MINARET

NETWORKING FOR THE FUTURE

WATER BASELINE LEBANON

Sweden
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FUTURE PIONEERS
Empowering Communities

IUCN

NERC
National Energy Research Center

Royal Scientific Society
Amman Jordan 1970

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List of Acronyms

ACS	Al-Shouf Cedar Society
BML	Beirut and Mount Lebanon
CDR	Council for Development and Reconstruction
CoM	Council of Ministers
CoS	Council for the South
EBML	Establishment of the water of Beirut and Mount Lebanon
EU	European Union
FAO	Food and Agriculture Organization
FMCS	Federation of Chouf Es-Souayjani Municipalities (FCSM)
FPEC	Future Pioneers for Empowering Communities
GDP	Gross Domestic Product
GP	Green Plan
HDPE	High Density Polyethylene
IUCN	International Union for Conservation of Nature
LARI	Lebanese Agricultural Research Institute
LRA	Litani River Authority
LCWMC	Lebanese Center for Water Management and Conservation
MCM	Million Cubic Meters
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 the Displaced
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water

MoPH	Ministry of Public Health
MORES	Management Of Resources and Environmental Solutions
NA	Not Available
NGO	Non-Governmental organization
NPMPLT	National Physical Master Plan for the Lebanese Territory
NSEQ	National Standards for Environmental Quality
NWSS	National Water Sector Strategy
OMSAR	Office of the Minister of State for Administrative Reform
RWE	Regional Water Establishments
TSE	Treated Sewage Effluent
UOB	University of Balamand
USD	US Dollars
WB	World Bank
WE	Water Establishment
WWTP	Waste Water Treatment Plant
ha	Hectare
km	Kilometer
km2	Squared kilometer
kVA	Kilo Volt-Ampere

1. INTRODUCTION

1.1. The MINARET project (MENA Region Initiative as a model of NEXUS Approach and Renewable Energy Technologies)

Many countries in the Middle-Eastern North Africa Region (MENA Region), including Jordan, Lebanon and Tunisia are facing several challenges, putting huge pressures on available energy, water and food resources. Existing water supplies can hardly meet the growing demand for irrigation and municipal water usage; and thus, the region must import most of its food.

To face these challenges and to tackle poverty, unemployment, and the growing demand for energy, water and food, these countries need to act quickly and respond to the different needs of their populations and economy. Improving energy efficiency, using renewable energy technologies and reducing water consumption for food production are the most cost-effective solutions that can be swiftly implemented. These solutions, which focus on the *nexus* of energy, water and food, have a great impact on the countries' economic growth and prosperity, while reducing poverty and improving livelihood opportunities of its people.

Based on case studies in three countries (Jordan, Lebanon, Tunisia), the MINARET project aims to identify such solutions that can support these countries' transition into affordable, sustainable and secure energy and water systems, while also leading to increased food security. The project aims to offer a framework for a coherent and inclusive regional strategy to support local authorities, municipalities, private sector and civil society in promoting renewable energy and energy efficiency, clean water accessibility and food security as well as executing relevant pilots.

The overall goal of the MINARET project is to strengthen regional cooperation within the MENA region through implementing the NEXUS approach integrating renewable energy technologies at the municipality's level to mitigate climate change impacts and combat poverty. More specific objectives include: building the municipalities' resilience to climate change; strengthening institutional capacities; promoting inter-municipal regional cooperation; reinforcing the role of women, youth, and marginalized groups; and developing a MENA dialogue knowledge platform.

The NEXUS approach is considered an effective and integrated approach that starts from the clear interactions that exist between water, food, and energy, to improve human well-being, reduce poverty and increase sustainable development. It aims to balance different uses of these ecosystem resources through identifying potential synergies between different sectors and/or related interest groups.

The first component of the MINARET project is set up to be a first step towards determining these synergies, through identifying baselines on energy and water consumption (related to agriculture), GHG emissions, and renewable energy use. This is done for a set of pilot areas in three countries (Jordan, Lebanon, Tunisia), presenting different socio-economic characteristics and reflecting the variety of challenges that the involved actors face. Given that agriculture accounts for 70 % of total global freshwater withdrawals, the water baseline data collection is merged with the collection of agricultural baseline data in one report.

The current report therefore, reflects the water/agriculture baseline for the Lebanese pilot area, and should as such be understood as one part of a tripartite first component of the MINARET project, which also includes similar baseline studies for Jordan and Tunisia.

1.2. Scope of Baseline

The overall scope of the current report is to identify the baseline information on the water and agriculture situation at the municipality level in the pilot area. For the water sector, this includes analysis of: (1) the geographical, demographical, economic, social, and governance situation of the country and case study, (2) the policies and regulations for the water sector at municipal and national levels to identify the main water needs, (3) the institutional and governance structure of the water sector at municipal and national levels, (4) the water supply and demand profile and components at municipal and regional levels, (5) capacity assessment for the involved decision makers and stakeholders at local level.

For the agricultural sector, this entails analysis of: (1) the agricultural situation and practices at the municipal level and national/regional levels, (2) the institutional and governance structure of the agricultural sector at municipal and national levels, and (3) the suitability for implementation of new and modern agricultural technologies that consume less water and energy within the municipality.

The analyses are targeted to identify the main needs for both sectors to support municipalities in meeting development challenges in accordance with international standards (such as the Sustainable Development Goals). Based on this, potential interventions in the field of water governance and policy dialogue are identified for the pilot area as an outcome of this study.

For implementation of the MINARET project in Lebanon, the area covering Jdeidet El Chouf/Baqaata and Semqanieh was selected. It is located in the Chouf District, Mount Lebanon Governorate (Figure 1). Both towns are members of the Federation of Chouf Es-Souayjani Municipalities (FCSM).

Jdeidet El Chouf/Baqaata was selected as it meets several criteria of the MINARET project: 1) the high level of cooperation of the Mayor, Mr. Hisham Fatayri, who is active and willing to accommodate such a project; 2) Jdeidet El Chouf/Baqaata is a medium-sized town that has witnessed a fast and uncontrolled urban sprawl, which led to an increased stress on the local natural resources as well as on the infrastructure in the area as it was originally designed for a significantly smaller population; and 3) the municipality lacks funding from donors and the central government.

The same applies to Semqanieh, bordering Jdeidet El Chouf/Baqaata to the west, which shares several of its problems as there is a continuation in the urban sprawl between the two towns.

1.3. Structure

After this introduction, Chapter 2 describes the methodology that was used in general for this paper and the data collection methods to take stock of the water and agricultural situation in the case study area. Chapter 3 structures background information on Lebanon including demographic, socio-economic and climatic situations, the existing policies related to the water and agriculture sectors, as well as the current water and agricultural situations. Chapter 4 presents the collected data for the case study area. Chapter 5 discusses the results and links them back to the objectives. Chapter 6 closes the report with conclusions and recommendations.

1.4. Project Team

The team involved in the preparation of this report consists of members from Al Chouf Cedar Society (ACS) supported by the consulting firm MORES s.a.r.l. The team worked in collaboration with the municipality of Jdeidet El Chouf during the various stages of the project, namely: planning, stakeholder's

invitation, workshops organization, progress reporting, data research, information solicitation, field visits and analysis of results.

ACS is an environmental NGO, established in 1994 with an aim to protect the Cedars forests in Lebanon mainly in the Shouf area. It played a key role in announcing the Al-Shouf Cedar Reserve in 1996 and Shouf Biosphere Reserve in 2005. ACS plays a key role in the management of the Shouf Biosphere Reserve through 5 main programs: research and monitoring, environmental awareness, eco-tourism, women empowerment /rural development and capacity building. ACS executive committee includes the mayors of the reserve's main villages and works under the umbrella of Ministry of Environment.

Founded in 2001, MORES s.a.r.l. is a consulting company providing services in environmental protection, resource management, strategic planning and sustainable development. MORES office is registered, qualified and recognized in Lebanon as a consulting firm by the Council for Development and Reconstruction (CDR) on projects with budgets exceeding 20 million US dollars, and by the Ministry of Environment.

2. METHODOLOGY

2.1. Data Collection Tools, Protocols and Methods

Data collection was initiated through a literature review. The reviewed studies cover data on the water and agriculture sectors, as well as geography, demography, climate, and socio-economy. National policies, laws, and regulations governing the water and agriculture sectors were also reviewed and are presented in Chapter 2. The reviewed studies were obtained from online sources, governmental institutions, international NGOs, the municipalities and the federation.

In addition to this, MORES held several meetings to collect additional information:

1. Two meetings were held with the Establishment of the water of Beirut and Mount Lebanon (EBML). The first one was on May 29, 2017 with Mr. Younes Jaramani, the head of Aley Office that covers the services in Chouf and Aley Districts (Cazas). The second meeting took place on June 20, 2017 with Mr. Georges El-Kadi, head of technical division of the Establishment. In follow up to these meetings, MORES addressed an official letter to the Water Establishment, requesting the following data related to Jdeidet El Chouf and Semqanieh:

    - Map showing the potable water network
    - Map showing the sewer network
    - Water sources in the area
    - Estimation of the water needs in the area
    - The following information if available: national water sector budget, EBML budget, and budget for Jdeidet El Chouf and Semqanieh
    - Proposed projects for the improvement of the water sector situation in Jdeidet El Chouf and Semqanieh

On July 7, 2017, a follow up meeting with EBML was held to collect the requested information.

2. MORES and ACS met with the Mayors of the municipalities of Jdeidet El Chouf and Semqanieh, as well as the President and staff of the Federation of Chouf Es-Souayjani Municipalities (FCSM). The meetings included collection of data by filling a questionnaire. Information included available demographic and socio-economic data, as well as data related to the water and agriculture sectors. Moreover, studies related to the area were collected, and discussion on the water and agriculture situation took place.

3. MORES and ACS organized four field visits in collaboration with the municipalities. All four visits assessed potential options for plausible interventions that would support the development of or re-enlivening agriculture in the area.

    - July 5, 2017: the team visited the agricultural areas of the towns and the water sources.
    - July 14, 2017: the team visited the river valley between Ain W Zain and Jdeidet el Chouf and observed and evaluated the condition of the existing small dams along the river course and related irrigation canals.
    - July 19, 2017: the team executed further observation of water dams and irrigation cannals located within Barouk valley in Jdeidet El Chouf, covering the remaining section leading to the main road between Jdeidet and Moukhtara. That visit shed more light on the need for protecting and

developing the water sources contributing to the river flow and the need for rehabilitation of the irrigation canals and connecting them to each other to maximize benefits to farmers in dryer spells.
- July 29, 2017: the team covered the western section of the river course beyond Jdeidet-Moukhtara road.

4. A workshop with the stakeholders was held at the Municipality of Jdeidet El Chouf on July 8, 2017. Stakeholders had been identified during the stakeholder analysis study conducted between May and June 2017 and finalized in September 2017, based on their involvement in the water, agriculture sectors. The concerned municipality sent invitation letters to relevant stakeholders. The attendees included the mayors of Jdeidet El Chouf, Semqanieh and FCSM, as well as representatives of the local NGOs[1], the center for agricultural guidance and the water establishment, as well as the farmers of Jdeidet EL Chouf. In total, 29 participants attended the workshop.

Mr. Maasri, General Manager of MORES s.a.r.l., chaired the meeting with the following agenda items:

- Introducing the MINARET project and NEXUS approach;
- Presentation of satellite imagery, geological, land cover/land use maps of the areas showing the locations of water sources and emphasizing the characteristics of the area;
- Presentation of the collected data related to the water sector including the water network map, the wastewater sector and the agricultural sector;
- Discussion amongst the attendees about the main problems related to water, wastewater and agriculture in the area, and attempted to propose solutions;
- A questionnaire related to agriculture and water use in the study was completed by the attendees. The questionnaire aimed to form a general idea on the agricultural trends in the area through collecting information about farmers (age, gender, educational level, employment etc.) and the techniques they use on their lands. Among the 29 farmers contacted by the municipality, 19 filled the questionnaires. The answers they provided and their analysis are presented in the following sections.

5. A meeting was held on 28 July 2017, with project proponents including the mayor of Jdeidet El Chouf to discuss the needs of the area related to water-energy-food NEXUS and the types of potential projects that can be implemented. The participants included representatives of ACS, MORES, FPEC, the Municipality of Jdeidet El Chouf and LANA youth organization (a local NGO in Jdeidet El Chouf). This meeting had been preceded by an awareness session on the effect of climate change on agriculture and corresponding adaptation measures as part of a training camp for young farmers, organized by the NGO Green Orient**.** About 56 people attended the awareness session.

2.2. Data Categories

The types of data collected for this report included:

- Geographic data for Lebanon and the case study area;
- Demographic data for Lebanon and the case study area;
- Legislative data: policies, laws and regulations related to water and agriculture sectors;

[1] Local NGO's that attended the meeting are: Jdeidet El Chouf- Baqaata Women Organization, Green Orient, and LANA Youth Organization.

- Water sector: including local and national demand and supply profiles, network, sources, water quality;
- Agriculture sector: including local and national production, land use, irrigation methods, legislation;
- Socio-Economic: including the national economy, main activities and income sources of residents, income distribution;
- Maps related to the abovementioned categories.

2.3. Data Quality

All data were collected from available literature and verbal consultations with stakeholders. However, the last study for the area on demographic socio-economic and agricultural data, Millennium Development Goals Report, for the Federation of Chouf Es-Souayjani Municipalities (UNDP/MoD, 2005), was performed in 2005. Although reliable, the data is considered outdated in an area characterized by its rapid growth in population and urbanization such as Jdeidet El Chouf and Semqanieh.

The last official population census in Lebanon was done in 1932, and since then, population on local and national level has only been estimated. Also, at municipal level, even though the number of voters is known, the number of residents (total), immigrants, refugees, foreign workers, etc. is based on estimations, and can therefore not be considered as official.

Finally, the 2005 demographic and socio-economic data were based on local surveys and do certainly not reflect the current situation due to the fast dynamism of the area. Some of the data were updated through stakeholder's consultation (population, socio-economic activities, etc.). However, this data should be considered as an estimation as it is not based on a detailed survey.

Data related to the water sector in Lebanon as collected from literature is considered reliable, as it is based on surveys and studies. As for the data on the study area, there are no meters to monitor water consumption or water losses which makes the estimation of supply and demand difficult. Additionally, since private water sources and wells are not supervised by water establishments, these fractions are often not accounted for even though they hold an important share.

Similarly, agricultural data and studies related to Lebanon performed by international and national organizations are considered reliable. The data related to the Jdeidet El Chouf and Semqanieh area are considered outdated, as the land use is changing rapidly in the area.

2.4. Limitation of the Collected Data

When comparing different sources on the same information, some discrepancy was noted. In this case, data found to be more reliable (e.g. more reliable collection methodology) and more recent data were used, or data were verified by contacting concerned stakeholders.

Notwithstanding this, the observed discrepancy of information between different sources and the deficiency in data and studies (from both private and public sources), especially on demography and socio-economy, should be taken into account as an inherent limitation of the data that underpin this study.

3. BACKGROUND

3.1. Lebanon's Context

3.1.1. Geography and Population

Lebanon is located on the eastern basin of the Mediterranean Sea at approximately 33.8547° N, 35.8623° E; it has a surface area of 10,452 km², and its coastline extends over 225 km. **Figure 2** shows the location of Lebanon.

Figure 1: Lebanon's Location (Wikimedia, 2017)

Lebanon is administratively divided into eight governorates (Mohafaza): Akkar, North, Beirut, Mount Lebanon, South, Nabatieh, Bekaa and Baalbek-Hermel, sub-divided into twenty-six districts (Caza) as shown in **Figure 3.**

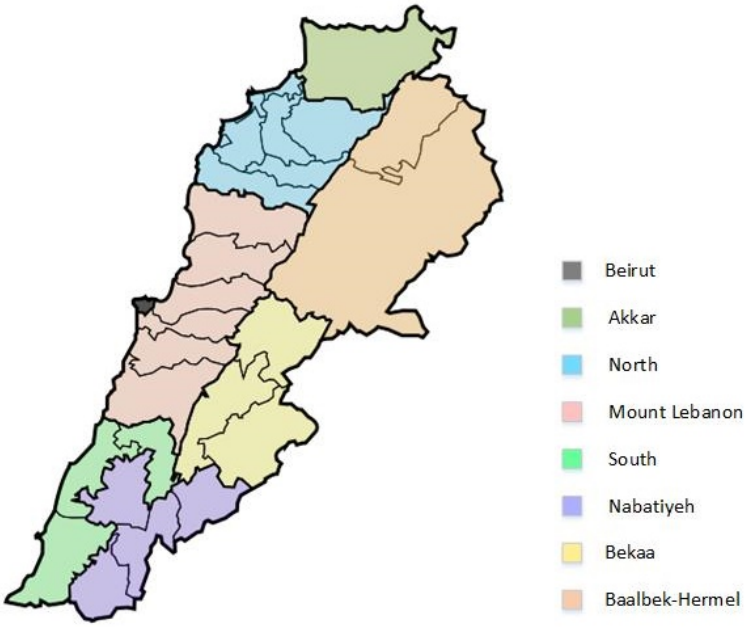


Figure 2: Administrative Division of Lebanon (Wikipedia, 2017a)

Although no official population census has been made since 1932 in Lebanon, the Lebanese population is estimated at 5,988,000 including foreign workers and refugees (Palestinian and Syrian), and is characterized by a high density of around 585 persons/km² (UN Data, 2017); with 87% of the population living in urban areas (WB, 2010). **Figure 4** shows the population density distribution in Lebanon.

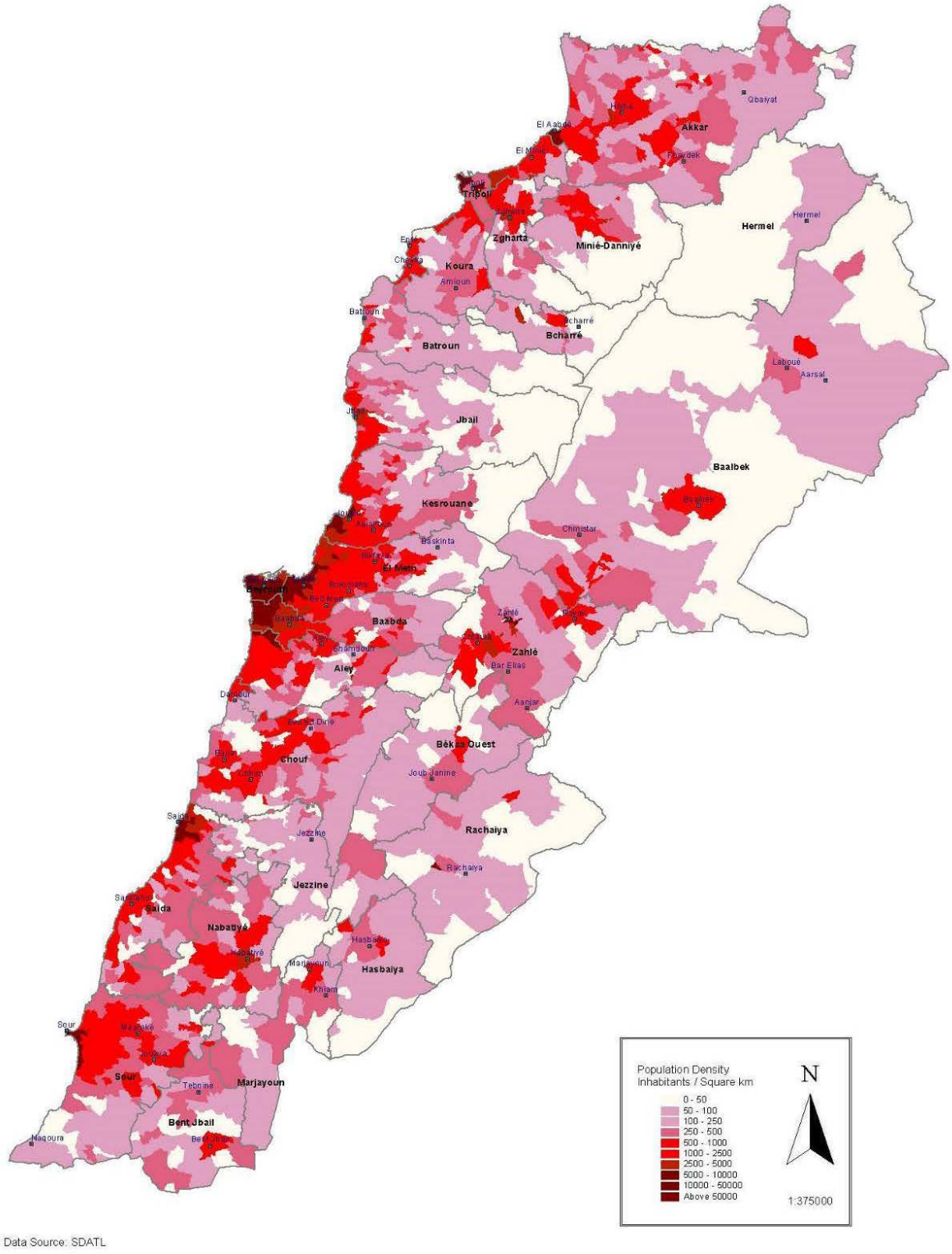


Figure 3: Population Density Map of 2004 (Localiban, 2016)

3.1.2. Climate

Lebanon's climate is Mediterranean. It is defined by Lebanon's position on the eastern coast of the Mediterranean Sea and its geography, as the topographical variations in Lebanon create localized modifications of the basic climatic pattern.

The three fundamental divisions of Lebanon include: a western Mount Lebanon rising to 3083m above sea level (i.e. the highest peak in Lebanon, Qurnat As Sawda'), a central Bekaa Valley and an eastern range known as the Anti-Lebanon. It is worth noting that the Bekaa is almost everywhere above 850m in altitude and lies above extensive aquifers. Lebanon can be divided into five geomorphological zones as seen in **Figure 6,** namely: the coastal zone, the Mount Lebanon Range, the Bekaa valley, the Anti-Lebanon Range and South Lebanon (DAR-IAURIF, 2005).

The Mediterranean climate is characterized by mild rainy winters and hot dry summers. Fall is a transitional season with a gradual decrease of temperature and little rain and spring occurs when the winter rains cause the vegetation to revive (US Library of Congress, 2016). The majority of rain falls between the months of October to May, and the average annual rainfall is estimated at 840 mm (refer to paragraph **3.3.1** on precipitation distribution in Lebanon). The daily range of temperature in Lebanon is not wide, although temperatures may reach above 38° C in the daytime and below 16° C at night. During the winter, cold winds from Europe affect the northern regions of Lebanon; and during spring, the Khamsin hot wind blows into Lebanon from North Africa.

A west wind provides relief during the afternoon and evening; at night the wind direction is reversed, blowing from the land out to sea. This phenomenon is caused by the air-sea flux which mostly affects the costal area's climate: during winter, when the water temperature is higher than the air temperature the sea warms up the coast; in summer, the water temperature is lower than the air temperature and thus the cool breeze from the sea helps reducing the coastal temperatures. This moderating influence on the climate makes the range of temperatures along the coast narrower than inland (US Library of Congress, 2016).

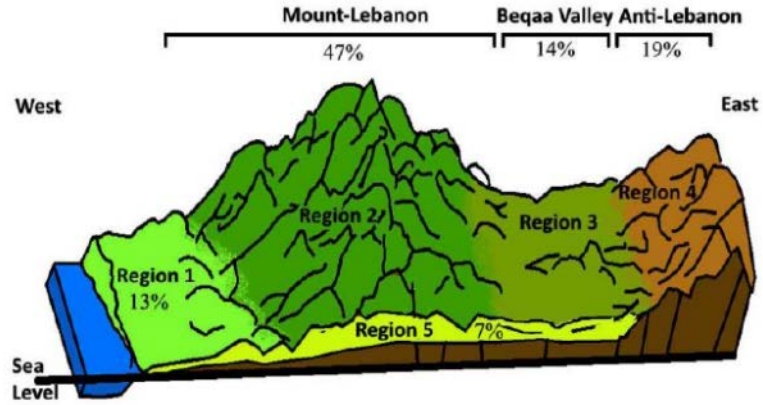


Figure 4: Five Geomorphological Zones of Lebanon[2]

[2] Region 1: the coastal zone, Region 2: the Mount Lebanon range, Region 3: the Bekaa valley, Region 4: the Anti-Lebanon range, and Region 5: South Lebanon

3.1.3. Economy

Lebanon has a free economy system that guarantees entrepreneurship and private property. It has a free market economy and a laissez-faire commercial tradition[3], whereby the Lebanese government does not restrict foreign investment. The investment climate however has several disadvantages including bureaucracy, corruption, high taxes, tariffs, and fees, and outdated legislation.

Lebanon faces serious challenges in the economic arena, which has funded reconstruction by borrowing heavily, mostly from domestic banks. In order to reduce the expanding national debt, in 2001 the government began to cut back its expenditures, increase revenue collection and privatize state enterprises. The Paris II international donor conference (Nov. 2002) provided Lebanon with much needed debt instruments, at low rates and for longer maturities. This eventually led to reduction in interest rates, improvements of the financial/economic accounts, and stabilization of government finances.

The July-August 2006 war caused an estimated $3.6 billion in infrastructure damage, and prompted international donors to pledge nearly $1 billion in recovery and reconstruction assistance. An 18-month political stalemate and sectarian and political violence hampered economic activity, until political stability in July 2008 helped boost tourism and, together with a strong banking sector, enabled real gross domestic product (GDP) growth of 7% in 2009 despite a slowdown in the region. However, due to the Syrian conflict, economic growth has slowed down to 1-2% range in 2011 to 2015 (IndexMundi, 2016)

The Lebanese economy is service-oriented, whereby the main growth sectors include banking and tourism (IndexMundi, 2016). The GDP in 2015 reached 83.06 billion US dollars, distributed as follows:

- Agriculture 5.6%;
- Industry 24.7 %;
- Services 69.7%.

3.1.4. Resources

Natural resources in Lebanon include: limestone, iron ore and salt, in addition to oil and gas reserves.

The main produced mineral commodities of the mining sector in 2010 included cement, gypsum, aluminum sulfate, lime, limestone, phosphate fertilizer, phosphoric acid, sulfuric acid, and salt. Additionally, pearls and precious and semiprecious gemstones accounted for 26% of the country's total exports, while exports of base metals and chemical products accounted for 11% and 7% of the total export value, respectively (AZO Mining, 2012). It should be noted that the industrial and crafts sectors were the main producers of the above, and that various raw material of the industrial processes are imports, especially those related to jewelry production and the phosphate related industries.

On the other hand, in October 2013, the Ministry of Energy and Water (MoEW) declared the estimated natural gas reserves as being 2.7 x 10^{12} cubic meters (96 trillion cubic feet). Moreover, in February 2013, an oil reservoir was discovered in the Northern maritime border of Lebanon, estimated to contain between 440 and 675 million barrels of oil. The MoEW declared that the reserves could reach up to 865 barrels of oil. However, to date the excavation and production works have not yet commenced.

[3] Laissez-faire: a doctrine opposing governmental interference in economic affairs beyond the minimum necessary for the maintenance of peace and property rights (source: https://www.merriam-webster.com)

3.1.5. Challenges in Different Sectors

Lebanon has long suffered from political instability, which has weakened its various sectors. More recently, the unprecedented influx of refugees has accentuated the problems and posed new challenges in different sectors including: energy, education, infrastructure, health, environment, water and agriculture. The following lists the main challenges faced by several sectors in Lebanon that were further aggravated by the influx of Syrian Refugees since 2011.

Energy Sector

- Poor endowment in domestic energy resources
- Subdued generation capacities
- Poor institutional and legal framework
- All of the installed power plants in Lebanon operate below capacity
  High electricity prices (tariffs and production cost). Despite frequent electricity cuts, electricity prices are surcharged with indirect taxes resulting in unfair billing for small domestic consumers. Compared to electricity prices in the region, the 2006 average tariff in Lebanon, which is 9.4USc/KWhr, is in the upper range (MOE/UNDP/ECODIT, 2011).
- Shortage in generating capacity and human resources

Education

- Funding
- Cultural differences and different educational opportunity
- Unsafe schools and unequal access to educational technology
- The labor force needs and global competition

Infrastructure

- The urban design of Beirut
- Constructions are badly organized
- The roads are in a very bad state
- Lebanon's newest fiber optic network, by all appearances, is completely switched off
- The price of internet service is very high relative to relevant comparator countries.

Health

- High health care expenditure
- Weak social security system
- Major health problems include: hypertension, diabetes, and asthma, in addition to eye and ear diseases, cardiac conditions, and dermatological problems
- Incapacity of public insurers in provision of funds for medical treatments

Environment

- Climate change: an analysis of historical climatic records of Lebanon from the early 20th century with future emissions trajectories show an increase of 1.7°C by mid-century and up to 3.2°C by 2100 as well as a decrease in precipitation of 4 to 11% with drier conditions by the end of the century (up to 5.8 mm decrease in average monthly precipitation) (MoE/UNDP/GEF 2016)

- Increase in the amount of generated solid waste and wastewater in the absence of the needed infrastructure and strategic plans
- Chaotic urbanization
- Water pollution
- Air pollution due to transportation

The challenges in water and agriculture sectors are listed in the following sections (3.3 and 3.4).

3.2. Political and Legal Situation in Lebanon

Lebanon is a parliamentary democratic republic, headed by the President of the Republic, who is elected by the parliament for a six-year term.

Lebanon's political system is based on the separation of executive, legislative and judicial powers:

- Legislative power rests with the Parliament (Chamber of Deputies) elected directly by the people every four years; it consists of 128 deputies. The Parliament proposes and adopts laws, supervises Government policy and elects the President of the Republic
- Executive power is entrusted to the Government (Council of Ministers), which determines and implements policies in all fields in accordance with the laws, appoints senior administrators and submits proposed legislation to the Parliament
- Judicial power is fully vested with judicial courts of different degrees and levels of jurisdiction, and is autonomous.

Finally, the Constitution provides for the formation of a Constitutional Council to rule on the constitutionality of laws and on challenges to the validity of presidential and parliamentary elections. (Presidency of the Republic of Lebanon, 2017) (IDAL, 2017a). At the local level, the 1977 Decree-Law entrusts municipalities with a broad range of tasks. It specifies that any work having a public character or utility within the area of the municipality falls under the jurisdiction of the municipal council. According to article 49 of the 1977 Decree-Law, the municipal council is in charge, among others, of the following:

- Formulate and adopt the municipality's annual budget;
- Determine the tax rate and fee to be collected as allowed by law;
- Manage the municipal funds;
- Plan, improve, and expand the streets, establish gardens and public places, and execute designs related to municipality, etc.; and
- Establish shops, parks, racing places, playground, toilets, museums, hospitals, dispensaries, shelters, libraries, etc. (ICMA, 2011)

Municipalities play a role at the level of licensing and permitting for water and wastewater projects located within their premises including the approval on Environmental Impact Assessment (EIA) studies for such projects. Relevant national legislation related to the water and agriculture sectors in Lebanon are presented in Section 3.3.8 hereafter.

3.3. Water Situation

The water sector in this report includes information on water resources and wastewater generated in Lebanon in general and in the pilot area in specific, and how it affects water resource quality.

3.3.1. Precipitation

According to the Establishment of the water of Beirut and Mount Lebanon (EBML), whose roles and responsibilities are described in paragraph **3.3.8**, Lebanon receives an annual average of 8.6 billion m^3 of rain. **Table 1** presents the annual received precipitation in Lebanon according to different sources. **Figure 7** represents the annual precipitation distribution in Lebanon. As seen in figure 7, the north-western mountainous areas receive the highest amount of precipitation, and the precipitation average in the country ranges between less than 200 mm to more than 1400 mm. Moreover, with 60 to 65% of mountainous terrain, Lebanon receives considerable amounts of snow which covers 25% of its area (above 1200 m altitude) (Shaban, 2009). Of these precipitation quantities, 30% are considered net exploitable, in other words, 30% of the precipitation can technically and economically be recovered. The rest is usually dissipated through evapotranspiration, and lost through rivers to neighboring countries or in aquifers as presented in **Table 1**.

Lebanon is therefore considered in a relatively fortunate hydrological position, and the yearly flow from precipitations give rise to 40 major streams and rivers, of which 17 are perennial rivers, and more than 2,000 springs. Melting snow is the primary water supply to many water resources as it contributes to 40 to 50% of the replenishment of rivers, springs and groundwater reservoirs (Shaban, 2009).

Table 1: Annual Received Precipitation in Lebanon[4]

Source	MCM (1)	MCM(2)	MCM (3)	MCM (4)
Precipitation	8,600	8,600	8,200	9,300
Evapo-Transpiration	(4,500)	(4,300)	(4,100)	(4,500)
Losses	(1,400)	(1,700)	(1,333)	(2,400)
▪ Rivers to Neighboring Countries	(700)	(670)	(648)	
▪ Groundwater	(700)	(1,030)	(685)	
Total Renewable Resources	2,700	2,600	2,767	2,400
▪ Surface Water	2,200		2,200	2,000
▪ Groundwater	500		567	400
Net Exploitable Resources	2,700	2,600	2,767	2,400

[4] (1)**MoEW, 2010b** (National Water Sector Strategy: Supply/Demand Forecasts, MoEW , November 2010), (2)**MOE/ECODIT**, 2002 2001 State of the Environment Report, Lebanon. (3)**Prepared by ECODIT for the Ministry of Environment**, 2002, MoEW, 2010c Information provided by Dr. Fadi Comair, DG of Water and Electrical Resource, MoEW, September 2010, **Fawaz 1992**, Fawaz, Water Resources in Lebanon, 1992

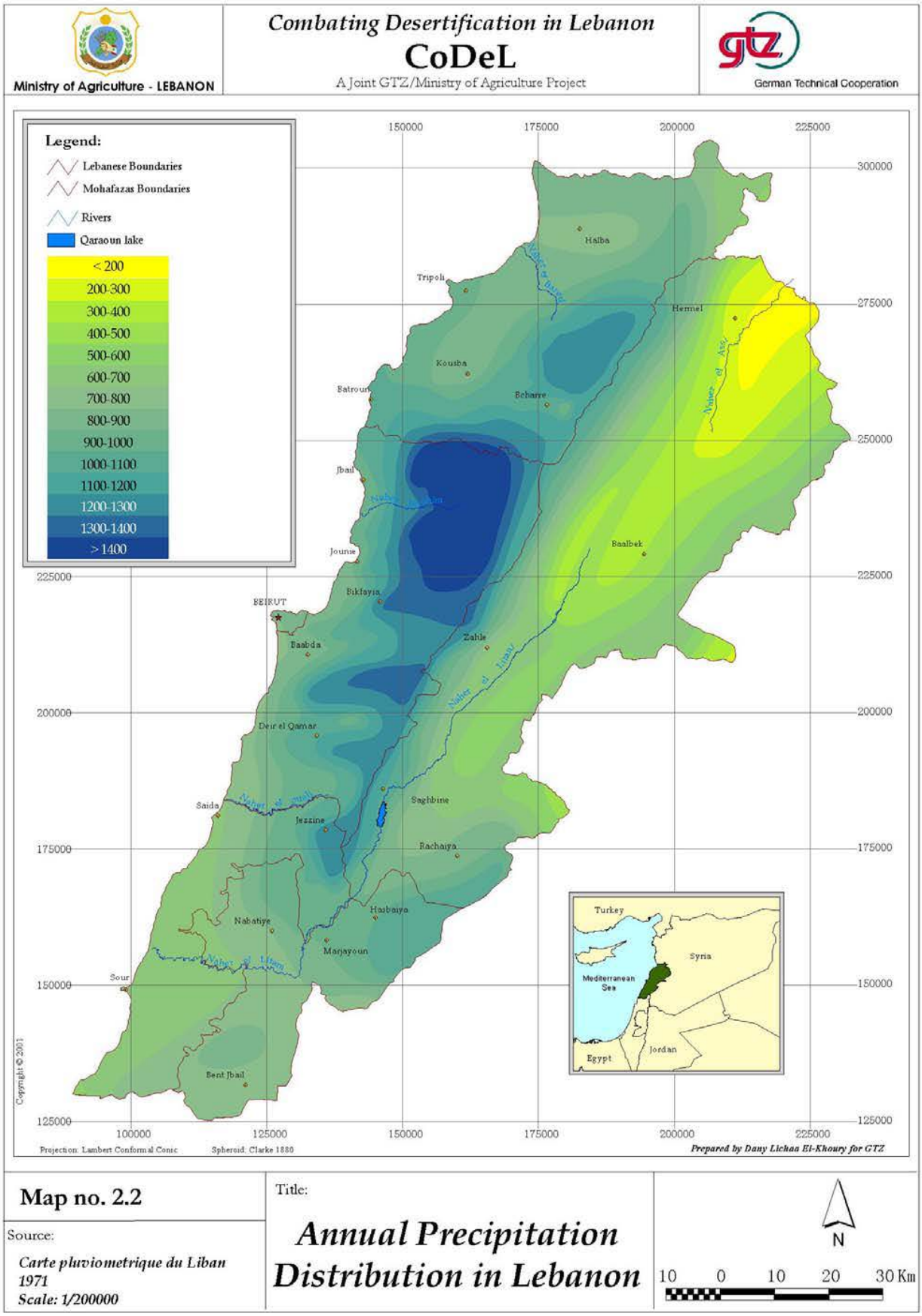


Figure 5: Annual Precipitation Distribution in Lebanon (MoA, 2003)

3.3.2. Rivers

Lebanon has 40 rivers; 17 perennial and 23 seasonal rivers; the total annual flow is around 3,900 MCM of which 700 MCM flow into neighboring countries. About 75% of the flows occurs between January and May; 16% between June and July and 9% between August and October. The highest river flows are Litani River, Naher Ibrahim and Orontes River (Nahr EL-Assi). **Figure 6** is a map showing the rivers of Lebanon.

Figure 6: Rivers of Lebanon (LCG, 2017)

3.3.3. Springs

Lebanon's geological characteristics, namely its highly fractured geological rocks, and the inter-bed rock formations of different permeability have led to the formation of around 2000 springs, which highly contribute to water supply. Their total yearly yield exceeds 1,200 MCM, however, this yield decreases to less than 200 MCM during the dry period. The total annual exploited volume from springs is 637 MCM (MOE/UNDP/ECODIT, 2011) (ECODIT, 2015).

3.3.4. Groundwater

Lebanon has eight major aquifers that store around 1,360 MCM, of which 400 to 1,000 MCM are exploitable (ECODIT, 2015). Groundwater supplies 50% of irrigation water and 80% of potable water (MOE/UNDP/ECODIT, 2011).

Figure 7 presents the groundwater basin map of Lebanon. According to the "Assessment of groundwater resources of Lebanon" report (MoEW/UNDP, 2014), most of the interior groundwater basins that are not in direct contact with the sea have witnessed a decrease in groundwater level (in comparison to their levels in 1970), in contrast with the coastal groundwater basins where the levels are almost constant due to seawater intrusion which compensates the pumped water. The decrease in groundwater levels is a result of the over-exploitation of the aquifers (MoEW/UNDP, 2014).

The water balance in the water budget at the national level varies between 2,140 MCM (million cubic meters) in the dry year and 4,675 MCM in the wet year. Despite this surplus in water budgets, most of the coastal basins show significant deficiencies in the water balance. The map in **Figure 8** shows the stressed aquifers in Lebanon. On this map, ground water basins were classified as: unstressed as per budget, under stress but not shown in the budget and stressed as per budget.

In the "Assessment of groundwater resources of Lebanon" (MoEW/UNDP, 2014), groundwater budget, also referred to as groundwater balance is defined as "the difference between water recharge and discharge", thus, the budget of a basin reflects its state:

- A basin is "unstressed as per budget", if its recharge is greater than the amount of water withdrawn from it; these mainly occur in Mount Lebanon range and anti-Lebanon.
- In contrary, a basin is "stressed as per budget" if the amount of water withdrawn is greater than the recharged amount; these mainly occur in the coastal zone and the Bekaa Valley.
- In the case of coastal basins, "under stress but not shown in the budget", the amount of pumped water is compensated by sea water intrusion, therefore, although the budget does not show a deficit in water levels, the amount withdrawn is greater than the recharged amount, and the basin is considered under stress. These mainly occur in the coastal zone.

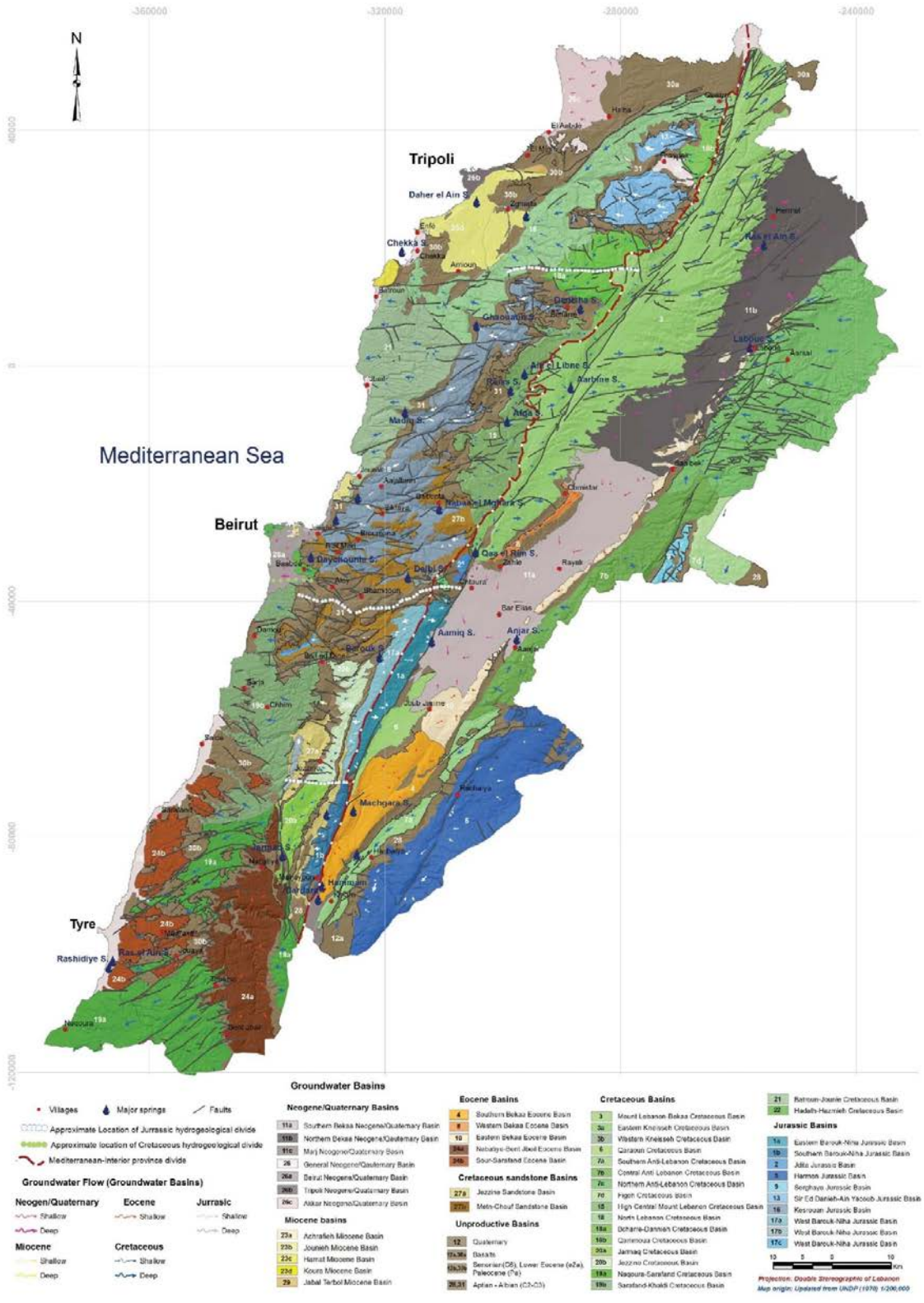


Figure 7: Groundwater Basin Map of Lebanon (MoEW/UNDP, 2014)[5]

[5] In the groundwater basin map, an unproductive basin is one that does not contribute to groundwater recharge due to its geological properties i.e. relatively high infiltration rate.

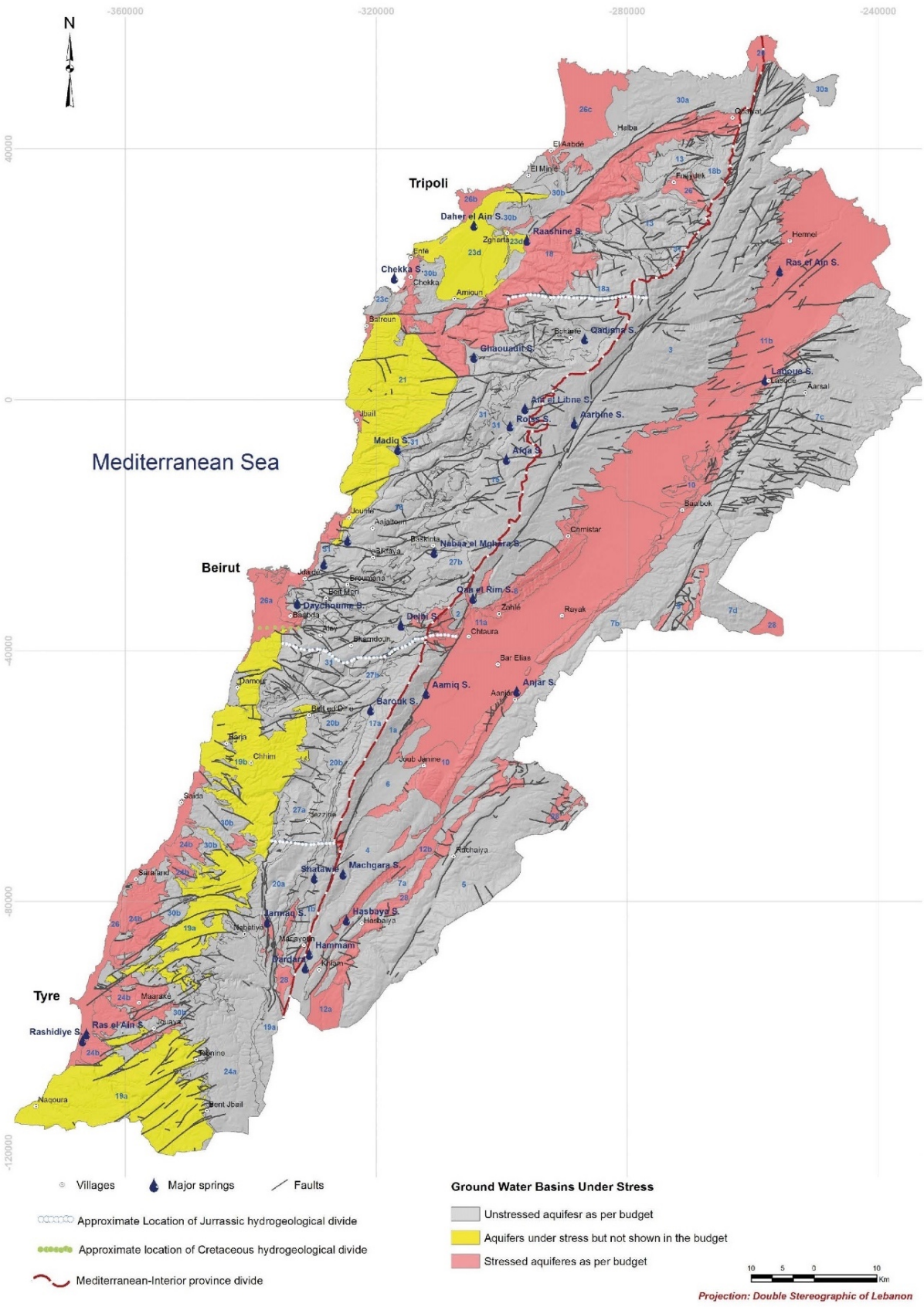


Figure 8: Map of the Stressed Aquifers (MoEW/UNDP, 2014)

3.3.5. Water Demand and Supply

According to the National Water Sector Strategy (NWSS), the water demand in Lebanon as assessed by the Lebanese Ministry of Energy and Water (MoEW)is 180 liters/capita/day in urban areas and 165 liters/capita/day in rural areas. The annual water demand in 2010 reached 1,500 MCM in Lebanon for all sectors, a value exceeding the withdrawal capacity, which led to 75 MCM deficit. The water demand is expected to increase by 55% in 2020, to reach 2,300 MCM (EBML, 2017)[6] (see **Figure 11**).

According to the National Physical Master Plan for the Lebanese Territory (NPMPLT) prepared by the Council for Development and Reconstruction (CDR) in 2005 and endorsed by the Council of Ministers (CoM) in 2009, the daily domestic water demand in 2030 will be 220 liters per capita. This increase in water demand for domestic consumption is related to demographic growth as well as to the growth in daily personal usage of water (that could be estimated to be 10% in the next 30 years). This situation will constitute a major challenge in the future as the total volume actually distributed by the Water Establishments is roughly 280 MCM, only half of which reach consumers (due to losses), who developed their own means of water provision. **Figure 11** presents the projected evolution of annual water demand by water use category, in MCM and percentage. In general, the water demand for agriculture, industries and domestic use are increasing with different proportions, the domestic water demand constitutes the highest increase (3.8 times between 2003 and 2030), and the fraction of water for domestic use seems to be increasing at the expense of irrigation water.

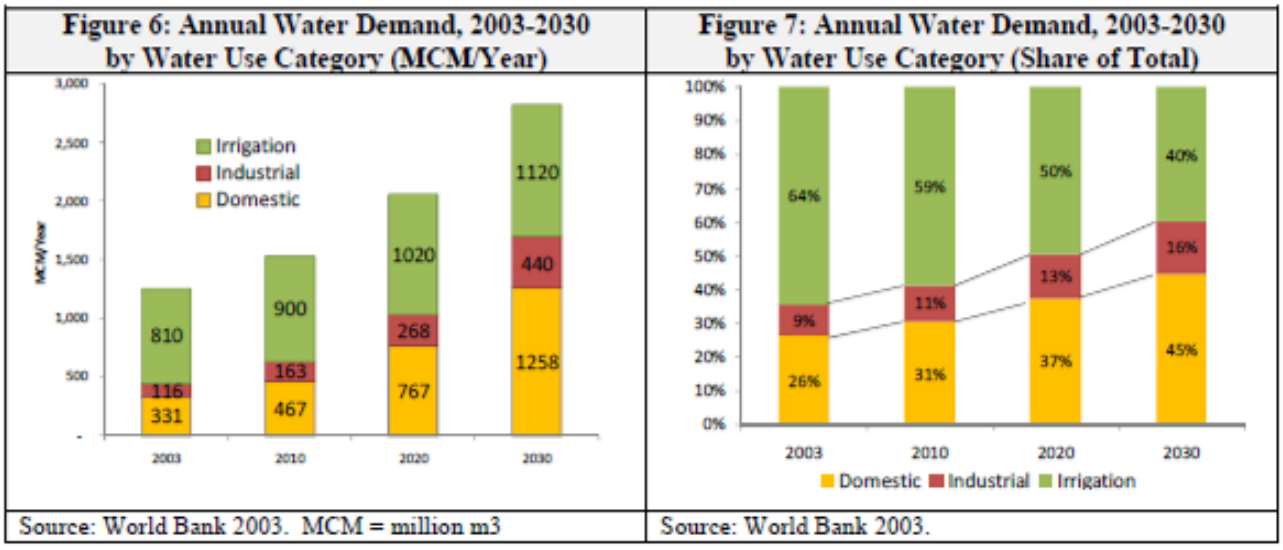


Figure 9: Annual Water Demand Evolution (2003 to 2030) (WB, 2010)

Public water is supplied to connected households on a subscription basis, with a fixed annual fee regardless of the amount of water that is actually delivered. Historically, consumption of water is regulated by a gauge system, therefore the amount of water received is function of the duration of water flow, and its pressure. Various attempts to introduce water meters have taken place, with limited success in few places, such as in Tripoli (as mentioned in the paragraph below). Although the water network coverage in Lebanon is

[6] Annual water demand includes irrigation, industrial and domestic demands.

relatively high (78%), the continuity of supply is low. **Figure 12** represents the household connection rate, and the connected population to the network by Regional Water Authority (i.e. Establishment) (RWA)[7], and **Figure 13** shows the continuity of supply in the high and low season by Regional Authority (Establishment). While the Beirut and Mount Lebanon area has the highest connection rates (93%), it is the only area in Lebanon with seasonal variations in supply, which varies between 3 hours per day (hr/day) in the high season (summer) and 13 hr/day in the low season[8]. Other areas have constant water supply, with the North receiving the highest supply (22 hr/day). Tripoli is the only area that receives 24 hours supply. The efficiency of bill collection is 70% (WB, 2010), although this number seems to be optimistic.

Figure 10: Household Connection to the Water Network and Connected Population by Regional Water Establishment (RWE) (WB, 2010) (BML: Beirut and Mount Lebanon area)

Figure 11: Continuity of Supply by Regional Water Establishment (RWE) in the High and Low Season (WB, 2010)

[7] Regional Water Establishments and Regional Water Authorities refer to the same entities "

The inability of water establishments to cover the need has led to the development of the private water market. The lack of regulation on the private water market, in the absence of an effective water service, increases the vulnerability of the population to waterborne diseases. Additionally, the reliance on private suppliers increases the financial burden, especially on low-income families, as the water bill consists of:

- Public network annual fee
- Additional cost for other sources of service water (private wells, tankers)
- Additional cost for other sources of drinking water (water gallons)
- Maintenance and investment costs

Figure 12 presents the sources of water at household level. The sources of water include public and private network subscriptions, artesian wells, mineral water bottles and gallons as well as delivery trucks. While the percentage of connected and unconnected households consuming mineral water gallons and bottles are similar, the percent of unconnected households using delivery trucks, artesian wells and private networks is higher; it can also be noticed that a significant fraction of connected households rely on delivery trucks (13 %).

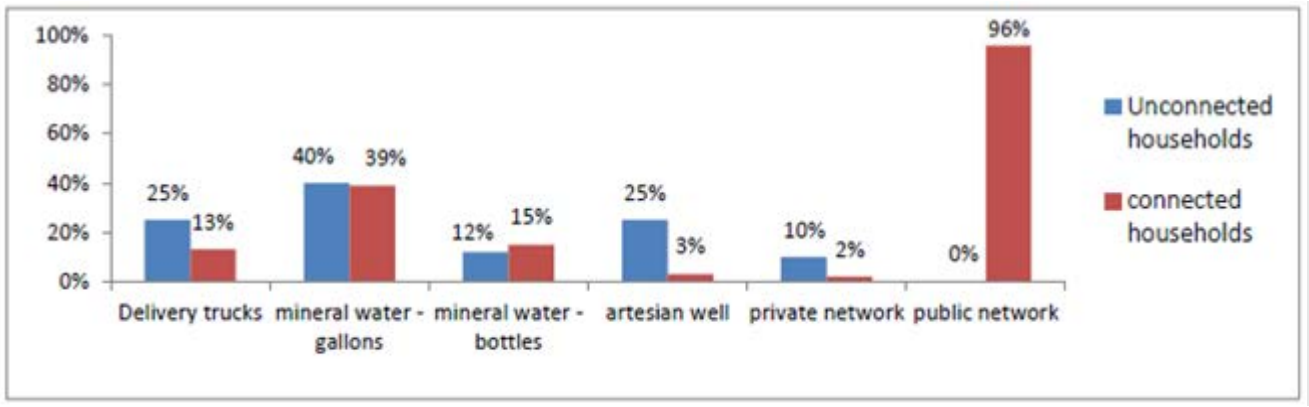


Figure 12: Sources of Water at Household Level (WB, 2009)

Figure 15 presents the share of household expenditure per water source per RWE. Household expenditure on water supply (public network, bottles, gallons, and delivery trucks) ranges from 1.7 percent (Bekaa) to 3.4 percent (Beirut and Mount Lebanon) of total household expenditure; less than 1 percent of which goes to the Water Establishments (WE) (public network). Additionally, in BML and the North, the highest share spent for water supply is that of water gallons, in contrast with the South and Bekaa where the highest share goes to the WE.

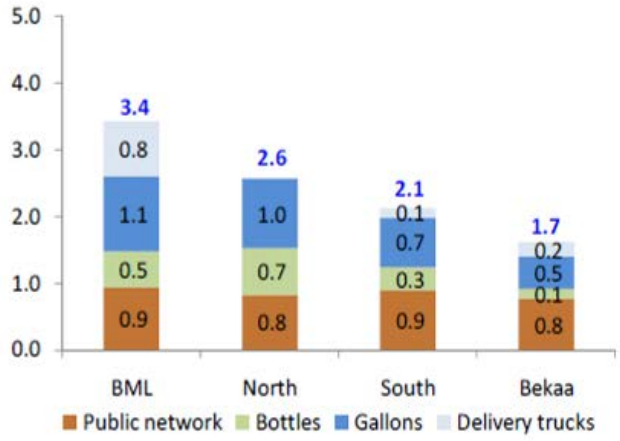


Figure 13: Budget Share, by RWE (WB, 2010)

3.3.6. Wastewater

Most of the generated wastewater in Lebanon is discharged without prior treatment into rivers, vacant land and the Mediterranean Sea due to the lack of treatment facilities. The wastewater network covers about 60% of the area, and only 8% of the generated wastewater undergoes treatment9 (ECODIT, 2015) **Figure 16** .

In rural areas, small septic tanks are widely adopted, however most tanks are permeable or deliberately drained to prevent overflow. Industrial wastewater is rarely treated prior to discharge into the environment or the public sewer network (MOE/UNDP/ECODIT, 2011) (ECODIT, 2015).

A number of small Waste Water Treatment Plants (WWTP) are operational, and most are in severe shortage, and discharge the collected wastewater untreated. Larger WWTP (Figure 16) have been developed by the Council for Development and Reconstruction (CDR) but are not yet operated due to limited capacity, and because the water supply network is unfinished (WB, 2010).

[9] Source: MoEW, National Water Sector Strategy, 2010

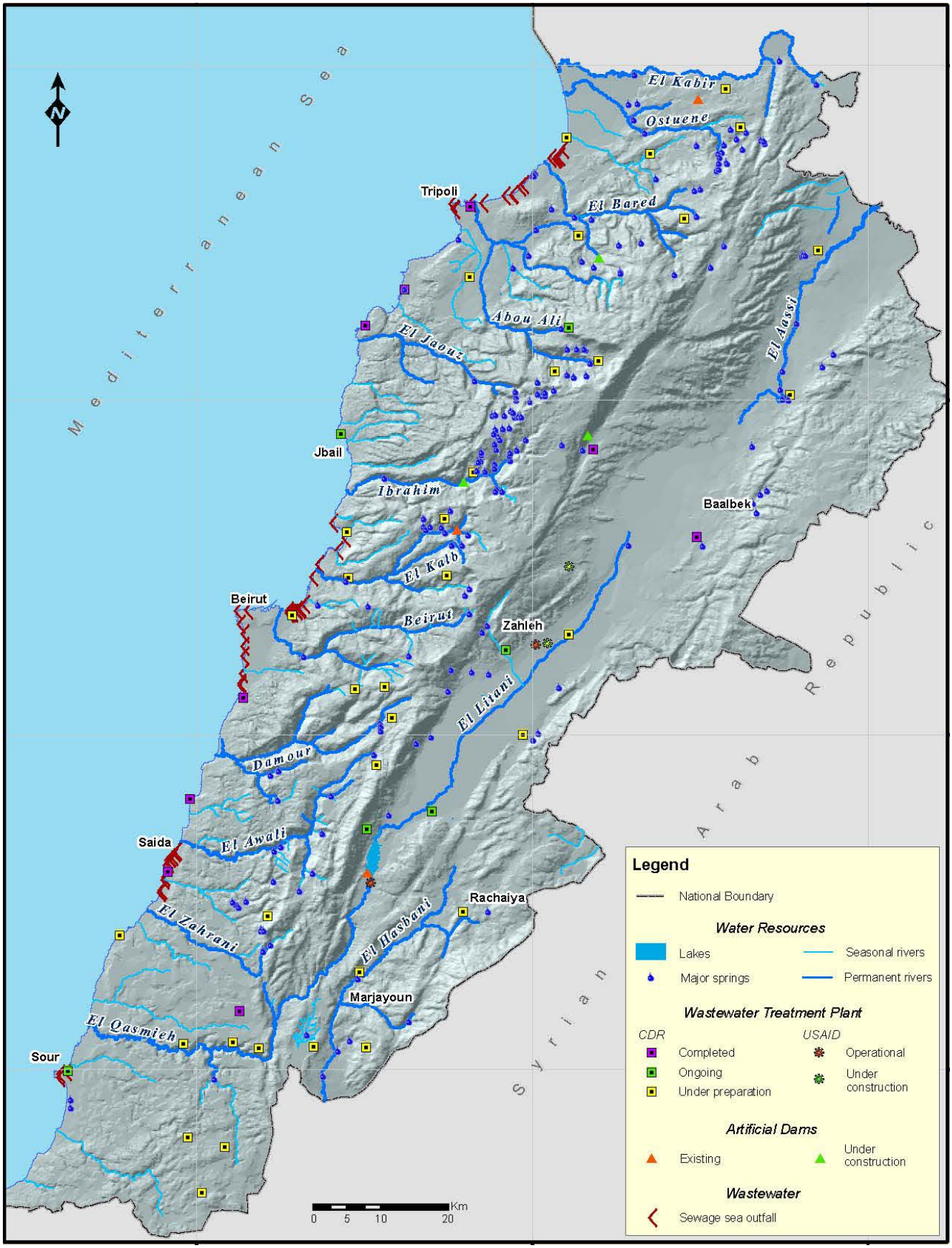


Figure 14: Represents Waste Water Treatment Plants in Lebanon (MOE/UNDP/ECODIT, 2011)

3.3.7. Challenges

Climate Change

According to a recent compilation of precipitation data by the American University of Beirut (AUB) for the period 1876 to 2014, Lebanon has been witnessing fluctuations in annual rainfall, as well as an increased occurrence of consecutive dry years. **Figure 15** shows the yearly precipitation in Beirut between 1876 and 2014. As seen in the figure, the frequency of consecutive dry years has been increasing lately.

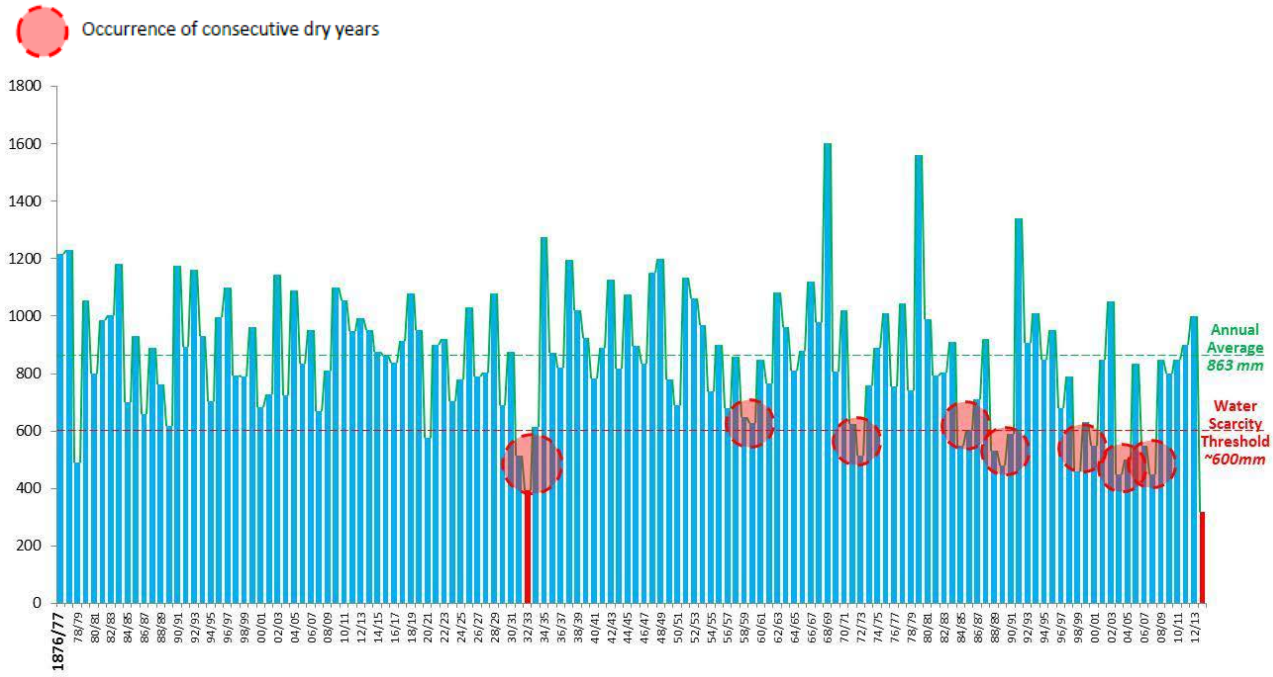


Figure 15:Yearly Precipitation in Beirut between 1876 and 2014 (ECODIT, 2015)

According to the Lebanon's Second National Communication to the UNFCCC, climate change will cause the average rainfall in the country to decrease from present values by 10-20% by 2040, and by 25-45% by 2090 (MoE, 2011). Moreover, the Intergovernmental Panel on Climate Change (IPCC) assessment report of 2013 states that the frequency and intensity of drought in the Mediterranean region will likely increase into the early and late 21st century. Additionally, the report predicts that change in average precipitation in the eastern Mediterranean for the period 1986-2005 to 2081-2100 will likely decrease between 20% and 30% coupled with an increase in temperature of 2°C to 3°C (Farajallah et al., 2014).

Rainfall in 2013-2014 was one of the lowest compared to the yearly national average, with a decrease of 40 to 50% in precipitation; which has led to drying of wells, springs and surface reservoirs (Farajalla, 2016). Additionally, the analysis of satellite images showing the snow cover over Lebanon has shown a noticeable decrease in surface area covered by snow, accompanied with a decrease in the residence time of snow, which affects the rivers' and springs' flow, and reduces groundwater replenishment (Shaban, 2009).

Furthermore, for the period 1961 to 1990, an increase in average air temperature in Lebanon of 1.3 to 1.8 °C has been reported by IPCC-DCC (1999). By the same trend, it is believed that further increase in temperature will be witnessed in Lebanon in the following four decades. The impact of this increase is reducing the water availability. It is estimated that additional 2°C by 2050 and 4°C by 2090 will cause the snow/rain limit line to rise from 1500 m to 1700 and 1900 m respectively, which will affect the recharge of Lebanese mountain springs from where the coastal rivers originate (Dar Al Handasah, 2014).

Finally, in Lebanon's State of the Environment Report (SOER) of 2001, indicators of groundwater replenishment issues were observed and it was noted that efforts to preserve water resources were lacking. Human activities were noted to exert significant pressure on water resources. In addition, the water cycle was directly affected at several stages, including deforestation, establishment of waterway altering dams, drainage canals and intensive irrigation. Groundwater recharge was also affected by the loss of plant cover that catches and channels rainfall to the soil, and loss of topsoil that effectively absorbs water.

Desertification

Desertification is the degradation of land, affecting arid, semi-arid and dry sub-humid areas. Several factors, natural and anthropogenic, contribute to desertification. These include: climate change, unsustainable land use practices, demographic pressure, wars and lack of technical expertise.

Desertification results in drying up of surface and groundwater, and increased frequencies of droughts and flooding, which in turn lead to degradation of water quality due to source pollution, siltation, sanitation and alkalization.

In Lebanon, desertification prone areas were identified taking into consideration different factors, namely: climate, soil, vegetation, land use intensity and demographic pressure. Figure 18 shows desertification prone areas in Lebanon due to demographic pressure, and Figure 19 shows desertification prone areas due to the combinations of the aforementioned factors. By comparing the two maps, it can be concluded that demographic pressure affects desertification to a great extent since most of the "very high desertification prone areas" on Figure 2-18 overlap with areas prone to desertification due to demographic pressure.

Water Quality

Water quality in Lebanon is affected by pollution sources that contaminate surface and groundwater.

In fact, many rivers receive raw sewage discharged (see **Figure 16**) from residential buildings and industrial facilities, leachate from municipal solid waste dumpsites, as well as agricultural runoff. Moreover, a study on 53 springs on the Lebanon Mountain Trail[10] showed that (ECODIT, 2015):

- 38% of the springs have no bacteriological contamination
- 30% have low to moderate contamination
- 15% have moderate to high contamination
- And 17% are highly contaminated

Some of the contaminated springs were located at high elevations, implying that pollution sources (such as households) are also present at high altitudes. Furthermore, groundwater reservoirs are subject to point and non-point pollution sources:

- Over-exploited reservoirs are experiencing salt-water intrusion, mainly in the coastal areas
- In some locations, wastewater is discharged in underground wells
- Surface direct pollutant infiltration into ground water

[10] The Lebanon Mountain Trail (LMT) is the first long-distance hiking trail in Lebanon. It extends from Andqet in the north of Lebanon to Marjaayoun in the south, a 470-km (293 miles) path that transects more than 75 towns and villages.

Finally, coastal water quality is affected by the discharge of raw and partially treated wastewater into the Mediterranean Sea from at least 53 outfalls (**see Figure 16**) along the Lebanese coast; pollutants carried out by rivers from agricultural runoff for example, as well as seafront dumpsites (ECODIT, 2015).

The geological specificities in Lebanon facilitate pollutant infiltration into groundwater and streams, as aquifer-bearing formations are extensive and generally located under permeable karst formations. In the National Physical Master Plan of the Lebanese Territory (NPMPLT) (DAR-IAURIF, 2005), a water resource vulnerability map was generated, taking into consideration several factors including; geology, vulnerability of sedimentary areas, intensity of lineaments and the main faults. The resulting map in **Figure 16** of water resource vulnerability shows that water resources in the western and eastern mountain chains are generally vulnerable to pollution infiltration. Additional challenges (that constitute current problems) to the water sector include a weak (aging and deteriorated) water distribution network, and heavy reliance on pumped groundwater.

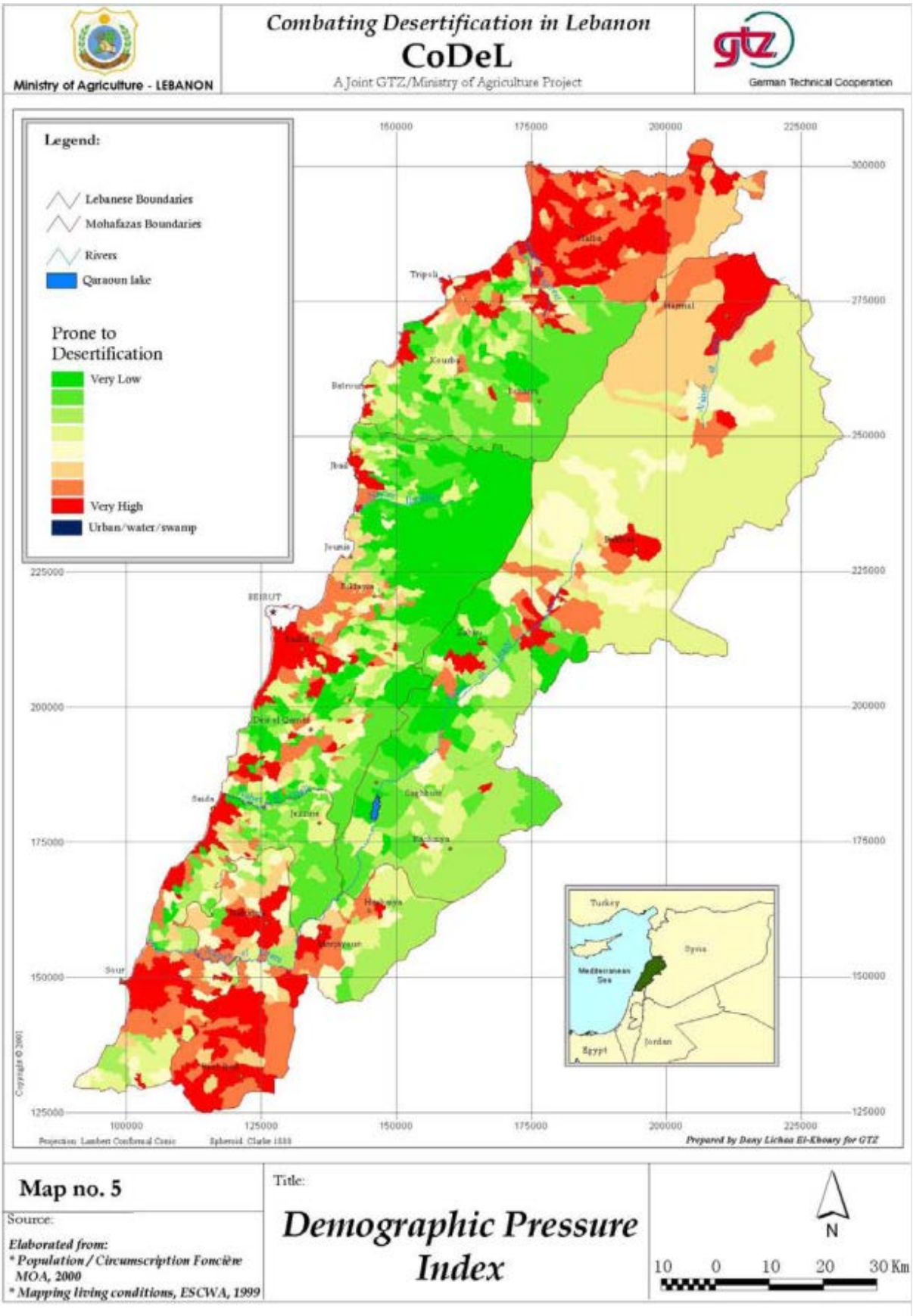


Figure 16: Demographic Pressure Index (MoA, 2003)

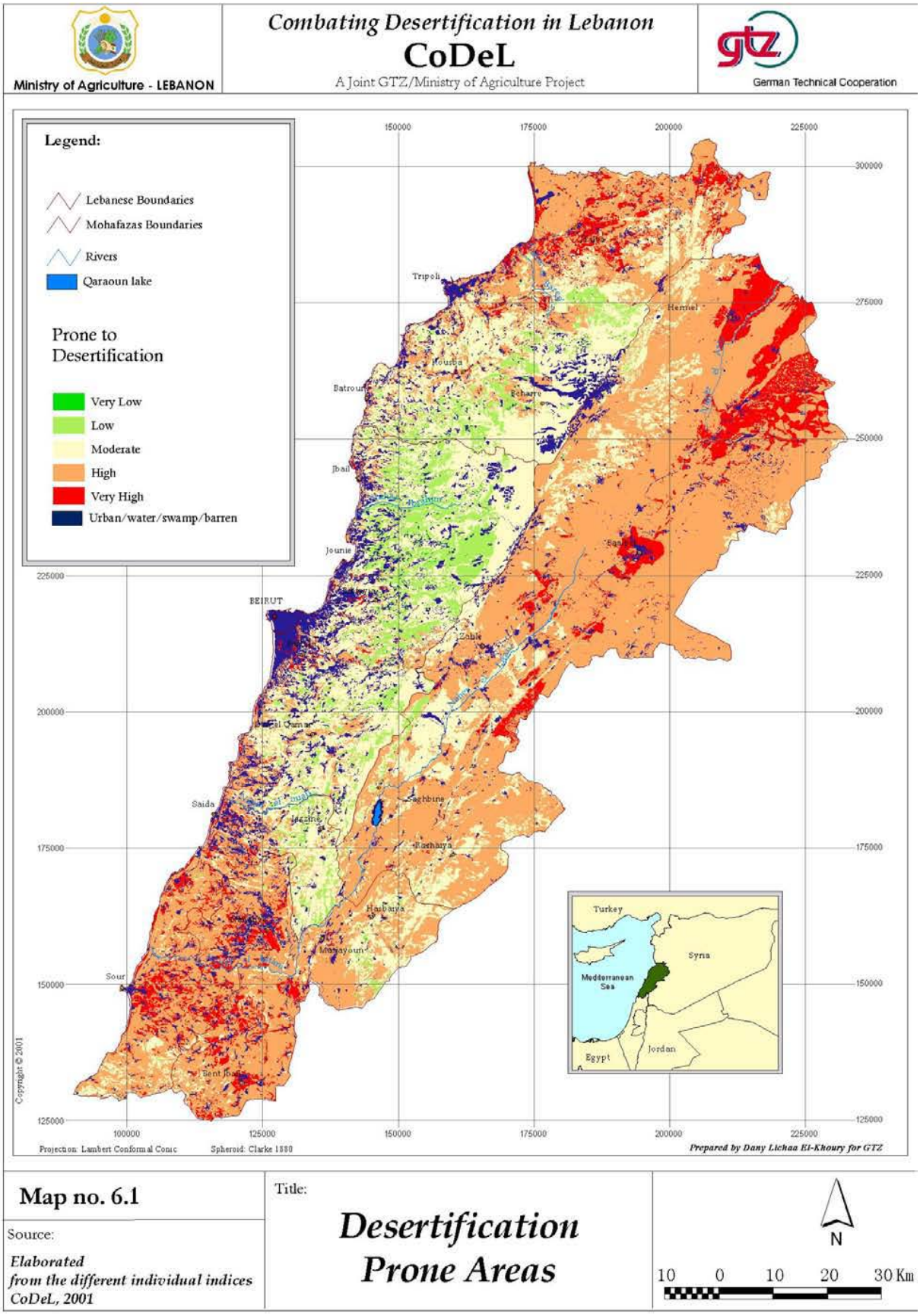


Figure 17: Desertification Prone Areas in Lebanon (MoA, 2003)

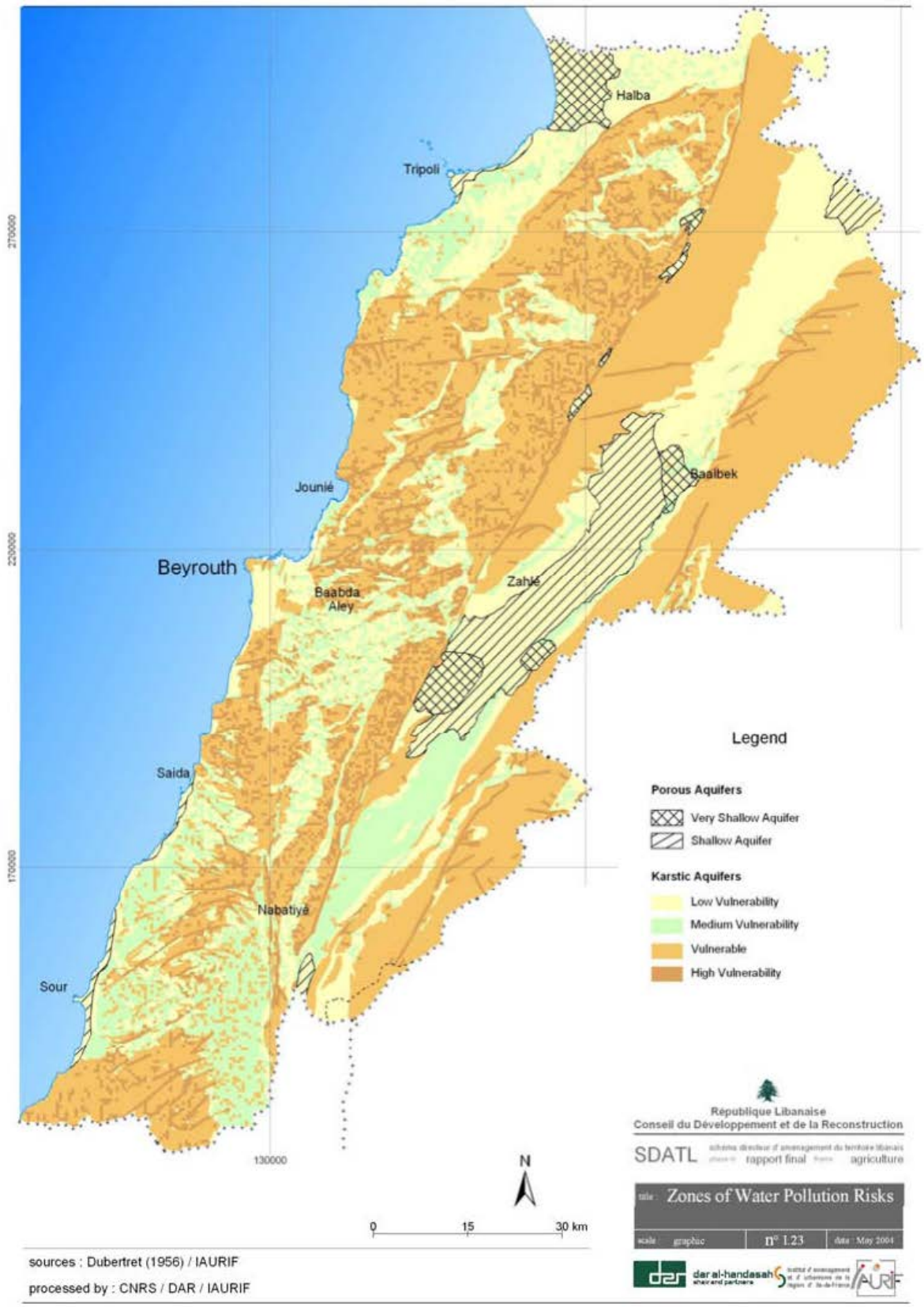


Figure 18: Map of Water Resource Vulnerability (DAR-IAURIF, 2005)

3.3.8. Water Governance

Policies

The water sector in Lebanon has various laws and regulations which date back to the Ottoman Empire and the French Mandate. Before the creation of the Lebanese state in 1920, the water sector was managed based on norms and customs proper to each village which organized water use, ensuring a balanced and fair distribution among residents to prevent conflicts. However, driven by the growing demand for water, franchises were issued by the Ottoman Sultan to meet the citizen's need, the first of which was to drag water from Naher El Kalb River to Beirut. This issuance initiated the transition to water management within a general administrative structure. Subsequently, the enactment of the Law Magazine for Judicial Ruling (

- Optimizing current wastewater treatment processes and sludge disposal.

The strategy presents initiatives which fall under three headlines:

- Production: provision of additional water resources
- Conveyance: Water Supply Transmission and Distribution
- Wastewater: Wastewater Collection and Treatment.

Laws and decisions related to the water sector

The national laws and regulations related to the water sector are presented in **Table 3,** and the multilateral environmental agreements related to water are presented in **Table 4. Table 5** presents the planned national laws and regulations related to the water sector.

Table 2: Presents the summery of the Lebanese Legislation Related to the Water Sector

Legislation	Year	Brief Description
Law No. 144	10/06/1925	Protection of Surface and Groundwater Resources.
Decision 320	26/05/1926	Protection of public water and its use Protection of catchment areas
Decree No. 7975	5/5/1931	Related to the cleanliness of residences and their extensions, and wiping out of mosquitoes and flies, and discharges of substances and wastewater.
Law 16/L	30/06/1932	General health rules and regulations.
Decree No. 2761	19/12/1933	Provides directions related to discharge of wastewater and dirty substances. General instructions for sewage networks and household pipe connections, septic tanks, leaching fields are listed.
Decree 10276	7/10/1962	Protection Zones for Water Sources and Recharge Areas
Decree 14438	1970	Regulates water exploration and usage. The drilling of wells and their operation would require Ministerial authorization.
Decision 67	1972	Methodology for bacteriological analysis of water.
Decree 8735	23/8/1974	It is forbidden to allow infiltration of sewage waters from cesspools or to leave them partially exposed, or to irrigate vegetables or fruits with their waters (Article 4). It reserves places assigned by each municipality for the treatment of wastes and agricultural and industrial residues (Article 13), empty sewage waters by tankers in special locations by decision of provincial or district governor until drainage canals are built (Article 15). It is forbidden to drill wells to undefined depth with the aim of disposing of sewage water (Article 3).
Law No. 64	18/08/1988	Protects the environment from hazardous waste and hazardous materials and establishes a Higher Council for Environmental Protection.
Law No. 216	2/4/1993	Establishes the Ministry of Environment (MoE) and defines its mandate. The MoE is responsible for environmental protection and monitoring.
Decree 5591	30/8/1994	Organizational structure of the MoE and its jurisdictions. Establishment of technical specifications for design of wastewater treatment plants. Setting maximum acceptable limits for air, water, and soil pollutants. Protecting and monitoring surface and ground water quality. Protecting rivers and springs from contamination by chemicals, pesticides, sewage, and municipal and industrial wastes. Safeguarding against illegal sewage disposal in coordination with relevant stakeholders.

Legislation	Year	Brief Description
Ministerial Decision No. 52/1	29/7/1996	Environmental Quality Standards & Criteria for Air, Water and Soil. Environmental Quality Standards for treated domestic wastewater (partly updated in Decision 8/1 dated 30/1/2001).
Law No. 667	29/12/1997	Amendment to Law No. 216, Organization of the MoE.
Project Law	1997	Code of Environment.
Decree 13495	5/11/1998	Identifying Measures of Application of Decree no. 68 dated 1983- Organization of excavation works to extend public services lines within the limits of streets and roads.
Draft Decree	1998	All agglomerations have to be provided with collecting systems for urban wastewater at the latest by 31 December 2010 for those with a population equivalent of more than 15,000 and 31 December 2015 for those between 2,000 and 15,000 (Article 3) All urban wastewater entering collection systems shall, before discharge, be subject to secondary treatment or an equivalent treatment. This deadline for achieving this goal is 31 December 2010 for all discharges from agglomerations of more than 15,000 people and 31 December 2015 for those between 2,000 and 15,000 people (Article 4).
Decree 1039	2/8/1999	Sets permissible standards for drinking water parameters. It adopts the Standardizations No. 161/1999 for potable water and No. 162/1999 concerning the bottled potable water as the Lebanese Standardizations.
Law 221	26/5/2000	Reorganization of the water sector. This law updated and clarified the regulatory authority of the MoEW and merged the 22 pre-existing water authorities into five Regional Water Establishments (RWE). But this Law did not clarify the respective roles of RWEs and Municipalities and the coordination between them, until today. An opinion (2004/40) from the Ministry of Justice confirmed that the RWEs were responsible for water supply and wastewater management.
Law 241	7/8/2000	Amends Law 221 by reorganizing the water boards into four Regional Water Authorities/Establishments: North Lebanon, Beirut and Mount Lebanon, South Lebanon and Bekaa.
Decision 8/1	3/1/2001	Updates/replaces Decision 52/1 by developing National Standards for Environmental Quality (NSEQ) Provides characteristics and standards related to air pollutants and liquid waste emitted from classified establishment and wastewater treatment plants.
Law 337	14/12/2001	Amendment of Law 221. Changed the Ministry of Hydraulic and Electric Resources (MHER) into the Ministry of Energy and Water (MoEW) and named the Regional Water Establishments as Water and Wastewater Establishments located in Beirut, Bekaa, North Lebanon and South Lebanon.
Decree 8018	12/06/2002	Determination of the permitting essentials, procedures and conditions to establish and exploit factories or industrial institutions or enterprises Article 20, Class I and II industries have to be 1000m distant from springs
Decree 8122	3/07/2002	Specifications for application of Law 221.
Law 444	29/7/2002	Law of the protection of the environment, sets the framework for environmental protection in Lebanon.
Decision 3	2003	Water policy for the creation of dams and hill lakes.
Decree No. 14596	14/06/2005	Internal organization of Beirut and Mount Lebanon Water Establishment (EBML).
Decree No. 14600	14/06/2005	Internal organization of South Lebanon Water Establishment (SLWE).

Legislation	Year	Brief Description
Decree No. 14602	14/06/2005	Internal organization of Bekaa Water Establishment (BWE).
Decree No. 14602	14/06/2005	Internal organization of North Lebanon Water Establishment (NLWE).
Decree 2366	20/06/2009	The Council of Ministries approved the National Physical Master Plan for the Lebanese Territory (NPMPLT) which describes the physical realities affecting land use, future challenges, alternative configurations for land use and development, land use principles and sectorial action plans.
Decision 2	09/03/2012	National Water Sector Strategy prepared by the MoEW in 2010 and enacted by the Lebanese CoM in 2012. This strategy presents a detailed road map for improving water conditions and service delivery in the country
Law No. 251	2014	Establishing the Public Environmental Prosecutor.
Draft Water Code	Not yet issued	Draft Water Code prepared by the MoEW and still under review by the CoM. Modeled on the French code, it defines: the water sector actors, establish a National Water Sector where all the actors will be represented, incorporate all the laws and statutes governing the water sector.

Table 3: Multilateral Environmental Agreements Related to Water Sector ratified by Lebanon (ECODIT, 2015)

Legislation	Year	Brief Description
Decree Law 126	1977	Convention for the Protection of the Mediterranean Sea against Pollution – Barcelona
Law 292	1994	Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources – Athens
Law 359	1994	United Nations Framework Convention on Climate Change (UNFCCC)
Law 23	1999	Convention on Wetlands of International Importance especially as Waterfowl Habitat – Ramsar
Law 360	1994	Law 360/1994 - Convention on Biological Diversity - Rio de Janeiro (CBD)
Law 469	1995	Law 469/1995 - United Nations Convention to Combat Desertification – Paris (UNCCD)

Table 4: Planned Laws and Regulations Related to the Water Sector (ECODIT, 2015)

Planned Laws and Regulations
Finalization of Water Code
Modernization of Ottoman irrigation laws (1913): Development of new irrigation Laws
Developing required legislation to initiate Private Sector Participation (PSP)
Treated Sewage Effluent (TSE) reuse standards and guidelines
MOE proposal to develop a master plan for the coastal zone, mountains, and other fragile ecosystems

Institutional Matrix

The water sector in Lebanon is governed by many institutions, including ministries, government agencies and municipalities. The main stakeholders of the sector are presented in **Table 6.**

Table 5: Water Sector Stakeholders

Water Sector Stakeholders	
Ministry of Energy and Water (MoEW)	Ministry of Environment (MoE)
Regional Water Establishments (RWE)	Ministry of Public Health (MoPH)
Litani River Authority (LRA)	Ministry of Agriculture (MoA)/Green Plan
Council for Development and Reconstruction (CDR)	Municipalities
Private Water Suppliers	Other Government Agencies
Lebanese Center for Water Management and Conservation (LCWMC)	Academic Sector

The responsibilities of the main actors in the water sector are presented in **Table 6. Table 7** presents a summary of the allocated responsibilities of each stakeholder. **Figure 21** presents a summary of the current institutional setting and commercial relations in the water sector in Lebanon.

Table 6: Responsibilities of Main Actors in the Water Sector in Lebanon (ECODIT, 2015) (MOE/UNDP/ECODIT, 2011)

Stakeholder	**Responsibilities**
MoEW	The Ministry of Energy and Water is responsible for the water sector under Law 221 dated 26 May 2000. According to Article 2 of this law, the responsibilities of the ministry are: Monitor, control and measure water resources, and determine needs and use of water resources Monitor the quality of water resources and set relevant quality standards for water resources Establish public plans for the utilization and distribution of water resources, as well as preparing the master-plan for water and wastewater to be endorsed by the COM through the MEW Design, build and put into operation major water facilities such as dams, mountain lakes, underground conveyors, river stream correction works and water supply networks and the like Implement artificial recharge of groundwater when required and regulate the volumes of water extracted Protect water resources from pollution and waste by issuing laws, rules and regulations and their application and enforcement License wells and all water extraction from rivers and public water resources according to applicable laws and regulations Implement continuous hydrological, geological and hydro-geological research, study, data gathering and mapping pertaining to the water sector Provide tutelage and oversight of all public institutions working in the water sector according to Law 221 and the laws governing these institutions Enhance the operational performance of regional water establishments and monitor their performance according to approved benchmarks

Stakeholder	Responsibilities
	Set the standards and benchmarks the RWEs will need to abide by in their design and operation of water supply, irrigation and wastewater systems Conduct all land expropriations for MoEW and RWEs in conformity with existing laws Provide advice in the licensing of mines and quarries when such mines and quarries impact on water resources Conduct outreach with citizens to inform them of water related issues and ways of conserving water
RWE	Law 221/2001 and its amendments created four Regional Water Establishments (RWE): Beirut and Mount Lebanon; North Lebanon; South Lebanon; and the Bekaa. Before the approval of Law 221, Lebanon had 21 water establishments and over 200 local water committees, mainly active in irrigation. The RWEs were given autonomy and control of their human resources. Financially, the RWE are subject to Government audit periodically, and their administrative activities are subject to the Government's administrative regulator (Central Inspectorate). They have the power to recommend tariff structure and rates to MoEW, but not set them. Under Clause 4 of Law 221, the RWEs were given the following responsibilities: Plan, build, operate and maintain potable and irrigation water transmission and distribution networks Plan, build, operate and maintain WWTP and networks Ensure the quality of water supplied to their communities Recommend tariffs for water, irrigation and wastewater (based on prevailing socioeconomic conditions) Oversee works, studies, and operation and maintenance of water installations by private service providers
LRA	The Litani River Authority (LRA) was established in 1954 with the responsibility of managing the Litani River Basin. In particular, the LRA would: Plan and operate all potable, irrigation and hydroelectrical schemes associated with the Litani River, Measure all surface flows throughout the country, Establish and operate all hydro-electrical generating plants. In 1962 it was given the power to develop and operate all water systems connected to the Litani River and Awali Rivers in the area of Lebanon between the Beirut Damascus Highway and its international border in the south. Clause 7 of Law 221 affirmed that irrigation water schemes tied to the Litani River would remain under the control of the LRA. Although Law 221 should have had an impact on the LRA, it still operates as it has for the last 30 years: its operations are within the Bekaa Water Establishment and South Lebanon Water Establishment area, yet no perceivable change has been recorded in LRA operations or those of the establishments.
CDR	CDR has the responsibility to prepare national sector plans in coordination with the different line ministries. CDR secures international funding for these plans and then manages their execution. As different projects are completed, the ownership of facilities and assets built are handed over to the respective line ministries or establishments for management and operation. CDR has led Lebanon's capital spending in the water sector.
MoE	The Ministry, established in 1993, is responsible for controlling pollution and regulating all activities that impact the environment. Its remit is wide. The ministry has several legal avenues for controlling

Stakeholder	Responsibilities
	pollution, including prevention. For example, the EIA decree requires that all sewage treatment plants undergo full environmental impact assessment studies. The ministry has set standards for treated wastewater discharged into sewers (Decision 8/1 dated 30/1/2001). Although the Ministry has very limited means for law enforcement, the Ministry of Justice recently appointed environmental prosecutors pursuant to Law 251 (dated 15/4/2014). Furthermore, the MoE has been calling for establishing an environmental police force, which awaits approval by the COM. It is hoped that the presence of an environmental police and environmental prosecutors will deter, detect, report, and prosecute environmental polluters in Lebanon
MoPH	The Ministry of Public Health has the responsibility of maintaining health standards in the community. In relation to water resources, it monitors drinking water to ensure compliance with local and international standards. The Ministry monitors the incidence of waterborne diseases and publishes related epidemiological data.
MoA/GP	▪ Study irrigation projects and provide technical supervision during implementation. ▪ Regulate the distribution of public irrigation water and ways to use it and monitor the implementation of these regulations. ▪ Construct small-scale irrigation water supply projects (artificial lakes, storage tanks, etc.). ▪ Conserve and utilize water resources. ▪ Enhance and monitor irrigation systems and manages small and medium irrigation projects.
Municipalities	Traditionally, sewage networks have been the responsibility of the municipalities. Law 221/2000 is ambiguous on the issue of sewer lines, and there is a view that the rehabilitation and condition of sewer lines remains the responsibility of the municipality. Further confusion is caused by one of the provisions in the municipal law related to municipal taxes. Municipalities levy tax on the rental value of residential and commercial units, as well as a tax on sidewalks and sewers. While the RWE are not yet equipped to take possession of the WWTPs and other sophisticated facilities, the municipalities are totally ill equipped to operate and maintain the expanding sewage networks that are coming into operation. Therefore, while collection networks are expanding, institutionally, their operation and maintenance is uncertain. It should be noted that the municipalities continue to build or upgrade sewer lines separately from MoEW, RWEs and CDR[11].
Private Water Suppliers	Currently, water supply from public resources is not sufficient, the demand is met by private suppliers including bottled water, gallons, tankers and private wells. Private water supply increases the financial burden on the community, and the provided water quality is not strictly regulated which poses a risk to public health.
LCWMC	The objective of the Lebanese Center for Water Management and Conservation (LCWMC) is to coordinate and promote sustainable water management through both technical and policy-level support. The center is located within the MoEW premises and its main results are: 1) Technical capacity building on sustainable water management and 2) National public awareness building. Water awareness has received little attention in Lebanon. The NWSS recognizes water conservation and awareness as one of five management initiatives. The MoEW is hosting since 2011 a UNDP-funded project "Lebanese Center for Water Management and Conservation" –the work of LCWMC would need to be scaled up and fully integrated into the mandate and organizational structure of MoEW to produce lasting results insofar as behavior change.

[11] Operation and Maintenance of the WWTP are contracted to the private sector or municipalities (WB, 2010)

Stakeholder	Responsibilities
Academic Sector	A number of universities are active in water research, most notably the American University of Beirut (Water Resources Centre), the Notre Dame University (Water Energy and Environment Research Centre) and Saint- Joseph University (Regional Centre for Water and Environment). In addition to their research and data, the universities are offering water resource and environmental studies as majors. This will allow water resource professionals to come into the sector with greater awareness of the environmental challenges facing the sector.
Other Government Agencies	The Council for the South (CoS) is very active in building water supply systems in the south and West Bekaa regions. These systems all rely on boreholes for the supply source. Separately, the Central Fund for the Displaced, which is responsible for rehabilitating and building water supply systems in the villages of Chouf, Baabda and Aley, has contributed substantially to expenditure during the last 15 years in building water supply wells. It should be noted that the Council for the South and the Central Fund for the Displaced have a lot of autonomy in terms of the decisions they take and the projects they execute. They inform MoEW and the RWE, and attempts at coordination are made, but coordination remains informal.

Table 7 shows the allocation of responsibilities in the water and wastewater sectors. The responsibilities of key actors in the water sector often duplicate, sometimes complement each other, always operating through weak links of communication and responsibility. This situation has led to a lack of policy focus with no specific institution taking the effective lead of the sector. Others include Council for the South, Municipalities, Other Ministries and agencies. **Table 8** presents the future responsibility of relevant authorities for wastewater sector as per the National Environmental Action Plan (NEAP) of the MoE.

Table 7: Summary of Water Sector Stakeholder Responsibilities (MOE/UNDP/ECODIT, 2011)

Function	MoEW	RWEs	LRA	CDR	MoE	MoPH	Other
Planning	X	X		X			
Licensing and permitting (including EIAs)	X				X		X
Capital Investment	X	X		X			X
Infrastructure Construction	X	X		X			X
Operation and Maintenance	X	X					
Financing (national)	X	X		X			
Financial (external funding)	X			X			
Regulations and guidelines	X				X	X	
Water quality/quantity monitoring	X		X		X		
Hydro-power plants	X		X				

Table 8: Future Responsibility for Wastewater Sector (NEAP by MoE)

Area of Responsibility	Responsible Authority
Overall Strategy	MoEW, CDR and MoE
Planning, Investment and Implementation	CDR and MoEW
Operation and Maintenance	MoEW and Regional Water AuthorityEstablishment (RWE)
Internal Finance	Ministry of Finance (MoF) and MoEW
External Finance	MoF and CDR
Regulations, Standards and Guidelines	MoPH and MoE

National Budget for Water Sector

The public investment in the water and wastewater sector in Lebanon amounts to approximately 0.5% of the GDP, a value below the optimal level of 0.8%. This amount is inadequate to meet the development needs of the sector (47.10 billion US dollars in 2015: 0.235 Bn $). Lebanon has limited fiscal space for increasing public expenditure, therefore one way to meet the development needs of the water sector is to improve its spending efficiency.

Moreover, the cost of inaction in the water sector, and that of environmental degradation are estimated at 1.8% and 2.8% of the GDP respectively, and the hidden costs, caused by inefficient collection and water losses are estimated at 0.5% of the GDP (WB, 2010). The share of CDR public investment in the period 1992-2007 for different sectors are shown in **Figure 21.** As seen in the figure, the water sector accounts for 14% of the CDR investments. **Figure 22** represents the capital expenditure in the water, irrigation and wastewater sectors by different agencies. The total expenditures in the three sectors are 97 Million USD, 13 Million USD and 32 Million USD respectively (WB, 2010).

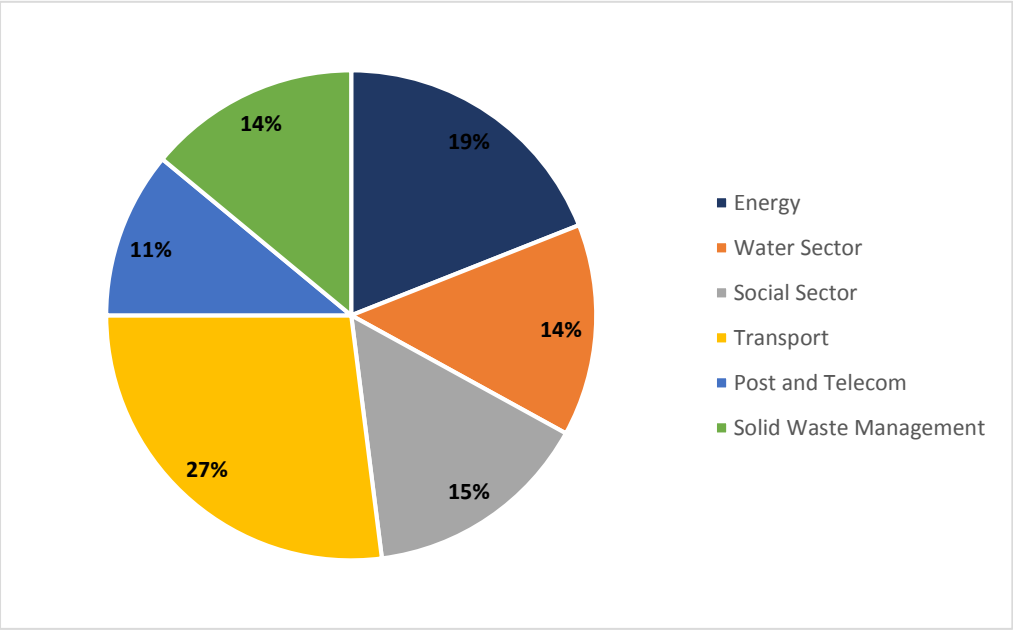


Figure 19: Share of CDR Public Investment (1992-2007) (WB, 2010)

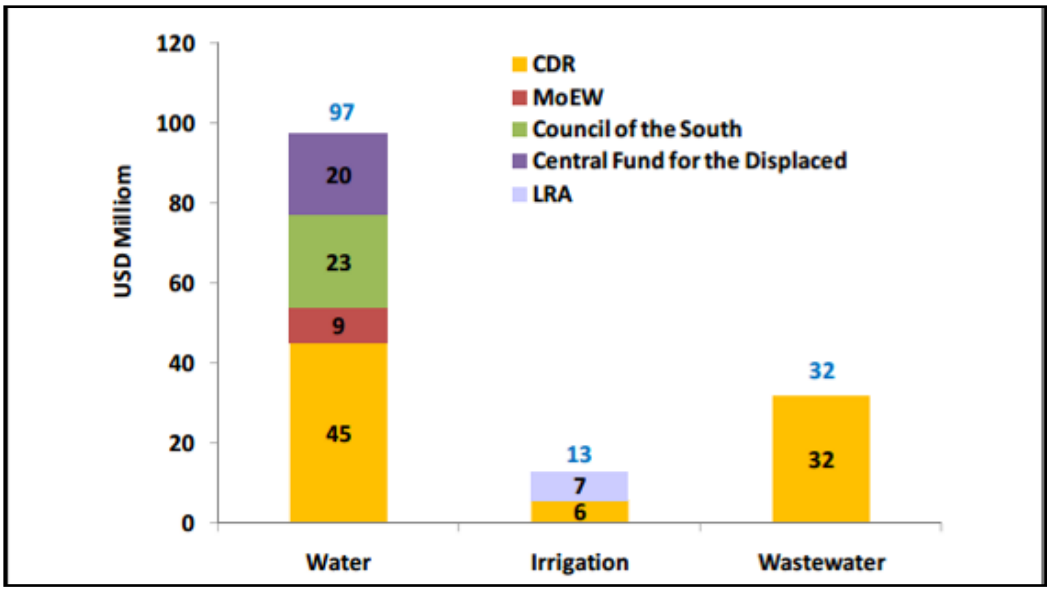


Figure 20: Capital Expenditure in Water, Irrigation and Wastewater Sectors by Different Agencies (WB, 2010)

3.4. Agriculture

3.4.1. General Figures

Due to its Mediterranean climate, rich soil and abundant water resources, Lebanon has the highest proportion of agricultural land in the Middle East (67%) (Databank, 2013). The agricultural sector in Lebanon contributes to 5-6% of the GDP, and employs 8% of the effective labor force. In the rural areas, agriculture related activities account for about 80% of the local GDP.

The agricultural census of 2010 showed that there are 170,000 farmers and agricultural holders in Lebanon. Farming households engage in non-agricultural economic activities in addition to agriculture, and only half of them depend solely on agriculture for their livelihood. Of the latter, 20% are highly vulnerable (MoA, 2014) (FAO, 2017).

Among the active population, 20 to 25% have some activity in agriculture, on full-time or part-time basis, including seasonal family labor (FAO, 2017). The rural population involved in agriculture in 2010 reached 817,000 people (MoA, 2014). Finally, women constitute 8.6% of the total workforce in agriculture, the average age of the farmers is 52 years (MoA, 2014).

In the livestock sector:

- women represent 15 % of the total number of farmers;
- less than one agricultural holding in eight is involved in animal husbandry;
- meat production has more than doubled since 1990, reaching levels slightly below 200,000 tons/year (IDAL, 2016).
- dairy farmers aged less than 40 years represent 28% of the total number of farmers.
- farmers with families with more than 8 dependents: 25% of total.
- 60% livestock farmers depend on dairy as their main source of living, 20% depend on dairy with crops as a secondary source of income, 22% depend on dairy and other businesses such as casual daily work, trading, retirement allowances.

Figure 21 shows the percentage of agricultural holders engaging in other economic activities by District. The District of Zahle hosts the majority of farmers whose main economic activity is agriculture, with only 33 % of farmers engaged in other economic activities, followed by the rest of Bekaa Governorate, Baalbek-Hermel, and Akkar (57.3 %), then Nabatieh and Mount Lebanon (64 % to 92%). In the North and South, the percent of pluriactive farmers varies from one District to another. The different types of land use classes related to the agricultural sector are presented in **Table 9.**

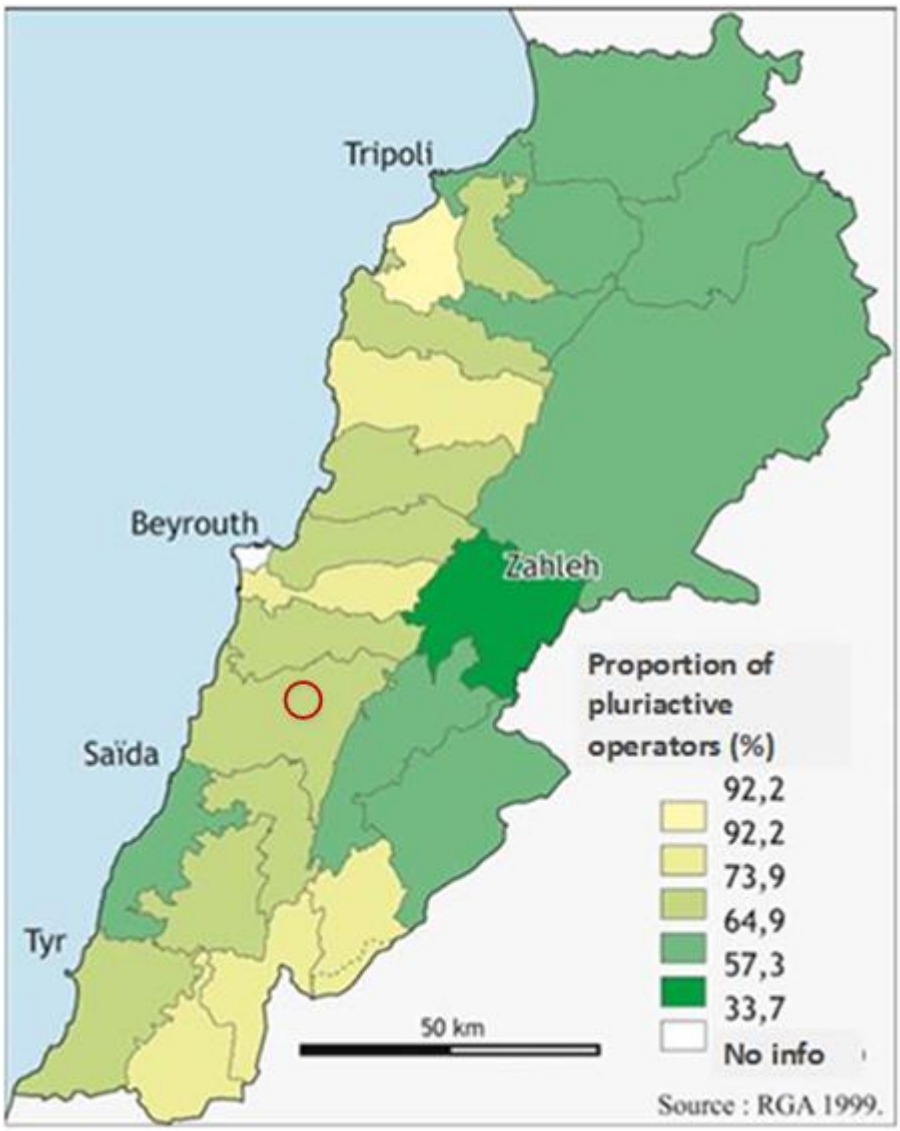


Figure 21: Multi-activity of agricultural holders (FAO, 2011)

Table 9: Agricultural Land Use (FAO, 2011)

Type	Area (km^2)
Utilized Agricultural Area (UAA)	2143.8
Arable Lands	1442
Agricultural Irrigated Land	1148.2
Land covered with greenhouses	35.8
Land under annual crops	1106.2
Land under permanent crops	1147.5
Temporary fallow land (1 to 5 years) within holdings	113.82
Abandoned land (> 5 years) within holdings	402.8
Nonagricultural land within holdings	155.40
Nonproductive lands	2750.86

Figure 24 shows soil, slope, agricultural land use and irrigation projects maps. As seen in the figure:

- On the soil map, the high fertility lands are mainly in the Bekaa area, river basins and in the coastal plains.
- Most of the highly fertile areas seem to have a slope less than 3% as shown on the slopes map
- Field crops are mainly grown in the Bekaa plain, Akkar plains, as well as some areas in the south of the country. Orchards and vines are planted in the Bekaa plain, in north Lebanon, the southern coastal plains as well as other mountainous areas.
- Rehabilitated irrigation projects[12] are mainly concentrated in the southern coastal areas, in some areas within the western mountain chain and in the small areas in the Bekaa valley; however, most irrigation projects in the Bekaa and Akkar are not rehabilitated. Most proposed irrigation projects are concentrated in the southern part of the country.

The maps of **Figure 24** were used in the National Physical Master Plan for the Lebanese Territory (NPMPLT) as a baseline for the generation of the "Agricultural Areas of National Interest" map in **Figure 25,** which shows the distribution of main agricultural and main urban areas in Lebanon. The main agricultural regions are:

- The Bekaa plain: more than 40% of the land is cultivated,
- The North: especially Koura and Akkar
- The South: intensive agriculture in the coastal region (Sidon and Tyre)

Mount Lebanon and Nabatiyeh have lower cultivated land due to their rough landscape. (Databank, 2013). **Figure 26** shows the size of agricultural exploitation by area Lebanon. Most of the exploited lands larger than 4 hectares (0.04 km^2) are concentrated in the Bekaa and Baalbek-Hermel, followed by Akkar and the South, while most of the land in Mount Lebanon and the North are small holdings. Moreover, the percent of exploited agricultural land larger than 4 hectares reaches 70% in some areas of the Bekaa.

[12] Rehabilitated projects are projects that have previously rehabilitated existing irrigation systems in different locations

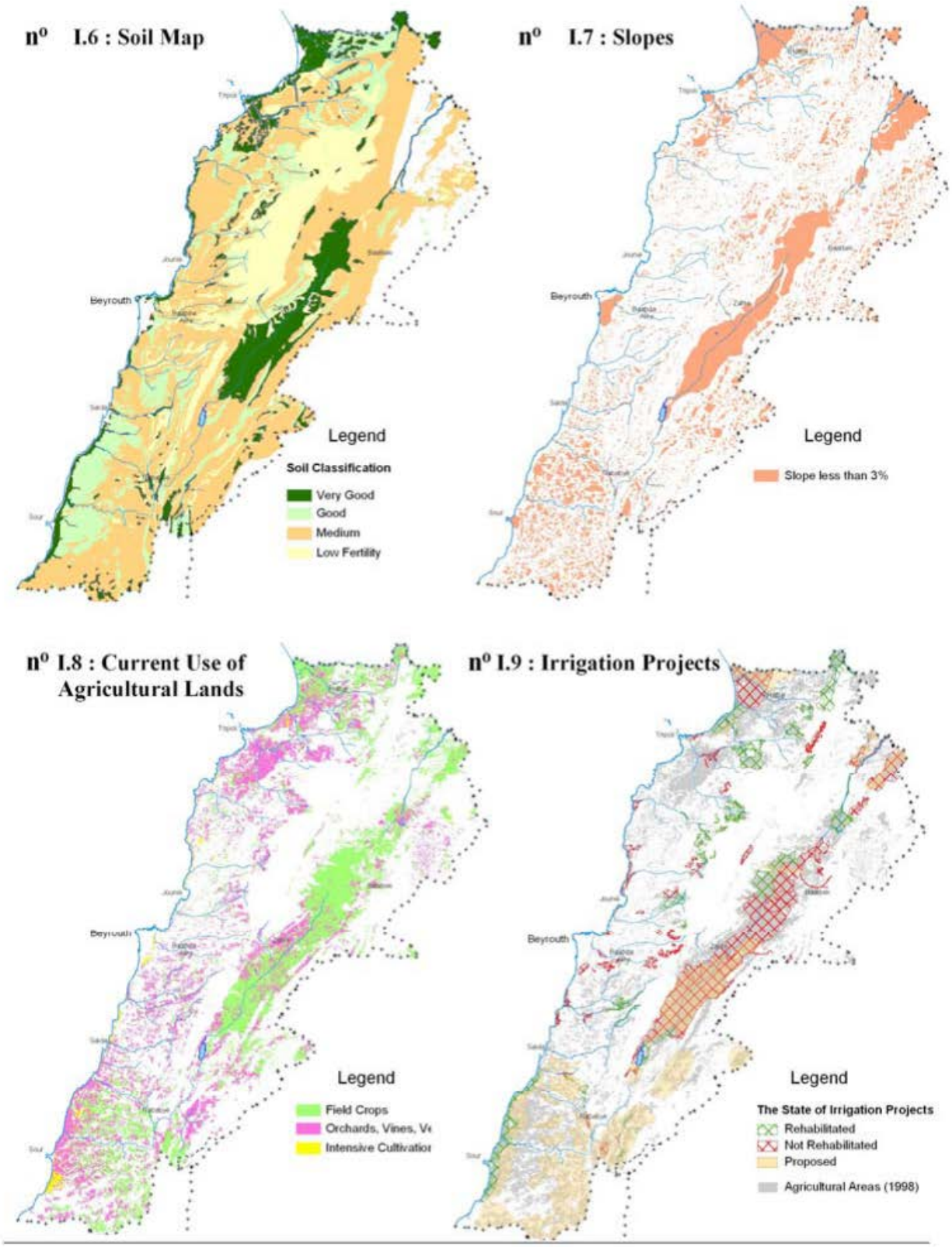


Figure 22: Maps of Soil, Slopes, Agricultural Land Use and Irrigation Projects (DAR-IAURIF, 2005)

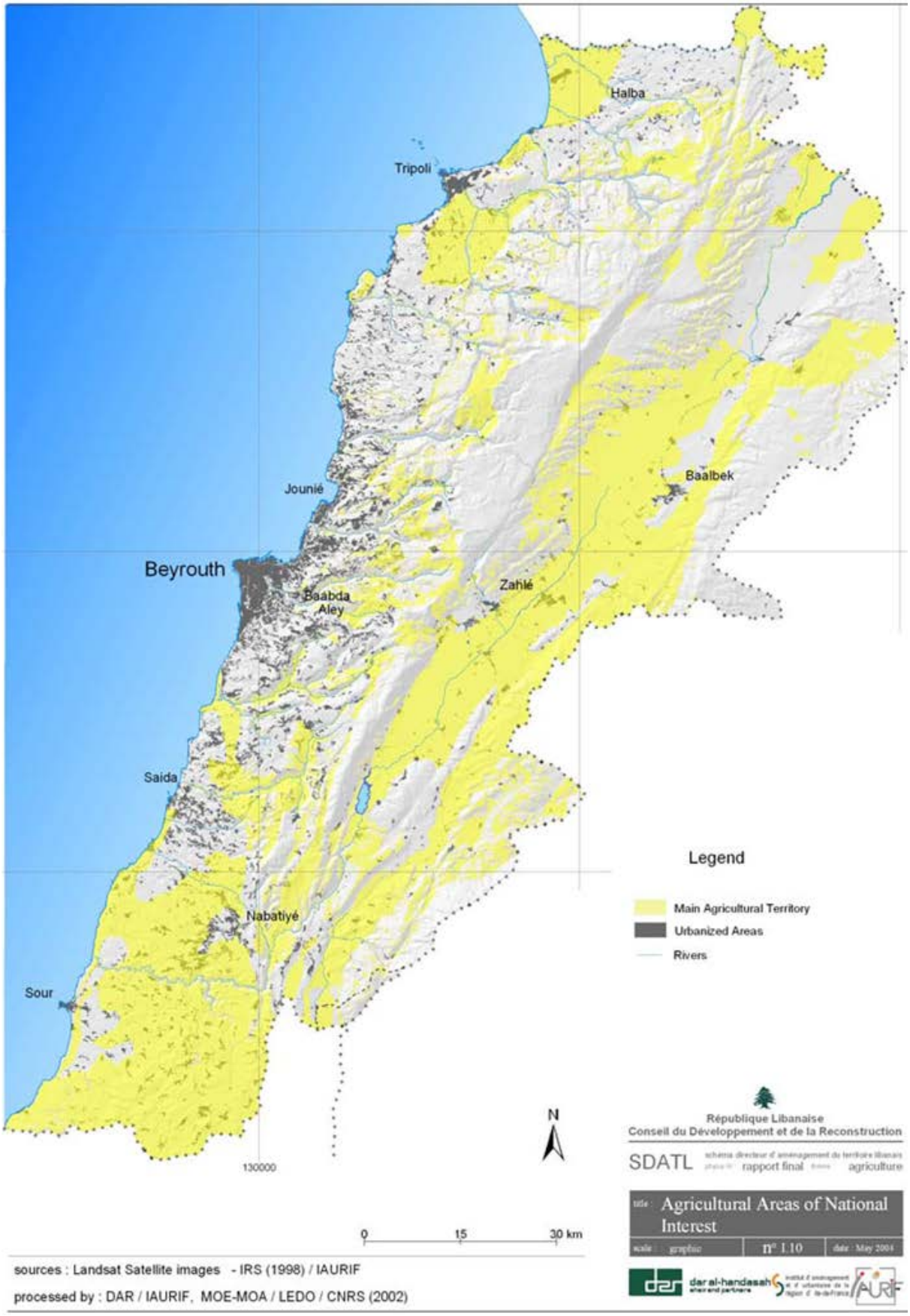


Figure 23: Agricultural Areas of Natural Interest (DAR-IAURIF, 2005)

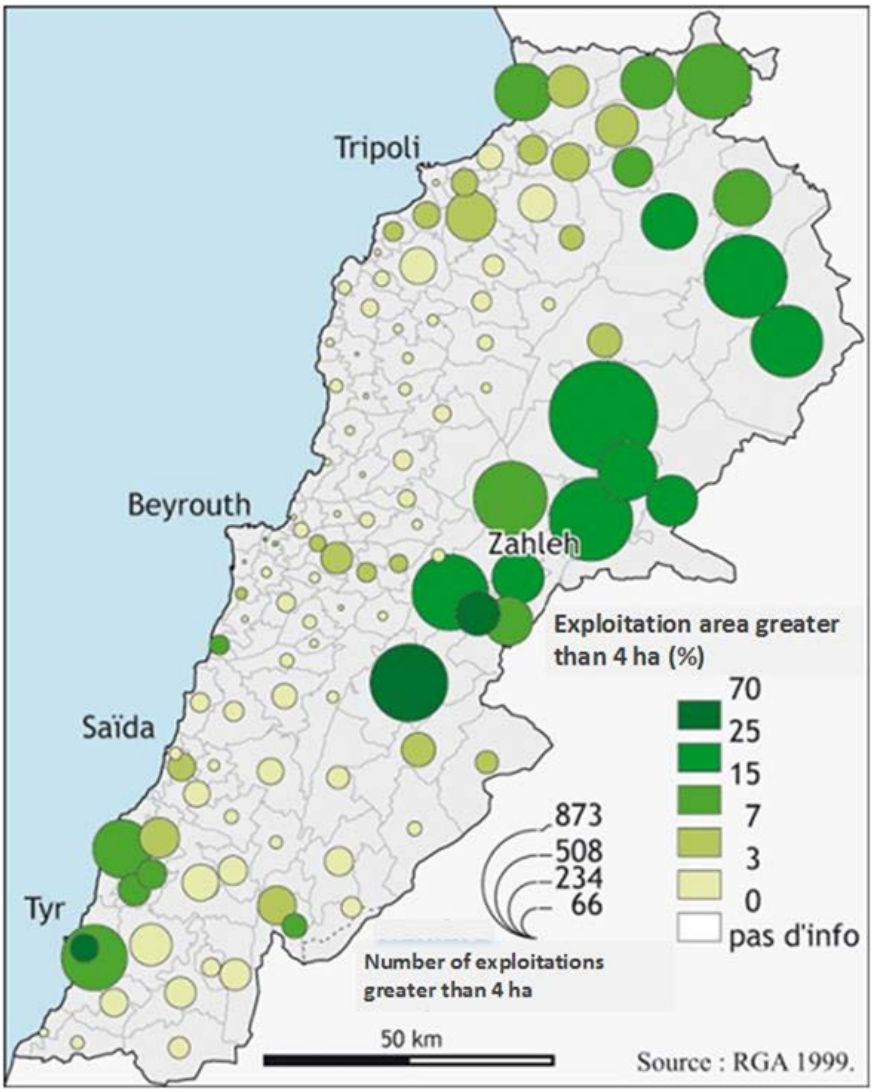


Figure 24: Size of Agricultural Exploitation in Lebanon per Area (FAO, 2011)

3.4.2. Agricultural Production

A variety of crops can be cultivated in Lebanon due to its Mediterranean climate, some of which typically grow in cold or tropical countries (Databank, 2013). The major agricultural products in Lebanon are classified under five categories:

- Cereals
- Fruits: apples, bananas, oranges and grapes
- Olives
- Industrial Crops: sugar beet, tobacco
- Vegetables: potatoes, tomatoes and maize

According to MoA data, cultivated areas in Lebanon amounted to 2,515 km² in 2009 which represents 24% of Lebanon. Their distribution is presented in **Table 10**; with fruits accounting for the largest proportion (almost 30%), followed by olives, cereals, and vegetables. Agro-industrial production accounts for only 3.3%.

Table 10: Distribution of Lebanese Cultivated areas by Category (Databank, 2010)

Type of Production	Cultivated Area (km²)	Percent of Total (%)
Cereals	556	22.2
Fruit Trees and Other Trees	746	29.6
Legumes	61	2.4
Vegetables	384	15.3
Olives	568	22.6
Agro-Industrial	83	3.3
Others	117	4.6
Total	2,515	100

Figure 27 shows the surface planted in olives, grapes, fruits and citrus respectively as well as their respective share in the total agricultural area:

- Olive cultivation is mainly concentrated in the North, Southern Mount Lebanon, the South and Nabatiyeh;
- Grapes are mainly cultivated in Mount Lebanon, the Bekaa and Baalbek-Hermel;
- Fruits are mainly planted in the Western Mountain Chain, in the Bekaa and Baalbek Hermel;
- Citrus are mainly cultivated in the Northern and Southern coastal areas.

Figure 26 presents the share of sub-sectors from the agricultural output in 2012. Vegetables represented the highest proportion (48 %), followed by fruits (26%), dairy (7 %), livestock products (6%), wheat (6 %), olives (4 %), eggs (2%) and almonds (1%). The composition of the fruit category in 2012 is presented in **Figure 29.** Apples constituted the highest fraction with 23%, followed by citrus, grapes and bananas. Other fruit types formed 28% of the production, including apricots, peaches, cherries, etc.

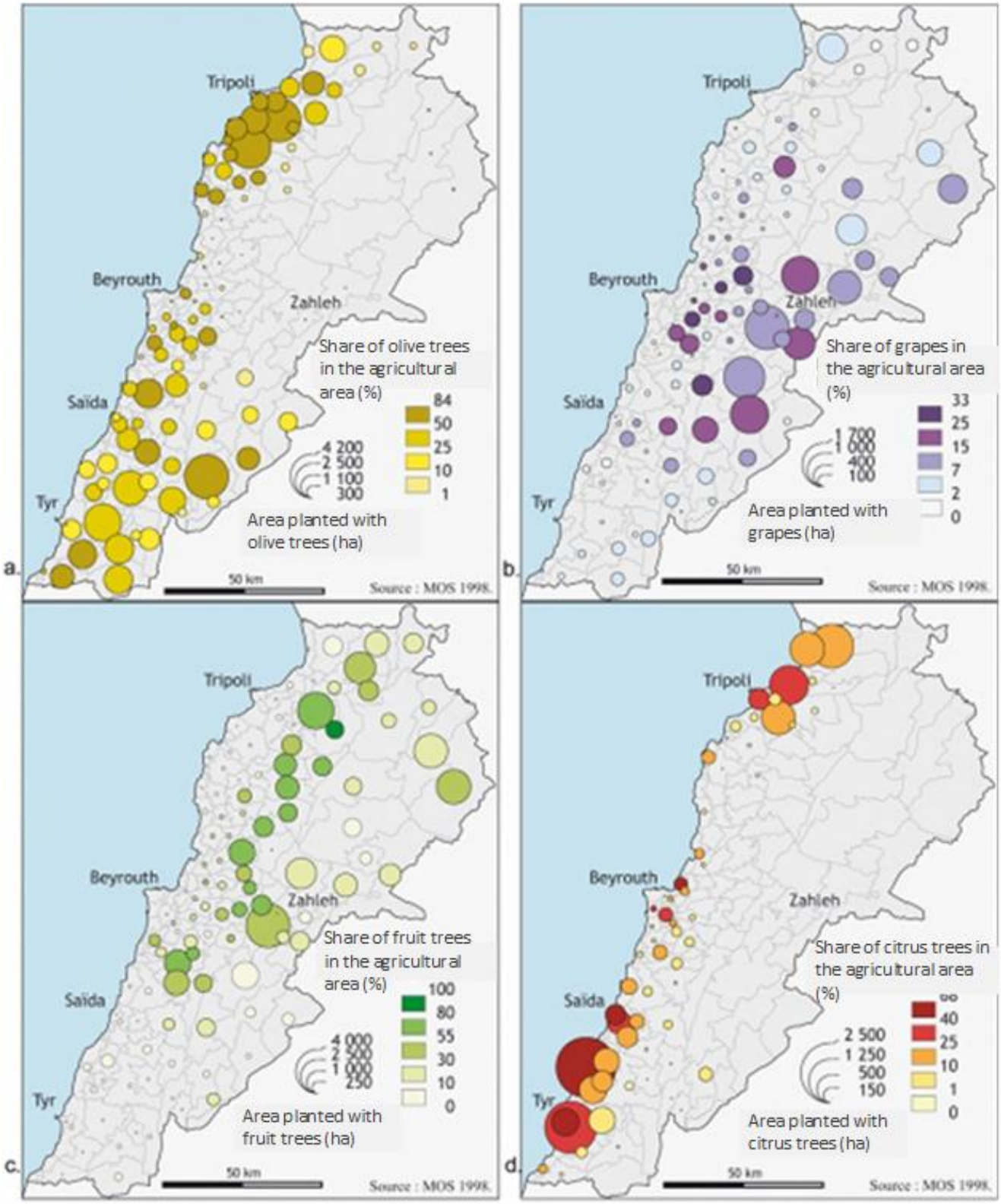


Figure 25: Distribution of Tree Crops in Lebanon (FAO, 2011)

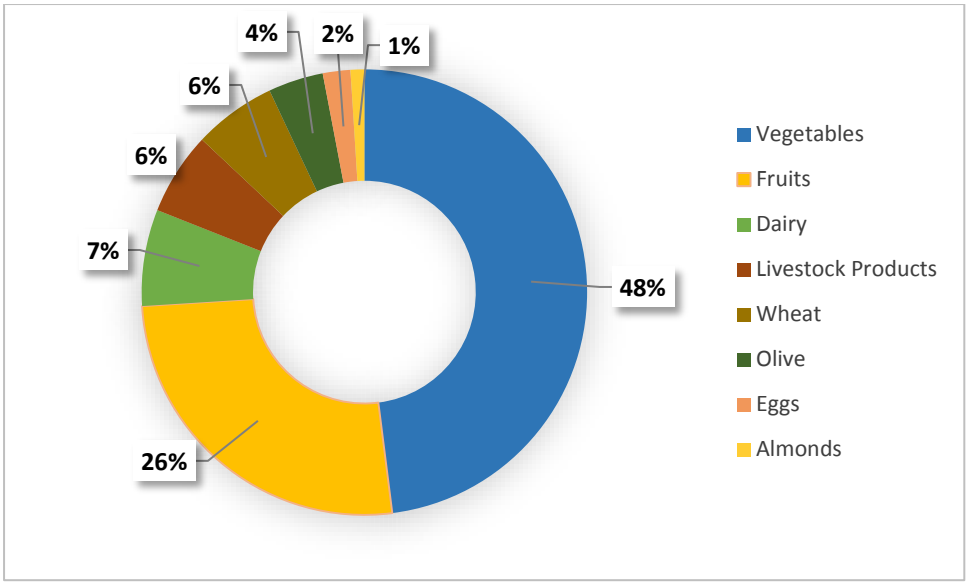


Figure 26: Agricultural Output per Sub-sector in 2012 (Databank, 2017)

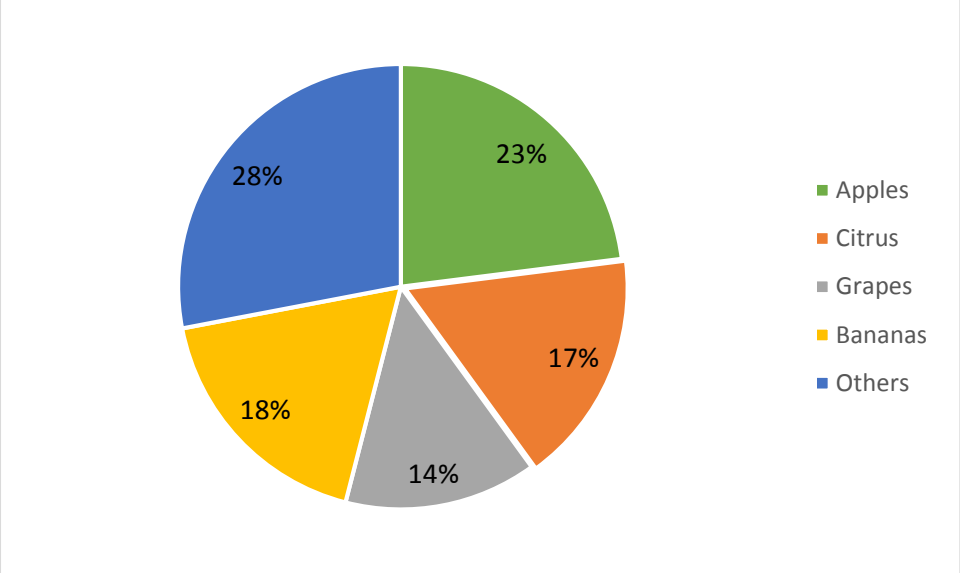


Figure 27: Composition of the Fruit Category (Databank, 2017)

3.4.3. Irrigation

Agriculture is the highest water consuming sector, utilizing 64% of the available water resources in Lebanon (CDR, 2013). Irrigation water is provided from surface water and ground water wells. **Figure 28** presents the size and percentage of irrigated lands in Lebanon. The Bekaa and Baalbek-Hermel governorates account for the highest irrigated surfaces in Lebanon.

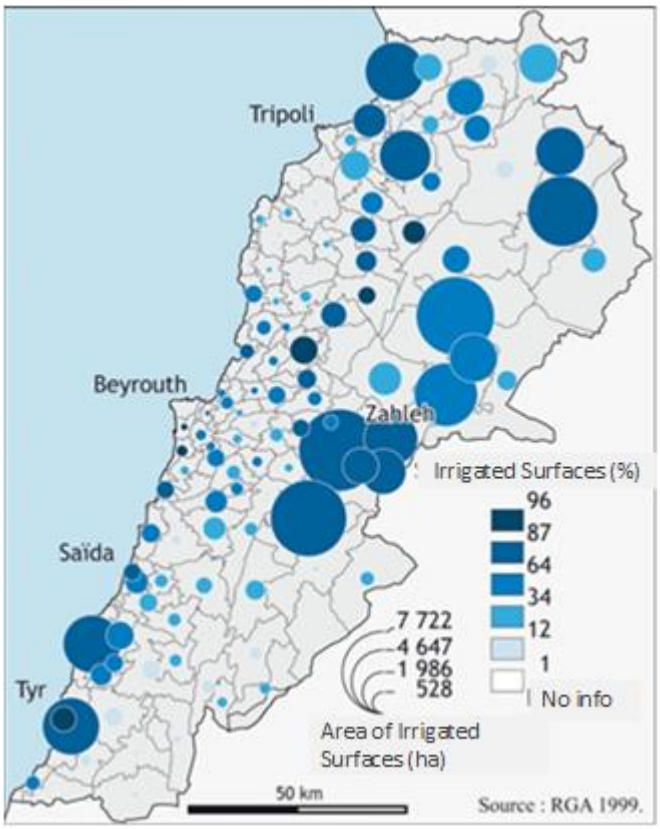


Figure 28: Percentage and Size of Irrigated Lands in Lebanon (FAO, 2011)

According to the Ministry of Agriculture Strategy 2015- 2019, the current irrigation systems used in Lebanon are old and inefficient, and the farmers lack awareness of the value of water and its rational use, which contributes to water wastage. Despite the availability of new irrigation technologies and expertise in the sector, as well as sewer infrastructures that allow the re-use of treated wastewater in irrigation, irrigation remains a weak sector due to several factors including:

- the absence of long-term plans for irrigation, water management and agriculture
- the limited number of policies and programmes for water management
- lack of adopting legislations
- decentralized poor information related to irrigation and lack of data sharing between research centers and farmers and
- no linkage between research and adoption of results, in particular related to rational usage of water (MoA, 2014)

3.4.4. Agro-Industry

The Lebanese agro-industry includes mainly: sugars & sugar confectionary, beverages, bpirits & vinegar, prepared vegetables, fruits, and nuts. Agro-industry is a major contributor to the Lebanese economy, generating up to 5% of the national GDP, it is the largest employer in the industrial sector accounting for 25% of the industrial workforce. Additionally, the agro-food enterprises account for 21.8% of the enterprises with around 963 companies involved in agro-industrial activities. The sector is predominantly composed of small family-owned enterprises, employing 6 workers on average (IDAL, 2017b).

3.4.5. Import and Export

Lebanon is a major food importer, with imports amounting to five times the value of agricultural export (Databank, 2017). In 2012, food constituted 16% of total imports, and the share of some imported products are represented in **Figure 31.** Foodstuffs[13] contribute to the highest share of food imports, this fraction consists mainly ofcereals, flour and starch, as well as sugars and confectionery sugar; followed by fruit and vegetable products and animal products (BankMed, 2013).

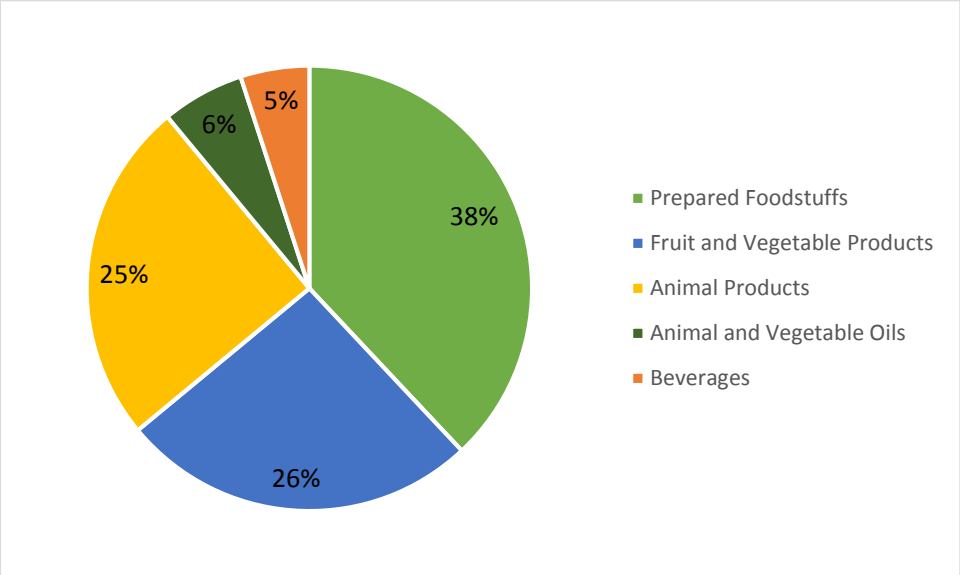


Figure 29: Share of Some Product from Food Imports (BankMed, 2013)[14]

Agricultural exports have fluctuated over the past years. In 2015, they accounted for 6.2 % of the total exports, and the contribution of different products to export are presented in **Figure 30** (Databank, 2017). Potatoes contributed to the highest share of exports (39 %), followed by apples (17 %), citrus (15 %), bananas, then grapes, apricots ant lettuce, the rest of the exported produce contributed to 9 % of the exports.

On the other hand, agro-food[15] products accounted for 21.2 % of the total exports in 2016, and 17.9 % of the total industrial exports. The key exported products include: sugars, beverages, spirits and vinegar, prepared vegetables, fruits and nuts, their contribution to exported agro-products are presented **Figure 31.**

[13] "Foodstuffs are any substance, whether processed, semi-processed or raw, which is intended for human consumption, and includes drink, chewing gum and any substance which has been used in the manufacture, preparation or treatment of "food" but does not include cosmetics or tobacco or substances used only as drugs" (source: FAO, "Definitions For The Purposes Of The Codex Alimentarius, www.fao.org) .

[14] Prepared foodstuffs: include processed and semi-processed foodstuffs.

[15] The agro-food industry can be defined as the sector which includes all operations related to processing, preserving, preparing and packaging agricultural and food products carried out in industrial production units.

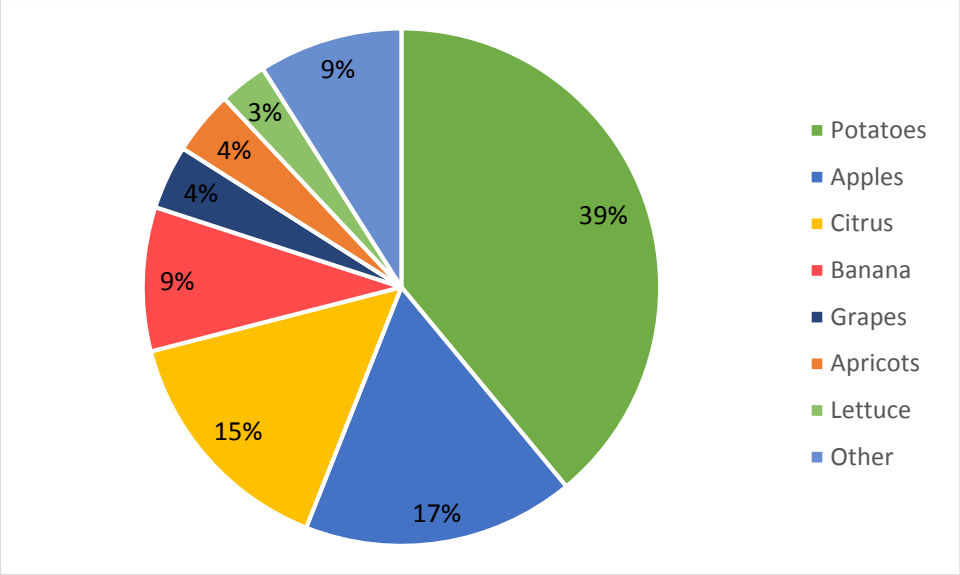


Figure 30: Percent of Products from Agricultural Exports in Lebanon in 2015 (Databank, 2017)

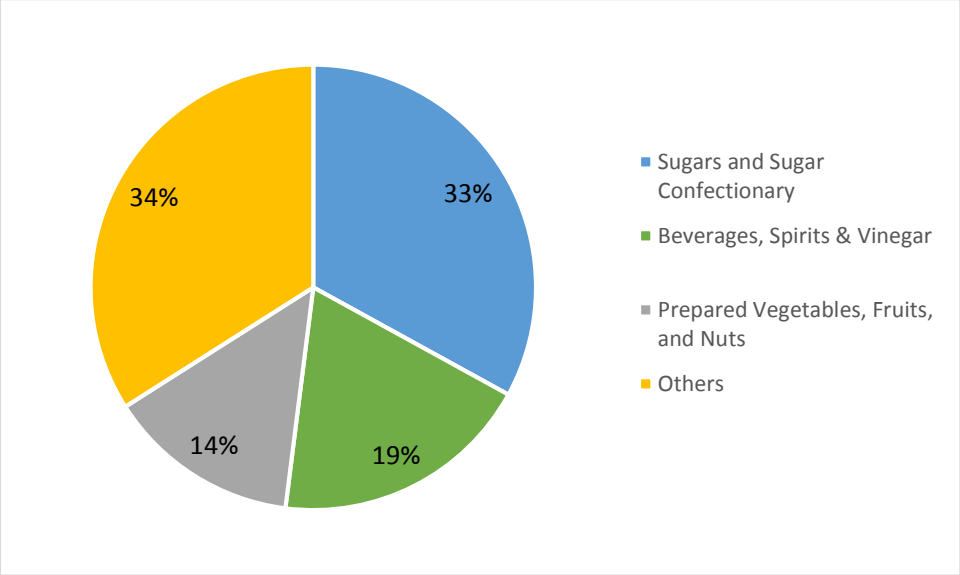


Figure 31: Share of Exported Agro-Products (Databank, 2017)

3.4.6. Livestock

In rural areas, especially where poverty rates are the highest in the country, livestock production represents one of the main activities of the population, employing most of the workforce, with 60 % of farmers depending on dairy products as their primary means of subsistence. The main species raised for livestock production are: goats, sheep and cattle, distributed as presented in **Table 12.**

Table 11: Distribution of Livestock Species

Cattle	▪ Average: 5 heads per holding ▪ Pure breed: 43% of total herd ▪ Dairy cows: 63% of total herd
Sheep	▪ Average: 62 heads per holding ▪ Milking; 63% of total herd
Goats	▪ Average: 66 heads per holding ▪ Number of Females: 61% of total herd

Figure 34 shows the distribution of bovine, goats and ovine respectively over the districts in Lebanon. The areas of Baalbek, Bekaa and Akkar and South host the highest numbers of livestock.

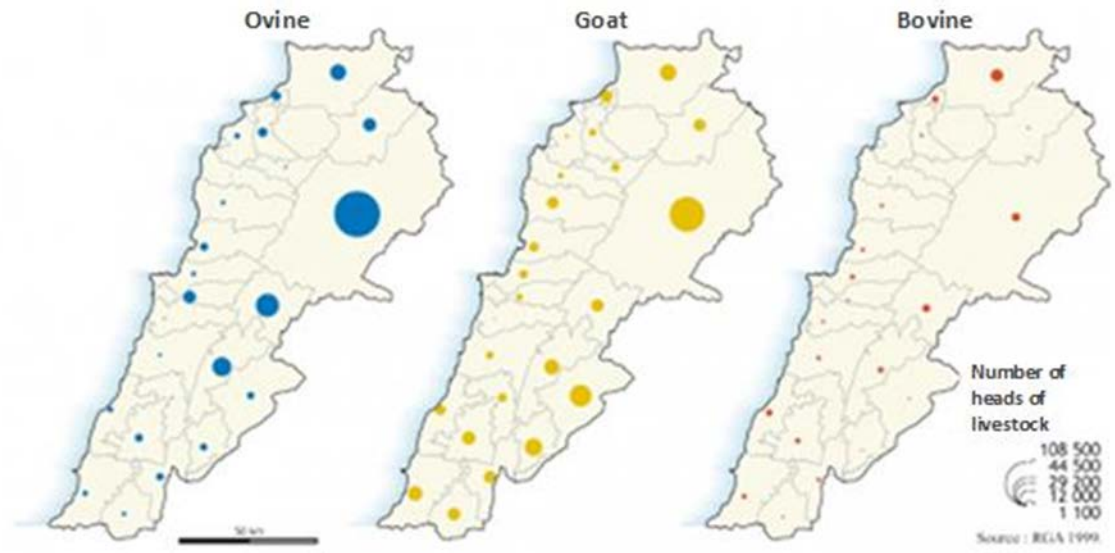


Figure 32: Livestock Distribution in Lebanon (FAO, 2011)

3.4.7. Challenges

Agriculture in Lebanon is one of the most vulnerable sectors, affected by many factors including climate change, in addition to social, technical, and political factors. Some of the challenges faced by the sector in general, and small farmers in particular are presented hereafter.

Social

- Lack of farmer status under the labour act, which does not contain any specific provision for farmers; (MoA, 2014)
- Steady loss of workforce and aging population in rural areas (figures of Index Mundi) show that urban dwellers are about 87.2 percent of the total population in 2011, with a net migration rate from rural to urban areas of 83.82 migrants / 1,000 population according to 2014 estimation

- 71% of dairy farmers rank as either poor or very poor for their living and livelihood standards (FAO, 2011)
- Two thirds of farmers depend only on goat and/or sheep products as their main source of income , the rest of the farmers have an additional source of income from agriculture (fruits and vegetables) and from forest products (charcoal, aromatic plants…) (FAO, 2011)
- 78% of nomadic shepherds are classified either as poor or very poor; they mainly live in rudimentary tents and shelters, with few concrete houses, scattered and separated from each other, with very limited, if any, access to the basic needs like roads, electricity, running water and social and medical services. (FAO, 2011)

Technical

- Changes in land use practices, mainly the shift from rural to urban areas is affecting livestock production, due to the reduction and fragmentation of rangelands and pasture land (MoA, 2014)
- Increased pressure on agricultural land due to the increase in water needs is leading to abandonment of agricultural land,
- Lack of knowledge among farmers in rural area of the new farming methods which would promote productivity and competitiveness of their products (FAO, 2017)

Political

- Free trade agreements allow the import of cheaper fruits and vegetables from neighboring countries, which compete with the local products
- The conflict in Syria has a significant impact on the agriculture and food sectors in Lebanon:
- Disruption of export routes to Gulf countries and Iraq
- Increase in the cost of agricultural production, caused by the unavailability of Syrian highly subsidized agricultural input since the start of the Syrian crisis
- Increased pressure on natural resources, as a large percentage of refugees are located in the main agricultural areas
- Collapse of animal health system in Syria has resulted in disease outbreaks in Lebanon, mainly due to trans-boundary movements of livestock

For Small Farmers

- Low income from agriculture
- Do not benefit from economy of scale to adjust to climate change consequences
- High vulnerability to economic globalization
- High prices of agricultural input
- Difficulty in marketing their products.

3.4.8. Policies and legislation

The MoA has developed a strategy for the period 2015-2019, based on the results of the 2010-2014 strategy. According to the strategy, the mission of MoA is "To improve the performance of the agricultural sector contributing to the economic, social, environmental and sustainable rural development of Lebanon", and its vision is "MoA adopts the principles of good governance for the development of the agricultural sector in view of ensuring food security including food safety, reducing poverty and rural-urban migration, creating job opportunities, and increasing efficiency and sustainable use of natural resources".

The strategy specific objectives are:

- To provide safe and quality food
- To improve the contribution of agriculture to the economic and social development of the country
- To promote the sustainable management of natural and genetic resources

Additionally, the strategy defines eight courses of action:

- Improve food safety and quality of locally produced and imported products
- Increase productivity and competitiveness of the Lebanese agricultural products
- Improve the good governance and sustainable use of natural resources
- Strengthening agricultural extension and education
- Strengthening agricultural research and laboratories
- Development of the cooperative sector and mutual funds
- Development of the Ministry of Agriculture capacities
- Responding to climate change impacts

Table 12 presents the Lebanese legislation related to the agriculture sector in relation to the project.

Table 12:Lebanese Legislation Related to the Agriculture Sector in Relation to the Project

Legislation	Date of Issue	Subject
Decree 2761	19/12/1933	Directions related to discharge of wastewater and dirty substances.
Decree 434	28/03/1942	Listed eight sites to be protected: the Cedars, Deir el Kalea in Beit Mery, Village of Bois de Boulogne, the Oaks of Mrouj, Forest of Beirut, historical site of Baalbeck, the lake of Yammouneh, natural bridge on Nabet el Laben (Faraya).
Forest Law	07/01/1949	The Forest Code, organizes the protection and the utilization of forests in Lebanon. It details the general conditions of forests and specifying what constitutes a forest and the manner of managing them. The function and use of the various types of forests have been defined in the law. Moreover the forest law laid down various penalties for offenses perpetrated by individuals. These penalties are in the form of fines or imprisonment from three to six months.
Law	09/11/1951	Conservation of soil and protection from pasture
Decree 31	18/01/1955	The Ministry of Agriculture (MoA) studies irrigation projects and provides technical supervision during implementation. The MoA regulates also the distribution of irrigation water and monitors the implementation of these regulations.
16766-	1957	Establishment of the Department of Agricultural Scientific Research of the Ministry of Agriculture
Decree 10276	7/10/1962	Protection of Surface and Groundwater Resources.
Decree 13785	1963	Creation of the Green Plan (GP) responsible for the installation of hill lakes, water reservoirs, irrigation system on farm level.
	1964	Department of Agricultural Scientific Research was reorganized as an autonomous public institution and became the Lebanese Agricultural Research Institute (LARI) working under the supervision of the Minister of Agriculture

Legislation	Date of Issue	Subject
Decree 10669	21/09/1970	Specifies the formal legal conditions to produce and sell pesticides, to control their production and distribution with a view of protecting the environment and human health.
Decree 8735	23/08/1974	Preservation of public sanitation. Local municipalities have the authority to determine the locations for industrial and agricultural waste treatment. It is illegal to dispose of septic tank effluents into watercourses, the sea, rivers and springs, storm water channels and sewage drains. Permit the use of tankers to dispose of sewage (from septic tanks) in areas that do not have a sewage network at pre-determined sites.
Law 85	12/09/1991	Law for the protection of forests: Bans and defines penalties for cutting, exploiting and manufacturing of resinous trees
Decision 108/1	12/09/1995	Prohibits the import and introduction of all cedar seeds and plants
Decision 92/1	28/02/1996	Regulates the export of all medicinal and aromatic plants
Law 92	24/07/1996	Conservation of burnt green areas and their destination of use.
Law 558	24/07/1996	Provides a legal framework for the protection of forests, it stipulates that all cedar, fir and juniper forests, and "other coniferous forests" in Lebanon are protected in facto.
Decision 52/1	29/07/1996	Decision by the Ministry of Environment for determining the standards and specific levels for limiting air, water and soil pollution.
Decision 340/1	01/08/1996	Regulates the harvesting of oregano and salvia
Law 195	24/05/2000	Amends the penalties of the Forest Law
Decision 8/1	30/01/2001	Setting of the National Standards for Environmental Quality by the MoE related to air pollutants and wastewater generated from classified establishments.
Decision 3	2003	Water policy for the creation of dams and hill lakes.
Decision 52	13/5/2009.	National Strategy for forest fire management
Decree 2366	20/6/2009	The Council of Ministries approved the National Physical Master Plan for the Lebanese Territory (NPMPLT) which describes the physical realities affecting land use, future challenges, alternative configurations for land use and development, land use principles and sectoral action plans.
Law 433/1	30/08/2010	Regulates forest and other wooded land harvesting

4. Collected Data on the Case Study Area

4.1. The Pilot Area

Jdeidet El Chouf/Baqaata and Semqanieh are located within the Chouf district, Mount Lebanon Governorate. Both towns lie on the western mountain chain of Lebanon, characterized by a Mediterranean climate, with colder and more severe winters than the coastal areas. Jdeidet El Chouf and Semqanieh municipalities are members of the Federation of Chouf Es-Souayjani Municipalities (FCSM). Their location within the federation and in the Chouf District are shown in **Figure 35.**

Figure 33: Location of the Chouf District within Lebanon (Wikipedia, 2017c)

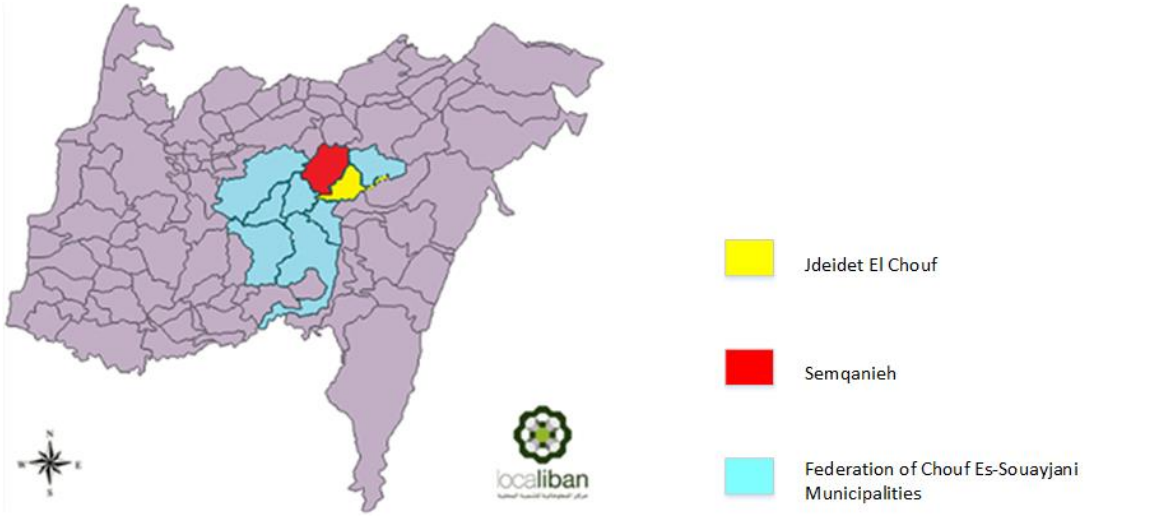


Figure 34: Location of Jdeidet El Chouf and Semqanieh in the Chouf District and in the Federation of Chouf Es-Souayjani Municipalities (Localiban, 2007)[16]

[16] In the following sections; Chouf Area designates the Chouf District and Chouf Es-Souayjani designates the area covered by the FCSM

Figure 37 is a satellite image of Jdeidet El Chouf and Semqanieh, showing the urban continuity between the towns.

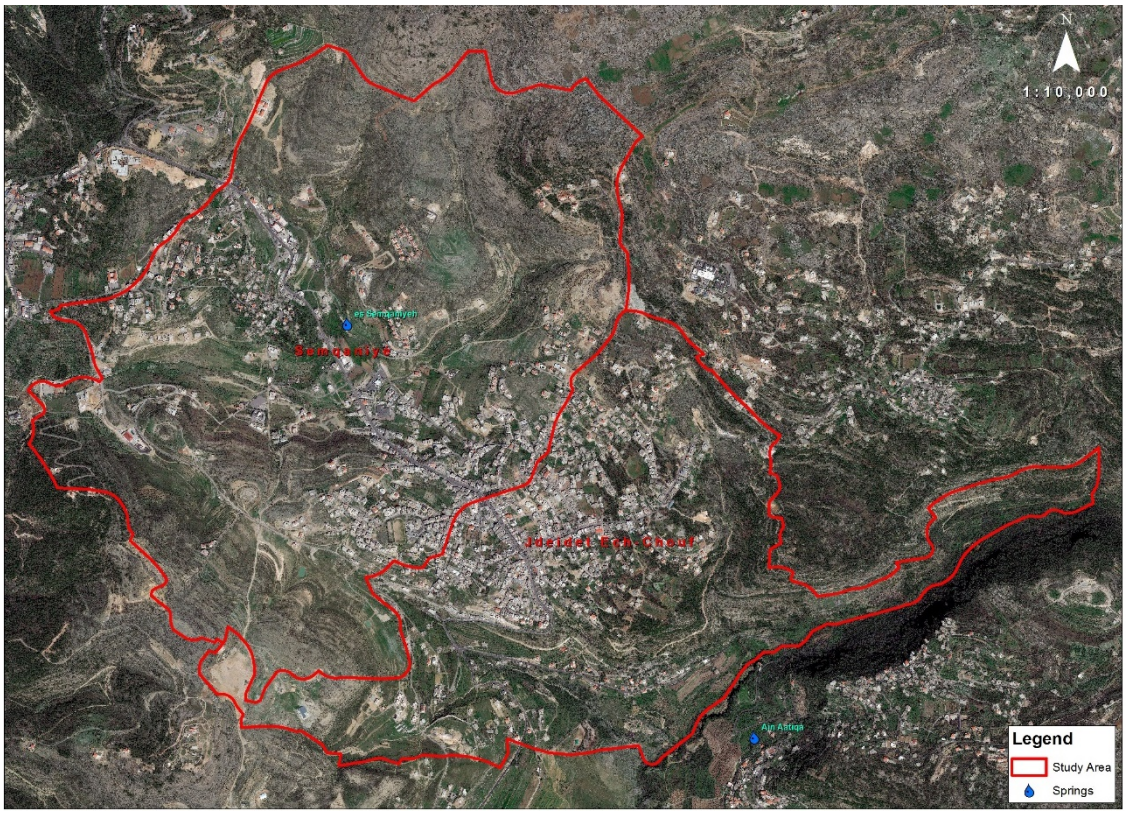


Figure 35: Satellite Image Showing the Study Area

4.2. Demographic Information

Demography of the Study area Jdeidet El Chouf/Baqaata has witnessed a rapid urban sprawl in the Chouf district, which expanded to reach Semqanieh to the northwest, transitioning the area from rural to urban. Several factors contributed to this transition. Following the civil war and in the absence of laws, regulations and urban planning for the area, a residential and commercial area arose in Baqaata which has become, and continues to be a center of attraction for investments, currently hosting 25 % of the companies of Chouf District (IDAL, 2017c). It constitutes of a residential, commercial and activity hub for the whole Chouf, as it hosts several businesses, companies and banks, as well as schools, health care centers, and apartments for rent and sale (OMSAR, 2005).

According to the head of Jdeidet El Chouf municipality, Jdeidet El Chouf and Semqanieh host respectively 3,500 and 3,000 residential buildings. In the first five months of 2017, permits were issued for the construction of 7,600 m² of built-up area in Jdeidet El-Chouf alone, equivalent to 50 new apartments (an average of 10 apartments per month), which reflects the fast human settling in the area. According to the Mayors, the populations of Jdeidet El Chouf and Semqanieh are estimated at 22,000 and 15,000 respectively, divided as in **Table 14.** As seen in the table, the population originally from Jdeidet El Chouf and Semqanieh represents only 5 % and 10% of their total population respectively, while the majority of the residents are permanent residents coming from other areas in the Chouf district (Caza), seasonal residents and refugees. Permanent residents from other areas are attracted to this region for various reasons,

including the availability of infrastructure and various services such as schools, banks, hospitals, as well as easements on loans for investments and buying apartments.

Table 13 Population Distribution in Jdeidet El Chouf and Semqanieh

Population Fraction	Jdeidet El Chouf	Semqanieh
Originally from town	1,200	1,500
Permanent residents from other areas	14,800	12,500
Immigrants	NA	NA
Seasonal residents	4,000	NA
Foreign workers	NA	NA
Refugees	2,000	1,000
Total	22,000	15,000

Source: Meeting with the Mayors of Jdeidet El Chouf and Semqanieh on July 5, 2017

Jdeidet El Chouf and Semqanieh have surface areas of 3.58 km² and 5.77 km² respectively, thus their estimated respective population densities are 6,145 person/km², and 2,599 person/km², which is significantly higher than the 2005 Chouf district average: 453 person/km² (UNDP/MoD, 2005). This rapid demographic and economic growth has increased the pressure on natural resources as well as the infrastructure of the area, as it was not foreseen during the design and planning phases. The consequences include:

- somehow unorganized road network leading to traffic congestions in the area
- the water network system currently supplies 35,000 people, which is almost four times higher than the foreseen numbers at the design stage
- the sewage network and wastewater treatment plant are not equipped to treat the generated quantities that are considerably more than designed capacities

The age distribution of the Chouf population, and the population pyramid of the Chouf Es Souayjani area (which includes the towns whose municipalities are members of FCSM) in 2005 are presented in **Table 14** and **Figure 38** respectively:

- Fertility rate is decreasing in the Chouf area, which could be related to the decline in marriage rates, coupled with an increase of the number and percentage of women working and having higher education (Ghossaini, 2016);
- The percentage of population younger than 15 years (18.87% in Chouf Es Souayjani) is lower than the country average (29.3 %), with the percentage of (10.02 %) being higher than females (8.85 %) males in this age category;
  The percentage of old dependents[17] (more than 65 years old) is higher than the country average – which could indicate a higher life expectancy, and reflect good health care services in the area -, with the percentage of females higher, showing their higher life expectancy compared to men;
- The indents observed between the age fractions 35 to 39, 40 to 44, 45 to 49 and 50 to 54 are result of the civil war, reflecting the high death and immigration rates;
- The percentage of males is higher than females from the age 0 to 34, and 55 to 59, and lower in the fraction 35 to 54.

[17] Dependent: requiring someone for financial or other support.

Generally, the population distribution for the district and pyramid for FCSM decreased fertility and mortality rates, with resulting ageing population which could increase the burden on the economically active population category in the absence of governmental retirement plans (Ghossaini, 2016).

Table 14: Age Distribution of the Chouf district Population (UNDP/MoD, 2005)

Age Group (Years)	Percent of Population (%)
Less Than 20	35 to 38
20 to 60	54 to 55
Higher than 60	11 to 13

Male Female

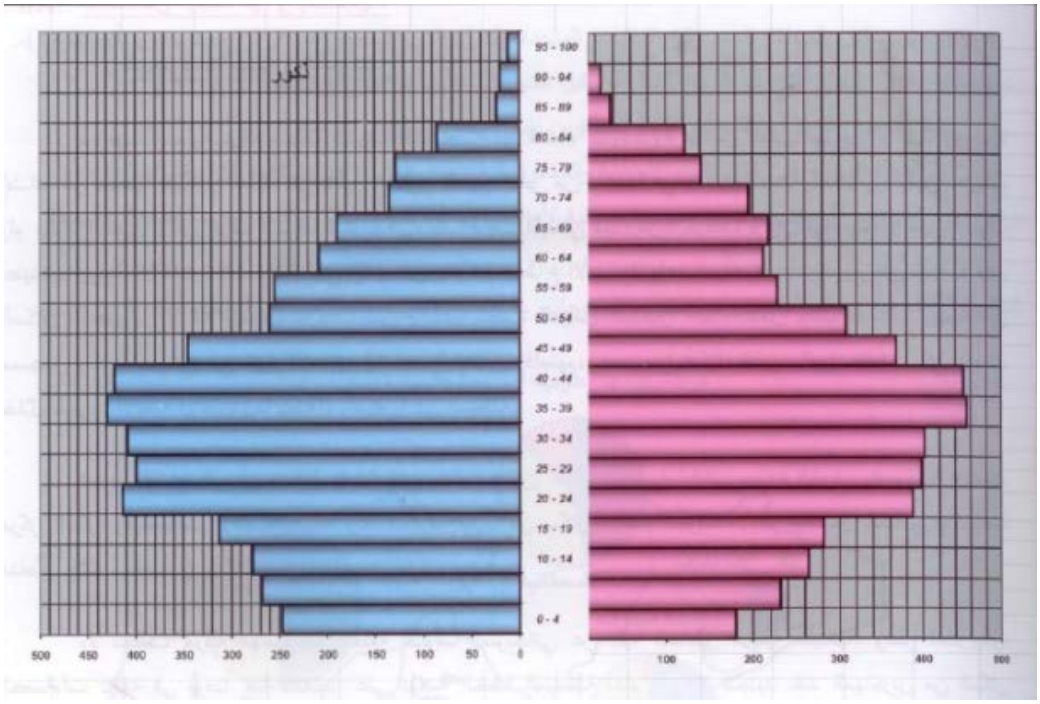


Figure 36: Population Pyramid for the FCSM Area (Ghossaini, 2016)

Table 15 shows the number and percentage of males and females in primary, secondary and technical schools. In primary and technical schools, the percentage of females is higher than males, in contrast to secondary education (high school). Also, the number of students decreases between primary and secondary education, with a dropout of 59% for male students and 70% for female students.

These variations can be attributed to the following factors:

- The decrease in the number of students in high school is partly caused by the choice for technical schools instead of high schools;
- A fraction of the male students drop out of school following primary education to start working, generally in vocational occupations (smith, carpenter, mechanical workshops, electrician, mechanic, construction, etc.);
- A fraction of the students with religious background (mainly females) drop out of school, for religious/social reasons;
- A fraction of the female students drop out of school to get married.

The total number of male students in technical schools is higher than females. However, based on data presented in the "Millennium Development Goals Report, for the Federation of Chouf Es-Souayjani Municipalities" of the UNDP (UNDP/MoD, 2005), the distribution of males and females per specialty varies significantly. For example, the specialties that seem to attract more females with low percentages of males include: nursery, cosmetology (beautician, hairdresser), advertising arts, nursing, and administration. Specialties attracting more males include: accounting, hotel management, heating, ventilation and air conditioning, and car mechanics. The specialties with similar percentages of males and females are: sales and agriculture.

Table 15: Number and Percentage of Males and Females in Schools per Academic Level in the FCSM (UNDP/MoD, 2005)

Academic Level	Number			Percentage (%)		
	Primary	Secondary	Technical	Primary	Secondary	Technical
Male	1559	637	741	46.7	55.2	57
Female	1782	517	558	53.3	44.8	43

Primary: year 9 (grade 9)
Secondary: year 12 (grade 12)

The number of educational institutions in Jdeidet El Chouf, Semqanieh and FCSM are presented in **Table 16.** According to the mayors, the percentage of diploma and higher education holders is increasing among the young generation, although no studies are available that estimate their numbers. Based on observation, most female students are oriented towards the education sector, which is reflected in the number and percentage of female students registered in the education department of the university in Semqanieh.

Table 16: Number of Educational Institutions in Jdeidet El Chouf, Semqanieh and FCSM (based on UNDP/MoD, 2005)

Area	Private Schools	Official Schools	Technical Schools (private and official)	Higher Education
Jdeidet EL Chouf	1	3	-	-
Semqanieh	1	3	2	1*
FCSM	10	27	7	

*based on data collected from meetings in 2017

4.2.1. Communities Distribution and Characteristics

Social Organization

Historically, the community in the Chouf area was rural, with strong familial ties, and most of the residents in the villages were connected through family relations. However, the area has been transitioning into a more urbanized community. This shift is mainly observed in Jdeidet El Chouf and Semqanieh which have witnessed a rapid urban sprawl accompanied by a population influx from the neighboring areas in the Chouf district. The latter has become a melting pot where people from different areas, mostly with no family relations, come and live, a phenomenon amplified with the incoming influx of refugees since the beginning of the Syrian crisis. With the exception of the refugees, the population in Jdeidet El Chouf and Semqanieh belong mainly to the same sect (Druze); however, the religious (practicing) community is small.

The Municipalities are local administrators that have legal power as well as financial and administrative independence (Municipal Act, Decree 118, Article 1). The authorities exercising administrative control over the municipal council decision are: the District Commissioner (Kaemakam), the Governor (Mohafez) and the Minister of Interior. Each work of public character or interest in the municipal area falls within the scope of the Municipal Council's competence. As such, the municipal council is entrusted to establish, manage and support implementation of projects such as: infrastructure, public schools, public houses, public hospitals, dispensaries, etc. The municipalities of Jdeidet El Chouf and Semqanieh are members of the FCSM, as per the municipal act. This federation (union of municipalities) equally have a legal power and fiscal autonomy. It has the power to execute public projects which benefit some or all of its members, such as: roads, sewage system, waste collection, civil defense, etc.

Within the community, political parties have the highest influence on public opinion. Four political parties are active in the area: Progressive Social Party, Syrian Social Nationalist Party, Lebanese Democratic Party, and Tawhid Party. The first one has the most followers and is therefore the most influential. Public opinion is also influenced by the municipality and key persons. Key persons have gained their status due to: their political involvement and ranks within their respective parties, their financial status, or their professional networking. Finally, familial ties and to a lesser extent religious notables play an important role in the community.

Despite the somewhat patriarchal society, where gender equality is often an issue among the religious communities, women empowerment within the community is increasing. Competency has allowed women to reach high ranks, of which formal Mayor of FCSM Dr. Noha Ghossaini is an example. There is an increasing number of women working outside the house. In 2005, the most appealing sectors to women were education and sales, accounting for 74% of the workforce (UNDP/MoD, 2005). The education sector in general seems to be attractive to women, most likely because there are less working hours and working days, and teachers are offered social security, especially in public schools. Also, women organizations in the area are gaining more power. As an example, the Jdeidet El Chouf- Baqaata Women Organization is currently managing a power generator which supplies the town with electricity. The main organizations in the local community [18] are listed in table 17.

[18] The mentioned organizations were all invited to the workshop of July 8, and most were represented and consulted throughout this project.

Table 17: Groups and Organizations within Community

Groups and Organizations	Type	Description/goals
Jdeidet El Chouf- Baqaata Women Organization	NGO	Disseminate the principles and values of citizenship within the framework of rights and duties Encourage the participation of citizens in local development Evaluate the principles, values and behaviors of citizenships Support the role of women in the development of social and cultural life
Progressive Women's Union – Jdeidet El Chouf	NGO	Raising awareness- activating the role of women in the community.
Popular committees – Jdeidet El Chouf/Baqaata	Informal	Representing and helping the Municipality to resolve some internal and local problems
Green Orient	NGO	Natural Heritage conservation and Development Raising awareness to minimize pollution Summer camp and local hiking activities
LANA Youth Organization	NGO	Financial support for people in need, human resources and socio-economic development. Awareness sessions, environmental projects, sport activities and service projects
Association of Shouf Traders	NGO	Local organization, operate and support the trade in the Shouf Area especially Bakaata and Semqanieh shop Participating in public relation activities advertising, exhibitions… other services, such as producing conferences, networking local events
Al-Shouf Cedar Society	NGO	A world class Biosphere Reserve where natural and cultural heritage are conserved, resources are treated as wealth, investment receives due care, and development is controlled by citizens, businesses, and the managing authority Sustainable use of the ecosystems and natural resources mainly forest, water and food management

Economic Organization

The Jdeidet El Chouf and Semqanieh area has become an activity center for the whole Chouf area. The main economic activities practiced in the area are presented in **Table 18,** including banking, education, trade, health care centers, gasoline stations, factories, craftsmanship, services. Information in the table below was obtained from the "Millennium Development Goals Report, for the Federation of Chouf Es-Souayjani Municipalities" (UNDP/MoD, 2005) and municipality data. As mentioned in the methodology section, the study used as reference (UNDP/MoD, 2005) was the last socio-economic study covering the project area, and although reliable it is considered outdated in an area characterized by rapid growth in population and urbanization.

The sources of income for the population of Jdeidet El Chouf and Semqanieh include the activities mentioned in the table below, as well as the army and internal security forces (about 15% of the population of Jdeidet El Chouf), and agriculture which makes the primary source of income for 2 to 3 % of the households in both towns (based on verbal consultations with the mayors of both towns).

Table 18: Number of activities in Jdeidet El Chouf and Semqanieh (UNDP/MoD, 2005, verbal consultations with the mayors)

Area	Factories	Aluminum and Iron Factories	Tiles and Granite Factory	Concrete Stone Factory	Small Workshops	Shops	Restaurants	Gasoline Station	Slaughter Houses	Banking	Educational Institutions	Health Care Centers
Jdeidet El Chouf	1	5	0	5	22	600	12	5	4	2	4	1
Semqanieh	2	0	2	2	12	600	5	3	4	0	7	3

The last study on income distribution for the FCSM was in 2005, with the national minimum wage then amounting to 200 USD (300,000 L.L.) (Country Economy, 2011). The income distribution is presented in **Table 19** As seen in the table in Jdeidet El Chouf, in 2005:

- Around one third of the population made less than the minimum wage;
- 42.9% made between the minimum wage and double the minimum wage;
- Only 7.14 % made more than three times the minimum wage;
- In total 77% made less than double the minimum wage.

While in Semqanieh:

- Only 2% of the population made less than the minimum wage;
- About 50% made between the minimum wage and double the minimum wage;
- 14.6 % made more than three times the minimum wage;
- In total 54% made less than double the minimum wage.

These numbers show that the income situation in 2005 in Semqanieh was better than in Jdeidet El Chouf. Additionally, only 27.55 % of households in Jdeidet El Chouf, compared to 56.25 % in Semqanieh had social security or insurance (UNDP/MoD, 2005).

Table 19: Distribution of Monthly Income per Household (%) (UNDP/MoD, 2005)

Village	Less than 200 $	300 to 400 $	400 to 500 $	500 to 600 $	More than 600 $
Jdeidet EL Chouf	34.69	42.85	12.24	2.04	7.14
Semqanieh	2.08	52	18.75	12.5	14.58

Since 2005, the minimum wage in Lebanon has increased to 450 USD. Based on meetings with the mayors of Jdeidet El Chouf and Semqanieh, current estimates are as follows:

- The majority of population makes between 500 and 1000 USD;
- About 20% of the population makes less than the minimum wage;
- In Semqanieh about 20% of the households makes between 1000 and 2000 USD;
- Population making more than 2000 USD work in Beirut, commuting there on a daily basis.

4.2.2. General Information about Household

Based on municipal data, the average size of households in Jdeidet El Chouf and Semqanieh is five. Generally, the original population lives in old neighborhoods which include houses of two to three stories high, while others settled in the newer higher buildings of the urbanized areas.

The distribution of families per number of providers[19] in 2005 is presented in **Table 20.** Respectively 85 % and 80% of households in Jdeidet El Chouf and Semqanieh depend on just one provider versus respectively 11% and 17% depending on two providers. As stated before, recently women have increasingly become providers with their participation in the workforce already around 20% of the total workforce in 2005. The main reasons behind this increase are economic necessity (increased cost of living) and increased access to higher education.

Table 20: Distribution of Households per Number of Providers (%) (UNDP/MoD, 2005)

Area	0	1	2	3
Jdeidet El Chouf	1.02	84.7	11.22	3.06
Semqanieh	2.08	79.16	16.66	2.08

[19] Provider: a person who earns money to support their family

4.3. Water specific information

The information presented in this section was collected through meetings with the EBML.

4.3.1. Water Governance

The national/regional water governance in Lebanon was described before in 3.3.8 Water Governance. As for the study area, the water and wastewater sectors in Jdeidet El Chouf and Semqanieh fall under the jurisdiction of the Establishment of the water of Beirut and Mount Lebanon (EBML), which is responsible for management of these sectors in the Governorates of Beirut and Mount Lebanon.

As stated before, municipalities play a role at the level of licensing and permitting of water and wastewater projects located within their premises including the approval on Environmental Impact Assessment (EIA) studies for such projects. The respective roles of Regional Water Establishments and Municipalities and the coordination between them are however not specified by law.

One of the other challenges of water management in the area is understaffing, as the water establishment has one water warden responsible for around 9,000 residential and commercial units. This challenge is seen to be encountered all over the country, as can be seen in **Table 22.**

Table 21: Understaffing of Water Establishments in Lebanon (ECODIT, 2015)

Water Establishment	Decreed Staff	Filled Positions	Vacant
Beirut and Mount Lebanon	1120	550	51%
Bekaa	787	261	67%
North Lebanon	1271	317	75%
South Lebanon	872	263	70%

4.3.2. Supply and demand

The approximate yearly supply to the area is 120,000 m3. The EBML estimates the daily water need for the area (both towns) to be 5,000 m3. According to the EBML, both towns are connected to the public potable water distribution network. Each household receives approximately 2,000 L (2 m^3) every three to four days, equivalent to 100 L/capita/day, a value lower than the standard set by the MoEW: 165 L/capita/day (for rural areas). Subscription to the public network is on a one cubic meter gauge system, and the network is not equipped with meters to monitor the consumption. The average fixed annual tariff is 233 USD, which is a lump sum. As for water from private suppliers, the price of 2 m^3 varies between 5 and 15 USD.

4.3.3. Available water resources

The main source of water for the network is the Barouk river (10,000 m^3 daily supply) and four springs. An additional 1,200 m^3 is supplied daily from the Moukhtara private water source. Water from the Barouk river flows by gravity to fill the tanks and reservoirs in the towns, where the water is chlorinated, then transferred to houses through the distribution mains by gravity. Water from the Moukhtara spring is pumped to the tanks, by a 100 kVA system to complement the supply; however this system is not constant and depends on power supply.

Pictures below shows the springs of Jdeidet El Chouf. One of the sources is located near the river, and contributes to its flow. As for Semqanieh, the water sources are limited to one water source. Additionally, the towns receive a yearly average of 700 to 800 mm precipitation, and some households employ rainwater harvesting technologies, mainly for the use in agriculture. All surface water sources are accessible, but their flow decreases considerably at the end of the dry season.

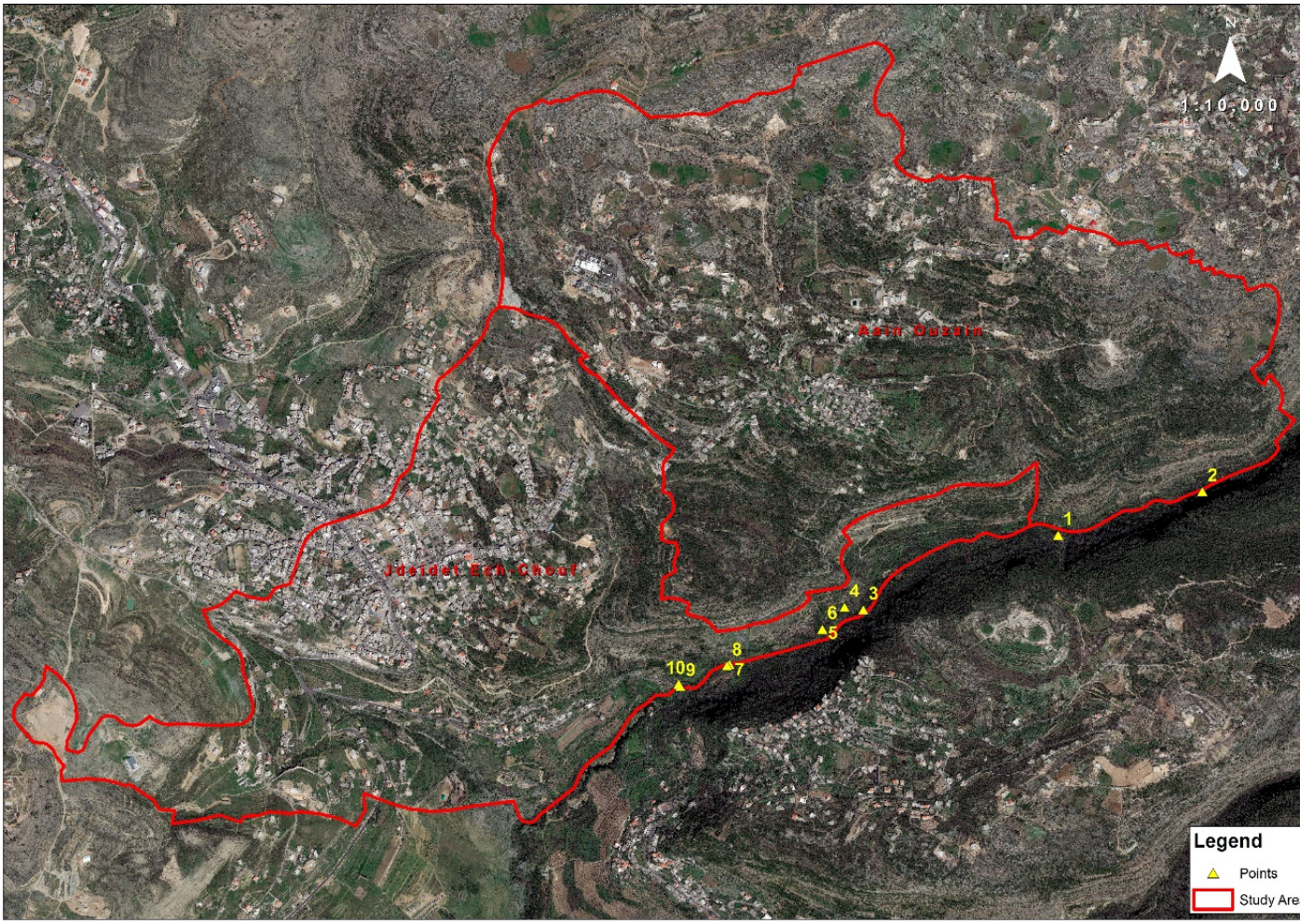


Figure 37: Satellite Images Showing the Visited Locations

Small dams in Jdeidet El Chouf have been established mainly to supply water to irrigation canals. Three out of four dams were developed using natural rocks in the area to narrow the channels and partially divert the flow. One of the dams however, the first within the Jdeidet el Chouf jurisdiction is an engineered dam with well-studied concrete works and metal gates. All dams need assessment and rehabilitation**.**

There is still a considerable deficit of about 27 litres/capita/day. This deficit is currently covered either by private sources and wells or by private suppliers, who take out water from the river, private sources or private wells and distribute it to households by trucks. Water deficit increases at the end of the dry season, mainly in the months of September and October, where the supply decreases 60 to 70%.

4.3.4. Water Quality

The EBML performs periodic tests for network water quality. If the results are not compliant with the drinking water standards (Decision 52/1 dated 1996), the supply ceases until the problem is solved. The problem however resides in water provided by private suppliers which is not submitted to periodic testing and is not regulated.

The water sources in both towns are prone to pollution due to their proximity to the sewer network in certain locations which increases the risk of contamination, and to other pollution sources including mechanic garages, gasoline retail facilities and butchers, which is the case of the Semqanieh water source.

4.3.5. Water Supply Technical Facilities

Jdeidet El Chouf and Semqanieh are both connected to the public network, however the network coverage is higher in Jdeidet El Chouf. The EBML drawings of the existing and planned water network in Jdeidet El Chouf and Semqanieh are shown in **Figure 40** and according to EBML, the length of the existing lines is 40 km, with an additional 35 km of proposed lines. Generally, transmission lines[20] are made of cast iron, and distribution lines[21] are made of polyethylene.

As mentioned in the previous section, water is transferred by gravity from the Barouk river to the tanks, and from the tanks to households, and the only line requiring pumping is that from Moukhtara to the tanks. Jdeidet El Chouf has two water tanks of about 1,000 m^3 capacity each. Semqanieh has two tanks. One was constructed in the 1940s with a 50 m^3 capacity supplying the old neighborhoods. The other one is a newer tank, with a 1,000 m^3 capacity, recently connected to the network and supplying the newly connected area. According to EBML, a new tank is planned for Semqanieh with a 500 m^3 capacity.

The majority of the pipelines in Jdeidet El Chouf has been replaced, the new supply mains are made of cast iron, while the new distribution mains are made of High Density Polyethylene (HDPE). Also in Semqanieh new lines have been installed (about 5 km) in the areas that were not previously covered by the network..

Both municipalities have addressed a request to the MoEW to obtain a permit for the drilling of two water wells, based on a geological and hydrogeological study performed in the area. Maintenance of the network is mostly corrective maintenance, performed after the occurrence of a breakdown. The old age of the network, together with the overflow from tanks and reservoirs, causes most of the physical losses. Additionally, the supply main which passes through Jdeidet El Chouf to Kahlounieh (1,600 m) is worn out, also causing excessive losses (estimated at 80%). Commercial and physical water losses amount to approximately 25%.

[20]A transmission line is any pipeline conveying raw/treated water from a well field or remote storage facility to a distribution storage tank.

[21] A distribution line is a line conveying water to customers from a common source, and can include individual customer connections and distribution mains.

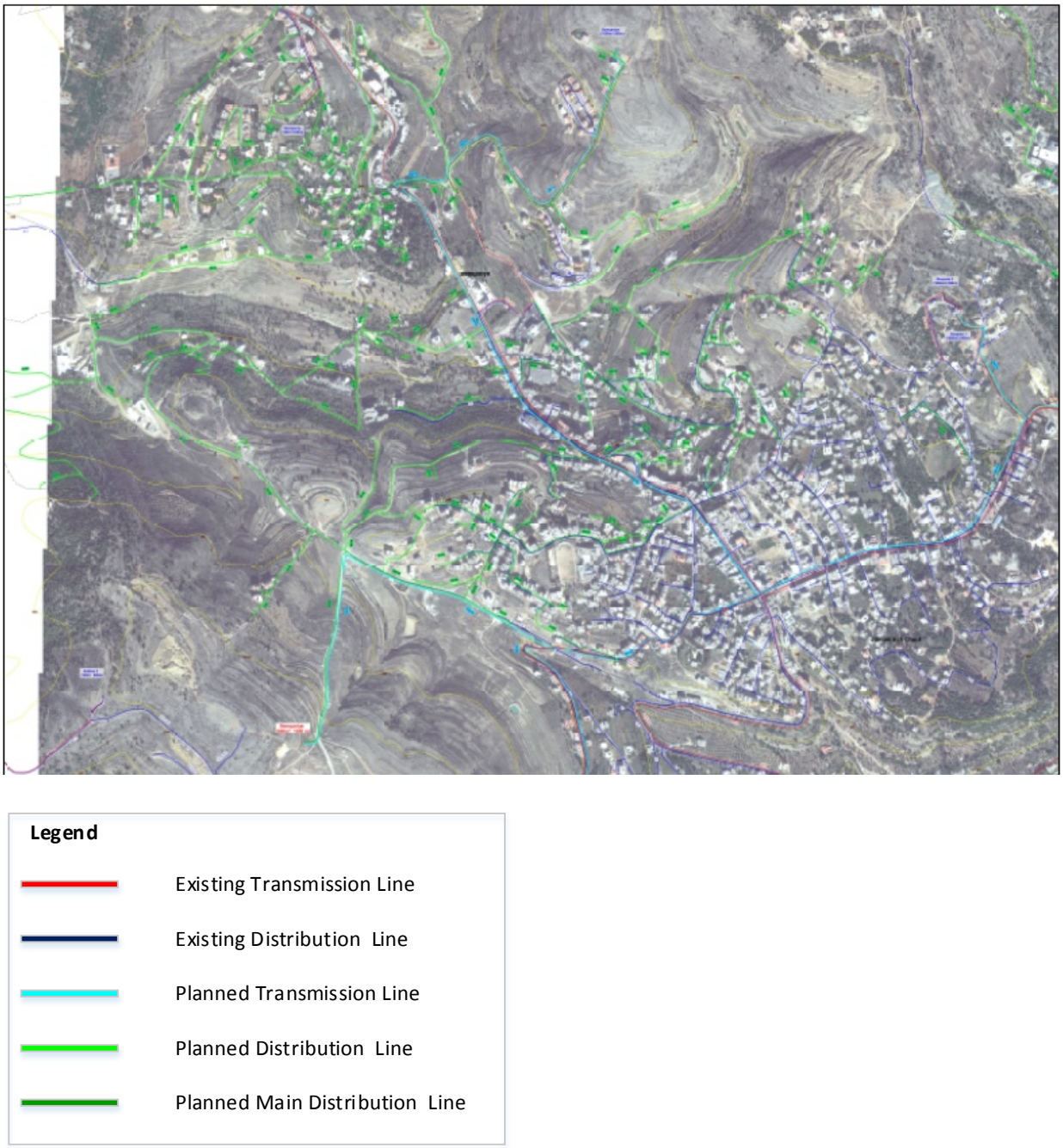


Figure 38: Existing and Planned Water Network in Jdeidet El Chouf and Semqanieh (source: EBML, 2017)

4.3.6. Wastewater Treatment

A sewer network exists in Jdeidet El Chouf and discharges into a wastewater treatment plant. The plant is a secondary treatment type with a capacity of 1,200 m^3/day. The plant falls under the jurisdiction of the EBML, and is currently managed by a contractor for a three years' term. The treated wastewater is currently

drained in the river, and the quality of the effluent is not suitable for use in irrigation due to the high levels of heavy metals, chemical oxygen demand, ammonium and total suspended solids.

The sewer network in Semqanieh is currently under construction. The network will transfer the water to the existing treatment plant in Ainbal located to the south west of Semqanieh. Until recently, wastewater was drained in canals.

4.4. Agriculture

4.4.1. Natural Resources

As mentioned in the previous sections of this report, Jdeidet El Chouf and Semqanieh are undergoing an expansion of urban areas at the expense of agricultural land, and many of the ancestral agricultural land that used to be terraced has been abandoned.

The land cover/ land use map of Jdeidet El Chouf and Semqanieh in **Figure 39** shows the distribution of artificial[22] and agricultural as well as wooded land. The map clearly shows the large share of built-up/urbanized area, as a continuous patch across the municipal border, and occupying about half of the area of Jdeidet El Chouf and one third in Semqanieh. A big part of the area is also covered by woods and grassland. Smaller parts are occupied by agricultural land. **Table 22** shows the distribution of agricultural land (both irrigated and unirrigated) as well as vacant land[23], arid land, and the possible expansion of agricultural land in Jdeidet El Chouf and Semqanieh.

Agricultural land constitutes about 16.8 % and 7 % of the total area in Jdeidet El Chouf (3.58 km^2) and Semqanieh (5.77 km^2) respectively. About one third of Jdeidet EL Chouf is vacant land, and there is a possibility to expand the agricultural land over about 1 km^2. As for Semqanieh, only 3% of the land is vacant, and the possibility to increase the agricultural land is over 0.1 km^2 (Ghossaini, 2016). **Table 23** presents the distribution of different sizes agricultural holdings in Jdeidet El Chouf and Semqanieh. In both municipalities, most holdings are holdings smaller than 0.025 km^2.

The main soil types in the area include: Calcaro - Hortic Anthrosols and Eutric Gleysols mainly in Jdeidet El Chouf, Eutric Regosols in Semqanieh and Areno-Eutric Leptosols in Ain Ouzain. According to the Lebanese Agriculture Research Institute (LARI) in Baaqline, no tests or studies have been performed in the area related to soil properties. However, soil erosion in the area is not frequent.

[22] Artificial land includes urbanized and built up areas.
[23] Vacant land is a land with no permanent structures and that are not in use.

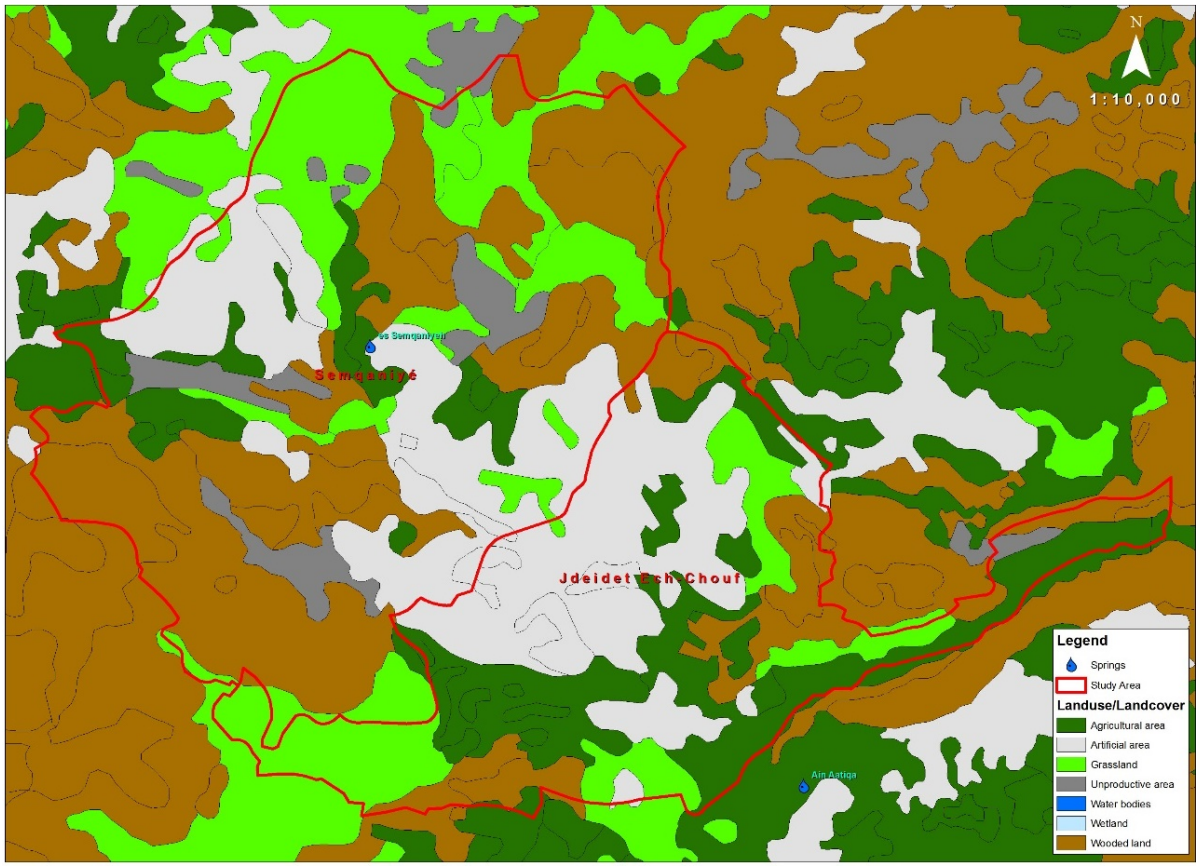


Figure 39: Land Cover/Land Use Map of Jdeidet El Chouf and Semqanieh (source: MORES)

Table 22: Distribution of Agricultural Land, Vacant Land, Arid Land and Possible Expansion in Agricultural Area in Jdeidet El Chouf and Semqanieh (Ghossaini, 2016)

Village	Agricultural Land (km^2)	Irrigated Land (km^2)	Unirrigated Land (km^2)	Vacant Land (km^2)	Possible Expansion in Agricultural Land km^2)	Arid Land (km^2)
Jdeidet El Chouf	0.605	0.240	0.365	1	1	0
Semqanieh	0.403	0.14	0.263	0.2	0.1	0.2

Table 23 Distribution of Agricultural Holdings (Ghossaini, 2016)

Village	Large Holding (>0.1 km^2)	Medium Holding	Small Holding (<0.025 km^2)
Jdeidet El Chouf	0.001 %	8 %	91.8 %
Semqanieh	0 %	1.4 %	98.6 %

Both figures below present the watersheds of the Awali River and Damour River respectively.

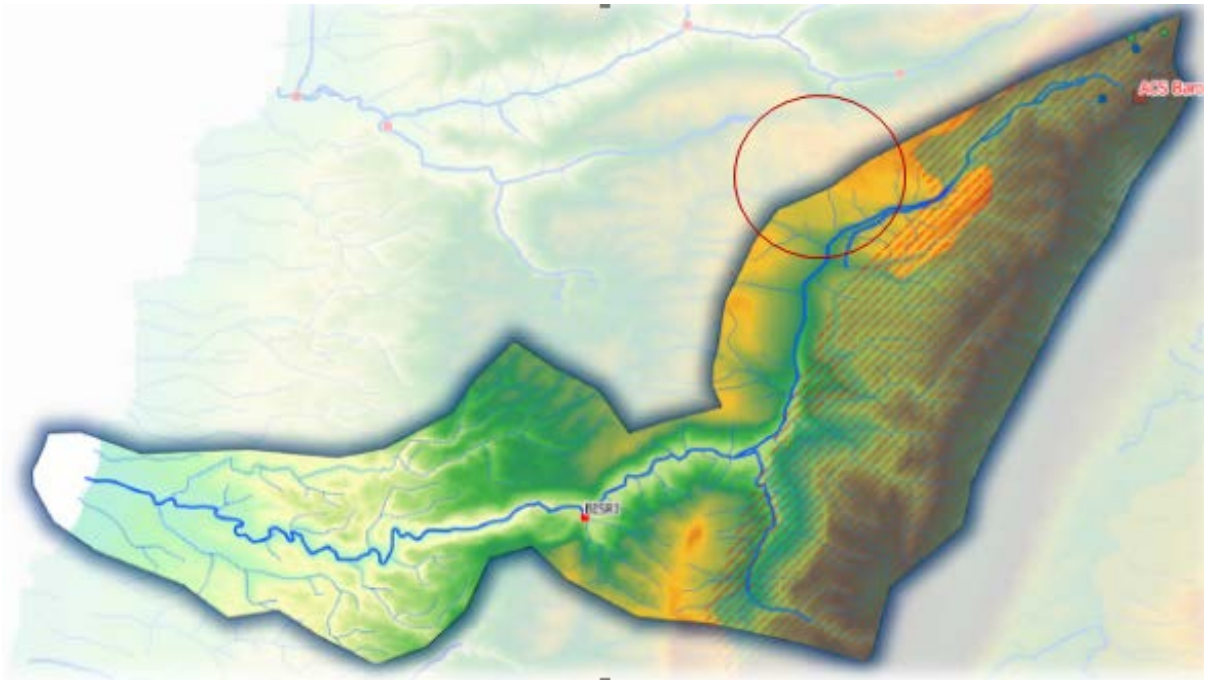


Figure 40 Awali River Watershed (Antea Group, 2017)

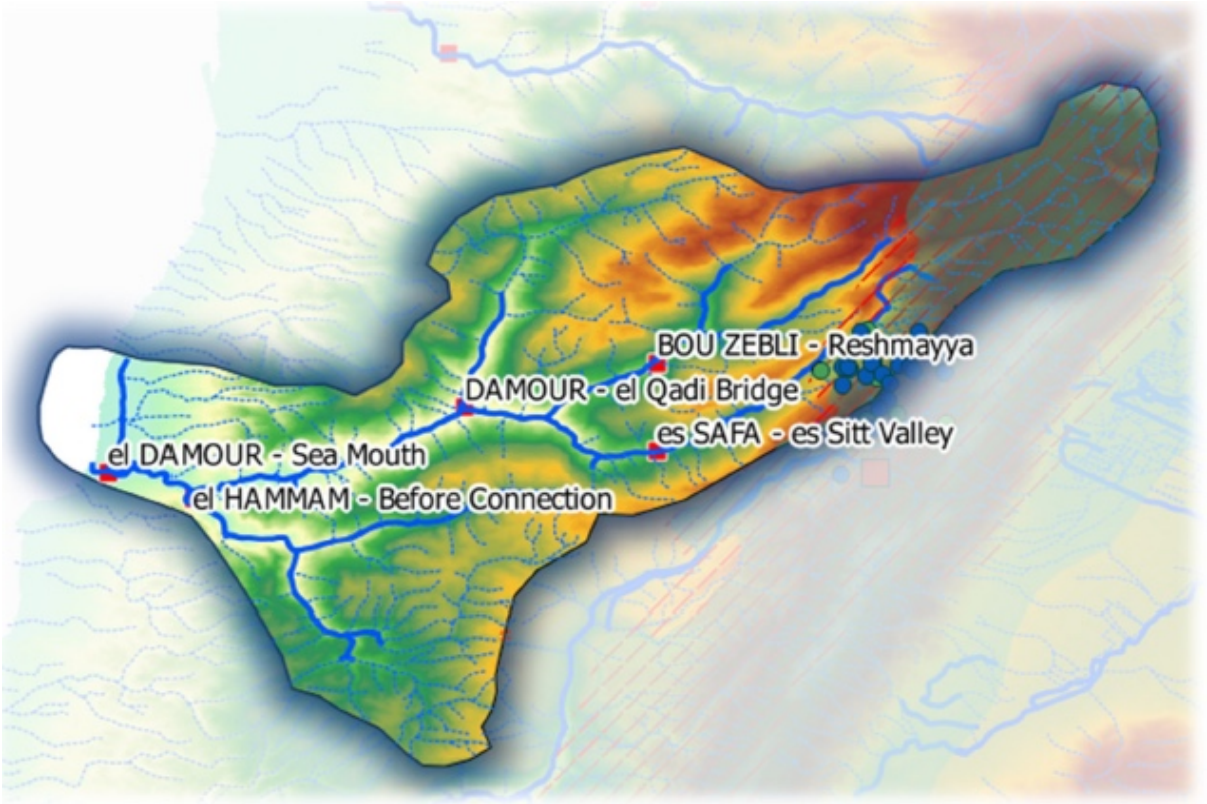


Figure 41 Damour River Watershed (Antea Group, 2017)

4.4.2. Livestock, Animal and Forest resources

Forests constitute 13 % and 42% of the total area in Jdeidet EL Chouf and Semqanieh respectively.

Table 25 presents the forest areas in both towns. These forests are privately owned and managed by their owners. The main tree crops include: pines, oak and cypress as well as oriental alder and Salix. Livestock and animal production in Jdeidet El Chouf and Semqanieh are presented **Table 26**.

Table 24 Distribution of Forest Areas in Jdeidet El Chouf and Semqanieh (Ghossaini, 2016)

Village	Forest Area (km^2)	Percent of total area (%)
Jdeidet El Chouf	0.463	13
Semqanieh	2.408	42

Table 25: Livestock and Animal Production in Jdeidet El Chouf and Semqanieh

	Cows	Goats	Beehive	Chicken
Jdeidet El Chouf	8	15	20	210*
Semqanieh	-	150	120	

*Based on surveys
Source: Ghossaini, 2016 and Survey Results

4.4.3. Cultivated Crops

The crops mainly grown in Jdeidet El Chouf and Semqanieh include the following crops. It is worth mentioning that several types of crops are usually grown together.

- Olive,
- Grapes,
- Fig,
- Peach,
- Walnuts,
- Vegetables,
- Other Fruit Trees (peaches, apples, apricot, cherries, …)

According to the field surveys, the main purpose for growing the abovementioned crops is self-sufficiency, and the excess products are sold to the market.

The crops grown at Jdeidet El Chouf and Semqanieh are harvested manually, and machines are only used at the tillage stage. Since more than 90% of the agricultural holdings are small holdings, and as the major crops are olives, grapes and fruits grown for self-sufficiency, mechanization is not employed at the cultivation stages.

4.4.4. Irrigation and Water Use Efficiency

About 40% and 35% of the agricultural land in respectively Jdeidet El Chouf and Semqanieh is irrigated. Among the surveyed farmers, 63.5 % grow irrigated crops, 5 % grow rainfed crops and 31.5 % grow both. The water sources for irrigation are distributed as follows: 71.5 % use water from river and sources, 23.5 % use excess potable water for irrigation, and 5 % use rainwater harvesting.

Three irrigation methods are used: irrigation canals, drip irrigation and irrigation by hoses. Among the surveyed farmers: 47 % use irrigation canals, 21 % use hoses, and 31% use drip irrigation. The main reasons that were stated for transitioning to drip irrigation is the decrease in water supply, and the increased awareness among farmers on water saving measures. Drip irrigation is highly efficient in terms of water use, whereas canal irrigation consumes excessive amounts of water without yielding higher production rates. Since canal irrigation and water hoses are more used in Jdeidet El Chouf and Semqanieh, it can be concluded that water use efficiency in irrigation is still low.

4.4.5. Agricultural Survey Results

As indicated before, a questionnaire related to agriculture and water use in the study area (Appendix B) was completed by the attendees. The questionnaire aimed to form a general idea on the agricultural trends in the area through collecting information about farmers (age, gender, educational level, employment etc.) and the techniques they use on their lands. Among the 29 farmers contacted by the municipality, 19 filled the questionnaires. The answers they provided and their analysis are presented in the following sections.

Demographic and Socio-Economic Profile of the Respondents

The tables below presents the age distribution of the surveyed farmers, and their level of education. Almost half of the respondents are 55 years old and above, and 21 % are between 46 and 55 years old. 5 % of them hold higher education diplomas, including the following majors: business, electrician, accounting, interior design, and medicine.

Table 26 Age Distribution of Farmers (based on survey results)

Age Group	Less than 25	26-35	36-45	46-55	Above than 55
Percentage	5%	15.7%	10.5%	21%	47.3%

Table 27: Level Of Education of Farmers (based on survey results)

Elementary	Intermediate	Secondary	Bachelor degree	Higher studies
26.3%	15.7%	15.7%	36.8%	5%

Challenges

The main factors stated to affect agricultural production in the area include:

- Climatic factors, mainly decrease in precipitation averages and cold weather
- Disease outbreaks
- Expired drugs

According to the surveys, the biggest problems faced by the farmers are limited market and water scarcity. However, when asked to rate the severity of certain challenges and problems they might be facing, 82 % think availability of water resources is not a severe issue whereas half of the surveyed farmers find that the problem of water supply and sanitation has medium severity. 65 % think water quality is not a severe problem. The problems farmers find highly severe are: increased energy demand (100%), optimal utilization of available water resources (86%), and drought preparedness (69%).

Table 28 Severity of Problems and Challenges According to Farmers

Challenge of problem	Severity of problem		
	High	Medium	Low
Water supply and sanitation	37.5%	50%	12.5%
Increased energy demand	100%	0%	0%
Water Quality- pollution	17.5%	17.5%	65%
Irrigation	6%	82%	12%
Biodiversity conservation	6.5%	20%	73.5%
Coping with droughts and floods	6%	19%	75%
Water resources availability	12%	6%	82%
Optimal utilization of available water resources	86%	7%	7%
Drought and/or Flood Forecasting and Preparedness	69%	19%	12%

4.4.6. Existing Related Initiatives or Programs

According to the Center for Agricultural Guidance[24] in Deir El Kamar (at about 10 km from the study area), the following projects are being implemented to improve agricultural quality:

[24] The Center for Agricultural Guidance is under the jurisdiction of the Lebanese Ministry of Agriculture, its mission being to spread awareness and provide guidance and agricultural consultancy for farmers, as well as to inspect the food factories.

- The center is organizing training sessions for farmers to plant alternative crops, to conserve soil properties, adapt to climate change and produce cash crops that generate higher revenues to the farmers (Kiwi for example).
- Awareness campaigns and trainings are being held to encourage the plantation of aromatic plants (thyme, lavender and rosemary) under fruit trees, as they reduce the need for pesticide use because these plants repel insects, improve bee production, and constitute an important product which could be sold directly or as an intermediate product for distillation processes.

Trainings are being held on backyard composting, and the plantation of leafy plants on balconies, mainly to encourage self-sufficiency.

The center informs farmers on the optimal timing for planting of specific crops, the agricultural cycle as well as the types of plants convenient for each altitude.

As described above, the municipalities of Jdeidet El Chouf and Semqanieh have performed a geological-hydrological study, for the drilling of two water wells which would boost water supply to the area. Based on the study, the municipalities addressed an official request letter to the MoEW for the obtainment of a permit to implement the project. The study was not evaluated for the purposes of this report. Also, the municipality of Jdeidet El Chouf is planning the following projects:

- To turn yard waste from pruning into an alternative fuel (brisket) which can be used for heating during the winter in the area;
- To upgrade the Waste Water Treatment Plant (WWTP) operating in Jdeidet El Chouf to support a higher capacity (3000 m^3/day) and install a pretreatment system to remove the oils. Generating an effluent which could be used for irrigation.

According to the EBML, the potential projects for the area are:

- A complete study for the Chouf area, including infrastructure;
- Rehabilitation and upgrading of existing water distribution networks;
- Finding new sources to boost water supply;
- Improving the quality of treated wastewater to be used in agriculture;
- Replacement of the currently used pumps by pumps powered by solar energy;
- Installation of a solar powered pump to transfer water from the spring to the tanks in Jdeidet El Chouf.

Additionally, the future plans of the EBML, which aim at improving the water situation in the area are:

- Drilling two water wells: in Kafra (Kfar Nabrakh) and in Barouk near the spring to boost supply to the Chouf area
- Study the feasibility of the construction of a dam in the Maasser El Chouf Area
- Installation of High-Density Poly-Ethylene (HDPE) pipes to supply the agricultural land in the area.

5. ANALYSIS AND DISCUSSION

Despite severe limitations of data both at national and local levels that were available for this report, and the limited timeframe for this study, some observations can be made that will be helpful in determining practical opportunities for synergies between different sectors and interest groups to improve human well-being while not jeopardizing sustainable development.

First, potential opportunities for the NEXUS approach need to take the context of Lebanon into account. Despite having a diverse geography, rich resources, and a wide variety of agro-climatic zones, the country is facing many challenges. These have been exacerbated by long-term political instability and an unprecedented influx of refugees in an already densely populated country with 87% of the population living in urban areas, since the start of the Syria-conflict in 2011. Challenges are being faced in different sectors such as energy, education, infrastructure, health, and environment. They include deficient energy generation with high electricity prices, education not being tailored to labor force needs, poor infrastructure, chaotic urbanization, water pollution, a weak social security system, and desertification. The latter is also impacted by climate change with anticipated increased average temperatures and decreased average precipitation quantities. Many challenges are being amplified by a weak legal and institutional framework.

Most of these challenges also indirectly or directly impact the water and agriculture situation. As for the water sector, to start with, poor infrastructure results in only 30% of the precipitation that can technically and economically be recovered. Also, sewage infrastructure does not meet waste water treatment needs and effluents end up untreated in the rivers. As a result, the water deficit amounted to 75 MCM in 2010, with water demand expected to further increase by 55% in 2020. A complicating factor is that the water sector in Lebanon is governed by many institutions, including ministries, government agencies and municipalities, whereas coordination is not always clear. As a response to these issues, the Council of Ministers endorsed the National Water Sector Strategy (2012) which presents a detailed road map for improving water conditions and service delivery in the country.

The biggest water consuming sector is agriculture. Whereas the sector's contribution to the national GDP is only 5-6%, employing 8% of the effective labor force, agriculture related activities in the rural areas account for about 80% of the local GDP. Agriculture is considered one of the most vulnerable sectors in Lebanon, affected by many factors including climate change, in addition to social, technical, and political factors. Some of the challenges faced affect the sector in general, others affect small farmers in particular. There is a steady loss of workforce and aging population in rural areas with net migration rate from rural to urban areas. Also, many farmers rank as poor or very poor for their living and livelihood standards. Land use practices are changing reducing the surface area of rangelands and pasture land. Increased water needs and lack of knowledge amongst farmers on new methods lead to the abandonment of agricultural land. Furthermore, access to the market is being impacted by free trade agreements and the turmoil in the region.

In response to these issues, the Ministry of Agriculture has developed a strategy for the period 2015-2019, its vision being to develop the agricultural sector in view of ensuring food security including food safety, reducing poverty and rural-urban migration, creating job opportunities, and increasing efficiency and sustainable use of natural resources.

All these issues trickle down to the local level, and the case study in this report is a representative example. Since the Lebanese civil war, the area of Jdeidet El Chouf and Semqanieh has been witnessing fast urban and demographic growth, and has become a center of activity for the whole Chouf area. This dynamism has clearly increased the stress on natural resources and infrastructure in the area, as it was not foreseen at the planning and design phase. The urban lifestyle is also reflected in the education level in the area which

has generally increased, both for males and females. Women are also becoming more involved in the workforce, mainly in the domains of sales and education.

Whereas agriculture was historically the major source of income in the area, it has decreased over the years. Currently, agriculture is a self-sufficiency practice constituting for most households only a secondary source of income. Several factors contributed to this regress, the main driver being the war, which caused the abandonment of agricultural land. Then, due to urban growth, and activity development in the area, the population has shifted towards services (commerce, education, banking, etc.), since agriculture became a low-income profession generating low revenues.

In summary, the issues that were identified as the main problems affecting the agriculture sector in the case study area, include: ageing of the workforce and the lack of interest of the younger generations in the sector, water scarcity in the dry season added to the lack of sustainable irrigation methods, the vulnerability of the sector to climate change, and the unavailability of a market to sell local products.

As for irrigation methods, the majority of the farmers use irrigation canals and water hoses to irrigate their crops. The chosen irrigation technique is function of water availability and proximity to water sources and rivers rather than age and educational level of the farmer. All consulted farmers seemed to become more aware of the water saving necessity and would accept the idea of a transition to more efficient water use techniques. Most of the farmers have abandoned old methods which used to collect rainwater in reservoirs, and river water through small dams. This dependence on river and source flow has made the situation more vulnerable to climate change and precipitation variations.

As such, water scarcity is mentioned as one of the main problems in the area. While Jdeidet El Chouf is richer in water sources than Semqanieh, both towns are suffering shortages in water supply. According to observation by locals, water flow from natural resources at some locations has decreased almost by half in the last 30 years. However, the stakeholders who have been consulted for this study generally believe that the problem lies in the management of the sector rather than resource availability. They consider the EBML as understaffed with one water warden responsible for around 9,000 households, whereas the network does not cover the entire area. Also, unsustainable practices are considered to be caused by the lack of public awareness on the necessity to save water, contributing to the wastage of the resource. Additionally, the network is not equipped with meters, which aggravates this problem as it makes tracking losses and unauthorized water use a difficult task.

In summary, the issues that were identified as the main problems affecting the water and waste water sector in the case study area, include: lack and unreliability of water sources in the area; unsustainable practices in the use of domestic and irrigation water, driven by the idea that water is an abundant resource in Lebanon; lack of responsibility among the population towards the maintenance of the network; inefficiency of supply due to the age of network, leakages and unauthorized use; water supply from the Moukhtara source varies with (unreliable) power supply; administrative problems caused partly by understaffing of the EBML; the pressure on resources and infrastructure caused by the unprecedented urban and demographic expansion in the area; closeness of sewer network to water distribution network at some locations which increases the risk of contamination; diversion of water course towards private properties and touristic resorts that are located along the Barouk River, ahead of Jdeidet El Chouf.

6. CONCLUSION, RECOMMENDATIONS AND PROPOSED INTERVENTIONS

6.1. Recommendations and Conclusion

Given the serious challenges in the study area, various initiatives by local farmers are already being developed, especially related to cultivating areas with legumes and seasonal crops. However, their sustainability and further development of the agricultural sector will depend mostly on the establishment of irrigation water sources and canals/piping. Therefore, the recommendations as an outcome of this study, cover various categories according to the priorities of the main stakeholders whose actions can generate positive change.

At the institutional level, it is recommended that central government in the form of the MoEW work with the local authorities to prepare long term strategies for the water and waste water infrastructure. The EBML should aim to combine the various available water studies into a comprehensive integrated study. It should also spend efforts to expand and upgrade its working staff to better manage the distribution services. This task could be initiated through a formal request by local authorities.

The efficient management of water resources could be the subject of an advocacy program targeting both the public and private sectors. As part of this, EBML and its contracted (private) local water operator should work together with the mayors/municipalities to optimize the use of spring and surface water and minimize the use of pumped groundwater during the winter/rainy season. This could be done in the form of installing individual reservoirs at each residence for rainwater harvesting, especially if there are built cisterns already available. Another measure could be the installation of a PV solar system to reduce power consumption while pumping water from the river into the reservoir or waste water treatment plant.

At the municipal level, the municipalities of Jdeidet El Chouf and Semqanieh should request EBML to compile an overview of the various projects related to the water sector, completed to date by the municipalities themselves and under private initiatives. These include the networks and the related structures executed under contract with the Ministry of Displaced (MoD). Other measures that the municipalities should implement are:

- Removal of pollution sources (such as car mechanic garages, gasoline retail facilities and butchers) near water springs and sources so they can be used;
- Use of treated wastewater in agriculture;
- Rehabilitation of old terraces to develop agriculture, increase food security, improve groundwater replenishment,
- Installation of suction and/or transfer pumps, along with needed reservoirs to supply irrigation water from the river channel/spring to supply water to up to 13 farmers whose properties are located along the banks of the down-gradient end of the Barouk river within Jdeidet El Chouf jurisdiction;
- Rehabilitation of small dams present along the Barouk river course that supply irrigation canals;
- Restoration and rehabilitation of irrigation canals and connecting the canals with each other to ensure versatility and complementarity in the supply of irrigation water.

The role of NGOs could include identifying local population, civic society actors including other NGOs involved in sustainable water use, agriculture and energy efficiency and organizing awareness campaigns and selected training for them. The local population should be encouraged to harvest rainwater, especially into home based cistern in winter and towards the end of the rainy season. Recommend installing solar

panels along existing buildings for water heating and electricity generation, and generally adopt more sustainable practices in water use and agriculture. Some of these proposed recommendations are included into more detail below in proposed intervention projects.

In conclusion, the bottom-up participatory method adopted by the MINARET project has helped identify the main local, national and regional stakeholders involved in energy, water, and food security, the three axes of the NEXUS approach. This has led to a better understanding of the administrative, governmental and local frameworks of energy-water-agriculture sectors as well as the natural and physical aspects governing these sectors. The adopted approach has also helped raise and develop awareness amongst stakeholders and authorities on the importance of this concept. Their input was crucial in identifying the needs of the Jdeidet El Chouf area, and related cross-cutting interventions.

As a result, four intervention projects were proposed aiming at achieving energy efficiency, sustainable water management and food security. The projects are: farmers' project - lower area traditional agricultural system, traditional dam and canals' project - the upper area, Al Karim spring project and the solar hybrid water project. A brief description of each is presented hereafter.

6.2. Proposed Interventions

6.2.1. Farmers' Project - Lower Area Traditional Agricultural System

The project suggests the creation of an irrigation water storage and irrigation system. The project could consist of water pumping powered by PV, from the Barouk river to reservoirs serving individual agricultural farms. It would therefore serve 20 individual farmers and support food security and energy efficiency. It would expand agricultural areas using surface water, and convey water in an efficient way powered by renewable energy. It could include the installation of approximately 700 meters of 3-inch diameter HDPE pipe, and 20 reservoirs with a 6000 liter capacity each; a pump, approximately 120 meters of appropriate electrical cable, and around 50 m^2 of PV panels. Accessories to the piping includes a minimum of 10 wash outs, with possible need for anchoring, and two or three electric poles. The project would permit the farmers to install appropriate drip irrigation systems that would by itself act as an adaptation to climate change measure.

Training would be however required to operate and maintain the PV system and the associated infrastructure. Moreover, farmers would need to be trained on drip irrigation, and possibly other ecological agriculture, such as integrated ecological agriculture and conservation agriculture. One can also offer the farmers other eco-friendly processes; and possibly train them and create stronger awareness on eco-tourism as the project could naturally lead to an extension to an existing hiking trail (outside the case study project area): the Barouk River Valley Trail.

The municipality of Jdeidet El Chouf would lead the implementation and management of the project with a possible role driven by the Ministry of Agriculture and Ministry of Energy and Water, specifically through the LCEC program.

6.2.2. Traditional Dam and Canal Project - The Upper Area

The project would involve the rehabilitation of an agriculture micro dam along the Barouk river course, the restoration/rehabilitation and amelioration of irrigation canals/system by establishing interlinks between them. The dam rehabilitation includes minor concrete works and the revamping of metal gates that direct water into existing irrigation canals.

The canals restoration works include repairing of minor damages at most locations with some parts requiring excavation and casting of new canal sections. The interconnections between the three canals require extensive earth works that need to be completed manually (without introduction of heavy machinery), minor ground stabilization (support), the installation of washouts out of the concrete canals and the laying of HDPE piping (could be between 6 or 8 inches in diameter). Establishing linkages between the three canals is required to ensure the continuous availability of irrigation water to the farmers, since certain parts of the river are partially drying up (although the flow is restored down-gradient by flowing perennial spring). The project would serve over 30 individual farmers and support food security and energy efficiency through re-establishing agricultural areas, exploiting surface water source, and conveying water by gravity.

Training would be required to operate and maintain infrastructure. Farmers would also need training on drip irrigation, and possibly other ecological agriculture, such as conservation agriculture. Additionally, one can offer the farmer of ecological agriculture and other eco-friendly processes; and possibly train them to create stronger awareness on eco-tourism as the project would naturally lead to an extension to an existing hiking trail like project A.

Municipality of Jdeidet El Chouf would lead the implementation and management. There are roles for the Ministry of Agriculture and Ministry of Energy and Water.

6.2.3. Al Karim Spring Project

The project consists of a partial catchment of the Karim spring situated near the Barouk River, and convey water from it to boost and complement the drinking water supply for Jdeidet El Chouf. Water would be conveyed using HDPE piping for a distance of approximately 250 meters where 10 water reservoirs, each with a 10 m^3 capacity, would be procured and installed (next to an existing mill). These reservoirs would act as intermediate storage before water is transferred for a distance of around 925 meters to an existing water reservoir. The project would include the procurement and installation of that transfer pump along with the needed HDPE piping. Additionally, the project includes the procurement of 75 KVA generator to address the electricity shortage and rationing. The transmission system consists of pipes, washout valves, relief valves, a generator and a pump O&M for water systems and generators. Training would be required to operate and maintain the system.

Municipality of Jdeidet El Chouf could lead the implementation and management. There would also be a potential role for the Ministry of Energy and Water through the Establishment of the water of Beirut and Mount Lebanon (EBML). Once implemented the project operation could be handed over to EBML.

6.2.4. The Solar Hybrid Water Project

The project consists of the transmission of water from an existing water reservoir to the main storage reservoirs that supplies the Jdeidet El Shouf potable water network via gravity. It includes the installation of a transfer pump, a generator and a solar photovoltaic (PV) farm. The main water tanks in Jdeidet El Chouf are operated by the Establishment of the water of Beirut and Mount Lebanon. Two options were considered: The first was to install a pumping system fully operated on solar power, and the second is to install a photovoltaic diesel hybrid system as to reduce fuel consumption. The second option is more plausible from a financial as well as technical and administrative point of view, with a main obstacle for the first option being the surface area requirement (greater than 850 m^2) and the challenging mountainous topography.

The cost of PV-diesel hybrid system, which would consist of a 100 kVA 100 HP diesel generator complemented with PV panels (without batteries, as it is estimated that the operation of the system during the day would be suffice) to be estimated at 80,000 USD (procurement and installation cost of the generator, PV solar panels, transfer pump and related accessories). The preliminary estimation of the first option had shown a 1.5 times higher cost over the selected option.

Municipality of Jdeidet El Chouf, and the Jdeidet El Chouf-Baqaata Women Organization would lead the implementation and management of the project. There also could be a role for the ministry of energy and water, specifically through the EBML and LCEC.

REFERENCES

Antea Group, 2017

Antea Group (France), Groundwater Resources Sustainable Assessment of the Western Slope of the Shouf Biosphere Reserve, Report Reference: A84001/A, Prepared for Nestle Waters Lebanon and Shouf Biosphere Reserve, 2017

AZO Mining, 2012

G.P. Thomas, "Lebanon: Mining, Minerals and Fuel Resources", November 14, 2012, retrieved July 3rd, 2017 from: http://www.azomining.com/Article.aspx?ArticleID=226

BankMed, 2013

"Analysis of Lebanon's Food Market, (2009-2013), BankMed, retrieved June 30th, 2017 from https://goo.gl/zUFmHm

BankMed, 2014

"Oil and Gas in Lebanon", Market and Economic Research division, BankMed, 2014.

CDR, 2013

"Productive Sectors and Other Sectros, Agriculture and Irrigation", November 2013, CDR, retrieved June 26th, from http://www.cdr.gov.lb/eng/progress_reports/pr102013/Eagric.pdf

CountyEconomy, 2011

"Lebanon, minimum wages", Lebanon 2011, retrieved July 11th, 2017 from http://countryeconomy.com/national-minimum-wage/lebanon

Dar Al Handasah, 2014

Dar Al Handasah, "Greater Beirut Water Supply Augmentation Project Environmental and Social Impact Assessment", CDR, 2014.

DAR-IAURIF, 2005

Dar Al Handasah and IAURIF (Institut d'Aménagement et d'Urbanisme de la Région Île-de-France), National Physical Master Plan of the Lebanese Territories (NPMPLT), December 2005

Databank, 2010

"Cultivated Area by Category", Ministry of Agriculture, retrieved June 27th, 2017 from http://www.databank.com.lb

Databank, 2017

Investment Development Authority of Lebanon (IDAL), "Agriculture Fact Book, 2016", Databank, retrieved June 28th, 2017 from http://www.databank.com.lb

EBML, 2014

Establishment of The Water of Beirut and Mount Lebanon, "About Us, History", 13 August, 2014, Retrieved on June 9, 2017 from: http://www.ebml.gov.lb/english/history

ECODIT, 2015

Strategic Environmental Assessment for the New Water Sector Strategy for Lebanon, ECODIT, May 19, 2015

EU/UOB/MOE/ELARD, 2005

Strengthening the Environmental Legislation Development and Application System in Lebanon, (SELDAS). Ministry of Environment, University of Balamand, ELARD. 2005

FAO, 2011

Fady R. Asmar, Country Pasture/Forage Resource Profiles, Lebanon, August 2011, FAO

FAO, 2017

"Lebanon", "Lebanon at a glance", retrieved June 28th, 2017 from http://www.fao.org/lebanon/fao-in-lebanon/lebanon-at-a-glance/en/,

Farajalla et al., 2014

Dr. Nadim Farajalla, Eduardo A. Haddad, Marina Camargo, Ricardo Lopes and Flavio Vieira, Issam Fares Institute for Public Policy and International Affairs (IFI), American University of Beirut (AUB), IFI Climate Change in Lebanon: Higher-order Regional Impacts from Agriculture, Working Paper #23, Climate Change and Environment in the Arab World, June 2014

Farajalla, 2016

Dr. Nadim Farajalla, Acting Head of Land, Water and Environment Department, 'Drought in Lebanon: This Past Year was one of the Driest on Record', SETS International, 2016

Ghossaini, 2016

Dr. Noha Ghossaini Abou Ajram, Strategic Plan for Development of the Chouf Es Souayjani Area, Baaqline, 2016

Hayek, 2009

Carolyn Hayek, "Maintaining Rainwater Harvesting Practices in Southern Lebanon: the kaza of Tyre", Massachusetts Institute of Technology, June 2009

ICMA, 2011

Municipal Finance Studies Program, Final Strategic Framework, ICMA, February 2011

IDAL, 2016

"Agriculture Fact Book", IDAL, 2016, retrieved October 25th, 2017 from http://www.investinlebanon.gov.lb/en/InformationCenter

IDAL, 2017a

"Lebanon at a glance", "Political & Legal Framework", Political Context", retrieved July 10th, 2017, from: http://investinlebanon.gov.lb

IDAL, 2017b

"Agriculture, Agro-industry", IDAL, retrieved July, 3rd, 2017 from http://investinlebanon.gov.lb/en/sectors_in_focus/agro_industry

IDAL, 2017c

"Investment Opportunities in the Chouf, 2017", IDAL, retrieved July 11th, 2017 from https://goo.gl/sABG2U

IndexMundi, 2016

IndexMundi, "Lebanon Economic Profile", retrieved June 22, 2017 from: http://www.indexmundi.com/lebanon/economy_profile.html

LCG, 2017

Lebanon Clean and Green, Maps, "Map of Lebanon's Rivers ", Retrieved June 22nd, 2017 from: http://www.lebanonclean.org/maps.html

Localiban, 2007

"Federation of Chouf Es Souayjani Municipalities", retrieved July 6, 2017, from: http://www.localiban.org/article537.html

Localiban, 2008

"Jdaideh (Chouf)", retrieved July 7th, 2017 from http://www.localiban.org/article628.html

Localiban, 2016

"Lebanese Population Density Map", retrieved June 21, 2017, from: http://www.localiban.org/article368.html

MoA, 2003

"National Action Plan to Combat Desertification", Ministry of Agriculture, June 2003.

MoA, 2014

"Ministry of Agriculture Strategy 2015-2019", Ministry of Agriculture, November 2014

MoE, 2011

Ministry of Environment (MoE) of Lebanon, Lebanon's Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), Beirut, February 2011

MOE/UNDP/ECODIT, 2011

State Of the Environment Report (SOER), Lebanon, ECODIT, MoE, UNDP, 2011

MoEW/UNDP, 2014

"Assessment of Groundwater Resources of Lebanon", MoEW/UNDP, 2014

MoE/UNDP/GEF (2016).

Lebanon's third national communication to the UNFCCC, November 2016 Beirut, Lebanon.

Mroueh, 2017

Wikipedia. (2013)., "Governorates of Lebanon", Retrieved June 29, 2017, from https://en.wikipedia.org/wiki/Governorates_of_Lebanon

Wikipedia, 2017b

Wikipedia. (2013)., Lebanon Topography, Retrieved February 23, 2017, from Wikipedia, the free encyclopedia: https://en.wikipedia.org/wiki/File:Lebanon_Topography.png, https://en.wikipedia.org.

Wikipedia, 2017c

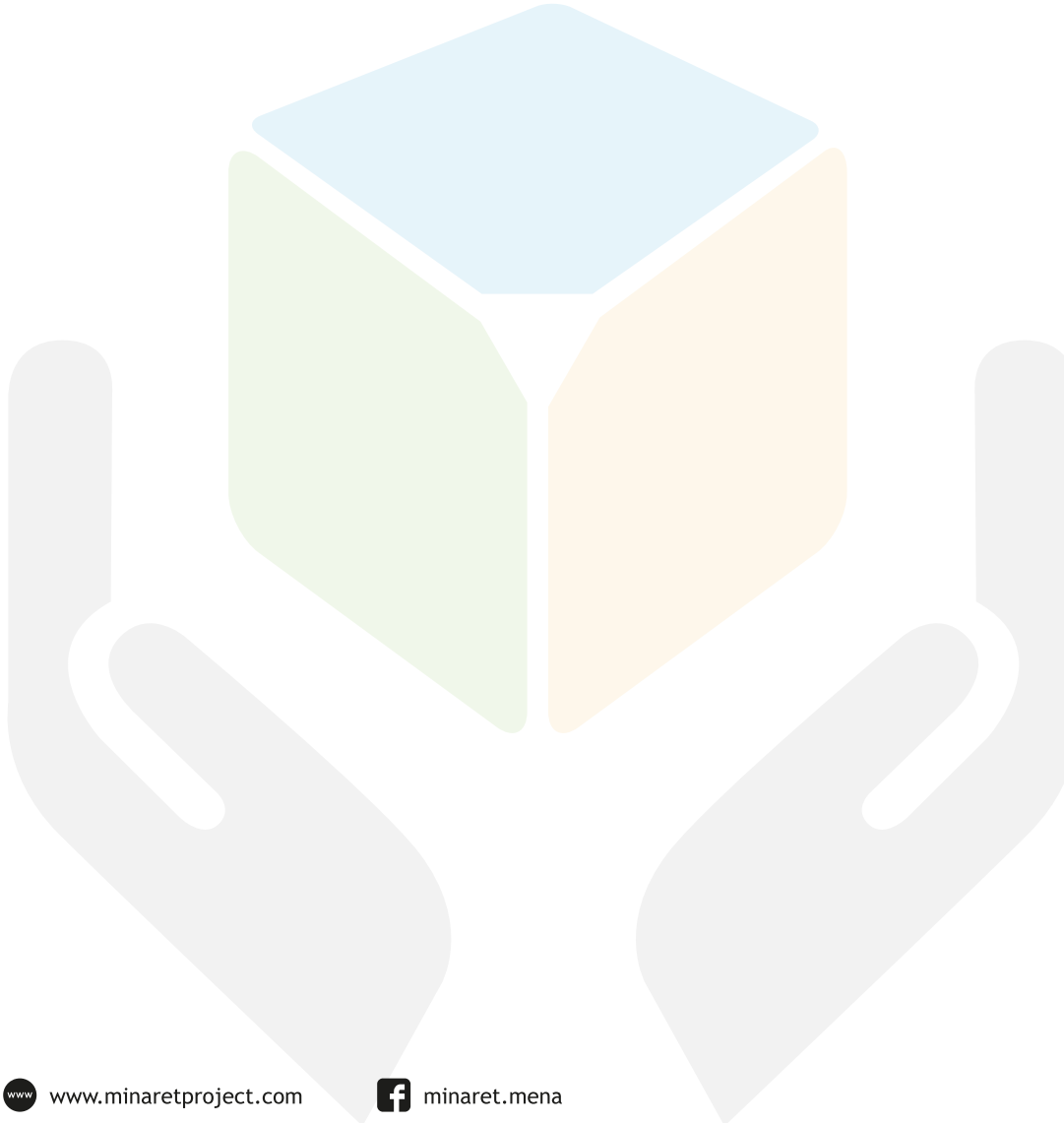
Wikipedia (2017), "Chouf District", Wikipedia, the free encyclopedia, retrieved on October 30, 2017 from: https://en.wikipedia.org/wiki/Chouf_District

UN Data, 2017

UN Data, Country Profile, "Lebanon", United Nations Statistics Division (UNSD), received June 20, 2017, from: http://data.un.org

UNDP/MoD, 2005

"



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