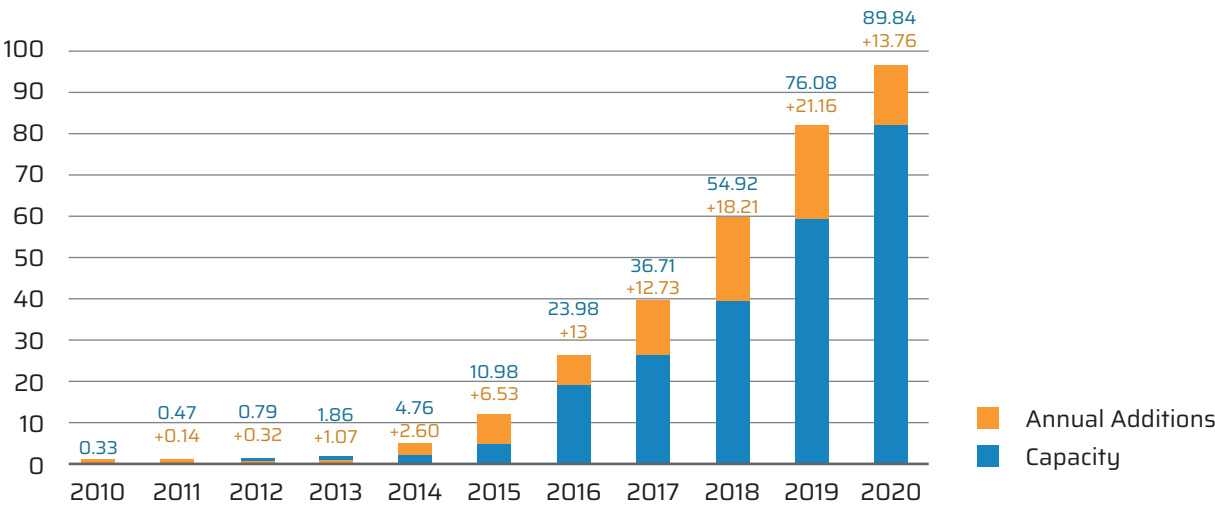
Lebanon has abundant renewable energy resources, which have significant potential for the development of the sector. The country has made a firm commitment to scaling up the use of renewables for both electricity generation and heating purposes with a recently established target of generating **30%** of total electricity consumption through renewables by 2030.

4 WTE: Waste-to-energy

In 2020, the total installed renewable energy power capacity from sources such as hydropower, landfill and solar reached a total of **350 MW** (IRENA, 2020) (see Fig. 2-17). There has since been a substantial rise in the demand for decentralised solar photovoltaic (PV) systems, thanks to decreasing costs, improved efficiency and extended storage lifetime (LCEC, 2022 (b)).

In May 2022, the Council of Ministers (CoM) granted **11** licenses for the production of electricity from solar energy, amounting to a total production capacity of **165 MW**. These projects are expected to start within three years (LCEC, 2022 (a)).

FIGURE 2-17 Increase in installed solar PV capacity in Lebanon between 2010 and 2020 (LCEC, 2022 (c)).



Regarding wind energy, the Lebanese Government has entered into power purchase agreements with private developers for the installation of three wind farms in the Akkar district. These wind farms, which have obtained the necessary licenses, are expected to have a combined capacity of **226 MW**. It is important to note, however, that these projects, whose bids were launched in 2013, have not been implemented yet (MoE/UNDP/ UNHCR/UNICEF, 2021). In 2018, a wind farm bid was launched, with a capacity ranging between **200 and 400 MW**. The contracting modalities were halted as a result of the 2019 crises, however (MoE/UNDP/GEF, 2022).

Bioenergy in Lebanon is currently underexploited, despite established action plans being outlined in the National Bioenergy Strategy for Lebanon in 2012 by the MoEW with the United Nations Development Programme (UNDP), as part of the Country Energy Efficiency and Renewable

Energy Demonstration Project for the Recovery of Lebanon (CEDRO) project. These action plans were reinstated in the National Renewable Energy Action Plan (NREAP) for 2016-2020, as the MoEW acknowledged that the future of bioenergy is promising (Jaoude *et al.*, 2020).

The main driving forces behind the utilisation of bioenergy from forest products in Lebanon include preventing and protecting against wildfires, conserving and enhancing forest health, and promoting rural development by improving livelihoods for rural communities (UNDP/CEDRO, 2016).

However, various barriers hinder the development of this energy source. These include high production costs, the establishment of a market, the creation of synergies between the agricultural and energy sectors, and the management of competition in terms of resource allocation,

markets and compliance with laws and regulations (UNDP/CEDRO, 2016).

Multiple types of biofuel can be derived from forests, including solid or milled wood (wood in any size or shape that is directly combusted), densified wood (compressed wood particles to increase fuel density) and charcoal (obtained through pyrolysis of wood) (UNDP/CEDRO, 2016).

There is potential to generate bioenergy by processing organic material derived from various sources. These include: (i) domestic activities, like municipal solid waste; (ii) agricultural activities such as weeding, pruning and felling, as well as waste from forestry and animal husbandry (manure); (iii) waste from agro-processing and slaughterhouses; and (iv) wastewater sludge.

Proper management of solid waste streams, particularly by valorising high-calorific value components, can lead to the creation of a refuse derived fuel that has the potential to complement and even replace fossil fuels.

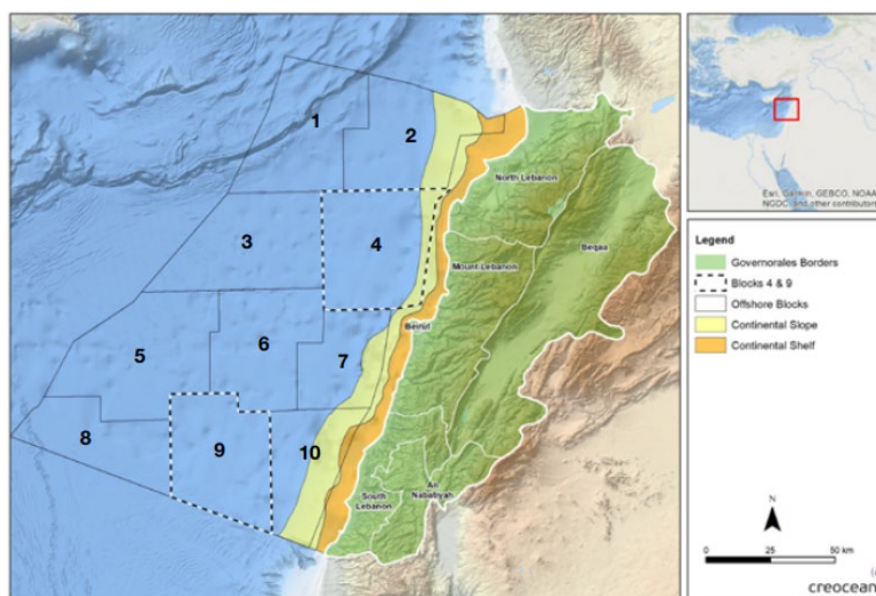
2.3.2 Oil and gas

The exploration of oil and gas resources offers an opportunity to enhance Lebanon's energy

security, provided commercially viable quantities are discovered and exploration efforts are successful (Jaoude *et al.*, 2020). Ten offshore drilling and exploration blocks have been defined (see Fig. 2-18). The first offshore exploration drill at block number 4 was concluded in May 2020, revealing traces of gas; however, no reports indicating commercially viable quantities for extraction have been published (Jaoude *et al.*, 2020). A subsequent licensing round for offshore activities was issued in December 2021, with the closing date for application submissions set for 30 June 2023 (LPA, 2022).

In October 2022, an agreement was reached on resolving the matter related to block 9, which was previously under dispute. The agreement includes various conditions concerning exploration, resource extraction and other relevant aspects. As a result, the Total/ENI consortium would begin mobilising in 2023 to prepare for the drilling of an exploration well. The necessary studies and assessments, including environmental impact assessments (EIAs), would be conducted and developed accordingly (personal communication from an LPA Representative, December 2022).

FIGURE 2-18 The 10 offshore drilling and exploration blocks (TotalEnergies and CRÉOcéan, 2021).



2.3.3 Transportation sector

The transportation sector is the main consumer of imported gasoline in Lebanon (MoE/UNDP/ UNHCR/UNICEF, 2021). Due to the lack of reliable public transportation options in the country, road transport relies heavily on privately owned passenger vehicles (MoE, 2017). However, the current economic and fiscal crises have had a negative impact on the transport sector: increased fuel prices, decreased purchasing power and the removal of car purchase credit facilities have all contributed to this downturn. The Renewable Energy Outlook for Lebanon adopted by the MoEW (IRENA, 2020), highlights the need to promote electric vehicles and indicates that there is potential to shift **3%** of passenger kilometres to electric vehicles.

2.3.4 Challenges and threats affecting the energy sector in Lebanon

The energy sector in Lebanon faces numerous challenges and constraints that have significantly impacted its overall performance and potential for development. The recent financial and economic crises have led to an increase in diesel prices, resulting in a decline in the number of subscriptions for neighbourhood generators. Consequently, approximately **70%** of the Lebanese population is currently facing energy poverty, making energy security a major concern. The challenges surrounding governance of the energy sector are presented in more detail in section 2.3.5.

2.3.4.1 Significant financial deficit in electricity production

The electricity sector is experiencing a substantial financial deficit, which has hindered its development and contributed to the country's national debt. This is mainly due to the need to purchase fuel and provide subsidies for tariff and electricity consumption in public sector establishments (MoEW, 2019).

2.3.4.2 High greenhouse gas (GHG) and pollutant emissions

The energy sector makes a substantial contribution to the country's GHG and air pollutant emissions. The use of various fuels at EDL facilities, coupled with the condition of the equipment, results in high emission levels. Additionally, private generators are commonly located in neighbourhoods, close to residential buildings, contributing substantially to toxic air emissions. Emissions from these generators surpassed those from EDL facilities in 2010 (MoE/ UNDP/UNHCR/UNICEF, 2021).

In 2018 the transport sector was responsible for **27%** of GHG emissions, with more than half of these emissions (**57.18%**) being from passenger cars (MoE/UNDP/GEF, 2021).

2.3.4.3 Increased stress on infrastructure

The Syrian crisis and the subsequent influx of displaced persons into Lebanon have greatly impacted energy demand in the country, reflected in a significant rise in oil demand since 2011. The smuggling of heavily subsidised oil to neighbouring countries has possibly exacerbated this situation. The sudden surge in energy demand has resulted in more frequent power outages and a deterioration in the quality of power supplied by EDL.

2.3.4.4 Low share of renewables in the energy mix

The SOER 2020 provides a comprehensive analysis of the main challenges and constraints that restrict the growth of renewables as a share of the energy mix. These can be summarised as follows (MoE/UNDP/UNHCR/UNICEF, 2021):

- Lack of needed funds for EDL to invest in large-scale renewable projects. In fact, electricity tariffs have been low for a long time and do not accurately reflect costs, due to the extended amortisation period. EDL cannot raise tariffs until the infrastructure and grid become

more reliable. However, EDL faces financial constraints that prevent it from making the necessary improvements to the system. It is worth noting that electricity tariffs have been raised since February 2023.

- ▶ The availability of electricity from renewable sources relies on weather conditions, making the supply from these sources unpredictable.
- ▶ Renewable energy projects incur significant operating and maintenance costs, primarily related to the labour required, and these may not always be feasible for operators.
- ▶ EDL lacks a specialised department dedicated to integrating renewable energy into the national grid, and there are no internationally recognised grid codes that could be readily adopted.
- ▶ The Lebanese electricity network does not comply with international standards, preventing effective connection of renewable projects to the grid (UN/ESCWA, 2018).
- ▶ The influence exerted by private companies benefiting from the profits generated by oil imports, coupled with the significant power

of private generator owners, has resulted in considerable sway over lawmakers, within an already complex political landscape.

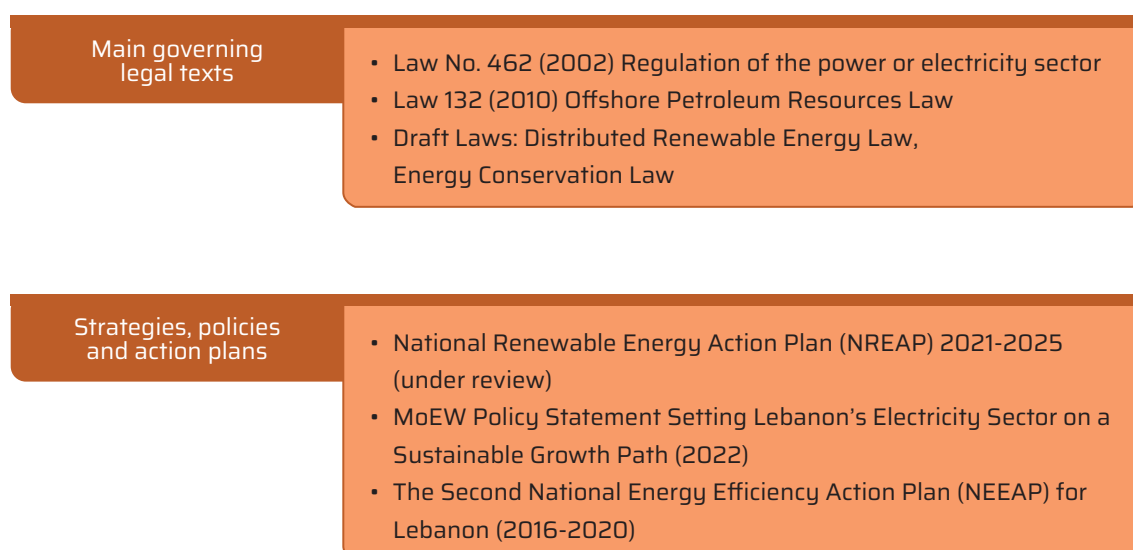
- ▶ Limited interest from local banks in funding small-scale distributed renewable energy projects (MoE/UNDP/GEF, 2022).
- ▶ Land acquisition/expropriation limitations and complex administrative processes for renewable energy expansion.
- ▶ Specifically for hydropower: inadequate governing framework for related concessions.

2.3.5 Energy sector governance analysis

The energy sector in Lebanon is regulated by a large body of legislation that organises the various aspects of governance, including the stakeholders involved in the sector and their roles. The sector is managed according to national strategies, which are periodically developed and updated to respond to needs and challenges.

The regulatory framework for the sector is presented schematically in Fig. 2-19 below.

FIGURE 2-19 Legal documents and strategies governing the energy sector.



The following sections present the results of the energy sector governance analysis.

2.3.5.1 Efficiency

The regulatory framework

Law 462/2002 is the main piece of legislation governing the energy sector. It has **yet to be fully implemented** and calls for restructuring the sector, creating a more competitive market for electricity with independent power producers, liberalising the generation and distribution of energy under private sector management and ensuring independent oversight by the Electricity Regulatory Authority (ERA) under the policy guidance of the MoEW. **The ERA has yet to be created.**

At the same time, regulations set out in older decrees (16878/1964 and 4517/1972) that grant EDL exclusive authority for generation, transmission and distribution are still in effect (MoE/UNDP/GEF, 2015).

A comprehensive review of Law 462/2002 to fill gaps in legislation governing the sector has been planned (in accordance with Law 181/2011). It was identified as a priority by the MoEW but was not completed. Decree 9626/2022 was recently approved to ensure, in the absence of the ERA, the country's energy security through licensing the private sector (with licences issued by the CoM instead of the ERA) where the proposed prices are much lower than conventional power plants, while adhering to the country's renewable energy commitments.

Concerning the **oil and gas sector**, Law 132, introduced in 2010, takes the first steps towards offshore fuel and natural gas exploration in Lebanese territories of the Mediterranean. Draft legislation on the exploration of onshore hydrocarbon resources is being discussed by parliamentary commissions, while a draft hydrocarbon policy is currently being developed by the Lebanese Petroleum Administration (LPA)

and will ultimately be subject to the approval of the CoM (Jaoude *et al.*, 2020).

As for energy efficiency, the **National Energy Efficiency Action Plan (NEEAP)** for 2011–2015 partially achieved its targets, with the lowest completion rates being associated with initiatives requiring specific legal frameworks that were not available at the time. The second NEEAP (2016–2020) therefore continued to build on the initiatives proposed in the first NEEAP, with two main areas of focus: (a) power sector measures and (b) end-use measures. The former tackle energy efficiency in electricity generation, transmission and distribution. The latter include end-use measures in the building sector, industry and agriculture, mobility and transport, and the public sector, as well as horizontal end-use measures.

The distributed solar PV capacity target for 2020 in the **National Renewable Energy Action Plan for the Republic of Lebanon** (NREAP 2016–2020) was met at **90%** (LCEC, 2022). Private sector initiatives have led to the increased use of renewables, driven by the fuel crisis and more power shortages. However, large-scale renewable projects have been slowed or halted due to the financial crisis, as is the case for most of the MoEW's other plans and projects (Jaoude *et al.*, 2020). The NREAP 2021–2025 is currently under review, in light of the economic crisis, and is expected to be published in 2023.

Moreover, two key decrees on promoting renewable energy and energy efficiency projects were approved by the CoM and submitted to the Lebanese Parliament to be reviewed and issued in 2022. According to the MoEW and the Lebanese Center for Energy Conservation (LCEC), these laws are considered as a priority for enhancing the performance of the electricity sector. They are supported by politicians and decision-makers.

The two draft decrees are:

- The Energy Conservation Law / Decree 9196/2022: The main objective of this

legislation is to introduce **energy efficiency concepts in all sectors**. This is considered as a priority to be tackled even before the introduction of renewable energy solutions.

- ▶ Distributed Renewable Energy Law / Decree 9000/2022: This legislation represents a crucial step in developing **renewable energy projects** (capacity <10 MW) across Lebanon through mechanisms to integrate private sector projects into the EDL network. It addresses the monopoly in electricity generation, enabling the private sector to get involved in electricity generation and even sell electricity under the supervision of the ERA. The legislation includes peer-to-peer exchanges and net metering schemes, empowering both producers and consumers. It also represents a practical measure in the MoEW's efforts to combat climate change and align with the Lebanese Government's sustainable development policies that give an essential role to the development of a market for renewable energy production.

In the same year, the MoEW issued a policy statement titled "Policy Statement Setting Lebanon's Electricity Sector on a Sustainable Growth Path". The policy is based on assessments by Electricité de France (EDF) and the World Bank, and focuses on finding quick, efficient solutions to improve electricity supply in Lebanon, considering the emergency situation the country is facing. Such initiatives include signing agreements with Jordan and Syria for the supply and wheeling of electricity from Jordan, finalising terms of contract with Egypt, Jordan and Syria for the supply and transportation/swap of natural gas from Egypt, awarding the Egyptian company TGS a contract to repair the Lebanese portion of the Arab Gas Pipeline (AGP) and issuing the order to proceed with the works, reaching agreement with the Iraqi Government on the possibility of extending the term of the Iraqi fuel supply agreement while fixing imports at a minimum of **75,000 tonnes per month** and fixing the delivery dates, coordinating and continuously communicating with the World Bank and its institutions, completing the environmental and social safeguards documents

related to the AGP to fulfil one of the financing conditions for gas imports from Egypt, and taking other executive measures to put the sector on the path to recovery.

Status of data and data-sharing mechanisms

Planning in the sector mostly relies on correlations, regressions and estimations, due to **considerable gaps in reliable and updated data**, including:

- ▶ Updated data on energy generation and consumption by source. Energy generation curves can be acquired from EDL. However, these only represent the electricity generated by EDL and do not account for the electricity from private generators. There are also gaps in the country's energy balance based on energy bills and actual consumption in the Lebanese market for all types of fuel, mainly diesel. Several factors lie behind this, chiefly the smuggling that takes place across Lebanese borders. Moreover, since 2020, the installed schedules for electricity supply from private generators vary across Lebanon, which makes it harder to develop electricity supply curves.
- ▶ Updated data on decentralised PV systems installed since 2021, due to the parallel PV market that has been established to meet the high need.
- ▶ Updated data on human resource requirements at the MoEW (energy-related) and EDL to implement developed strategies and plans.
- ▶ Although studies describe the electricity infrastructure as being old with poor operational efficiency, the work required to upgrade the system and improve its performance has not been assessed.
- ▶ Updated data related to the transport sector and the impact of the crisis on various aspects of its management.

- ▮ Evaluating the energy needs of each sector to assess the potential for meeting them and for improving energy efficiency.

In 2018, the LCEC made a significant contribution to the country's energy sector by publishing the first comprehensive energy indicators report. This report covers various aspects of energy indicators; however, it was based on many assumptions, particularly regarding end-use scenarios.

Financial constraints and funding mechanisms

The power sector suffers from a **significant financial deficit**, which has hindered its development and contributed to the country's national debt. The debt has been mainly caused by low electricity tariffs, low fee collection rates (about **45%** of EDL's bills are not collected), high operational and maintenance costs for facilities, low efficiency at facilities, technical and non-technical losses and illegal connections to the network (MoE/UNDP/UNHCR/UNICEF, 2021). EDL has limited control over its budget, and this negatively affects its focus and capacity to improve operations and services, due to the lack of a systematic and transparent process to evaluate adequate tariffs and objections from the CoM, MoEW and MoF to modifying tariffs (World Bank Group, 2020). In November 2022, changes to EDL electricity prices were announced, raising the price for the first time since 1990. Bills based on the new prices began to be collected in February 2023.

Donors and funding agencies have helped to fund the sector through specific programmes, including renewable energy projects. In 2020, the total installed renewable energy power capacity amounted to **350 MW**, including **286 MW** from hydropower sources, **7 MW** from landfill gas and **56.37 MW** from solar power (IRENA, 2020). According to the Renewable Energy Outlook report published by the International Renewable Energy Agency (IRENA) in the same year, the increased deployment of renewable energy could result in average savings amounting to **USD 249 million per year**, even without taking into consideration

a reduction in costs from air pollution and CO₂ emissions (IRENA, 2020).

The sector is now in need of intervention from IFIs, which will, however, only step in once it is restructured.

2.3.5.2 Effectiveness

Policy coherence status

The development and proposal of laws relevant to the sector have changed over the decades, reflecting the **prevailing political climate**. Lebanese legislation did **not place much emphasis on energy conservation** issues until relatively recently, despite the drastic need for reform and improvement in the energy sector. Political interventionism has been "crippling decision-making and progress in the sector" (MoEW, 2022 (b)).

For example, the MoEW and the LCEC had been actively collaborating on an energy conservation law since 2011, as highlighted in the initial NEEAP 2011–2015. Numerous legislative proposals were forwarded to the CoM during that period, but only one of them was discussed by the Parliamentary Committee of Public Works, Transportation and Energy. Due to political reasons, the proposal was ultimately not approved at the time. The driver behind the NEEAP was to fulfil Lebanon's renewable energy commitment and reduce energy consumption in line with international environmental agreements and related targets.

Two policy papers issued by the MoEW and the Lebanese Government in 2010 and 2019 also proposed reforms for upgrading the electricity sector, including a focus on renewable energy targets and energy efficiency, with the launch of tenders for solar and wind energy projects. However, political and security crises affecting the development of several sectors delayed efforts to plug the legislative gap in the energy sector and produced weak enforcement.

A major **shift in political priorities** followed the further deterioration in the sector due to the economic crisis and the limited availability of primary energy resources and fuel in the country, also exacerbated by fluctuations in global energy prices. This led decision-makers to approve the specific laws required to guarantee **energy security and align with the sector's reform agenda**.

The Energy Conservation Law / Decree 9196/2022 and the Distributed Renewable Energy Law / Decree 9000/2022 were finally approved by the CoM in 2022 and submitted to the Lebanese Parliament to be reviewed and issued. Approval of these laws would enable Lebanon to adhere to the **energy, renewable energy and climate change mitigation** targets described in the updated NDC for 2020 (MoE, 2020), namely for Lebanon to:

- ▶ unconditionally generate **18%** of its power demand (i.e. electricity demand) and **11%** of its heat demand (in the building sector) from renewable energy sources in 2030.
- ▶ conditionally generate **30%** of its power demand (i.e. electricity demand) and **16.5%** of its heat demand (in the building sector) from renewable energy sources in 2030.

The document also proposes the use of renewable sources for water and food security, as highlighted in the relevant sections of this Assessment.

International donors recognise the establishment of the ERA as an initial step towards reforming the electricity sector, which has emerged as a top priority in the discussions initiated by the Lebanese Government with the IMF to seek support and guidance in devising a recovery plan for the country. However, while the appointment and significance of the ERA have been incorporated into Law 462/2002, which is the main law governing the electricity sector, the **ERA has not been established yet**.

As previously noted, an amendment to Law 462/2002, Law 288, was approved and published

in 2014 for a limited period of time to grant the CoM authority to issue licenses and permissions for private sector electricity generation, in the absence of the ERA, and has undergone multiple updates. Recently, the CoM approved this law through Decree 9626/2022. The motivation behind the requested amendment was to ensure the country's energy security by allowing licensing for the private sector, where the proposed prices are significantly lower than those of conventional power plants, all while adhering to the country's renewable energy commitments.

As for **hydro energy**, the legal and administrative frameworks for hydropower in Lebanon are not well established. A World Bank study developed for the hydropower sector formulates several recommendations and measures to be undertaken, requiring the promulgation of the necessary legal and regulatory amendments and the promotion of an integrated action plan, including the expected outcomes over different timeframes (World Bank, 2017).

Law 462 also confirmed the distribution concessions previously awarded by the State to private companies to produce and distribute hydroelectric power in a specific area for a set period of time and stated that they would remain valid and operate under their own rules. Following the establishment of EDL and given its monopoly in production, transmission and distribution services, all of the concessions' functions were undertaken by EDL (except for those related to the LRA). Currently, there are only eight fully functional concessions of different types and conditions, according to the contract signed between EDL and each entity. Agreements between EDL and these eight remaining concessions are still considered to be in force, despite EDL's contestation. The types of concession agreements include, but are not limited to, distribution concessions that prohibit entities from producing their own electricity and require them to buy exclusively from EDL, or production concessions that must sell exclusively to EDL. To help the concessions financially, the Government has set subsidised prices for electricity sold by EDL

to the concessions, taking into account distribution costs. An example of a concession agreement is the one issued through Law 107, dated 30 November 2018, allowing Electricité de Zahle to generate and sell electricity for a set period.

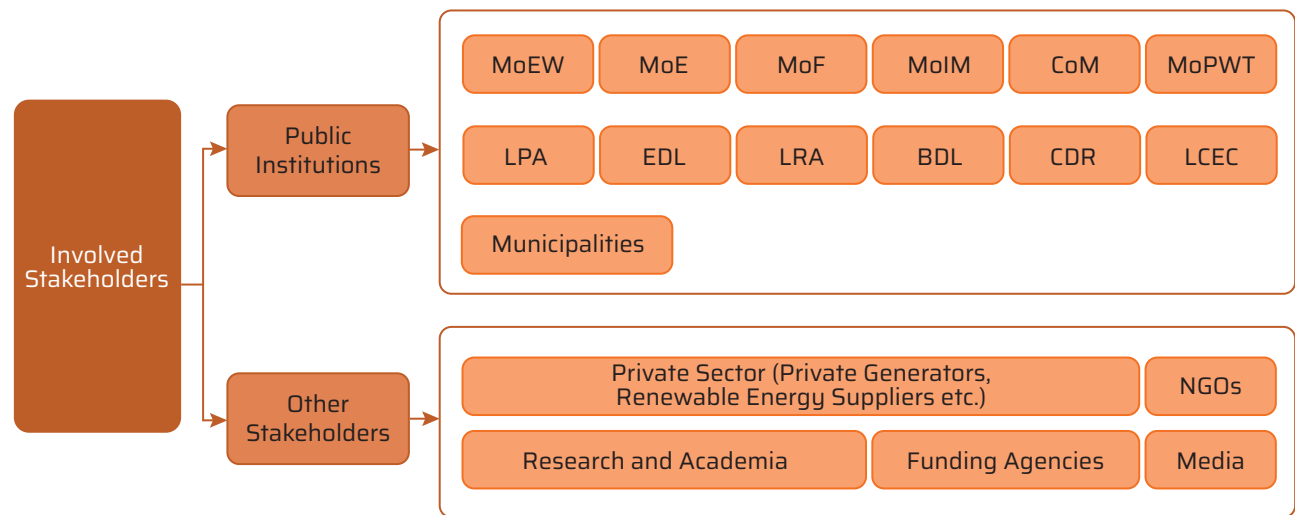
Action plans for the production of **bioenergy** were set out in the National Bioenergy Strategy for Lebanon published in 2012 by the MoEW with support from the UNDP. These were reinstated in the NREAP 2016–2020, as the MoEW recognised that the future of bioenergy is promising (Jaoude *et al.*, 2020). However, several barriers constrain the development of this energy source: the cost

of production, market formation, the creation of synergies between the agricultural and energy sectors, and management of competition over resource use, markets, and laws and regulations (UNDP/CEDRO, 2016).

The offshore **oil and gas sector** has been regulated since 2010, while draft legislation covering onshore hydrocarbon resources exploration is being discussed by parliamentary committees. Moreover, as previously noted, a draft hydrocarbon policy is currently being developed by the LPA and will ultimately be subject to the approval of the CoM (Jaoude *et al.*, 2020).

Stakeholder roles and responsibilities

FIGURE 2-20 Stakeholders involved in the energy sector.



The role and mandate of institutions and administrations relevant to the energy sector are overall well defined by the legislation governing the sector. The MoEW leads decision-making in the sector and, under its supervision, EDL is the public authority in charge of generating, transmitting and distributing power. The Ministry of Finance (MoF) also exercises control over EDL by assessing the investment viability of all projects that may have financial surplus or deficit implications, and reviewing the need for a financial contribution from the State. The LRA is responsible

for operating hydraulic power plants (Nahr Ibrahim, Al Bared and along the Awali River).

Gaps in the responsibilities and authorities of hydropower sector stakeholders were highlighted by the World Bank in a study carried out 2017 (World Bank, 2017).

It is also important to acknowledge that the owners of private generators, despite not being recognised as decision-makers, hold significant influence over the welfare of the Lebanese population. The majority of these owners do not

comply with the tariffs enforced by the MoEW and, furthermore, have implemented restrictive supply schedules. These actions have had detrimental consequences for end users, in terms of both economic stability and energy security. The prevailing diesel prices have exacerbated the issue, leading to a situation where over **70%** of the Lebanese population can be classified as experiencing energy poverty.

The oil and gas sector is mainly supervised by the LPA, which was created in 2012 by Decree 7968. The LPA is an autonomous institution with a mandate to plan and regulate petroleum activities under the supervisory authority of the MoEW. Other stakeholders involved in the sector include the Ministry of Public Works and Transport (MoPWT), the MoE and municipalities.

Status of human capacity in the sector

While there is no available information on the status of human capacity at the LPA or in the MoEW's energy departments, it is known that EDL lacks essential human resources, hampering the effective operation of its facilities. Furthermore, the organisation faces financial constraints, preventing it from recruiting additional competent staff, such as engineers and technicians. To mitigate this gap, EDL engages daily and contractual workers, many of whom are politically appointed and frequently lack the necessary qualifications for their appointed roles (MoE/ UNDP/UNHCR/UNICEF, 2021).

EDL's inability to recruit new employees who are suitable for their roles is a key challenge affecting the overall governance of the sector, as it directly impacts the organisation's ability to maintain its operations efficiently.

Inter-ministerial coordination and collaborative planning

Inter-ministerial coordination on energy-related issues is usually carried out at government level, and is led by the MoEW working closely with other ministries. When strategies tackle a crucial sector,

such as the energy sector, and when investment is needed, strategies or action plans are presented to the CoM for approval, with each ministry commenting and suggesting amendments.

Moreover, stakeholder meetings have defined the goals for the development of the NEEAP 2016–2020 and NREAP 2016–2020, since they cover multiple sectors. These have been shared with public and private stakeholders for comment before publication. As previously noted, energy targets have also been considered in the NDC, through meetings between the NDC Committee, the MoEW and the LCEC.

Lack of efficient monitoring and evaluation

The lack of sufficient data accessible to the respective institutions and administrations, along with their limited capacities, hinders effective planning and the development of adequate policies and strategies, including for monitoring and evaluation. In fact, poor data availability is a huge obstacle to assessing sector performance, providing relevant support to stakeholders and users, and understanding the potential for improving their energy efficiency. In addition, there is no centralised platform for data acquisition, and most of the available information is gathered through decentralised efforts by ministries.

2.3.5.3 Trust and engagement

Transparency and stakeholder engagement

There is **limited transparency within the energy sector** due to a lack of shared data and the failure to establish the ERA. The management structure of EDL poses accountability challenges, particularly as reporting at EDL facilities primarily focuses on operations (technical reporting) rather than financial, human resources and accounting issues, making it difficult to analyse performance and improve operations (World Bank Group, 2020).

The absence of a sufficient information system at EDL, combined with a lack of process automation, political factors and capacity gaps, has resulted in

an inefficient, bureaucratic management system. This complexity further hinders the evaluation of performance and accountability (MoEW, 2022 (b)).

Stakeholders responsible for overseeing the energy sector have achieved low scores for compliance with the Access to Information Law (Law 28/2017) (Gherbal Initiative, 2023).

Compared to the electricity sector, the **oil and gas sector** demonstrates a **remarkable level of transparency**. This can be largely attributed to the Lebanese Petroleum Association's compliance with Law 84/2018, which aims to enhance transparency in the petroleum sector. This legislation not only enforces a strong commitment to transparency and accountability within the oil and gas sector, but also mandates the disclosure of secondary contracts and information on subcontracted companies. Additionally, it clearly outlines the rights of individuals to pursue legal action in the event of any violation of this law.

Concerning stakeholder engagement, the primary legislation governing this sector (Law 462/2002 and the Energy Conservation Law) establishes the responsibilities and obligations of all relevant parties. However, the ERA would greatly enhance stakeholder collaboration and coordination. It is worth noting that one limitation of the current system is the failure to include private generator owners in decision-making processes, despite their significant contribution to meeting electricity demand. Furthermore, there is no formal organisational structure that promotes and evaluates the level of stakeholder engagement.

2.3.6 Thematic areas of priority for the energy sector

Following the analysis of the energy sector, including its associated governance frameworks, several areas have been identified that, if addressed, could lead to significant improvements in the sector. They are outlined below.

2.3.6.1 Enforcement of the energy sector regulatory framework

Enforcing regulations governing the energy sector, including the development of implementing decrees for the Distributed Renewable Energy Law and the Energy Conservation Law, following their approval by the Lebanese Parliament, is essential if the sector's performance is to be enhanced. The enforcement of both laws would help to scale up the use of widely available renewable resources and reduce the use of fossil fuels for electricity generation, resulting in increased energy security, reduced costs and a positive environmental impact.

2.3.6.2 Access to financing and risk mitigation schemes

The main barrier to developing large-scale renewable energy projects with the potential to greatly enhance energy security is economic and political instability. Implementing measures to mitigate risks and facilitate funding for renewable energy projects would enable large-scale renewable energy farms to be established, increasing energy supply at a lower operational cost.

2.3.6.3 Integrated approach for the transport sector in Lebanon

Addressing the challenges faced by the transport sector in Lebanon necessitates an integrated approach that encompasses the development of a national strategy to effectively oversee all transportation services – public and commercial – as a unified entity. As part of this approach, the feasibility of incorporating hybrid electric vehicles and electric vehicles into the system would be assessed, along with plans for establishing charging stations and determining tariffs. These measures aim to effectively reduce the emissions produced by the sector on a global scale.

2.3.6.4 Electricity pricing in liberal markets

Electricity sector reforms and the implementation of the Distributed Renewable Energy Law, covering the involvement of private sector entities in the renewable energy market (on a large scale and on a small scale), require expertise in pricing management to ensure the protection of consumer rights, with a particular emphasis on vulnerable consumers, such as farmers.

2.3.7 Energy in the Nexus

The energy and fuel supply shortages that have been ongoing since 2019, combined with the subsequent rise in costs, have had a detrimental effect on several essential sectors in Lebanon. This situation has highlighted the interconnectedness and reliance of various sectors

and services on energy resources, including water supply, wastewater treatment, food production, forest and ecosystem preservation, healthcare, telecommunication, and more.

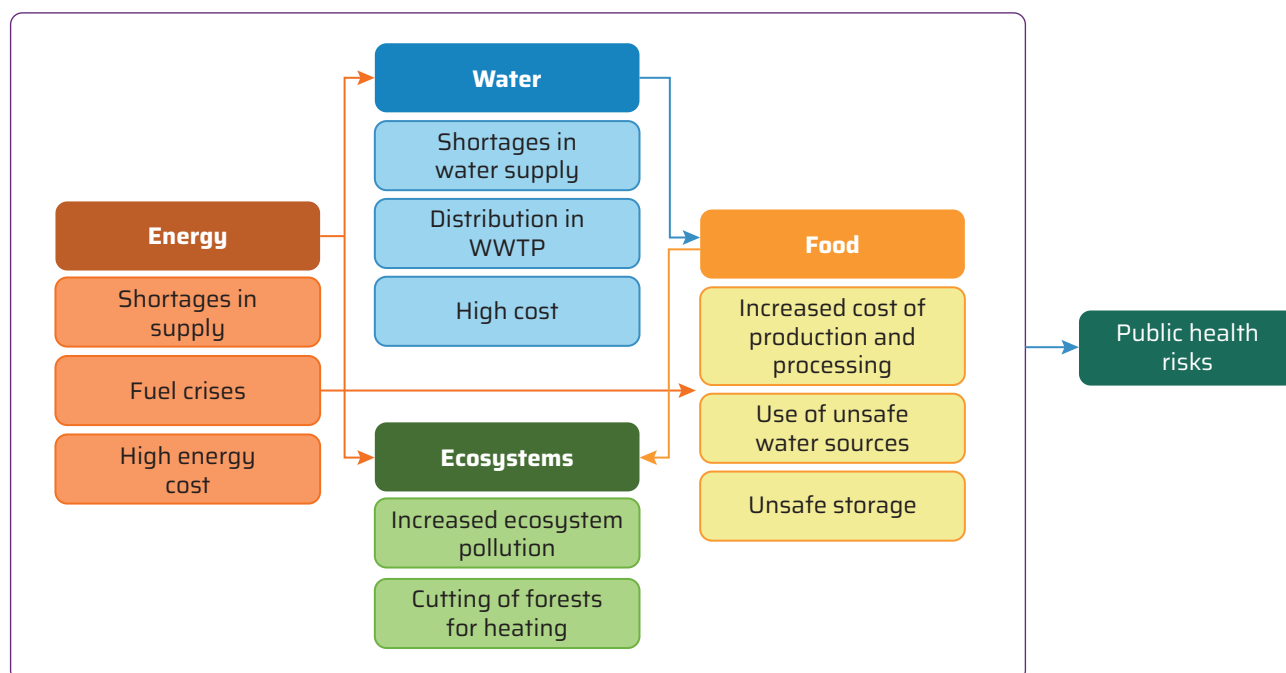
The interlinkages between energy and the other Nexus sectors (water, food and ecosystems) in Lebanon are outlined in Table 2-5, with the most significant connection being between energy and water. This connection has also led to severe impacts on agriculture and ecosystems, as illustrated in Fig. 2-21. Consequently, **ensuring an adequate energy supply to support water-related activities and food security** has been recognised as the key entry point for Nexus solutions by stakeholders. This priority is particularly crucial in the short term, as it aims to enhance the performance of different sectors, bolster water and food security, and safeguard ecosystems.

TABLE 2-5 Interlinkages between energy security and water, food and ecosystems security in Lebanon

Interlinkage	Description of direct and indirect impacts
Energy- Water/ Wastewater	▶ Operation of water supply facilities and WWTPs has been disrupted as a result of power supply shortages. ▶ The cost of operating and maintaining back-up generators for water and wastewater treatment facilities has increased due to rising fuel prices and the devaluation of the Lebanese pound. ▶ To fill gaps in water supply, private wells are being drilled and private suppliers are being relied upon, but this has led to uncontrolled water quality, placing additional stress on groundwater resources and posing risks to public health. ▶ The discharge of untreated wastewater and sludge into the environment has caused increased pollution, resulting in severe damage to natural resources such as soil, surface water and groundwater. This has impacted public health by potentially spreading waterborne diseases such as hepatitis and cholera.
Energy-Food	▶ The decrease in water supply due to the energy crisis has resulted in a decline in agricultural production and an increase in the cost of obtaining water or using diesel generators for water pumping and transfer. ▶ Water supply shortages have occasionally been addressed by utilising unsafe water sources, such as polluted water or untreated wastewater. This reliance on alternative sources has negative effects on the quality of produce and poses a threat to public health. ▶ Disruptions in WWTP operation lead to soil and water pollution, which in turn affects the productivity and quality of agricultural production.

Interlinkage	Description of direct and indirect impacts
Energy-Food (continued)	▶ The increased cost of power from private generators, along with supply shortages, has had several consequences including: ■ higher food prices ■ disruption throughout various stages of food value chains, including agro-processing activities, the operation of farm machinery and, more significantly from a public health perspective, the cold storage of certain food products, leading to the deterioration of these products and potential food poisoning.
Energy-Ecosystems	▶ Fuel shortages and rising costs are leading to the illegal cutting of trees and unsustainable forest logging for use or sale of firewood in winter, thus placing additional stress on these ecosystems. ▶ Inefficiency and disruption in WWTP operation, and open discharge of untreated wastewater and sludge that end up in rivers are causing a significant decline in the health and well-being of aquatic and riparian ecosystems, some of which are rare and endangered at the national and global level.

FIGURE 2-21 Energy-water-food-ecosystems interlinkages.



The governance and technical barriers already described in the previous sections, which affect the efficient management of trade-offs and synergies

between energy and the other sectors, are summarised in Table 2-6 below.

TABLE 2-6 Barriers to addressing energy-related intersectoral trade-offs and benefiting from synergies

Barrier type	Description
Governance	▶ Gaps in the current legal framework and insufficient enforcement of existing laws, including the establishment and sustainable operation of needed entities to facilitate coordination and enhance sectoral transparency, such as the ERA. ▶ Limited cross-sectoral policy coherence due to the delayed set-up or limited functioning of relevant bodies, such as the NWC, the Food Safety Lebanese Commission (FSLC), the multi-stakeholder committee for management of the agricultural sector proposed by the NAS 2020-2025, the National Council for the Environment (NCE), etc. ▶ The lack of human resources at national authorities, which affects the effective management and operation of facilities, an issue further exacerbated by the ongoing economic and fiscal crises. ▶ The lack of an efficient system for facilitating the sharing and exchange of information and expertise. ▶ Insufficient monitoring, data collection and information systems, leading to a lack of available and trustworthy data. ▶ Emerging crises and the redeployment of managers to prioritise addressing immediate issues instead of long-term strategies. ▶ The lack of funds to implement existing strategies and national plans. ▶ The development of sectoral strategies independently, without effective consultation with other stakeholders, except for a few documents noted in the governance section. ▶ Political interference that hinders stakeholder collaboration.
Technical	The current infrastructure is outdated, leading to significant technical losses and decreased operational efficiency, and incurring high operational and maintenance expenses.

National legislation, strategies and action plans are addressing performance in the energy sector through both short-term emergency plans and long-term management approaches.

Documents considering how to increase power supply capacity tackle national energy security but do not address sectoral energy needs, for example securing the energy needs of the water sector. Other sectoral strategies target increased reliance on renewable energy sources to reduce operational costs and GHG emissions, and enhance

sustainability (Table 2-7). Additionally, several ongoing projects and initiatives are addressing the energy-water interlinkage, prompted by the current crises and associated repercussions. One such effort is the solarisation task force set up by the MoEW to assess the potential role of renewables in supporting water and wastewater facility operations, in collaboration with relevant international organisations and other stakeholders.

TABLE 2-7 Examples of national strategies and action plans addressing interlinkages between energy and other sectors

Strategy or action plan	Elements addressing interlinkages with energy sector
NWSS final version (2020–2035)	Proposes the development of a specific strategy to control the energy costs of water supply facilities and WWTPs
NAS (2020–2025)	Under the pillar titled “Improving climate change adaptation and sustainable management of agri-food systems and natural resources”, the use of renewable energy systems is included
Lebanon’s updated NDC for 2020	Identified as a priority the “Structuring and development of sustainable water services, including irrigation, in order to improve people’s living conditions”, using renewable energy in water supply
National Bioenergy Strategy for Lebanon (2012)	Assesses and proposes potential and opportunities for sustainable use and production of bioenergy in Lebanon

The implementation of an integrated approach with energy as the entry point would yield numerous advantages for the four WEFE sectors. By enhancing the effectiveness of water supply services, the need for less sustainable alternatives would be reduced. This would also lead to improved wastewater treatment, potentially generating an alternative source of irrigation water (once adequately treated to meet quality requirements), which would, in turn, alleviate pressure on water resources and ecosystems caused by pollution, and bolster agricultural and food production. Additionally, if this interlinkage is addressed with a focus on sustainable practices, such as utilising renewable energy sources and energy-efficient equipment, it would significantly enhance the overall performance of the energy

sector, contributing to the country’s targets for reducing GHG emissions.

To address the challenges identified in this section, it is important to enhance coordination between the energy and other sectors. To achieve this, it is crucial to understand the energy requirements of each sector and identify opportunities to improve energy efficiency. This task requires the collective collaboration of all stakeholders involved. By pooling their knowledge and agreeing common goals, stakeholders can develop an approach for coherent planning and development. To facilitate this coordinated effort, it is imperative to establish a platform where stakeholders can come together, and the WEFE Inter-Ministerial Group could be a promising starting point for fostering this kind of intersectoral coordination.

BOX 2-2 Contribution of energy security to UN SDGs

Ensuring the energy requirements of the water and agriculture sectors in Lebanon would positively impact a range of SDGs through increased food production, enhanced food safety and security, improved public health by mitigating the risks associated with water pollution, access to clean water sources, facilitating reliable sanitation through the efficient operation of WWTPs, improved infrastructure and reduced inequalities, among other benefits. The environment and ecosystems would also benefit from reduced pollution sources.



2.4 Food/agriculture sector overview

As mentioned at the beginning of this chapter, Lebanon's climate and topographic characteristics allow for diversity in ecosystems and agricultural production. Lebanon defines agricultural zones according to the agricultural homogeneous zoning method. While less accurate than delineating

zones by bioclimate, homogenous zones have comparable socio-economic factors conducive to producing similar crop systems, and follow permanent and easily marked borders that do not change as agroclimatic zones do (see Fig. 2-22 and Fig. 2-23). Zones defined in this way are thus convenient for administrative purposes (World Bank Group, 2021).

FIGURE 2-22 Lebanon’s bioclimatic zones (World Bank Group, 2021).

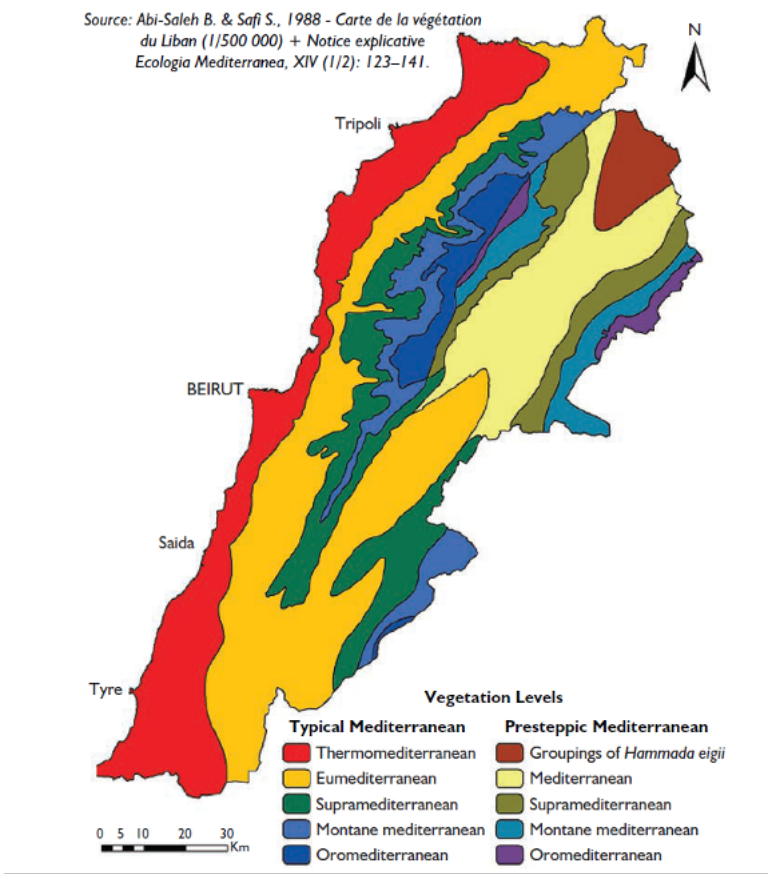
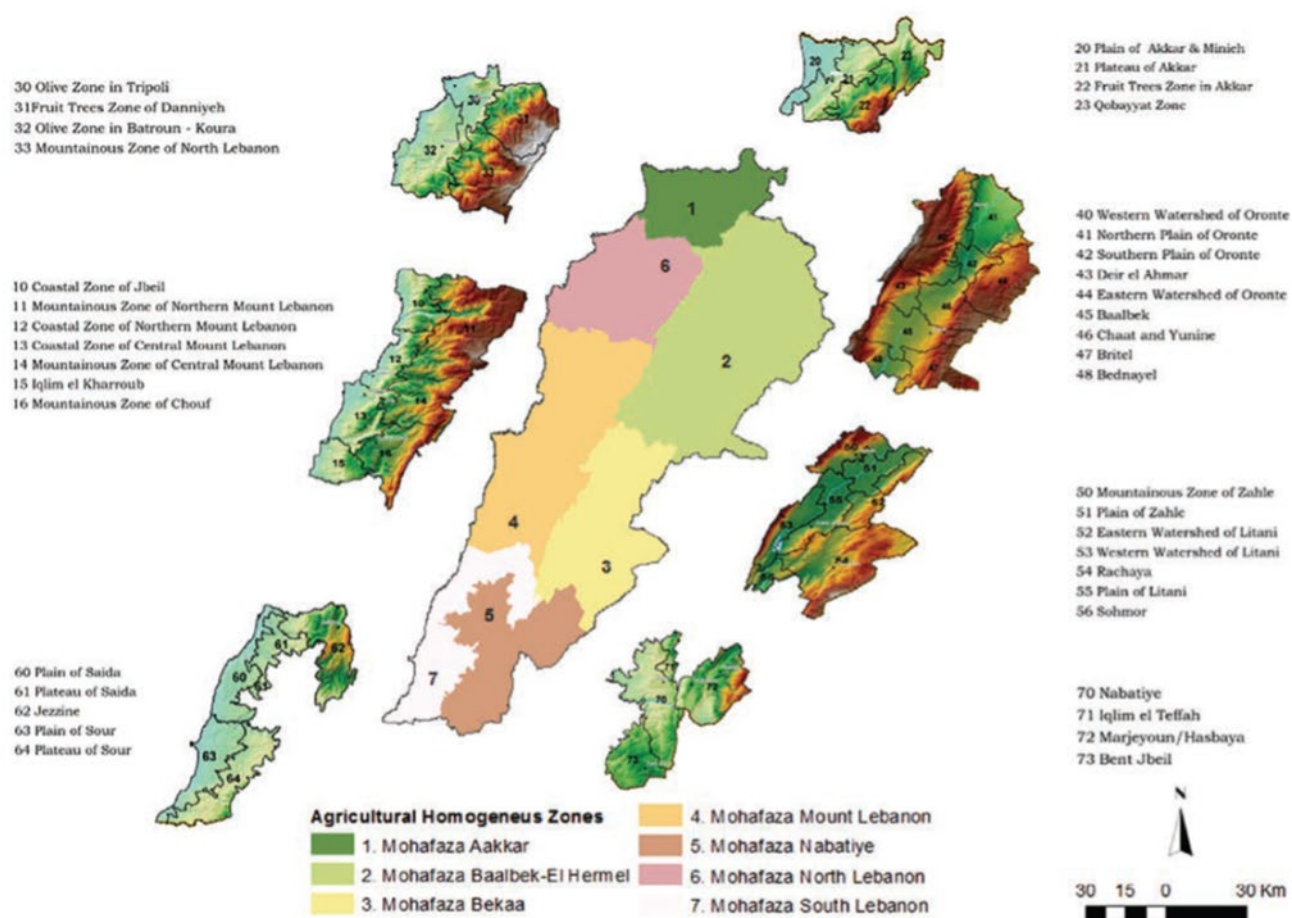


Figure 2-22 shows the areas of Lebanon that tend to have similar agricultural characteristics and climatological features, allowing administrations to

draft policies in these areas with clearly delineated limits.

FIGURE 2-23 Lebanon's agricultural homogenous zones (World Bank Group, 2021).

2.4.1 Agricultural production

In 2018, the agricultural sector in Lebanon accounted for **38%** of the country's industrial output and **2.9%** of its GDP (IDAL, 2020).

Traditionally, households have considered agriculture as a secondary or part-time activity rather than a primary means of sustenance (Asmar, 2011). This perception is reflected in the average size of agricultural holdings in Lebanon, where only **5%** are larger than **4 ha**, and **92%** of agricultural holders work individually, without engaging in large-scale operations (Asmar, 2011).

According to the Ministry of Industry (MoI), there are approximately **21,000** individuals employed in the agricultural sector. Lebanon has abundant fertile land, which accounts for **35%** of the

country's total land area (**360,000 ha**). However, only **232,200 ha** of this land are currently being used for agriculture (World Bank Group, 2021), and these are distributed across the four main regions of Lebanon as follows: Mount Lebanon **9%**, Bekaa Valley **43%**, North Lebanon **26%** and South Lebanon **22%**.

The agricultural sector in Lebanon generates a wide range of products, including crops and livestock, benefiting from the country's diverse geography and climate.

2.4.1.1 Plant production

Fruit trees account for **31%** of total plant production, followed by olives (**23%**), cereals (**20%**) and vegetables (**17%**). The remaining **9%** includes

tobacco, grapes and other plants (World Bank Group, 2021):

- ▶ **Cereals** are widely cultivated throughout the country, across a total area of **45,000 ha**. The majority of cereal crops are grown in the Bekaa Valley (**65%**), followed by Akkar (**20%**).
- ▶ **Fruit** cultivation varies by region, with apples occupying the largest planted areas (**12,425 ha**) in Mount Lebanon, North Lebanon and Baalbek-Hermel. Grapes (**10,609 ha**) are predominantly grown in Bekaa and Baalbek-Hermel, while citrus fruits (**9,994 ha**) are mainly cultivated in South Lebanon. Other fruits such as cherries, almonds, apricots, peaches, plums and pears are also grown, but in smaller quantities.
- ▶ Many products are cultivated in greenhouses, which covered a total area of **3,800 ha** in 2010, accounting for **2%** of the total cropland (Rujis, 2017). These greenhouses are typically made of plastic tunnels and are mainly concentrated in Akkar (**1,574 ha**). **Vegetables** such as tomatoes, cucumbers, eggplants, iceberg lettuce and others are primarily cultivated in these greenhouses (Rujis, 2017).
- ▶ Local **seed** production is only able to meet a negligible portion, around **3%**, of total demand (World Bank Group, 2021). As a result, the country relies heavily on seed imports from abroad.

Inputs to these value chains are largely imported. In 2017, Lebanon produced an estimated **110,000 tonnes** of phosphate nutrients for use as fertiliser in the agricultural sector. However, additional nutrients are necessary for optimal performance, and the majority of these are imported from abroad (FAO, 2020). The ongoing financial crisis and limited availability of foreign currency to facilitate the import of these commodities have prompted many companies to suspend nutrient imports. As a result, some projects and initiatives to produce fertilisers by

composting local agricultural byproducts and food waste have been implemented in Lebanon.

2.4.1.2 Animal production

Animal production plays a significant role in the agricultural sector, making up **40%** of agricultural output (FAO 2021). The primary products in this sector include milk, chicken and cattle meat. In rural areas characterised by high poverty rates, livestock production represents a primary economic activity, employing a majority of the workforce. Notably, **60%** of farmers in these areas rely heavily on dairy products as their primary means of subsistence (FAO, 2011).

- ▶ **Cattle** are predominantly raised for milk, goats for both milk and meat, and sheep mainly for meat.
- ▶ **Poultry** production exceeds local market demand (Asmar, 2011) and is practised on both small-scale farms, using traditional methods, and large-scale farms, using industrial methods.
- ▶ Lebanese **fisheries** are primarily artisanal or traditional in nature. Due to the absence of seasonal or size limits on fish caught, fishers heavily exploit available resources and exert significant pressure on marine ecosystems. Additionally, illegal fishing techniques, such as dynamite and nets with small mesh sizes, continue to be chronic issues that, while reduced, have not been fully resolved (Nader *et al.*, 2020).
- ▶ **Aquaculture** is primarily focused on freshwater aquaculture, with over **90%** of production consisting of rainbow trout (*Oncorhynchus mykiss*). Farms operate as semi-intensive growing systems, are family-owned artisanal businesses, vary in size from small to medium and are concentrated in the Bekaa area. The majority of trout is sold to local restaurants located near the production farms (Pinello & Majdalani, 2018).

- There is only one saltwater onshore **shrimp** farm (*Penaeus vannamei*) in Aabdeh, Akkar. Its estimated annual production is about **20-25 tonnes** per annum, and it is the only business that freezes its products.

As is the case with plant production, the majority of inputs used in animal production in Lebanon, such as animal feed, drugs and vaccines are also imported, which has resulted in a significant financial burden on farmers. The cost of feeding dairy cattle “represents **80% to 90%** of the production cost, and **60% to 80%** of the milk’s farm gate price” and is “slightly less for small ruminants” (IFAD, 2017). Moreover, the operation of farms and machinery often depends on fossil fuels or fossil fuel-derived energy sources, which have become increasingly expensive. Furthermore, the movement of cattle between Lebanon and Syria has raised the risk of disease and has negatively impacted the profitability of the sector.

In rural areas, traditional Lebanese (*Baladi*) dairy products such as goat cheese or labneh are widely consumed due to their high protein content (Asmar, 2011). Milk from cows, goats or sheep is processed into cheese using the traditional customs of ripening and recipes that give the end product a very distinctive flavour, setting them apart from other products in the market. However, these artisanal items are typically only available in specific areas or farms, where they are sold in small quantities and are produced on a small scale at the household level (Asmar, 2011). As a result, they cannot be exported in large quantities as a major commercial product.

2.4.2 Food imports and exports

Lebanon’s agricultural sector exported products with a value of **USD 434 million** in 2019, accounting for approximately **11.7%** of the country’s total exports. The main exported items include jams and fruit jellies (**38%**), fruits and nuts (**10%**), and chocolate and other food preparations (**8%**). Additionally, the country exports sauces (**7%**), tobacco (**7%**), vegetables (**6%**), olive oil (**6%**), miscellaneous food preparations (**5%**), and wine,

waters (e.g. rose and orange blossom water, etc.) and pastry (**5%**, **4%** and **4%** respectively) (IDAL, 2020). These products are primarily exported to the Gulf Cooperation Council region, with limited diversification observed (IDAL, 2020).

However, there is a significant disparity between the volume of food products imported and Lebanon’s agricultural exports. Food imports amounted to approximately **USD 1.6 billion** in 2019. Several factors contribute to this gap. Firstly, local production fails to meet the demand for many essential products such as wheat and vegetable oils. The presence of large refugee populations requiring nourishment that exceeds the capacity of the local agricultural sector exacerbates this situation. Out of the top **25** agricultural products exported, **17** are also imported in significant amounts. Some items are re-exported with minimal added value, while others are transformed domestically for higher-value exports. On average, around **75-80%** of total food consumption in Lebanon is reliant on imports. Currently, there are challenges related to US dollar liquidity and credit issues affecting import dependency. Based on the NAS 2020-2025, this opens a window of opportunity for more import-substitution domestic production, which would reduce consumption of foreign exchange, add greater value to the economy and boost employment, especially for the more marginal population groups (MoA, 2020).

The export of agri-food products relies on Arab markets where competition from European Union products is increasing and quality standards are becoming stricter. Many domestic products struggle to match the quality standards of foreign commodities and the country lacks the logistics systems that are needed to capitalise on its agri-food export potential.

2.4.3 Water consumption and irrigation

With about **55%** of water demand coming from irrigation (MoEW, 2022 (a)), the agricultural sector is the highest consumer of water resources in Lebanon. The following techniques are used (Mhanna, 2016): surface irrigation (**50%**),

sprinklers (25%) and drip (25%). They derive their water from groundwater (49%), surface waters/ rivers (39%) and reservoirs and hill lakes (12%).

The NWSS 2020–2035 states that the total irrigated area under the four RWEs is **99,760 ha**, with an irrigation efficiency of **50–60%**, and estimates irrigated areas to reach **138,000 ha** by 2035 (MoEW, 2022 (a)).

Low irrigation efficiency is a key issue plaguing the agricultural sector in Lebanon. However, due to the abundance of water resources relative to other areas in the region, many farmers are still capable of meeting their demand via groundwater resources (FAO, 2021). Once this source of water begins to dry up, the sector will be forced to become much more resource-efficient and improve irrigation to produce more commodities using less inputs (water, fertiliser, seeds, etc.). Relying on groundwater for irrigation also leads to excessive and inefficient energy consumption.

2.4.4 The 2019 crisis and changing consumption patterns

Since the onset of the 2019 crisis, there has been a notable change in consumption patterns in Lebanon. A significant portion of the population is now finding it difficult to afford basic nourishment. While households typically allocate approximately **70%** of their expenditure to food, regions like the Bekaa are experiencing a shift in spending priorities, with transportation expenses taking precedence over food costs (Khater *et al.*, 2019). When making food purchasing decisions, a majority of consumers (**34%**) considers price to be the primary factor, followed by the product's expiration date (**18%**) and quality (**17%**).

According to the Lebanon Crisis Response Plan (LCRP), there has been a substantial **557%** increase in the food basket price since October 2019. As a result, households have had to adopt various coping strategies, including reducing portion sizes and the number of meals consumed per day, cutting back on healthcare and education expenditure, relying on credit and borrowing

cash to purchase food, withdrawing children from school and selling productive assets. Assessments have indicated that **34%** of the Lebanese population, **50%** of displaced Syrians and **33%** of refugees of other nationalities currently face food insecurity (Government of Lebanon and United Nations, 2021).

2.4.5 Challenges and threats affecting the food sector in Lebanon

The agricultural sector in Lebanon faces numerous challenges that significantly undermine agricultural production.

2.4.5.1 Weak status of farmers and lack of skills

The lack of farmer status under the Labour Law (MoA, 2014) increases the vulnerability of workers and discourages young people from getting involved in the sector. Additionally, the persistent adoption of unsustainable practices, such as monocropping instead of crop rotation, excessive use of fertilisers, improper irrigation management and excessive ploughing has led to the loss of soil fertility, which is a significant issue in Lebanon (FAO, 2021).

Furthermore, the Lebanese agricultural sector faces difficulties in terms of low productivity and competitiveness, due to the fact that the majority of agricultural land holdings are either small or medium-sized. While some of these farms are market-oriented, a significant number operate on a subsistence model, producing goods solely for household consumption, and lack profitability (FAO, 2021).

2.4.5.2 Haphazard urbanisation

Changes in land-use practices, particularly the shift from rural to urban areas, and haphazard urban expansion are negatively impacting agricultural production, resulting in the loss of valuable topsoil and increased pollution of water and soil. Urbanisation has a significant effect on livestock production due to the reduction and fragmentation of rangelands and pastureland

(MoA, 2014). This issue is further exacerbated by the lack of policies concerning land tenure and pastoralism.

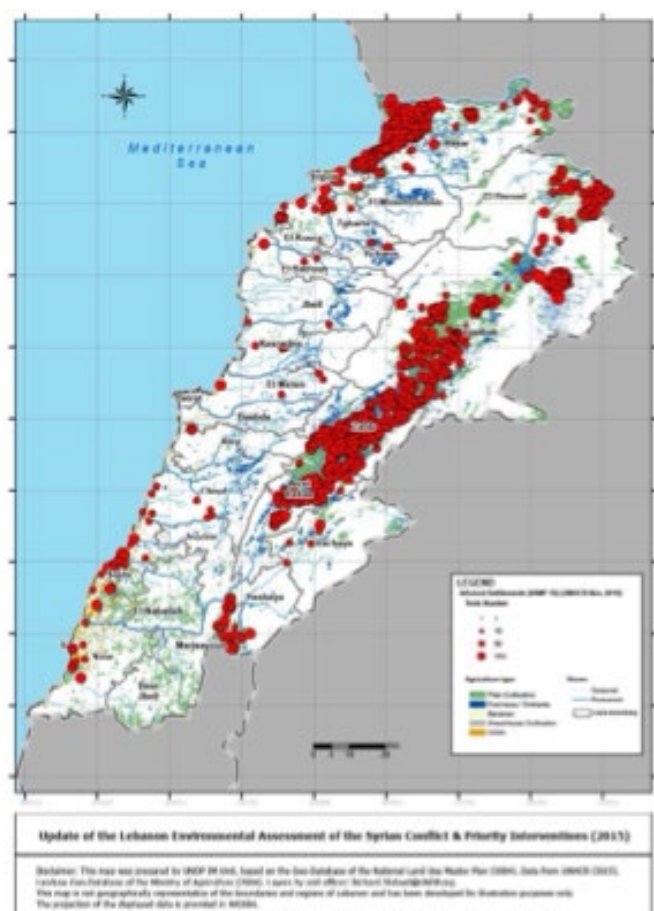
Overall, there was a significant increase (approximately **147 km²**) in the expansion of urban areas from 2005 to 2013, and urban sprawl onto agricultural lands nearly quadrupled, covering approximately **268 km²** (MoE/UNDP/UNHCR/UNICEF, 2021).

Coastal areas have been significantly impacted by these trends and experienced drastic land-use changes, shifting from natural to biocultural activities (such as agriculture and fisheries) to urban settings. Among other things, this has resulted in substantial shifts from agricultural to artificial land. These shifts are mostly irreversible. For example, coastal towns that previously relied on agriculture, such as Akkar, Damour – Chouf, Ras El Ain and Naqoura – Tyre, have been converting

their land for residential use to attract higher revenue, and there is a growing concern regarding gradual urban expansion into the remaining agricultural lands, which is evident in various coastal regions (MoE/UNDP/UNHCR/UNICEF, 2021).

The situation has further deteriorated since the onset of the Syrian crisis and the significant increase in the number of individuals seeking refuge in Lebanon. Many of them are currently residing in informal tented settlements, which are located close to agricultural and environmentally sensitive zones such as Bekaa and Akkar. The situation has placed significant strain on natural resources in these regions, including land, biodiversity and water resources, with agricultural lands being converted into residential areas (from **12% in 2015 to 19% in 2018 in Bekaa**) (MoE/UNDP/UNHCR/UNICEF, 2021).

FIGURE 2-24 Distribution of informal tented settlements in agricultural areas (MoE/UNDP/UNHCR/UNICEF, 2021).



2.4.5.3 High production costs

The competition between agriculture and other land uses, coupled with the high price of land, impacts the viability of agricultural projects. In fact, the substantial capital investment required may not be recouped for several years, or even decades, particularly for small-sized holdings (FAO, 2021). Meanwhile, other land uses can offer more lucrative opportunities.

Agricultural production costs in Lebanon are high due to several factors. Chief among these is the reliance on imported inputs for various value chains, including seeds, fertilisers, pesticides, animal feed, drugs, vaccines and live animals. Furthermore, the use of fuel-derived sources of energy in different stages of production also adds to overall costs.

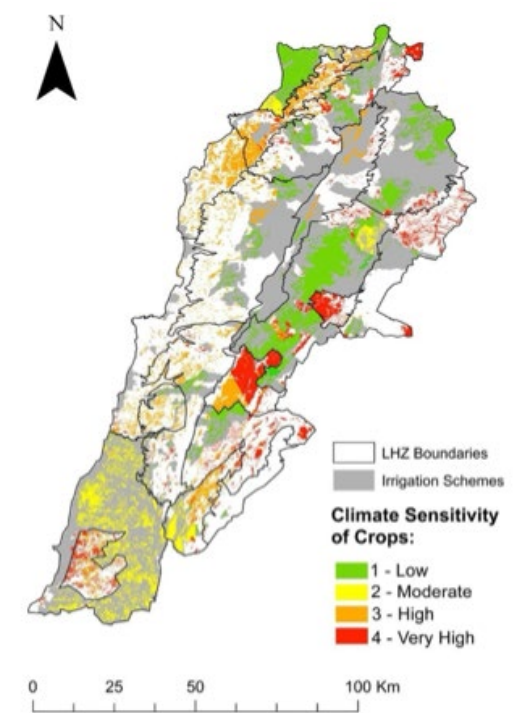
Post-harvest activities, which consume substantial amounts of energy, are particularly expensive and this also negatively impacts agricultural production. Specifically, the high costs of cold storage have led farmers to abandon their produce. According to the MoA (personal communication from Ms. Maya Mhanna, November 2022), the cost of cold storage for apples surpasses the price farmers receive by selling them. This has resulted in significant losses for apple farmers, discouraging them from

harvesting their fruits, which are left unpicked on the trees.

Given the significant production costs, coupled with the restricted availability of financial services such as credit and insurance, as well as essential services like extension, technical assistance and market information, farmers often lack the necessary funds to modernise their operations, leverage technology, enhance yields and add value to their products. Furthermore, excessive transaction costs and inadequate marketing mechanisms, in terms of both infrastructure and information, further hinder their financial capabilities.

2.4.5.4 Climate change, water scarcity and natural hazards

Projected increases in temperature and prolonged periods of drought are expected to affect agricultural productivity if no adaptation measures are taken. Most areas in Lebanon will witness moderate potential impact, affecting **70% to 85%** of agricultural areas, with **1% to 3%** of areas signalling high potential impact by the end of the century. Figure 2-25 shows crop sensitivity to climate change across Lebanon, and **Box 2-3** presents the hotspots of highly vulnerable agricultural areas in Lebanon.

FIGURE 2-25 Climate sensitivity of crops (IFI/WFP, 2020).**BOX 2-3** Hotspots – Highly vulnerable areas for agriculture (MoE/UNDP/GEF, 2022)

Special attention needs to be paid to hotspots – the agricultural areas that are most vulnerable to climate change. Hotspots are primarily located in the following five areas:

South-eastern Akkar: Hotspot areas are estimated to cover **~2,600 ha** and include fruit trees and field crops. This area is dominated by high sensitivity stemming from steep slopes, flooding and soil erosion. Secondly, this area has low adaptive capacity due to poverty, low irrigation capacity and limited groundwater resources.

Hasbaya: Hotspots are estimated to cover **~3,800 ha** and include olives, field crops and fruit trees. Limited irrigation capacity, high unemployment and illiteracy, as well as a lack of crop diversification, all contribute to low adaptive capacity. Moreover, sensitivity is elevated due to poor soil characteristics, including shallow depth, low storage capacity and low organic content. Lastly, exposure is moderate due to decreasing precipitation coupled with increasing temperature.

Rachaya: Hotspots are estimated to cover **~2,600 ha** and include field crops, olives, fruit trees and vineyards. The area has very high sensitivity combined with low adaptive capacity. The area has limited irrigation capacity, high unemployment and a shortage of groundwater resources.

Baalbek and Zahle: Hotspots are estimated to cover **~2,000 ha** and include fruit trees, field crops and vineyards.

Zgharta and Bcharre: Hotspots are estimated to cover **~2,100 ha** and include field crops, fruit trees and olives.

These effects include reduced water availability, decreased soil fertility and the proliferation of pests and diseases. Such factors will, in turn, increase the vulnerability of “poverty-prone agricultural workers and threaten their livelihoods” (MoE/UNDP/UNHCR/UNICEF, 2021), especially those who depend on rainfed agriculture.

Lebanon faces a significant number of natural hazards, particularly related to weather events. These hazards have a major impact on the agricultural sector, posing significant risks of flooding, storms, wind, hail, cold and heat waves, and late frosts, which affect both animal and plant production (FAO, 2021). Climate change-related disasters in the agricultural sector resulted in estimated economic losses of **USD 605 million** in 2018. Floods caused the most damage, generating high financial losses, casualties, and the destruction of agricultural lands, fisheries, boats and forests. Flash floods also harm freshwater raceways, causing turbidity and contamination (MoE/UNDP/GEF, 2022).

The use of contaminated water from polluted surface and groundwater sources (see Section 2.2), or the reuse of partially treated and, in some cases, untreated wastewater, is also adversely impacting agricultural production by compromising product quality, leading to reduced competitiveness and acceptance into international markets, and posing a significant risk to public health. The lack of an effective quality monitoring system for water used in irrigation and the

absence of national standards regulating the use of treated wastewater in irrigation are significant obstacles to making progress in this area. It is worth noting that LIBNOR, in collaboration with the Lebanese Agricultural Research Institute (LARI) and a multi-stakeholder committee, is actively working to develop national standards on the reuse of treated wastewater in agriculture. These are tentatively expected to be issued in January–February 2024 (personal communication, Ms. Amal Hamieh, LIBNOR, 26 June 2023).

2.4.6 Food sector governance analysis

This section presents the results of the governance analysis for the food and agricultural sector.

2.4.6.1 Efficiency

The regulatory framework

The sector is not governed by an all-encompassing law but rather by **various legal texts, most of which are issued by the MoA and regulate various aspects**, based on needs and developments. These documents cover areas such as natural resources, irrigation projects, soil conservation, afforestation and protection from pasture, organic agriculture, the organisation of cooperatives, food production, machinery and imports/exports. Others respond to international developments in agriculture and related technologies, like regulations on pesticides management.

FIGURE 2-26 Legal documents and strategies governing the food sector.



The national agricultural strategies guide decision-makers in drafting the legislative framework for the sector to adapt to changing dynamics.

Another key strategy is the National Strategy for Conservation and Management of Plant Genetic Resources for Food and Agriculture in Lebanon 2015–2030 (FAO/MoA, 2015). This aims to tackle the **degradation of natural resources through holistic interventions relevant to the food sector**.

Concerning the provision of **water for irrigation**, this is regulated by one of the key water sector laws, namely Law 221, which gives responsibility to the MoEW and RWEs for large-scale water projects, including irrigation ponds with capacities higher than **100,000 m³**, while the MoA focuses on smaller, farm-level initiatives.

Despite being the biggest water consumer, **irrigation is poorly managed** due to gaps in legislation, and a lack of resources and funding. Law 221 created RWEs, gave them responsibility for water supply within their jurisdictions and cancelled the roles of water user associations (who were mainly responsible for irrigation management). However, the law lacked implementing decrees, leaving no departments or staff with responsibility for irrigation. Water rights committees manage water distribution among farmers, where such rights exist.

The increased responsibilities for RWEs, without an adequate legal framework, funds or control measures, have led to the widespread abuse of irrigation methods. Farmers often resort to using drinking water, illegally drilling wells and utilising untreated or polluted water sources for irrigation. Existing legislation is insufficient to address this issue, and a lack of awareness among farmers further hampers efforts to rationalise water use in agriculture. The current crisis has made it even more difficult to control these occurrences due to limited public sector resources.

Moreover, under existing laws, **farmers in Lebanon lack social protection and health insurance**,

making the sector unattractive, especially to young people. The NAS 2020–2025 recognises the importance of this issue, which should be tackled through a review of the relevant legal provisions, identifying gaps and drafting the necessary legislation. However, the challenge lies in securing funding for the preparatory work and implementing the protection required.

Status of data and data-sharing mechanisms

Data on the food and agriculture sector are gathered by several institutions, such as the MoA, the National Council for Scientific Research (CNRS), LARI, the Investment Development Authority of Lebanon (IDAL), the MoI, and various academic institutions and NGOs.

The most extensive and reliable source of information is the MoA census conducted in 2010. Supplemental data have also been collected through surveys which have received support from FAO and the EU (FAO, 2021 (b)). Although a new census was scheduled to be carried out, financial limitations have hindered its implementation.

However, it is worth noting that there is currently **a lack of detailed information pertaining to water resource consumption in irrigation**. The available data are primarily based on estimations at the national level and remains in non-digital formats, hindering effective coordination and informed decision-making.

The MoA has emphasised the significance of implementing a database or platform that can be accessed by relevant stakeholders. This would improve efficient resource use and enhance agricultural production. By utilising real-time data, including information on crop types suitable for specific areas, possibly based on a watershed approach to take account of the unique characteristics of the basin (water availability and quality, soil types, microclimates), effective planning could be implemented in the sector. This would also be in line with the integrated approach promoted by the MoEW based on the new Water Code, with a focus on IWRM at the watershed

level. Such a platform would facilitate direct communication with stakeholders, eliminating the need for time-consuming bureaucratic procedures.

Financial constraints and funding mechanisms

The Lebanese Government has consistently failed to invest in the agricultural sector, with funding for the MoA constantly representing a small share of the public budget (MoA, 2020). In fact, the MoA has always received less than **0.5%** of the Lebanese Government's annual budget (Eid-Sabbagh *et al.*, 2021).

Public financial assistance for agricultural production has targeted tobacco and wheat commodity support programmes as a priority. However, insufficient investment in infrastructure, research and development and extension services, and inadequate organisation of the agri-food value chain have ultimately resulted in inefficiencies (MoA, 2020).

Large parts of the funding allocated to the agricultural sector in Lebanon have thus been provided by IFIs and bilateral donors, while UN organisations have contributed to a significant number of projects (FAO, 2021 (b)).

Involvement of the private sector and individuals has been limited due to the lack of access to loans and credit (FAO, 2021 (b)). Very high bank loan interest rates and difficult collateral conditions discourage farmers from seeking loans (FAO, 2021 (b)). This particularly impacts women and young farmers, who typically do not have access to such resources. Furthermore, loans from micro-financing institutions to small farmers or small and medium enterprises in the sector have become less accessible since the onset of the financial crisis.

2.4.6.2 Effectiveness

Policy coherence status

The food and agriculture sector in Lebanon has traditionally been assigned a **low priority** by the

Lebanese Government in its various guises. This is evident from the lack of a comprehensive policy framework (MoA, 2020), the fragmented nature of the policies and legal provisions that govern interventions in the sector and the limited public funding allocated to it.

As previously noted, this has resulted in insufficient investment in infrastructure, research and development and extension services, and inadequate organisation of the agri-food value chain leading to inefficiencies (MoA, 2020), while public financial support for agricultural production is focused primarily on two commodity support programmes – tobacco and wheat – both managed by entities external to the MoA.

The long-term vision in the NAS 2020-2025 is to **make the agri-food system a significant contributor to ensuring food security** and powering the resilience and transformation of the Lebanese economy into a productive one, through enhanced inclusiveness, competitiveness and sustainability. To achieve this, the NAS focuses on strengthening interconnections with other sectors, particularly through a pillar dedicated to improving **climate change adaptation and sustainable management of agri-food systems and natural resources (MoA, 2020)**, by:

- ▶ Enhancing **climate change adaptation** and encouraging related private investment along the agri-food value chains.
- ▶ Promoting the **sustainable use of natural resources**, including soil, pastures, forests and fisheries to minimise environmental and natural resource degradation. This can be achieved through the adoption of sustainable farming practices, improved food processing techniques, efficient logistics operations (such as smart agriculture and organic farming), and better training and awareness among operators.
- ▶ Enhancing the **efficient use of irrigation water** and expanding the supply of water resources for irrigation, including management of water harvesting and storage of irrigation

water, enhanced efficiency of distribution and governance, construction of hill lakes and water tanks for better water efficiency and promoting the adoption of modern irrigation techniques.

- ▶ Encouraging and supporting the **use of renewable energy in the agricultural sector**. Priority interventions include promoting low carbon emission technologies, reducing agricultural pollution (at the farm level), encouraging the reuse of agricultural waste, producing compost from animal farms and agricultural products, including by establishing the relevant regulatory frameworks and more effective awareness and communication campaigns on responsible food consumption.

These targets are also at the centre of several priorities outlined in Lebanon's updated NDC for 2020, with the goal of **enhancing water and food security**. Specifically, these priorities are connected to the following actions:

- ▶ enhance the efficiency and competitiveness of agri-food value chains, including fisheries
- ▶ encourage private investment along the agri-food value chain, including innovative technical solutions and improved access to climate finance and insurance
- ▶ strengthen the enabling institutional environment
- ▶ enhance the efficient use of irrigation water and expand the supply of surface water sources for irrigation
- ▶ encourage and support the use of renewable energy in irrigation and drinking water supply.

Moreover, NDC targets for the sector also include actions aimed at strengthening its resilience to **enhance Lebanon's agricultural output in a climate-smart manner** through:

- ▶ restoring the livelihoods and productive capacity of farmers and producers

- ▶ increasing agricultural production and productivity
- ▶ increasing the resilience of households with reference to food and nutrition security.

To reduce the stress on freshwater resources, particularly considering that over **55%** of these resources are utilised for irrigation purposes, the MoA has focused on the reuse of **treated wastewater in irrigation**, developing specific standards in collaboration with the FAO, MoEW, LIBNOR, MoPH and RWEs. Once issued, these standards should be complemented by legislation to organise the relevant activities.

The **significance of energy within the sector** has become more prominent due to limited electricity and fuel supplies, and the increasing cost of these supplies. In light of these challenges, a preliminary proposal has been devised to allocate funds and provide subsidies for **solar energy used in irrigation (solar pumping)**. However, scant resources make it difficult to implement such concepts. The MoA also acknowledges the potential **risks associated with solar pumping**, especially if there are no regulations in place regarding the maximum amount that can be extracted, or proper monitoring. The MoA therefore plans to collaborate with the MoEW to address this issue, and also understands the urgency of issuing the relevant standards promptly, as applications have already begun.

As previously highlighted, efforts to reduce the **degradation of natural resources through interventions relevant to the food sector** have also been made through the National Strategy for Conservation and Management of Plant Genetic Resources for Food and Agriculture in Lebanon 2015–2030 (FAO/MoA, 2015), encompassing the entire process from preservation to sustainable utilisation, including seed distribution, through a holistic approach.

The **absence of an updated urban master plan** that takes into account agricultural land and natural resources, including ecosystems,

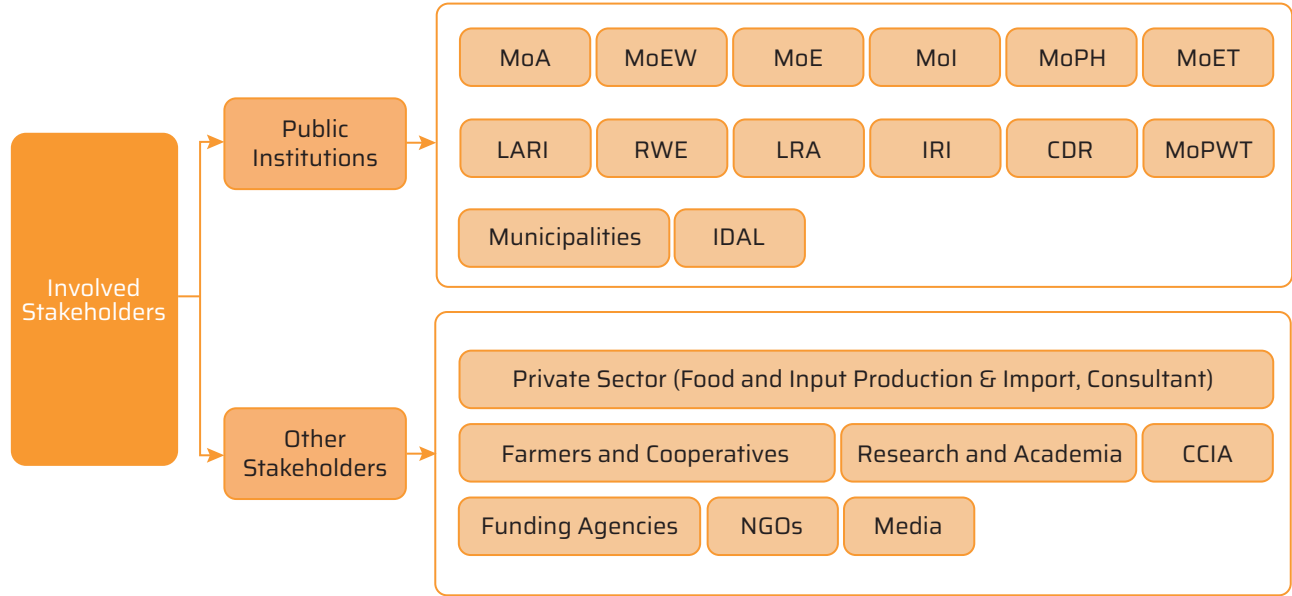
poses another key challenge, as does the lack of awareness on the part of the public and policymakers in charge of other sectors regarding the importance of protecting agricultural land and ecosystems. The National Physical Master Plan of the Lebanese Territory (NPMPLT), developed in 2005 and endorsed by the CoM in 2009, sought to organise Lebanese territory and land use but was never fully implemented. Most of the data are now outdated, and while the CDR and Directorate General of Urban Planning (DGUP) called for an

update in 2017, this has yet to be initiated (MoE/ UNDP/UNHCR/UNICEF, 2021).

Stakeholder roles and responsibilities

Several stakeholders are involved in various aspects of managing the food and agriculture sector; their roles and mandate are overall well defined by the relevant laws, and summarised in the following sections.

FIGURE 2-27 Stakeholders involved in the food sector.



The MoA is the main institution in the sector. It is responsible for proposing legislation relevant to agricultural activities, formulating the national strategic vision and developing related policies and programmes. Moreover, it plays a key role in managing natural resources (agricultural land, soil, irrigation water at the farm level, forests and forestry, fisheries and rangelands), in preparing and implementing rural development programmes and in managing pesticides, by controlling the mechanisms for granting import permits and registrations, production and disposal.

Other institutions with responsibilities for food security are the Ministry of Economy and Trade (MoET), the MoI, the Ministry of Social Affairs

(MoSA), the MoE, the MoEW and the Ministry of Public Health (MoPH).

The use of water resources for agriculture and ecosystem protection requires coordination with the MoEW, MoE, RWEs, LRA, CDR, the Green Plan and municipalities. As for financing agriculture projects, this is supported by IDAL, MoET, MoF, Banque Du Liban (BDL), the Green Plan, CDR and the MoA Directorate of Cooperatives.

Moreover, the four Chambers of Commerce, Industry and Agriculture (CCIA), grouped under a federation, are non-profit organisations that play an important role in agriculture, as they represent the interests of the private sector and

help to formulate policies and legislation affecting businesses (FAO, 2021 (b)).

The involvement and responsibilities of these many institutions require significant cooperation. Regrettably, effective tools for coordination are in short supply (MoA, 2020). Additionally, there is a need to improve coordination within the departments and institutions associated with the MoA, which is poor due to limited digitisation of workflow and administrative procedures.

Finally, only around **10–20%** of farmers' organisations and cooperatives in the sector, which were created to provide inputs and marketing support to farmers, are currently active and functioning. These organisations are commonly structured around relatively large-scale mechanised facilities that cater to various stages of production, transformation or packaging.

Status of human capacity in the sector

The institutions responsible for managing the agricultural sector are weak due to the low priority attributed to the sector by the various Lebanese governments (MoA, 2020). The two MoA directorates general lack sufficient human resources, primarily because of budgetary constraints, and both the LARI and Green Plan, under MoA tutelage, experience high staff turnover (MoA, 2020). Most staff are underqualified and lack experience (FAO, 2021 (b)).

The MoA Extension Service offices have a total of **135** employees, who are also assigned other roles, such as inspections, statistics and implementing the MoA's support policies. This multitude of roles reduces the effectiveness of extension services, and the staff are in most cases underqualified and lack experience (FAO, 2021 (b)).

However, due to these staff and resource limitations, the different stakeholders in the food and agriculture sectors, including farmers' organisations and cooperatives and agricultural guidance centres receive capacity-building support primarily through programmes financed

by international organisations, NGOs and development agencies. Specifically, women's cooperatives are being supported to enhance their operations and improve skills in various areas, including management.

Moreover, LARI, a governmental organisation under MoA supervision, has developed a publicly accessible digital platform offering comprehensive information on various agricultural products and how they are farmed. The application is as a valuable resource for farmers, providing data on weather conditions, early warning systems and a range of other relevant information to support their work and enhance their knowledge.

Inter-ministerial coordination and collaborative planning

According to the NAS 2020–2025, the implementation of the previous strategy (NAS 2015–2019) has suffered from inadequate governance mechanisms, including weak stakeholder coordination and fragmentation of authority and enforcement powers. While the MoA is the main institution in charge of governing the sector and developing policy priorities, only the Internal Security Forces can enforce the rules regulating various aspects of the food and agriculture sectors. This may result in long bureaucratic processes until the required legal actions are enforced. The current crisis has also reduced the human and financial resources available to the public sector, and it has become harder to control infractions.

The NAS 2020–2025 therefore emphasised the importance of stakeholder collaboration to address agri-food issues, and identified several bodies that could facilitate this:

- Inter-ministerial high-level committees or councils, such as the Higher Council for Urban Planning, the Committee for Food Safety, and the Committee for Rural Development
- Inter-ministerial technical coordination committees, such as the Committees for

LIBNOR, the technical committees at the Disaster Risk Management Unit and the Climate Change NDC coordinated by the MoE

- Public-private committees, established under the MoA on a sub-product/value chain basis.

Furthermore, the NAS proposes reactivating the **Higher Council for Agriculture** as a multi-stakeholder advisory body, including representation from the private sector, academia and civil society, and focusing on key selected investment areas. It also suggested establishing a policy-making body for agri-food issues, the **Higher Inter-Ministerial Committee**, which would be headed by the MoA. However, the strategy still lacks the necessary regulatory framework and funding resources to be implemented.

The CoM has recently (2022) formed a ministerial committee headed by the MoET, with representatives from the MoI, MoA, MoF, Ministry of Culture and Ministry of Defence (MoD). The committee's remit is to follow up on the issue of food security and to propose necessary and urgent measures and procedures (National News Agency, 2022). However, it is worth noting that this committee does not include an essential stakeholder, the MoEW, and focuses solely on addressing food security through imports, rather than giving due consideration to local production.

Lack of efficient monitoring and evaluation

The MoA is responsible for gathering information and facilitating communication on food and nutrition security and sustainable agriculture, with a focus on advocating for these causes. As outlined in the NAS 2020-2025, the lack of clear monitoring and evaluation systems, coupled with the poor availability and reliability of data, poses a significant obstacle to evidence-based policy-making within the agricultural sector. To address this challenge, collaboration between stakeholders from different sectors and at various levels is required. Establishing and sustaining this kind of collaboration is challenging in the

short term, given the current financial and human resource shortages within the various institutions.

The issue of polluted water use in agriculture provides an illustrative example. This practice adversely affects the quality of agricultural products, compromising their competitiveness and acceptance on international markets and posing a significant threat to public health. Unfortunately, in many cases, no proper assessment is carried out, making it difficult to track the trajectory of pollution, monitor pollution levels, plan for clean-up and remediation efforts, establish and enforce water quality standards for irrigation purposes and create awareness among farmers regarding the risks associated with the use of untreated or polluted wastewater.

2.4.6.3 Trust and engagement

Transparency and stakeholder engagement

Stakeholders overseeing the agricultural sector have achieved low scores for their commitment to the Access to Information Law (Law 28/2017) (Gherbal Initiative, 2023). The MoA has been found partially compliant in terms of publishing information required by the law, however, most of it is "outdated, fragmented and disorganised" (Sleiman, 2022).

Regarding stakeholder involvement in the sector, the limited allocation of human and financial resources has led to constrained capacity of extension services to assist farmers and other key actors engaged in food security. One consequence of this situation is the stronger engagement of private companies in providing advice to farmers, for example on the use and required quantities of the chemical inputs (fertilisers, pesticides, herbicides, etc.) they sell to farmers. Due to their commercial nature, these types of agricultural services do not offer a satisfactory level of transparency (FAO, 2021 (b)).

2.4.7 Thematic areas of priority for the food sector

Following the analysis of the food sector, including its associated governance frameworks, several areas have been identified that, if addressed, could lead to significant improvements. They are outlined below.

2.4.7.1 Protecting agricultural land from urban expansion and strengthening farmers' status

The protection of agricultural land (through zoning and land-use planning) is crucial for the development of the agricultural sector and the sustainability of projects in this area. Strong political will, the coordinated efforts of various stakeholders and increased awareness about the risks associated with haphazard urbanisation will be needed to achieve this goal. It is imperative to comprehend the irreversible consequences from the loss of topsoil and agricultural land, as well as the potential benefits of preserving and safeguarding these areas, which would also positively impact water resources.

To promote a robust agricultural sector, it is also crucial to prioritise the empowerment of farmers by offering them social protection within the framework of labour regulations or through other means. This will help mitigate their vulnerability to risks and attract younger generations to the sector.

2.4.7.2 Producing agriculture and food production inputs locally to minimise reliance on imports

As mentioned in the previous sections, the agriculture and food value chains rely heavily on imported inputs. This dependence has had an enormous impact, raising production costs, reducing revenue and increasing farmers' vulnerability. Developing local alternatives could help alleviate the financial strain on the sector and improve food security.

2.4.7.3 Adopting sustainable agricultural practices

Sustainable agricultural practices minimise over-exploitation of resources and optimise production efficiency, making them valuable preventive measures rather than reactive solutions. Embracing these practices not only benefits the environment, but also reduces production costs, and enhances product quality and the long-term sustainability of agricultural production.

2.4.7.4 Adopting water-saving techniques in agriculture

Implementing water-saving techniques and promoting efficient water use in the agricultural sector in Lebanon is vital to reducing competition for and strain on limited available resources. These techniques not only enhance profitability and sustainability but also contribute to environmental conservation and climate change resilience in the sector.

2.4.7.5 Supporting agricultural projects that utilise surface water rather than groundwater

The use of surface water rather than groundwater for irrigation is a long-term objective that can be achieved gradually by establishing the necessary infrastructure for collecting rainwater and surface water to ensure a sufficient and reliable supply of water resources of suitable quality for irrigation purposes.

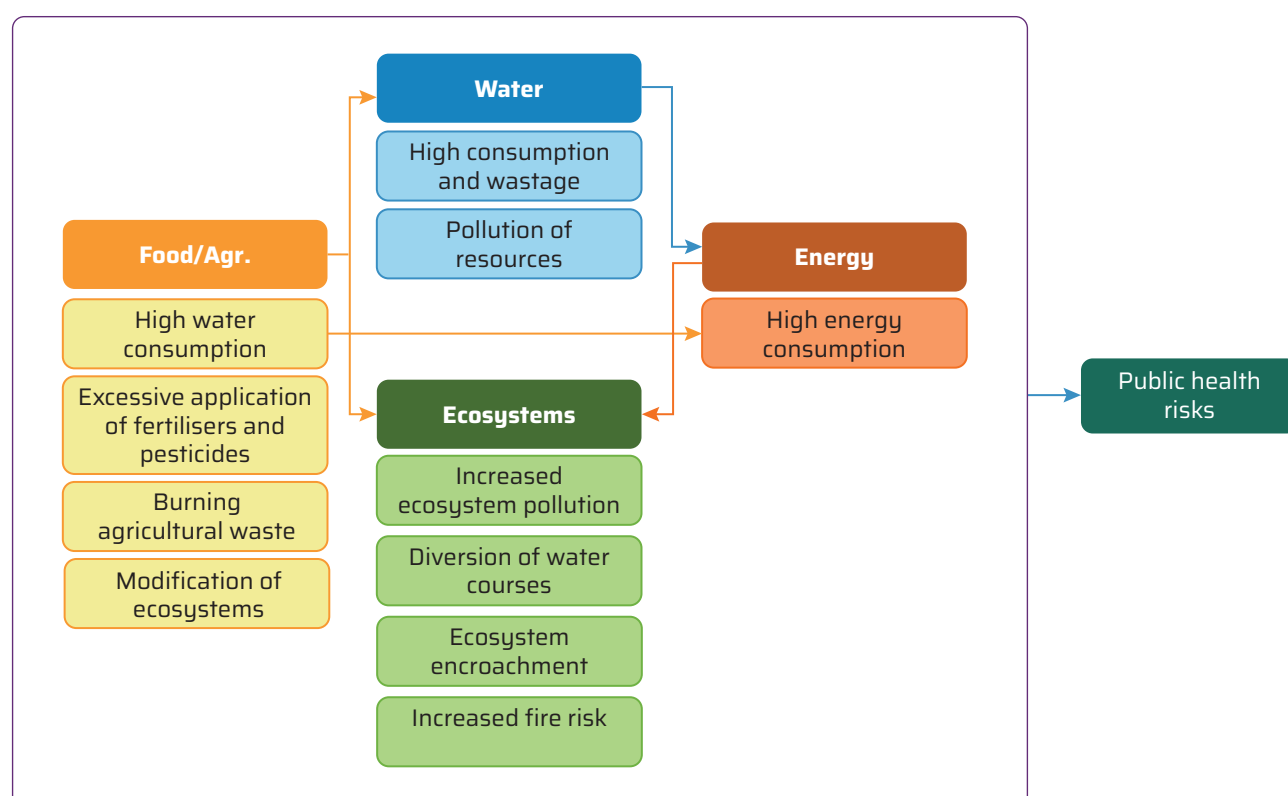
2.4.8 Food in the Nexus

Table 2-8 and Fig. 2-28 below describe the key interlinkages between food security and water, energy and ecosystems security in Lebanon, based on an in-depth assessment of the interdependencies between the sector thematic areas and the security of resources in the other WEFE sectors. This analysis has identified the promotion and mainstreaming of sustainable food production to enhance water safety and security and preserve ecosystems as a key priority that, if properly addressed, would greatly improve the performance of all sectors within the WEFE Nexus.

TABLE 2-8 Interlinkages of food security with water, energy and ecosystems security in Lebanon

Interlinkage	Description of direct and indirect impacts
Food-Water	Increased stress on water resources due to excessive exploitation of groundwater and pollution of surface and groundwater due to the excessive use of fertilisers and pesticides.
Food-Energy	Excessive pumping of groundwater and wastage of resources increase the sector's energy consumption and requirements.
Food-Ecosystems	- Unsustainable agricultural practices have a significant impact on ecosystems and biodiversity: - There is competition between water needed for agriculture and for ecosystem sustainability, especially where natural water courses and springs are diverted without accounting for the needs of ecosystems downstream - Pollution of soil and water sources due to the overuse of pesticides and fertilisers pose a major threat to aquatic and other terrestrial ecosystems and are increasing the vulnerability of various species - The burning of agricultural waste and byproducts (from weeding and pruning trees for example) has caused the burning of ecosystems in various areas, and increased forest fire risks.

FIGURE 2-28 Agriculture/food-water-energy-ecosystems interlinkages.



Mitigating negative impacts from the food sector will require the adoption of sustainable agricultural practices that reduce water consumption, regulation of the use of pesticides and fertilisers (thus reducing pollution of water, soil and ecosystems), recycling of the byproducts and waste generated by various activities (avoiding

open burning) and adoption of renewable energy technologies and energy-efficient machinery and equipment at every stage of the food product value chains to reduce the sector's energy needs, while increasing productivity and efficiency. These measures are in line with several national strategies, as listed in Table 2-9.

TABLE 2-9 Examples of national strategies and action plans that address interlinkages between agriculture/food and other sectors

Strategy or action plan	Elements addressing interlinkages with agriculture/food sector
NWSS final version (2020-2035)	Addressed the increase in irrigation projects and the reuse of treated wastewater in irrigation, enhancing the efficiency of water use in the agricultural sector through upgrading irrigation systems, and the use of renewable energy in various facilities
NAS (2020-2025)	In its fourth pillar, dedicated to "Improving climate change adaptation and sustainable management of agri-food systems and natural resources", the NAS promoted water-saving techniques in agriculture and the adoption of renewable energy technologies in the sector
NREAP 2021-2025, and Second NEEAP for Lebanon (2016-2020)	Recommended the adoption of renewable energy and increased energy efficiency at facilities
Lebanon's updated NDC for 2020	Identified as a priority the "Structuring and development of sustainable water services, including irrigation, in order to improve people's living conditions", using renewable energy in water supply
National Bioenergy Strategy for Lebanon (2012)	Assesses and proposes potential and opportunities for sustainable use and production of bioenergy in Lebanon

The governance and technical barriers affecting the efficient management of trade-offs and synergies between agriculture/food and the other

sectors have been described in previous sections and are summarised in Table 2-10 below.

TABLE 2-10 Barriers limiting Lebanon's capacity to address agriculture/food security-related intersectoral trade-offs and benefit from synergies

Barrier type	Description
Governance	▶ Gaps in legal framework and failure to implement existing laws, including the establishment of entities that allow coordination and increase sectoral transparency (NWC, FSLC, the multi-stakeholder committee for managing the agricultural sector proposed under the NAS 2020–2025, NCE, etc.) ▶ Lack of institutional and administrative framework permitting efficient management of irrigation and related infrastructure ▶ Lack of human resources at national authorities permitting efficient management of the sectors and operation of facilities ▶ Lack of funds to implement existing strategies and national plans, specifically the NAS 2020–2025 ▶ Lack of reliable and updated data covering the agricultural sector (including data related to farmers, agricultural land, irrigation water needs, water consumption in the sector, energy needs of the sector, etc.)
Technical	▶ Lack of metering and monitoring of water resource consumption in agriculture ▶ Lack of irrigation infrastructure in most areas, leading to reliance on unsafe sources and private wells, and complicating the possibility of rationalising consumption ▶ Abundance of unsustainable practices and lack of skills among farmers on sustainable management practices ▶ Lack of awareness on sustainability issues and inefficient extension services

Improving the performance of the sector and effectively managing trade-offs and synergies can be achieved through efforts at multiple levels:

- ▶ At the national level, implementing governance reforms and enhancing coordination among stakeholders involved in project planning and implementation. This could be achieved by establishing and maintaining cross-sectoral bodies, as outlined in existing legislation and strategies.
- ▶ At the regional level, particularly on a watershed basis, coordinating resource management and allocation to minimise conflicts and competition among users, including ecosystems. This approach should be tailored to address the specific needs of each area.
- ▶ At the local level, establishing cooperatives or water users' associations would play a crucial role in allocating water resources among users, monitoring consumption and quality, and facilitating the exchange and dissemination of expertise and information, etc.
- ▶ Increasing awareness and building capacity across institutions and actors in the sector and various value chains to promote the adoption of sustainable practices.

BOX 2-4 Contribution of agriculture (water-energy-ecosystems) entry point to UN SDGs

The adoption of the proposed measures for agriculture and food would have a positive impact and contribute to the SDGs through increasing productivity and enhancing food security and safety, reducing pollution, leading to an improvement in the quality of water resources and preservation of terrestrial and aquatic ecosystems. Furthermore, these measures would contribute to public health and promoting innovative infrastructure and technologies, and would also play a crucial role in climate change mitigation and adaptation.



2.5 Ecosystems sector overview

Lebanon is located within the Mediterranean Basin biodiversity hotspot and is characterised by its rich biodiversity due to its geographical position, climate and topography, which have created diverse bioclimatic conditions and therefore a richness in “ecosystem, habitat and microhabitat variation” (MoE/UNDP/UNHCR/UNICEF, 2021) (refer to Fig. 2-22).

2.5.1 Ecosystems, habitats and biodiversity in Lebanon

This richness in species makes Lebanon unique on a global scale. Despite occupying only **0.007%** of the world’s land surface area, it is home to **1.11%** of the world’s plant species and **2.63%** of reptile, bird and mammal species. This gives Lebanon one of the “highest densities of floral diversity in the Mediterranean Basin, which is one of the most biologically diverse regions in the world and the third among the world’s hotspots in both plant diversity and endemism” (MoE/UNDP/UNHCR/UNICEF, 2021). Lebanon’s major ecosystems⁵ are listed in Table 2-11, habitats are presented in Table 2-12 and biodiversity in Table 2-13.

5 As included in the SOER 2020.

TABLE 2-11 List of Lebanon's major ecosystems (extracted from SOER 2020) (MoE/UNDP/UNHCR/UNICEF, 2021)

Type of ecosystem	Sub-category/characteristics
Terrestrial	Forests
Mountainous	Lower mountain ecosystem associated with the thermo-Mediterranean vegetation series
	Middle mountain ecosystem features the EU-Mediterranean vegetation series
	Upper mountain ecosystem integrating the supra-Mediterranean vegetation series
	High mountain ecosystem where coniferous forests thrive
	Subalpine ecosystem the very high slopes reaching nearly 2,000–2,500 m above sea level
	Alpine ecosystem with a high rate of endemism on the very high peaks of Mount Lebanon at 2,700 m and above
River valley	Highly distinctive and subject to their own characterising features
Aquatic	Rivers, streams, springs, boggy lands and wetlands encompass a high degree of diversity
Semi-arid and arid	Inlands of Northern Bekaa in their natural extension towards the desertic internal plains of Syria
Coastal and marine	Coastal ecosystem includes sandy shore ecosystems and rocky shore ecosystems; island and archipelago systems have particular significance as they present special combinations of terrestrial and marine habitats
	Marine ecosystem typical of the East Mediterranean

TABLE 2-12 Habitats in Lebanon (extracted from SOER 2020) (MoE/UNDP/UNHCR/UNICEF, 2021)

Habitat	Description
Forests	Forests occupy around 13% of Lebanon, while other wooded lands cover about 10% of the territory. About 57% of the forests comprise broadleaved species, coniferous species contribute 32% and the rest are mixed conifer/broadleaf forests. The largest forest areas dominated or characterised by single tree species include (MoE/UNDP/UNHCR/UNICEF, 2021): - oak forests of <i>Quercus coccifera</i> - pine forests of <i>Pinus brutia</i> - cedar forests of <i>Cedrus libani</i> - juniper forests of <i>Juniperus excelsa</i>. The highest forest concentrations in Lebanon are in Mount Lebanon (37%) and North Lebanon (30%), followed by South Lebanon (9%) and Nabatieh (6%) (UNDP/CEDRO, 2016). Forest ownership in Lebanon is divided almost equally between the public sector and private owners and religious orders (MoE/UNDP/ECODIT, 2011).
Riparian and wetlands	Riparian vegetation and wetlands: Lebanon is rich in river courses, with 17 perennial and 23 seasonal rivers, characterised by varying topographic features and creating diverse conditions for riparian habitats and species. In addition to these rivers, other habitats are created by the many streams (some seasonal) that flow over the slopes of the Lebanese mountains in narrow courses, and small ponds accumulating rainwater, creating optimal conditions for certain species to grow (MoE/UNDP/UNHCR/UNICEF, 2021). A number of wetlands are also distributed across Lebanon, such as the Aammiq and Anjar wetlands. These are “valuable habitats for aquatic fauna and flora, and vital for migratory birds” (MoE/UNDP/UNHCR/UNICEF, 2021).

Habitat	Description
Coastal and marine habitats	Coastal zone: the Lebanese coastline extends over 220 km, with various references giving different estimates, the highest of which is 370.92 km. The coastline is characterised by 3 bays, 12 headlands and several river deltas (MoE/UNDP/UNHCR/UNICEF, 2021). Of the 17 rivers in Lebanon, 15 flow into coastal waters, supplying sediment and nutrient uploads, especially during floods. Coastal areas in Lebanon include sandy beaches (20%) and rocky shores (80%), creating several coastal habitat types where species are spread across supra-littoral, mid-littoral, infra-littoral and circa-littoral habitats (MoE/UNDP/UNHCR/UNICEF, 2021). Vermetid platforms: these are one of the most characteristic habitats of the Lebanese coastal zone and are threatened. Vermetid platforms are very fragile habitats and their optimum environmental conditions are in the intertidal or immediate subtidal zone, which interacts with the surrounding physical and chemical changing factors. They provide key ecosystem functions and services, including: protecting shorelines from wave erosion, acting as carbon sinks, functioning as nursery grounds and refuge habitats from predators for many diverse assemblages of species, including large numbers of invertebrates and fish of commercial interest. Marine habitats in Lebanon are not well defined or mapped for fauna and flora associations. More than 20 benthic biocenoses of hard substrata for the littoral rock, infra-littoral rock and upper circa-littoral rock have been identified. Certain characteristics of Lebanon's benthic habitats are peculiar, making it difficult to apply the Mediterranean habitat/biocenosis classifications (MoE/UNDP/UNHCR/UNICEF, 2021). Continental shelf: the shelf stretches from 0 m at the shore to depths ranging between 100 m and 200 m. It is relatively wide in the north between Enfeh and Akkar (18 km) and in the south between Ras Beirut and Naqoura (7 km). Between Beirut and Enfeh, the shelf is extremely narrow (less than 3 km) where the margin exhibits its steepest slope, with the water depth dropping from 100 m to 1,500 m in less than 5 km (MoE/UNDP/UNHCR/UNICEF, 2021).

TABLE 2-13 Biodiversity in Lebanon (extracted from SOER 2020) (MoE/UNDP/UNHCR/UNICEF, 2021)

Type	Description
Terrestrial flora	Lebanon is home to around 2,600 terrestrial plant species, revealing a high rate (12%) of endemism, including 8.5% broad endemics (Lebanon, Syria and Palestine) and 3.5% narrow endemics to Lebanon. A significant number of species are rare and endangered; most of these are in the high mountain summits, and so are affected by isolation (MoE/UNDP/UNHCR/UNICEF, 2021).
Terrestrial fauna	There are more than 20,000 species of fauna in Lebanon, with 46% living in terrestrial habitats (MoE/UNDP/UNHCR/UNICEF, 2021): Mammals: terrestrial mammals in Lebanon include 59 species, most of which are listed as Least Concern in the International Union for Conservation of Nature (IUCN) Red List, with the exception of the striped hyena (Near Threatened) and the marbled polecat (Vulnerable). Insects: an estimated 842 insect species are known to exist in Lebanon, however specialists in the field estimate that there are between 14,000 and 18,000 species (MoE/UNDP/UNHCR/UNICEF, 2021). Palaeontological arthropods: these species have long been extinct; however some are captured in amber, leading to the discovery of 105 taxa of arthropods and 1 taxon of green algae; 73 of those taxa present new genera and species recorded by science for the first time. Another 21 taxa are new species. Birds: a total of 404 species of birds were recorded in Lebanon by the end of January 2021: 70.4% of these species are passage migrants, winter visitors or both; 17.0% are vagrants; 18.0% are summer breeders and 16.0% are breeding residents (it should be noted that some species fall into more than one category). Of the remaining species, four have uncertain status, two have originated from escapes, three were introduced and two had disappeared from Lebanon around 70 to 120 years ago but reappeared recently as vagrants. According to the IUCN Red List, 1 bird species in Lebanon is Critically Endangered, 4 are Endangered, 13 are Vulnerable, and 24 are Near Threatened. Herptile species: 63 known reptile species and 7 amphibian species have been identified in Lebanon. Globally, 2 of Lebanon's amphibian species and 17 of its reptile species are considered threatened.

Type	Description
Freshwater biodiversity	Freshwater biodiversity in Lebanon contributes 16% of fauna and 6% of flora species. There are 987 species of freshwater fauna and flora: 656 are known freshwater invertebrates, including 61 worm species, 41 mollusc species, 60 crustacean species, and 494 insect species. About 5% of the country's freshwater fauna are threatened, including the otter (<i>Lutra lutra</i>), which is globally Near Threatened, and 1.3% are endemic (MoE/UNDP/UNHCR/UNICEF, 2021). ► Freshwater fish: of the 25 species of freshwater fish, one species is considered Vulnerable, three Endangered and two Critically Endangered. The only endemic freshwater fish to Lebanon, <i>Phoxinellus libani</i>, was considered extinct in 1996, however, its presence has been confirmed in Yammouneh Lake, Litani River and Qaraoun Lake, all of which face many threats from human activities and pollution. ► Molluscs: a survey of limnic and terrestrial molluscs collected 17 freshwater and 33 land gastropod species as well as 6 small clams; 11 new records of molluscs were also reported for the first time in Lebanon.
Biodiversity of Lebanese coasts	Lebanese waters constitute less than 1% of the world's ocean surface but hold 6% of global marine species. Several marine biotopes, including rocky, sandy, sludgy, coastal, neritic and oceanic can be found, where biocenoses have developed according to the prevalent geological, physical and chemical conditions (MoE/UNDP/UNHCR/UNICEF, 2021). There is no national list of species for Lebanese marine biodiversity. However, the following data are available from various sources (MoE/UNDP/UNHCR/UNICEF, 2021): ► Phytoplankton: 385 species. ► Zooplankton: 783 species have been identified, 220 microzooplankton and 563 macrozooplankton. ► Macrophytes: 243 including 29 non-native species. ► Zoobenthos: 1,072 marine invertebrates recorded, 156 of which are exotic. Molluscs account for 371 species, including 30 gastropods and 18 alien bivalves. Benthic communities contain an extremely diverse assemblage of species groups like sponges, Cnidaria, Nemertea, Polychaetes, Sipunculans, Molluscs, Brachiopoda, crustaceans, echinoderms and Asidies. ► Ichthyofauna: 367 species comprising 39 Chondrichthyes. ► Marine mammals: a total of seven species have been recorded in Lebanese waters: short-beaked common dolphin, common bottlenose dolphin, fin whale, Cuvier's beaked whale, Risso's dolphin, striped dolphin and Mediterranean monk seal. In winter 2019-2020, orcas were observed and documented along the Lebanese coast. ► Marine herpetofauna: there are four species of marine herpetofauna in Lebanon, the most common being the loggerhead sea turtle and the green sea turtle, which regularly nest along some of Lebanon's few remaining sandy beaches. Rare records exist for the other two species, the leatherback sea turtle and the olive ridley sea turtle. ► Marine ornithofauna: a total of 404 bird species have been reported in Lebanon. Of those, 86 species, including 35 foreshore species, 18 coastal species, 6 maritime species and 27 species with different affinities were documented in the northern part of Lebanon.

FIGURE 2-29 Forest map of Lebanon (Sarkissian, A. J. 2015).

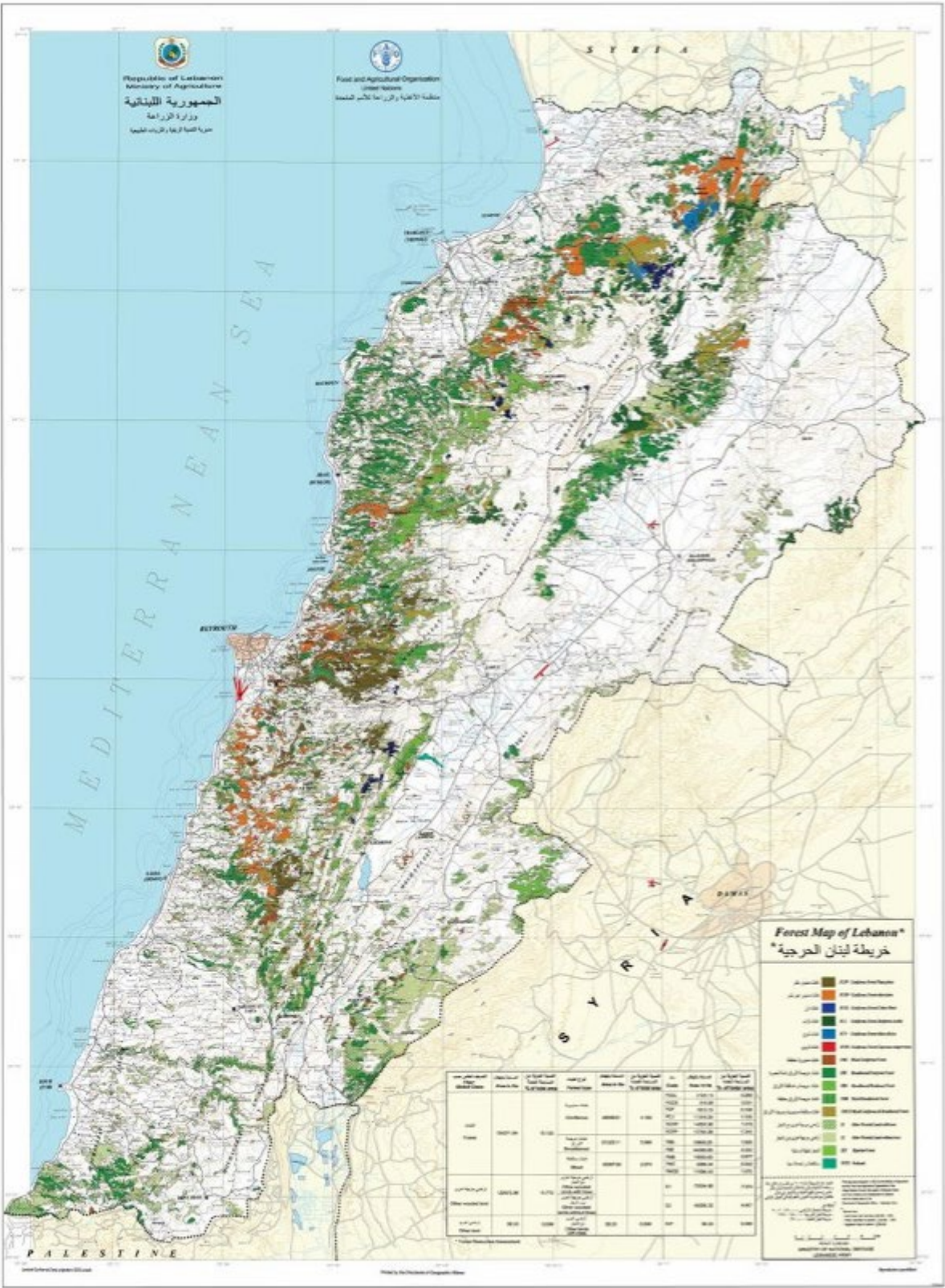
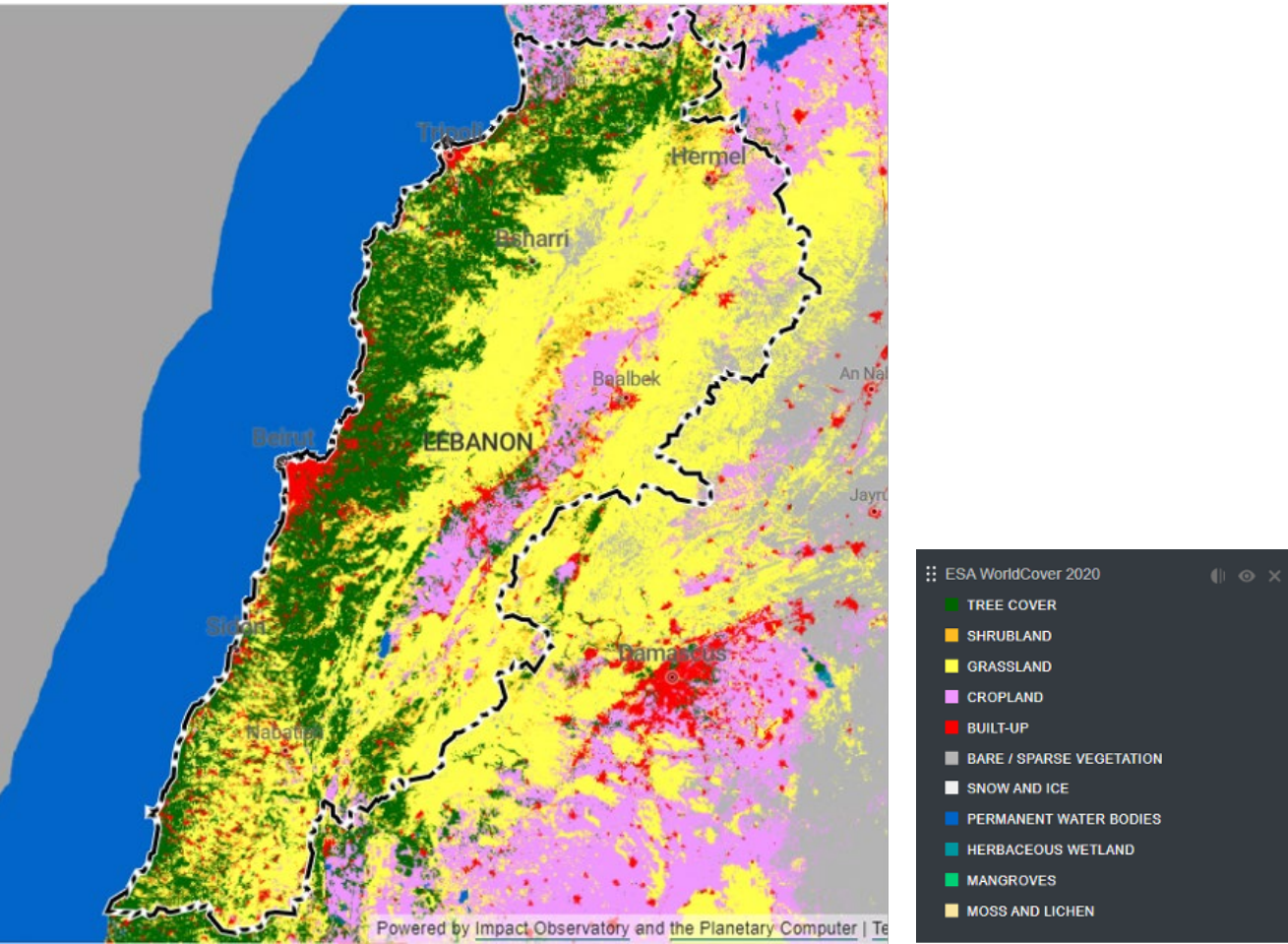


FIGURE 2-30 Land cover map (source: UN Biodiversity Lab, 2023).



2.5.2 Challenges and threats affecting the ecosystem sector in Lebanon

The main challenges and threats facing ecosystems in Lebanon, according to the SOER 2020 (MoE/UNDP/UNHCR/UNICEF, 2021), are described in the following sections.

2.5.2.1 Urban expansion, haphazard urbanisation and changes in land use

Urban expansion and haphazard urbanisation have had adverse effects on different ecosystems in Lebanon. These impacts have been particularly significant on forest landscapes and woodlands, especially in the mountainous systems of the Western Mount Lebanon slopes and coastal areas.

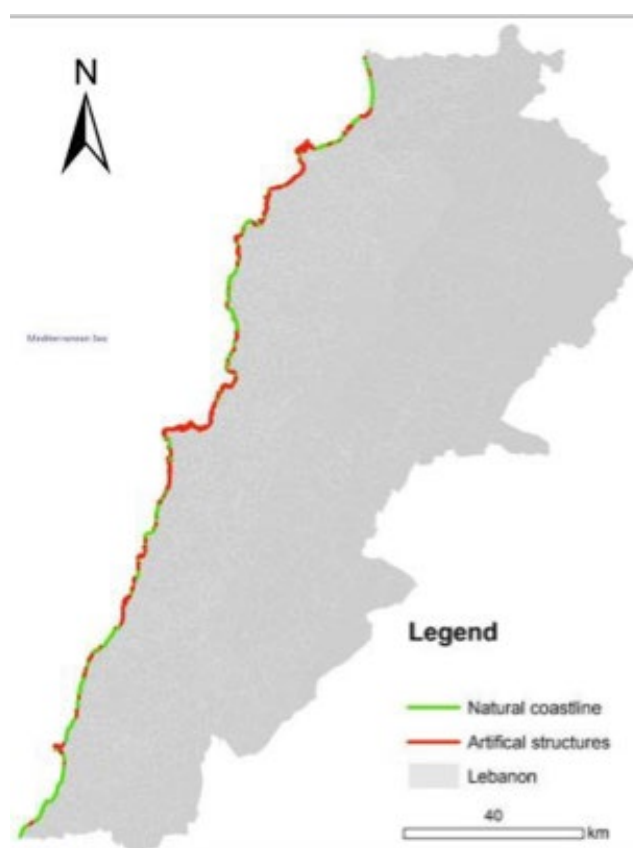
As in most Mediterranean countries, the Lebanese coastal zone has undergone drastic land-use changes, shifting from natural to biocultural uses associated with traditional activities like agriculture and fisheries, and ultimately to urbanised settings. Unfortunately, most of these transformations are irreversible, resulting in the conversion of natural and agricultural areas into built-up residential spaces (MoE/UNDP/UNHCR/UNICEF, 2021).

The changes that occurred between 2015 and 2020 are currently being assessed as part of a different United Nations Environment Programme (UNEP) Global Environment Facility (GEF) MedProgramme activity focused on integrated coastal zone management (ICZM). Provisional

results show a substantial increase in some built-up areas (up to **66.55%**), a reduction in agricultural areas and wetlands (up to just over **33%**) and a slight increase in forest and semi-natural areas (**7.08%**). In certain regions, the increase in built-up areas along the coast exceeds **100%**, and even **500%** in some cases (provisional data provided by the Priority Actions Programme/Regional Activity Centre (PAP/RAC) in the draft report on the Second WEFE Nexus Consultation in Lebanon).

The inadequate implementation of urban planning and failure to adhere to established plans has created significant pressures on biodiversity in Lebanon (MoE/UNDP/UNHCR/UNICEF, 2021). The informal settlements of displaced Syrians have further intensified pressures on urban areas and natural sites, resulting in significant impacts on Lebanon's biodiversity (MoE/UNDP/UNHCR/UNICEF, 2021).

FIGURE 2-31 Encroachment over coastal habitats (Fadel A., 2021).



2.5.2.2 Over-exploitation of resources

Overgrazing: Despite the potential benefits of grazing for forest ecosystems and its capacity to protect them from fires, inadequate management of grazing has depleted forest cover in several

regions of Lebanon (MoE/UNDP/UNHCR/UNICEF, 2021).

Over-exploitation of forest resources: Non-timber forest products, including edible wild plants, are over harvested, and the economic crisis is increasing the stress on forested areas as

vulnerable people rely on firewood for heating (MoE/UNDP/UNHCR/UNICEF, 2021).

Uncontrolled hunting and fishing threaten fauna species (MoE/UNDP/UNHCR/UNICEF, 2021):

- ▶ Bird species have declined at rates of **14-19%** between 1999 and 2008, a trend that can be reversed through enforcement of the hunting law (2017), and the expansion of protected areas.
- ▶ Although marine fishing in Lebanon is characterised as artisanal and traditional, it exerts significant pressures on marine ecosystems. Nonetheless, the MoA has actively undertaken regulatory measures to mitigate and minimise destructive fishing practices.
- ▶ Overfishing of freshwater fish has led to the extinction of certain species in river ecosystems.

Quarries and sand extraction (MoE/UNDP/UNHCR/UNICEF, 2021):

- ▶ Quarries are established without proper assessment of their effects on natural systems, habitats, geological features and groundwater systems. Consequently, they cause significant habitat loss and permanently alter landscapes.
- ▶ Sand extraction in coastal areas has significantly disrupted ecosystems, primarily due to inadequate law enforcement.

2.5.2.3 Pollution

Pollution in Lebanon is adversely impacting natural ecosystems and biodiversity. Multiple sources of pollution have been identified as significant contributors to this damage, including (MoE/UNDP/UNHCR/UNICEF, 2021):

- ▶ Discharge of untreated or partially treated municipal and industrial wastewater into the environment
- ▶ Uncontrolled disposal and incineration of municipal solid waste and other waste materials
- ▶ Excessive use and application of agro-chemicals such as pesticides and fertilisers
- ▶ Improper discharge of construction and demolition waste
- ▶ Air pollution originating from various sectors including transportation, power generation and industry
- ▶ Light pollution from urban areas, resulting in a significant decline in the nesting potential of marine turtles on sandy beaches
- ▶ Oil spills affecting birds, marine mammals and fish, especially in coastal areas and habitats.

FIGURE 2-32 Municipal waste management in Lebanon, areas served and projects in 2018 (Farah *et al.*, 2021).

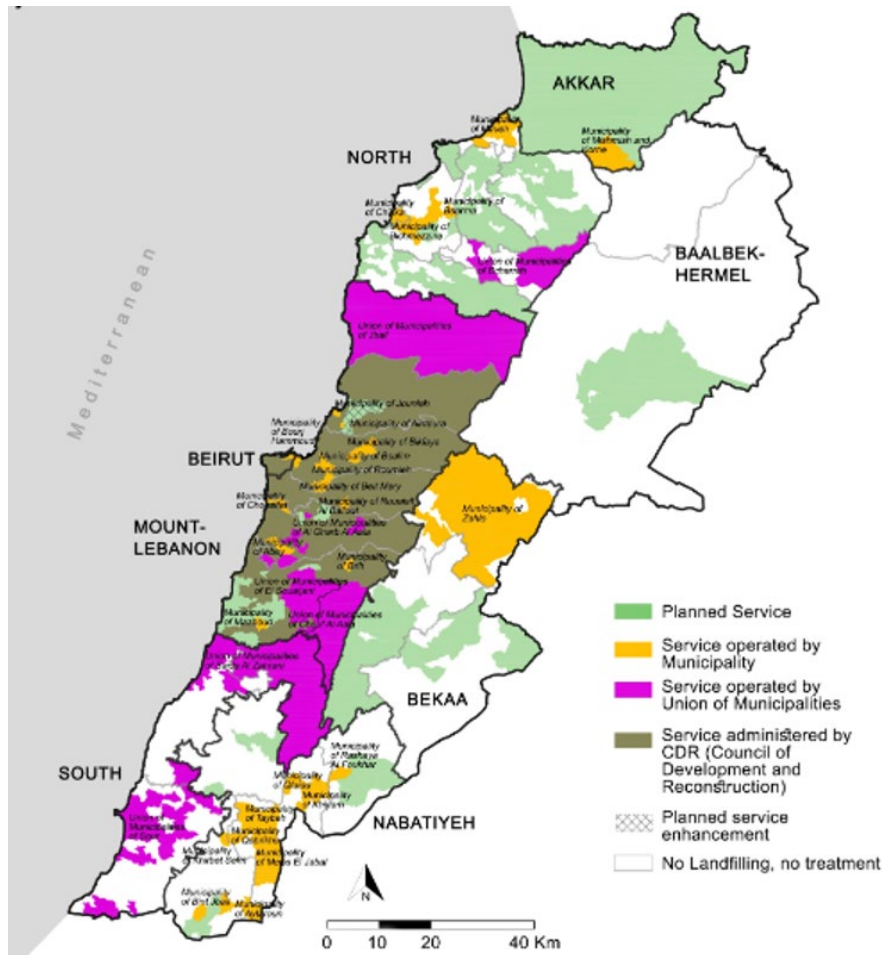


FIGURE 2-33 Locations, status and volumes of dumpsites in Lebanon in 2016 (UNDP/MoE, 2017).

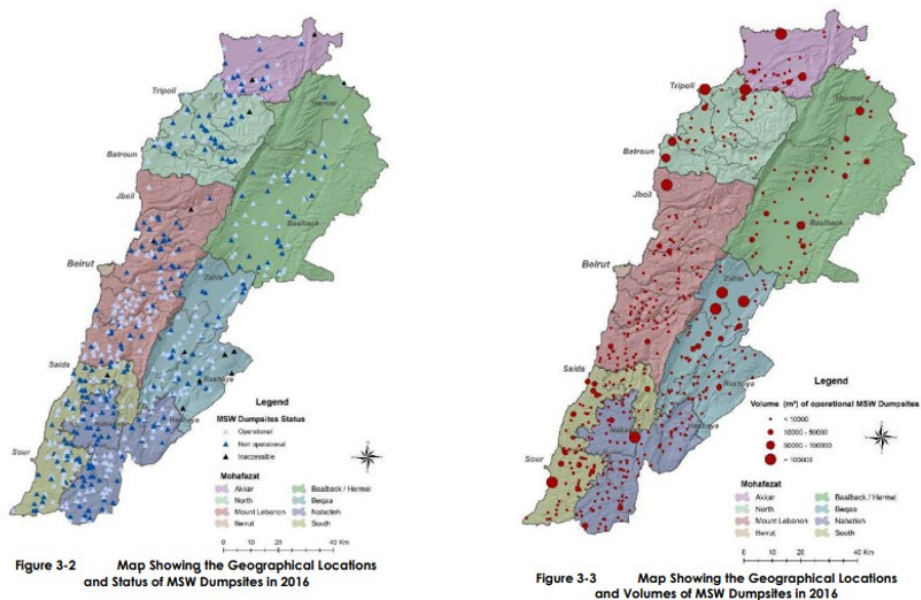


FIGURE 2-34 Bacteriological status of seawater at monitored stations (CNRS, 2023).



2.5.2.4 Climate change

The Mediterranean climate is projected to experience more frequent and intense droughts and higher temperatures. Species that inhabit the high-altitude zones of Lebanon are predicted to be the most affected by bioclimatic shifts. Species with limited and localised habitat ranges, especially endemic species, are particularly vulnerable to these shifts. Mammals may disappear due to habitat loss and amphibian species are also expected to be adversely affected (MoE/UNDP/UNHCR/UNICEF, 2021).

The risk of forest fires is expected to rise, especially in areas near human settlements and activities. Forest fires have caused the fragmentation, loss and degradation of sizable hectares of forested land, affecting ecosystem services and the livelihoods of local communities. There may also be an increase in pest infestations, with various types of insects already causing significant damage to Lebanon's forests (MoE/UNDP/UNHCR/UNICEF, 2021).

Additional factors that are considered to impact ecosystems include fewer cold periods necessary

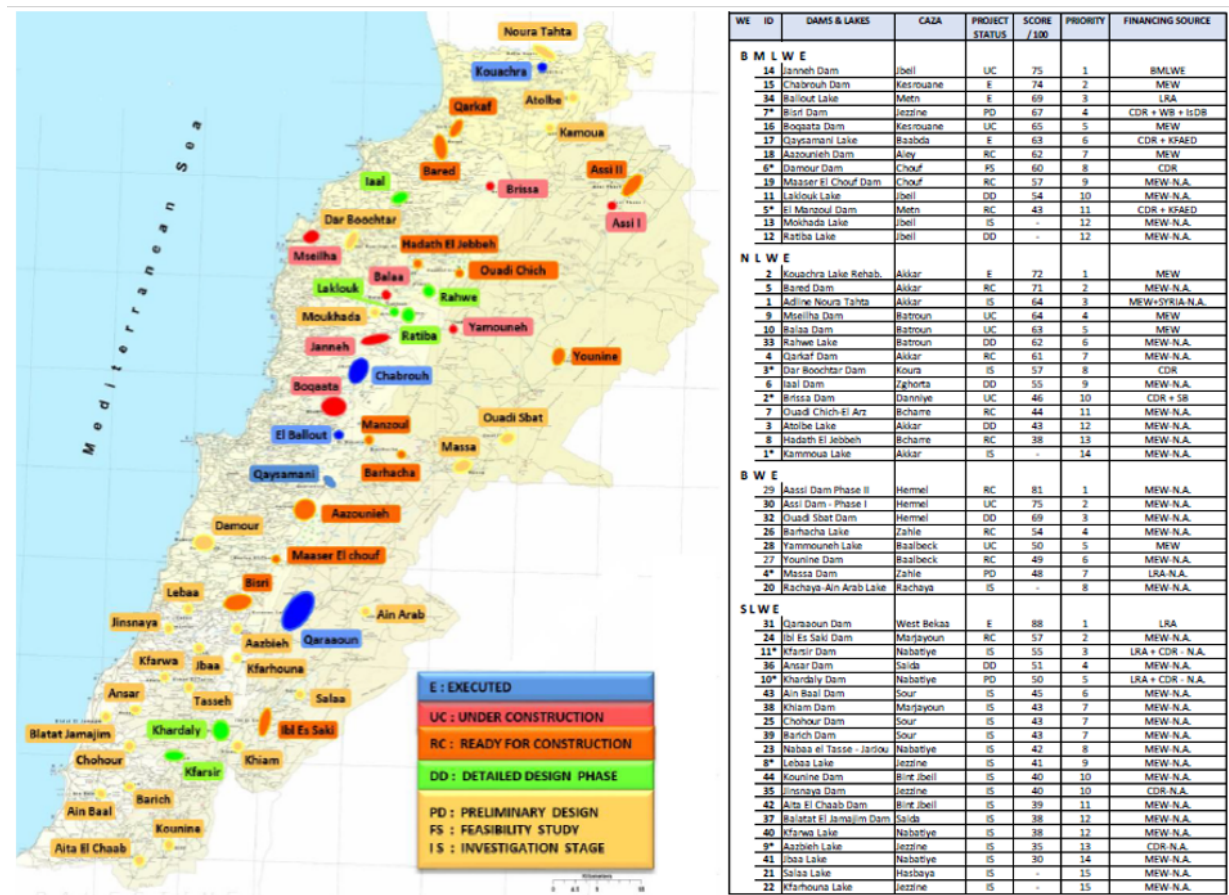
for flowering and seed germination, advancement in the flowering period, a longer growth season, insufficient winter hardening, a decrease in snow and other winter damage (MoE/UNDP/UNHCR/UNICEF, 2021).

The effects of climate change on the marine environment might include intensified storms, elevated sea surface temperatures, increased water acidity (ocean acidification) due to the absorption of CO₂ emissions, sea level rise, the introduction and proliferation of non-indigenous species and a decrease in ocean oxygen levels. Alterations in sediment flow may also contribute to increased risks of beach erosion or regression (MoE/UNDP/UNHCR/UNICEF, 2021).

2.5.2.5 Dams and river diversions

Dams can have adverse effects on surrounding ecosystems by interrupting the natural water flow and altering the characteristics of these areas. In the coastal region, the construction of dams along rivers and the diversion of many coastal rivers for drinking water and irrigation purposes have reduced the supply of sediment (MoE/UNDP/UNHCR/UNICEF, 2021).

FIGURE 2-35 Dams in Lebanon according to the NWSS 2020-2035 (MoEW, 2022 (a)).



2.5.2.6 Uncontrolled recreational activities

Uncontrolled recreational activities, including recreational fishing, scuba-diving, jet-skiing, boating, skiing and other snow sports, and off-road activities using all-terrain vehicles, pose a significant threat to various ecosystems in Lebanon through trampling, excessive noise, littering and habitat damage (MoE/UNDP/UNHCR/ UNICEF, 2021).

2.5.2.7 Invasive species

Several invasive species have been documented in Lebanon. These species threaten to overtake natural habitats and may reduce biodiversity (MoE/UNDP/UNHCR/UNICEF, 2021).

2.5.2.8 Lack of data

There is a lack of information regarding many aspects of biodiversity, hindering the development of appropriate management measures. The intrinsic value of Lebanon's biodiversity, including its socio-economic and cultural significance, is not sufficiently recognised and rarely addressed (MoE/ UNDP/UNHCR/UNICEF, 2021).

2.5.3 Ecosystem sector governance analysis

2.5.3.1 Efficiency

The regulatory framework

Ecosystems are not governed by a sector-wide law. However, legal texts regulating and managing ecosystem protection are exhaustive and include laws, decrees and decisions issued by the Lebanese Parliament, CoM, MoE and MoA.

FIGURE 2-36 Legal documents and strategies governing the ecosystems sector.

Main governing legal texts	Many regulations, aiming at protecting, organizing, and setting the rules for the management of various ecosystems • Environment Protection Law 444/2002 • Forest Law (1949) and related regulations • Laws regulating coastal zone • Laws regulating hunting and fishing • Protected Areas Law (130/2019), and laws declaring protected areas • ICZM draft law
Strategies, policies and action plans	• MoE-Lebanon's National Biodiversity Strategy and Action Plan (NBSAP), 2016-2030 • Lebanon National Forest Program (2015-2025) • National Afforestation and Reforestation Programme (NARP) 2014-2028 • ICZM draft strategy

The Environmental Protection Law 444/2002 regulates environmental protection, stipulates the need to protect ecosystems and calls for the creation of a National Fund for the Environment.

The Environmental Prosecution Law 251/2014 allocates public prosecutors and judges, appointed by the Ministry of Justice, to prosecute violations of environmental regulations.

The Water Code (77/2018 and 192/2020) covers the protection of environmental and water resources, such as freshwater habitats and wetlands.

The Air Quality Protection Law (78/2018) addresses the protection of air quality and includes the identification and monitoring of air pollutants.

The Protected Areas Law 130/2019 aims to improve nature conservation procedures and regulate the management of protected areas. Other legal texts declare selected sites as protected, with different degrees of protection and

conditions related to their management (nature reserve, natural sites, *himas* (community-based conservation areas), etc.).

Law 80/2018 introduces integrated solid waste management (ISWM) and covers all stages of the solid waste management process: source reduction, reuse, source and plant sorting to recycling, composting and final disposal of residual waste.

Law 85/1991 and its amendment, Law 558/1996, targeted the protection of forests and banned several activities inside forests. In addition, Law 195/2000 allowed the criminalisation of illegal actions (including fines or imprisonment). A draft forest fire law has been prepared by the MoE but has yet to be approved by the CoM.

In 1994, Lebanon ratified the "Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources – Athens" through Law 292.

Moreover, following the ratification of the ICZM Protocol of the Barcelona Convention (ratified by Decree 126 in 1977), a draft ICZM Law was drafted in 2017 and is ready for submission to the CoM before being presented to Parliament. The MoE also developed a draft ICZM Strategy in 2015, which is currently under review.

Status of data and data-sharing mechanisms

Public institutions, research centres and NGOs produce data and information on ecosystems. Unfortunately, this valuable knowledge is often left unpublished or is not effectively shared with stakeholders, which can result in redundant efforts. The inadequate interaction between research and policymakers also affects the country's development (MoE/UNDP/UNHCR/UNICEF, 2021).

The Lebanese Government periodically publishes a variety of ecosystem-related data as a requirement of the international conventions that Lebanon has signed. These include Lebanon's National Reports to the UN Convention on Biological Diversity and Lebanon's National Communication on Climate Change.

Financial constraints and funding mechanisms

The MoE's budget is one of the lowest budgets of any ministry, restricting its ability to procure consulting services, as well as operational and maintenance services (MoE/UNDP/UNHCR/UNICEF, 2021).

To fulfil Lebanon's international obligations, the international community, including donors, funding agencies and UN organisations, has consistently provided funding for environmental matters. These funds have been instrumental in enabling Lebanon's reporting on various international environmental agreements, as well as the implementation of numerous environmental protection projects (MoE/UNDP/UNHCR/UNICEF, 2021).

Additionally, the BDL has made contributions towards environmental protection, specifically through the Lebanon Environmental Pollution Abatement Project (LEPAP), which aimed to assist industries in achieving environmental compliance (MoE/UNDP/UNHCR/UNICEF, 2021).

2.5.3.2 Effectiveness

Policy coherence status

As previously noted, the **preservation and rehabilitation of aquatic ecosystems, forests and coastal ecosystems** is addressed in legislation, and there are specific sectoral strategies to tackle these issues. However, some of the relevant laws lack the decrees required for effective implementation, and inadequate enforcement, stemming primarily from **political and bureaucratic constraints**, exacerbates the **challenges to ensuring sound environmental governance** in the country.

The cases of the Forest Guards and the Environment Police demonstrate this. Despite being legally established, these organisations are not currently operating. This lack of functionality makes it extremely difficult to enforce regulations that aim to protect crucial ecosystems, including forests, aquatic environments, coastal areas and marine ecosystems. The consequences of this include chaotic management of solid waste, unsustainable use of natural resources, unauthorised development and construction along the coast, a resurgence in hunting and bird massacres, uncontrolled logging and charcoal production, and illegal quarrying practices. Social and economic instability has only worsened this situation.

Furthermore, there are several draft laws which have been pending for a significant period of time, yet are crucial if specific ecosystems are to be effectively managed. These drafts encompass various pieces of legislation, such as the proposed ICZM Law, a law on fisheries and aquaculture, and numerous laws designating natural reserves. Additionally, a draft ICZM Strategy was initially

produced by the MoE in 2015; however, it has not progressed further and is currently under review.

Another significant policy challenge is the **absence of a comprehensive urban master plan** that incorporates considerations for agricultural land, natural resources and ecosystems. Additionally, there is a lack of awareness among both the public and policymakers responsible for managing various natural resources regarding the significance of safeguarding ecosystems.

Strategies and plans aimed at protecting biodiversity implicitly benefit the preservation of important ecosystems. These strategies and plans include the National Biodiversity Strategy and Action Plan (NBSAP 2016–2030) and the National Strategy for Conservation and Management of Plant Genetic Resources for Food and Agriculture in Lebanon (PGRFA 2015–2030). Various plans address the protection of forest ecosystems, such as the Lebanon National Forest Program (2015–2025), the National Afforestation and Reforestation Programme (NARP 2014–2028) and the National Strategy for Forest Fire Management.

Concerning the **protection of mountainous ecosystems** and following a specific request from the MoE, in 2019 the CoM entrusted the CDR to develop a master plan to protect mountain peaks and natural areas, and regulate the exploitation of beaches, green areas and agricultural land (MoE/UNDP/UNHCR/UNICEF, 2021). This work is currently focused on the high mountains, above **1,500 m**.

Lebanon's updated NDC for 2020 addresses climate change issues relevant to ecosystems through a cross-sectoral approach reflected in a set of adaptation priorities and linked actions.

Ecosystems protection is particularly targeted through:

- **NDC adaptation priority 2:** Promote the sustainable use of natural resources, restore degraded landscapes and increase Lebanon's forest cover while meeting the ecological, social

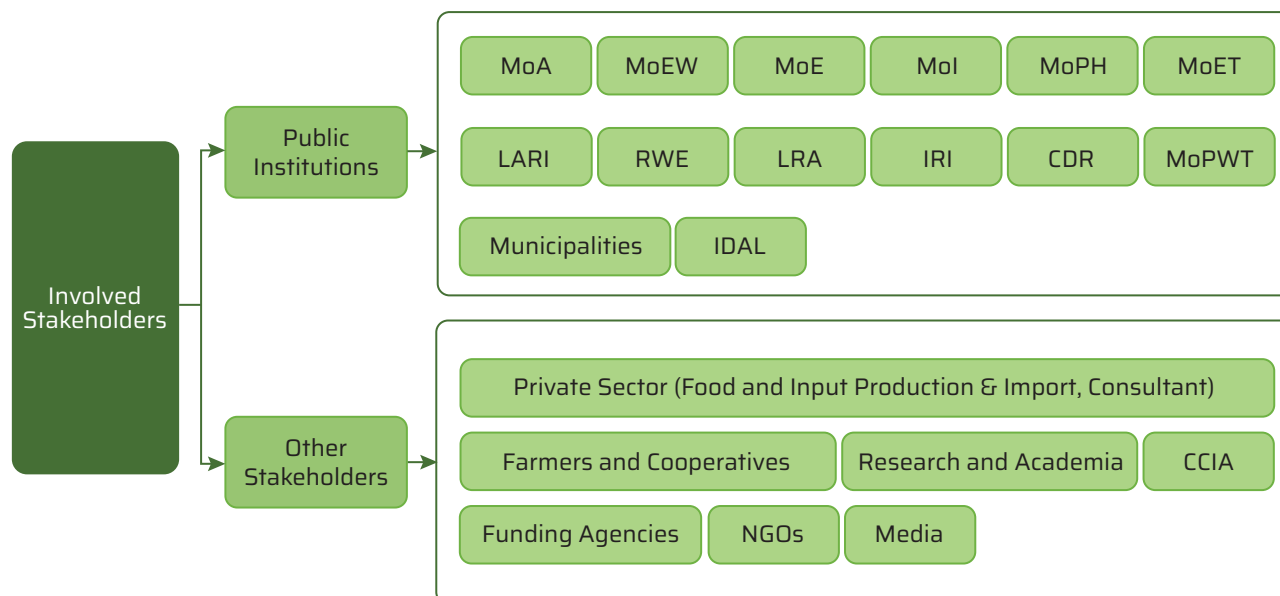
and economic needs of sustainable forest management:

- Adapt forest systems to climate change by halting land degradation, controlling erosion of topsoil, improving water quality and soil productivity
- Establish sites with improved production capacity linking with the development of the wood and non-wood forest product processing industry and with the people's needs in terms of goods and services and improved employment opportunities
- Promote sustainable rangeland management
- Reduce the risk of intense and frequent forest fires through the development of fire prevention measures and early warning systems
- Manage pest and disease outbreaks to protect forests and forest resources.
- **NDC adaptation priority 4:** Value and sustainably manage Lebanon's terrestrial and marine biodiversity for the preservation and conservation of its ecosystems and habitats and the species they harbour in order to adequately respond to anthropogenic and natural pressures and to ensure Lebanese citizens equal access to ecosystem goods and services:
 - Identify the status of **75%** of known flora and fauna species and implement conservation actions on **50%** of threatened species
 - Protect at least **20%** of natural terrestrial and marine ecosystems and represent all types of ecosystems in the protected areas network
 - Increase the total percent coverage of nature reserves to reach at least **5%** of Lebanon's area

- Sustainably manage **50%** of all natural ecosystems and properly consider them in spatial planning implementation
- Alleviate the gap between Lebanon's ecological footprint and biocapacity to reach an equal state
- Establish effective measures to control the introduction and diffusion of non-indigenous biodiversity into the environment
- Identify vulnerable ecosystems to climate change and develop and implement appropriate adaptation plans
- Implement rehabilitation plans in at least **20%** of degraded sites so that they can safeguard the sustained delivery of ecosystem services
- **NDC adaptation priority 5:** Reduce the vulnerability of climate change impacts on coastal zones, especially in cities:
 - Assess seawater intrusion in the major coastal aquifers
 - Enhance the artificial recharge of some selected aquifers
- Refresh the water budgeting of all aquifers progressively (i.e. update and collect the data required to enable water budgeting for Lebanese aquifers)
- Perform the modelling of the karstic, saline and porous aquifers
- Increase the protective capacity of coasts against storm surges and sea level rise
- Promote sustainable use of natural resources, such as fisheries.
- **NDC adaptation priority 7:** Reduce disaster risk and minimise damage by mitigating and adapting to climate-related natural hazards and extreme weather:
 - Conduct a multi-hazard risk assessment
 - Update/revisit flood, fire and drought risk maps
 - Upgrade and develop an early warning platform for multi-hazards
 - Coordinate the updating of the National Strategy for Forest Fire Management

Stakeholder roles and responsibilities

FIGURE 2-37 Stakeholders involved in the ecosystems sector.



The MoE is the main public body in charge of protecting and managing ecosystems and the environment. The MoA, through the Rural Development and Natural Resources Directorate, is the official body in charge of the forestry sector.

The MoEW and RWEs are responsible for issues related to watershed management, the conservation, remediation and rehabilitation of aquatic ecosystems, including wetlands, and combatting floods and droughts.

Several other public institutions are involved in managing and protecting ecosystems, including the MoET, MoPH, MoD, Ministry of Tourism (MoT), Ministry of Interior and Municipalities (MoIM), municipalities and Unions of Municipalities.

Status of human capacity in the sector

The MoE's human and financial capacities are highly inadequate. Despite its vast responsibilities, more than half of the MoE's required positions, as established by regulations, have remained vacant (MoE/UNDP/UNHCR/UNICEF, 2021).

Cooperation projects with international development organisations fill the gap in human resources. These projects provide experts and support staff to help with the implementation of various legislative, research, training, monitoring and environmental awareness activities and functions. Many projects have also supported public sector staff working on environmental issues through capacity-building, including on biodiversity, conservation of birds and hunting law, and awareness around SEAs and EIAs, land use and ecosystem management, etc. (MoE/UNDP/UNHCR/UNICEF, 2021).

Inter-ministerial coordination and collaborative planning

The MoE has created councils to facilitate coordination between different authorities, including the NCE, the National Council for Quarries and the Higher Council for Hunting. It has also formed the ISWM Committee (in accordance with Law 80/2018) to coordinate ISWM matters. The inter-ministerial NDC Committee was also formed in 2018 to establish mitigation targets

and actions to reduce GHG emissions through cross-sectoral collaboration. Unfortunately, most of these bodies are not currently meeting.

Lack of efficient monitoring and evaluation

Despite the large amount of data, coordination on data exchange is lacking and a comprehensive central national database on environmental monitoring has yet to be established (MoE/UNDP/UNHCR/UNICEF, 2021).

On biodiversity in particular, various programmes, strategies and action plans focus on monitoring, such as the NAS 2020-2025, and Lebanon's National Biodiversity Strategy and Action Plan (NBSAP 2016-2030), while specific initiatives have been designed exclusively for this purpose, such as the National Monitoring Programme for Marine Biodiversity in Lebanon (developed by the MoE in 2018).

2.5.3.3 Trust and engagement

Transparency and stakeholder engagement

The Environmental Protection Law 444/2002 pushes for public participation in decision-making. Public hearings, meetings and consultations are participatory approaches that form an integral part of the SEA and EIA studies (Decree 8213/2012 and Decree 8633/2012). However, these meetings are purely consultative. Stakeholders can only influence decision-making, not participate in it.

Moreover, the same law states that any individual interested in environmental management and sustainable development has the right to access environmental information from the MoE by making a written request. To meet the requirements of the Access to Information Law 28/2017, the MoE assigned four employees to share information that was requested, although it is unclear whether this process has been successful (MoE/UNDP/UNHCR/UNICEF, 2021). Additional stakeholders overseeing the sector have achieved low overall scores in relation to the implementation of this law.

2.5.4 Thematic areas of priority for the ecosystems sector

Following analysis of the current status of ecosystems, including an examination of the relevant governance frameworks, several areas have been identified that, if properly dealt with, have the potential to bring about significant improvements. These areas are outlined in the following sections.

2.5.4.1 Enforcement of environmental protection regulations

The enforcement of environmental protection regulations in Lebanon has been hindered by social, political and economic instability. This has resulted in the ineffective management of various sectors, including the improper handling of solid waste, unsustainable use of natural resources, uncontrolled hunting and bird massacres, chaotic logging and charcoal production, and illegal quarrying. Enforcing environmental protection legislation would reduce the negative impacts on natural resources and ecosystems and requires addressing the gaps in the legislative framework, including by developing implementing decrees for legislation to protect and conserve ecosystems.

2.5.4.2 Issue of pending draft laws

The proposed legislation encompasses the ICZM draft law, a new draft law focusing on fisheries and aquaculture, issued and endorsed by the MoA in 2020, as well as multiple laws establishing nature reserves. Adopting these laws would complement the existing legislative framework and further protect various habitats and species. Their approval requires the collaborative efforts of relevant ministries and legislative bodies, to ensure that executive regulations enabling their effective implementation are issued.

2.5.4.3 Enforcement of environmental management plans (EMPs) included in EIA/SEA studies

EMPs developed as part of EIA and SEA studies to mitigate the potential impact of development projects are not always implemented. Proper execution of these plans would require the creation of effective monitoring systems and the introduction of penalties. This effort would necessitate collaboration among the MoI, MoE, MoIM and law enforcement agencies.

2.5.4.4 Updated NPMPLT

Land degradation, habitat fragmentation and coastal infringement are major threats to Lebanese ecosystems. Unfortunately, both the public and private sectors have failed to adhere to the NPMPLT, which was issued in 2005 and approved in 2009, with infrastructure and development projects implemented in areas designated as being of high importance and needing protection (such as dams in protected natural sites). This plan must be revised and updated to account for developments and changes in land use, and enforced through monitoring, evaluation and plans that involve all relevant stakeholders.

2.5.4.5 Implementation of climate change mitigation and adaptation measures outlined in national documents

Several national documents and policies address the important issues of climate change mitigation and adaptation. Nevertheless, the implementation of these plans remains ineffective primarily due to insufficient funding. Adhering to the guidance provided in these documents would not only help Lebanon to achieve its GHG emissions targets, but also safeguard and improve biodiversity and ecosystems.

2.5.4.6 Enhanced public awareness about the value of ecosystems and biodiversity

An effective public awareness effort is needed to emphasise the value of nature and biodiversity, and their importance for overall community well-being. It is crucial to facilitate capacity-building and raise stakeholder awareness, focusing on the importance of ecosystems and the need to preserve them.

2.5.5 Ecosystems in the Nexus

The beneficial services provided to water, energy and food Nexus resources by effectively protected and well-managed ecosystems, including purification of water, maintenance of soil health, promotion of agro-biodiversity, provision of food sources, energy sources and carbon sinks, are globally researched and understood. This section focuses particularly on analysing the key interlinkages between two prominent anthropogenic causes of ecosystem disruption in Lebanon, namely **haphazard urbanisation** and **poor management of solid waste**, and water, energy and food security. These have been emphasised by stakeholders contributing to the WEFE Nexus Policy Dialogue in Lebanon as significant contributors to sustainability concerns across all Nexus sectors, through increased pressures on land, water resources, ecosystems and human health. While it is not discussed again here, the detrimental impact on water, energy and food resources from other causes of ecosystem degradation, as described in previous sections (resource over-exploitation, pollution, climate change, modification of environmental flows through infrastructure projects, uncontrolled recreational activities, invasive species) is addressed alongside haphazard urbanisation and mismanagement of solid waste through the specific WEFE Nexus solutions outlined in the next chapter.

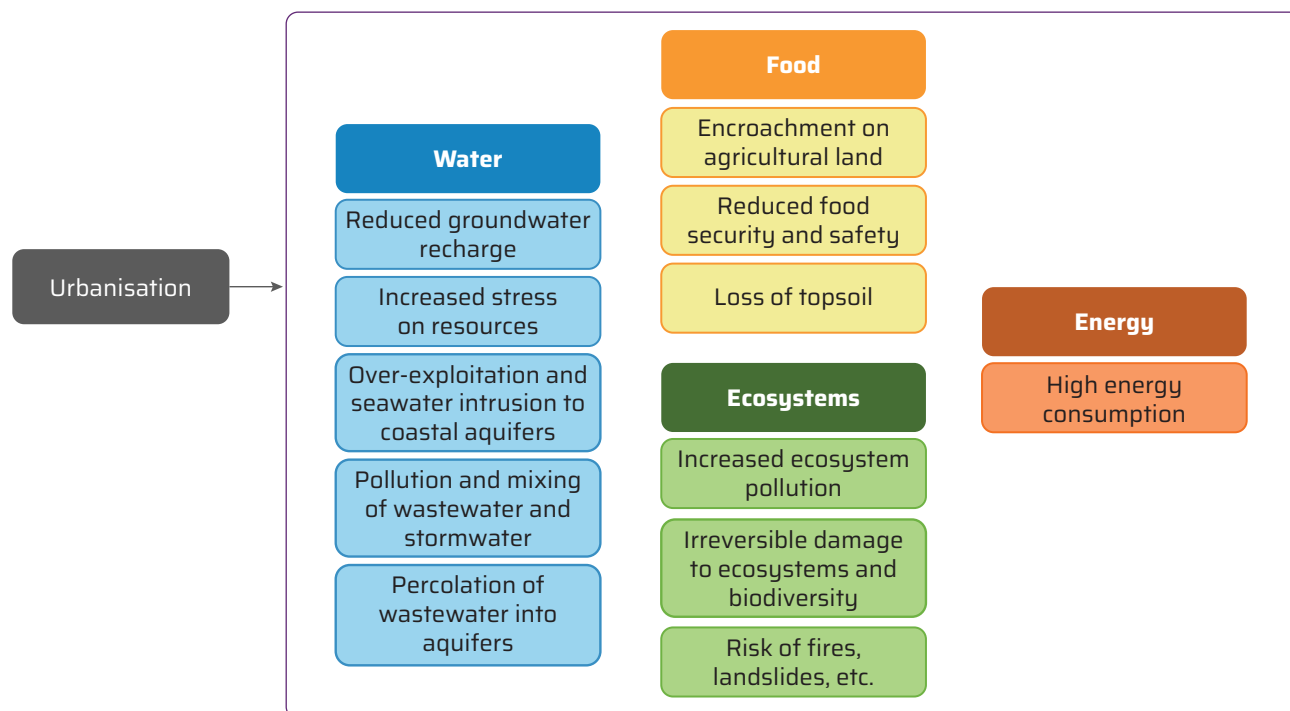
2.5.5.1 Haphazard urbanisation

The impacts of haphazard urbanisation on the WEFE sectors are summarised in Table 2-14 and Fig. 2-38.

TABLE 2-14 Interlinkages between haphazard urbanisation and WEFE sectors in Lebanon

Interlinkage	Description of direct and indirect impacts
Haphazard Urbanisation - Water and Wastewater	- Large paved areas, especially in densely populated zones, prevent rainwater from percolating through the soil and replenishing groundwater. - Current infrastructure rarely includes rainwater harvesting technologies, which could reduce pressures on other water resources (including groundwater). - In many cases, stormwater and wastewater are collected using the same networks, thus increasing the load on WWTP and decreasing their operational efficiency.
Haphazard Urbanisation - Energy	Most buildings are constructed without accounting for energy efficiency and conservation, therefore increasing energy demand for heating and cooling.
Haphazard Urbanisation - Food	- Urban sprawl into agricultural areas is reducing the amount of land suitable for cultivation, which in turn decreases agricultural production and increases the risks of pollution and soil contamination, especially in cases where the necessary infrastructure is lacking. - Topsoil, a highly valuable resource with a lengthy natural formation process, is sometimes regarded as waste instead of being reused to rehabilitate agricultural areas after being removed from lands used for construction purposes.
Haphazard Urbanisation - Ecosystems	Urban development and large infrastructure projects may cause permanent damage to natural ecosystems and disrupt habitats, thereby endangering various species and increasing the likelihood of fires, floods, landslides and other hazards when not planned based on sound scientific and technical knowledge.

FIGURE 2-38 Haphazard urbanisation impacts on water-energy-food-ecosystems.



As previously highlighted, the NPMPLT (2009) presented a framework for land development and use in the country, with the goal of integrating sectoral policies and programmes. The plan addressed important issues such as natural resource conservation and management as part of spatial planning, specifically in areas of biodiversity importance, such as valleys and coastal areas. However, it has not been fully implemented.

Several draft laws have also been introduced to address sustainable urban development, including the draft Energy Conservation Law, which covers all aspects of energy efficiency and conservation for buildings. Additionally, there is a draft ICZM Strategy, which is currently under review as part of the GEF/UNEP MAP MedProgramme CP 2.1, along with other related laws.

Sustainable urbanisation and infrastructure development, covering both new installations and the retrofitting of existing structures, present opportunities for innovation, job creation and long-term cost reduction by decreasing the

operational and maintenance expenditure of various projects, especially large-scale public projects and those funded and overseen by local authorities. These initiatives should consider and integrate groundwater recharge, energy efficiency, water conservation, rainwater harvesting and similar practices.

The key barriers to properly addressing trade-offs and synergies between urbanisation and natural resources are related to governance (gaps in legal framework, regulations that do not prioritise the protection of natural resources, lack of implementation of existing legislation on protecting ecosystems, lack of zoning and urban master plans in several areas), and to the lack of infrastructure for properly managing waste generated from urban areas (wastewater and solid waste), the prevalence of unsustainable practices (as previously discussed) and the absence of incentives to adopt sustainable practices.

Effective coordination in planning and developing urban communities and natural resources requires clear and open communication among

the different stakeholders responsible for managing various sectors. Furthermore, the development of guidelines and regulations, particularly implementing decrees for laws, is vital

to promoting and incentivising or enforcing the adoption of sustainable urbanisation practices, while reducing negative impacts on natural resources.

BOX 2-5 Contribution of sustainable urban development to UN SDGs

The implementation of sustainable practices in urban development and the integration of technologies that improve the performance of existing infrastructure and buildings has the potential to positively impact several SDGs, notably through enhanced water resources, innovation, efficient infrastructure and more sustainable cities and communities. These practices include applying technologies that promote energy efficiency, reducing water consumption, implementing rainwater harvesting, recycling greywater, utilising materials that enable stormwater infiltration and installing groundwater recharge galleries. Moreover, by protecting resources from urban expansion, agricultural land and terrestrial and aquatic ecosystems would also be safeguarded.



2.5.5.2 Mismanagement of solid waste

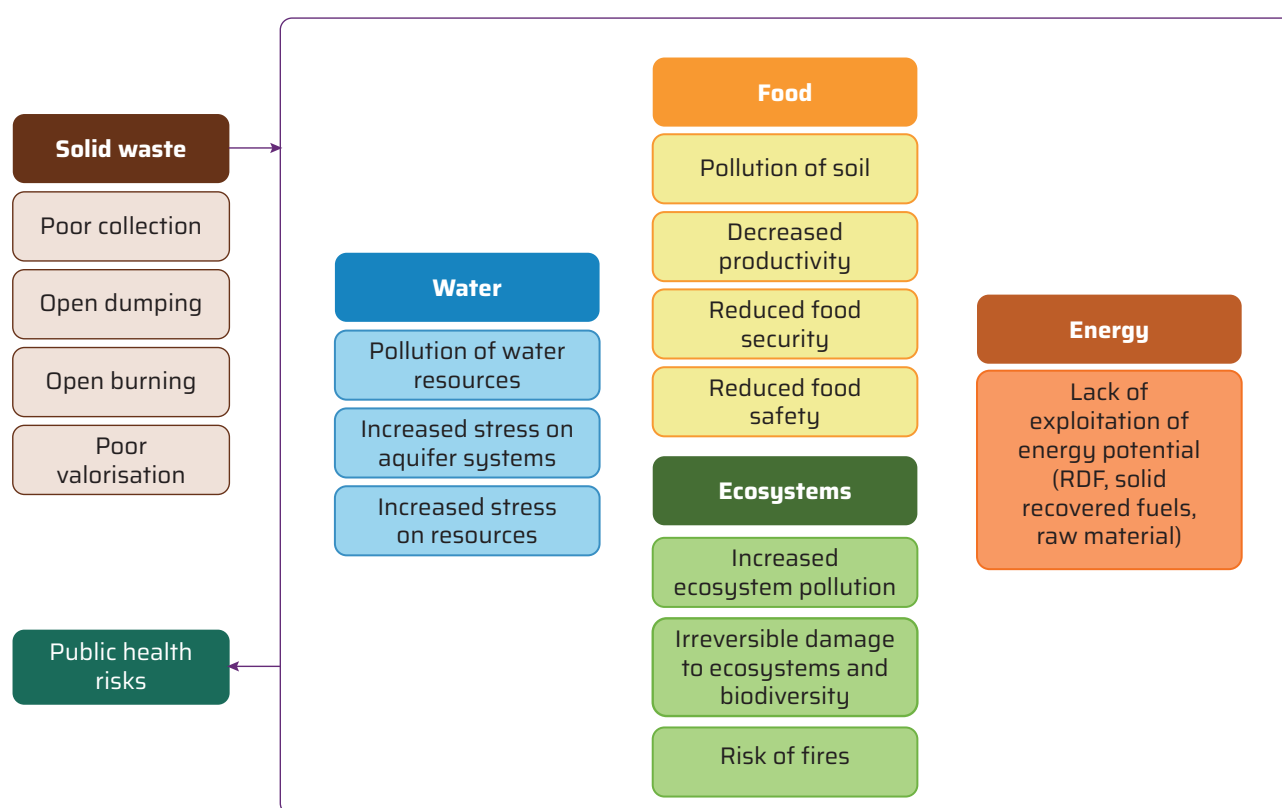
Table 2-15 and Fig. 2-39 below summarise the impacts of poor solid waste management on the WEFE sectors.

TABLE 2-15 Interlinkages between solid waste and the WEFE sectors in Lebanon

Interlinkage	Description of direct and indirect impacts
Solid Waste - Water	- Increased pollution of water resources and water courses due to: - leachate infiltration - solid waste dumping in valleys - waste being washed out by storms to reach rivers.
Solid Waste - Energy	Missed opportunities to exploit the energy potential of various solid waste streams that could contribute to the energy mix.

Interlinkage	Description of direct and indirect impacts
Solid Waste - Food	Pollution of soil and water resources has negatively impacted the food sector, decreased the productivity of land and threatened food safety.
Solid Waste - Ecosystems	Pollution from improper management, open dumping and burning of solid waste is severely impacting soil, causing the deterioration of various aquatic, marine and terrestrial ecosystems, and harming human health.

FIGURE 2-39 Mismanagement of solid waste impacts on Water-Energy-Food-Ecosystems.



Efficient solid waste management is crucial for safeguarding natural resources. Numerous stakeholders, including international organisations (World Bank, EU, UNDP, USAID and others), are currently working on this issue and providing financial support for research and projects to enhance management in the sector. However, it is important to note that implementing actual reforms requires political will.

The adoption of ISWM offers several benefits in addition to preventing and reducing pollution:

- Sorting solid waste at source would enable valorisation of various components of the waste stream that can be used in a range of applications:
 - Sorting, recycling and composting/processing organic material would provide a good quality fertiliser that can be used as a substitute for imported chemical fertilisers, or as animal feed, thus reducing the cost of agricultural production

- Plastics, cardboard and metals can be recycled and upcycled.
- Material with a high calorific value can be processed into refuse derived fuel (RDF) and alternative fuels, allowing energy to be generated using modern technology that maximises energy efficiency and minimises potential environmental impact.

The key challenges affecting the proper management of solid waste that could produce benefits for WEFE natural resources and sectors include issues related to governance (similar to the barriers for the other sectors), infrastructure availability, funding for waste collection and treatment, lack of diversion practices and visions for material reuse in industry and agriculture, and

an absence of support to help industry become part of the solution. There is also no existing policy framework to simplify material reuse and recycling and reduce the need for imported materials.

To address these challenges, a comprehensive sector reform is necessary. This should include a clear definition of the roles of the stakeholders involved to reduce overlap, better distribute responsibilities and improve financial recovery. It is important to coordinate this reform with other relevant sectors to promote coherent planning and allow solid waste components to be valorised. This would involve recycling, upcycling and reusing materials as inputs for other sectors, ultimately reducing the negative impacts on water, soil and air quality.

BOX 2-6 Contribution of ISWM to UN SDGs

The contribution of ISWM to the UN SDGs includes preventing pollution, enhancing public health, reducing the pollution of water sources and protecting ecosystems (terrestrial and aquatic).



2.6 WEFE Nexus governance assessment: conclusion

2.6.1 Governance and the WEFE sectors in Lebanon through a gender lens

The Lebanese Constitution emphasises the principle of equality among all citizens, including Lebanese women who enjoy “equal constitutional rights with men and have the right to vote, hold public office, elect and be elected in municipal councils” (IE Med, 2017). However, despite the existence of a free political climate and electoral system, women’s participation and involvement in decision-making processes still fall short compared to men (MoE/UNDP/GEF, 2022) (NCLW, 2011). From a legal perspective this disparity is evident

in various areas, such as marital and family relationships, as well as citizenship rights, where unfairness and discrimination persist.

Lebanon faces one of the highest gender gaps in the world. It is particularly apparent when comparing women’s roles in urban and rural settings. Specifically, in rural areas, “women tend to carry a higher burden of both unpaid productive and reproductive work” (UNDP/MoE/NCLW, 2021).

Lebanese women constitute a significant majority, making up 53% of the population, and play an active role in the multiple facets of Lebanese society (IE Med, 2017). However, their representation in the labour force stands at a relatively low **29.3%**. It is noteworthy, however,

that the percentage of women in managerial positions aligns with their overall workforce participation, at approximately **29%** (MoE/UNDP/GEF, 2022). Additionally, the number of female entrepreneurs in Lebanon remains limited, indicating a reliance on wage employment opportunities for women (World Bank and UN Women, 2021).

Gender inclusion in policy varies significantly by sector. The agricultural and forestry sectors have made notable strides in this area, whereas the biodiversity, energy and water sectors lack any gender considerations (UNDP/MoE/NCLW, 2021).

Due to their traditional roles in the household, women are the main managers of water resources. This increases their risk of exposure to waterborne diseases and impacts from energy sector issues. Women face many challenges in access to energy and economic participation in the sector (UN, 2020).

In the field of agriculture, women play a significant role in the workforce. However, their contributions often go unnoticed, and they are not given financial or social recognition (FAO, 2021 (a)).

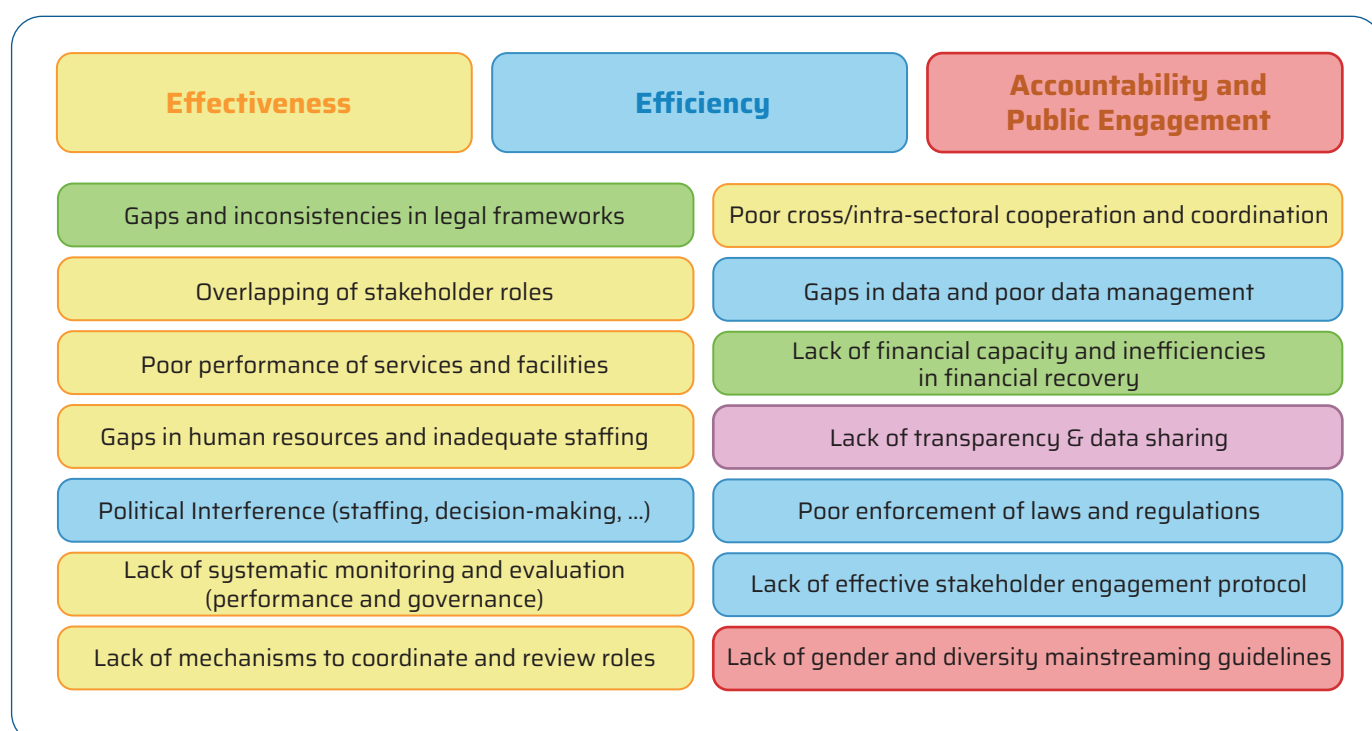
There are notable gender disparities when it comes to agricultural wages, and women face various challenges that hinder their involvement in the sector, including restrictions on land ownership, difficulties in transportation and mobility, and limited access to funds, technical training, technology and extension services (FAO, 2021 (a)) (UNDP/MoE/NCLW, 2021).

It is important to acknowledge the crucial role of female cooperatives in the agricultural sector. These cooperatives have been instrumental in advocating for social change in rural areas, empowering women economically and fighting for their political and economic rights. They have also been influential in ensuring that women have access to financial resources and productive assets (FAO, 2021 (b)).

2.6.2 Integrated WEFE Nexus governance

The enabling governance framework for the WEFE Nexus in Lebanon has various important gaps that affect effective planning and management both at the sectoral and cross-sectoral levels. These issues and weaknesses are schematically presented below (see Fig. 2-40).

FIGURE 2-40 Challenges facing WEFE Nexus governance.



Sector-specific national strategies have analysed weaknesses in governance and have put forth plans of action to address these issues. However, a lack of political interest and financial resources has hindered implementation of these reforms. At the intersectoral level, Lebanon does not have a formal approach that integrates the four WEFE sectors and the key stakeholders involved. Currently, the sectors are managed independently with limited coordination and support. This is particularly evident from various intersectoral management initiatives, such as the proposed committees on the ICZM Strategy, the Water Code, the NAS and the NDCs, and the recently established inter-ministerial committee for food security. Most of these initiatives have not been successfully implemented or sustained due to various factors.

The NDC plan was formulated by an inter-ministerial committee including the MoE, MoA, MoF, MoPWT, Petroleum Sector Administration, Prime Minister's Office and Ministry of Foreign Affairs. This is well reflected in the plan, which takes into account the interlinkages between the four sectors and leverages the existing strategies and goals of each one. The primary objectives of the plan are to reduce GHG emissions, safeguard the environment, promote food security and achieve water security through the sustainable utilisation of resources.

The Lebanese Government should focus on insulating technical cooperation and policy formulation within the WEFE sectors from political disagreements. It is essential to work towards

attaining adequate financial and institutional capacity in order to establish a sustainable trajectory for these sectors. Additionally, there is a need to streamline and align the regulatory framework across all sectors to ensure policy coherence and effectively manage interlinkages.

During the first multi-stakeholder consultation meeting related to the preparation of the Phase I WEFE Nexus Assessment for Lebanon, participants emphasised the importance of establishing a unified vision and harmonising the objectives and development of the WEFE sectors. A key priority identified was the reactivation of the Ministry of Public Planning, originally created in 1954 (through Decree 6393) to oversee the coordination and direction of Lebanon's development policies, statistical data collection to promote national wealth and the improvement of living standards and national income. The ministry was later abolished in 1977 and replaced by the CDR.

Finally, considering the ongoing crisis in Lebanon, a source of significant strain on its natural and physical endowment, it seems important to establish and sustain a WEFE Nexus process in order to effectively mitigate the negative impacts of the crisis and ensure the long-term sustainability of these resources through collaborative approaches. The WEFE Inter-Ministerial Group set up under the framework of this project could initiate a Nexus dialogue that would pave the way for more effective coordination between the sectors.

3. Proposed WEFE Nexus solutions

The WEFE Nexus solutions that have been identified are visualised in this chapter through schematics showing goals, objectives, sub-objectives, actions and alignment with national strategies. The assigned number for each Nexus solution facilitates cross-referencing. For instance, in number 1.2, the number 1 indicates the relevant goal, while the number 2 denotes the specific solution. From chapters 3.3 to 3.6, solutions are numbered to correspond with the discussions held during the second multi-stakeholder consultation workshop. Similarly numbered solutions within these sections refer to steps that were considered collectively to achieve a common output. Chapter 3.7 reflects

the outcomes of that discussion and presents the proposed solutions in sequential order.

3.1 Entry points to Nexus solutions

Based on the analysis of top-priority interlinkages presented in the previous section, four entry points to the WEFE Nexus in Lebanon have been identified, with corresponding goals to be achieved through the proposed Nexus solutions (see **Table 3-1**). An additional goal, which does not fall under the entry points, has been added to enhance WEFE Nexus governance and coordination between stakeholders.

TABLE 3-1 Entry points to WEFE Nexus solutions and corresponding goals

#	Entry Point	Goal
G	All	Goal G: Enhance WEFE Nexus governance
1	Energy	Goal 1: Enhance planning in the energy sector and close the energy gap
2	Water	Goal 2: Protect and enhance water resources management in Lebanon
3	Agriculture/Food	Goal 3: Enhance the sustainability of agricultural production and food security
4	Anthropogenic Activities/ Ecosystem Protection	Goal 4: Protect ecosystems from anthropogenic pressures

For these goals to be achieved, objectives, sub-objectives and solutions have been identified and discussed in detail with various stakeholders, including national authorities participating in the WEFE Inter-Ministerial Group, donors and funding institutions, during bilateral meetings, and the

second stakeholder workshop, which was held on 27 and 28 February 2023. As noted in the introduction to this chapter, the feedback received on these occasions has been integrated in the results presented below.

3.2 WEFE Nexus governance solutions (Goal G)

G1) To mainstream the adoption of the WEFE Nexus approach and integrate it in the planning of strategies and projects at the national level, a **WEFE Nexus intersectoral body** should be set up and sustained. This body would include representatives of relevant ministries and public institutions, and would allow for better coordination among the WEFE sectors on strategies, plans, measures and so on, as well as agreement on common priorities.

The highly participative approach applied during Phase I WEFE Nexus activities in Lebanon, whereby concerned stakeholders were consulted at the various stages of implementation, has permitted the initiation of a multi-stakeholder national dialogue on the WEFE Nexus, and the creation of a WEFE Nexus Inter-Ministerial Group, acting as the governance body for the WEFE Nexus dialogue in the country. This group included nominated representatives from WEFE-related institutions, while other ministries and high-level national authorities had also expressed interest in participating in the start of a Nexus dialogue that would pave the way for effective coordination across the sectors. Recognising the importance of this initiative and its alignment with the MoEW's intention to better coordinate policies and actions with other institutions through the activation of an inter-ministerial committee in the framework of NWSS implementation, the MoEW asked GWP-Med to support this Inter-Ministerial Group through the WEFE Nexus Policy Dialogue.

On 26 June 2023, the **first meeting of the WEFE Inter-Ministerial Group** took place at the MoEW. This technical group has an 'enlarged' membership including, in addition to representatives from the key WEFE institutions, representatives from the MoPWT, MoT, MoI and the CNRS. Other institutions have also been invited to join, including the MoIM and the MoPH. The objective of this group is to discuss and coordinate action on common priority issues of concern for the different sectors and the country as a whole.

G2) To engage the private sector and incentivise other actors to invest in Nexus solutions, measures should be developed to **facilitate access to financing for WEFE Nexus projects**, including:

- ▶ The BDL (Central Bank) offering subsidised loans at very low interest rates to incentivise investors to develop such initiatives.
- ▶ A sovereign fund set up by the Government or voted by the Lebanese Parliament to support WEFE Nexus projects. This fund will be sustained by international grants, NGOs and other funders and sources, and should be used to support corporations and SMEs developing projects related to the WEFE Nexus.
- ▶ Lebanese commercial banks that used to play, and could resume playing, over the long term, an intermediary role in financing WEFE Nexus projects, especially if they are restructured and capitalised.
- ▶ Microfinance institutions should be established/ strengthened and supported to help unemployed or low-income individuals or groups to realise WEFE Nexus projects.

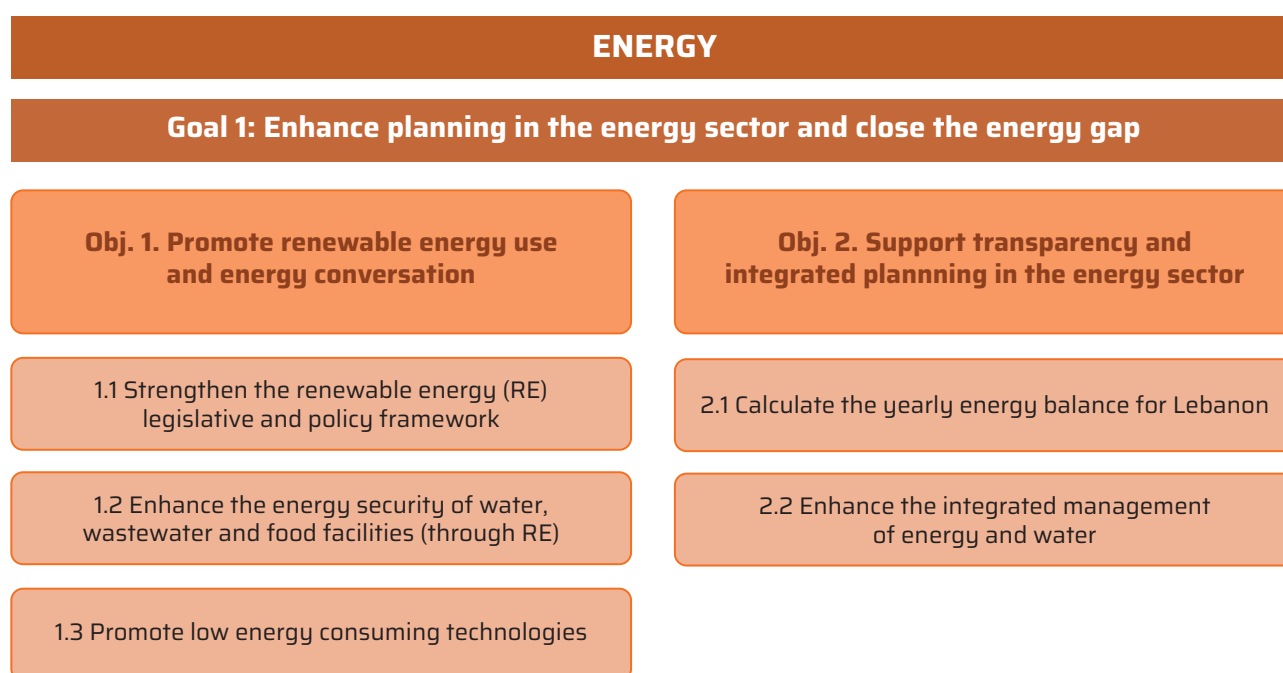
G3) Haphazard urban expansion is one of the main challenges affecting natural resources and ecosystems. It is therefore essential to conserve and protect these resources, including through **land-use planning and zoning that prioritises the protection of natural resources**, such as water resources and sensitive recharge areas, soil, agricultural lands and ecosystems.

3.3 Goal 1: Enhance planning in the energy sector and close the energy gap

For the energy entry point, the goal to be achieved is to enhance planning in the energy sector and close the energy gap, through two objectives:

- Promoting renewable energy use and energy conservation
- Supporting transparency and integrated planning in the sector.

FIGURE 3-1 Entry point 1 to WEFE Nexus solutions – energy.



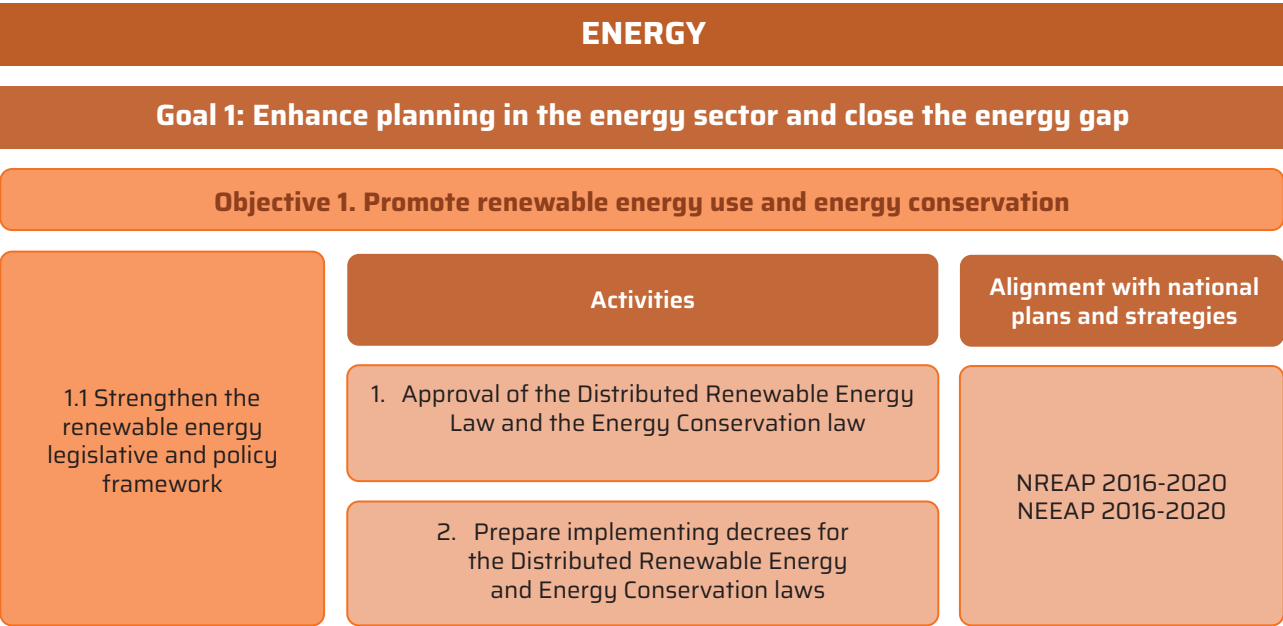
The objectives, sub-objectives and solutions proposed under Goal 1 are presented in sections **3.3.1** and **3.3.2**.

3.3.1 Objective 1: Promote renewable energy use and energy conservation

3.3.1.1 Strengthen the renewable energy legislative and policy framework

1.1) The development of implementing decrees for the Distributed Renewable Energy Law and the Energy Conservation Law, once these laws are passed by the Lebanese Parliament, would enhance governance and performance in the energy sector.

FIGURE 3-2 Goal 1 – Objective 1 – Sub-objective 1.1 Strengthen the renewable energy legislative and policy framework.



3.3.1.2 Enhance the energy security of food, water and wastewater facilities through renewable energy

1) Enhance the energy security of the food sector

The electricity and fuel crises have added a new burden on the struggling agricultural sector in Lebanon, increasing the financial difficulties faced by farmers, with some preferring not to exploit their lands or harvest their produce any more. Additionally, given the current shortages in electricity supply and diesel availability, most types of facilities have been reducing their operating hours and some have stopped working completely.

These issues affect the sustainability of food production and availability in both the short and long terms, and have a consequent impact on food security, especially for vulnerable groups.

No national or regional strategies have yet been developed or planned to address the challenges created by this interlinkage between energy and agricultural production and improve the

socio-economic situation of farmers and food producers. Certain projects have been addressing the energy needs of food producers, but these are still small-scale initiatives.

1.2) The direct targeting of the energy needs of local agriculture through renewable energy would ensure a minimum level of food security, but this should be accompanied by efforts to raise awareness on various issues, including how to save water and rationalise the use of groundwater.

Solar pumping, **accompanied by energy efficiency measures** such as variable frequency drives for the pumps and the introduction of efficient and smart irrigation systems and strategies, would allow Lebanese agriculture to reduce its energy costs while using water rationally. In addition, the food sector, which uses a lot of energy and water in other steps of the value chain (processing, storage, heating/cooling, etc.), can also benefit from renewable energy systems.

1.3) This measure could be complemented by designing and developing novel agro-energy cooperative business models to increase farmers’

incomes, allowing citizens to apply and benefit from the innovations and technologies developed to improve the management of WEFE resources in agriculture, thus improving their livelihoods and increasing their climate change resilience. This should **include a replicable business model** to be implemented in other regions. The benefits of adopting such models through farmers associations or cooperatives are important. This type of approach would allow for better business organisation (coordination and collaboration, exchange of expertise and equipment, benefiting from economy of scale in procurement, processing, etc.) and could help to make use of the excessive energy produced using renewables for additional processing steps, greenhouses etc. Cooperatives could also support outreach efforts and help to disseminate information and best practices to a larger number of farmers through specially targeted communication (e.g. on the need to save water resources, particularly if they are made available through solar pumping).

Law 462/2002 allows the installation of renewable systems of less than **1.5 MW** for the owner's own use. Cooperative schemes would allow groups of shareholders to install such systems and to benefit from electricity generation proportional to their share. This would be beneficial at a municipality level or for groups of farmers where the cooperative scheme would still be legal under Law 462/2002 because each shareholder is benefiting from the electricity generated for their 'own use', with no electricity being sold. Moreover, the Distributed Renewable Energy Law, which permits peer-to-peer electricity exchange and several types of net metering would benefit all sectors in need of electricity for capacities less than **10 MW**.

2) Enhancing the energy security of water and wastewater

The operation of water supply facilities and WWTPs by RWEs has been hugely affected by

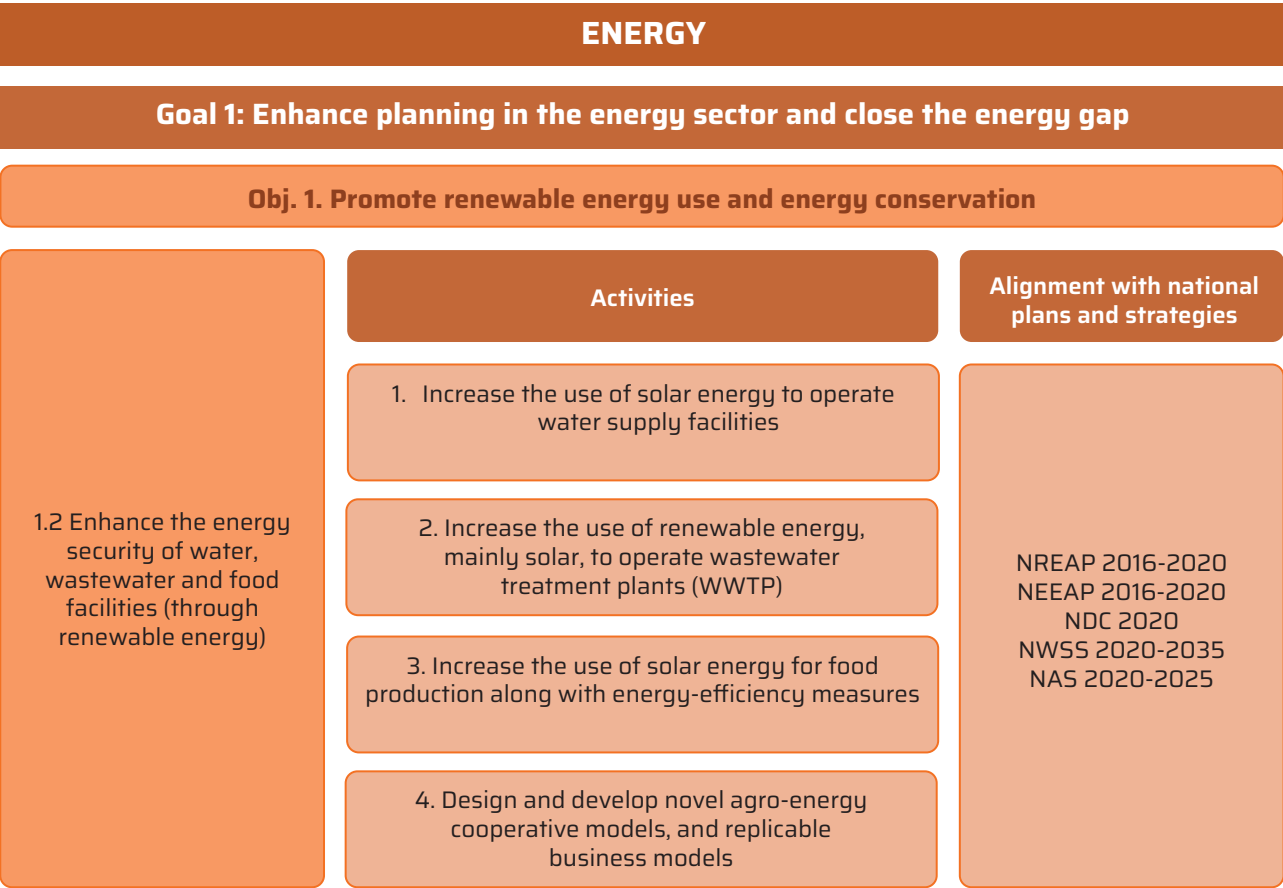
electricity and fuel shortages and the increase in diesel prices.

1.4) Concerning **WWTPs** that are already installed in several regions in Lebanon but are not operating, the idea is to explore the potential to **operate them using renewable energy, mainly solar, and enhance their energy efficiency**. The impact on water quality and ecosystem would be significant, with sewage water not going directly to nearby rivers or underground, thus preserving the ecosystems in different Lebanese regions and positively affecting the health of the neighbouring regions.

1.5) Regarding **potable water facilities**, the operation of water distribution networks in several Lebanese regions has been stopped or reduced, affecting the communities who depend on them and have been suffering from shortages of the water needed for daily use. **Operating these plants and networks using renewable energy and enhancing their energy efficiency** seems a priority, thus guaranteeing water security. Families have been paying for several water bills separately to guarantee the daily availability of water. Water provided by the informal sector is not always of good quality due to the potential pollution of the water resources used for supply, unsanitary transportation and transmission conditions, and the lack of monitoring and enforcement of regulations and standards within this informal water supply system.

According to meetings and discussions with stakeholders (including the MoEW, CDR and the Beirut and Mount Lebanon Water Establishment (BMLWE)), an assessment is being conducted by various organisations under the supervision of the MoEW Solarisation Task Force to evaluate the energy needs of water and wastewater facilities in Lebanon, and the potential for installing renewable energy systems (mainly solar farms) to ensure that they function properly.

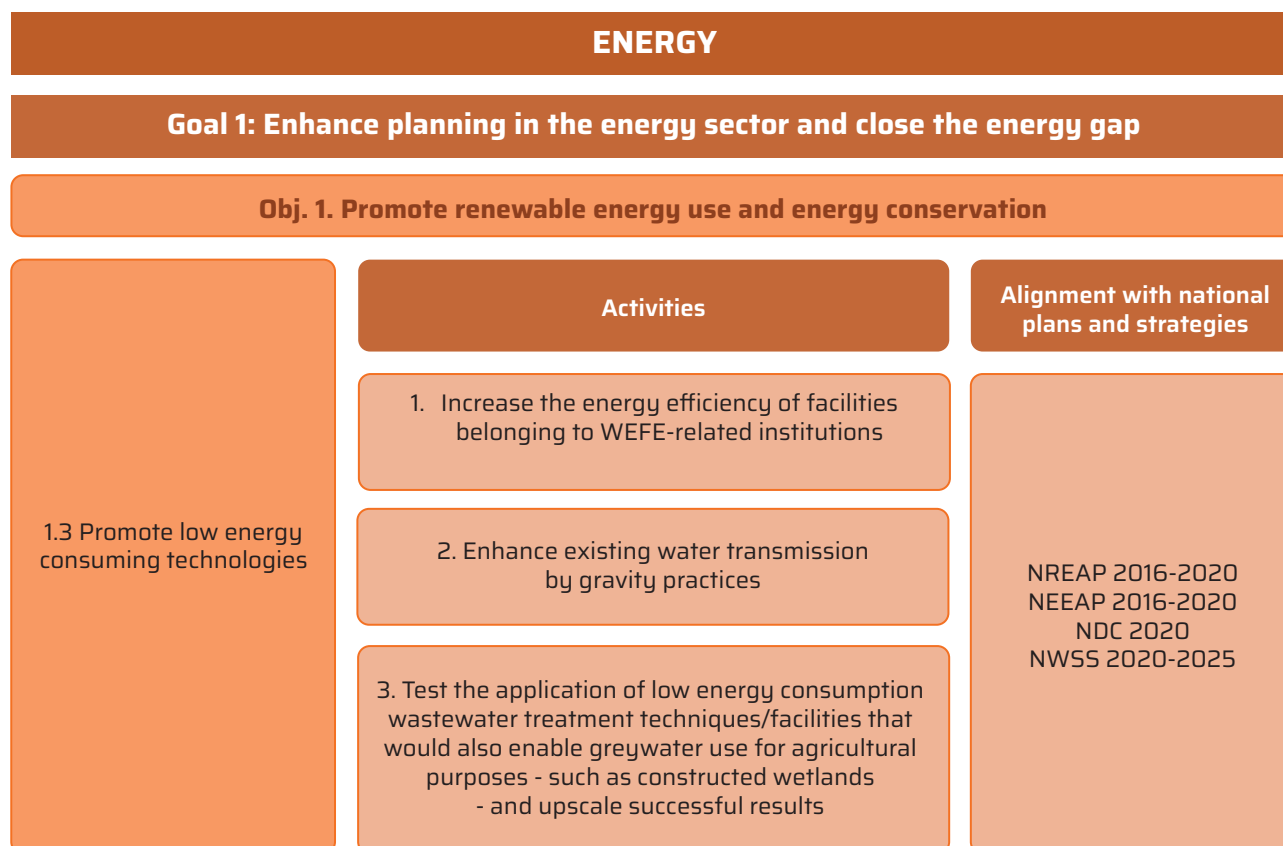
FIGURE 3-3 Goal 1 – Objective 1 – Sub-objective 1.2 Enhance the energy security of food, water and wastewater facilities through renewable energy.



3.3.1.3 Promote low energy consuming technologies

1.6) Enhancing the energy efficiency of existing facilities, and optimising it in new projects, especially for **public sector institutions and facilities**, is essential to reduce operational costs and enhance environmental performance. In addition to the proposed solutions addressing the use of renewable technologies in various sectors,

planning for development projects should explore options that require minimum energy input. In the water sector specifically, this approach can be integrated through water transmission by gravity **(1.5)**, efficient wastewater treatment through low energy treatment techniques (constructed wetlands) **(1.4)** especially in rural areas, and making use of the water generated in agricultural activities where possible.

FIGURE 3-4 Goal 1 – Objective 1 – Sub-objective 1.3 Promote low energy consuming technologies.

3.3.2 Objective 2: Support transparency and integrated planning in the energy sector

3.3.2.1 Calculate the yearly energy balance for Lebanon

Although Lebanon was one of the first countries in the Arab region to adopt strategies and plans on electricity, energy efficiency and renewable energy, the main issue remains the poor availability of data, which prevents actual targets from being set in the planning phase. Most of the data used in planning are based on correlations, regressions and estimations based on some available energy indicators. The LCEC published the first energy indicators report for the Republic of Lebanon in 2018, a huge step in the Lebanese energy sector. The report includes all types of energy indicators, but was based on many assumptions, specifically related to end use.

Creating an energy database platform in Lebanon is crucial for keeping track of the available data and paving a path to a realistic approach for setting energy efficiency and renewable energy targets and quantifying the progress achieved. There is currently no data acquisition platform in Lebanon, and most available data are based on local efforts within ministries. A database platform will help to create a reference base that will be used to compare future data. A systematic database platform could be used in multiple sectors and would help relevant stakeholders and information users to visualise and assess the state of the sector.

1.7) This measure consists firstly of **developing guidelines and a methodology for data collection at different levels**: primary level (through interviews, questionnaires, etc.) and behind the meter level (i.e. using meters to monitor consumption). This will include a methodology

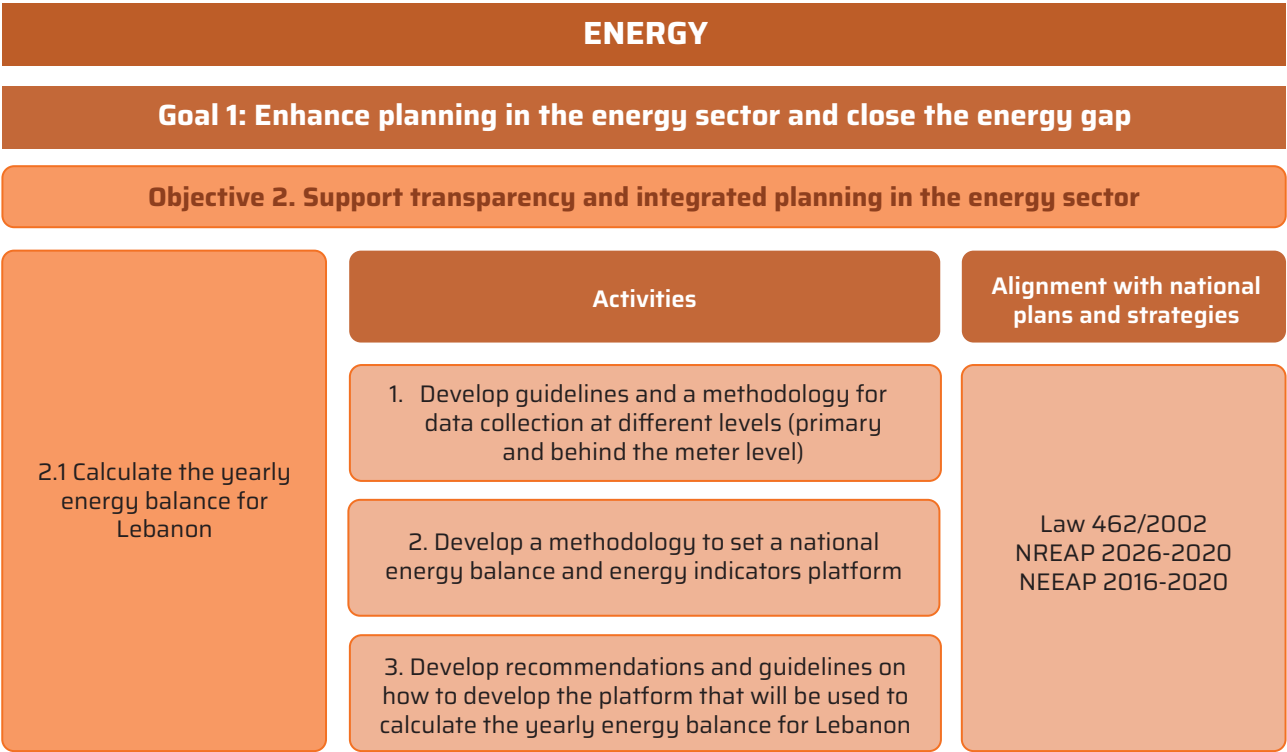
for setting a national energy balance and energy indicators. While international guidelines for energy indicators do exist (e.g. those issued by IRENA and the International Energy Agency) and are currently in use, they are not entirely suited to the Lebanese context.

1.8) The second step involves **creating a database** where data can be stored and shared to enhance the use of the available information and build plans based on this data. A study should be carried out to produce recommendations and guidelines on how to develop the platform and utilise it to calculate the yearly energy balance for Lebanon. This would **increase the transparency**

of the energy sector and detail energy needs by sector (water, food, agriculture, industry, building, transport, etc.). This information could then be used to prioritise the sectors and create a database of sectoral needs for the Government and donors. The creation of the platform itself is a must for all public and private entities, as well as donors.

This solution would allow access to reliable information in the energy field and throughout the sector, from energy production and consumption to energy efficiency savings and renewable energy solutions for each sector.

FIGURE 3-5 Goal 1 – Objective 2 – Sub-objective 2.1 Calculate the yearly energy balance for Lebanon.



3.3.2.2 Enhance the integrated management of energy and water

1.9) The MoEW has several plans to enhance the performance of the energy sector, achieve renewable energy targets and increase power production, which have been issued as part of policies and action plans. When developing the

designs of these projects, it is important to use the WEFE Nexus approach to better manage interlinkages between the sectors, by maximising cross-sectoral benefits and reducing competition for resources, specifically when water resources are used either for utilities or hydro production, since both sectors fall under the responsibility of the MoEW. This coordinated management of

water and energy could be organised through the **development of a holistic and integrated water-energy master plan**.

Development of the master plan would start with an overview of proposed renewable energy and water sector projects, and the connection between energy and water across the whole country, before moving on to the regional context, where these projects are planned. The WEFE Nexus Assessment for Lebanon could constitute a baseline for understanding the challenges currently facing the target sectors, and their interlinkages with food and ecosystems, as well as existing potential and opportunities in Lebanon. A more in-depth assessment at the regional level (this could be at the level of RWEs, or preferably at the watershed level to align with the requirements of the Water Code) would result in more specific plans that consider the characteristics of selected areas.

Following these assessments, an integrated approach should be developed as part of the master plan to tackle the challenges in the water, energy and food sectors, associated with MoEW projects, while enhancing residents' quality of life, reviving small businesses, creating jobs (in renewable energy and agriculture/food) and protecting the environment. The integrated approach will lead to a holistic and inclusive national master plan featuring concrete actions and activities that respond to the current crises in Lebanon, based on existing plans in the country (such as those outlined in the following paragraph), while respecting international and European commitments and trends. The master plan should propose and estimate the benefits of concrete activities. To achieve this, cost-benefit analysis methodologies should be used, while social, environmental and well-being indicators should be included to enhance the plan's chances of producing concrete benefits in those areas. The following paragraph outlines several ideas about what could be tackled as part of such a holistic approach, using plans and projects proposed by the MoEW:

- Hydropower targets and plans. In these projects, the designs should take into consideration water uses by various sectors and allocate them in a way that avoids significantly affecting other sectors and causing environmental impacts, with a focus on ecosystems and biodiversity. For example, environmental flows should be kept to maintain biodiversity downstream, proper sediment management should be planned for dams, and so on.
- In addition to the hydropower targets, where interlinkages between energy and water are the most evident, one of the main renewable energy sources tackled is solar, including thermal solar, solar photovoltaic and concentrated solar power (CSP). The MoEW is currently exploring CSP through an ongoing feasibility study. It is considered to be an interesting technology due to its storage capacity. The optimistic scenario in the NREAP 2016-2020 suggests the development of **100 MW**. CSP plants require large amounts of cooling, which is usually carried out using water sources. Several studies have been performed to identify ways to reduce water consumption by these plants. The main potential of CSP in Lebanon is in the Hermel region, through which the Assi River passes. In this case, the integrated approach would tackle using water in a proper way that does not affect its normal use for irrigation, domestic purposes and sustaining ecosystems. Other options for ensuring that the CSP plant can obtain the water it needs should also be studied. At the same time, some of the electricity generated by the CSP plant could be used in reverse osmosis systems to clean the water used in the plant and distribute it to residents in the same area for irrigation and domestic use. This constant supply of water could reduce the number of illegal and unlicensed wells being dug and the volume of groundwater being extracted. The benefits in this case include water sustainability and the provision of electricity and clean water using renewable sources, helping to ensure energy, water and food security.

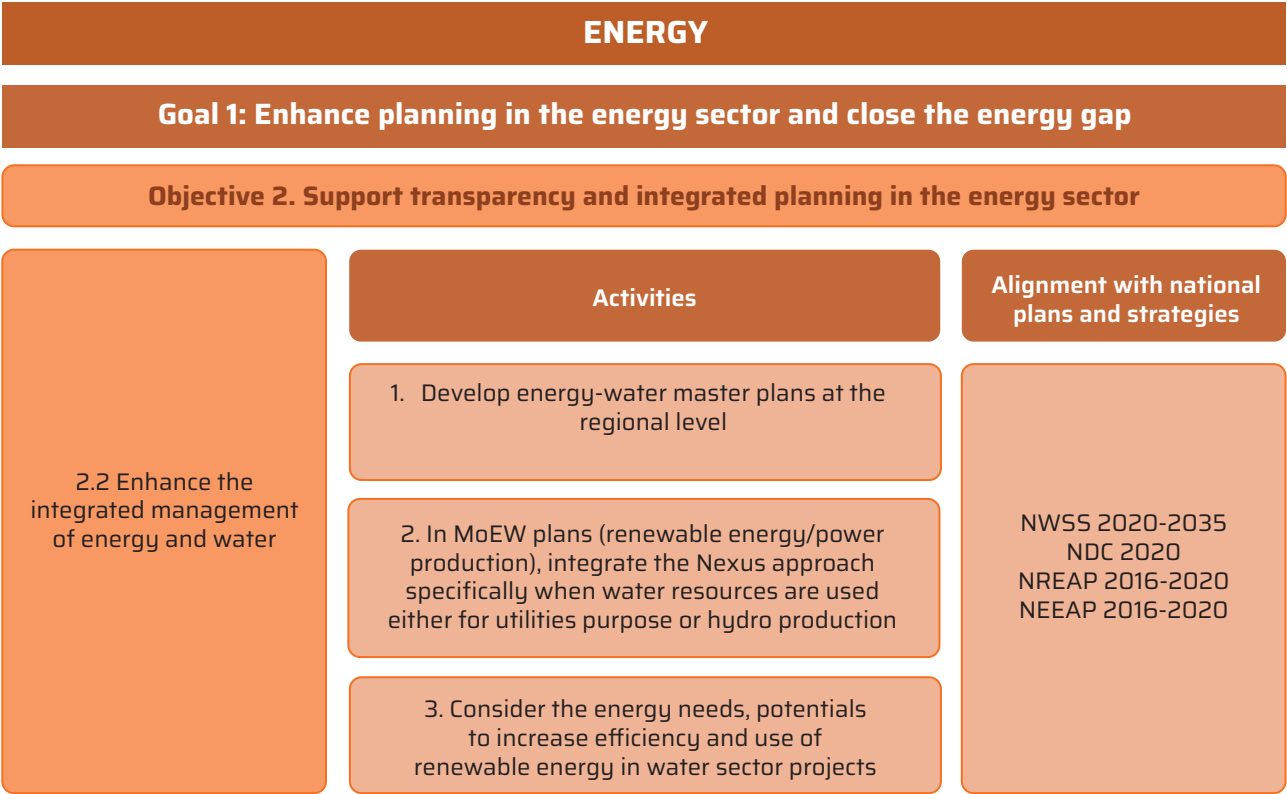
- The renewable energy systems proposed in the MoEW’s plans are large and centralised. Reaching the **30%** target and reducing energy consumption through energy efficiency measures would lead to the generation of excess electricity. This excess can be used to promote the supply of renewable gases, mainly hydrogen, which is currently a hot topic internationally. However, one main drawback of hydrogen generation is its reliance on water, as it uses the electrolysis method. The impact on water sustainability and availability should be studied in the local context to avoid disturbing the usual water supply. Moreover, a feasibility study would show whether hydrogen generation is feasible in Lebanon, in which case

hydrogen could be used to transport locally produced goods, mainly agricultural produce.

► When planning and designing water sector projects (water and wastewater), the energy needs of projects, the potential to increase efficiency, use renewable energy and reduce energy-related operational costs need to be considered.

In summary, the national integrated master plan would ensure the integration of the Nexus approach into large-scale public projects and might offer a wide range of solutions to tackle the WEFE sectors in a very complex, yet rich local context.

FIGURE 3-6 Goal 1 – Objective 2 – Sub-objective 2.2 Enhance the integrated management of energy and water.

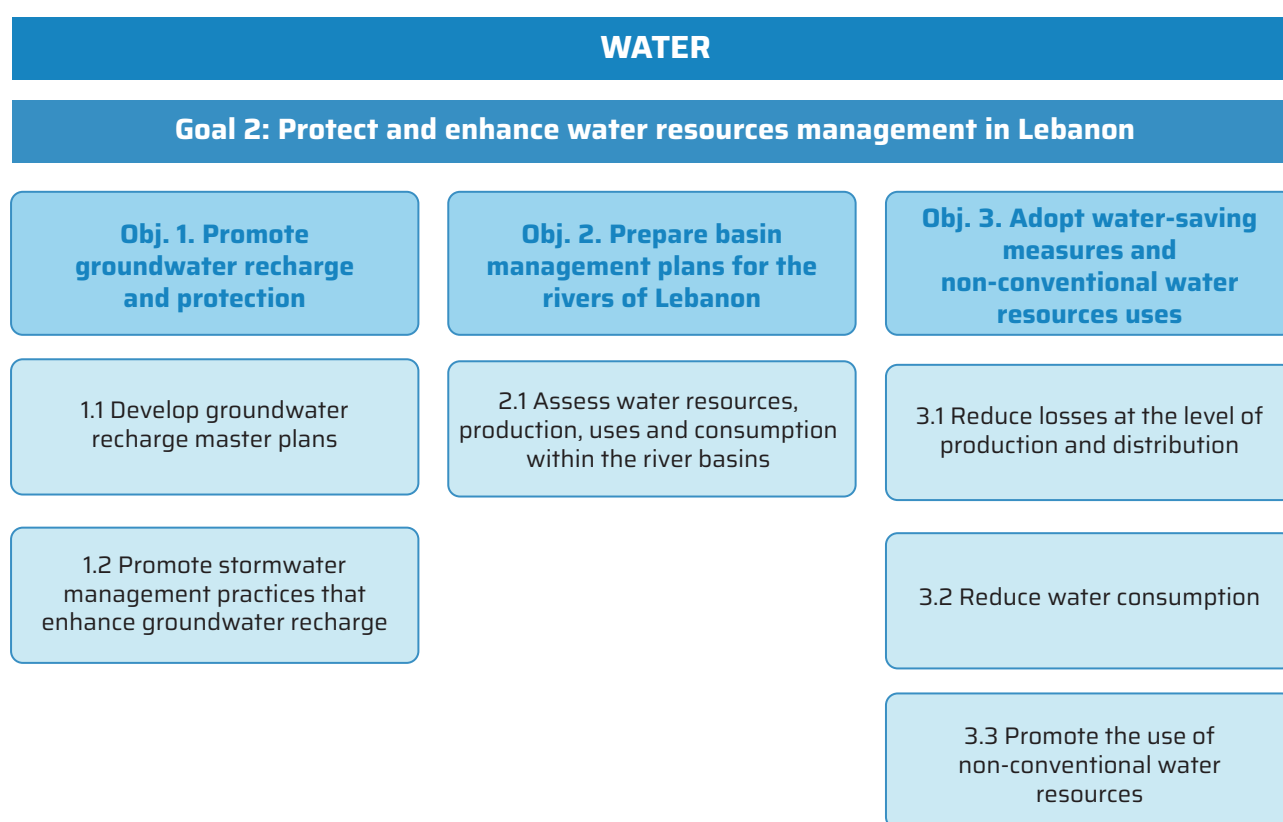


3.4 Goal 2: Protect and enhance water resources management in Lebanon

For the water entry point, the goal is to protect and enhance water resources management in Lebanon through three main objectives that are complementary and essential to achieving the goal:

1. Promote groundwater recharge and protection
2. Prepare basin management plans for the rivers of Lebanon
3. Adopt water-saving measures and non-conventional water resources use

FIGURE 3-7 Entry point 2 to WEFE Nexus solutions – water.



The objectives, sub-objectives and solutions proposed under Goal 2 are presented in sections 3.4.1 to 3.4.3.

3.4.1 Objective 1: Promote groundwater recharge and protection

3.4.1.1 Develop groundwater recharge master plans

2.1) The development of groundwater recharge master plans is a priority that would help to

reduce the pressures on water resources. Plans should begin by mapping sensitive groundwater recharge areas (in line with the master planning being conducted for the high mountains, above **1,500 m**) and developing urban master plans that take into account the sensitivity of these areas and the mitigation measures that would allow recharge, reduce pollution risks and minimise negative impacts. This mapping would include the delineation and classification of areas based on the quality of water expected within them as follows:

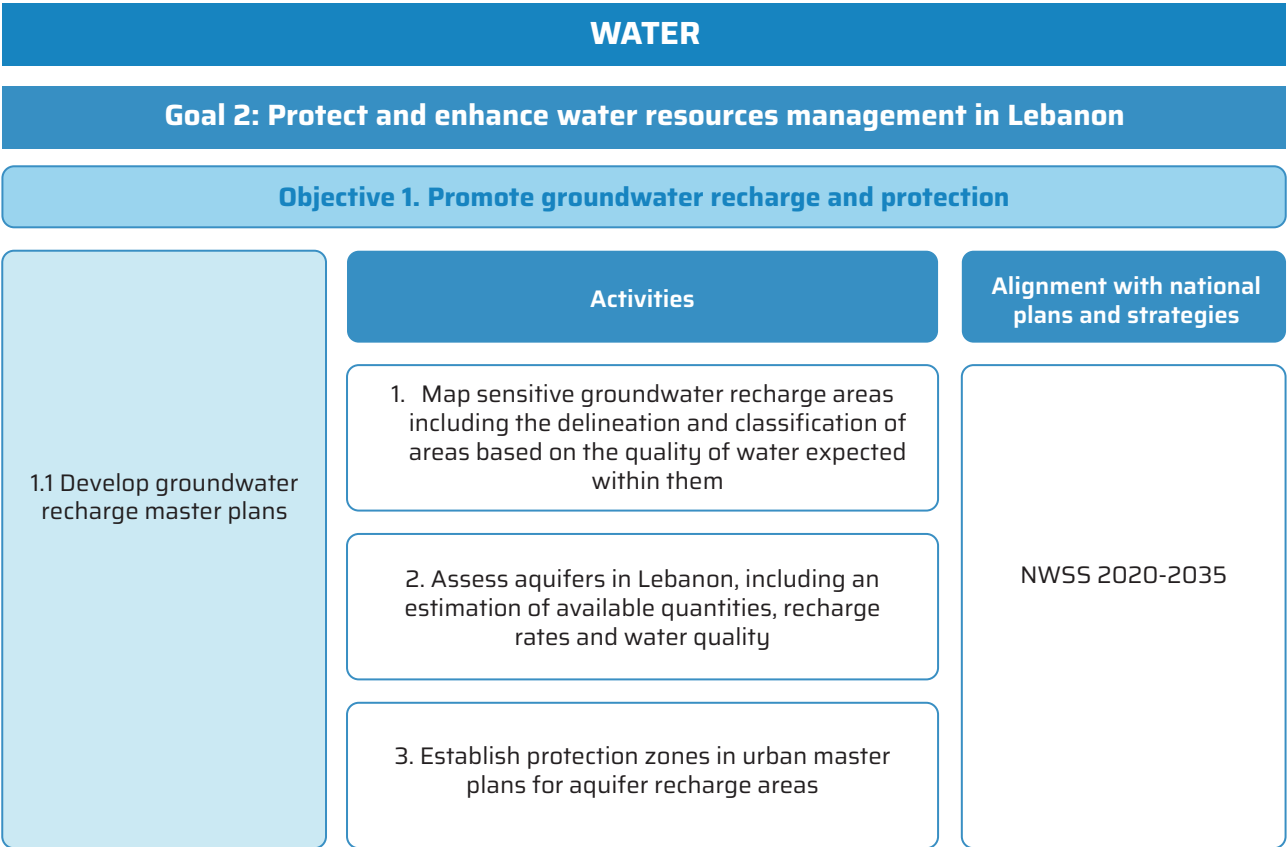
- 1. GW-1: Potable water (no tolerance for any pollution and plans to remedy any current source or potential source).
- 2. GW-2: Potable after minor treatment. Can be used for irrigation (without treatment, or with minor treatment depending on the crops) and pollution sources in such areas should be limited to biological and carbon pollutants that can be remediated.
- 3. GW-3: Polluted groundwater that could be used to limit saltwater intrusion, as greywater (toilet flushing, washing and cleaning of cars, outside areas, etc.), but should not be used for irrigation or drinking. Should undergo advanced treatment if it is to be used for irrigation.
- 4. GW-4: Should not be utilised for any purpose that entails human contact (could be used for specific applications, such as cooling towers).

In parallel with this mapping, the aquifers in Lebanon should be assessed, including an estimation of available quantities, recharge rates and water quality. This assessment would support the estimation of the national water balance based on real data, and permit forecasting of expected trends, taking into consideration climate change impacts.

Based on these exercises, groundwater recharge master plans can be developed. Among other things, they would recommend stormwater management practices that enhance groundwater recharge, as set out in the following sub-objective.

G3) The master plans would indicate **protection zones for aquifer recharge areas that should be established under urban master plans.**

FIGURE 3-8 Goal 2 – Objective 1 – Sub-objective 1.1 Develop groundwater recharge master plans.



3.4.1.2 Promote stormwater management practices that enhance groundwater recharge

Stormwater management is essential for enhancing groundwater recharge, preventing and reducing flooding and associated damage, and increasing climate change resilience. Improving stormwater management requires various efforts to be implemented in parallel at different levels:

- ▶ At the governance level:

- ▶ **2.2.) As part of the permitting process for development projects, complete accounting for stormwater recharge within the plot(s), and its proper management, should be required,** especially in rural settings (through the DGUP and possibly the Order of Engineers in collaboration with the MoPWT).

- ▶ **2.3.) The development of guidelines and national standards for public green infrastructure that prioritise groundwater recharge and better management of stormwater** through the adoption of suitable designs and materials is essential and would help to mainstream such practices.

- ▶ Enhancing stormwater management through greening and retrofitting existing infrastructure, in urban and rural areas:

- ▶ **2.4.) When rehabilitating infrastructure or developing new infrastructure, stormwater collection systems and wastewater collection systems should be separated;** stormwater can be used for recharge through

existing and to-be-developed unpaved areas. Current pavement and elevated berms should be ameliorated to be at grade or below grade level, to improve stormwater management and enhance recharge. Designs would vary according to the area:

- i. near roads with significant traffic and near unpaved areas, the water would be diverted to the berms, and silt traps and oil-water separators installed to filter out the impurities prior to recharge

- ii. in areas (such as squares) with limited traffic (pedestrian areas), the pavement should be made of permeable material allowing infiltration of stormwater

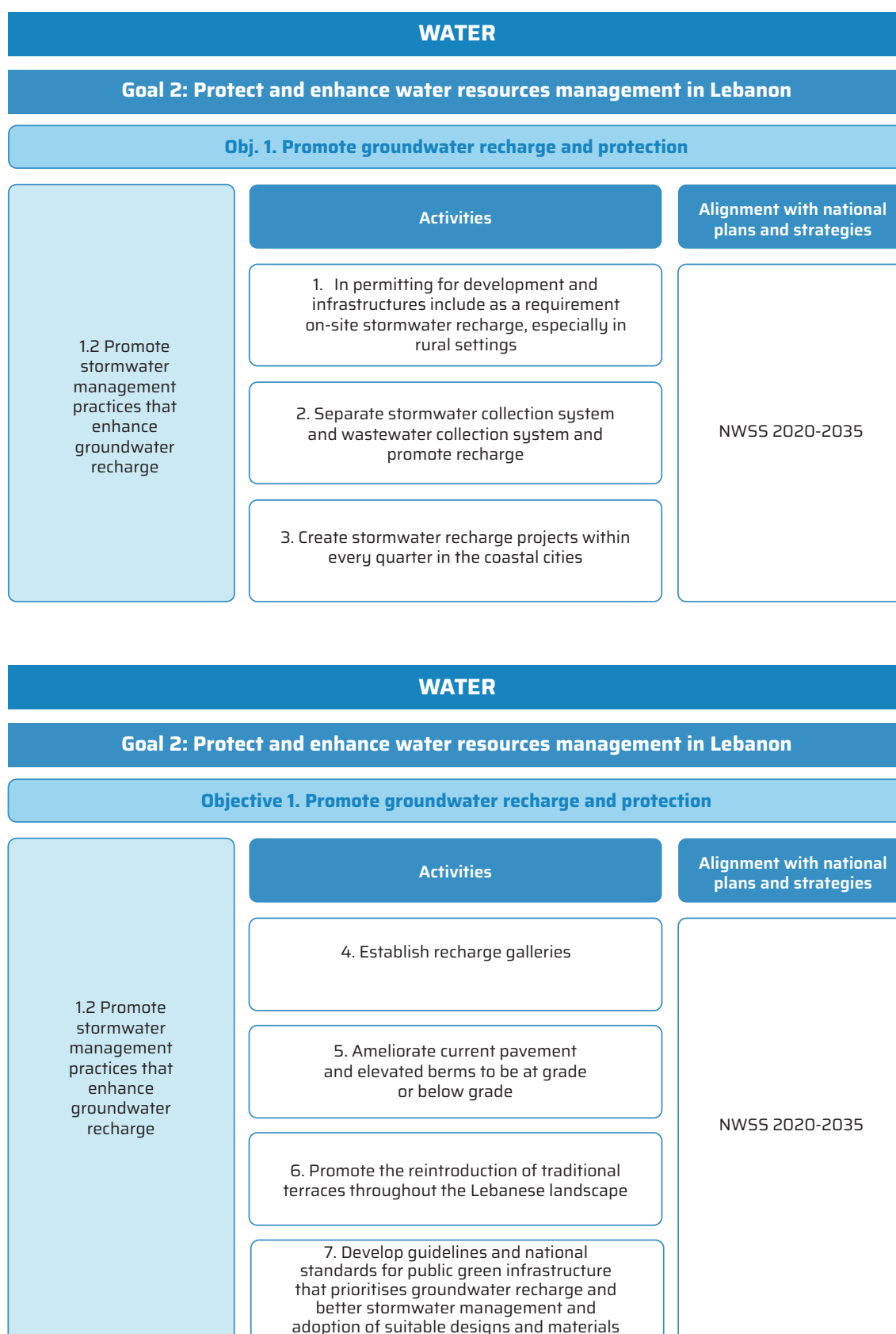
- iii. greening of pavements to enable stormwater to be absorbed using vegetation to filter pollutants.

- ▶ **2.5.) Stormwater recharge projects should be developed within every quarter (every four blocks/street intersections) within coastal cities,** including 'greater' areas.

- ▶ **2.6.) Recharge galleries should be established wherever possible.**

- ▶ **2.7.) The reintroduction and rehabilitation of traditional terraces should be promoted throughout the Lebanese landscape.** These enhance groundwater recharge, including within individual properties (potentially through incentives).

FIGURE 3-9 Goal 2 – Objective 1 – Sub-objective 1.2 Promote stormwater management practices that enhance groundwater recharge.



3.4.2 Objective 2: Prepare basin management plans for the rivers of Lebanon

3.4.2.1 Assess water resources (quality and quantity), water production and water use and consumption within the river basins

2.8) River basin management plans can be prepared in parallel with the groundwater recharge master plans, benefiting from and integrating the results of the proposed mapping exercises and recharge-enhancing practices. The plans would be developed to promote IWRM with due consideration of resource availability, flows, uses, pressures and so on in a source-to-sea continuum. This would help to shift management of the sector towards IWRM in line with the Water Code and updated NWSS 2020-2035.

They should draw on a range of data, including from hydrological and hydrogeological analysis of the basins, climate change projections, water balance (quantities of water resources available and water consumption by various users), water production capacity, quality of water resources, status of infrastructure for water distribution, wastewater collection and treatment, sources of liquid pollution from industrial, agricultural (described in the following sections), tourism, healthcare and other human activities, sources of solid waste, types of ecosystems in the area and the dependence of ecosystems on water resources.

Based on these data, the management plans would be developed, accounting for sources of water, how they are allocated among the various users, and programmes to reduce the stress on resources. Where surface water is of good quality, the use of these sources for drinking and irrigation purposes should be promoted in the short term to reduce stress on groundwater. Legislation imposing pollution limits should be enforced to curb resource degradation.

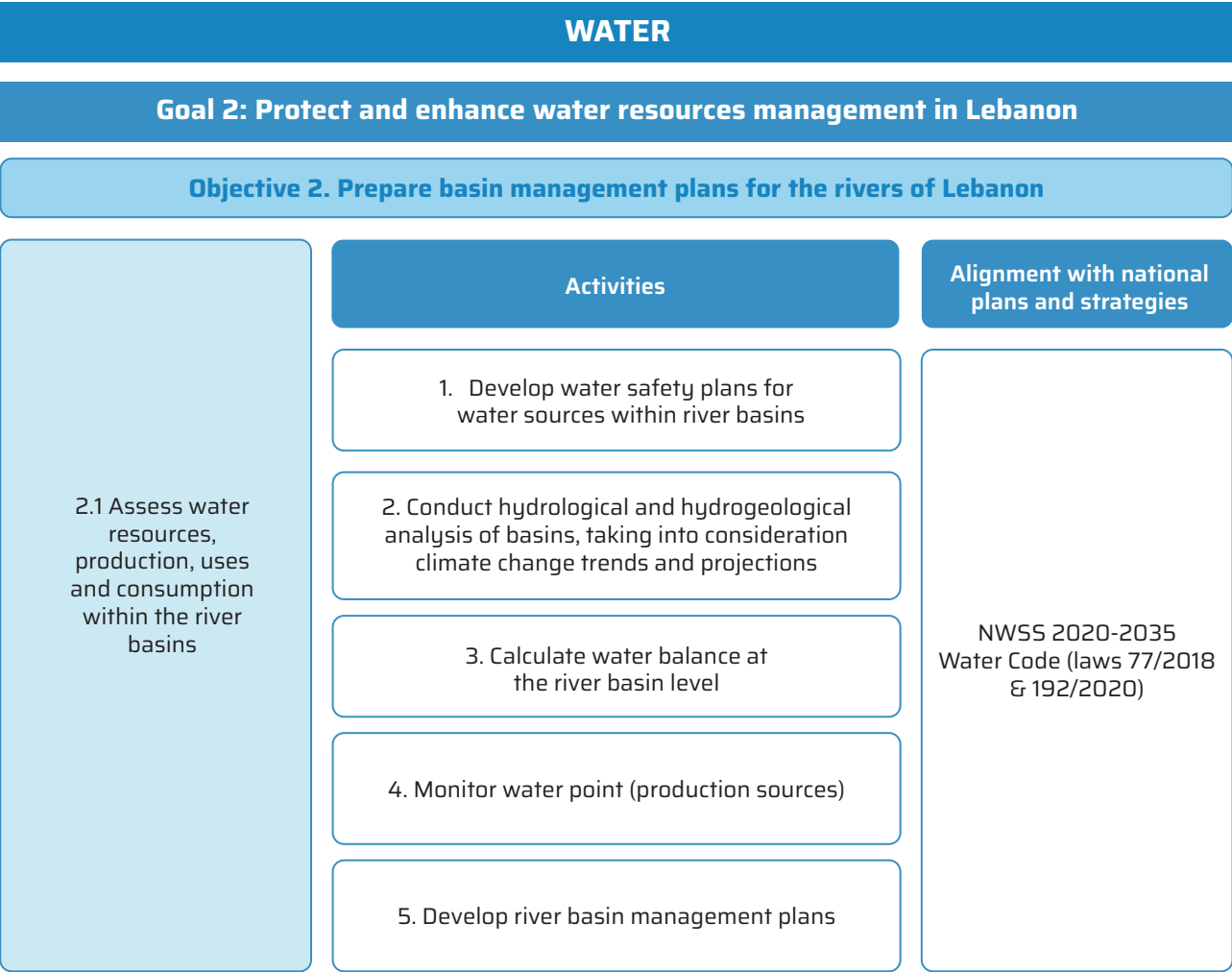
Water sources within the river basins should therefore be assessed to evaluate their condition, possibly through water safety plans (a priority under the NWSS 2020-2035). These assessments would include an evaluation of water flows, water quality parameters, determination of pollution sources, and more. The environmental flows required to enhance the ecosystems that depend on these sources and ensure their sustainability should also be evaluated. Accordingly, management plans for the exploitation and protection of these sources should be developed, including measures to remove sources of pollution and ensure clean-up/remediation where needed.

The objective of preparing river basin management plans is in line with the Water Code (77/2018 amended by 192/2020) and the prerequisites discussed above can be summarised in the following activities/solutions:

- ▶ **2.8)** Develop water safety plans for water sources and conduct hydrological and hydrogeological analysis of basins, taking into consideration climate change trends and projections.
- ▶ **2.9)** Assess available water resources, water production and water use and consumption within the river basins, including identifying and assessing water sources within the river basin.
- ▶ **Calculate the water balance** at the river basin level (monitoring water points to evaluate production, monitoring consumption by user and sector, etc.).
- ▶ **2.10) Identify opportunities to use surface water instead of groundwater** to reduce the pressure on these resources.

The national water balance can be calculated based on the exercises done at the river basin level.

FIGURE 3-10 Goal 2 – Objective 2 – Sub-objective 2.1 Prepare basin management plans for the rivers of Lebanon.



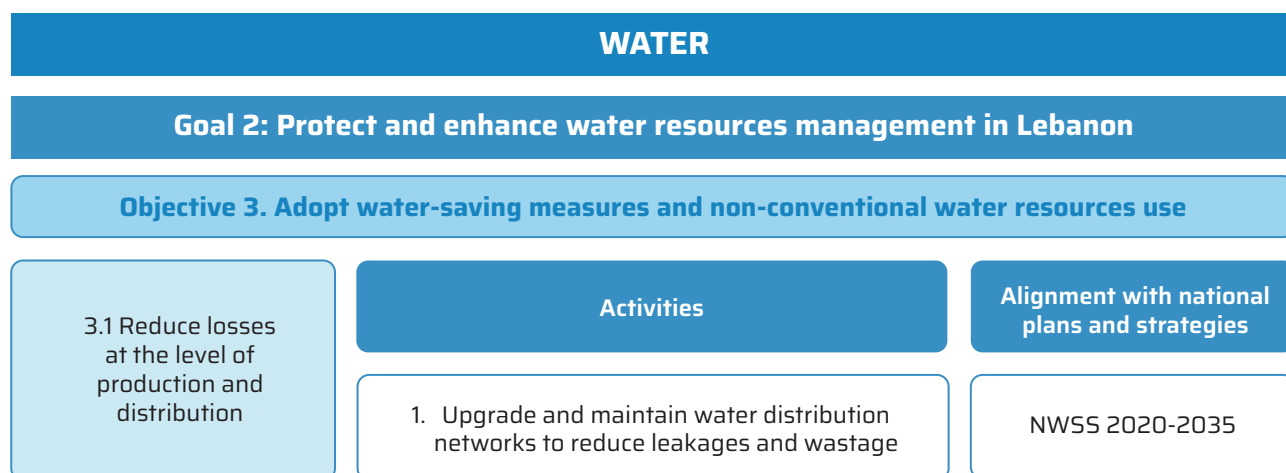
3.4.3 Objective 3: Adopt water-saving measures and non-conventional water resources use

3.4.3.1 Reduce losses at the production and distribution levels

2.11) The water production infrastructure and distribution network in Lebanon produces

significant losses that amount to **50%** according to the NWSS 2020-2035. It is therefore essential to **upgrade** this infrastructure **and maintain water distribution networks to reduce leakage and wastage**.

FIGURE 3-11 Goal 2 – Objective 2 – Sub-objective 3.1 Reduce losses at the production and distribution levels.



3.4.3.2 Reduce water consumption across various sectors

Water-saving measures and strategies are essential to enhancing water sector management, rationalising demand, and reducing wastage and losses, and should be adopted across sectors. These measures could be applied at various levels (domestic, industrial, infrastructure, tourism establishments, healthcare facilities, food (mainly in irrigation), etc.). They can be implemented over the short, medium and long terms and would show better results if monitoring of actual consumption of water resources by various users is conducted. Currently, in the absence of metered water subscription in most areas, users pay a flat rate regardless of the quantities consumed, and water consumption by sector is calculated based on assumptions and estimations (as is the case for energy, discussed in previous sections).

In the short and medium terms, the high energy bills associated with pumping water could drive the rationalisation of water use. However, other methods could be used to promote and mainstream the issue:

- **2.12) Conducting national communication and awareness-raising campaigns** targeting various users and covering water scarcity and water-saving measures and technologies.
- **2.13) Promoting the use of water-efficient technologies** in facilities related to hospitality, industry, healthcare, and education. Moreover, it is important to implement and enforce no water discharge into roads, limiting the use of open water jets for washing surfaces and promoting sweeping and mopping instead.
- **(3.4 see below) Supporting farmers to acquire, install and use water-saving irrigation technologies.**
- **2.14) In the long term, through increased adoption of metered systems** and billing, it becomes feasible to monitor water consumption. Once users can monitor their consumption, a **database could be created to gather this data** and develop plans accordingly. The plans could target specific sectors and promote competition by setting water-saving goals and incentivising achievement (incentives could be fiscal, for example a tax reduction, or non-fiscal through awards and publicity).

FIGURE 3-12 Goal 2 – Objective 2 – Sub-objective 3.2 Reduce water consumption.

WATER		
Goal 2: Protect and enhance water resources management in Lebanon		
Objective 3. Adopt water-saving measures and non-conventional water resources use		
3.2 Reduce water consumption	Activities	Alignment with national plans and strategies
	1. Promote water savings in specific sectors through the development of guidelines targeting each sector (industry, hospitality, healthcare, education, etc.)	NWSS 2020-2035
	2. Conduct national communication and awareness-raising campaigns (water scarcity and saving)	
	3. Install meters to monitor consumption and adjust billing accordingly	
	4. Create database for data collected on water consumption	

WATER		
Goal 2: Protect and enhance water resources management in Lebanon		
Objective 3. Adopt water-saving measures and non-conventional water resources use		
3.2 Reduce water consumption	Activities	Alignment with national plans and strategies
	5. Set goals for specific sectors to incentivize water-saving	NWSS 2020-2035 NDC 2020 NAS 2020-2025
	6. Support farmers in water-saving irrigation technologies, conducting awareness-raising and capacity-building on water-saving techniques	
	7. Promote the use of water-efficient technologies in the hospitality sector and industrial facilities	

3.4.3.3 Promote the use of non-conventional water resources

The use of non-conventional water resources could reduce groundwater stress and over-exploitation, and offer reliable alternative resources of adequate quality:

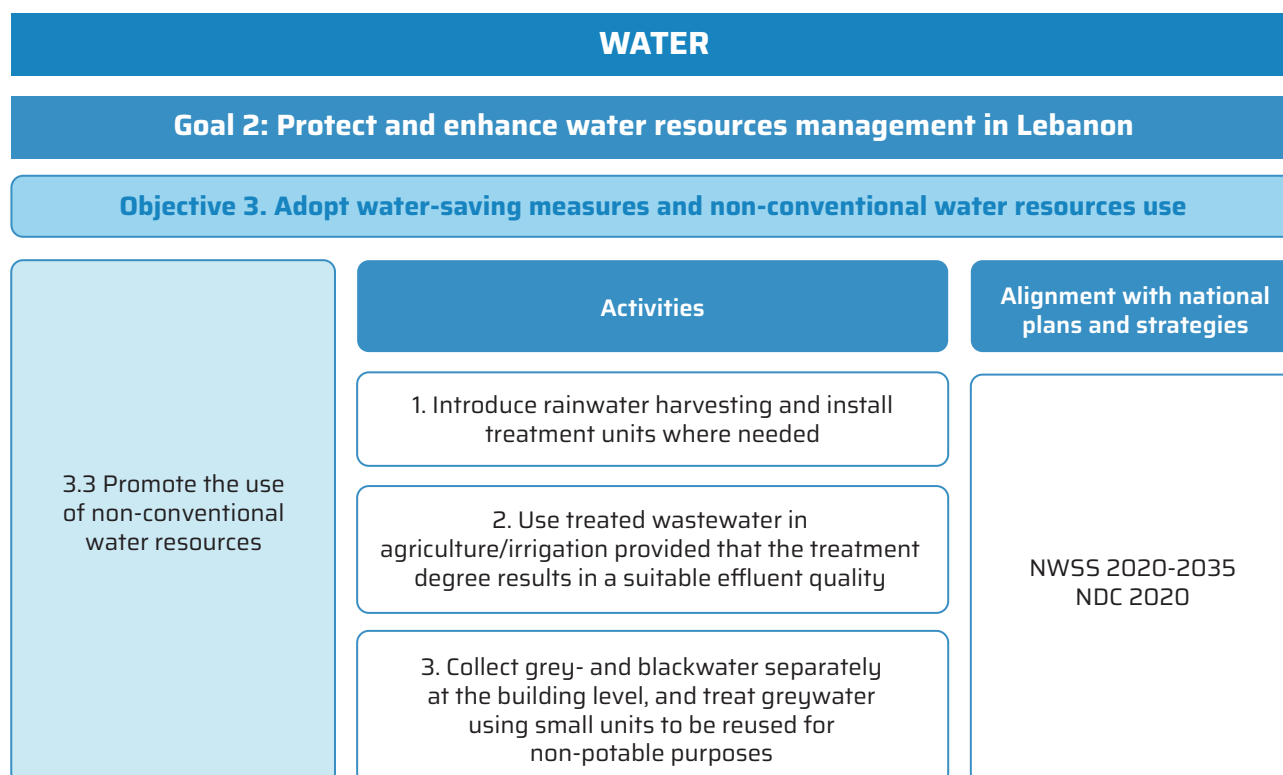
2.15) Rainwater (or snowmelt) could be **harvested** from various surfaces and used for several applications. These surfaces could be natural surfaces, paved areas, buildings, etc. Rainwater harvesting and collection requires the installation of reservoirs to store and use the water. These could be hill lakes and ponds for agricultural use, reservoirs for domestic use, etc. According to the intended use and the characteristics of the collection area, treatment systems might be needed to render the water useable for various applications. Rainwater harvesting, specifically in buildings, could be incentivised and promoted

using various methods during the permitting process for new establishments, and could also be retrofitted to existing structures.

Additionally, **treated wastewater could be used** as a source of water for various applications:

- ▶ **2.16) In agriculture/irrigation**, provided that WWTPs treat wastewater at a high degree, resulting in a suitable effluent quality.
- ▶ **2.17) At the building level**, grey- and blackwater could be collected separately, with greywater treated using small units and reused for non-potable purposes.
- ▶ At petrol stations, the water used for car washing could be treated and reused (this proposed solution was not identified as a priority at the stakeholder workshops).

FIGURE 3-13 Goal 2 – Objective 2 – Sub-objective 3.2 Promote the use of non-conventional water resources.

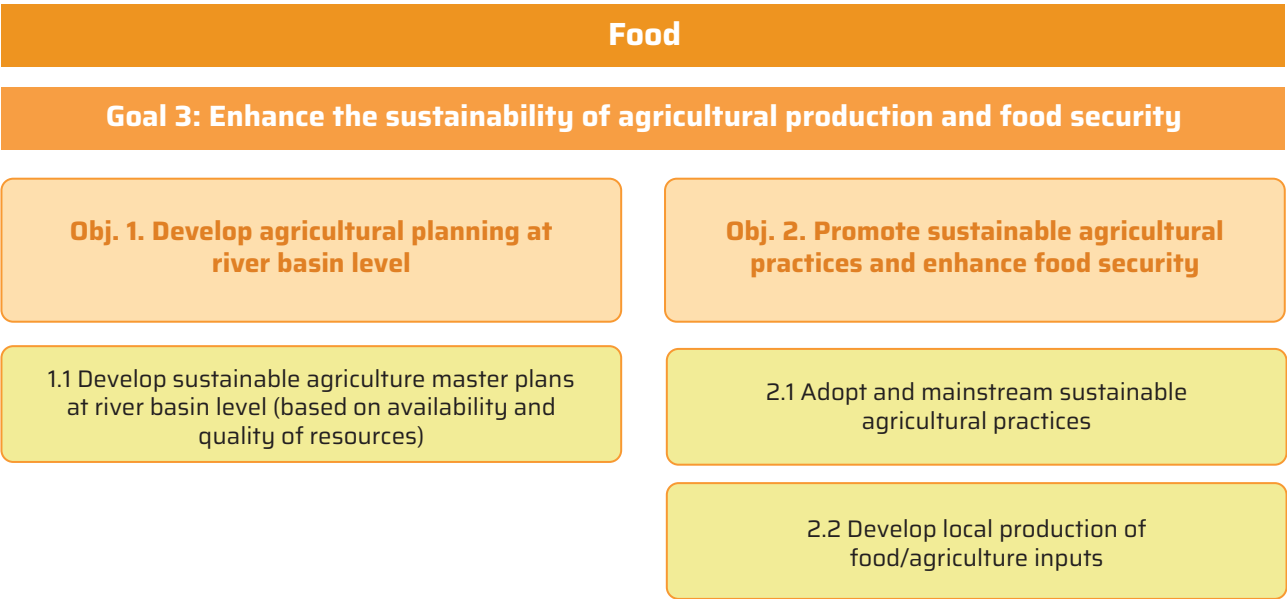


3.5 Goal 3: Enhance the sustainability of agricultural production and food security

For the food entry point, the goal is to enhance the sustainability of agricultural production and food security through two main objectives:

- 1. Develop agricultural planning at river basin level
- 2. Promote sustainable agricultural practices and enhance food security.

FIGURE 3-14 Entry point 3 to WEFE Nexus solutions – food/agriculture.



The objectives, sub-objectives and solutions proposed under Goal 3 are presented in sections 3.5.1 and 3.5.2.

3.5.1 Objective 1: Develop agricultural planning at river basin level

3.1) To complement the plans focusing on energy and water use proposed earlier, **sustainable plans for agricultural development should be developed, preferably at the watershed/ river basin level**, taking into consideration the availability of water resources, soil types, areas that have already been cultivated, availability

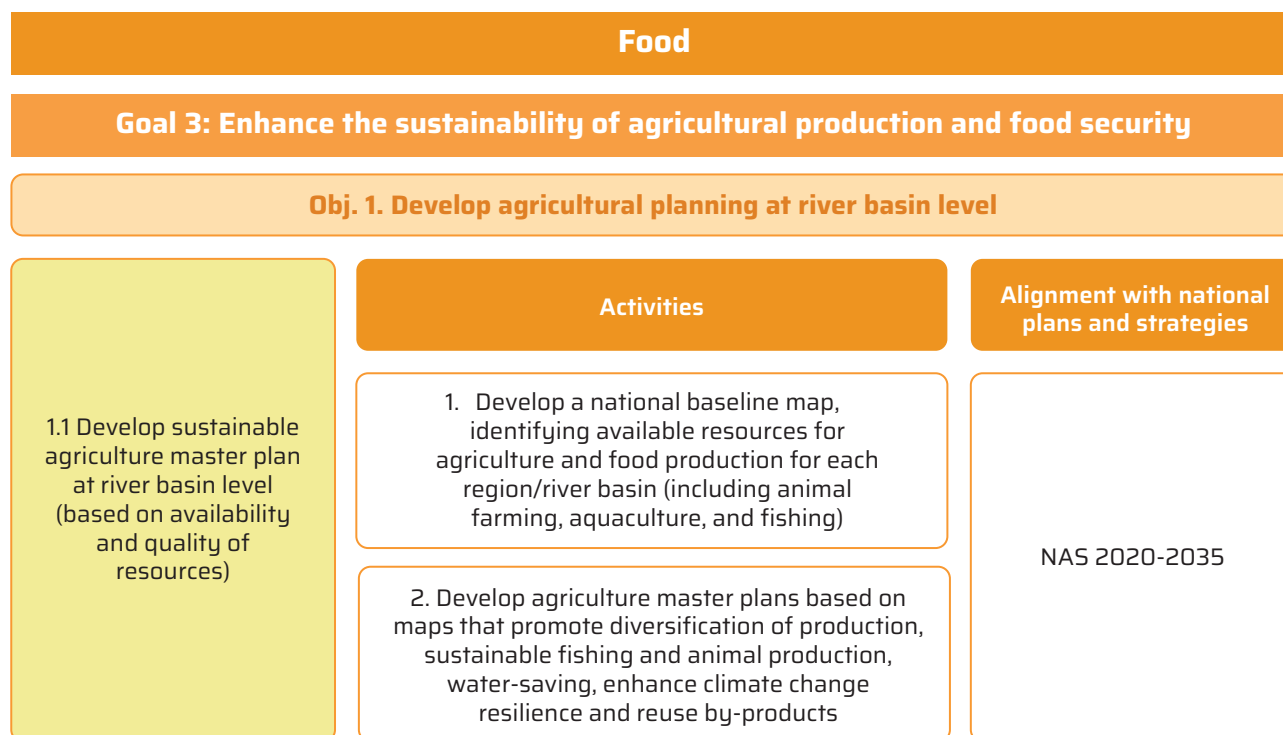
of areas with potential to be developed for agriculture, altitudes and microclimates.

3.2) This information will enable the **development of a national baseline map** recommending a list of crops for each region or watershed.

These plans would promote the sustainable agricultural practices described under objective 2 of this goal.

G3) Additionally, protecting agricultural land from urban expansion (through **urban planning and zoning**) and other threats is essential if the food sector is to be enhanced.

FIGURE 3-15 Goal 3 – Objective 1 – Sub-objective 1.1 Develop sustainable agriculture master plans at river basin level.



3.5.2 Objective 2: Promote sustainable agricultural practices and enhance food security

3.5.2.1 Adopt and mainstream sustainable agricultural practices

The sustainable agricultural practices promoted in the agricultural management plans should contribute to enhancing the performance of the food sector in Lebanon, increasing climate change resilience and improving the livelihoods of workers in the sector, including through:

3.3) Practices that minimise negative environmental impacts, enhance climate change resilience and improve farmers' livelihoods through diversification of production and sustainable practices that conserve and protect natural resources and ecosystems, and take future climate change projections into consideration. They also include the adoption of agricultural exploitation that limits large excavations, conserves topsoil and protects ecosystems (refer to Section 3.5.2.2).

3.4) Adoption and mainstreaming of water-saving agriculture throughout the various steps of agricultural production, including crop selection, installation of smart irrigation infrastructure, adoption of agro-forestry by promoting the use of tree windbreaks, adoption of zero tillage farming especially in orchards, promotion of recycling farm byproducts through composting, encouraging winter cover crops to enrich the soil with organic matter and suppress weeds, especially when integrated with animal production and similar agricultural practices that help to reduce water consumption and retain soil water for a longer period of time. This solution would include supporting farmers to acquire, install and use water-saving irrigation technologies.

3.5) Recycling of agricultural waste through composting and the reuse of compost to improve soil quality and reduce the need to apply chemical fertilisers. This measure would divert organic matter from dumpsites and landfills, valorise this waste and substitute current unsustainable

agricultural waste management practices (burning of biomass that increases the risks of wildfire and emissions).

3.6) Treatment of agricultural byproducts to produce alternative fuels by processing and burning these materials for heating, or anaerobic digestion and the production of biogas.

3.7) Sustainable pest management focusing on preventive measures and sustainable practices, where the use of pesticides is optimised on scientific bases.

3.8) Sustainable animal farming with high health and safety standards. Instead of the widely implemented concentrated animal feed units (CAFUs), free-range animal production through the promotion of silvo-pastoral agro-forestry would be adopted. CAFU production farms have a negative impact on nature and on animals, with large amounts of nitrous oxides emitted from the manure lagoons of large CAFUs, and animals are often subject to infectious diseases, requiring the use of antibiotics to keep their health in check. In silvo-pastoral animal production systems, on the other hand, the animals are spread over large grazing areas. Their manure percolates locally into the soil and produces substantially fewer greenhouse gases. These practices improve animal welfare, freeing the animals from confined spaces into wide grazing areas, and reduce negative environmental impacts.

The fisheries sector could be enhanced through:

3.9) The elaboration of a holistic strategy that creates linkages between aquaculture, fish feed production and agriculture. The strategy would help to develop a freshwater aquaculture sector that relies on locally produced inputs as much as possible.

The promotion of **sustainable fishing** through the **training of fishers on**

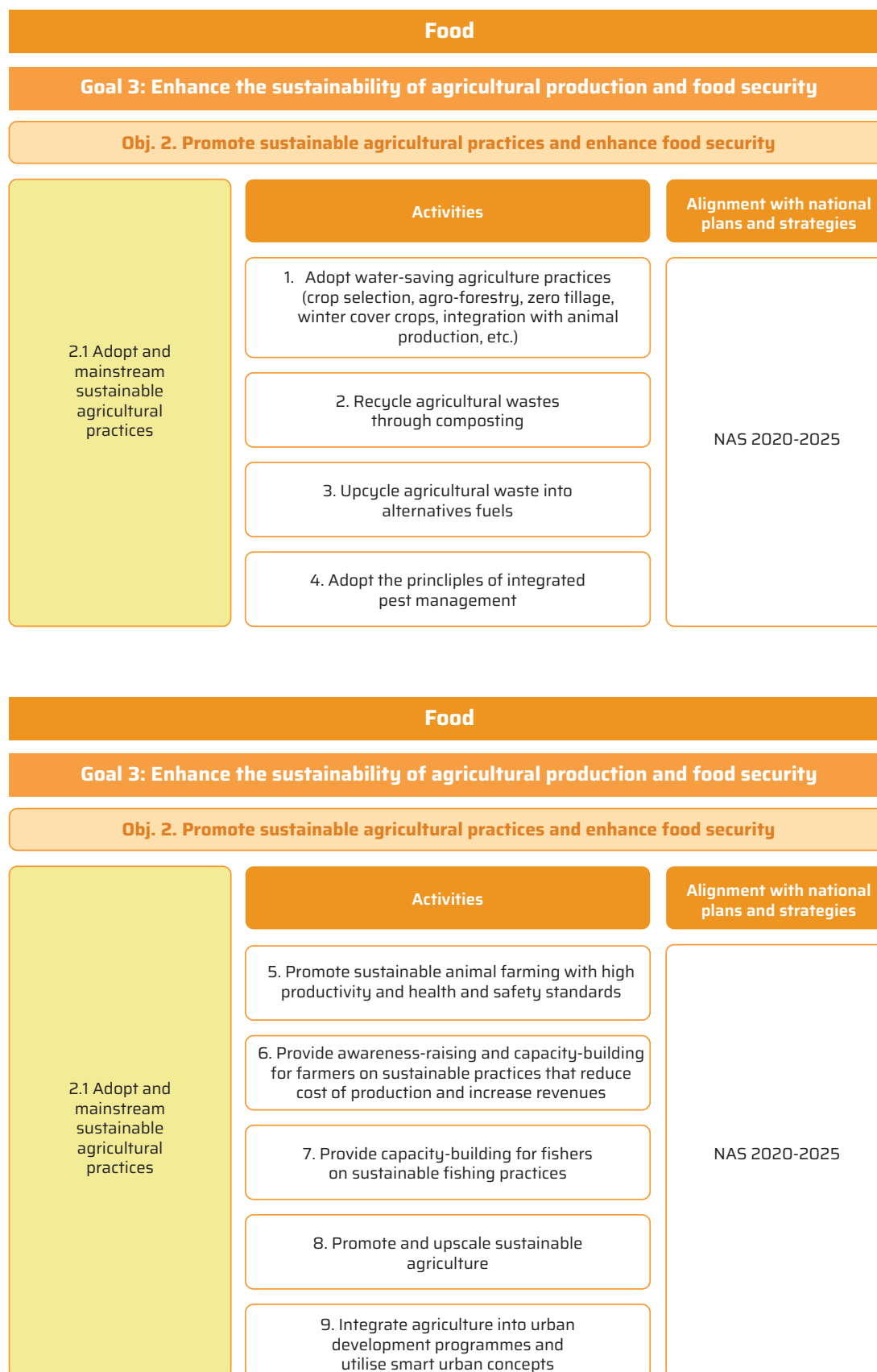
3.10) best fishing practices and adding value to their products, and

3.11) using new sustainable gears and targeting new fishing grounds, releasing pressure from shallow coastal areas where fishing activities are mostly concentrated.

3.12) Promotion of the upscaling of sustainable agriculture (not keeping it at the level of small farms).

3.13) Awareness-raising and capacity-building for farmers on these sustainable practices, and how they can help to reduce the cost of agriculture production, and thus increase profitability. In light of the current crises, the financial aspect could be the main driver behind the mainstreaming of these practices.

3.14) Integration of agriculture into urban development programmes and use of smart urban concepts. This could support agricultural production and the greening of cities, especially with facilitated marketing of products close to the production sites. This solution was, however, considered a low priority in the short term at the second stakeholder workshop, 'Food Round Table'.

FIGURE 3-16 Goal 3 – Objective 2 – Sub-objective 2.1 Adopt and mainstream sustainable agricultural practices.

3.5.2.2 Develop local production of food/ agriculture inputs

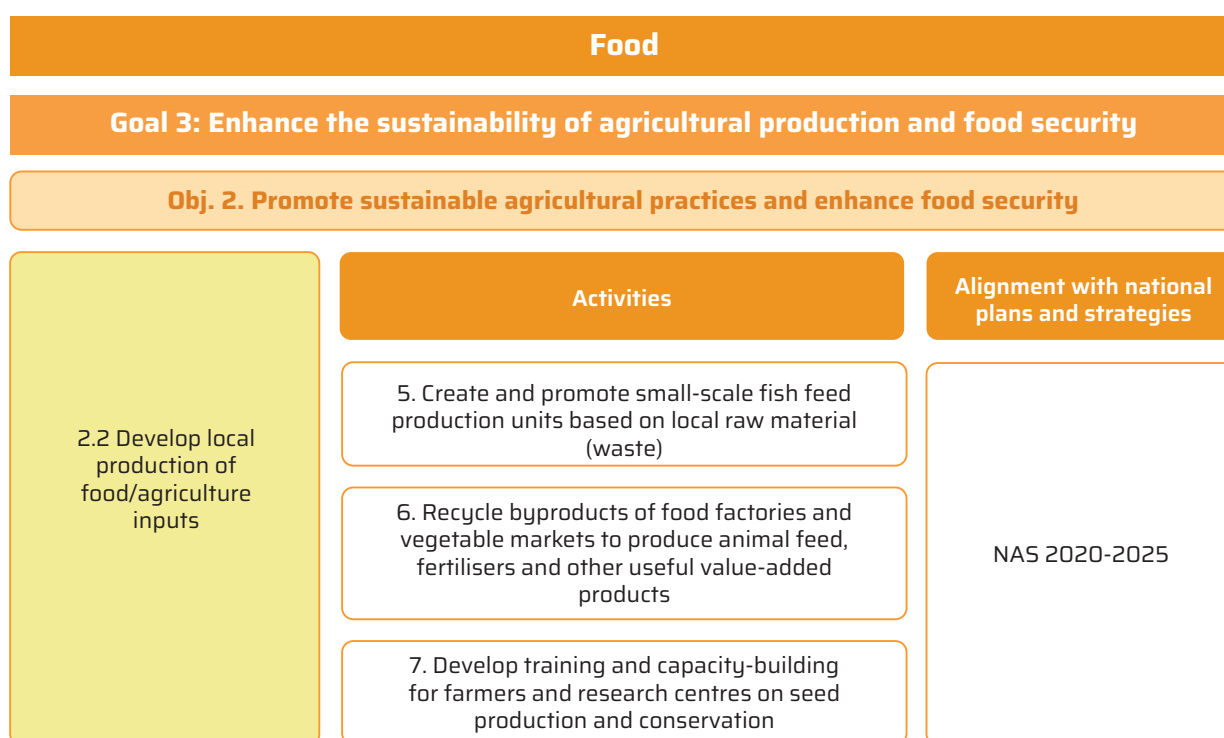
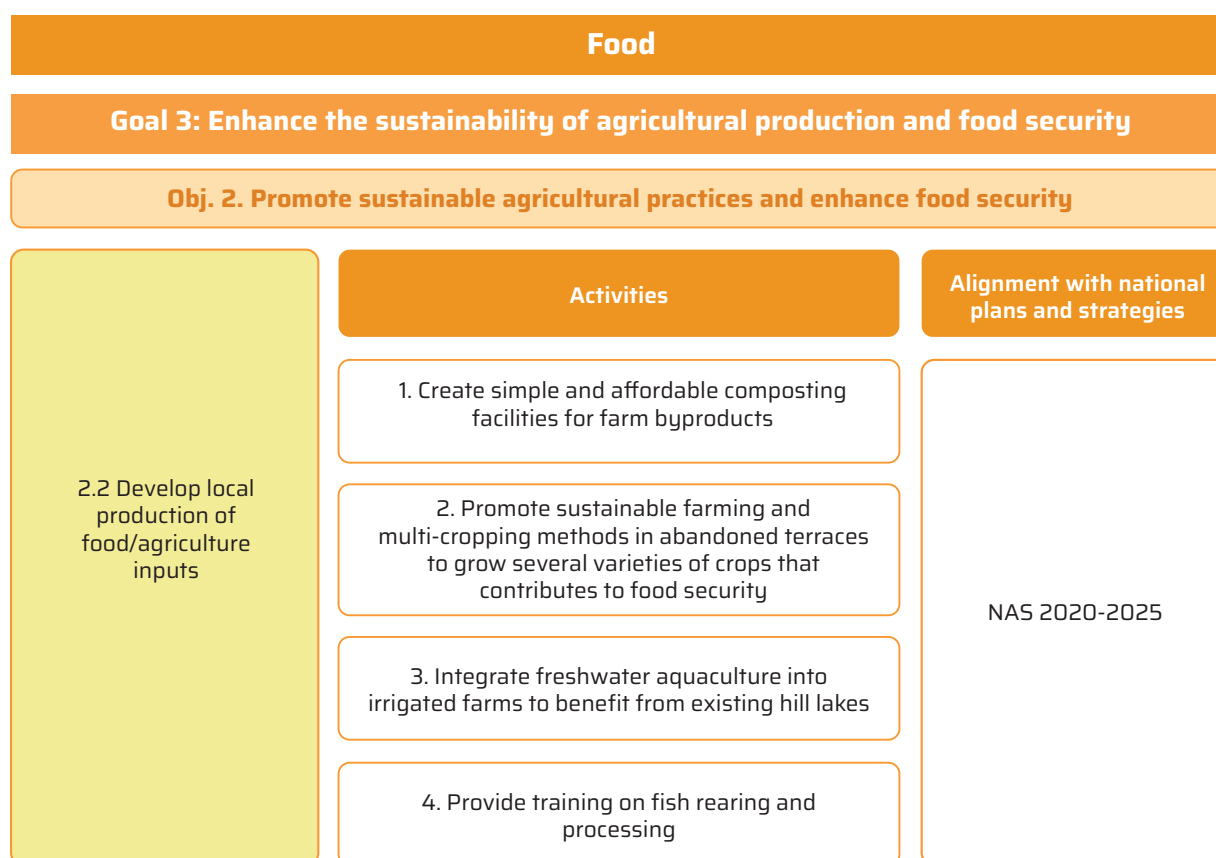
Most agricultural sector inputs are imported. This increases the cost of production, raises the risks and vulnerability faced by farmers and discourages investment in the sector.

The local production and alternatives should be promoted, and could include:

- ▶ **3.3) Supporting and encouraging sustainable farming** by adopting different integrated agricultural systems that could, for example, combine the use of multi-cropping methods in mountainous terraced areas with the rehabilitation of abandoned terraces, and take into consideration altitude variations (and different microclimates), allowing several varieties of crops to be grown and sold at very local markets, contributing to food security and reducing dependence on imports. All of these methods would have a low carbon footprint and would increase the income of small-scale farmers. Such practices would benefit several ground-dwelling species of birds, insects (honeybees) and other wild species as well.
- ▶ **3.5) Operating simple and affordable composting facilities** for farm byproducts, particularly sorted at source organic matter, to substitute imported fertilisers. These projects could be implemented at small and large scales in agricultural areas involving municipalities and agriculture cooperatives.

- ▶ **3.15) Supporting and encouraging farmers to grow cereals/fodder crops**, taking advantage of abandoned terraces and from various altitudes, allowing several varieties of crops to be grown that contribute to food security and reduce dependence on imports.
- ▶ **3.16) Recycling byproducts from food factories and vegetable markets to produce animal feed**, fertilisers and other useful value-added products.
- ▶ Providing training on fish rearing and processing (this solution was not identified as high priority at the stakeholder workshop).
- ▶ **3.16) Creating and promoting small fish feed production units** based on local raw materials.
- ▶ **3.17) Delivering training and capacity-building for research centres, cooperatives and farmers on seed production and conservation**, sustainable farming, composting, scaling up farm refuse, etc.

FIGURE 3-17 Goal 3 – Objective 2 – Sub-objective 2.2 Develop local production of food/agriculture products.

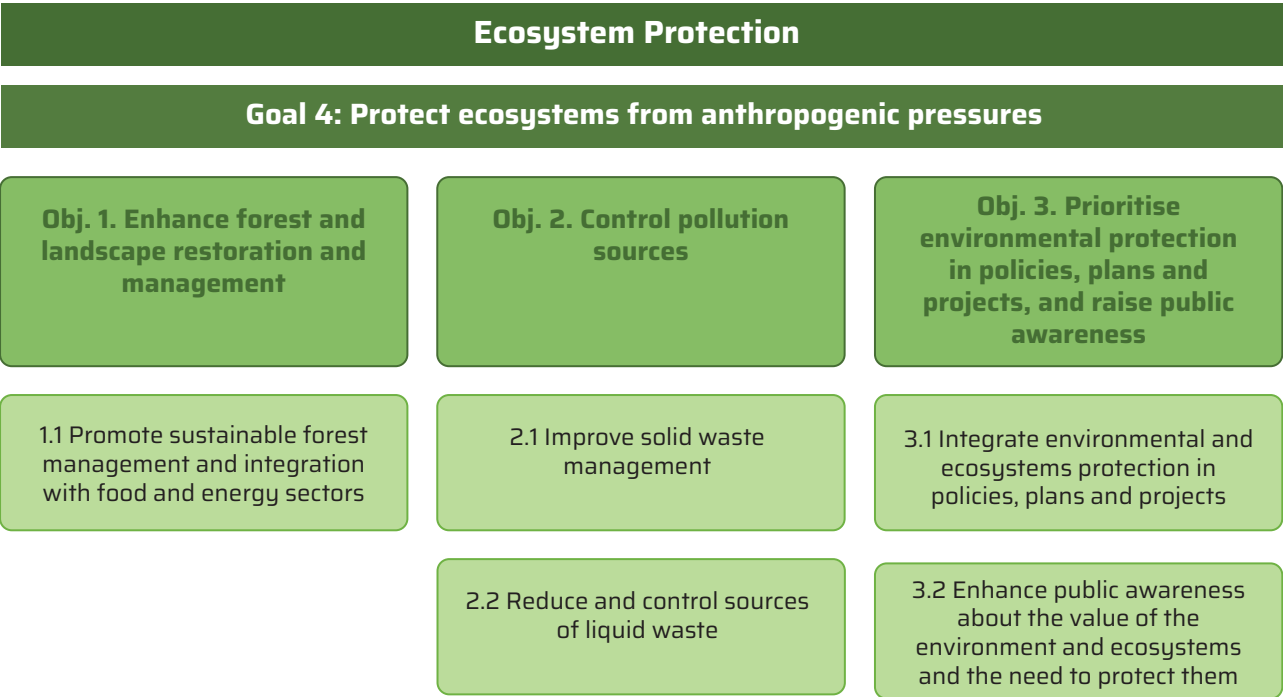


3.6 Goal 4: Protect ecosystems from anthropogenic pressures

For the ecosystem protection entry point, the goal is to protect ecosystems from negative effects caused by various WEF-related and other activities with significant impact through three main objectives that are complementary and essential to achieving this goal:

- 1. Enhance forest and landscape restoration and management
- 2. Control pollution sources (solid and liquid)
- 3. Prioritise environmental protection in policies, plans and projects, and raise public awareness.

FIGURE 3-18 Entry point 4 to WEFE Nexus solutions – anthropogenic activities/ecosystem protection.



The objectives, sub-objectives and solutions proposed under Goal 4 are presented in sections 3.6.1, 3.6.2 and 3.6.3.

3.6.1 Objective 1: Enhance forests and landscape restoration and management

3.6.1.1 Promote sustainable forest and landscape management practices through integration with food and energy sectors

4.1) The development of sustainable restoration management plans for forests and landscapes (including rangelands and other ecosystems) is needed at the national level to cover these

ecosystems, regardless of their ownership, due to the increased risks of fire and fire incidents in recent years. These management plans would offer fire protection by reducing biomass and creating firebreaks. The **biomass can then be processed for reuse in 3.5) composting (as an input for agriculture) or 3.6) mixed with other high-calorific agricultural byproducts to produce alternative fuel sources for heating in the winter.**

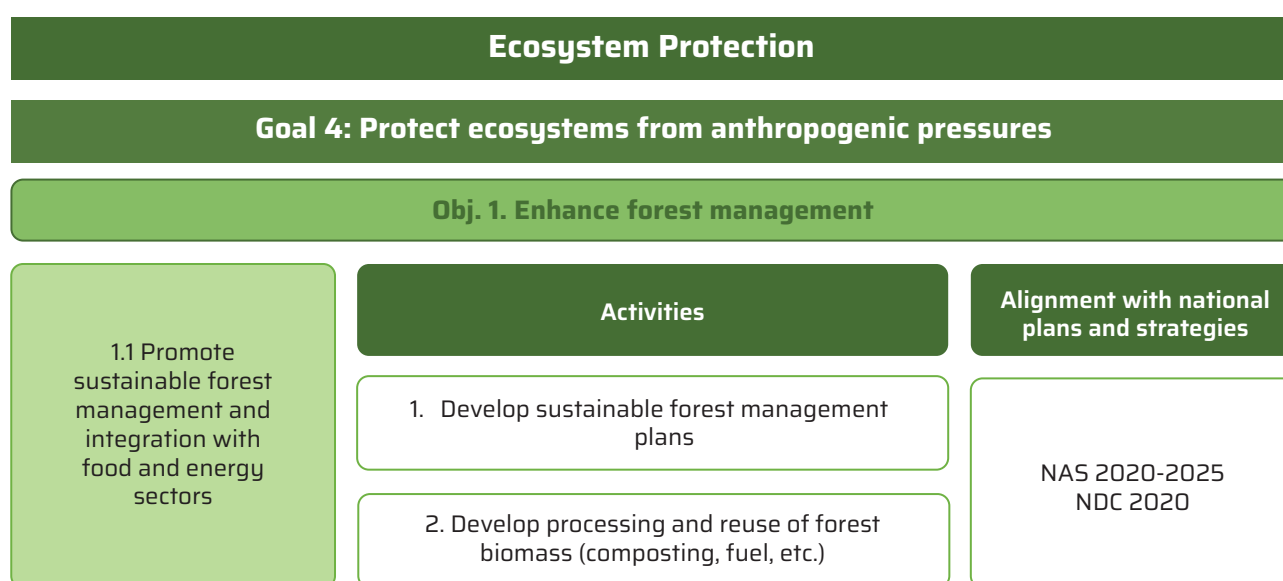
4.1) Sustainable forest and landscape restoration and management plans would encourage community-based activities to tackle afforestation/reforestation, quarry and landscape restoration, rangeland restoration

and protections, climate change adaptation, fire prevention and management, rural tourism management, biodiversity conservation and other related activities.

Sustainable forest management and agriculture should also be integrated where possible to make

use of the forest biomass generated from forest management for producing compost to help increase the carbon content of soil in surrounding agricultural lands. This kind of management has a positive impact on both forests and agriculture.

FIGURE 3-19 Goal 4- Objective 1 – Sub-objective 1.1 Promote sustainable forest management practices through integration with food and energy sectors.



3.6.2 Objective 2: Control pollution sources

3.6.2.1 Improve solid waste management practices and increase the value of specific materials that could support the development of the WEFE sectors

The poor management of solid waste in Lebanon is having a significant negative impact on natural resources and ecosystems. Open dumping and burning of solid waste are polluting soil, water and air and affecting public health.

The following solutions are proposed to enhance the management of solid waste:

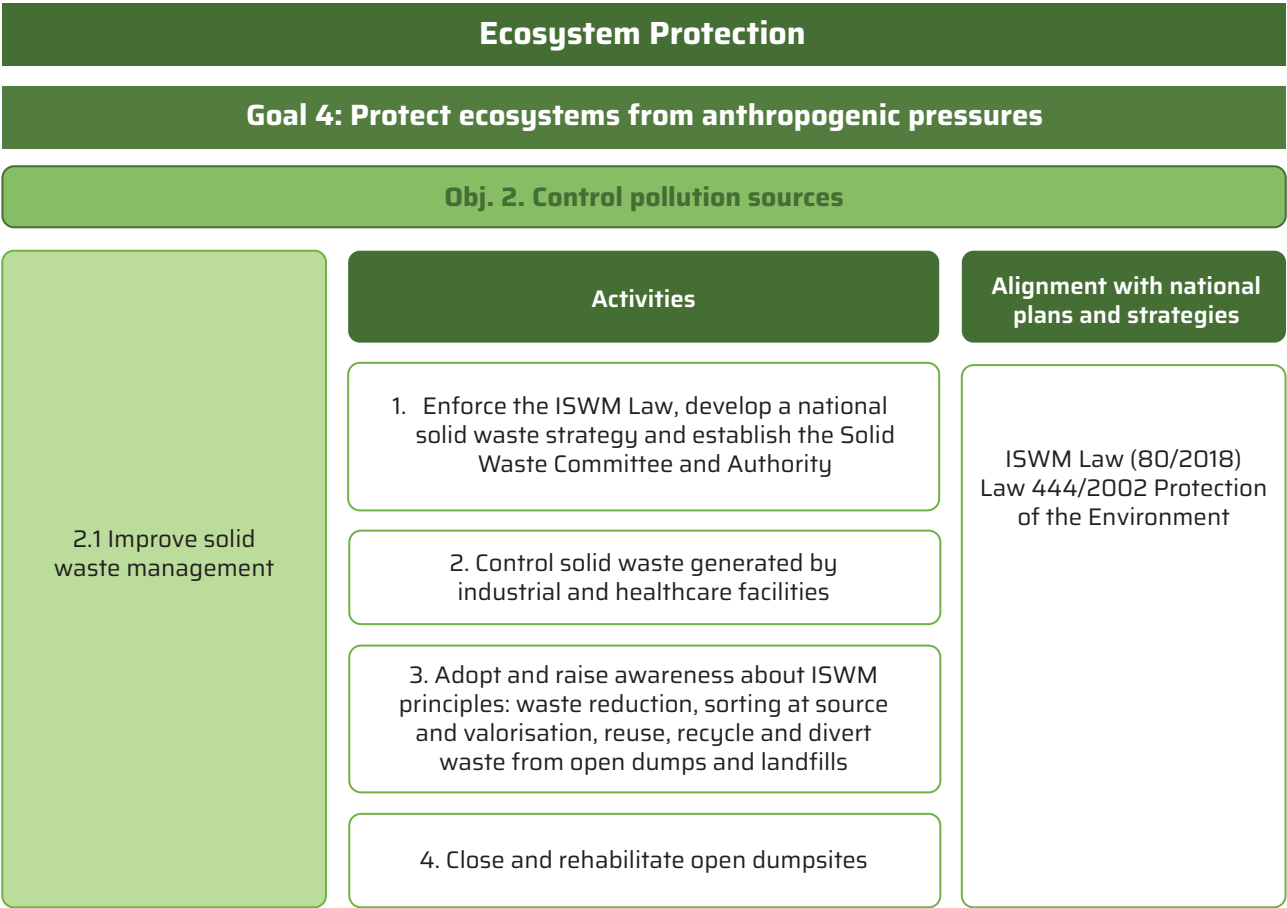
- Amend (as needed) and enforce the ISWM Law (80/2018), including developing implementing decrees and a national solid waste strategy,

and establishing the National Solid Waste Committee and National Solid Waste Authority. It is worth noting that work is currently under way to amend the law (related to cost recovery) and develop the strategy, and so these have not been included here as proposed solutions.

- **4.2) Adopt and raise awareness about ISWM principles** to reduce pollution and stress on natural resources, starting by reducing the amount of waste generated, improving sorting at source - at a first level of wet (organic) fraction and dry fraction - to valorise the various components, enhancing recycling and treatment, diverting solid waste from open dumping, open burning and landfill, and generating products that can be used as agricultural inputs and/or as energy sources.

- ▶ **4.3) Control solid waste streams generated by industrial and healthcare facilities** (these are different from municipal solid waste) and enforce laws regulating specific streams generated at these facilities.
- ▶ **4.3) Remediate polluted areas.**
- ▶ **4.3) Close and rehabilitate open dumpsites.**

FIGURE 3-20 Goal 4- Objective 2 – Sub-objective 2.1 Improve solid waste management practices.



3.6.2.2 Reduce and control sources of liquid waste

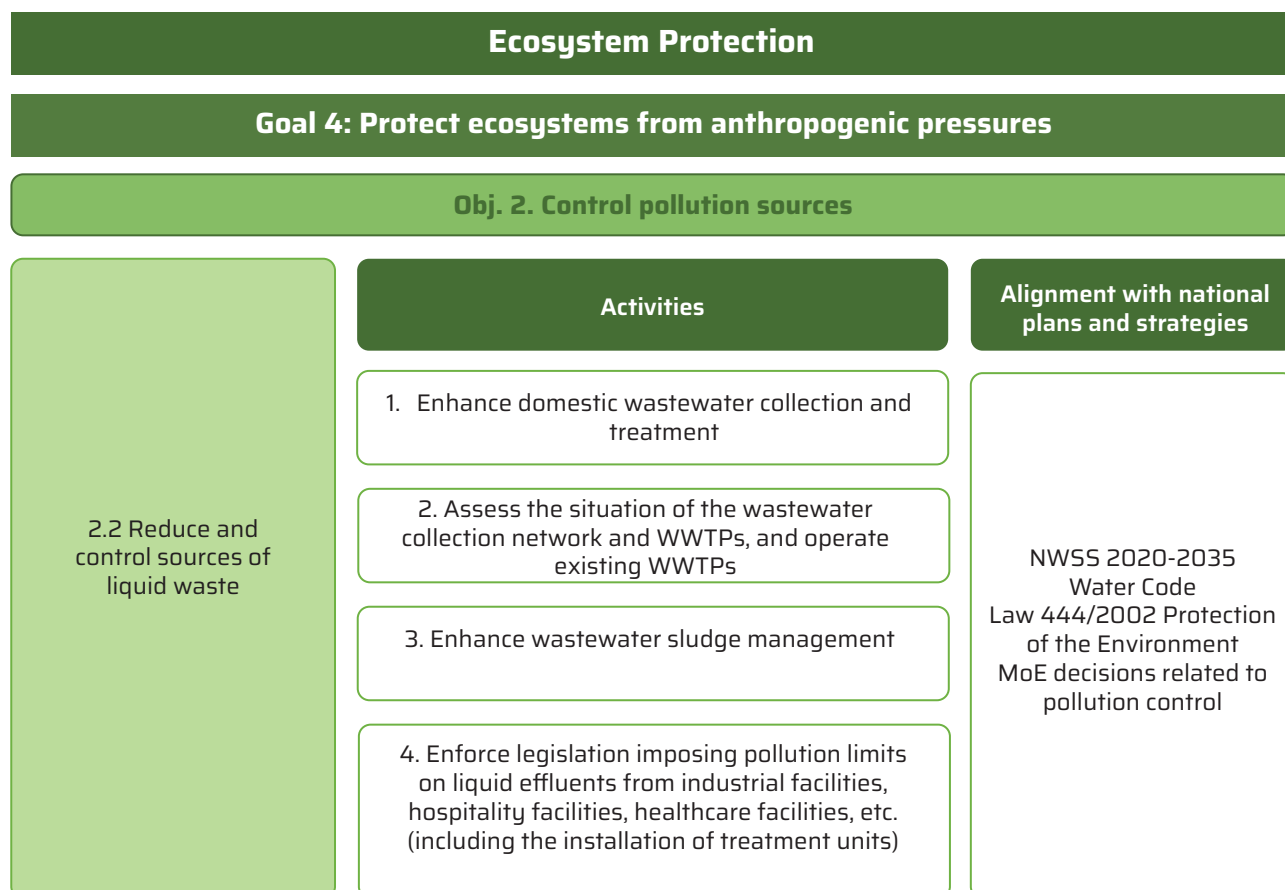
The poor management of wastewater, from both domestic and nondomestic sources, is severely affecting natural resources, ecosystems and biodiversity, and increasing public health risks. In addition to the measures included under the Energy goal, related to the provision of renewable energy solutions for WWTPs operated by RWEs, the following solutions are proposed:

- ▶ **4.4) Enhance domestic wastewater collection and treatment** by increasing collection network coverage, wastewater treatment plant coverage and treatment levels, properly managing sludge, etc. This solution would require an assessment of the current situation regarding networks and WWTPs, the need for upgrades and increased capacity, and the addition of treatment steps that will result in better effluents.
- ▶ **4.4) Manage wastewater sludge generated by WWTPs properly.**

- **4.4) Enforce legislation imposing pollution limits on liquid effluents** from industrial facilities, hospitality facilities, healthcare

facilities, etc. (including the installation of treatment units within facilities, where needed to meet the required levels).

FIGURE 3-21 Goal 4- Objective 2 – Sub-objective 2.2 Reduce and control sources of liquid waste.



3.6.3 Objective 3: Prioritise environmental protection in policies, plans and projects, and raise public awareness about related issues

3.6.3.1 Integrate environmental and ecosystems protection in policies, plans and projects

In addition to the positive impacts that the previously described solutions are expected to create for ecosystems, additional solutions should be considered, including:

- **4.6) Appointing environmental prosecutors and investigating judges, and activating environmental inspection in accordance with the provisions of Law 251/2014 and**

environmental police in accordance with Lebanese Government Decree 3989/2016 to enhance the enforcement of environmental legislation and improve coordination mechanisms between the relevant ministries to ensure better implementation of environmental legislation (water, waste, etc.).

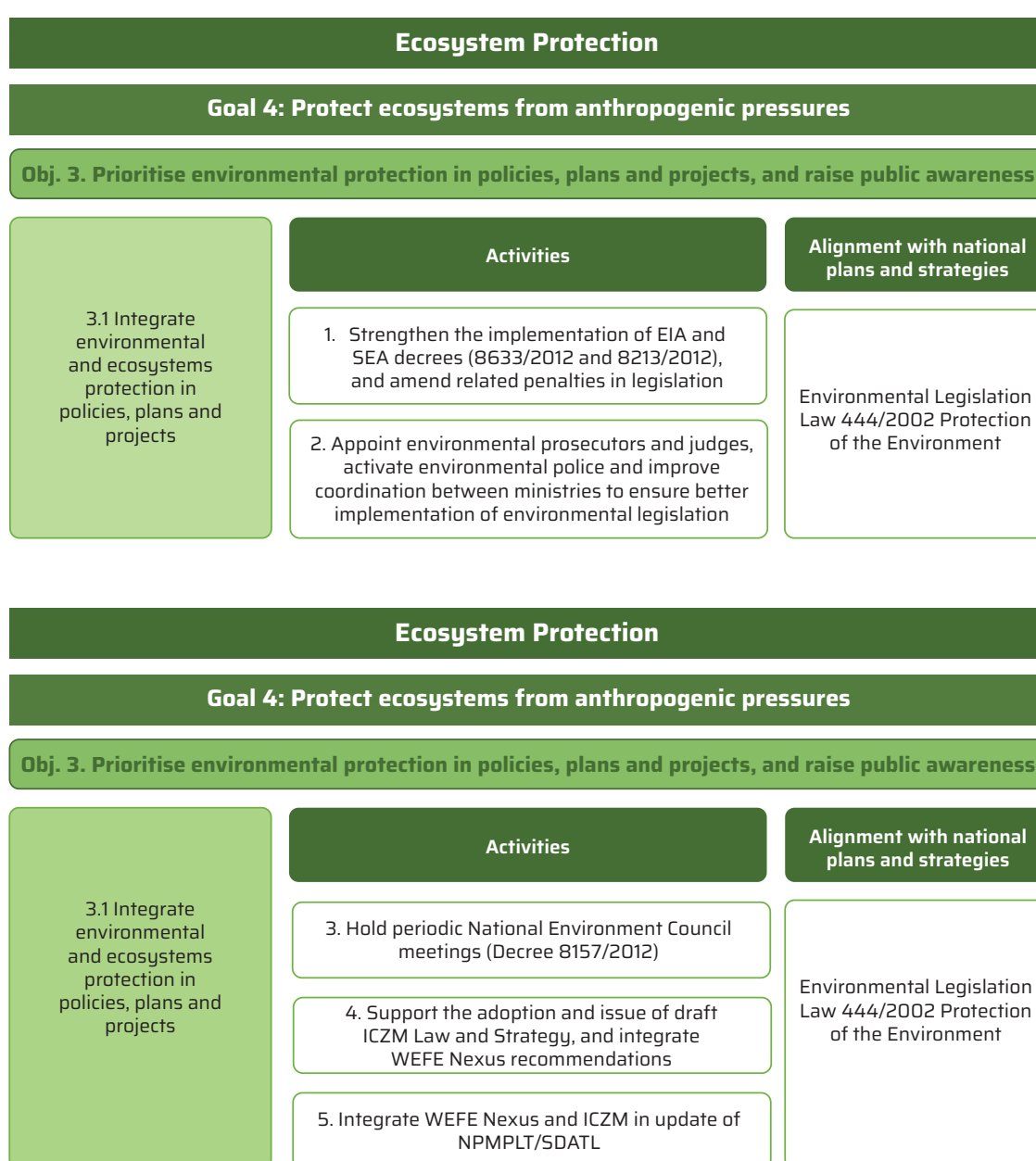
- **4.7) Strengthening implementation of EIA Decree 8633/2012 and SEA Decree 8213/2012**, by enhancing MoE monitoring of the implementation of EMPs developed under these studies, and amending related penalties in legislation to account for devaluation in the national currency.

- ▶ **4.8) Holding periodic National Environment Council meetings** in compliance with the requirements of Decree 8157/2012.
- ▶ **4.9) Supporting the adoption and issue of the draft ICZM Law and Strategy** and integrating the WEFE Nexus recommendations that benefit ecosystems protection; raising awareness and

building capacity for various stakeholders on related issues.

- ▶ **4.10) Integrating the findings of the WEFE Nexus Assessment** that reduce pressure on natural resources and ecosystems **in the updated NPMPLT**.

FIGURE 3-22 Goal 4- Objective 3 – Sub-objective 3.1 Integrate environmental and ecosystems protection in policies, plans and projects.

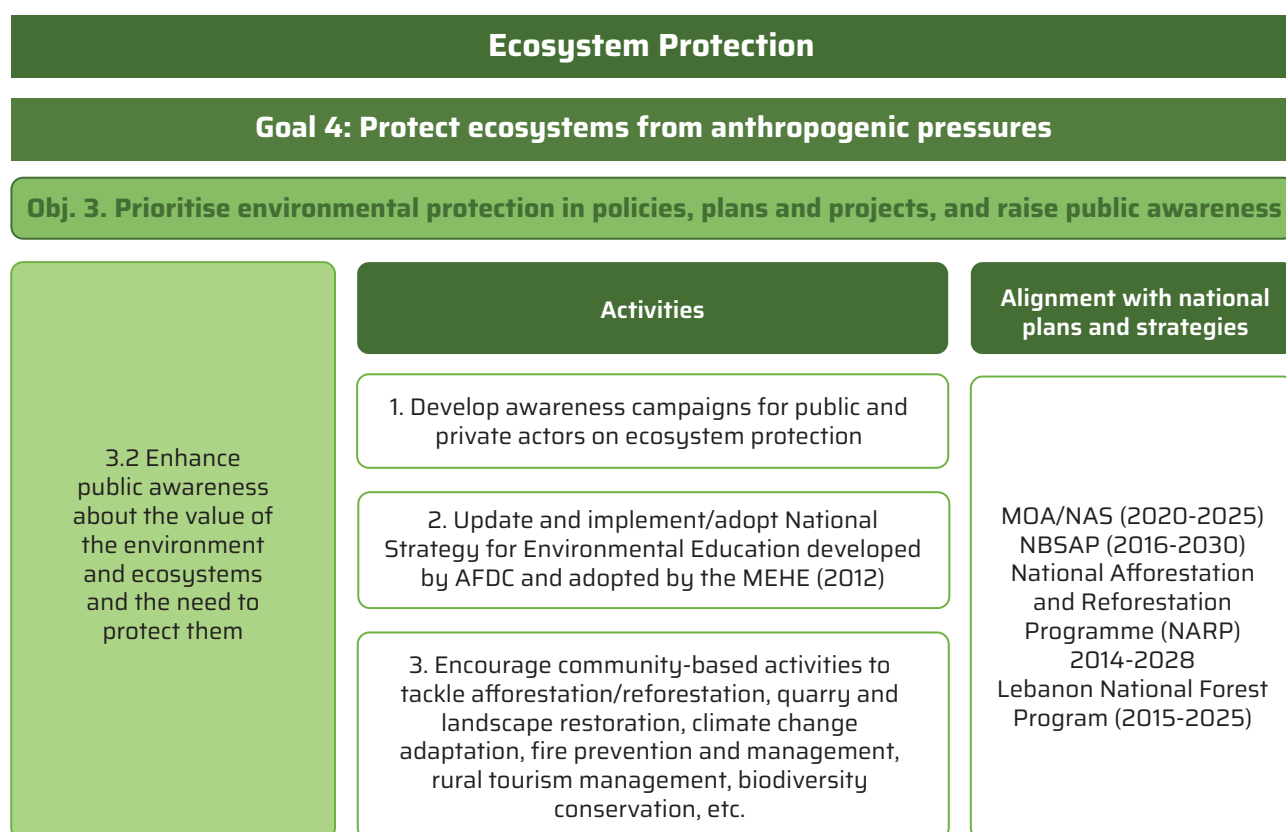


3.6.3.2 Enhance public awareness about the value of the environment and ecosystems and the need to protect them

In parallel with implementing solutions targeting various issues affecting the WEFE sectors, it is essential to raise public awareness about the subjects discussed throughout this project, on the sectors, interlinkages and environmental protection. Awareness-raising activities could focus on sustainable water management, sustainable agriculture, the importance of ecosystems and of protecting them, forest fire prevention, solid waste hierarchy (focusing on avoidance, reduction, reuse, recycling and upcycling). The solutions could include:

- ▶ Developing awareness campaigns for public and private actors on the various issues.
- ▶ **4.12) Updating and implementing/adopting the National Strategy for Environmental Education developed by the Association for Forests, Development and Conservation (AFDC) and adopted by the Ministry of Education and Higher Education (MEHE) (2012).**
- ▶ **4.5)** Encouraging community-based activities to tackle afforestation/reforestation, quarry and landscape restoration, climate change adaptation, fire prevention and management, rural tourism management, biodiversity conservation and other related activities.

FIGURE 3-23 Goal 4- Objective 3 – Sub-objective 3.2 Enhance public awareness about the value of the environment and ecosystems and the need to protect them



3.7 List of Nexus solutions

Some of the activities have been combined to prevent duplication where they can be implemented under the same framework and involve the same stakeholders (such as the control and enforcement of laws related to liquid and solid waste from industrial and healthcare facilities, which were included separately in the previous sections); while others have been divided (such as the use of renewable energy for water facilities, wastewater facilities and the food sector, as the stakeholders and impacts involved are different.

A note in red has been added next to governance-related projects, to facilitate prioritisation (refer to Chapter 5).

Goal G: WEFE Nexus governance solutions

G1 Set up and sustain a WEFE Nexus intersectoral body (Governance)

G2 Develop measures to facilitate access to financing for WEFE Nexus projects (Governance)

G3 Develop land-use planning and zoning that prioritises the protection of natural resources (including ecosystems, groundwater recharge areas and agricultural land) (Governance)

Goal 1: Enhance planning in the energy sector and close the energy gap

1.1 Strengthen the renewable energy legislative and policy framework (approval of Distributed Renewable Energy Law and the Energy Conservation Law and preparation of required implementing decrees) (Governance)

1.2 Enhance the energy security of the food sector (implementing solar installations for food production and enhancing the energy efficiency of systems)

1.3 Design and develop novel agro-energy cooperative models and replicable business models

1.4 Enhance the energy security of the wastewater sector (implementing solar installations for WWTPs, enhancing the energy efficiency of the facilities and relying on low energy consuming technologies)

1.5 Enhance the energy security of the water sector (implementing solar installations for water supply facilities, enhancing the energy efficiency of facilities and relying on low energy consuming technologies, such as transmission by gravity, where possible)

1.6 Increase the energy efficiency of various facilities (public sector)

1.7 Develop guidelines and a methodology for energy-related data collection at different levels (primary and behind the meter level), including methodologies to set a national energy balance and energy indicators

1.8 Create an energy indicator database platform to enhance transparency in the Lebanese energy sector (this could be used to calculate the yearly energy balance for Lebanon, and help relevant actors and users to visualise and assess the state of the sector related to energy)

1.9 Develop an integrated energy-water master plan

Goal 2: Protect and enhance water resources management in Lebanon

2.1 Develop groundwater recharge master plans (including mapping sensitive groundwater recharge areas, assessing aquifers, delineation/identification of protection zones for aquifer recharge areas and issuing recommendations on stormwater management)

- 2.2 Adjust building permit process to regulate stormwater management** (Governance)
- 2.3 Develop guidelines and national standards for public green infrastructure that prioritise groundwater recharge and better stormwater management**
- 2.4 Green and retrofit existing infrastructure and build new facilities/services to enhance stormwater management**
- 2.5 Create stormwater recharge projects within coastal and high-density cities**
- 2.6 Implement recharge galleries wherever possible**
- 2.7 Promote reintroduction of traditional terraces throughout the Lebanese landscape** which enhance groundwater recharge, including within individual properties (potentially through incentives)
- 2.8 Develop river basin management plans** (including water safety plans for water sources, hydrological and hydrogeological analysis of basin)
- 2.9 Calculate water balance at river basin and national levels** (including assessment of water availability, water production (monitoring of water points (water supply facilities) and water consumption by end users)
- 2.10 Identify opportunities to use surface water sources instead of groundwater where and when possible**
- 2.11 Upgrade water distribution networks** to reduce leakage and waste
- 2.12 Raise awareness about water scarcity and saving**
- 2.13 Promote water-saving technologies in various sectors** (agriculture, education,

industry, tourism, healthcare, domestic use, cleaning, etc.) including through the development of guidelines targeting each sector

- 2.14 Install meters to monitor water consumption, create database for water consumption** (by area, sector and user) **and set goals for specific sectors to incentivise water-saving**
- 2.15 Promote rainwater harvesting in rural and urban areas** (for reuse at domestic level and for irrigation)
- 2.16 Reuse treated wastewater in agriculture provided that the treatment results in suitable effluent quality**
- 2.17 Separate grey- and blackwater; treat and reuse greywater where possible**

Goal 3: Enhance the sustainability of agricultural production and food security

- 3.1 Develop sustainable agriculture master plans at river basin level**
- 3.2 Develop national agriculture baseline maps** identifying available resources for agriculture, and recommending crops to be grown at the river basin level
- 3.3 Promote agricultural practices that minimise negative impacts on the environment, enhance climate change resilience and improve farmers' livelihoods**
- 3.4 Promote various water-saving techniques and practices in agriculture** (crop selection, agro-forestry, zero tillage, winter cover crops, integration with animal production, etc.)
- 3.5 Recycle agricultural waste for fertiliser production**

3.6 Recycle agricultural waste, including forest biomass, to produce alternative fuel

3.7 Promote sustainable pest management techniques

3.8 Adopt sustainable animal farming and production with high productivity and health and safety standards

3.9 Elaborate a holistic strategy that creates linkages between aquaculture, fish feed production and agriculture

3.10 Train fishers on sustainable fishing practices and how to add value to their products

3.11 Train fishers on using new sustainable gears and targeting new fishing grounds, releasing pressure on shallow coastal areas

3.12 Promote the upscaling of sustainable agriculture (rather than keeping it at the level of small farms)

3.13 Build farmers' capacity on sustainable agriculture and food production

3.14 Integrate agriculture into urban development programmes and utilise smart urban concepts

3.15 Support and encourage farmers to grow cereals/fodder crops

3.16 Recycle agricultural waste to produce animal feed

3.17 Deliver training and capacity-building for farmers, cooperatives and research centres on seed production and conservation

Goal 4: Protect ecosystems from anthropogenic pressures

4.1 Develop sustainable forest and landscape restoration and management plans

4.2 Adopt and raise awareness about integrated solid waste management (ISWM)

4.3 Identify and remove pollution sources affecting natural resources and ecosystems, including the control of solid waste and liquid wastes generated by healthcare and industrial facilities, closure and rehabilitation of open dumpsites, and remediation of polluted areas

4.4 Increase coverage of wastewater collection networks and extend/enhance wastewater treatment plant services (in terms of covered areas and level of treatment, including sludge management)

4.5 Encourage community-based activities related to ecosystem protection and conservation

4.6 Appoint environmental prosecutors and investigating judges, and activate environmental inspection and environmental police (to enforce laws related to natural resources and environmental protection) (Governance)

4.7 Strengthen and enforce the implementation of EIA Decree 8633/2012 and SEA Decree 8213/2012 (Governance)

4.8 Ensure the resumption of the National Environment Council and hold periodic meetings in compliance with the requirements of Decree 8157/2012 (Governance)

4.9 Support the adoption and issuance of the draft legislation and strategy on ICZM, and integrate the WEFE Nexus recommendations that benefit ecosystem protection, raise awareness and build the capacities of various stakeholders on related issues (Governance)

4.10 Integrate the findings of the WEFE Nexus Assessment that reduce pressure on natural resources and ecosystems in the update of the National Physical Master Plan of the Lebanese Territory (NPMPLT/SDATL) (Governance)

4.11 Update and implement/adopt the National Strategy for Environmental Education developed by AFDC and adopted by the MEHE (2012) (Governance)

The following general recommendations should be considered:

- identify the different needs of women and men in relation to the solutions and address these in project design and implementation
- ensure inclusivity in educational and capacity-building projects through targeted training and awareness campaigns where needed (for example on issues related to energy and water-saving, sustainable agriculture, etc.)
- ensure the effective participation of women in the committees to be established (this could be achieved by specifying quotas)
- ensure equal opportunities for women and men in access to financing to implement WEFE Nexus-related projects
- account for vulnerable households when setting tariffs for services
- address specific barriers that women and their cooperatives face in agriculture
- encourage and build the capacities of women to participate in traditionally male-dominated fields (such as the environmental police, forest guards, environmental prosecutors, etc.).

3.8 Accounting for gender in proposed WEFE Nexus solutions

In the detailed design and planning of the solutions proposed under this project, it is essential to account for the different situations experienced by women and men due to their roles in society and economic life. This will enable the solutions to better respond to the existing needs of beneficiaries and, therefore, to be successful.

4. Overview of national and international financing schemes and instruments and of IFIs' strategies and priorities

For years, international organisations, multilateral banks, NGOs and other actors have provided financing to support the development of the Lebanese WEFE sectors. The type of funding provided and the modalities applied to achieve this purpose have varied depending on the project.

Prior to the 2019 crises, WEFE sector projects were largely funded by the Lebanese Government, multilateral banks, development agencies, local commercial banks, local and international NGOs, microfinance organisations and other organisations such as incubators and accelerators. The Lebanese Government has since been unable

to provide adequate funding for each sector. Local commercial banks have ceased lending to public and private entities, while microfinance institutions and other local actors have reduced their involvement. Some of the programmes supported by international funding have also been put on hold.

Table 4-1 presents a concise overview of available funding partners (by category) and the support modalities that could help to implement WEFE Nexus interventions in the current Lebanese context.

TABLE 4-1 Funding partners categories in Lebanon

Funding partner category	Current and potential assistance to WEFE sectors in Lebanon
Multilateral banks	- Assist developing countries with stable and long-term financing - Provide financing facilities at low interest rates - In Lebanon, funding interventions have primarily focused on providing international technical assistance and direct grants and loans to relevant government bodies and other stakeholders
Multilateral organisations and development agencies	- Have had a crucial presence at all stages of WEFE Nexus sector initiatives - Donor countries act through their own development banks and development agencies to assist developing countries - Financial contributions, whether in the form of grants or medium and long-term loans, have been essential in supporting WEFE sectors

Funding partner category	Current and potential assistance to WEFE sectors in Lebanon
Non-profit organisations (NPOs) and NGOs	▶ The private sector has been a key driver of the Lebanese economy for many years, with a wide range of actors intervening through private companies, NPOs and NGOs ▶ These actors have had a significant impact across all sectors, including WEFE
Incubators and accelerators	▶ Lebanese start-ups can take advantage of these to make their business a success by approaching the potential business investors' programmes, which offer comprehensive benefits such as funding, mentorship, office space and networking opportunities ▶ Incubators provide entrepreneurs with a space to develop and grow their business, while accelerators provide the necessary resources and guidance needed to scale businesses ▶ For the past four years, the crises in Lebanon have had a detrimental impact on all sectors of the economy, particularly the start-up ecosystem
Lebanese Government	▶ The Lebanese Government is unable to provide coherent and sufficient funding to support the economic sectors due to internal and external deadlocks and the financial crisis ▶ No comprehensive financing plan can be relied upon to support the WEFE Nexus initiatives, apart from the existing facilities, staff and limited financing in Lebanese pounds, which are suffering from a continuous devaluation; it is thus essential to consider alternative methods of funding in order to ensure the sustainability of these initiatives
Local banks	▶ The Central Bank of Lebanon and the banking sector are suffering from the crippling economic and financial crisis, and lending activities have ceased since the fourth quarter of 2019 with no signs of improvement in sight. The lack of trust in the banking sector, combined with its inability to provide support to public and private entities, has hindered the banks' traditional intermediary role. ▶ The banks are only intervening in limited areas, such as when international donors and development agencies use their facilities to support initiatives.

5. Shortlist of concrete WEFE Nexus interventions

5.1 Results of the project prioritisation exercise

The proposed WEFE Nexus solutions have been evaluated based on the methodology explained in Chapter 1, and the results are presented below.

Table 5-1 and **Table 5-2** show the results of the grading exercises for governance-related and other solutions, listed by score in decreasing order, i.e. the highest scoring projects are at the top of the list. The number assigned to the project in the first column on the left is the same number used in Chapter 3 to facilitate cross-referencing.

TABLE 5-1 Prioritised governance-related WEFE Nexus solutions

#	WEFE Nexus solution	Criteria										Period			Total score	Rank	
		Impact on sectors				Governance			Financial sustainability			Short term	Medium term	Long term			
		Water	Energy	Food	Ecosystems	Impact on legal Framework	Impact on administrative Framework	Alignment with national Strategies and Action Plans	Capital cost / investment	O&M cost	Possibility of cost recovery						Existence of funding mechanism
G1	Set up and sustain a WEFE Nexus intersectoral body	5	5	5	5	5	5	5	4	4	1	2	x			46	1
1.1	Strengthen the renewable energy legislative and policy framework	4	5	5	3	5	4	5	4	4	1	2	x			42	2
2.2	Adjust building permit process to regulate stormwater management	5	2	4	4	4	4	4	4	2	3	3		x		39	3
G2	Develop measures to facilitate access to financing for WEFE Nexus projects	4	4	4	4	2	2	4	3	4	2	5		x		38	4
G3	Develop land-use planning and zoning that prioritises the protection of natural resources	5	2	4	5	5	5	3	4	3	1	1	x	x	x	38	4
4.7	Strengthen and enforce the implementation of EIA Decree 8633/2012 and SEA Decree 8213/2012	4	3	3	5	4	5	4	4	2	1	1	x	x	x	36	5
4.8	Ensure the resumption of the National Environment Council and hold periodic meetings	3	2	2	5	4	5	5	4	4	1	1	x	x	x	36	5
4.9	Support the adoption and issuance of the draft legislation and strategy on ICZM, and integrate the WEFE Nexus recommendations	4	2	3	4	5	4	4	3	3	1	2	x			35	6

#	WEFE Nexus solution	Criteria											Period			Total score	Rank
		Impact on sectors				Governance			Financial sustainability				Short term	Medium term	Long term		
		Water	Energy	Food	Ecosystems	Impact on legal Framework	Impact on administrative Framework	Alignment with national Strategies and Action Plans	Capital cost / investment	O&M cost	Possibility of cost recovery	Existence of funding mechanism					
4.6	Appoint environmental prosecutors and investigating judges, and activate environmental inspection and environmental police	3	2	5	4	2	3	4	3	4	3	2		x		35	6
4.10	Integrate the findings of the WEFE Nexus Assessment that reduce pressure on natural resources and ecosystems in the update of the National Physical Master Plan of the Lebanese Territory (NPMPLT/SDATL)	4	4	4	4	3	3	4	3	4	3	1		x		34	7
4.11	Update and implement/adopt the National Strategy for Environmental Education developed by AFDC and adopted by the MEHE (2012)	3	3	3	3	2	2	3	3	3	1	2		x	x	28	8

TABLE 5-2 Prioritised non-governance-related WEFE Nexus solutions

#	WEFE Nexus solution	Criteria											Period			Total score	Rank
		Impact on sectors				Governance			Financial sustainability				Short term	Medium term	Long term		
		Water	Energy	Food	Ecosystems	Impact on legal framework	Impact on administrative Framework	Alignment with national strategies and Action Plans	Capital cost / investment	O&M cost	Possibility of cost recovery	Existence of funding mechanism					
2.13	Promote water-saving technologies in various sectors (agriculture, education, industry, tourism, healthcare, domestic use, cleaning, etc.) including through the development of guidelines targeting each sector	5	5	4	4	3	3	5	4	5	2	3	x			43	1
1.4	Enhance the energy security of the wastewater sector	5	5	4	4	2	2	5	3	2	4	5	x			41	2
2.1	Develop groundwater recharge master plans	5	5	4	4	3	3	4	3	4	3	3		x		41	2
1.2	Enhance the energy security of the food sector	4	5	5	3	2	2	4	3	2	5	5	x			40	3
1.5	Enhance the energy security of the water sector	5	5	4	3	2	2	5	2	2	4	5	x			39	4
1.9	Develop an integrated energy-water master plan	5	5	4	4	3	3	4	3	4	2	2		x		39	4
2.9	Calculate water balance at river basin and national levels	5	3	4	4	2	4	5	2	2	4	4		x	x	39	4
2.11	Upgrade water distribution networks to reduce leakage and waste	5	5	4	3	2	2	5	3	4	3	3		x		39	4
3.1	Develop sustainable agriculture master plans at river basin level	5	2	5	4	2	3	4	3	4	3	4	x			39	4
3.13	Build farmers' capacity on sustainable agriculture and food production	5	4	5	5	1	1	3	4	4	3	4	x	x		39	4

#	WEFE Nexus solution	Criteria											Period			Total score	Rank
		Impact on sectors				Governance			Financial sustainability				Short term	Medium term	Long term		
		Water	Energy	Food	Ecosystems	Impact on legal framework	Impact on administrative Framework	Alignment with national strategies and Action Plans	Capital cost / investment	O&M cost	Possibility of cost recovery	Existence of funding mechanism					
3.12	Promote the upscaling of sustainable agriculture (rather than keeping it at the level of small farms)	4	3	5	4	1	1	4	3	4	5	5	x	x	x	39	4
1.8	Create an energy indicator database platform to enhance transparency in the Lebanese energy sector	4	5	4	3	4	4	4	2	3	2	3		x		38	5
1.3	Design and develop novel agro-energy cooperative models and replicable business models	3	5	5	3	2	2	4	2	3	5	4	x	x		38	5
1.6	Increase the energy efficiency of various facilities (public sector)	3	5	3	3	2	3	5	3	2	4	5	x	x	x	38	5
2.5	Create stormwater recharge projects within coastal and high-density cities	4	2	3	4	3	3	4	3	4	4	3		x		37	6
2.8	Develop river basin management plans	5	2	4	4	3	3	4	3	4	2	3		x		37	6
3.6	Recycle agricultural waste, including forest biomass, to produce alternative fuel	4	4	4	5	2	2	3	3	3	4	3		x		37	6
2.3	Develop guidelines and national standards for public green infrastructure that prioritise groundwater recharge and better stormwater management	4	2	3	4	4	3	4	3	4	2	3	x			36	7
2.4	Green and retrofit existing infrastructure and build new facilities/services to enhance stormwater management	5	2	3	4	3	3	3	3	4	3	3			x	36	7

#	WEFE Nexus solution	Criteria											Period			Total score	Rank
		Impact on sectors				Governance			Financial sustainability				Short term	Medium term	Long term		
		Water	Energy	Food	Ecosystems	Impact on legal framework	Impact on administrative Framework	Alignment with national strategies and Action Plans	Capital cost / investment	O&M cost	Possibility of cost recovery	Existence of funding mechanism					
2.12	Raise awareness about water scarcity and saving	4	5	3	4	2	1	5	3	3	2	4	x			36	7
4.3	Identify and remove pollution sources affecting natural resources and ecosystems, including the control of solid waste and liquid waste generated by healthcare and industrial facilities, closure and rehabilitation of open dumpsites, and remediation of polluted areas	5	2	4	5	3	3	4	1	3	3	3			x	36	7
3.3	Promote agricultural practices that minimise negative impacts on the environment, enhance climate change resilience and improve farmers' livelihoods	4	4	3	5	2	2	4	3	3	3	3	x	x		36	7
3.8	Adopt sustainable animal farming and production with high productivity and health and safety standards	3	4	5	5	2	1	4	3	3	3	3		x		36	7
3.9	Elaborate a holistic strategy that creates linkages between aquaculture, fish feed production and agriculture	3	4	5	5	2	2	4	3	3	2	3		x		36	7
4.1	Develop sustainable forest and landscape restoration and management plans	4	3	5	5	2	2	4	3	3	2	3		x		36	7
3.5	Recycle agricultural waste for fertiliser production	4	2	4	5	2	1	4	4	3	3	4		x		36	7
2.6	Implement recharge galleries wherever possible	5	2	4	4	3	3	3	3	4	2	2			x	35	8

#	WEFE Nexus solution	Criteria											Period			Total score	Rank
		Impact on sectors				Governance			Financial sustainability				Short term	Medium term	Long term		
		Water	Energy	Food	Ecosystems	Impact on legal framework	Impact on administrative Framework	Alignment with national strategies and Action Plans	Capital cost / investment	O&M cost	Possibility of cost recovery	Existence of funding mechanism					
4.4	Increase coverage of wastewater collection networks and extend/enhance wastewater treatment plant services	4	3	4	5	2	2	4	2	2	3	4			x	35	8
4.2	Adopt and raise awareness about integrated solid waste management (ISWM)	4	2	4	4	3	2	5	2	3	3	3		x		35	8
2.16	Reuse treated wastewater in agriculture provided that the treatment results in suitable effluent quality	4	4	4	5	1	1	4	3	3	3	3		x		35	8
3.4	Promote various water-saving techniques and practices in agriculture (crop selection, agro-forestry, zero tillage, winter cover crops, integration with animal production, etc.)	4	2	4	4	1	1	4	4	4	3	4	x	x		35	8
3.15	Support and encourage farmers to grow cereals/fodder crops	4	0	5	5	2	2	4	3	3	4	3	x	x		35	9
1.7	Develop guidelines and a methodology for energy-related data collection	3	5	3	3	3	4	3	3	3	2	2	x	x		34	9
3.16	Recycle agricultural waste to produce animal feed	3	2	4	4	2	2	4	3	3	4	3		x		34	10
2.7	Promote reintroduction of traditional terraces throughout the Lebanese landscape	5	1	4	4	2	2	4	3	3	2	3		x		33	10
2.17	Separate grey- and blackwater; treat and reuse greywater where possible	3	4	3	5	2	2	3	3	3	3	2		x		33	10

#	WEFE Nexus solution	Criteria											Period			Total score	Rank
		Impact on sectors				Governance			Financial sustainability				Short term	Medium term	Long term		
		Water	Energy	Food	Ecosystems	Impact on legal framework	Impact on administrative Framework	Alignment with national strategies and Action Plans	Capital cost / investment	O&M cost	Possibility of cost recovery	Existence of funding mechanism					
3.2	Develop national agriculture baseline maps identifying available resources for agriculture, and recommending crops to be grown at the river basin level	4	2	5	4	1	3	3	2	4	1	4	x	x		33	10
2.10	Identify opportunities to use surface water sources instead of groundwater where and when possible	4	2	3	3	2	2	3	3	4	3	3		x		32	11
2.15	Promote rainwater harvesting in rural and urban areas (for reuse at domestic level and for irrigation)	4	2	3	3	1	1	3	4	4	3	4	x			32	11
3.7	Promote sustainable pest management techniques	4	2	4	5	1	1	3	4	3	2	3		x		32	11
4.5	Encourage community-based activities related to ecosystem protection and conservation	3	2	4	5	1	1	3	4	4	2	3	x	x		32	11
2.14	Install meters to monitor water consumption, create database for water consumption (by area, sector and user) and set goals for specific sectors to incentivise water-saving	5	2	3	4	3	3	3	3	2	2	1			x	31	12
3.10	Train fishers on sustainable fishing practices and how to add value to their products	2	2	5	5	1	1	4	3	3	2	3	x			31	12
3.11	Train fishers on using new sustainable gears and targeting new fishing grounds, releasing pressure on shallow coastal areas	3	2	5	5	0	1	4	3	2	3	3		x		31	12

#	WEFE Nexus solution	Criteria											Period			Total score	Rank
		Impact on sectors				Governance			Financial sustainability				Short term	Medium term	Long term		
		Water	Energy	Food	Ecosystems	Impact on legal framework	Impact on administrative Framework	Alignment with national strategies and Action Plans	Capital cost / investment	O&M cost	Possibility of cost recovery	Existence of funding mechanism					
3.17	Deliver training and capacity-building for farmers, cooperatives and research centres on seed production and conservation	3	2	5	5	1	1	3	3	3	2	3	x	x		31	12
3.14	Integrate agriculture into urban development programmes and utilise smart urban concepts	3	2	3	3	2	2	3	3	3	3	3		x		25	13

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