EURO-MEDITERRANEAN REGIONAL PROGRAMME
for Local Water Management ME8/AIDCO/2001/0515/59763-P 016

ISIIMM project:

Case studies synthesis

L e b a n o n

MEDA Water

AGROPOLIS INTERNATIONAL

Institutional and Social Innovations in Irrigation Mediterranean Management

ISIIMM

"Promoting an integrated and balanced management of water resources by reconciling respect for the environment with economically viable irrigated agriculture» is the objective of a local dialogue operation between farmers, development professionals, scientists and various stakeholders. This concept has served as a reference for the Institutional and Social Innovations in Irrigation Mediterranean Management project (ISIIMM) led by Agropolis International (France).

ISIIMM is a Euro-Mediterranean regional project funded by the European Commission "EU-MEDA Water" involving six countries: Egypt, France, Italy, Lebanon, Morocco and Spain. The aim of the ISIIMM project was to share experiences, knowledge and build new perspectives for sustainable water management in Mediterranean agriculture, based on a common understanding of six key mechanisms: Social, Institutional, Historical, Agricultural, Territorial, Hydrological/Hydraulic.

A comparative, progressive and participatory approach was adopted between different stakeholders coming from the eleven selected study areas where water is a central topic issue to social and economic life.

The ambitious and challenging activities of the ISIIMM project were built upon a framework of regional network co-operation systems. Many multi-national and multi-sectoral teams worked together with the support and organisational efforts of project partners.

With a primary objective to help local rural communities adapt to the emerging problems resulting from pressures on water resources, two priorities guide the project: a) working with local irrigation organisations; and b) working with the development professionals.

Three main activities were developed with the participation of the target groups.

Diagnostics for action in each of the 11 river basins (national and local case studies) leading to new water-sharing behaviours and institutional innovations. This was focused on a statement of conditions and aims for each river basin and country using a participatory approach and based on existing documentation plus the scientific assessment of the ISIIMM experts.

Social and institutional innovations have been approached thought the ***concrete actions*** on the ground and a wide series of ***training workshops and exchange seminars*** complemented by field visits with farmers, managers of public organisations and canal managers. In total, 19 international workshops and seminars and around 35 local and national meetings and trainings were organised with participation of more than 1500 persons to enable the target groups to gain a wider vision of the problems in Mediterranean irrigation management and more references to solve them in more suitable ways. Concrete actions (SWaMMA (Solid Waste Management in Mostafa Agha) micro-project in Egypt, AIRMF *(Association des Irrigants des Régions Méditerranéennes Françaises)* in France, Irrigators association in Lebanon, wider stakeholder participation in decision making in Morocco, pluri-stakeholders involvement at regional and local level in Italy and Spain) have been initiated with local stakeholders and will be continued thanks to the strong relations developed.

An ***extensive information and data base system called OSIRIS*** has been developed to enable target groups to access information about the ISIIMM case studies and compare this with their own situations (www.isiimm.agropolis.fr).

In addition, a concerted effort was being coordinated to distribute this information through books, films, newsletters, guides and other media. ISIIMM has been contributed to mutual learning and knowledge transfer at local, national and regional scales.

The EU Partners are:

- In France: Chambre Régionale d'Agriculture du Languedoc-Roussillon (CRALR), VERSeau Développment
- In Italy: Autorità di Bacino dei fiumi Isonzo, Tagliamento, Livenza, Piave, Brenta-Bacchiglione (ABAA), Fondazione Eni Enrico Mattei (FEEM)
- In Spain: Universidad Politecnica de Valencia(UPV), Unidad Sindical de Usuarios del Júcar (USUJ)

The MEDA Partners are:

- In Egypt: Center for Rural Development Researches and Studies (CRDRS), Egyptian Association for Sustainable Rural Development (EARSUD)
- In Lebanon: Chambre de Commerce, d'Industrie et d'Agriculture de Zahle et de la Bekaa (CCIAZ)
- In Morocco: University Cadi ayyad (UCAM), Association Al Majal

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Case studies synthesis

L e b a n o n

Final Report by

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Institutional and Social Innovations in Irrigation Mediterranean Management

TABLE OF CONTENTS

1. INTRODUCTION 1

2. INTERNATIONAL CONTEXT 2

2.1. WATER IN THE MIDDLE EAST 2

2.2. ISRAEL AND WATER 2
2.2.1. Water Politics from 1948 to 1967
2.2.2. Water Politics After 1967

2.3. ISRAEL AND LEBANON CONFLICT: THE LITANI RIVER 5

2.4. WATER PARTITION BETWEEN SYRIA AND LEBANON 7

3. NATIONAL APPROACH – LEBANON 8

3.1. GENERAL PRESENTATION 8

3.2. POPULATION, ECONOMY AND AGRICULTURE 9

3.3. HYDRO GRAPHIC ORGANISATION 10
3.3.1. The coastal zone
3.3.2. The Interior zone

3.4. WATER BALANCE AND IRRIGATION 15

3.5. INSTITUTIONAL AND LEGAL FRAMEWORK 20
3.5.1. Historical background
3.5.2. The new Water regulation (law 221/2000)

3.6. WATER USERS ASSOCIATIONS REGULATION 25

3.7. THE 10 YEAR PLAN OF THE MOEW 26

3.8. WATER PRICING 28

4. REGIONAL CONTEXT: THE BEKAA VALLEY 30

4.1. GENERAL PRESENTATION 30

4.2. BEKAA'S AGRICULTURE 31

4.3. BEKAA INDUSTRY 36

4.4. BEKAA TOURISM 36

5. ISIIMM CASE STUDIES IN LEBANON 37

5.1. THE LITANI RIVER BASIN 37
5.1.1. General Overview
5.1.2. Future projects

5.2. SOUTH BEKAA IRRIGATION SCHEME: FIRST CASE STUDY IN LEBANON 41
5.2.1. Topographic features of the canal 900 area
5.2.2. Geology
5.2.3. Hydrology
5.2.4. Agriculture, Land-use and main activities
5.2.5. Population
5.2.6. Water Quality
5.2.7. Stakeholders
5.2.8. Field survey

5.3. THE KHRAIZAT SCHEME: SECOND CASE STUDY IN LEBANON 53
5.3.1. General presentation
5.3.2. Water
5.3.3. Water Distribution
5.3.4. Water Pollution
5.3.5. Economical importance of Khraizat scheme

6. CONCLUSION 56

LIST OF FIGURES AND TABLES 57

REFERENCES 59

ANNEX: AGREEMENT 60

ABBREVIATIONS

CCIAZ	Chamber of Commerce, Industry and Agriculture of Zahle
CDR	Council of Development and Reconstruction
ESCWA	United Nations Economic and Social Commission for Western Asia
FAO	Food and Agriculture Organization
ISIIMM	Institutional and Social Innovations in Irrigation Mediterranean management
LARI	Lebanese Agricultural Research Institute
LBP	Lebanese Pound
LRA	Litani River Authority
MCM	Million Cubic Meters
MOA	Ministry Of Agriculture
MOEW	Ministry of Energy and Water
MOH	Ministry Of Health
SAU	Surface Agricole Utile
WUA	Water Users Association

1. INTRODUCTION

The current report represents the Lebanese case study for the ISIIMM project which is implemented in collaboration with the Chamber of Commerce, Industry and Agriculture in Zahle and the Bekaa. The report is the result of 4 years of data collection, analysis, field visits and survey, expert missions, exchange of experience, etc.

Lebanon is situated in a critical zone marked by a high pressure on water, where the neighbourhood countries are dry with intensive level of evaporation, which induces important water challenges (increasing shortage of water resources, over exploitation and lack of management due to the underdeveloped institutional capacities,…).

The experience of Lebanon in Water Users Association has been very shy. The mission of ISIIMM, especially through the exchange of experience seminars, was to raise the debate on these crucial institutions for local water management and to help farmers to understand the WUA concept and to implement it according to their local situations.

In Lebanon, WUA legislations were set during the French mandate (1918-1943) and were not adapted to the local realities. Such institutions seem to be very important especially that problems facing irrigators become more critical. Farmers are very enthusiastic to such kind of cooperation which represents the main objective of ISIIMM. In addition, the project, in collaboration with many national and international experts, aimed to prepare a draft legislation which could enhance the promotion and the creation of WUA.

The case study is focusing on two working sites: The *South Bekaa Irrigation Scheme* irrigated by the Canal 900 from the Qaraoun Lake and managed by the Litani River Authority (LRA) representing the basin agency, and the *Khreizat Source Irrigation Scheme*, a mountainous traditional canal situated in face of the Canal 900 and irrigating lands in 3 villages in the West Bekaa region: Kherbet Kanafar, Kefraya and Saghbine. In both cases, water is provided to individual farmers because the non-existence of Water Users Association.

This study is divided into several parts. The first one is focusing on the international approach especially the water conflict in the Middle East region. The second part is giving a general overview of water in Lebanon in its different aspects: geographic, hydraulic, hydrologic, agricultural, institutional, social and legal.

The same aspects mentioned in the second part will be developed in the parts 3 and 4 for the Bekaa valley and the *South Bekaa irrigation Scheme* as well as the *Khreizat Scheme*.

The part 5 represents the actions taken and implemented by the ISIIMM team in Lebanon as well as some conclusions and lessons learned from the exchanges made during the 4 years of work.

2. INTERNATIONAL CONTEXT

2.1. WATER IN THE MIDDLE EAST

Water, is so essential for life that it can promote cooperation as easily as conflicts. In the Middle East region (Jordan, Syria, Palestine and Lebanon), it has generated disputes only and was considered as the major reason for the Arab-Israeli conflict. In addition, the ground water reservoirs are not matching the national borders, meaning that many countries have to share the same aquifers and surface water.

Even in the absence of consensus on high political levels, there may be benefits from cooperation on water management and supply. Securing water resources is a major objective of all countries, but hydrology, economics and politics combine to make it particularly important to those in the Middle East.

The problems can be summarized in 6 points:

1- Global scarcity of water resources in an arid region with high evaporation level.
2- Increasing population growth.
3- Disproportion of water distribution between countries (some countries are suffering from scarcity while others are more watered).
4- Complexity of hydrologic networks.
5- Lack in legislations, institutional capacities and the high level of losses (The development policies have increased the unbalance between resources and consumption. In fact 70% of water is consumed by the agriculture, which caused the dryness of downstream rivers).
6- Water quality is decreasing due to over exploitation of water table causing salinization.

From an hydro-geographic point of view and particularly for the surface water in Lebanon, we can distinguished 3 types of rivers:

- River flowing totally inside Lebanon (quasi- totality of the coastal rivers and the Litani).
- Cross border rivers: Orontes and Naher el Kabir.
- Rivers affluent of Jourdain : Hassbani and Ouazani.

This hydro-geographic division of the Lebanese surface water reflects the existence of many hydro-political disputes implicating Lebanon with his neighbours (Israel and Syria):

- The dispute between Lebanon and Israel about the Jourdain river effluents.
- The dispute between Lebanon and Israel about the Litani river.
- The dispute between Lebanon and Syria about Orontes and Nahr Al Kebir rivers.

2.2. ISRAEL AND WATER

Water has been integral to local and regional politics in the Middle East for centuries. It was recognized by the early Zionists to be critical to the success of their dreams. The territorial and water claims made by Zionists early in the 20th century were predicated on "the requirements of modern economic life" (Zarour and Isaac, 1993) based, in large part, on the availability of water resources. The World Zionist Organization's submission to the Paris Peace Conference in February 1919 clearly delineated the proposed boundaries of Palestine to include the headwaters of the Jordan River, the lower Litani River in Lebanon, and the lower reaches of the Yarmouk River. Chaim Weizmann, who later became the first president of the State of Israel, stated that it is "of vital

importance not only to secure all water resources already feeding the country, but also to be able to conserve and control them at their sources" (Hurewitz 1959, as quoted in Lowi 1992, p. 39; Hosh and Isaac 1992,). He clarified this statement noting that the guiding consideration is economic and "economic" in this connection means "water supply" (Wolf 1995). Water was not simply viewed as a valuable natural resource, but as essential to the livelihood of the Jewish people and the viability of a Jewish state.

A survey of water resources, focusing specifically on the Jordan Valley, was undertaken in 1937 by M. Ionides, a British employee of the Trans–Jordanian government proposed a diversion scheme for the Yarmouk River (later adopted in part by the Jordanian government), it also concluded that there were insufficient water resources in the river to sustain a Jewish state (Doherty 1965; Naff and Matson 1984).

2.2.1. Water Politics from 1948 to 1967

A secure supply of fresh water was an important goal for the early Zionists. It was seen as a necessary condition for economic growth and security. The pursuit of this goal had raised tensions between various states in the region. Before the 1967 war, Israel and the neighbouring Arab states had occasionally feuded over access to Jordan River waters.

Some analysts have speculated that the need for more water was a major factor in Israel's involvement in the 1967 war. "The constant struggle for waters of the Jordan was a principal cause of the 1967 Arab–Israeli war..." Naff and Matson (1984) noted that "the increase in water-related Arab–Israeli hostility was a major factor leading to the 1967 June War." Bulloch and Darwish (1993) are even more explicit, stating: "the Six Day War was caused largely by competition for waters of the River Jordan."

Studies of the history of water and politics in the region offer mixed support for the contention of a hydrologic imperative on the part of Israel. It is true that throughout 1965 the Israeli army attacked construction attempts to divert the headwaters of the Jordan River in Syria. Skirmishes over Arab attempts to divert water from the Banias River into the Yarmouk River continued in 1966 and 1967 (Wolf 1995). These attacks were the result of tensions between Israel and Arab states over the withdrawal of Jordan River water. In 1964, Israel began operation of its National Water Carrier, withdrawing 320 Mm^3/year from the Upper Jordan. The Arab states responded by planning two diversion schemes involving the headwaters of the Jordan River. The first proposed diverting approximately 50 MCM annually from the Hasbani River via a tunnel into the Litani; the second involved construction of a canal to divert both the Hasbani and the Banias rivers into the Yarmouk River for irrigation in both Syria and Jordan (Figure 1) (Doherty 1965).

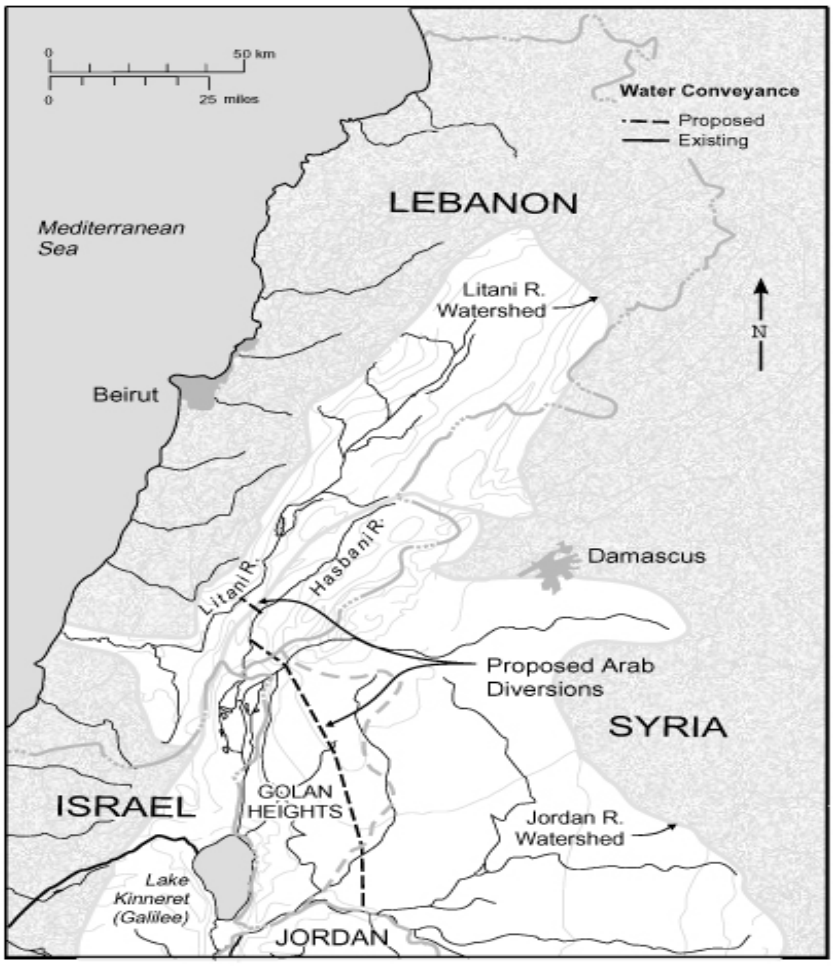


Figure 1. The Litani River watershed and proposed Arab diversions from the Upper Jordan River.

2.2.2. Water Politics After 1967

Occupation of the West Bank and the Golan Heights by Israel after the 1967 war significantly changed the dimensions of water demand and supply in Israel. (As a water-deficit region, the Gaza Strip was less important in this respect.) First, it increased Israel's fresh water supplies by almost 50%. Second, it gave the country almost total control over the headwaters of the Jordan River and its tributaries, apart from the Yarmouk River, as well as control over the major recharge region for the Mountain Aquifer.

Finally, Israel solidified its position on the Yarmouk River (which forms the boundary between Jordan and Syria and then joins the Lower Jordan River within Israel at a point just below the outlet from Kinneret). Israel was always a downstream riparian on the Yarmouk, but now, as a result of the war, it controls half of the river, compared with 10% previously. This change allowed Israel to increase its use of Yarmouk water, and it now appears to be taking about 100 Mm^3/year (this water is diverted to Lake Kinneret), most or all of which Jordan would like to regain to supplement its own very limited sources. More importantly, it made any upstream development of the Yarmouk dependent upon Israeli consent. Either plan requires agreement, however, with both Syria and Israel, something that is unlikely, even in the context of a limited peace agreement. Syria has built 25 small

dams to capture water draining southward to the Yarmouk and would not want the value of these structures compromised.

In addition to direct use of water from the Mountain Aquifer from wells within Israel, West Bank (and Gaza) water is used to supply new Jewish settlements outside the boundaries of pre-1967 Israel. About 70% of the groundwater on which Israel is dependent, and more than 40% of its sustainable annual fresh water supply, originate in the Occupied Palestinian Territories, mainly in its aquifers.

2.3. ISRAEL AND LEBANON CONFLICT: THE LITANI RIVER

Lebanon, which some experts consider as a « chateau d'eau » in the Middle East region, has not been saved from the water conflicts that caused many wars toward controlling this strategic resource.

Although not connected to the Occupied Palestinian Territories, Israel's incursion into Lebanon and the establishment of the "Security Zone" in the early 1980s allows it access to the lower reaches of the Litani River (which flows within 10 km of the Israeli border). These actions, coupled with past unsuccessful attempts by Israel to reach an agreement with Lebanon to share Litani water, have led to great Arab concern that Israel will unilaterally divert the Litani into the Jordan River. Certainly, the value of the Litani was recognized by Zionist planners (Lowi 1992) and, as was noted earlier, the proposal by the World Zionist Organization to the Paris Peace Conference in 1919 included the Litani River within the Jewish state (Figure 2). The Maronite Patriarch, succeeded, with the support of France, to keep it as a Lebanese resource. Chaim Weizmann noted that Lebanon "is a well watered region and the Litani River is valueless to the territory north of the proposed frontiers.

This interest in the Litani continued through the 1950s, when both Prime Minister Ben-Gurion and Moshe Dayan, Israel's Chief of Staff, advocated Israeli occupation of Lebanon up to the Litani River (Amery and Kubursi 1992). The fact that Litani water is very high in quality with a low mineral content only enhances its value — and the perceived threat. In 1954, Israel has presented a project to divert 400 MCM from Litani.

The Litani River rises and flows entirely within the borders of Lebanon (Figure 2), but its possible use by Israel or Jordan or both has increased its international importance.

Israel has long claimed that the Litani is actually part of the Jordan River watershed, because there is some geological evidence that the lower Litani may provide water for the Hasbani River and the Dan Spring, which form the headwaters of the Jordan (Kolars 1992).

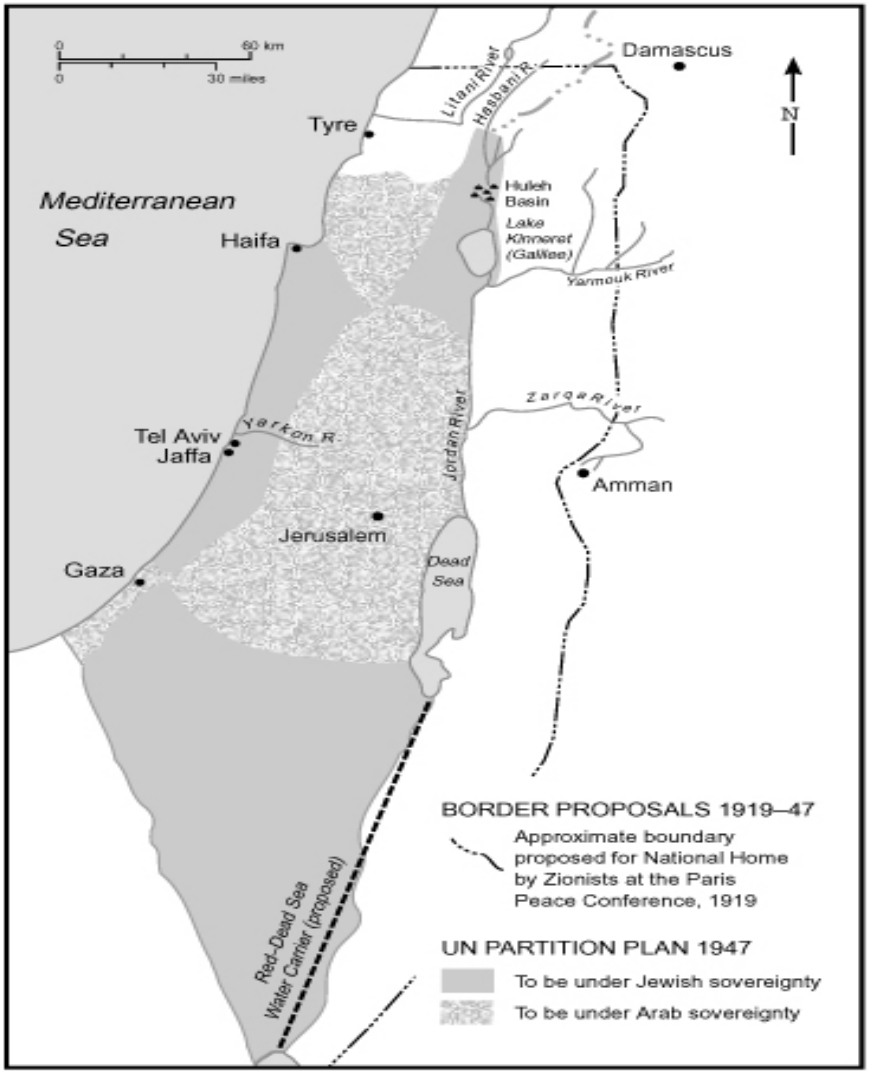


Figure 2. Border proposals for a Jewish state, 1919–1947 (adapted from Wolf 1995)

The problem of water transfer from Lebanon to Israel raises a number of sensitive issues. First, some authors (such as Amery and Kubursi 1992) claim that this water will be needed by Lebanon to serve the country's economic growth in the future. Any long-term agreement involving the diversion of water to Israel, therefore, should be avoided. Second, there are political sensitivities involved in selling water to the Israelis. Third, Israel would not be willing to build up a dependency on Lebanese water. Fourth, and last, Lebanon would, in turn, be hesitant to allow Israel an interest in water that might be used as an excuse for military intervention in the future. As a short-term solution to water problems in the region, however, the Litani River could play an important role.

In 1994, A report, published in the ministerial meeting of ESCWA, claimed that Israel was withdrawing Litani River water. This report asserted that, since 1978, Israel has been using 215 MCM of water per year from the Litani and Wazzani rivers. The report also claimed that, after its invasion of Lebanon in 1982, Israel drilled an 18-km tunnel linking the Litani River to Israel. In opposition, no evidence was found till now.

Concerning the effluents of the Jordan River, Israel intended to create a band including the river course of Hasbani, with an average annual flow of 135 MCM, which constitutes a very important source for Israel who is procuring from the quasi- totality of water resources of the Jordan basin.

Origin	Israel	Syria	Lebanon	Total
Dan	245	-	-	-
Hasbani	-	-	135	-
Baniyas	-	120(Golan)	-	-
Yarmouk	-	450	-	-
Water courses of Golan	-	150	-	-
Total Golan/Hermon	245	720	135	1100

Table 1. Water resources of Jordan basin used by Israel according to their geographic origin and quantity (MCM) of water (Source: Encel 1999)

2.4. WATER PARTITION BETWEEN SYRIA AND LEBANON

Lebanon is sharing with Syria the *Orontes River* in the North of the Bekaa valley and *Nahr El Kabir River* in the North of Tripoli. Many agreements have been signed between the 2 countries especially for the Orontes river which is flowing all over the year (see Annex 1).

The Orontes River (450 km) flows from the northern part of the Bekaa valley and reaches the Lebanese-Syrian borders at 46 km, to end in the Swaidieh (between Syria and Turkey) in the Mediterranean. The Orontes water was totally exploited by Syria without taking in consideration the Lebanese rights. We have assisted during this period to the development of many Syrian irrigation projects in the central zone (Homs and Hamah) where the Qattina Lake, the marshy dry zones of Ghab and the agricultural plain are so important for the Syrian economy. At the same period we haven't seen from the Lebanese side any project for the exploitation of these resources, excepting the water used for the irrigation of the lands situated on the river borders in the Hermel region. At the moment, Lebanon has prepared a project for the establishment of 2 dams in the Hermel region which will be used for irrigation and hydropower production.

3. NATIONAL APPROACH - LEBANON

3.1. GENERAL PRESENTATION

Located in the Middle East, on the eastern Mediterranean coasts, Lebanon is a small country of 10 452 km sq with a north-south coastline of 210 km and an east-west inland penetration of 50 km.

Lebanon has 4 principal geographic units which are parallel to the Mediterranean border:

- The coastal plains; 210 km in length.
- The Lebanese Mounts; 150 km in length and 25 km wide.
- The Bekaa Valley ; 2713 km sq of area, 10-15 km of width and 850 m of average altitude.
- Anti-Lebanon Mountains; about 177 kilometers in length and 9.6 to 16 km width with an average altitude of 762 meters.

Figure 3. Map of Lebanon

From the administrative point of view, Lebanon is divided into 8 provinces (Mohafazat): Beirut, Mount Lebanon, South Lebanon, Nabatieh, North Lebanon, Akkar, Baalbek- Hermel and Zahlé-West Bekaa.

3.2. POPULATION, ECONOMY AND AGRICULTURE

During the year 2000, the population was estimated to 3.5 million inhabitants according to the Ministry of Internal Affairs, the Central Administration for Statistics and the UNRWA. The yearly average growth ratio of population is 2.0%. Lebanon is characterized by a very complex social structure with 18 different religious confessions. The Lebanese Republic's political regime is democratic with a high number of political parties.

The Lebanese economy is based essentially on Services and Trade. The total labor force is estimated at 34% of the population and agriculture employs around 9% of the total labor force. The agricultural sector contributes to around 13% of the total GDP. The resources allocated by the government for this sector don't exceed 1% of the National budget. The contribution of the agriculture to the national economy has declined continuously during the last ten years. In the period 1975-1990, Lebanon faced 15 years of war where, agriculture, as the case of many other economic sectors, was severely affected through direct loss of structures, resources and assets. After being for decades a net exporter of agricultural products, Lebanon became a net importer of agricultural and processed food products where local production had stopped satisfying the domestic needs.

The diversity of agro-ecological zones has contributed to a diversity of agricultural and livestock production systems. The cultivated land area is of 261 000 hectares, with a total number of 200 000 farm holders. Around 73% of the total farm holders (140000 farmers) have an area less than 1 Ha and cultivate only 19% of the total cropping area. Around 3 100 farm holders (1.6%) cultivate around 30% of the total crop area. Crop production accounts for around 71% of the total agricultural production. Fruit trees constitute 39% of the total value of crop production, followed by vegetables (29%), then industrial crops (11%), olives (7%), and cereals (3%). In 2001, the total production of fruits and vegetables reached 1.388.000 tons, whereas the production of potato, carrots, onions and other tuber crops was of 429.000 tons, and the production of the remaining crops (cereals, industrial, crops,….) reached 378.000 tons. Since 1997, the value of agricultural production has decreased by 11%. This mainly due to the decrease in crop production (by 16%) despite the considerable increase in the cultivated area of cereals (subsidized crop). The cultivated area of all crops (except onions and cereals) has decreased since 1997. On the other hand, there is significant increase in the value of animal production (7% since 1997) due to the good standing of the poultry sector.

The country is importing 80% of its food requirement namely basic commodities: animal products (meat, fish, dairy products,…) and crop products (wheat, vegetables and fruits in some seasons…). Major agricultural exports include fruits (apples, banana, apricots, cherries, citrus fruits,…) vegetables and tubers (potato, tomato, onion…). Lebanon mainly exports to neighboring Arab and gulf countries. Exportations of fruits and vegetables to the Gulf countries (24% of the domestic production) in the last 5 years have increased by 21% in weight and decreased by 2% in value.

The total number of agricultural cooperatives in Lebanon is of 681. Since 1997, the rate of creation of new cooperatives has increased (+46%), where most of these cooperatives (supply and services cooperatives) were created to benefit from donations from the government, donors or non-profit organizations. Such structures, similar to the CUMA (cooperatives for utilization of agricultural machinery), despite their social benefits, will not be able to enhance production and increase farmer's revenues. One positive indication, however, is that farmers are capable to organize themselves into groups when there are common interests. Unless some exceptions, farmer groups and agricultural cooperatives of production and marketing are not active in Lebanon. On the other hand, around 40 small rural women cooperatives produce a large variety of processed products; these cooperatives contribute to increasing the value of agricultural production.

The Lebanese agriculture has known big transformations in the last 30 years especially during the civil war and later, in the last 15 years after the war, there were not any elaboration and planning of an agricultural strategy for development.

During the years of sixties, especially during the petrol prosperity in the Arab and Gulf countries, we have noticed the increase on the demand of some agricultural products: fruits, vegetables, and poultries. Lebanese farmers were pushed to increase their production to provide the Arab markets needs. The commercialization of the agricultural products was largely developed without leaving any chance to other socio-economic local contexts. All this have contributed to the disruption of the traditional agrarian systems in Lebanon and have made an irreversible change in the Lebanese agriculture orientation without instituting sustainable agriculture.

Since the civil war, the Lebanese agriculture has lost the most of its traditional markets. The emergence of new producers in the Arab countries, the irregular Lebanese production influenced by the conflicts and the absence of promoters looking for recent costumers taste, has progressively ended by decreasing the demand of Lebanese products. The Lebanese farmer had faced major problems in the absence of a national politic of reorientation.

Lebanon has signed many agreements for the trade of the agricultural products and is partner in the GAFTA (Greater Arab Free Trade Area) and EFTA (European Free Trade Area) which facilitates the transportation of goods in the mentioned zones.

Mohafaza	fruits	olives	cereals	Industrial crops	Gardening crops
Bekaa	37	6	57	62	57
North	23	40	23	15	28
Mount Lebanon	16	15	1	1	7
Nabatyeh	3	22	12	16	3
South	21	17	7	6	5
Total	**100**	**100**	**100**	**100**	**100**

Table 2. Percentage of the main agricultural speculations by Mohafaza

3.3. HYDRO GRAPHIC ORGANISATION

The Lebanese hydro graphic system is separated by the Western Mountains of Lebanon. From the Hydro geological side, the Lebanese territory is divided into two major regions: the Mediterranean Region (or Coastal Region) and the Interior Region (or Inland Basin). The rainfall in the Coastal Basin flows into the Mediterranean Sea and the rainfall in the inland Basin flows into the Bekaa. The Bekaa valley has two outlets: one to the north through the Orontes River (Al Assi) which flows out to Syria, and the other one to the south through the Hasbani River which flows out to Palestine. And beside them, the Litani River, the overwhelmingly largest river in the country, collects the major part of water in the plain and courses out to the Coastal Basin at the south of the plain. Lebanon's geology is denominated by fissured limestone where 60-66% (6597 km sq) of surface being composed of such rocks. This type of geological formation is permeable to water infiltration and favors the storage of underground water reserves.

3.3.1. The coastal zone

Many basins exist in this area due to erosion. 14 principal basins were identified. Only Nahr Al Kebir basin communicates with Syria in the Northern border of the country. Between these basins, secondary intermittent courses appear during winter and are almost inexistent in summer.

Table 3. Main and secondary basins on the coastal zone

N°	**Basin**	**Area in sqkm**
1	Nahr El Kebir	323
2	Nahr Oustouène	166
3	Nahr Arqa	135
4	Nahr El Bared	281
5	Nahr Abou Ali	493
6	Nahr El Jaouz	199
7	Nahr Ibrahim	326
8	Nahr El Keleb	280
9	Nahr Beyrouth	229
10	Nahr Damour	306
11	Nahr Awali	311
12	Nahr Saitaniq	108
13	Nahr Zahrani	101
14	Nahr Abou Assouad	154
	Part of Nahr Litani	514
Total 1		**3 924 km²**
15	Between El Kébir and Aassi	15
16	Between Oustouène and Arqa	36
17	Between Arqa and El Bared	58
18	Between El Bared and Abou Ali	51
19	Between Abou Ali and El Jaouz	249
20	Between El Jaouz and Ibrahim	260
21	Between Ibrahim and El Keleb	102
22	Between El Keleb and Beyrouth	73
23	Between Beyrouth and Damour	160
24	Between Damour and Awali	92
25	Between Awali and Saitaniq	30
26	Between Saitaniq and Zahrani	51
27	Between Zahrani and Abou Assouad	154
28	Between Litani and boundary	536
Total 2		**1 867 km²**
Total Coastal Basins		**5 791 km²**

3.3.2. The Interior zone

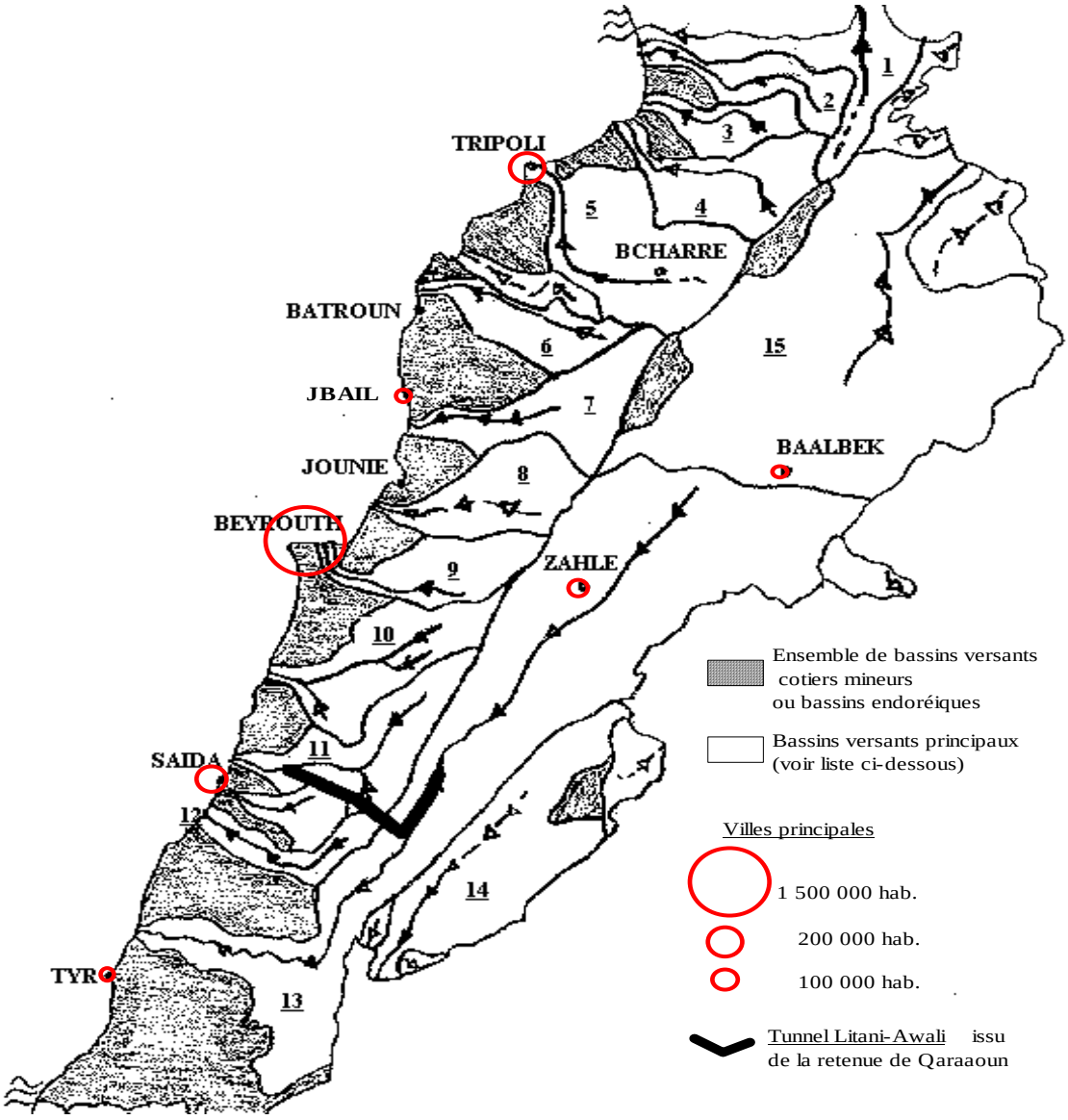
Three main basins appear in this zone:

- The Litani, collecting the Bekaa's water, and discharging it in the sea north to Tyr.
- Oronte (Assi) goes to the Syrian border. Its flow is constant all over the year.
- Hasbani, is one of the Jordan effluents.

Table 4. Main and secondary Basins in the Bekaa

N°	**Basin**	**Area in sqkm**
1	Nahr Assi	2 168
2	Nahr Litani	1 757
3	Nahr Hasbani	562
Total 1		**4 486**
4	Between Litani and Hasbani	175
Total 2		**175**
Total Eastern Basins		**4 661 km²**

Figure 4. Water resources in Lebanon (Source: CDR – Lebanese Republic)



1	Nahr el Kébir	**6**	Nahr Jaouze	**11**	Nahr Awali
2	Nahr Ostouène	**7**	Nahr Ibrahim	**12**	Nahr Zahrani
3	Nahr Aarqa	**8**	Nahr el Kelb	**13**	Nahr Litani
4	Nahr Bared	**9**	Nahr Beyrouth	**14**	Nahr Hasbani
5	Nahr Abou Ali	**10**	Nahr Damour	**15**	Nahr Aassi

Figure 5. Map of main basins in Lebanon

3.4. WATER BALANCE AND IRRIGATION

The climate of Lebanon is typically Mediterranean, humid to sub-humid in the wet season and semi-arid in the dry season. The wet season coincides with winter period, which lasts from October till May, whereas the dry season coincides with the summer period, which lasts from June till September. During this period, no rain is recorded and a state of high pressure dominates the whole country. Average annual rainfall in Lebanon is estimated at about 860 mm, and varies from 250 to 1,000 mm depending on the location. About 50% are evaporated and only 2280 MCM are available. Concerning water resources v/s demands, we consider a dry year with a recurrence interval of 10 years. Based on studies carried out on various water courses, it is possible to estimate the 10 year drought flow to be equal to 66% of the annual drought flow.

Table 5. Annual water balance in Lebanon (FAO, 2001)

Description	Average yearly flows (MCM)
Precipitation	8600
Evapo-transpiration	4300
Unexploited ground water and ground water	880
Ground water losses to lake Houla	150
Losses to Syria: Assi River El Kabir River	 415 95
Allocation to Lebanon from El Assi	80
Losses to Palestine: Hasbani River	160
Exploitable ground water	400
Net potentially available surface flow	**2280**

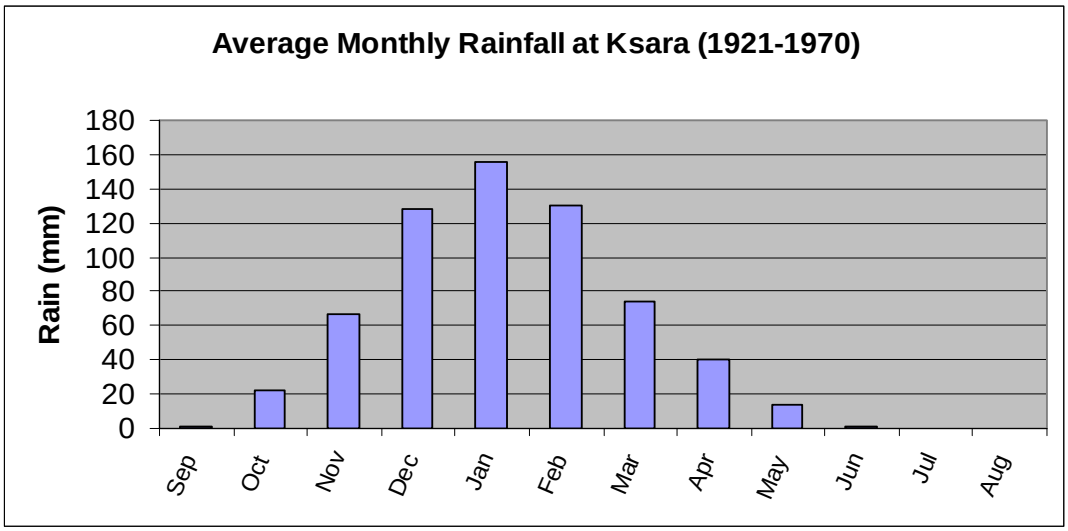


Figure 6. Annual distribution of precipitations

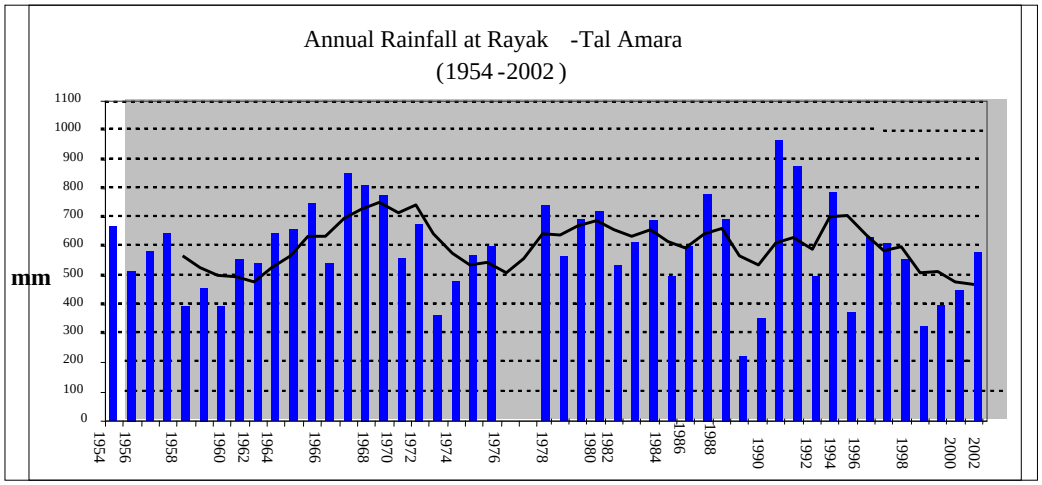


Figure 7. Annual rainfall (1954 - 2002) in the Bekaa Valley

Water demand for domestic use is 150-175 litres/capita/day, whereas the losses in water supply and conveyance in new networks are about 20-30%. The Industrial demand is equivalent to 30% of domestic demand according to World Bank reports. The following graph shows the requirements in each sector in MCM:

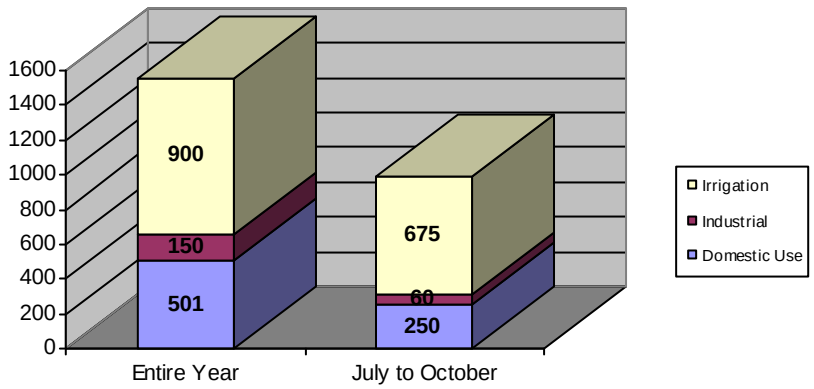


Figure 8. Water demand (MCM) per sector of activity

The surface irrigation represents 64% of the total irrigated area; the sprinkler irrigation represents 28% and the drip irrigation 8%. 48% of the total volume of water consumed for irrigation is supplied from surface sources and 52% are withdrawn from groundwater aquifer (global results of agriculture census, FAO/MOA, 2002).

The agricultural surface planned to be irrigated in 2030 is estimated to 180,000 ha. The Average consumption of water for irrigation including losses in conveyance and distribution networks is:

10,000 m^3/ha/year for the year 2003
9,000 m^3/ha/year for the year 2010
8,000 m^3/ha/year for the year 2020
7,000 m^3/ha/year for the year 2030

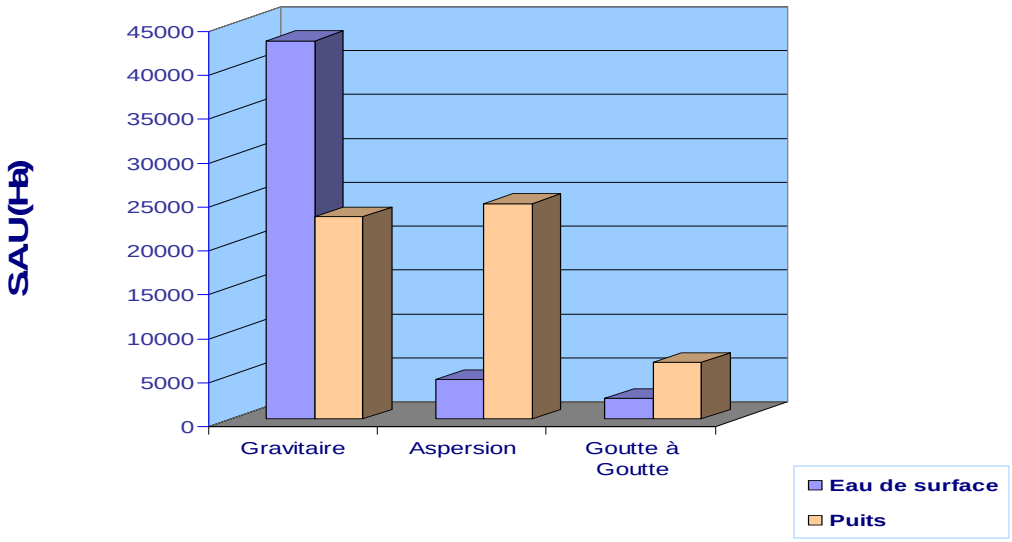


Figure 9. Irrigation techniques and Source of water per Irrigated Area

The water demand for Irrigation was estimated to 782 MCM in 2002 and is being projected to grow up during the next 25 years to reach 1435 MCM.

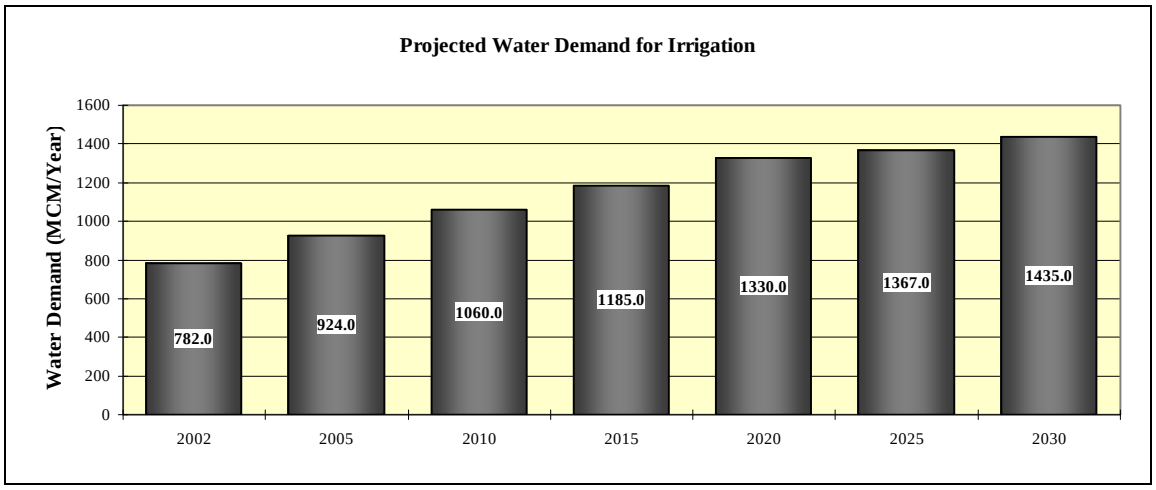


Figure 10. Projected water demand for irrigation in Lebanon (Comair F., 2004)

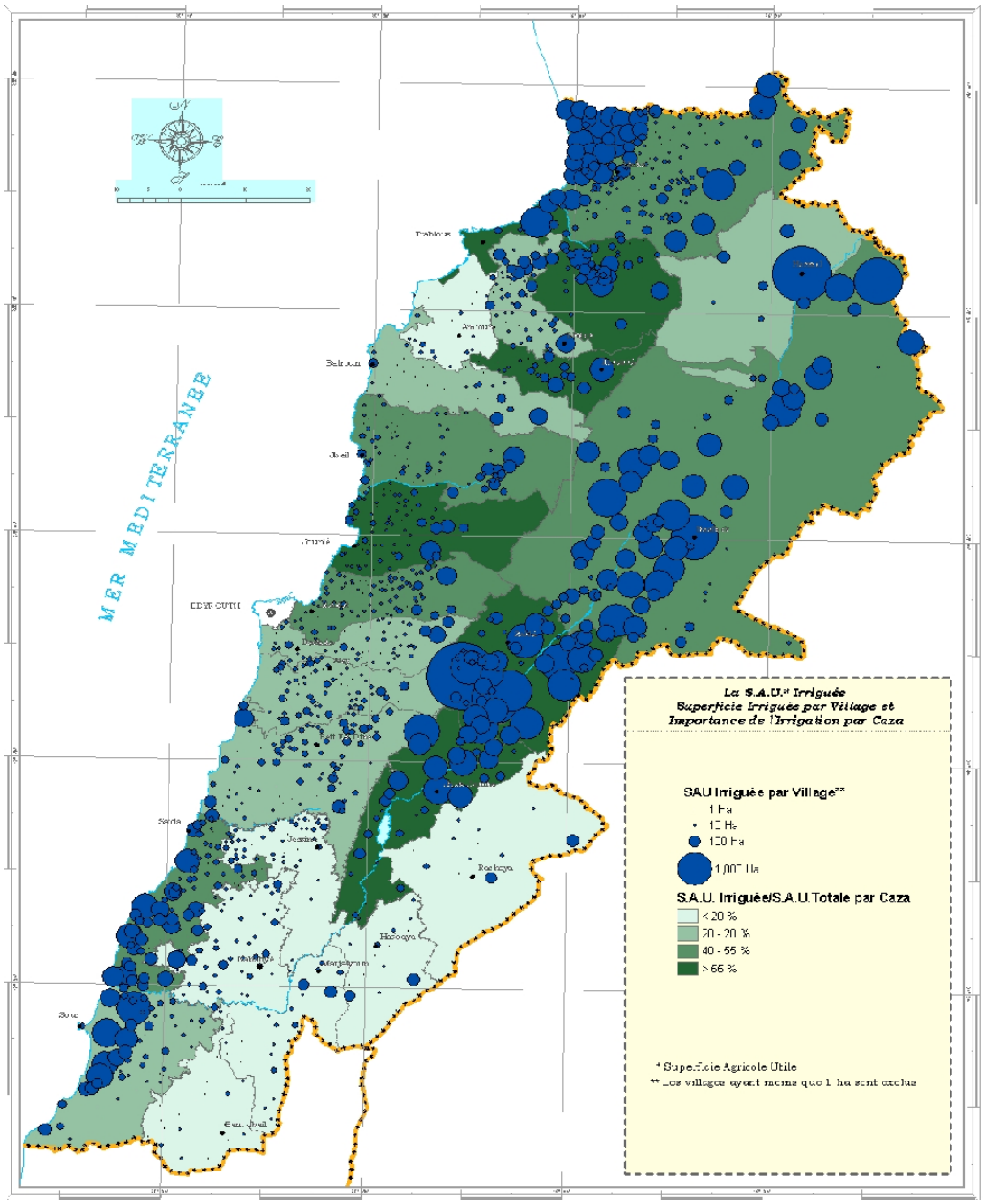


Figure 11.Distribution of Irrigated Area per village and Importance of Irrigation per District. (Source: FAO/MOA, 1999)

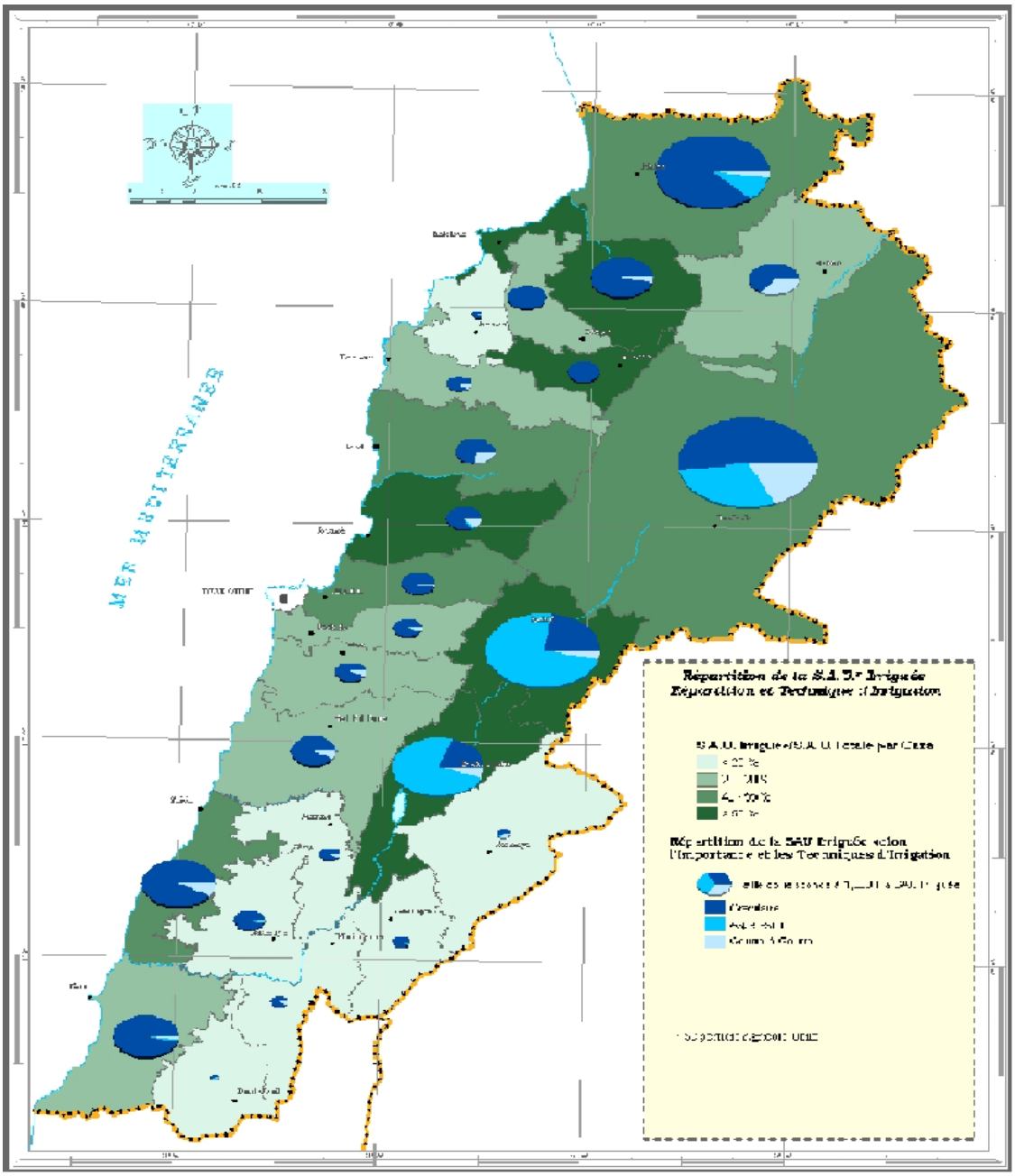


Figure 12.Distribution of Irrigated area and irrigation techniques per District. (source: FAO/MOA, 1999)

The agricultural Land is estimated to about 261000 ha in 2002, where the net irrigated area is about 118000 ha. The Bekaa valley represents 38% of the total agricultural Land and 57% of the total irrigated area. Figures 11 and 12 show that in the South Bekaa region irrigation is very important and the irrigated area is more than 55% of the total. Sprinklers irrigation is dominating.

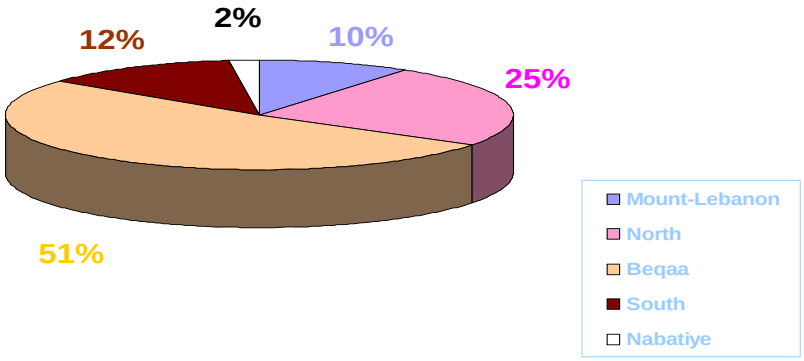


Figure 13. Distribution of Water irrigation quantity per District

3.5. INSTITUTIONAL AND LEGAL FRAMEWORK

3.5.1. Historical background

Long time ago and especially after the period of agrarian stabilization, all human organizations living in Lebanon have always chosen to be installed next to water resources. Most of the communities have developed practices and customs, even rules managing water uses, as a natural source, and to adjust it according to the demographic development of the rural population. Each community tried to find an appropriate solution to make balance between the needs and the resources, especially in irrigation where agriculture occupied the main activity.

Historically, irrigation practices in Lebanon have been divided in five periods:

1- Centuries ago until the end of the First World War.
2- The period of the French mandate in Lebanon.
3- From the independence till the Lebanese civil war in 1975.
4- Period of war between 1975 and 1990.
5- Actual period since 1990.

a) Centuries ago until the end of the First World War

For centuries, the irrigation management was lead through customs and practices which were usually unwritten, but transmitted from generation to another. These customs have established some rules managing the practical uses of water and particularly its exploitation in irrigation. Two principles were held:

- Avoid disputes between users.
- Ensure a fair distribution of the water within the concerned rural population.

These customs were not definitely legislated till 1733, date of publication of a treaty named "Moukhtassar El – Shariaa" (Summary of the legislation) in Lebanon during the "Chehab Emirs" period, by the bishop of Abdallah Qhorra Ali. In this global juridical treaty, we can find a complete

text concerning the water use, law and forms of distribution of common canals between different properties.

The treaty contained definitive elements about irrigation where there is an "obligation for the users of a canal to re-establish it in their own properties, and if one of the users re-establish a canal from his own money, then he has the right to ask for participations from the other users proportionally to their use, and if someone refused to pay, he will be prohibited to use the water unless if he proved that the re-establishment was not necessary".

Also, this treaty reflected how the water rights have been defined: most of the chiefs and powerful persons having financial capacities to re-establish canal and bring water, have benefit personally from these "acquired laws" at different levels: water distribution and land selling with irrigation rights. By the time these rights were transmitted from a generation to another and finally fixed by the legislation.

After a considerable period, a huge step in this domain was represented in the publication of the ottoman legislation under the name of "Mdjelle" between 1870 – 1876. This code has transformed a big part of these customs into juridical texts. Since that moment, the use of water has marked definite criteria and references that are still applied in Lebanon. The Medjelle Law confirms that the ground water is a community property. Concerning the Rights of use, Water was considered as not saleable good, and rights of use refer to the customary law as the drinking water (the right to satisfy the thirst) that any owner can not refuse to a potential user.
We can take the example of "Herim" the article dealing with the protection of the different sources of water: shafts, sources, rivers and canals.

Concerning the irrigation, two codes were published at the end of ottoman period:

- The first in 1913: the customs and the practices in the domain of irrigation.
- The second in March 1918: the repartition of the common canals of irrigation and the relative works of renovations.

The code of 1913 is the only one concerning the water uses in the agricultural domain. This code is still practiced in Lebanon despite its flaws in methodology and redaction. Not any significant amendment has been taken to modify it.

The first eight articles in this code define the different parts of an irrigation network according to the ottoman system. The Lebanese legislator has kept the same Turk nomination: *Yadock, Khork, Aghzalog, Sanjak, Ayak and Ughin*, indicating the main and second ramification of an irrigation network and the water drainage in the agricultural properties.

"The article 8, differentiates between the public property which gathers all the ramification of the irrigation network including the other infrastructures related to the managing authority which is responsible of its restoration, and the private property which is only responsible of the restoration of the drainage network and all there particular constructions on the private ground.

The article 10 dictates an obligation to all the owners of down stream land to accept the discharge of the water coming from the up stream land owners which are obliged to avoid any damage on down stream lands.

Another rule in this code defends any owner to stop any works for establishing an irrigation network or drainage especially if these works have been given by the responsible authorities (article 11).

Particulars are responsible of renovation and cleaning of the networks which they have established and used, under the watchful eye of the water agency. If the number of owners is limited and having not the financial capacities to achieve the work, the water agency will do it from its own financial resources and will recover it after the harvest period.

The legislative code issued on March 1918 mentioned the relative judgments of cleaning and renovation of common canals. All the eligible parties or users will be forced to participate into the cleaning and the renovation. The agency has the authority to fix the engagement of each user under financial sanctions.

Many other articles concerning damages, establishing irrigation networks or drainage, payments, particular authorizations…are included in the legislation.

b) The period of the French mandate in Lebanon

During this period, many legislations were published: the decree 144 S of June 10, 1925 and the decree 320 of May 29, 1926 which are considered fundamental for the water sector in Lebanon.

1- Decree 144 S of the 10th of June 1925 concerns the public property of water and the related legal dispositions such as :

   - Definitions (beaches, water-courses, underground water, rivers, falls…).
   - Limits of public goods.
   - Occupation of public goods.
   - General dispositions

2- Decree 320 of the 29th of may 1926 concerning the protection and the use of public water domain:

   - Status of water as a public good and its protection.
   - Limits of the perimeters of protection defined by the authorities.
   - Dispositions concerning the permissions and the concessions.
   - Dispositions on the creation of water users associations.
   - Liquidation of "acquired rights".
   - Juridical authorities and penalties
   - Cancellation of contradictory dispositions.

We have to note that the article 6 of this decree has instituted to the citizens the possibility to dig wells to explore underground water under the condition of presenting a demand to the managing authorities who has to answer in a time limit of 4 months.

Due to the absence of planned irrigation projects during this period, all the elaborated legislations have been general and haven't matched the purpose of developing the agricultural use of water.

c) From independence (1943) till the civil war (1975)

After the independence (1943) we have assisted to the elaboration of many codes and legal texts relative to water use.

- The law of December 14, 1963 that has forbidden the prospecting the underground water for 2 years in the Bekaa.
- The decree number 14438 of May 2nd ,1970, organized the prospection and use of underground water according to the article 6 of the decree 320 of the 29th of may 1926.

Prospecting the underground water is essential for the agricultural production, especially in the regions where there is no possibility to explore any source of water and where no development plans have been implemented.

Despite the absence of a clear methodology and the fast edition of the decree, it has constituted the first important approach for organizing the exploration of underground water in Lebanon according to two criteria:

- The wells depth (+ or – 150 m).
- The type of use (domestic, agriculture, industrial).

More than 200 Committees and 22 offices were created under the supervision of the ministry of Hydraulic and electric resources (MHER) to organize the water use and eliminate the private rights. In 1972, a decree proposed to reorganize these committees into 5 institutions (one is by District) and to create a higher authority of water planning within the MHER.

The government is charged of the authorization and the control of water use. Rights of use, existing since a previous juridical regime, can also be eliminated by the purge procedure.

The government was also responsible for the protection of the private individual's water rights and therefore had to prevent a non authorized exploitation. The pollution's control has been carried out by the ministry of public health and by the ministry of the environment.

Waste water management and treatment were accorded to municipalities (Decree 8735 of august 23, 1974 and decree 118 of June 30, 1977) controlled ministry of the interior, and other several authorities (ministry of public health, ministry of housing and coop, agency of big projects in Lebanon, executive council of Beirut's big projects, council for the south Lebanon).

The major action during this period was the creation of the Litani River Authority in 1954 amended by the law of December 30 of 1955, and has 4 missions:

- To execute the **project of Litani River including irrigation**, marsh draining, potable water, hydroelectricity, in accordance with the services of the state and the support of the American technical mission.
- To establish a junction network between the electrical units in Lebanon.
- To establish transformation stations and distribution networks in Lebanon.
- To exploit the different phases of the project in technical and financial aspects.

d) Period of war between 1975 and 1990

The civil war in Lebanon interrupted the execution of many projects especially those concerning the optimal exploitation of water resources in the Litani River and many others.

The infrastructures of hydraulic systems have been destroyed especially the measurement and survey stations on different networks and sources; essential tools for future planning were lost.

Many offences were caused at different levels:

- Prospecting underground water.
- Anarchic development of habitation in the rural zones and the invasion of the cement on large areas that have been planed as irrigated zones before the war. It's necessary to review all this plans.

Also the civil war has influenced the water usage and the balance between domestic, agricultural and industrial use which have totally changed. Reestablishing the distribution of water resources between sectors still an evident and urgent step in the future planning.

e) Actual period (since 1990)

After 15 years of civil war, Lebanon has been forced to review many dispositions related to water use to recapture the missed period of war. The reestablishment of plans, projects and legislations, constitute a necessary step.

The main actions that have marked this period:

1- Promulgation of many amendment of laws and decree–law since 1993 especially the one that incorporated the waste water to the ministry of energy and water.
2- The collaboration with the World Bank for an institutional reorganization of the water sector. This collaboration succeeded in creating the law 221 of the 29th of May 2000.
3- Reestablishment and modernization of the water distribution system in the Qasmieh-Ras El Ain irrigation project between 1996 and 1998 with a loan given by the World Bank.
4- Execution of the first phase (2000 hectares) of the irrigation projects in the South Bekaa irrigation scheme and the infrastructures of the second phase (6700 hectares).
5- Since 1990, and after the destruction of many measurement stations, the LRA has hardly worked to stimulate these services: computerizing the measures and construction of new measurement stations equipped with modern materials. At the moment, the network is constituted by 30 stations established on the water – courses, a dozen of stations on the canals and a dozen of stations on the main sources.

3.5.2. The new Water regulation (law 221/2000)

The water sector in Lebanon has been restructured by the law 221/2000 (May 29, 2000). The law noticed that the protection and the development of the water natural resources is considered in the heart of the public interests. The law delegates to the Ministry of Energy and Water several tasks of which:

- Controlling, measuring, studying, calculating and establishing statistics related to water resources. Also it should evaluate the water demand and its usage in the different regions.

- Controlling the surface and underground water quality and fixing the correspondent criteria's.
- Establishing and planning the general directive on drinking and irrigation water distribution.
- Studying and executing the major hydraulic installations as dams, tunnels and others.
- Feeding, upon needs, the water table and controlling the pumped volume.
- Giving the authorization to create wells.
- Undertaking research and studies on water, geology and hydrology and collecting the technical data.
- Controlling the institutions and organizations dealing with water sector.
- Reinforcing and controlling the performance of these institutions.

Also, 4 Water Authorities (Beirut and Mount Lebanon, North Lebanon, South Lebanon, and Bekaa) were created by the same law in addition to the Litani River Authority for the Management of the Litani River Basin.

The tasks of the Water Authorities are:

- Studying, executing, maintaining and renewing schemes for drinking, irrigation and waste water.
- Suggest water tariffs according to the socio-economic situation.
- Controlling the drinking and irrigation water quality.

The LRA created in 1954 is responsible of the irrigation water management in the south Bekaa and South Lebanon and the valorization of the Litani river basin.

Unfortunately the current law isn't fully implemented as it is written due to heavy administrative procedure and the absence of appropriate decrees of application.

The Ministry of Agriculture is responsible for the "on farm" extension in irrigation techniques and efficiency. The "green plan" created in 1963 under the governance of the ministry of Agriculture develop small lakes in mountains and the small irrigation projects.

The Council of Development and Reconstruction, created in 1977, is taking in charge the financial aspects. It is also dealing with international financing bodies for the projects execution.

3.6. WATER USERS ASSOCIATIONS REGULATION

In 1926 (French mandate), the decree 320S regulates the WUA activities, which are Land Owners Association. The objectives of these institutions are:

- Protection of lands against temporary or permanent water courses.
- Clearing, deepening, straightening of water courses.
- Drying and draining wet lands.
- Sealing or filling in marshy lands.
- Irrigation.

Since its issuing, only 1 WUA has been created within this decree, in the northern part of the country, but without any traces.

The French mandate has elaborated the same decree in Lebanon, Morocco, Algeria and other occupied countries. It has never been adapted to the local specifications or to social realities of the

countries. Its articles include many administrative complications: In fact, the heavy routine procedures make it not applicable at all. One of the points raised was the direct supervision of the "President" of the country in the different phases of creation, implementation and administration of the WUA. This can give an explanation for the unique Association created in Lebanon in the 40's.

3.7. THE 10 YEAR PLAN OF THE MOEW

Facing the problems of the water sector, the Lebanese government searched for solutions to ensure the sustainability of water resources especially for the irrigation sector (65-70% of the water use).

The General Directorate of Hydraulic and Electric Resources in the MOEW has proposed a 10 year plan in order to satisfy the water needs of the population in several sectors and ensure Additional Water Resources.

The water deficit in Lebanon is about 700 MCM/year for a normal precipitation year and is being increased during the dry years. It is also affected by the increasing needs for water.

During the dry season, the scarcity of springs discharge and the overuse of water by the administration and individuals lead to decrease the water table levels.

The MOEW raised the necessity of winter water storage to be used in dry season by preparing hydro geological plans, studying the possibility of storing underground and surface water with the necessary infrastructures to insure artificial feeding, and executing the construction of dams and hill lakes in some regions.

It also studied the current and the future demands for irrigation and irrigated area. The cultivated land in Lebanon according to the regions was divided in:

1) Coastal plains planted with fruit trees represented by citrus, bananas and vegetables with water supplied from the nearby rivers.
2) Mountainous areas planted with fruit trees represented by apple with water supplied from small springs that emerge at high elevation.
3) Bekaa plain planted with vegetable crops using water from nearby rivers and groundwater aquifer.

According to each region, a calculation of irrigation requirement, were prepared based on the crop evapo-transpiration and irrigation efficiencies (Tables below…..).

Table 6. Diversion Water Requirement for Surface Irrigation

	Vegetable	Potato	Cereals	Sugarbeet	Cotton	Tobaco	Olive	Grape	Banana	Citrus	Wheat
North Lebanon	9083	7850	8600	8350	9083	6717	6017	8383	12050	9983	4900
North Mountain	10317	9033	9717	9317	6933	7700	6767	9350	13683	11050	5550
Central Lebanon	10967	9567	10283	9917	10917	8167	7817	10633	15683	12633	6917
Central Mountain	8100	7083	7700	7317	7950	5967	5033	6883	10300	8250	3650
South Lebanon	9833	8567	9400	8950	9617	7167	6217	8350	12317	9875	4233
Inland Assi	13350	11833	12683	12650	13717	10033	9800	13150	19083	15517	7633
Inland Litani	12033	10600	11400	11133	12183	8967	8517	11450	16633	13450	6617
Inland Hasbani	4863	8400	9167	8757	10067	7067	6817	9250	13567	10983	5183
Average	**9818**	**9117**	**9869**	**9549**	**10058**	**7723**	**7123**	**9681**	**14165**	**11468**	**5585**

Table 7. Diversion Water Requirement for Sprinkler Irrigation

	Vegetable	Potato	Cereals	Sugarbeet	Cotton	Tobaco	Olive	Grape	Banana	Citrus	Wheat
North Lebanon	7786	6729	7371	7157	7786	5757	5157	7186	10329	8557	4200
North Mountain	8843	7743	8329	7986	5943	6600	5800	8014	11729	9471	4757
Central Lebanon	9400	8200	8814	8500	9357	7000	6700	9114	13443	10829	5929
Central Mountain	6943	6071	6600	6271	6814	5114	4314	5900	8829	7071	3129
South Lebanon	8429	7343	8057	7671	8243	6143	5329	7157	10557	8464	3629
Inland Assi	11443	10143	10871	10843	11757	8600	8400	11271	16357	13300	6543
Inland Litani	10314	9086	9771	9543	10443	7686	7300	9814	14257	11529	5671
Inland Hasbani	4169	7200	7857	7506	8629	6057	5843	7929	11629	9414	4443
Average	**8416**	**7814**	**8459**	**8185**	**8621**	**6620**	**6105**	**8298**	**12141**	**9829**	**4788**

Table 8. Diversion Water Requirement for Drip Irrigation

	Vegetable	Potato	Cereals	Sugarbeet	Cotton	Tobaco	Olive	Grape	Banana	Citrus	Wheat
North Lebanon	6813	5888	6450	6263	6813	5038	4513	6288	9038	7488	3675
North Mountain	7738	6775	7288	6988	5200	5775	5075	7013	10263	8288	4163
Central Lebanon	8225	7175	7713	7438	8188	6125	5863	7975	11763	9475	5188
Central Mountain	6075	5313	5775	5488	5963	4475	3775	5163	7725	6188	2738
South Lebanon	7375	6425	7050	6713	7213	5375	4663	6263	9238	7406	3175
Inland Assi	10013	8875	9513	9488	10288	7525	7350	9863	14313	11638	5725
Inland Litani	9025	7950	8550	8350	9138	6725	6388	8588	12475	10088	4963
Inland Hasbani	3648	6300	6875	6568	7550	5300	5113	6938	10175	8238	3888
Average	**7364**	**6838**	**7402**	**7162**	**7544**	**5792**	**5342**	**7261**	**10623**	**8601**	**4189**

Concerning the drinking water, the Ministry started to rehabilitate the networks, reinforce their capacities or even find new water resources to follow up with the daily increase of water needs of the population.

The wastewater volume was increased with the population growth mainly in big cities. The strategy is to build about 20 treatment plants in Lebanon of which 6 have been tendered and these could serve about 70% of the Lebanese population. The treated water will be used either for irrigation or for the recharge of the aquifer.

3.8. WATER PRICING

Water in Lebanon is a considered as a common good, but due to the dryness for 7 consecutive months the water resources became limited and could generate some conflicts.

In 1970, the decree 14438 fixed the taxes for wells foundation, water consumption for irrigation, industry and drinking.

In 1990, the decree 547 has increased the previous taxes. Also the decree 13034 of September 11, 1998 fixed the water tarification as follow:

- Well foundation: 1 000 000 LBP (550 €) in a public area, and 500 000 L.L. (275 €) in a private area.
- Irrigation water: 100 LBP / m^3 (or 0.055 €/ m^3).
- Industrial purpose water: 600 LBP/m^3 or (0.33 €)/ m^3.

In the South Bekaa irrigation scheme, water pricing was supposed to be binomial (fixed allocation per hectare + allocation per water consumption). But the LRA, during the first years of functioning, have proceeded to apply promotional prices for irrigation to motivate farmers to use the canal 900 water. The current tariffs are: 300 000 LBP / Ha for the winter crops and 600 000 LBP / Ha for summer cops (respectively 175 € and 350 € per hectare). These tariffs were proposed due to the high competition with private wells who sell water for irrigation with lowest cost. Currently farmers are using the canal 900 water due to the increase of fuel prices which increases the production costs.

The number of legal wells in Lebanon doesn't exceed 1% of the total number. This situation increases the uncontrolled water consumption and decreases the water table level.

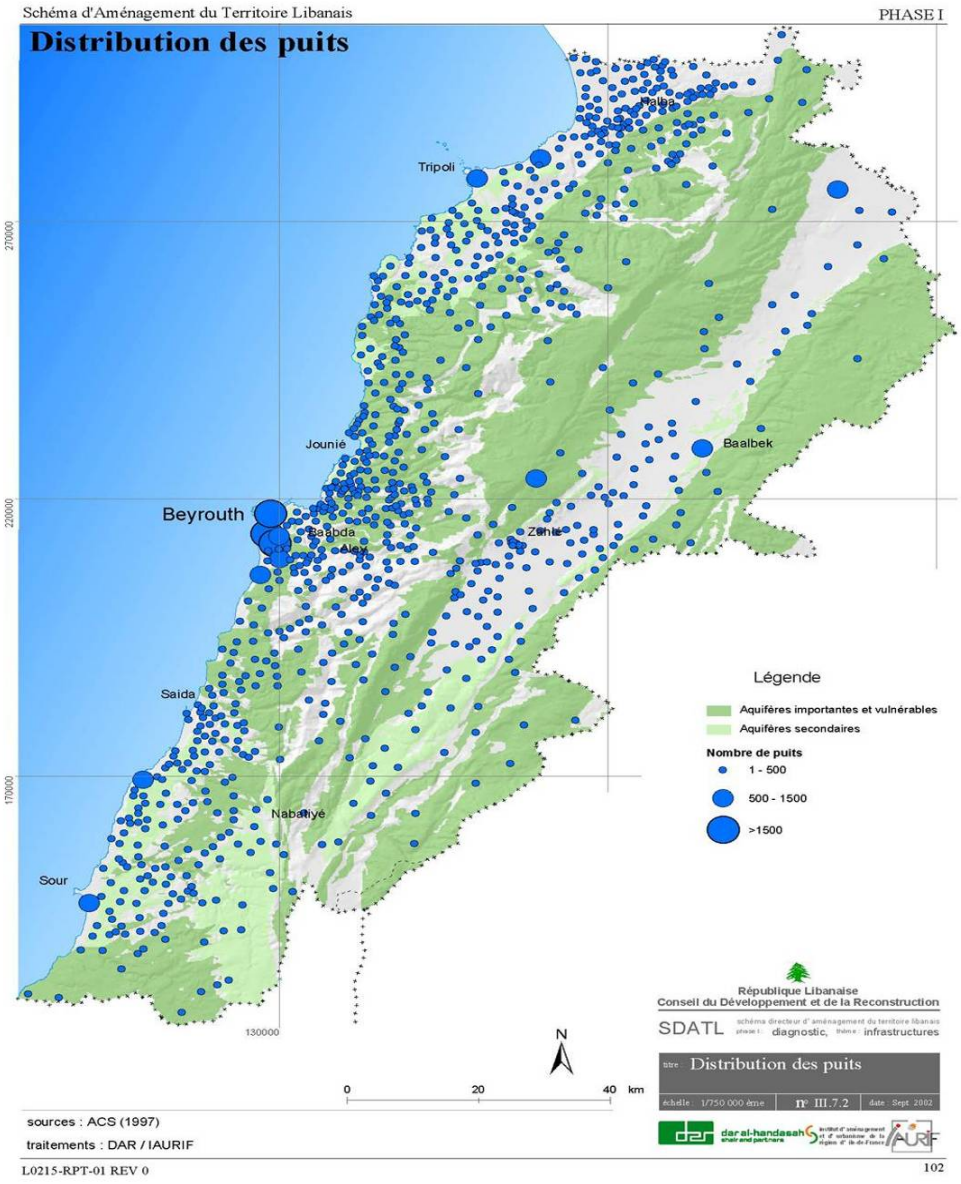


Figure 14. Wells Distribution in Lebanon

4. REGIONAL CONTEXT: THE BEKAA VALLEY

4.1. GENERAL PRESENTATION

The Bekaa valley, situated on the Eastern side, is covering 43% of the Lebanese area. It is characterized by the fertile lands and was considered "the Roman Empire silos". The population is estimated to 870 000 inhabitants. It's the main agricultural region in the country and is consuming around 51% of water irrigation.

The Bekaa is divided into 5 districts:

1. **Zahleh:** in the centre with 42 villages and the city of Zahleh, with 300 000 inhabitants.
2. **Baaalbeck:** in the North with 146 villages and the city of Baalbeck with 350 000 inhabitants.
3. **Hermel:** in the North with 81 villages and the city of Hermel with 75 000 inhabitants.
4. **West Bekaa:** in the south with 37 villages and around 110 000 inhabitants.
5. **Rashaya:** in the South-East with 28 villages and 35 000 inhabitants.

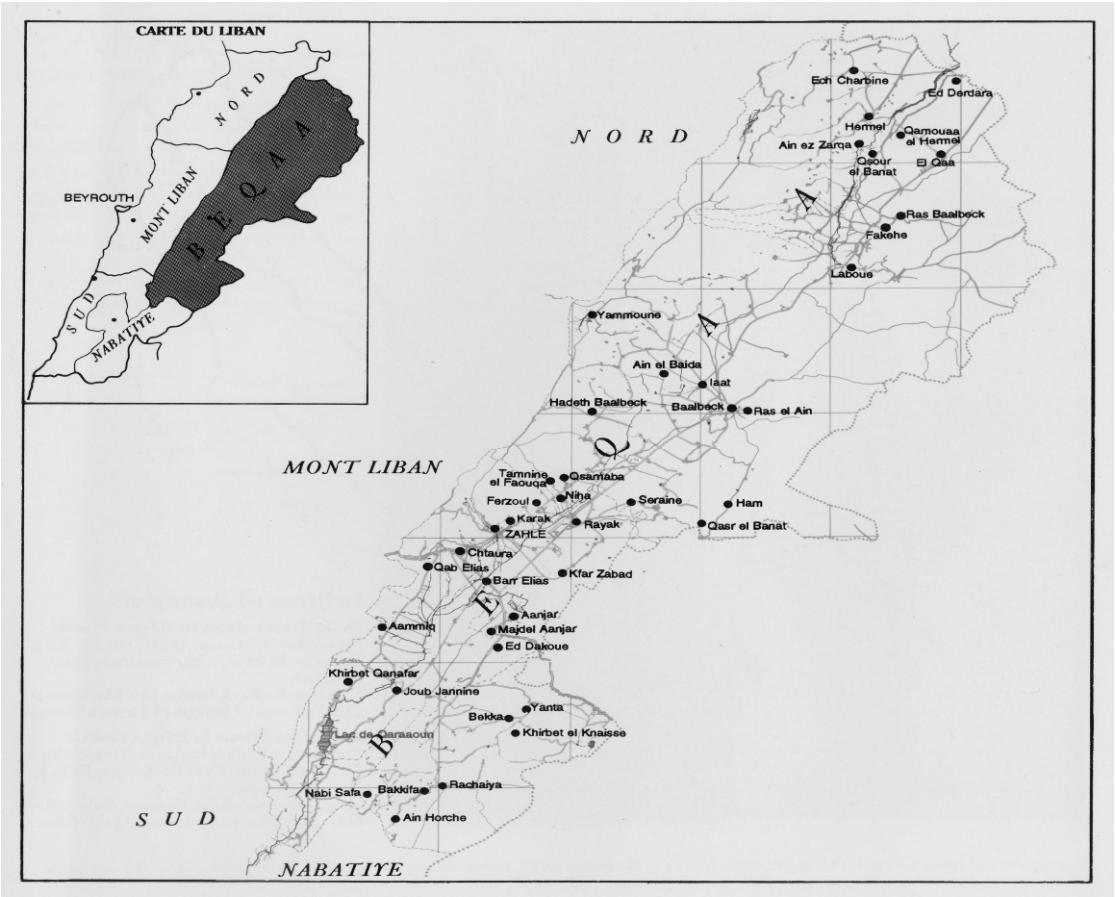


Figure 15. Map of the Bekaa valley

The Bekaa is a large plain situated on an average altitude of 900 m with 120 km of length and 7 to 20 km in large. It is surrounded by mountainous chains of mount-Lebanon and the Anti-Lebanon and constituted by three main parts. A first Nordic part, the biggest one and the less populated, is a dry

region crossed by the Orontes River which constitutes the main water resource but not too much exploited in the irrigation unless by some farmers who owns parcels next to the river. A second part, central, is the most populated and exploited, and characterized by the presence of fertile and deep soils. A third and last part is the West Bekaa that has almost the same agricultural qualifications as the central part and are both crossed by the Litani River and its tributaries.

For the hydro-climatic aspect, the Bekaa is considered as a semi-dry region where the Mediterranean rainfall rhythms are irregular, extensive in a cold and humid winter season and minimal or even rare in dry and hot season from April till October. The annual precipitation varies between the northern side which receives 250 mm and the central and southern parts receiving 600 and 800 mm respectively.

During the war and even after, the northern region was known for the illicit cultures which were the main source of revenue for the population. Since the year 1991, the Lebanese government decided to forbid this culture without proposing any plans of development to substitute the "Hashish". The UNDP program launched in 1994 couldn't give any alternative for the region. Few development programs succeeded to implement some substitution crops essentially the vine grapes in Ainata and neighbourhoods.

176 cooperatives exist in the region but few of them are functional; they represent 26% of the total number of the country.

4.2. BEKAA'S AGRICULTURE

The agricultural census of 1999 showed that the farmers' number in the Bekaa is about 35146 (18% of total in Lebanon) on a useful agricultural superficies of 102948 hectares. The following table shows the farmers repartition in the different Bekaa districts:

Table 9. Distribution of SAU and farmers per district in the Bekaa (Agricultural Census FAO/MOA, 1999)

Caza	Nb of farmers	SAU (Ha)	Irrigated SAU (Ha)
Zahle	5405	200751.9	161035.3
West Bekaa	5208	155225.6	104330.7
Baalbek	18846	557535.2	236054.7
Hermel	2979	81227.9	32085.0
Rachaya	2708	34707.7	3110.2
Bekaa	**35146**	**1029481.3**	**536616.0**

The number of farmers without superficies is about 1327 in the Bekaa and is mainly practicing animal production. 50.1% of farmers have less then 1 hectare of SAU (75% on national level) and exploit only 6.3 % of the SAU. On the other hand, the farmers having more than 4 hectares represent 16 % of the total and dispose 70.6% of SAU. On the National Scale, the Bekaa (18% of number of farmers) is in the third place after South Lebanon (29%) and Mount-Lebanon (21.6%).

Women farmers are 1177, representing 3.35% (7% on national scale) of Bekaa farmers, from whom 55.4% are more than 55 years old. Globally, farmers having more than 65 years old represent 19.7% of total number. On the other hand, young farmers under 35 years old are 14.2%.

The average of useful agricultural superficies per farmer increases with age, it's about 2 hectares (1 ha on the national scales) only for the farmers who are under 25 years old, it reaches 2.7 ha for those

between 24 and 45 years old. It also progresses, for the section between 45 and 55 years, to 3 ha and reaches its maximum of 3.1 ha for the farmers between 55 and 65 years old. The following table resumes the repartition of the SAU per farmers' age sections

Table 10. Distribution of SAU per farmers' age (Agricultural Census FAO/MOA, 1999)

Section of age	Nb	SAU/Ha	%
Non concerned	41	1237.56	1.2
<25 years	775	1446.25	1.5
25 to 34 years	4901	13090.46	12.7
34 to 44 years	7881	21217.49	20.6
45 to 54	7935	23737.26	23.1
55 to 64	6976	21852.93	21.2
> or = 65 years	6637	20316.16	19.7
Total	**35146**	**102948.1**	**100**

15.8 of farmers are illiterate (the same average on the national scale) and exploit 14.7 % of the useful agricultural superficies. The farmers having the basic education in primary school constitute 61.5 % of the total number of the farmers and dispose from 56.5% of total useful agricultural superficies.

For non agricultural activities, 44.6 % (34% at the national scale) farmers participate exclusively to the agricultural activities and dispose from 60.3% of the total useful agricultural areas, with an average of 3.69 ha (1.84 ha following the national scale) per farmer. The other farmers, about 55% work at the same time in other activities and owns almost an average of SAU less than 2.1 ha.

Globally, the average SAU per farmer is maximal in the Bekaa 2.93 ha comparing to the national level which is about 1.27 ha.

The irrigated superficies in the Bekaa is 53 661.6 ha (52 % of SAU). This average reaches 55.8% for the farmers who own less than 0.1 ha of the SAU and decreases progressively (31.5%) for the farmers who owns between 0.5 and 2 ha. This average progresses to 55 % for the farmers who own more than 10 ha of SAU. We can notice that the appeal to irrigation practice increases with the increase of the exploitation dimensions starting from 2 ha. 68% of water resources used in irrigation is from the underground and 32 % from the surface. Concerning the irrigation processing in the Bekaa, there is a remarkable development of water savings techniques (drip, sprinklers), in opposition to surface irrigation with 37.5% of irrigated SAU of which 38.2% is pumped from underground water.

Table 11. The SAU in the Bekaa in accordance with the sources and the mode of irrigation (Agricultural Census FAO/MOA, 1999)

Source of irrigation	Irrigated SAU (Ha)	Surface irrigation (Ha)	Sprinkler (Ha)	Drip (Ha)
Surface water	17205.5	12427.3	3682.5	1095.6
Underground water	36456.1	7696.2	23472.3	5287.6
Total	**53661.6**	**20123.5**	**27154.8**	**6383.2**

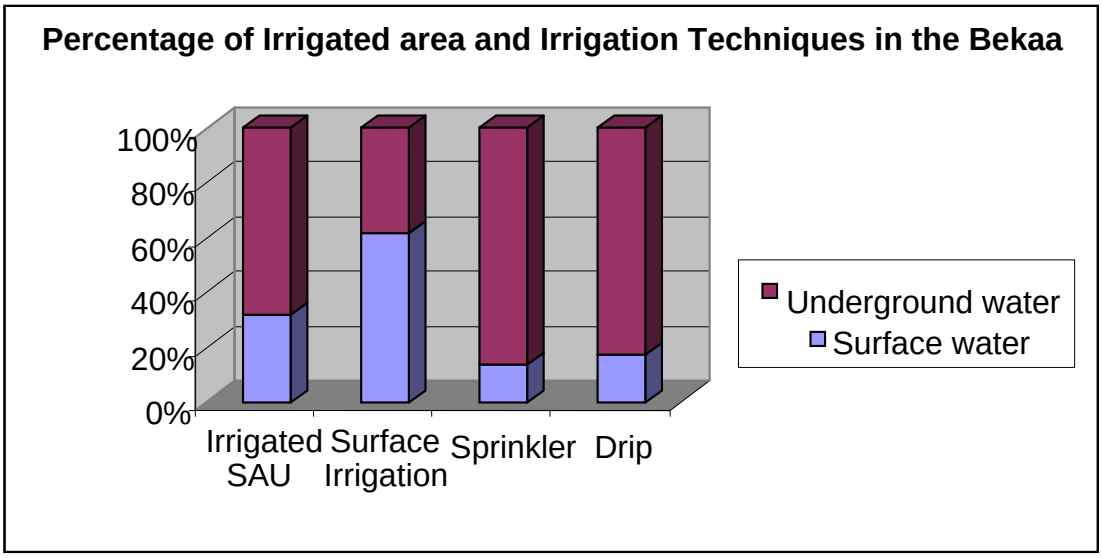


Figure 16. Percentage of irrigated area and techniques in the Bekaa according to water sources

The covered SAU in the Bekaa reaches 2213.46 ha of which 84.6% are in tunnels.

We notice the significant presence of non-used agriculture land in Lebanon. In accordance with the national scale 53137 ha of agricultural lands are permanent fallows which mean non exploited 5 years ago. They don't belong to the SAU and are mainly located in the Bekaa (36%).

The 102948 ha in the Bekaa constitute 95771 agricultural lands, with an average of 1.1 ha per farm (0.5 ha at the national scale).

The direct farming mode is relatively less frequent in the Bekaa comparing to other districts in Lebanon. It is applied on 46.4% (62% on the national scale) of total SAU. This proportion exceeds 70% in the small farms of which the SAU is less than 0.5 ha. It decreases progressively to 50% for the exploitations more than 4 Ha.

The indirect farming (land location or lease in nature) concerns 30509.1 ha in the Bekaa with 26.3% for the location and 3.3% for the lease in nature. The indirect farming mode is still so limited for the farms less than 0.2 Ha and increases with the farms size. The farming mode under the transitory regulations is composed by 19562 ha or 19% of the SAU in the Bekaa. In opposition, 5096 ha are illegally exploited (4.9% of the total useful agricultural superficies).

For the juridical status of agricultural properties in the Bekaa 71.5% (84.6% at the national scale) of the total SAU are private properties, about 73585 ha. This part varies between 74.4 and 83.3 for the

small farms less than 0.5 ha, it decreases progressively with the size of the exploitation to reach the 67% for the ones that are bigger than 10 ha. After these farms called "melk" (private), the properties "Amiri" concerns 27239.8 ha in the Bekaa, about 26.5% of the SAU in the Bekaa. This juridical status is limited for the farmers that own between 0.2 and 2 ha. The other juridical status (public, Waqf, Machaa) is relatively less important and covers 2.1% of SAU.

Table 12. Land occupation per District in the Bekaa (Ha): (Agricultural Census FAO/MOA, 1999)

Caza	Cereals	Fruit trees	Olives	Industrial cultures	Legumes
Zahle	33344.3	4332.4	71.4	5148.1	7021.0
West Bekaa	19607.0	1924.0	1038.3	4450.9	3431.4
Baalbeck	17279.1	13776.7	899.6	5565.0	12387.9
Hermel	3500.1	634.0	438.5	155.9	2799.1
Rachaya	699.3	1089.8	696.4	3.2	334.9
TOTAL	29773.8	21756.9	3144.2	15323.1	25974.3

The predominant cultures in the Bekaa are cereals (27% of explored area) followed by legumes (24%), the fruit trees (20%) and industrial cultures (14.2%). This repartition is totally different from the national scale where fruit trees (23%) are predominating and the cereals (20%) come in the third position.

The analysis of the predominant cultures in the Bekaa regarding the farm size shows that the part of some agricultural speculations increases with the SAU farm size: cereals, legumes and industrial cultures. We notice that the part of cereals, limited for the small exploitations (less than 1ha) increases progressively with the increase of the exploited land to surpass 25% and 30% in the bigger exploitations (4 Ha and more than 20 ha) respectively. It is the opposite for the fruit cultures, oleaginous.

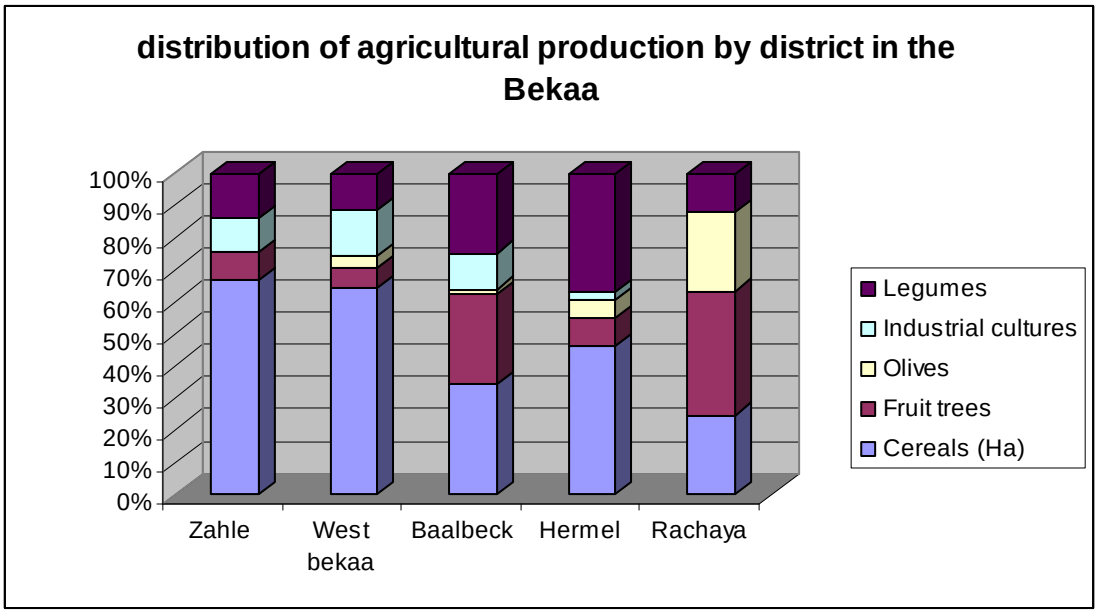


Figure 17. Distribution of agricultural production by district in the Bekaa

Concerning the influence of the farmers' age on the agricultural speculation, we notice that the part of the fruit trees and the olives increases with the age of the farmer. In the case of fruits, this part reaches 25.6% for the farmers who are older than 65 years old. It is the same for the olives, where the part represents only 0.5% for the younger than 25 years old. It is the opposite for Legumes and industrial cultures then we have a small variation for cereals in the Bekaa according to age.

The instruction level in the Bekaa could affect some agricultural production where the part of olive trees and the fruit trees increases with the instruction level of farmers.

The animal production is practiced by 6429 farmers in the Bekaa, about 18.3% (11.6% on the national scale) of the total. 1161 of these do not have a SAU. In percentage, 9.8% of farmers own 0.1 ha to 1 ha. 15% - 25% of farmers have more than 1 Ha and reaches 87.5% for those who do not have agricultural properties.

The table hereafter shows the live stock repartition per district in the Bekaa.

Table 13: Livestock repartition per District in the Bekaa (Agricultural Census FAO/MOA, 1999)

District	Farmers Nb	Cows	Sheep	Goat
Zahle	742	6828	46825	15528
West Bekaa	636	4233	32277	22657
Baalbeck	3563	7961	178538	108478
Hermel	912	1315	15911	15009
Rachaya	576	1105	5252	44578
Total	6429	21442	278803	206250

4.3. BEKAA INDUSTRY

In 2005, the CCIAZ has conducted an industrial census for the Bekaa manufactories.

The Central Bekaa incubates big percentage of industrial institutions and companies which reaches 259 institutions namely 64% of the total number (404). However, 2.73% are located in Hermel and Rachaya districts. But, through the laws of encouraging investment, the government gives big inducements to encourage the industrial investment in the Bekaa especially in Baalbeck, Hermel and Rachaya districts (as the discharge, for 10 years, from income, interests and customs taxes….).

The distribution of companies per district is as follows:

Table 14. Distribution of Industries per district in the Bekaa

Region	Number	Percentage
Central Bekaa	259	64.08%
Baalbeck	107	26.55%
West Bekaa	16	3.97%
Hermel	11	2.7%
Rachaya	11	2.7%
Total	**404**	**100%**

Most of the industries (66%) have less than 10 employees, while less than 1% have more than 250 employees. Most of them are family industries, and their ability to development is limited.

4.4. BEKAA TOURISM

The Bekaa valley is known for its historical monuments, especially Baalbeck which was founded by the Roman Empire. Many other sites are visited yearly by Hundred of thousands of visitors (Anjar, Niha, Hermel,…). This sector constitutes an important source of revenue for population especially the restaurants which are spread all over the Bekaa and known for their famous Mezzé (Traditional Menu).

5. ISIIMM CASE STUDIES IN LEBANON

In Lebanon, the ISIIMM project focused mainly on the Canal 900 area (upper Litani Basin). During the implementation of the activities, the team work found interesting to include another working site: the Khreizat Source, where the irrigation networks, techniques, management, water resources and crops are different from the first site.

5.1. THE LITANI RIVER BASIN

5.1.1. General Overview

The Litani River Basin covers 2160 km^2 (20% of Lebanon area). The River has a length of 170 km and an average discharge of 770 MCM per year. It is considered among the most important freshwater resources in the country. The surface and ground water in river basin provide drinking water for about 350,000 people living in 161 communities and irrigation water for about 36,000 ha of cultivated lands. The river serves as a fundamental component of the Bekaa Valley's (or Bekaa plain) agricultural and industrial sectors. The river lies entirely in within the Lebanese border.

The Government of Lebanon originally placed great priority on developing the river to generate electricity, and more than half of the river's total annual flow is already diverted through the Markaba tunnel below the Qaraoun Dam to the Awali River (also entirely within Lebanon) to increase capacity at power stations on the river. The Litani is also used for irrigation, primarily in the upper and lower sections, but construction of major irrigation systems has been delayed largely due to the Lebanese war.

Still, Lebanon remains dependent on the Litani as a source of water and must continue to develop and harness the resources of the river. Despite upstream diversions, the Litani gathers more water in its middle and lower sections, and it still carries a volume equal to the flow of the Jordan to the sea. As noted, most Lebanese analysts now believe that the Litani can be fully utilized for economic development within Lebanon itself.

The major water management feature in Litani River basin is the Qaraoun Dam, which was completed in 1956 and forms the Qaraoun Lake. The Lake has a storage capacity of 220 MCM of which approximately seventy percent is used annually for irrigation and hydropower and 60 MCM remain in storage through the dry season. Groundwater reserves, estimated at a total of 104 MCM are relatively low and shallow in depth. Regions covered by Litani Projects represent 42% of Lebanese territorial area.

Because of its hydro geographic capacities, the Litani has constituted the first water course in Lebanon that is likely to receive a strong hydraulically plan equipment essential to exploit and develop its water resources for agricultural use.

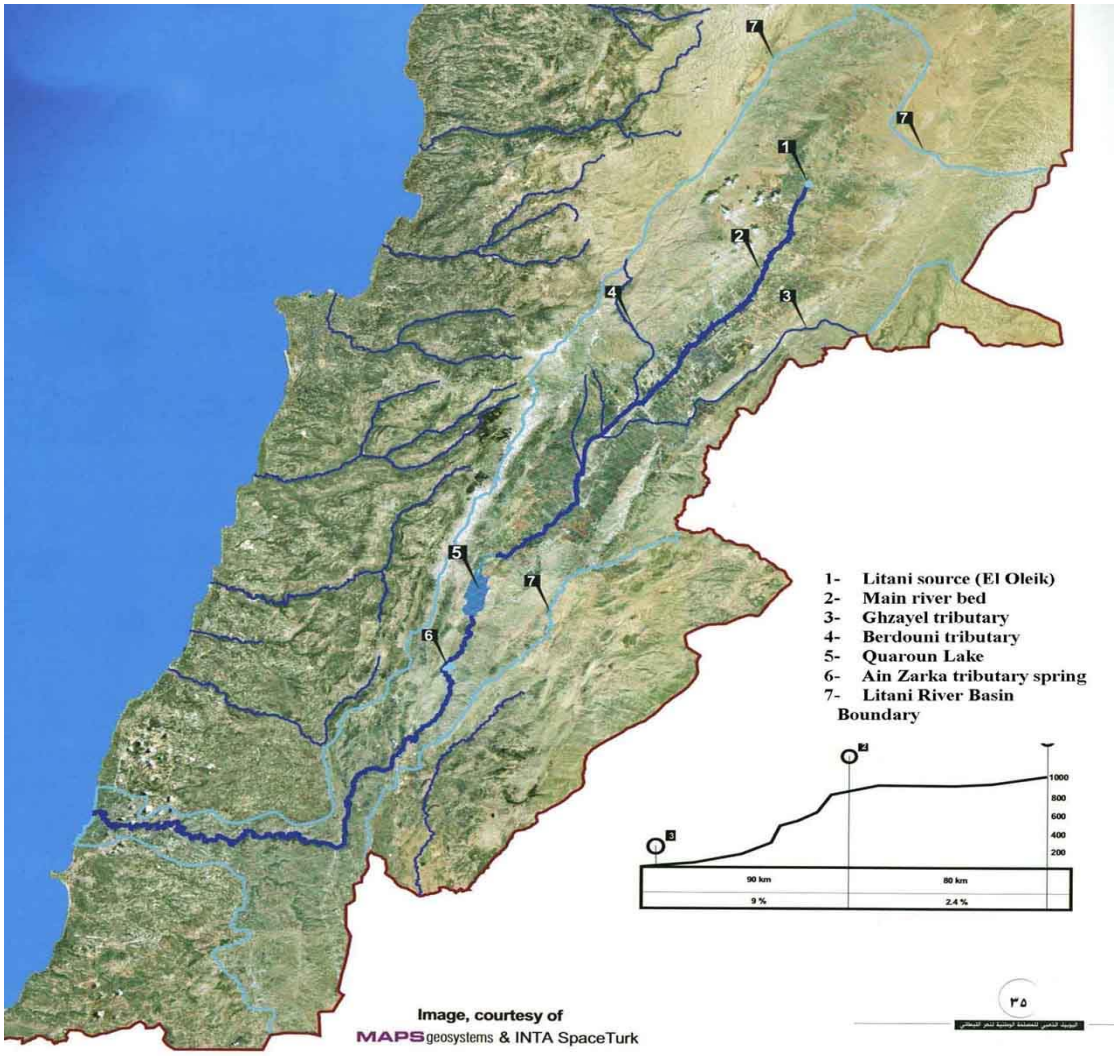


Figure 18. The Litani River and its tributaries

Table 15. Water balance in Litani River Watershed (source: Karaa, 2002)

Parameter	Precipitation
Annual Rainfall (mm)	800
Baalbeck	500
Qaroun	800
West Mountains	1500
Total rainfall volume (MCM)	1280
Water Losses (MCM)	775.8 (60.6%)
Surface runoff (MCM)	116.4 (9.1 %)
Subsurface infiltration (MCM)	387.8 (30.3 %)

Many studies and projects were established for the irrigation; the first one was prepared by American experts and proposes the irrigation in the following regions:

- The two sources of water from Anjar and Chamseen will irrigate the Bekaa where the altitude is 970 m, on a surface of 5700 hectares. The experts mentioned that the sources will cover only 1200 hectares in the years of low precipitations.
- The lands on 900m of altitude in the Bekaa covering 4700 hectares will be irrigated by a direct pumping from the Qaraoun Lake, when there is enough reserved water in the lake.
- The lands between 500 and 300 m in the Nabatieh region in south Lebanon occupying 3500 hectares.
- The lands at 200m in Nabatieh in the South occupying 3700 hectares, the water will be delivered from Khardalé dam.
- The lands between Saida – Beirut (3900 hectares under 200 m), the water will be delivered from the Qaraoun after passing by the hydroelectricity plant of Besri.
- In total, the American experts estimate the irrigation of 10400 hectares in the Bekaa valley and 11100 hectares in the South.

In another report presented on the 15th of January 1957, French experts proposed the following project:

First phase:

- The irrigation of Bekaa land: total surface 5700 hectares, from Anjar and Chamseen sources.
- The irrigation of the region Saida (Sidon) – Beirut: 3870 hectares, from the lake of Qaraoun.
- The irrigation of the Qasmieh region in the south from the hydroelectricity plant of Joune.

Second phase: the irrigation project will cover supplement areas:

- 4700 hectares in the Bekaa
- 3500 hectares in the north part of Nabatieh
- 3700 hectares in the south part of Nabatieh
- 2000 hectares in Kharoub region
- 2000 hectares in Saida – Rouhm.

After the construction of the Qaraoun dam, two situations were expected by the Litani River Authority:

- The total capacity of water retention of the dam passed from 60 to 220 MCM.
- Increasing the agricultural land areas between Beirut and Saida.

Only three small and medium projects of irrigation were executed by the LRA and only two of them were functioning after the civil war in Lebanon:

- The irrigation project executed in 1969, between Saida and El – Awali fall in the north with a total area of 1200 hectares of which 350 hectares are served today.
- The irrigation project in Qasmieh - Ras el Ain: this project was implemented in November 1974 to ensure the irrigation for the coastal zone (0 to 70 m). The total areas actually benefiting from irrigation is 3400 hectares.
- The irrigation project of the South Bekaa (canal 900): only a part of this project was executed before 1975.

5.1.2. Future projects

The future projects planned by the LRA related to the exploitation of the Litani are:

- Project of irrigation in south Lebanon (800 m): this project is constituted by a main canal of 51 km and 56 km of secondary canals of distribution. It allows the irrigation of the region situated between the Litani courses and south Lebanese perimeter, it covers 1500 hectares. The total cost is estimated to 217 millions of dollars. The quantity of water transmitted by this project is 120 MCM of which 90 MCM will be specified for irrigation. This project will be constructed in 5 years starting from 2005.
- Irrigation Project of the south Bekaa: constitutes the second phase of the project already functioning. The project proposes to achieve the works and the equipment of the network of the second phase to cover 6700 hectares. The execution of the canal 900 project will ensure water irrigation for 21500 hectares.
- Projects of Dam constructions:
  1. El – kharadali (127 MCM)
  2. Kfar – Sir (12 MCM)
  3. Massa (8 MCM)
  4. Besri (110 MCM)

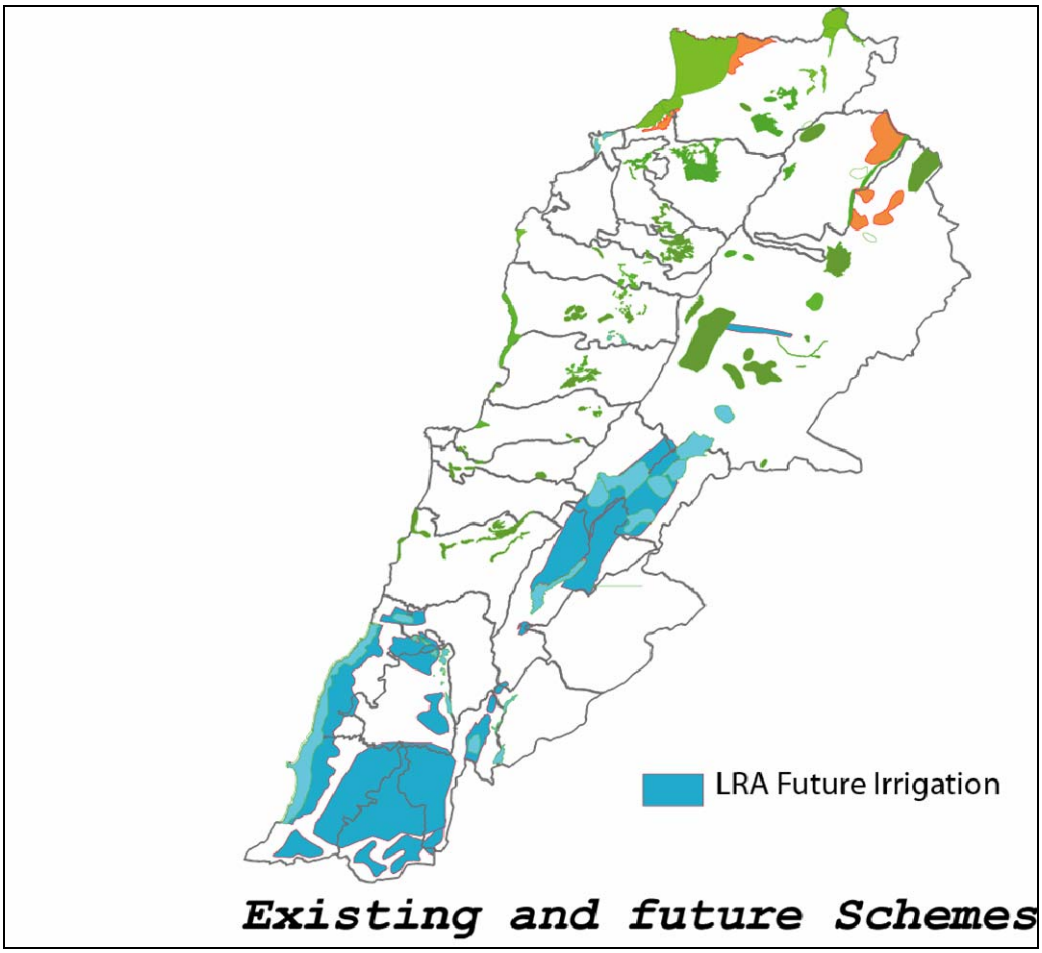


Figure 19. LRA existing and future Irrigation projects

5.2. SOUTH BEKAA IRRIGATION SCHEME: FIRST CASE STUDY IN LEBANON

The ISIIMM Lebanese case study covers a part of the South Bekaa scheme which is located on the western flank of the Anti-Lebanon Mountain, and the left bank of the Litani River, just upstream the Qaraoun dam. It is managed by the Litani River Authority. The total average rainfall varies between 700 and 1000 mm per year. Temperatures are moderated and do not fall bellow 5.8 degrees in January and remain below 25 degrees during the month of July.

The current scheme with 2000 ha is the first phase development of 8600 ha on left bank of the Litani River. Created in the early 70's, the canal 900 became operational only in 2000 due to the civil war. It provides only irrigation water for the scheme. It is sited at 900m altitude and has 18 km of length (the first part). A main pumping station feed the canal by 30MCM of water from the Qaraoun dam as well as 4 wells giving 75 MCM. Secondary pumps send water to large reservoirs situated at a higher level. Water is distributed to farmers in underground pressurized canals with 3.5 – 4 kg/cm^2 of pressure. Most of the agricultural ownerships are less than 2 ha. (South Bekaa Scheme, new technologies Development for irrigation systems management, KARAA Kamal, 2000)

The Phase 1 of the south Bekaa scheme project is divided into 3 sectors; each one is equipped by a main reservoir:

- Sector 1: **Qaraoun 1,** covering an area of 257 Ha.
- Sector 2: **Qaraoun 2,** covering 435 Ha.
- Sector 3: **JoubJannine,** covering 1220 Ha.

The south Bekaa scheme objectives are:

- Management of the ground water and surface water in the south Bekaa region.
- Reducing water cost for irrigation.
- Create a social equity in irrigation water usage.
- Improvement of water use efficiency.

Table 16. Specifications of hydrants used in the Scheme (Abou Hamad, 2004)

Class	Flow		Area to serve
	L/s	m3/ h	(Ha)
0	2.1	7.5	0.30-1.27
1	4.2	15	1.28-2.50
2	5.5	20	2.51-3.37
3	8.4	30	3.38-5.00
4	13.8	50	5.01-8.36
5	20.8	75	8.37-12.6

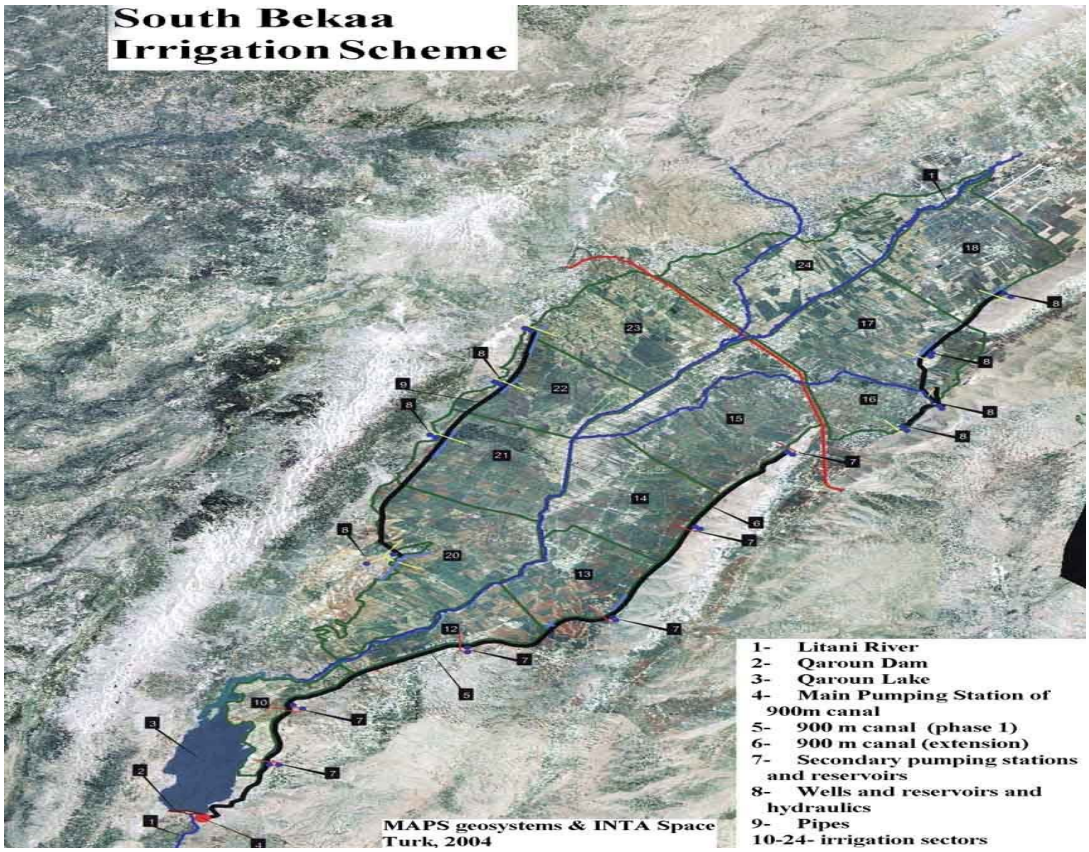


Figure 20. The South Bekaa irrigation Scheme

5.2.1. Topographic features of the canal 900 area

The phase 1 of the South Bekaa Scheme (Canal 900 area) occupies a narrow and stretched out fringe of the left bank of the Litani and includes the adjacent parts of the 5 fundamental localities of the South Bekaa (Qaraoun, Lala, Baaloul, JoubJannine and Kamed El Laouz). Its width varies between 700 meters to the North of Lala and 300 meters to the north of JoubJannine. The surface is generally flat and presents a weak slope toward the Litani River, main drain collector of all the central and south Bekaa. This zone is characterized by the absence of permanent out-flow and the small valleys of the region; effluents of the Litani are dried or on intermittent out-flow. So some valleys are fed by small sources, but water is exploited before reaching the region of the canal.

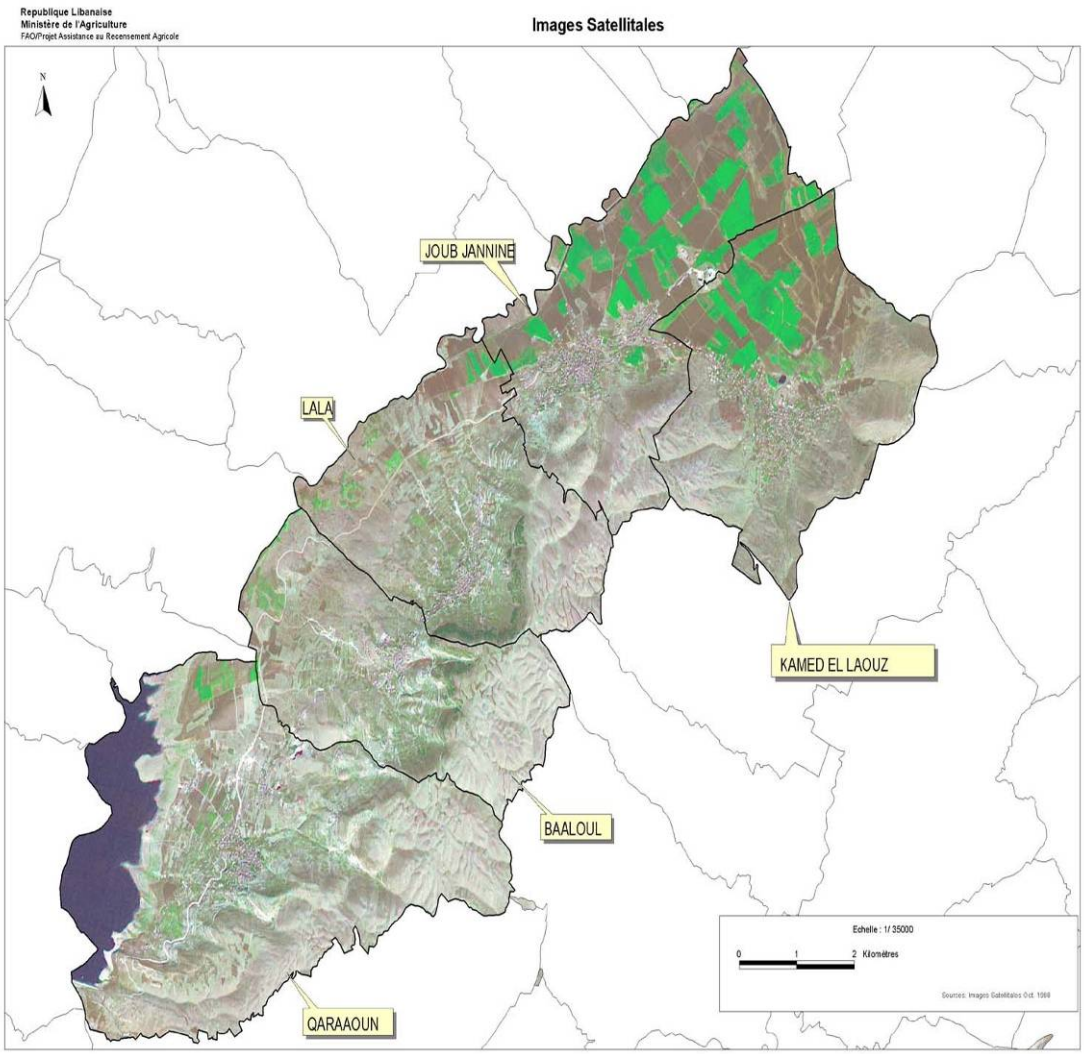


Figure 21. The case Study Area (South Bekaa Irrigation Scheme, phase 1) (Source: FAO/MOA, 1999)

5.2.2. Geology

Lands of the region are secondary and tertiary sedimentary rocks. Their layers constitute an active and continuous set of the Albien until the superior Lutetian. Their outcrops present themselves in successive strips from the south to the North. The White calcareous of the superior Lutetian and the marl calcareous of the lower Lutetian (800 m of total thickness) occupy the extreme Northern part of the region whereas the calcareous and marl calcareous of the Cenomanian of 600 m of thickness occupy the remaining part (central and south). Senonian Marls that have a thickness of 250 m, appear on the surface on the North of Joub Janine and the west of the Qaraoun. Layers constitute a narrow synclinal (figure 20) (synclinal of Kamed EL Laouz) that is limited to the East by the anticline of Jabal el Aarbi. The Quaternary is represented by earthy alluviums and clays of decalcification that cover the plain especially in several places in the Northeast of Joub Janine and the East of the Qaraoun Lake.

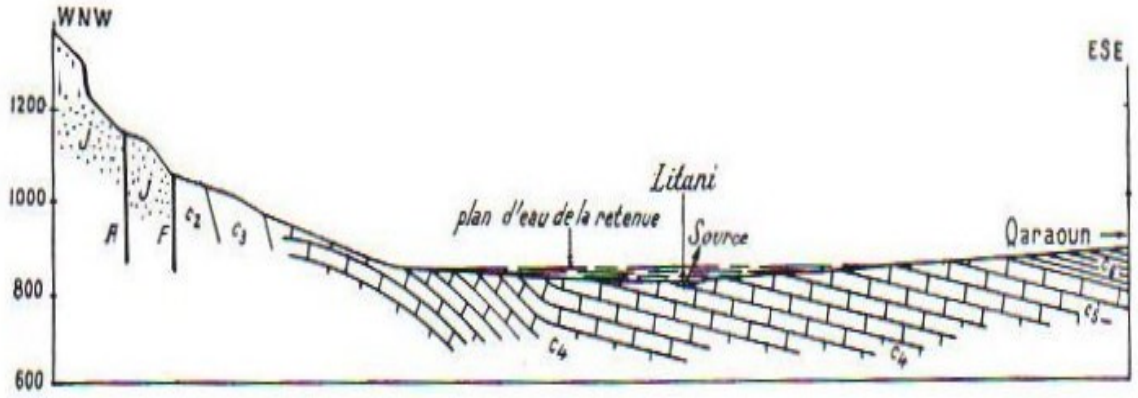


Figure 22. Transversal cross of the lake at Qaraoun Level

5.2.3. Hydrology

The project area receives about 850 mm of precipitations per year. It can be described like a pan dominated to the west by Jabal Barouk and to the East by the Hermon Mounts receiving each one more than 1300 mm of rainfall annually; the wet period starts in October and lasts till May. The rainiest months are January and February and the dryness is total in July and August. 75% of the total rain falls between the beginning of December and the end of March under shape of violent downpours. The water table doesn't benefit therefore from any natural flow feed after the end of the snow melting.

5.2.4. Agriculture, Land-use and main activities

Before the construction of the Qaraoun dam in the mid 60's, all the cultivated land in the scheme was rainfed. Cultivation was done directly by landowners who mainly cultivated it with wheat, and barley. However, the agricultural property owned was very small between 0.1 and 2.5 Ha.

In the mid 60's, there was a huge widespread of the irrigation borehole phenomenon and the owner of this borehole leases the surrounding land (between 40-100 Ha) for cultivation according to two growing seasons: winter cultivation of wheat, and barley, and summer cultivation of vegetables, and potatoes.

Landowners farm out their land to the irrigation borehole owner according to a seasonal rent. In his turn, the irrigation borehole owner farms out the leased land to one or more farmers as he provides the water needed for irrigation in return of a seasonal rent that ends in November. At this stage the irrigation borehole owner cultivates the land with winter crops (mainly wheat, and barley).

Crop rotation was achieved according to this regime: part of the land was ploughed and prepared for summer cultivation in the following season and the other part was cultivated with wheat and barley that replace the previous summer cropping.

Furrow irrigation was the major irrigation system used until the early 70's when farmers were introduced to the new irrigation techniques or the so called pressurized irrigation systems: drip and sprinkler irrigation that overtook completely furrow irrigation.

Referring to the global Agricultural Census (FAO and Ministry of Agriculture, 1999) the total area that can be used for agriculture was estimated to 2362 hectares. The cultivated land had an area of 2099 hectares. Seasonal crops cover most of the northern part of the region specifically the lands of Lala, Joub Jannine, Kamed el laouz and some parts of the lands of Qaraoun. Winter cereals (wheat and barley) with other legumes cover more than 46% of the cultivated area where the vegetables area cover around 41%. The fruits and olive production areas are mainly concentrated in Qaraoun and Baaloul villages. The olive and vineyards plantation constitute around 75% of the orchard area. Sparse grassland and forbs exist between the villages of Baaloul and Lala and is used as pastures for local livestock. A natural swap vegetation of wetland area appears around Qaraoun Lake starting the month of March forming a belt large of 500 to 700 meters. The land cover is characterized by the absence of any forest cover, by the presence of large sparse grassland and a small area of swamp vegetation.

Table 17. Land use per locality (in hectares)

Village	Altitude	Village area	Cultivated land	O/w irrigated area	Abandoned
Joub-Jannine	930 m	1574	921	737	60
Kamed el Laouz	950 m	1354	564	511	1
Qaraoun	990 m	2705	377	55	4
Lala	1120 m	1278	169	49	52
Baaloul	1110 m	1100	68	8	2
Total		**8306**	**2099**	**1360**	**119**

Table 18. Land use per locality by crops (in hectares)

Village	Cultivated land	O/w irrigated area	Cereals	Vegetables	Olives	Fruit trees and vineyards	Green houses	Abandoned
Joub-Jannine	921	737	605	276	13	9	1	60
Kamed el Laouz	564	511	135	549	21	8	-	1
Qaraoun	377	55	166	36	100	20	1	4
Lala	169	49	64	6	55	27	-	52
Baaloul	68	8	15	-	32	7	-	2
Total	**2099**	**1360**	**984**	**868**	**222**	**71**	**2**	**119**

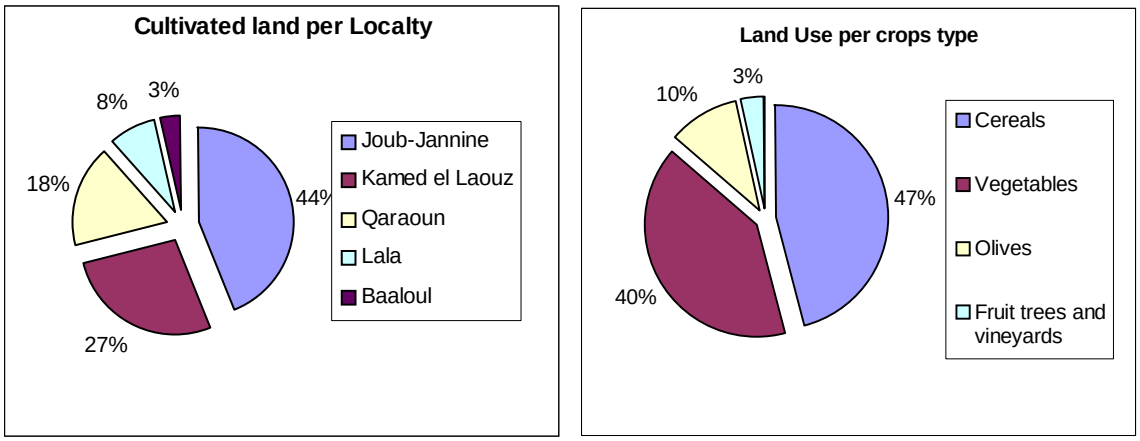


Figure 23. Distribution of cultivated land and land use per village

The main agricultural productions are cereals (wheat, barley), vegetables, potatoes, onions, garlic, melons, fruits (almond, walnut ...), olives and grapes. The agricultural census of 1999 shows the existence of many small farms for cattle rising; 61 cow farms mainly for milk production, 38 sheep farms and 23 goat farms for milk and meat production.

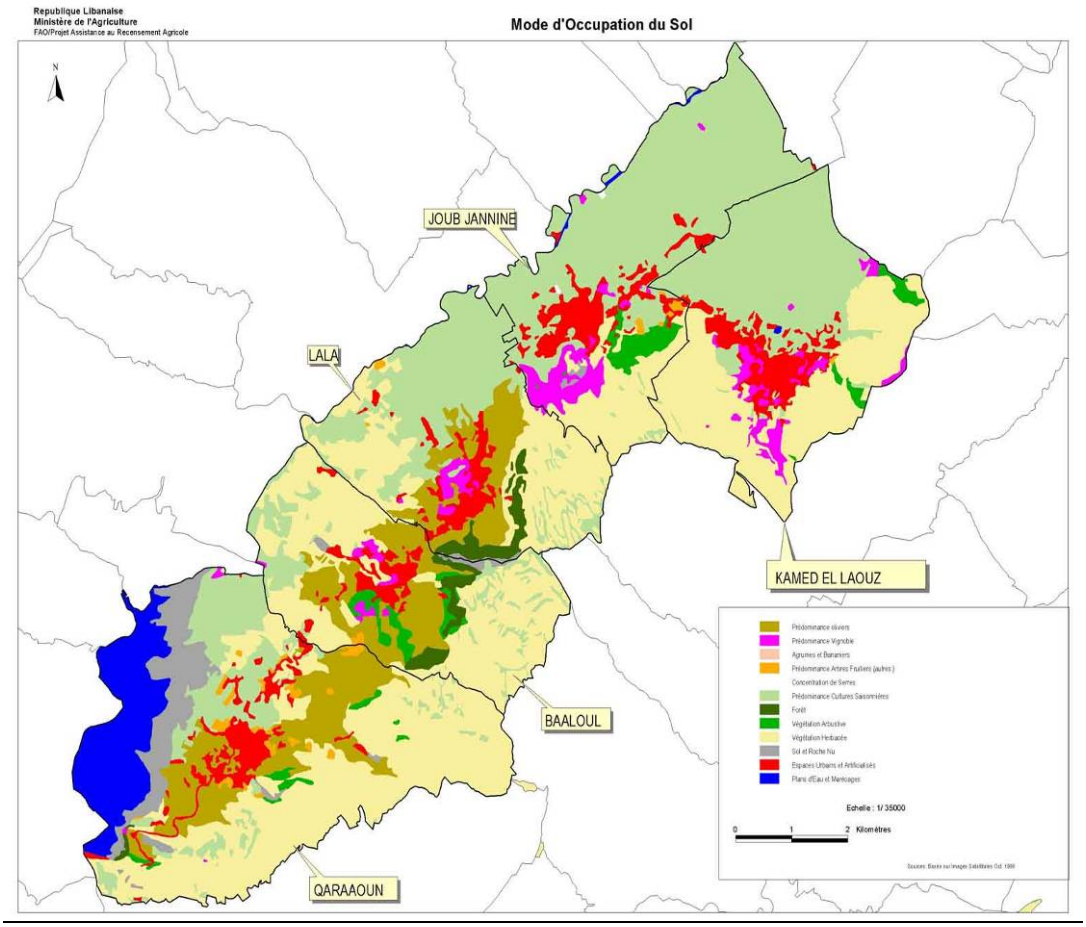


Figure 24. Land use in the South Bekaa Scheme (phase 1). (Source: FAO/MOA, 1999)

Agriculture and commerce (small retail and wholesale) represent the main economic activities in the region. The industrial activity is less important and is mainly constituted by small family owned industries. The main industries are stones, brick and light metal work for construction, small mills, one manufacture for detergent and cleaning products and one olive oil transformation unit exists in Qaraoun. On the other hand we find a wholesale business of wood and metals in the region and small retail businesses of food, pharmaceutical products, electrical equipment, offices supplies and construction materials.

The Qaraoun Lake was used to be a tourist place: many restaurants were created on its borders. Fishing and swimming were also practiced before the pollution became upsetting.

5.2.5. Population

The project area is characterized by the large number of emigrants that left the villages to different destinations mainly to Latin America (Brazil, Colombia, Venezuela, etc.), Canada and the USA. The registered population of the five villages is estimated to be around 28000 persons while the resident population is nearly half that number. An introductory survey shows the following population figures.

Table 19. Estimated population in the case study area

Village	Area (hectares)	Registered population	Resident population
Joub-Jannine	1574	8000	5500
Kamed el Laouz	1534	5000	2800
Qaraoun	2705	8000	5000
Lala	1278	4500	2200
Baaloul	1100	3000	1500
Total	**8191**	**28500**	**17000**

The emigrants played an important role in the economic stability of the region due to money transfer for the resident population (parents, family). In addition, money was used essentially for construction (mainly villas) which has described as an invasion of the rural areas on behalf urban zones, especially during the war period (1980 - 1990). This can explain the presence of magnificent houses in the region, which isn't related, at all, to the agricultural development.

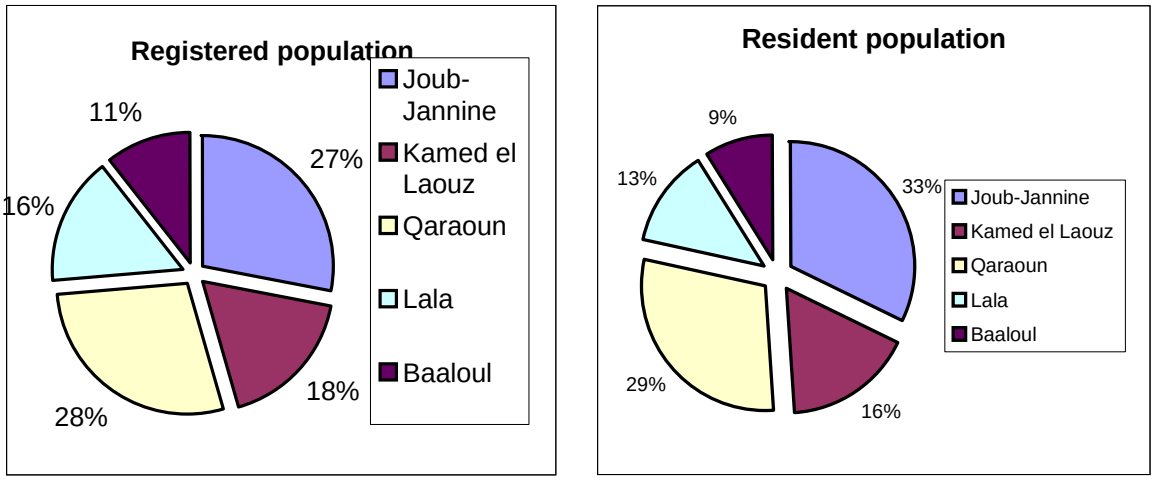


Figure 25. Distribution of Registered and Resident population per village

5.2.6. Water Quality

a) Groundwater Quality

In 2000, a field survey was made by a Swedish consultant (MVM, Konsult, AB) for the Ministry of Environment in order to test the Groundwater quality in the Litani Basin. Water samples from wells and springs were tested and the results were:

- High Organic content in general. The water is borderline acceptable for drinking purposes. Contamination by sewage is very likely.
- Bacterial analyses haven't been executed. However, some samples from wells show contamination with faecal coliforms.
- High concentration in iron, water is almost suitable for drinking purposes. Zinc is in general below unusable values.
- The concentrations of heavy metals are low except for mercury, which render the water as unsuitable and hazardous to human health in a significant number of samples.

The Nitrate level in shallow groundwater in the region of Zahle city in Upper Litani Basin showed high Nitrate values.

b) Surface Water quality

Domestic wastewater is considered as the most important pollutant of the Upper Litani Basin surface water.

The untreated wastewater coming from factories and municipalities are discharged directly into the watercourses. The sewage system is in several cases pipelined directly to the Litani River or its major tributaries. No industry in the area has wastewater treatment plant in operation (MVM konsult AB, 2000).

The sewage systems release their untreated effluents into the Litani River or its tributaries at an estimated rate of 36,000 m3/day or 13.14 MCM per year. (Khatib and Alami, 1998).

Solid wastes (industrial and hospitals products) are also a source of pollution. Dumps leach pollutants incineration products into watercourses and aquifers. Only Zahle landfill is built on sound environmental specifications.

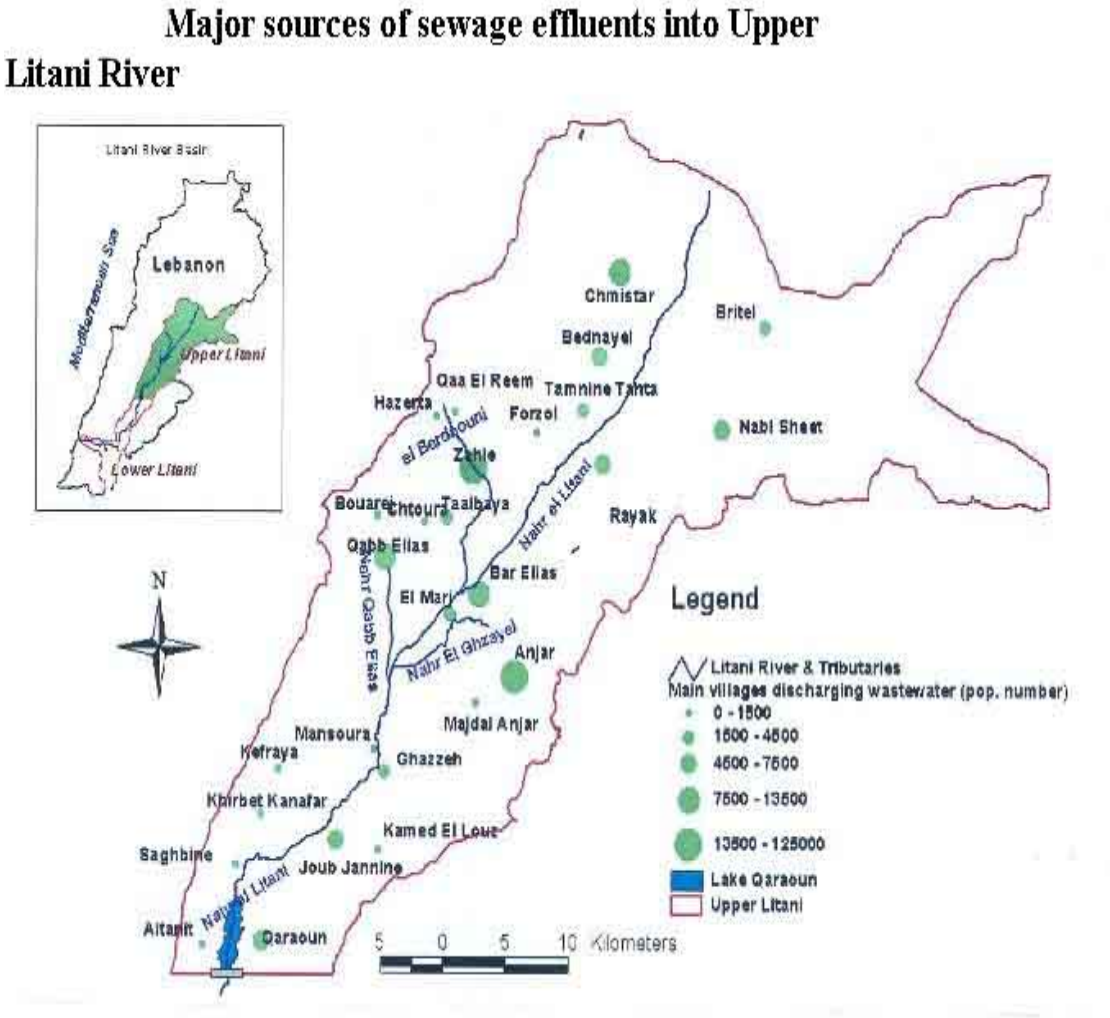


Figure 26. Major Sources of waste water discharge in the upper Litani

The tested samples from the Litani River and Qaraoun Lake show high concentrations of Organic Matters originated from sewage and industrial discharges. The level of metals is also high especially for Mercury and Copper in upstream Litani River and tributaries.

Table 20. Effluent from sewage water into Litani River in Upper Basin (Khatib& Alami, 1998)

Region (District)	Population	Population served by sewer systems	Discharge into sewers (m3/day)	Discharge into sewers connected to Litani River	
				(m3/day)	Rate of local sewer discharge
Baalbeck	42,824	14,151	2704	2075	76.7 %
Zahle	217,069	150,256	22,550	19182	85%
South Bekaa	22,682	13,531	2022	2022	100%
Total	**282,575**	**177,938**	**27276**	**23279**	

Some reports published by the Ministry of Health (MOH) and other experts showed a high number of water-related morbidity cases in the region between 1995 and 1997. Microbiological pollution adversely affects human health when water is used for domestic and irrigation purposes.

Table 21. Water-related illnesses in Upper Litani Basin (Jaradeh, 1998)

Disease	1995	1996	1997
Dysentery	414	990	559
Hepatitis	135	217	301
Typhoid	398	524	497
Bilharzias	2	3	3
Total	949	1,734	1,360

The main problem is that the water quality monitoring system is not continuous to assess water quality of the Litani River on regular basis. So far, water quality surveys are made sporadically by different organizations.

5.2.7. Stakeholders

The LRA is managing the South Bekaa Irrigation Scheme. The scheme's objectives are:

- Management of the ground water and surface water in the south Bekaa region.
- Reduce water cost for irrigation.
- Create a social equity in irrigation water usage.
- The improvement of water use efficiency.

A cooperative of water users in the south Bekaa scheme area was created in 2003. It gathers 13 farmers but not all of them are using the canal 900 water. The cooperative objectives are:

- Improvement of the economical situation of the farmers.
- Improvement of water use efficiency.
- Collaboration with different actors working in the water management sector.
- Reduce the production cost.
- Making experimentations on new crops and irrigation techniques.

The cooperative is not dealing only with the water preoccupations, but goes forward to general agricultural and economical interests.

Nowadays, about 75 farmers, working individually, are using the canal 900 water. They are suffering from many problems such as the pollution and algae, pressure and pipes explosion. A survey made by the ISIIMM Lebanese team showed that farmers are interested in creating a WUA which could empower their situation facing the problems encountered.

5.2.8. Field survey

A field survey was conducted by the Lebanese team and has covered 33 farmers out of 70 approximately. In addition, in order to sstrengthen the relationship with stakeholders, 4 meetings were held in the villages concerned by the project (Joub Janine, Kamed El laouz, Baaloul and Kherbet Kanafar). The farmers showed a high level of cooperation and enthusiasm toward the WUA creation as soon as possible due to their need for a reference to defend their rights and to solve the problems faced. It was a real brainstorming for the first 4 years of the south Bekaa irrigation scheme implementation. In general, farmers have a negative impression but do not have alternatives especially with the increasing fuel prices. The main problems raised were:

- The Lebanese economical and agricultural situation in general and in the region in particular.
- The bad water quality which is the main factor in decreasing the prices of the vegetables and fruits produced in the region.
- The low ratio of quality of service / price.
- The discrimination in water distribution and payments.
- The technical failures and flow problems in the distribution network and the disengagement of the basin agent from any responsibility.
- The irrigation period is supposed to start in April and is usually delayed.
- The inexistent cooperation between farmers due to individualism.

On the other side, the Litani River Authority is conscious of some of these problems but cannot solve them due to dispute with the project applicant (Development and Reconstruction Council) and the contractor. Concerning the pollution, the LRA is trying to elaborate an awareness campaign with the municipalities of the basin and to communicate with some projects related to water management.

The survey showed that farmers are mainly growing summer crops. In addition, information about the social status, cultivated area, crops distribution, irrigation techniques were collected.

a) Civil situation

Family status	Nbr. of users
Single	2
Maried / (≤5 members/family)	16
Maried / (>5 members/family)	15

The main issue raised was that farmers are married and working without any assistance from their family members.

b) Education

The farmers' educational level isn't very high; most of them have been in primary schools. Only 1 farmer made technical studies in an agricultural school and two others have participated to short term training sessions on irrigation.

Educational level	Nbr of users
Illiterate	1
Primary	8
College	21
Secondary	1
Technical	1
University	1

For the Professional background, most of users are native farmers and were installed before the creation of the canal 900 project. But they are not living only with agricultural revenues. In fact, a large number of the area population has migrated to Latin and Northern America and send money regularly to their families.

c) Land Use

The 33 users are exploring 557 Ha (almost 26% of the project area) where 385 ha are irrigated from the canal 900. The table below shows the distribution of cultivated area by number of farmers.

The survey showed that 99% of land users are not owners. This reality complicates the creation of WUA under the current legislation where members should be land owners.

Ha	Nb. Of users
≤ 1	3
$1 \leq x \leq 5$	6
$5 \leq x \leq 10$	7
$10 \leq x \leq 20$	8
$20 \leq x \leq 50$	6
> 50	3

The cropping system is based on cereals, potatoes, vegetables and legumes. Fruit trees cover a narrow area: olive trees are predominant.

Crops	Ha	%
Fruit trees	4	0.1
Potatoe and sugar beet	201	36.2
Cereals : Wheat, Barley	143	25.7
Vegetables: Tomate, Cucumber, Melon, Oignon, Garlic, Lettuce	146	26.3
Legumes: Beans and lentills	53	9.5
Cultures fourragères: Alfalfa, corn	9	0.2

d) Irrigation techniques

Irrigation	Ha	%
Sprinklers	213	55.2
Drip	147	38.2
Canons	25	6.6
Total	**385**	**100**

The irrigation techniques used are essentially sprinklers and drippers. The major problems faced are related to water quality especially in drip irrigation. Little number of them is equipped with sand filters, usually expensive.

5.3. THE KHRAIZAT SCHEME: SECOND CASE STUDY IN LEBANON

The Khraizat irrigation scheme is one of the Small Irrigation Projects in Lebanon where farmers ensure water management. These projects are mainly known for their traditional networks and irrigation techniques. Even if farmers are involved in the scheme's management, they are not formally grouped in associations or any legal institutions.

5.3.1. General presentation

The Khraizat sources are located to the South West of Kherbet Kanafar village under the Khraizat Hotel, at 940 m of altitude. Water issued from the sources are divided into 2 effluents:

- ***Abou Ezzé Canal***, to the North, is crossing Kherbet Kanafar and Kefraya villages and reaching the Litani River.
- ***Al Sakiyé Canal***, to the West, is crossing Kherbet Kanafar and Saghbine villages and reaching the Litani River also.

The main source feeding the Khraizat sources is located to the East of Barouk Mountain (Mount Lebanon Chain) and is being connected by underground canals. At the sources level, soils are calcareous.

Figure 27. Khraizat Canals (Abou Ezzé and Sakiyé) (M. Soulié, 2006)

5.3.2. Water

The Khraizat Source water quantity is very fluctuant. In fact, the Mediterranean climatic conditions and the Karstic soils explain the dryness during summer months especially in August. This occurs mainly if the precipitations are less than 800 mm/year.

The irrigated area served by the Khraizat sources used to be 500 Ha: wheat, Barely, Corn and fruit trees were the main crops cultivated. Nowadays, vegetables are representing more than 200 Ha which has a direct impact on the water scarcity during summer and decreased the irrigated surface to 400 Ha instead of 500 Ha. In addition we have noted an increasing number of illegal artesian private wells, which have a direct impact on the underground water table.

The surface irrigation is dominating, but some farmers have made their own reservoirs to collect and pump water for drip irrigation.

The canals are open. Thus, some fragments have benn rehabilitated with the support of the Ministry of Water and Kherbet Kanafar Municipality.

Figure 28. Khraizat Sources (M. Soulié, 2006)

5.3.3. Water Distribution

All lands, distributed according to families and situated within the Khraizat scheme, have the right to irrigation. This right is directly related to land. Every Hectare has the right to be irrigated for 30 minutes every 9 days for Abou Ezzé canal and every 10 days for Al Sakiyé canal.
For a long period we have assisted to the next repartition:

1. Abou Ezzé Canal:
   - Karam Family: 3 days.
   - Hatoum Family: 1 day.
   - Nouaïm Family: 1 day.
   - Mghames Family: 3 days.

- Kefraya village: 1 day.

During the dry years, they add 1 day of irrigation to every family using Abou Ezzé canal, and the total number of days become 13 instead of 9.

2. Al Sakiyé Canal:
   - Karam Family: 3 days.
   - Hatoum Family: 1 day.
   - Nouaïm Family: 1 day.
   - Mghames Family: 3 days.
   - Saghbine village: 2 days.

In 2001, these customs have been changed due to the increasing number of problems between farmers and the dryness of the last years. A new method was adopted, consisting on irrigation all parcels, one after one, until the last parcel, except for the covered crops. This method was the result of a consensus between all the users of Khraizat sources.

The person responsible of water distribution "Shawa" must resident of the neighborhoods and aged under 60 years. All users must sign a letter of acceptance which will be approved by the president of Kherbet Kanafar Municipality and the governor of the district of West Bekaa. This letter helps the Shawa to be protected in case of conflicts on water use.

The annual fees is 150 000 LBP (80 Euros approx.) per Hectare, covering the Shawa's salary and some rehabilitation works.

5.3.4. Water Pollution

Several sources of pollution have been identified on the Khraizat:

1. Fisheries established beside the sources, especially by the neighboring restaurants. The efforts made by water users succeed to stop this activity.
2. Some times, Sewage water is mixed with Abou Ezzé water, increasing the organic matter level and the presence of algae. The municipality of Kherbet Kanafar has lately taken a decision to establish a network to collect the sewage water.
3. Pesticides and Fungicides pollution: farmers are used to wash the pulverization equipments with the Khraizat water and drawing off the seepage water again in or around the canal.

5.3.5. Economical importance of Khraizat scheme

The Khraizat water is an important source of revenue for Kherbet Kanafar village and its neighborhood. This importance is represented in the following points:

1. The population living in the village is composed mainly by farmers using the Khraizat water. In fact, the fees paid by farmers are quite affordable especially with the increasing prices of fuel.
2. The Tourism activity due to the establishment of restaurants around the sources ensures financial resources for more than 400 persons.
3. Irrigated lands from the Khraizat sources are more valuable than others situated in the village without any source of irrigation.

6. CONCLUSION

The current report has collected a number of information mentioned in the coherence grid. The data collection and analysis will continue in the coming period especially after the support of some external experts who are coming to assist the Lebanese team especially in the field of socio-economic analysis. The TOR for these missions has been elaborated. They will assist us also to clarify the main concern which is the legal status of the WUA that should be initiated throughout the ISIIMM activities.

We believe that capacity building of the farmers is the main issue to take in consideration during the next period.

We also have established links with other projects dealing with water management and pollution, such as IrWa (Meda) and LWQM (USAID). This collaboration could be helpful for the project implementation in Lebanon.

LIST OF FIGURES AND TABLES

Figure 1. The Litani River watershed and proposed Arab diversions from the Upper Jordan River.
Figure 2. Border proposals for a Jewish state, 1919–1947 (adapted from Wolf 1995).
Figure 3. map of Lebanon
Figure 4. Water resources in Lebanon.
Figure 5. Map of main basins in Lebanon
Figure 6. Annual distribution of precipitations.
Figure 7. Annual rainfall (1954 - 2002) in the Bekaa Valley.
Figure 8. Water demand (MCM) per sector of activity.
Figure 9. irrigation techniques and Source of water per Irrigated Area.
Figure 10. projected water demand for irrigation in Lebanon.
Figure 11. Distribution of Irrigated Area per village and Importance of Irrigation
Figure 12. Distribution of Irrigated area and irrigation techniques per District.
Figure 13. Distribution of Water irrigation quantity per District
Figure 14. Wells Distribution in Lebanon.
Figure 15. Map of the Bekaa valley.
Figure 16. percentage of irrigated area and techniques in Bekaa according to water sources
Figure 17. Distribution of agricultural production by district in the Bekaa.
Figure 18. The Litani River and its tributaries.
Figure 19. LRA existing and future Irrigation projects
Figure 20. the South Bekaa irrigation Scheme.
Figure 21. the case Study Area (South Bekaa Irrigation Scheme, phase 1)
Figure 22. Transversal cross of the lake at Qaraoun Level
Figure 23. Distribution of cultivated land and land use per village
Figure 24. land use in the South Bekaa Scheme (phase 1).
Figure 25. Distribution of Registered and Resident population per village.
Figure 26. Major Sources of waste water discharge in the upper Litani.
Figure 27. Khraizat Canals (Abou Ezzé and Sakiyé) (M. Soulié, 2006)
Figure 28. Khraizat Sources (M. Soulié, 2006)

Table 1. Water resources of Jordan basin used by Israel according to their geographic origin and quantity (MCM) of water
Table2. Percentage of the main agricultural speculations by Mohafaza.
Table 3. Main and secondary basins on the coastal zone
Table 4. Main and secondary Basins in the Bekaa
Table 5. Annual water balance in Lebanon
Table 6. Diversion Water Requirement for Surface Irrigation.
Table 7. Diversion Water Requirement for Sprinkler Irrigation.
Table 8. Diversion Water Requirement for Drip Irrigation.
Table 9. Distribution of SAU and farmers' number per district in the Bekaa
Table 10. Distribution of SAU per section of farmers' age
Table 11. the SAU in the Bekaa in accordance with the sources and the mode of irrigation
Table 12. land occupation per District in the Bekaa (Ha).
Table 13. live stock distribution per District in the Bekaa
Table 14. Distribution of Industries per district in the Bekaa
Table 15. Water balance in Litani River Watershed.
Table 16. Specifications of hydrants used in the Scheme
Table 17. Land use per locality (in hectares)
Table 18. Land use per locality by crops (in hectares)
Table 19. Estimated population.
Table 20. Effluent from sewage water into Litani River in Upper Basin
Table 21. Water-related illnesses in Upper Litani Basin

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ANNEX: AGREEMENT

Dividing up of the Orontes water rising from the Lebanese territory
Between the Lebanese republic and the Syrian Arab republic

In accordance to the negotiations concerning the division of the relative shares of each country in term of water quantities of the Orontes River rising from the Lebanese territory,
And, in the light of the need of exploitation of this water in each country,
It was decided the following:

Article 1:
The two parties are considering that the water of the Orontes River rising from the Lebanese territory are in common interest and that each country has the right to use this water following the repartition mentioned below.

Article 2:
Are taking in consideration in the repartition: the water flow at the Hermel bridge, the sources, the rainfalls, the effluents, the water wells pumped from both borders till 500 m of width from each border and a circle of 1500 m of ray centered in sources of Ain El Zarka Hermel, Ras el Mal and other important continuous sources in the Orontes river, and other sources designed by a technical commission.

The water quantities exploited from all these points situated inside the Lebanese territory will be deducted from the part attributed to Lebanon as it is written in the article 3.

Context:
Is considered as an average year, the year in which the annual average water flow reaches 403 – 420 millions of cube meters following the monthly repartition:

Month	Monthly flow (MCM)	Average Flow (cubic meters/sec)
September	32.25	12.44
October	31.44	11.74
November	28.68	11.07
December	29.50	11.01
January	30.07	11.23
February	29.34	12.03
March	35.14	13.12
April	36.76	14.18
May	39.24	14.65
June	37.61	14.51
July	37.63	14.05
August	35.63	13.30
Total	**403.29**	

Article 3:
The total quantity of water reserved to Lebanon is about 80 000 000 m^3 per year.

Is considered in the Lebanese part, the quantities of water taken off from the points of water mentioned in the article 2, divided into 4 periods as following:

Period	Lebanese part: millions cubic meter
1- September , October	10
2-November, December, January, February	10
3-March, April	10
4-May, June, July, August	50
Total	**80**

In case that Lebanon does not explore effectively his total part in a period of the year, it will be possible to benefit from the rest of this part in the next month of the same period in the sane year.

Article 4:
Is considered a dry year, the year in which the debit of the river decreases to less than 400 millions of cubic meters on the Hermel bridge point, including wells and the stations of the article 2, in this case the Lebanese part of water will be reduced 20% .

As it is impossible to know in advance the annual flow, the monthly average flow of an average year will be considered as a base for the division of water in the dry year.

Article 5:
The Technical Commission constituted from both parties, has to measure the water flow and to supervise the quantities of water coming from the river, the wells, the sources and also from the pumps installed on the river, inside the Lebanese territory till the Syrian border. To guarantee the equal repartition of this deal, the commission organizes a monthly meeting or more, as much as it is necessary, under the demand of one of the two parties.

Article 6:
The two parties, Lebanese and Syrian, must undertake, on the charge of the Syrian party, the following items:

a- Maintenance of the canals, where there are Syrian rights, inside the Lebanese territory.
b- Maintenance of the Orontes River bed inside the Lebanese territory in order to avoid water losses. The execution should be done according to the Lebanese legislations. These works will be considered as public utilities and must be limited to the direct border of sources and the river bed.

Article 7:
It was instituted an arbitral commission, formed by the technical commission mentioned in the article 5, in order to sort out the dispute issues for the application of this deal, and, in case of conflicts, each party gives its point of view to the chief of the respective party in the Lebanese - Syrian follow up committee.

Article 8:
It is considered that the wells made in the zone of the feeding basin till 20/9/1994 are lawful to this deal. These wells will be listed in an inventory and mentioned on the plans with the specifications of the well and the quantity of water pumped every year. The plans will be signed by the two delegated parties, 10 days after the signature of this deal.

The two parties agreed after 20/9/1994, any new well in the feeding basin region of the Orontes River, will be closed and considered as illicit well.

In case that, after the signature of this deal, the Lebanese party decided to drill any well that she suppose important, she must notify the Syrian party and the quantity of water used will be deducted from the Lebanese part.

Article 9:
This deal has been signed on 20/9/1994 by the two parties.

For the Syrian Arab Republic	**For the Lebanese Republic**
Minister of Irrigation	Minister of Water and Electrical Resources
Eng. Abdel Rahman Al MADANI	**M. Elie HOBEIKA**

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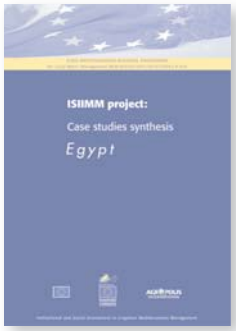

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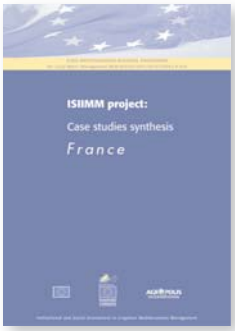
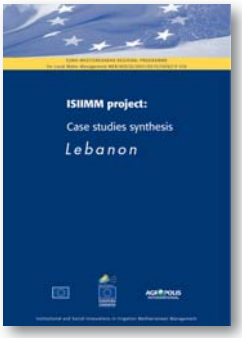


Case studies synthesis *France* (English, French)

Case studies synthesis *Italy* (English, Italian)



Case studies synthesis *Lebanon* (English)

Case studies synthesis *Morocco* (English, French)

Case studies synthesis *Spain* (English)

General synthesis (English, French)

Institutionnal report (English)

Partner

Chamber of Commerce, Industry and Agriculture of Zahlé and the Bekaa

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