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Republic Of Lebanon

Policy Note on Irrigation Sector Sustainability

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Preface

This Policy Note has three main objectives. The first is to formulate strategic choices related to the sustainability of irrigated agriculture in Lebanon. The second is to recommend institutional strengthening of water resource management in the irrigation sector in general, especially for operations and maintenance (O&M). The third is to define the Bank's possible future involvement in the irrigated agriculture sector. The main recommendations of this Policy Note (PN) will be used as an input to the Country Assistance Strategy (CAS) currently under preparation by the Middle East and North Africa (MENA) Region.

The Bank originally planned to collaborate with the Government of Lebanon (GOL) officials to prepare a strategy for overall water resource management in Lebanon. However, the government of Japan offered to assist the government carry out an urgently needed Water Resources Management Master Plan (WRMMP) through the Japan International Cooperation Agency (JICA). Consequently, the GOL and the Bank agreed to focus the study on the irrigation sector. It should be noted that the scope of the report does not include the rainfed agriculture sector.

The Bank team has used the concept of sustainability in two contexts. First is the physical sustainability of the irrigation system network, which is achieved through adequate operation and maintenance. The second is sustainability of the irrigated agricultural sector. The sustainability of the entire agriculture sector is more fully discussed and developed in the Bank's report entitled "Lebanon: Perspectives on Agricultural Sector Issues (Draft)". While in Lebanon, it became evident that the Note would have to go beyond its original objectives. First the team had to work out a new water balance for Lebanon due to controversial figures. Second, the Ministry of Energy and Water (MOEW) and the Litani River Authority (LRA) had very ambitious investment programs, which needed to be made more realistic.

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Acronyms and Abbreviations

ARIL	Agriculture Research Institute of Lebanon
AUB	American University of Beirut
BCM	Billion Cubic Meter
BOD	Biochemical Oxygen Demand
CAS	Country Assistance Strategy
COD	Chemical Oxygen Demand
DGO	Directorate General of Operations
DGHER	Directorate General of Hydraulics and Electrical Resources
ESCWA	Economics and Social Commission for West Asia (United Nations)
EA	Environmental Assessment
EC	Electric Conductivity
FAO	Food Agriculture Organization
GCC	Gulf Cooperation Council
GOL	Government of Lebanon
GP	Green Plan
IRMP	Irrigation Rehabilitation and Modernization Project
JICA	Japan International Cooperation Agency
LRA	Litani River Authority
MCM	Million Cubic Meter
METAP	Mediterranean Technical Assistance Program
MOE	Ministry of Environment
MOEW	Ministry of Energy and Water
MOPH	Ministry of Public Health
NERP	National Emergency Recovery Program
NGO	Non-Governmental Organizations
RWA	Regional Water Authority
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
WA	Water Authority
WHO	World Health Organization
WRMP	Water Resources Master Plan
WUA	Water Users' Association

Executive Summary

As demand for domestic, industrial, and agriculture water increases, Lebanon could face chronic water shortages in the next two decades, particularly in the summer months. In fact, signs of such shortages are already apparent. The data on water demand and water balance are conflicting, but they generally indicate that the overall annual water balance will practically go into deficit just after 2020, while the dry season balance will be in deficit in 2004. Faced with this challenge, the Government of Lebanon (GOL) is keen to take measures to enhance the sustainability of water resources in the country, including irrigation, which accounts for about two thirds of the annual water use.

Presently the total water demand is estimated at about 1,260 MCM/year and this figure is expected to rise to about 2,820 MCM/year by 2030. Tentative findings show that, by 2004, the water shortage during the dry months that could exceed 700 MCM by 2030. At the same time, Lebanon loses over 700 MCM of water to the sea annually. Most of the demand is concentrated on agriculture in the Bekaa Valley and and on potable water and industry in the large cities like Beirut and Tripoli. To overcome the large dry season deficit, the country will have to rely on excessive pumping at considerable economic and environmental cost unless water resources management is improved. In the medium term, GOL plans to increase water storage capacity from its present level of 220 MCM to about 500 MCM or more in addition to taking drastic measures to improve the water supply and distribution efficiencies.

In addition to existing structural problems, the quality of existing water resources is being undercut by pollution, such as, direct discharges of municipal and industrial wastewater, uncontrolled solid waste disposal, leaching of pesticides and fertilizers from agricultural lands, and seawater intrusion along the coast as a result of over exploiting groundwater. For example, pollution in the Litani River, the largest in Lebanon, has limited its use.

THE ROLE OF THE AGRICULTURE IN THE ECONOMY

Agriculture's contribution to gross domestic product (GDP) grew during the civil war, peaking at 23 percent in the 1990s. Since the mid-1990s, its role has gradually eroded to pre-war level, reaching 6.3 percent in 1997.[1] There is no evidence that its share has grown since then. Annual agriculture growth rates experienced wide fluctuations within a declining trend—for example, 8.6 percent in 1995 and 1.1 percent in 2000. The main reasons for the low rate of growth of the agriculture sector include: a high cost structure, an overvalued exchange rate and high interest rates, an infrastructure that was either damaged or neglected during the civil war, and structural issues. For more details on the subject, reference is made to the Bank's agriculture policy note for Lebanon titled "Lebanon: Perspectives on Agricultural Sector Issues" (World Bank 2003).

The agricultural labor force fell from over 30 percent of total employment in 1964 to its current level of nine percent, and there are wide regional differences in this figure.[2] Agriculture and food products account for about 20 percent of total trade, with the major exports being fruits and vegetables. The main

[1] According to revised National Accounts by the Ministry of Economy

[2] For more details on the subject, please refer to Lebanon - Perspectives on Agriculture Sectors Issues December 2003 - Report no 26265-LE. Water, Environment, Rural and Social Development Department, Middle East and North Africa Region.

agricultural export markets are Saudi Arabia and Kuwait, followed by Syria, Jordan, the United Arab Emirates (UAE), Egypt, and Bahrain. The United States, Syria, and the European Union are the largest exporters of grains (wheat) and flour, dairy products, meat, and fish to Lebanon.

REFORMING THE ORGANIZATION OF THE WATER SECTOR

There are a number of institutional and administrative issues in the water sector. First is the delay in implementing legally mandated systems to support the new Water Authorities (WA). Law 221, passed in April 2000, addresses the organization of the water sector and the consolidation of water resource management. The law covers several issues involving the Ministry of Energy and Water (MOEW), the four new Water Authorities (WAs), the 22 Regional Water Authorities/Boards (RWAs), and the 209 Local Water Committees (LWC). Although the law was published in year 2000, the presidents and members of the WA boards were only appointed in late 2002, delaying its effective application. The WAs are expected to take over the management of the irrigation, potable water, and sewerage schemes, but technical, administrative, and financial constraints are preventing this. Therefore, the Local Water Committees still manage the irrigation and sewerage schemes, and there are no immediate plans to shift to the new system.

Second is the fragmentation of, and lack of cooperation between, the numerous agencies in charge of water resource management—including, MOEW, Litani River Authority (LRA), WAs, RWAs and LWCs. The third issue is the lack of stakeholder participation in project design, implementation, and operation and maintenance (O&M). The sector also suffers from the absence of Water User Associations (WUAs), although some of the LWCs play a slightly similar role.

Another issue is that the laws and regulations governing the water sector, which were promulgated under Ottoman and French codes, have not been updated to deal with emerging issues such as acquired water rights and the legal framework for the establishment and operation of WUAs. Finally, the government lacks an effective mechanism to enforce existing regulations and permits for drilling wells and maintaining the appropriate distances between wells and springs.

Several organizations are responsible for O&M in Lebanon (MOEW, LRA, WAs, RWAs, Local Committees, and municipalities). The newly created WAs are expected to oversee the planning, the design, the implementation, as well as the O&M of water and wastewater infrastructure. The MOEW is expected to supervise all these WAs in the areas of planning and formulation of strategies for water monitoring and distribution. Moreover, MOEW is responsible for setting specifications of water development and service levels, establishing regulations for supervision, evaluating the quality of water services, and setting water tariffs and pricing mechanisms.

LWCs and farmers' groups are most involved with O&M for small and medium irrigation schemes. Of the total number of schemes, about half are operated and maintained by farmers groups. This is a clear indication that introducing formal WUAs, as an efficient and sustainable way for organizing O&M, is possible and could be successful.

While a wide range of laws and regulations regulate water use and disposal in Lebanon, there are no references to a policy on cost recovery. Lebanon generally uses two tariff systems: area charges and volumetric charges, but each RWA has its own procedures for setting and collecting tariffs. Currently, the tariff rates vary widely, from US$0 to US$400/ha RWAs or LWCs are responsible for enforcing tariffs.

The outlook for physical sustainability of Lebanon's irrigation network is promising. Schemes operated by LRA do achieve full cost recovery. Many small schemes, which are operated by LWCs already finance part of O&M costs, and now have to finance the subsidy that used to be provided by MOEW. In other schemes, O&M charges and collections need to cover O&M costs, in line with recommendations given in

this Note. Any future water tariff policy should take into consideration economic efficiency, ability to pay, and access to services and distribution.

RATIONALIZING PUBLIC INVESTMENT FOR IRRIGATION

MOEW and LRA are the two agencies in charge of irrigation investment programs. Their planned investment programs represent about US$1.3 billion in spending, which averages to about US$48 million per year. If the irrigation investment programs are implemented, the water storage capacity of dams/reservoirs in Lebanon would increase from 220 MCM to over 500 MCM, and the total irrigated area would increase by about 50,000 ha over 30 years. The irrigation investment program alone would rehabilitate or modernize 30,500 ha of irrigated areas. This program is very ambitious when one considers that Lebanon increased its irrigated area by about 20,000 ha and rehabilitated about 25,000 ha during the last 15-20 years.

Lebanon currently has only one large and around 15 very small wastewater treatment plants. GOL has a long-term plan to build 25 new plants for the major cities. The development of cost-effective, small-scale wastewater treatment plants for rural communities is a priority, as treated wastewater can be used in agriculture. However, this requires a regulatory framework, public awareness campaigns, and training concerned staff and farmers on using treated wastewater for irrigation.

Irrigation efficiency can be improved through incentives for water-saving technologies—such as, duty free imports for drip and sprinkler equipment; technology transfer through effective applied research and extension services to improve on-farm irrigation efficiency; and raising cost recovery in irrigation schemes in addition to rehabilitating and modernization of the irrigation schemes main networks.

The Bank recommends several actions to better manage the demand for irrigation water and cost recovery system. First, the agencies responsible for setting and collecting tariffs on irrigation water should raise those tariffs to cover O&M costs, and these charges should be based on the volume of water used rather than area, which does not provide an incentive for more efficient water use. Second, the agencies should also periodically review and adjust water tariffs to reflect actual costs. Finally, GOL should enforce the licensing of wells by imposing heavy penalties for violations in order to reduce construction of new illegal wells. By one estimate, there are 10,000 legal and about 40,000 illegal wells. These steps should contribute to the sustainability of irrigation schemes.

This Policy Note (PN) recommends scaling down the investment program to no more than an average of US$35-40 million per year. This would mitigate any increase in the high public debt, and it takes into consideration the capacity of the implementing agencies. If GOL adopts this recommendation, irrigated area would still increase by around 36,000 ha over 30 years. Farm income would also increase but there would be room for more orderly marketing of incremental production in the new irrigated areas.

INCREASING AGRICULTURAL COMPETITIVENESS

The planned increase in irrigation potential—by 30-50 percent in the next 30 years—would result in substantially increased agricultural production. The local market would absorb a large proportion of this production, given the present population growth rate. However, the increasing the irrigation potential should go hand-in-hand with producing high-value crops for international markets. The proper processing and quality control mechanisms will be needed to take advantage of this change.

Lebanon has a comparative advantage in high value horticultural crops, but is not competitive in field crops. This is enhanced by the diversity of its climatic zones, proximity to the Gulf and European markets, and advantageous terms negotiated in the EU Association Agreement. Nevertheless, Lebanon

faces strong competition in vegetables and some fruits from neighboring countries that either have lower costs, subsidize inputs, or both. Therefore improving competitiveness is key to the future of agriculture in Lebanon. The Bank recommends that any investment in irrigation should be accompanied by investments to improve marketing infrastructure and services—such as, wholesale markets, and communications networks. GOL should also encourage private investments in storage, processing, packaging, and risk management, aided in the short term by an incentive framework. Finally, GOL should create a regulatory environment that enhances the role of farmer organizations and cooperatives to improve quality, efficiency, competitive price formation, and reduce market risks.

Lebanese farmers can further enhance their competitiveness by producing high-value specialty crops—such as, organic food, seedless grapes, cherry tomatoes, wines, medicinal plants, herbs, etc.). They should replace aging varieties of apples and other fruits and cater to changing consumer preferences. Farmers can also reduce costs by increasing the cropping intensity of irrigated agriculture; using less agro-chemicals; adopting more efficient irrigation technology (drip and sprinkler use). GOL should mitigate the impact of structural obstacles such as small and fragmented holdings and the land tenure system over the long term.

Lebanon has good potential for expanding the export of high quality processed food products to the EU, the Gulf, and the US. GOL has made a good start by hiring three international firms for quality control of agricultural produce for export. However, the Government needs to make more of an effort to improve product quality so that it meets EU and international standards. It is particularly important to have an internationally accredited laboratory certify the pesticide levels in exports. It will also be necessary for exporters to wage an aggressive marketing campaign and hire a European firm to develop markets for them. They also need to receive real time market data and information on tariffs, country of origin, and other export requirements in destination markets by IDAL or Chambers of Commerce.

The falling exchange rate should also improve the competitiveness of agricultural and processed food products, but its magnitude is not known, due to the lack of empirical estimates of the elasticity of agricultural exports to the exchange rate.

Institutional aspects

Overall, irrigated agriculture should be sustainable in the long term because agriculture in Lebanon supplements family income instead of being the only source. The challenge is to make agriculture more competitive and efficient. The EU Partnership Agreement provides a unique opportunity and potential market for high value horticultural produce, provided Lebanon complies with health and quality standards. Moreover, Lebanon can expand its export of processed food and specialty products for which it is competitive.

Although WAs in principle have administrative and financial autonomy, they face serious staffing and financial constraints. In view of their limited administrative and financial capacity, WAs have expressed the need for farmers to assume responsibility for the O&M functions of irrigation schemes through the formation of WUAs. This Note endorses that move. To facilitate this, GOL should accelerate issuing the executive regulations and by-laws that will empower WAs with the autonomy envisaged by Water Law and that would enable them to hire the technical staff they need. It should also pass legislation to update the laws regulating the water sector, especially to provide a legal framework governing WUAs and to address the issue of acquired water rights. Moreover, the capacities of the MOEW, of the RWAs, and of the LRA need to be strengthened in the areas of water quality testing and monitoring, data analysis, quality assurance and control, and database and reporting.

This study commends GOL for its policy of encouraging a public-private partnership in water resource management and for seriously considering the eventual privatization of the services of WAs and establishment of WUAs. Best practice has shown that the most successful projects are those that involve

stakeholder management of O&M functions through WUAs. The newly established WAs are in favor of this approach and support the establishment of the WUAs because this would reduce their administrative and financial burdens. However, the WAs should remain in charge of the O&M of larger main canals, intake structures and pumping stations which are often well above the farmers' capacities. MOEW should continue to assist the WAs and regional and local committees in the O&M of irrigation schemes, especially those that are in bad state of repair, until the WAs become fully operational. Large civil works should remain MOEW responsibility.

Bank proposes that GOL consider an option that has been implemented in Morocco and Egypt. The government would give a role to the private sector as a potential partner in public investment and/or manager of an irrigation scheme. This can be designated as a pilot, and if successful, it can be replicated. In this option, a private firm would be in charge of O&M functions of the scheme, decide on the level of service needed by farmers in collaboration with stakeholders, and set irrigation water tariffs to cover those O&M services.

Environmental aspects

Environmental mitigation measures are essential for improving water quality. To implement this, the Bank recommends that GOL establish a national water quality program to monitor surface and groundwater resources, particularly in the Litani basin. It should also start pilot projects to test different technologies and practices for the reuse of treated effluent from municipal plants. GOL should establish and implement the "polluter pays" concept that is commensurate with the degree of pollution. Finally, the Government needs to strengthen the capacity of the agencies dealing with water quality testing, data analysis, quality assurance, and control, in addition to establishing and maintaining databases on water quality.

AREAS OF POSSIBLE BANK SUPPORT

The World Bank can provide support to a number of the planned irrigation investments that will be implemented by MOEW and LRA. These include:

- *South Bekaa Phase II Project.* This project would improve irrigation on 6,700 ha that are currently irrigated through uncontrolled private pumping. The 2002 updated feasibility study showed that the project is viable, since a significant proportion of the major investments in basic infrastructure have already been made in Phase I, which was financed by the Bank and GOL. The total cost of the project, excluding contingencies, is US$45 million. LRA would implement the scheme in over a period of four to five years.
- *South Qaraoun Irrigation Scheme.* The feasibility study currently underway shows that at an estimated cost of about US$5 million, the scheme would irrigate an area of 800 ha from the Qaraoun reservoir. LRA would implement the scheme in two years.
- *El Bared Dam and Reservoir Scheme.* This scheme includes constructing a storage dam on the El Bared river, with a storage capacity of 40 MCM, and rehabilitating the irrigation conveyance and distribution networks. The project provides drinking water (20 percent) in addition to irrigation water (80 percent). Although a feasibility study has not been carried out, the project is expected to be viable since it capitalizes on existing infrastructure. The project would provide irrigation water to around 4,000 ha in some of the poorest *Cazas* in Lebanon (Akkar, Minieh, and Dannieh) and drinking water for Tripoli and its surrounding areas. The estimated cost of the project is US$45 million, to be implemented by MOEW over a period of four years. The Bank could finance rehabilitation and modernization of the irrigation network for around 4,000 ha.

In addition, the Bank can play an extremely useful role in supporting the establishment of WUAs by providing technical support to establish the legal framework and formal creation of WUAs, and by training the staff of concerned agencies. This is now more urgent since GOL stopped subsidizing O&M of irrigation schemes operated by local water committees. WUAs would eventually replace other organizations in charge of O&M functions of irrigation schemes. Another area of possible Bank support involves human resource capacity building of MOEW and LRA in the technical and management fields, to enable them to carry out the proposed investment programs.

Many irrigation schemes proposed by MOEW or LRA are in a preliminary phase. Before any irrigation scheme is undertaken, it is imperative to carry out a full-fledged feasibility study to determine the economic feasibility of the proposed project and taking into consideration the social aspects of the project. The World Bank can assist GOL in this regard by reviewing terms of reference for consultants, selecting consultants, and reviewing feasibility studies.

In addition to the areas above, any new investment by the Bank in the irrigation sector should be accompanied by parallel investments in the agricultural sector in order to ensure that high-value horticultural crops are being produced and that their marketing channels are ensured.

1. Introduction

Lebanon has an area of 10,452 km^2, and a population of about 4.4 million inhabitants, excluding migrant workers. Therefore high population density high: in excess of 420/km^2. Much of the country is mountainous and cultivable land is limited to around 250,000 ha. Of this area, 90,000 ha are equipped for irrigation. About one-half of irrigation water is supplied from rivers and spring water and the other half from groundwater. With an average overall per capita supply around 2,000 m3/year and annual average precipitation at 8.6 BCM/year, Lebanon is relatively better endowed with water resources than its neighbors. The country has 17 main rivers, of which three are international; about 2,000 springs; and nearly 50,650 wells. However, water is distributed unevenly among regions and between seasons, and in some locations it is difficult to harness, due to steep slopes. As a result, Lebanon loses an estimated 1.4 BCM to the sea annually, which is a cause of great concern for the country.

At present, Lebanon has only one large dam, Qaraoun Dam in the Bekaa valley, with a storage capacity of 220 MCM and is now constructing another dam for potable water supply, the Chabrouh Dam in Mount Lebanon with a storage capacity of 8 MCM. In addition, Lebanon has one large hill lake with a storage capacity of two MCM.

There are several government agencies involved to varying degrees in water resource management in Lebanon, with overlapping functions. The main agencies are the MOEW, the Litani River Authority (LRA), and the recently established four regional Water Authorities (WAs), which officially replaced the 22 regional water authorities and about 210 local water committees. The MOEW is responsible for strategic planning of water resource management, including the preparation of the water master plan, conservation of surface and groundwater resources, as well as the design and implementation of large projects and dams; in addition, it has oversight of the WAs. The LRA was established in 1954 to implement the multi-purpose Litani River Scheme covering irrigation, potable water supply, and drainage, in addition to power generation. According to its mandate, LRA has responsibility for irrigation schemes in South Bekaa and South Lebanon. The WAs have the responsibility to plan, design, and implement small schemes in the areas of domestic water supply, irrigation, and wastewater networks that do not come under the jurisdiction of the MOEW and the LRA. The WAs also propose water tariffs through MOEW and the Ministry of Finance (MOF) for cabinet approval. Although the WAs in principle have administrative and financial autonomy, and have recently become operational, yet administrative, staffing, institutional capacity, and financial constraints abound.

2. Water Resources

Water Supply. Although Lebanon is relatively well endowed with diversified water resources that are adequate for its present and short term future needs in annual and multi annual terms, it does nevertheless have water shortages during the dry season which extends over the four months of July and October and which will become more acute in the coming years.

Data concerning water supply and water demand often do not converge, so this Note tries to reconcile the conflicting figures as much as possible. In addition, data from the JICA report were not fully used as the report is not yet finalized. Typical annual average rainfall ranges between 880-1,000 mm in the coastal areas, 1,000-1,400 mm in the mountains, 200-600 mm in the Bekaa and 600-1,000 mm in the South. Of the total annual rainfall, 70 percent falls on the western slope of the Mount Lebanon. The total annual water resources available to Lebanon according to a large number of sources are estimated at about 8.6 billion cubic meters (BCM), of which about 4.0 BCM/year are lost to surface evaporation.[3] Of the remaining water, about 700 million cubic meters (MCM) per year flows to adjoining countries, 150 MCM infiltrates to groundwater beyond the southern boundaries and 700 MCM is lost to the sea by deep percolation (table 2.1). This leaves about 3.0 BCM remaining in Lebanon, of which 2.1 BCM is readily available for utilization.

Estimating the amount of usable water is made difficult by the lack of reliable information on the interaction between surface and groundwater in the karstic system, which covers 60 percent of Lebanon. Of the available surface flows about 800 MCM is stored underground because of the karstic nature of the geology. Water resources are generally difficult to manage due to the cost and the technical difficulty of storage in spite of the considerable length of rivers estimated at about 800km resulting in the shortages experienced during the dry months of the year.

The main rivers are:

- The main river of Lebanon is the Litani, which is 170 km long with a basin originating in the upper Bekaa in the east and flowing south and west before finally flowing into the sea in the southwestern corner of the country.
- El Assi river basin in the north flowing into Syria in the north-eastern corner of the country;
- All the remaining major coastal river basins (except for the Hasbani) originate from the western slopes of Mount Lebanon and flow westward into the Mediterranean Sea. Of these, the northern most river, the El Kabir, forms the northern border of the country with Syria.

Springs. Lebanon's groundwater table is generally high because of the high infiltration rate into the generally calcareous foundations. At the slopes of the mountain ranges this results in springs flowing out of the ground in many parts of the country including from openings of karstic caves. The water also runs down through subterranean water channels. The number of the springs in Lebanon is estimated at around

[3] Several sources cite a number of 4.5 BCM/year, while the recently completed first phase of the JICA report cites a figure of 2.7 BCM/year. For the purpose of this policy note, the Bank team uses an average figure of 4.0 BCM/year.

2,000. These vital sources of good quality water have been used by the inhabitants since time immemorial and are distributed almost evenly throughout the country.

Table 2.1 Catchment areas of the major rivers of Lebanon

			Catchment Area (km2) and Runoffs (MCM/year)			
No	*Region*	*Name of River*	*UNDP (1970)*	*JICA (2002) (*1)*	*Runoff*	*Notes*
1	The North	El Kebir	437	340	131	Shared with Syria
2		El Ostouene	160	173	67	
3		Arka	153	191	70	
4		El Bared	277	268	72	
5		Abou Ali	484	494	205	
6		El Jouz	198	190	40	
7	Mount Lebanon	Ibrahim	330	353	319	
8		El Kelb	260	260	117	
9		Beirut	231	229	65	
10		Damour	288	292	157	
11	The South	Awali	302	304	371	
12		Saitaniq	111	111	11	
13		El Zahrani	88	106	13	
14		Abou Assouad	132	148	3	
15		Litani	2,168	2,181	689	
16	The Bekaa	El Assi	1,870	1,884	656	Flowing into Syria
17		El Hasbani(*2)	526	531	85	Flowing into Israel
	Total		**8,015**	**8,055**	**3,069**	

Note: (*1) By GIS System under JICA Study; (*2) Excluding Marjaayoun Basin.

Spring Yields. Relatively high precipitation and very high infiltration rates means that all springs have high seasonal flows. The total average yield of all springs is estimated to be about 1.4 BCM/year. Some springs discharge more than 140 MCM/year, such as Afka and Jeita, and the Ras El Assi spring being the largest with yields of more than 363 MCM/year.[4] These levels of flow exceed the yearly runoff of some of the rivers—such as the River Beirut or the River Awali (UNDP, 1970). Lebanon has a Mediterranean climate with two distinct seasons: the dry summer and the rainy winter. As a result, the flows from springs also have high seasonal fluctuation with some of the larger springs and almost all the smaller springs drying up before the start of the winter season. The highest runoff flows occur in May, and while spring flow has a close correlation with rainfall there is a considerable time lag between the two.

Groundwater wells and uses. Since there are many springs everywhere in the country, providing convenient sources of water for domestic, potable, and agricultural uses, no other form of groundwater has been used in the past, such as deep wells. Recently, however, people have started to dig wells or drill boreholes to secure a water supply because of the increasing demand for water and decreasing water sources. The agriculture and water supply sectors are the main developers of groundwater resources. The biggest consumer of groundwater is the agriculture sector, with the LRA being the biggest public sector organization. Altogether, 22 Water Authorities (now combined into four Regional Authorities) and several Water Supply Committees now own production wells to supplement the water supply from

[4] There are 30 major springs where average annual flow exceeds 10 MCM/year, four have between 10 and 20 MCM/year, 13 have between 20 and 50 MCM/year, five between 50 and 100 MCM/year and 4 springs with flows exceeding 100 MCM/year.

springs. More wells are being continuously drilled to meet the increasing demand for water, which makes it difficult to estimate their number. Besides the production wells constructed and operated by official agencies or public sector organizations, there are numerous private sector wells. These are generally small scale, mostly less than 100m in depth with a yield of about 50-80 m^3/day. Well construction by the private sector has increased considerably since 1975 due to the breakdown of public services for the delivery of water during the period of civil strife in Lebanon. It is estimated that there are nearly 10,000 private wells in Lebanon which are formally approved by the MOEW, but it is thought that there are also more than 40,000 illegal wells. Wells are distributed all over the country with the major production wells, which are operated by public sector being concentrated near the major cities. The estimated total yield of all these wells is about 400 MCM/year.

Re-use of treated sewage effluent. There is potential of re-using treated sewage effluent for irrigation purposes. However due to health issues and economical feasibility as well as to the fact that the GOL decided to discharge treated water effluent from major cities to the sea, the total available water for re-use is relatively small (max. 0.05 million m3/year) and would not be considered in the water balance exercise.

Water Balance. Based on the best available data, an approximate water balance for the whole of Lebanon is presented in figure 1. In order to have better figures, a complete hydrological network and permanent measurement are required.

Flood prevention and mitigation. The flood prevention and mitigation efforts suffer from the general inconsistencies of the sector. There is no one institution that coordinates matters, so the reaction is very slow in times of emergency. This generally results in a considerable loss to farming land and property. Unfortunately flood issues are not covered by any technical reference in Lebanon. Therefore any serious discussion of the subject could not easily be undertaken.

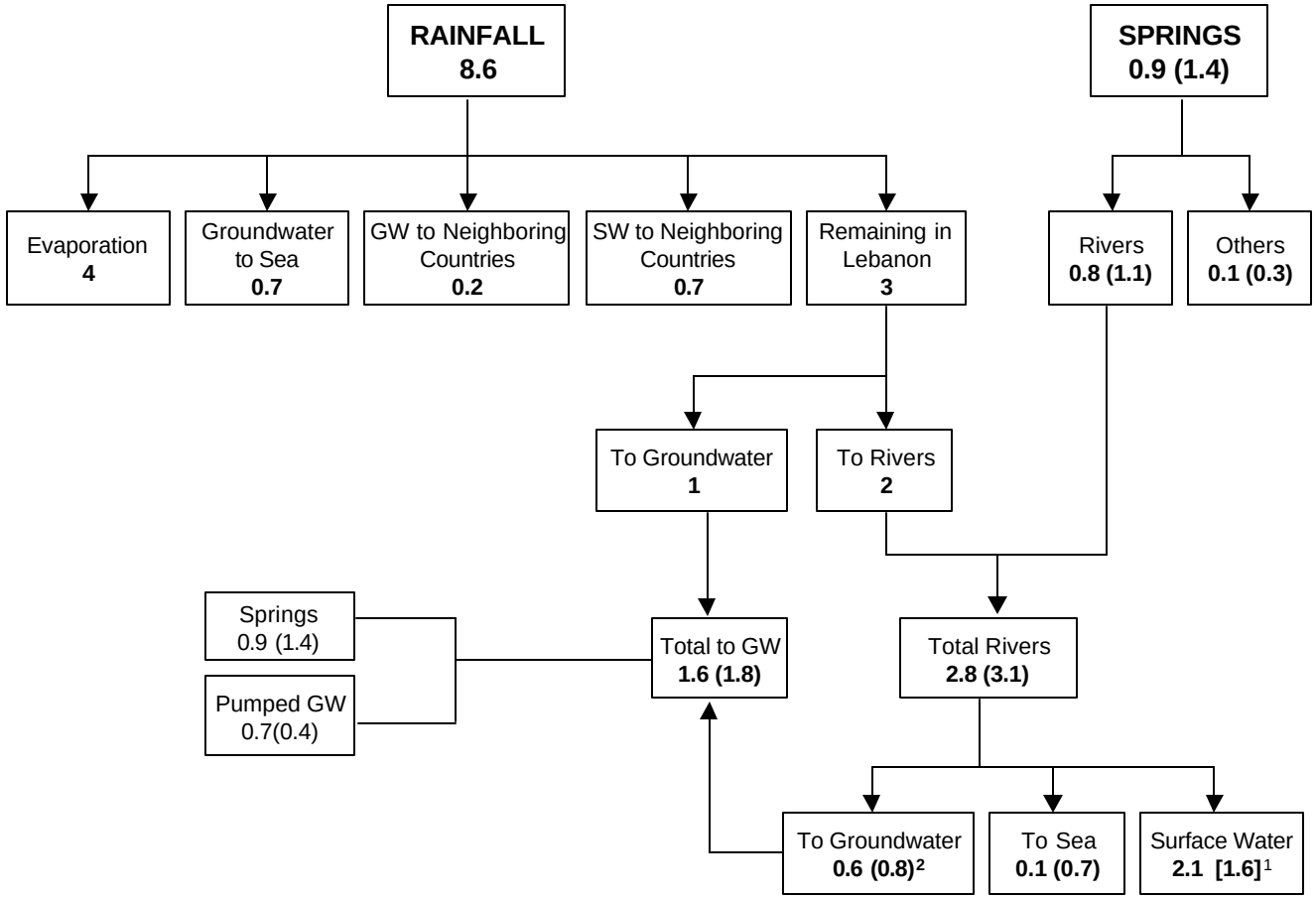
The winter of 2003 brought a considerable amount of heavy precipitation after several years of near drought conditions, which resulted in heavy flooding in the Bekaa from the Litani River and other areas. This was the result of 400 mm of rain falling over an 11 day period over the slopes of the two mountain chains and on the Bekaa plains. While the Litani river encountered large flooding this year, most of the other rivers flowing through plain areas will encounter flooding during the winter months and in particular the southern banks of the Nahr El Kabir forming the border between Lebanon and Syria.

MOEW is the authority responsible for monitoring and proposing amelioration of damages caused by river floods. The LRA will also carry out such functions in its areas of responsibility and is currently cooperating with the European Union to obtain technical and financial support for carrying out river training and for dredging the course of the Litani to reduce the risks of similar flooding in the future. There is also a General Council for Emergency Relief that maintains a database of consultants to review relief matters, including flood relief. The MOEW often asks the General Council to take action regarding any right of way violations of the natural watercourses in the country, which may have aggravated the ability of natural watercourses to convey high intensity flood flows.

Inadequate meteorological early warning forecasts and inadequate monitoring of stream flow at the upstream watershed areas have contributed to the lack of preparedness. The logistics of flood prevention and mitigation require that certain stocks of equipment and materials be available in convenient storage to be called out to raise banks and repair breached embankments to contain flood damage in a short period thus limiting damage to life and property.

Agriculture drainage, as practiced in irrigated agriculture in the river basins of the Nile, is not used in Lebanon mainly due the high soil infiltration rates and lack of any present water logging conditions. Some drainage may be required in the Bekaa Valley, but this is more as a result of flooding which the LRA deals with on an *ad hoc* basis. Future projects in the Bekaa valley should investigate the drainage requirements in more details.

Figure 2.1 Future and Current Water Balance for Lebanon (BCM/Year)



Notes: 1. (1.6) = Value of presently available surface water. (2.1) = Maximum possible values. 2.(0.8) = Present value of groundwater recharge of 0.8 BCM / Year, goes to springs and the rest to wells. GW = Ground Water. SW = Surface Water.

WATER DEMAND

For irrigation water

The agriculture sector is the main water consumer in the country, using about 64 percent of water diverted from surface and groundwater sources. Given the impending water scarcity, most planners now recognize the need to adopt more efficient irrigation methods, which implies modernized irrigation techniques and practices to ensure higher irrigation efficiencies. To estimate the overall demand for water, it is essential to assess the present use of water for irrigation; however, data and information to identify the actual consumption of irrigation water, such as the volume of water diverted and applied in the field, are scarce. The amount of water crops consume depends on climate, cropping calendar, and farming practice. Actual water allocations will depend on the method of irrigation—such as surface, sprinkler, and drip irrigation. Parameters for estimating irrigation water demand include:

- *Existing Irrigated Area*. The total gross equipped area is estimated at 90,000 ha, of which the net irrigated area is about 81,030 ha as shown in table 2.2 and in appendix table A1.1.

Table 2.2 Existing schemed and small scale irrigation areas (ha)

Category	*67 Schemed Irrigation*	*Small Scale Irrigation*	*Total*
Equipped Area	65,600	24,400	90,000
Net Irrigated Area	59,070	21,960	81,030

Ref. Preliminary JICA Report.

- *Proposed New Irrigation Areas.* In total, 17 irrigation and 18 hill lakes projects are being studied or are proposed for future implementation up until 2030, with an irrigation area of about 80,000 ha.[5] The estimated cost and the implementation time frame have been discussed with MOEW and the LRA. The total estimated cost of the programs of both the Ministry and the LRA is about US$1,350 million. If the expenditure is incurred by 2030 the average basic annual cost (not including contingencies) would be about US$48 million. The choice of a development scenario would depend on available external funding and counterpart funding from GOL, on institutional capacity, and on other considerations related to agriculture (for instance, research, extension, quality control, marketing, etc.).
- *Cropping Pattern.* The relative distribution of cultivated land in Lebanon according to the regions can be simplified as the:
  - coastal plains with fruit trees and vegetables with water supplied from the nearby rivers;
  - mountainous areas with fruit trees with water supplied from small springs that emerge at a high elevation, and
  - Bekaa plain with vegetable crops and cereals supported by the industrial processing of sugar beets and using water from nearby rivers and groundwater aquifer and treated wastewater.

[5] This includes expanding the current schemed areas by 50,000 ha and rehabilitating and/or modernizing 30,000 ha of existing irrigation schemes (see table A2.2).

For determining the water requirement for irrigation, the crops are categorized into three, namely cereals represented by winter wheat, vegetables, and fruit trees.

- *Crop Water Requirements.* Appendix table A2.1 shows seasonal fluctuation of the crop water requirement derived from reference crop evapo-transpiration after consideration of the crop coefficients for the various crops. Banana consumes the largest amount of water, 1,240 mm/year, while potato needs 575 mm per crop, both on the irrigated field. As for seasonal fluctuation, maize consumes 235 mm in August while 95 mm is required in July by olives that are also irrigated in some places of Lebanon.
- *Effective Rainfall.* This varies from the highest in January at 128.9 mm to lows of 19.9 in May and 31.1 in October. There is practically no effective rainfall in June with 1.7 mm and practically no effective rainfall in the months of June, July, August and September.
- *Field Water Requirements.* These are detailed in appendix table A2.3, and are derived from crop water requirements after subtracting effective rainfall.
- *Irrigation Efficiencies*. Those adopted in Lebanon in consultation with MOEW and LRA officials are as follows:

Table 2.3 Proposed irrigation efficiencies

Irrigation System	*Efficiencies*			
	Conveyance	*Distribution*	*On-farm*	*Overall*
Sprinkler	0.95	0.95	0.8	0.7
Drip			0.9	0.8
Surface	0.90	0.90	0.75	0.6

- *Diversion Water Requirement.* Diversion water requirement for irrigation, after application of irrigation efficiencies, are summarized in appendix tables A2.4-A2.6. The data indicates that the highest user of irrigation water is Bananas where irrigation requirements range between 14,165 m3/ha, 12,141 m3/ha and 10,623 m3/ha for surface, sprinkler and drip irrigation respectively. The lowest user of irrigation water is wheat where the requirements for surface irrigation are 5,585 m3/ha and 4,788 m3/ha for sprinkler irrigation.
- *Current and Projected Irrigation Water Demands.* Based on the above, and on the projected cropping intensities of no more than 150-160 percent, the water requirements of irrigated agriculture, as determined in the JICA study, gave the gross requirement in 2002 of 782 MCM/year increasing gradually to 1,127 MCM/year in 2030. Table 2.4 shows the projected water demand for irrigation by Mohafaza. During discussions with the MOEW it became apparent that they had reservations about the values adopted by the JICA report and mission has after discussions arrived at different realistic figures whereby the on farm average gross water requirements, including losses from source can be taken now as 9,000 m3/ha. This figure would be lowered to 8,000 m3/ha by year 2030. When this is translated to water demands in 2003, using a figure of 90,000 ha for the total irrigated area for the year 2003, the total demand would be 810 MCM/year of irrigation water requirements, increasing to 1,120 MCM/year in 2030 for an irrigated area of 140,000 ha. These figures correspond well with those calculated in the JICA report (782 and 1,127 m3/ha).

For domestic and industrial use

Domestic demand is estimated on the per capita water consumption assigned to each area, with non–residential demand consisting of commercial and administrative uses in addition to any anticipated

expanding demand for tourism. The sources for satisfying water demand are either the public supply network, which provides water for the domestic and industrial uses, while incurring losses due to the leakage of the piped distribution system, or the private supply system, primarily from wells, which covers the demands for some domestic and industrial users.

Table 2.4 Projected water demand for irrigation by Mohafaza

(MCM/year)

No.	*Name*	*2002*	*2005*	*2010*	*2015*	*2020*	*2025*	*2030*
1	Beirut	0	0	0	0	0	0	0
2		78.4	78.4	78.4	78.4	78.4	78.4	78.4
3	N. Lebanon	158.3	158.3	158.3	158.3	174.8	174.7	174.5
4	S. Lebanon	117.7	145.4	145.4	167.9	192.3	191.6	220.5
5	Bekaa	411.7	412.2	478.1	477.7	481.8	481.6	481.0
6	Nabatiyeh	15.8	101.5	100.65	117.8	117.6	116.7	172.6
Total		781.9	895.8	960.7	1000.1	1044.8	1042.9	1127.0

Criteria for estimating Current Water Demand. Considering the results and observations of various studies, the basic criteria for estimating current water demand are set up as follows:

- *Residential Consumption.* The majority of systems currently operate on a suppressed demand supply basis and there are few, if any, operating flow meters. There are furthermore no available records from which typical per capita consumption rate of existing water usage can be estimated. Based on discussions with the MOEW, a flat rate was used for the per capita water requirement, which would reflect the actual and future demand for water. An average national value of 140 l/c/d has been used for the purpose of this note. To reflect the higher standard of living in Lebanon, compared to many developing countries, as it is indeed a well-developed middle-income country, this rate has been assumed to increase by about 2.5 percent annually to take into consideration the increasing demand in the next 30 years.
- *Industrial Consumption.* The mission had extensive discussions with the MOEW regarding the demand for water in industry. MOEW maintained that the allocations for this category should be adequate to cover the needs of industry in its broadest sense which should include tourism, an industry which is currently seeing the beginnings of a revival after many years of subdued activity due to the many years of civil strife and occupation. They maintain that in the medium and long term tourism and other agricultural and niche industries make Lebanon an ideal center of expanding economic activities in the region which would be very difficult to maintain if there was a water stressed situation in the country. It was therefore agreed that the industrial water demand would be maintained at 35 percent of the per capita residential consumption.
- *Wastewater and Reuse.* The current amount of wastewater is about 550,000 m^3/day. Of this, the raw wastewater is about 190,000 m3/day to which is added a further 45,000 m3/day as infiltration inflow into the sewage system resulting in the total sewer wastewater of 235,000 m3/day. It is estimated that about 10 percent of this (25,000 m3/day), which is about one percent of the average daily water demand for irrigation, can be used for irrigation. It is to be noted that this is a relatively small quantity of water and would not affect by any mean the national water balance.

Assumptions:

- Present Potable Water (PW) requirements per capita per day: 140 liters increasing annually by 2.5 percent.
- Losses in the potable water conveyance and distribution systems: 35 percent.

- Yearly growth rate in population: 2.5 percent.
- Industrial Water (IW) needs: 35 percent of Potable water requirements including losses.
- Present Irrigation Water (IRRW) requirements: 9,000 m3/ ha (including losses in the conveyance from source and distribution systems) decreasing to 8,000 m3/ha in 2030.
- Actual irrigation area in 2003: 90,000 ha.
- Planned irrigation area in 2030: 140,000 ha.
- Dry Season: Four Months: July to October.
- Water needs during the dry season: 0.5 x PW+0.4 x IW+0.85 x IRRW.
- Total Available Annual Water:
  - Readily Available Surface Runoff: 1.6 BCM/year.
  - Readily exploitable groundwater: 0.4 rising to 0.7 BCM/year.
- Total available water during the four dry months: 45 percent of the total Annual Supply.

In table 2.5, readily available and sustainable water supplies are assumed to be about 1.6 BCM/year of surface flow in rivers plus about 0.4 increasing to 0.7 BCM/year of readily available groundwater supplies from the aquifers. Of these about 0.9 BCM/year will be available during the dry four months of the year (when about 85 percent of the irrigation water will be required). This compares to dry season requirements of 0.9 BCM/year in 2003, 1.06 BCM in 2010, 1.36 BCM in 2020 and 1.76 BCM in 2030. This clearly indicates that the overall annual water balance will practically go into deficit just after 2020, while the dry season balance will be in deficit in 2004. To overcome the large dry season deficit over pumping will have to be relied upon to cover the deficit, at considerable economic and environmental cost associated with the resulting receding aquifers, unless the situation is improved by increasing the water storage capacity from its present level of 220 MCM to higher levels of about 500 MCM as well as taking drastic measures to improve the water supply and distribution efficiencies.

Table 2.5 Total annual water demand and available supply
(MCM/year)

Category	***2003***	***2010***	***2020***	***2030***
Irrigation Water Demand	810	900	1,020	1,120
Domestic Water Demand	331	467	767	1,258
Industrial Water Demand	116	163	268	440
Total Annual Water Demand	1,257	1,530	2,055	2,818
Total Annual Supply	2,000	2,100	2,200	2,300
Annual Water Balance	743	570	145	- 518
Total Dry Four Months Demand	900	1064	1358	1757
Total Dry Four Months Supply	900	945	990	1,035
Dry Season Water Balance	0	-119	- 367	- 722

Scenarios for the Water Balance. If the population is assumed to increase by 1.5 percent annually, then annual deficit for 2030 would be around 125 MCM (deficit starting by Year 2027), while the dry season deficit by 2030 would be in the range of 535 MCM/year. In another scenario, if we assume that the total irrigated areas would only increase to 126,000 ha as recommended in this Note (Chapter 10), then the annual deficit for the same year would be about 406 MCM and the dry season deficit would be about 627 MCM/year. If both these two scenarios are combined, the annual deficit would only start to appear by the year 2030 and the dry season deficit for the same year would be about 440 MCM/year. In all cases, the need for additional storage will be warranted.

3. The Agriculture Sector

ROLE OF AGRICULTURE IN THE ECONOMY

Agriculture has always been a private sector activity in Lebanon in a market-driven economy. The budget of the Ministry of Agriculture (MOA) is typically one to two percent of the national budget. Agricultural income is exempt from income tax, and agricultural workers neither contribute to nor benefit from the country's social security system. Government is not involved in the production of agricultural or processed food products, but has provided the basic infrastructure, a macroeconomic policy environment, and services (roads, power, transport and communications networks, potable water and irrigation networks, agricultural research, and an ineffective extension service). Some of these services, such as water supply, wastewater disposal, and treatment facilities are not universally available or reliable.

Within the context of a shrinking economy, loss of export markets, and sluggish growth in other sectors during the civil war (1975-90), the contribution of agriculture to Gross Domestic Product (GDP) peaked at 23 percent in the 1990s before falling after the end of the civil war to its pre-war level. (World Bank 2003a) The role of agriculture in the economy has been gradually eroding since the mid-1990s, and in 1997 it contributed 6.3 percent of GDP, and there is no evidence that its share has grown since then. This is lower than other countries in the region. Agriculture experienced wide fluctuations within a declining trend of annual rates of growth (8.6 percent in 1995 and 1.1 percent in 2000). At the same time, other sectors outpaced growth in agriculture, and in particular the manufacturing and services sectors. The main reasons for the low rate of growth of the agriculture sector include: a high cost structure in relation to neighboring countries, an over-valued exchange rate and high interest rates, an infrastructure that was either damaged or neglected during the civil war, and structural issues. A longer-term perspective, 1961-2000, shows a positive trend in growth and productivity, with significant variation around this trend. During this period, crop production grew at an annual rate of 2.8 percent for the 1962-80 period, and at five percent for the 1981-2000 period, and was accompanied by a substantial increase in tractors and fertilizer use. Land productivity as measured by value added is high at US$7,000-7,500/ha in 1995 prices. Figures on agricultural labor productivity are not very reliable and need further analysis (World Bank 2003b).

The *value of agricultural production* continued to increase, mainly in response to shifting cropping patterns that favored fruits, vegetables, and subsidized industrial crops (sugar beets, until recently, and tobacco), at the expense of cereals and pulses, and an increase in irrigated area from 41,000 ha in 1961 to about 90,000 ha in 2002 (FAO/MOA 2000). This value fell to LL1, 818 billion, or US$1,212 million, in 2001 (table 3.1), of which 71 percent, was the value of plant production, and 29 percent, the value of animal production. Fruits contributed 37 percent of the value of plant production, vegetables 29 percent, followed by industrial crops, 10.0 percent, and olives, nine percent. The value of animal production remained steady in the 1999-2001 period at around LL530 billion (US$353 million).

Table 3.1 Gross Value of Agricultural Production

	1999		*2000*		*2001*	
Category	***LL Billion***	***percent***	***LL Billion***	***percent***	***LL Billion***	***percent***
Plant Production	1347	72	1405	72	1285	71
Animal Production	525	28	535	28	533	29
Total Production	1872	100	1940	100	1818	100

Note: Value is given at farm-gate prices. Source: MOA, Agriculture in Lebanon, 2000-2001, May 2002 (Arabic)

Agriculture still plays an important role in the rural economy and its importance varies considerably among regions: employment in agriculture varies from 0.2 percent of the labor force in Beirut to 20.7 percent in the Bekaa (MOSA, UNDP 1998). Nevertheless, income from agricultural activities is often not sufficient to support farm families, and household members seek employment outside agriculture, either in rural or urban areas, to sustain their families. This trend is continuing and has led to internal migration towards the main cities, and to foreign migration. Women workers in agriculture get rewarded at about half the wage for men. For both men and women, wages in agriculture are comparable to or below the wages of unskilled labor, which provides an additional incentive for seeking employment in other sectors or outside rural areas, which accentuates rural-urban migration (World Bank 2003b).

Agriculture (including animal products) accounts for about 20 percent of both total exports and total imports. The major exports are fruits (apples, citrus, bananas, grapes, and cherries), and vegetables (potatoes, tomatoes, and onions). The main agricultural export markets are Saudi Arabia and Kuwait, followed by Syria, Jordan, the United Arab Emirates (UAE), Egypt, and Bahrain. The United States, Syria, and the European Union are the largest exporters to Lebanon of grains (wheat) and flour, dairy products, meat, and fish (World Bank 2003b). It is noteworthy that Lebanon's exports to the European Union are negligible, which reflects the potential market that exists for high quality and high value added fruits, vegetables, and processed food products.

AGRICULTURE IN THE LAST FIVE-YEAR PLAN

Within the context of government's Five-Year Economic Development Plan for the 2000-04 period, which gave priority to the social sector, balanced regional development, and stimulating the productive sectors, MOA prepared a five-year plan for agricultural development (ESCWA 1999). This plan sought to increase the contribution of agriculture to the national economy and employment through investment in the sector, increasing income in rural areas and reducing rural-urban migration, and the adoption of policies for the sustainability of agriculture and natural resources. The plan envisaged an investment exceeding $400 million, including a $100 million credit scheme that would lead to an annual rate of growth in agricultural production of 15 percent, which is quite an ambitious undertaking, considering the historical performance of the agriculture sector.

Due to the very ambitious nature of the development plan in agriculture on one hand and private sector-led development on the other, it is not surprising that many of these targets were not achieved, with one main exception. The target of increasing irrigated area to 74,000 ha has been exceeded. The current area equipped for irrigation is estimated to be around 90,000 ha. This is largely due to an increase in uncontrolled groundwater irrigation development by many smallholders, particularly during the civil war. The credit target has been partially met with International Fund for Agricultural Development (IFAD) financing agricultural cooperatives ($25 million) with participating banks, the European Union's (EU's) Economic and Social Fund for Development (ESFD, total 25 million Euros for rural development and

credit); the United States' Agency for International Development's (USAID's) Rural Community Development Cluster Program ($12-13 million annually for rural development and credit); and several NGO programs. The targets of increasing agricultural production by $325 million, increasing investment to around $600 million, and increasing agricultural exports by 45 percent to $242 million, have not been achieved (actually, the value of agricultural production fell to LL1818 billion in 2002 as shown in Table 6). Likewise, the objective of reducing imports has not been realized as imports of agricultural and food products continued to slowly rise, and the share of jobs in the agriculture sector continued to fall.

4. Main Features of Irrigated Agriculture

WATER AND LAND USE

Agriculture uses about 64 percent of the available resources. Table 4.1 gives the best possible estimates of the current breakdown of water resource use.

Table 4.1 Estimates of water resources utilization

(MCM/year)

Item	*Surface water*	*Groundwater*	*Total*	*Percentage*
Agriculture	490	320	810	17
Domestic	300	31	331	7
Industry	100	16	116	3
Neighboring Countries	743	200	943	21
Groundwater Recharge	850	150	1,000	22
Sea	700	700	1,400	30
Total	**3,183**	**1,417**	**4,600**	**100**

Source: Total figures given by FAO (1997) and IFAD (2000) with details revised as discussed with MOEW

According to a village survey (1997) and the recent MOA Agricultural Census (1998) both conducted by FAO under the IBRD Agriculture Infrastructure Development Loan (Ln 4092-LB), the total arable land of Lebanon amounts to 248,000 ha or about 24 percent of the country's total land area of 1,045,000 ha (table 4.2).

Table 4.2 Land resources and land use (1,000 ha) in Lebanon, 1998

Category	*On-farm*	*Off-farm & Abandoned Farms*	*Total*	*Percentage*
Farm land	248	0	248	24
Permanent fallow	53	84	137	13
Forests and Garrigues	21	97	118	11
Non-cultivated land	50	423	473	45
Thereof with potential for agricultural use	35	75	109	10
Other (buildings, roads etc.)	4	65	69	7
Total	**377**	**669**	**1,045**	**100**

Source: République Libanaise (2002) : Draft Agricultural Strategy.

Readily available sources of water, rather than land resources are limiting the expansion of irrigated agricultural production. The total area, which could be mobilized for short-term agricultural expansion (the current permanent fallow, 13 percent of the total land area) is equivalent to 55 percent of the

currently cultivated farmland. Another ten percent of the total area (equivalent to 44 percent of the current farm land) is classified as non-cultivated but with potential for agricultural use, yet requiring larger investments. Hence, in the long-term, Lebanon has enough land resources to actually double its agriculturally used area.

Lebanon's agriculture is characterized by small and fragmented land holdings, limiting efficient large-scale irrigation and mechanization. Since the last agricultural census in 1961, the number of farms has increased by about one third (36 percent). With 195,000 farms cultivating a total of 248,000 ha, the average farm size measures about 1.27 ha. Three in four (73 percent) farms are smaller than 1 ha. Small farm areas are particularly frequent in the southern districts like Marja'ayoun and Bent Jbail. Farms in the North, particularly in Hermel, are larger than the national average (table 4.3).

Table 4.3 Farm land in four selected districts and entire Lebanon, 1998

Item	*Akkar*	*Hermel*	*Marja'ayoun*	*Bent Jbail*	*Total*
Number of farms	22,577	2,979	7,522	7,581	194,829
Total farm area, ha	36,252	8,123	7,747	6,098	247,940
Thereof irrigated, ha	16,324	3,209	454	103	104,009
Proportion irrigated, percent	45.0	39.5	5.9	1.7	41.9
Farm area under greenhouses, ha	809	641	17	44	4,995
Proportion under greenhouses, percent	2.2	7.9	0.2	0.7	2.0
Average farm size, ha	1.6	2.7	1.0	0.8	1.3

Source: République Libanaise: GOL draft Agricultural Strategy (2000).

Land Use. Present land use in Lebanon is summarized in table 4.4 below and is based on the land use map by Lebanon Agricultural Research Institute/FAO (1995). The data has not changed much despite the recent urbanization of last years, which was limited mainly to the suburbs of the major cities along the Mediterranean and due to the fact that irrigation schemes development have focused mainly on rehabilitation. About one quarter of the national land (10,452 km^2) is used for the agriculture. Field crops (50 percent) and orchard (48 percent) dominate the agricultural land use. Spatial variation of the agriculture is consistent with topographical features. Arable land extends in the coastal plain near the northern and southern borders, and Bekaa plain, thus 41 percent, 23 percent and 12 percent of the agriculture land are located in Bekaa, North Lebanon and South Lebanon Mohafazats, respectively.

Pasture is limited to animal husbandry and dominates the land use in Lebanon, accounting for 31 percent of the national area. Forests, which comprise 25 percent of the national area, are found mostly in mountain ranges along the Mediterranean Sea due to relatively high precipitation, while urban area (about six percent of the national area) is mainly located in the narrow coastal strip of the Mediterranean Sea, accounting for 75 percent of the total urban area. Since the Qaraoun dam with the surface water area of 12 km^2 is located in Bekaa plain, almost 70 percent of the swamp and water land are located in Bekaa Mohafazats.

About every second farm (51 percent) is irrigating at least part of its farmland. Irrigated farm areas have increased by 155 percent since the last agricultural census in 1961. However, the southern districts are low on development of irrigated farms where in Marja'ayoun and Bent Jbail only about 5.9 percent and 1.7 percent of farmland is irrigated, respectively, while in Akkar close to 45 percent of farmland is irrigated on average.

Table 4.4 Present Land use

(km2)

	Mohafaza						
Land Use	*Beirut*	*Mount Lebanon*	*North Lebanon*	*South Lebanon*	*Bekaa*	*Nabatieh*	*Total*
Agriculture Land	0.05	348.94	780.92	418.47	1,405.65	453.64	3,407.65
Horticulture	0.05	19.94	9.98	29.16	6.03	1.27	66.42
Field Crops	0.00	50.68	319.50	88.79	1,003.51	232.18	1,694.66
Orchard	0.00	278.31	451.44	300.52	396.11	220.20	1,646.57
Grassland	0.13	430.56	430.22	146.14	1,887.86	343.63	3,238.54
Forest	0.20	808.39	654.33	301.88	617.41	248.84	2,631.06
Urban Area	19.12	285.08	106.16	77.94	86.81	78.97	654.07
Barren Land	0.31	158.70	81.16	7.01	251.57	2.16	500.91
Swamp/Water	0.02	1.26	2.62	0.17	9.97	0.02	14.05
Total	19.83	2,032.92	2,055.39	951.62	4,259.26	1,127.26	10,452.00

Source: Lebanon Agricultural Research Institute/FAO (1995) updated by JICA Interim Phase I Report.

EXISTING AND PROPOSED IRRIGATION SCHEMES

Although irrigation is the largest sector in water use, data to identify consumption of irrigation water, such as irrigated area, cropping pattern, cropping calendar, intake volume and so on, are very limited because the civil war has resulted in weakness of government capacity to handle extension service and water resources management. Thus, the existing irrigation schemes were identified based on the previous studies and confirmed through the discussion with authorities concerned. Two reports, "Irrigation in the Near East Region in Figures" (FAO, 1997) and "Global Result of Agriculture Census" (FAO/MOA, 2000) estimated the irrigated area respectively in 1993 and 1999 (see table 4.5).

Table 4.5 Irrigated areas

Year	*Cultivated Area (ha)*	*Equipped Irrigation Area (ha)*	*Irrigated Area (ha)*	*Surface Irrigation (ha)*	*Sprinkler Irrigation (ha)*	*Micro Irrigation (ha)*
1993	189,206	87,500 *	NA	53,500	21,000	13,000
	Ratio to the total equipped irrigation area			61 percent	24 percent	15 percent
1999	248,000	NA	104,010	66,130	29,040	8,840
	Ratio to the total net irrigated area			64 percent	28 percent	8 percent

* This figure does not match the one given in Chapter 3 para 3.2. Most probably the later is outdated.

Source: FAO, 1997 for 1993 figures and FAO/MOA, 2000 for 1999.

The total irrigated area of 104,000 ha given by the FAO/MOA census includes the areas that are not regularly irrigated (irrigated only once during the cropping period) and also very small land holdings such as 0.025 ha which may be classified as house gardens. The actual areas irrigated have therefore been estimated by MOEW and LRA at 90,000 ha and used in this Policy Note. Besides, the government has focused on the rehabilitation and modernization of irrigation schemes since 1994 without expansion of new schemes.

Through the inventory of previous studies and information from MOEW, 67 irrigation schemes were identified, covering mainly medium (between 100 ha and 1,000 ha) and large schemes (over 1,000 ha). The total equipped area of those schemes is about 65,600 ha as listed in table 4.5 and table A1.2.

Various crops are being planted in Lebanon, such as maize, potato, wheat, onion, tobacco, watermelon as field crops; tomato, cabbage and other green vegetables as market crops; and apple, grape, pear, citrus, cherry and olive as perennial/fruit crops. In order to estimate the water requirements for irrigation, those crops are simply categorized into three, namely cereals represented by winter wheat, vegetables, and fruit trees.

An FAO/MOA Agricultural Census also gives irrigated areas classified by different sources of water such as surface water and groundwater. Of the irrigated farms, 48 percent are by surface water and 52 percent by groundwater. As for the methods of irrigation, surface systems, such as furrow irrigation is adopted on 64 percent of the irrigated area, while sprinkler and drip systems are adopted respectively on about 28 percent and about eight percent of irrigated land. Of the farms irrigated by surface water, about 86 percent use surface irrigation, nine percent use sprinkler irrigation, and five percent use drip irrigation. Of the farms irrigated by groundwater about 43 percent are irrigated using surface irrigation, about 45 percent using sprinkler irrigation and 12 percent using drip irrigation.

Proposed and Under Implementation Irrigation Schemes: The JICA Phase I Interim Report of February 2003 reported that 12 irrigation projects are under detailed study or proposed for future implementation with a net irrigation area of 63,025 ha including 38,530 ha of new expansion areas. These are summarized in table 4.6 below.

Table 4.6 Proposed and ongoing irrigation schemes

No	*Scheme*	*Net Irrigation Area (ha)*	*Newly Expanded Area (ha)*
1	Noura El Tahta Dam	5,000	2,300
2	El Bared Dam	750	0
3	Assi River Basin	6,700	6,700
4	Younine Dam	1,545	0
5	Southern Qaraoun Irrigation	550	500
6	South Bekaa (Phase II), Left Bank	6,700	6,700
7	South Bekaa, Right Bank and North	12,800	0
8	South Lebanon – Conveyor 800	13,230	13,230
9	Conveyor Anane-Nabatiyeh	3,500	3,500
10	Saida-Jezzine	1,200	1,200
11	Qasmieh-Ras El Ain (Phase II)	2,100	2,100
12	Khardale	9,000	9,000
Total		**63,025**	**38,530**

As a result of discussions between the Bank, the MOEW and LRA a revised listing of priorities and areas with cost estimates and tentative implementation program have been arrived at as presented in chapter 9 and Appendix table A1.2. The main conclusions from these discussions are that the GOL plans to increase the irrigated areas to about 140,000 ha from the current figure of about 90,000 ha by the year 2030, in addition to the rehabilitation and modernization of about 30,500 ha of the existing areas.

CROPPING PATTERNS

Table 4.7 below gives the percentage of area cropped under each of the main crops in each of the five Mohafazats and for Lebanon in general.

Lebanon's richness in agro-climatic conditions, from the Mediterranean Sea to the Syrian desert and from sea level to above 3,000 m above sea level, provides the basis for a high diversity in crops grown in the country. While agricultural production in the coastal plains is dominated by citrus fruits, vegetables, tobacco, figs, and bananas, higher altitudes support the production of apples, pears, peaches, cherries, and olives. Cereals are predominantly produced in the Bekaa valley.

Table 4.7 Cropping pattern in the Mohafazats

(percent)

Crop Production	*North Lebanon*	*Bekaa*	*Mount Lebanon*	*South Lebanon*	*Nabatiyeh*	*Total Lebanon*
Cereals	18.9	28.9	1.2	12.7	22.9	20.9
Vegetables	20.2	25.2	12.1	7.0	4.7	18.2
Industrial crops	5.9	14.9	0.6	4.9	15.4	10.0
Fruit Trees	21.3	21.1	38.1	41.7	8.0	24.0
Olives	32.9	3.1	30.3	30.2	44.6	21.1
Other Crops	0.8	6.8	17.7	3.4	4.5	5.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: GOL draft Agricultural Strategy (2003).

Some technical weaknesses include:

a. present lack of a national water master plan. MOEW is aware of this constraint and is in the process of preparing a Water Resources Master Plan for Lebanon (financed by the Japanese Government);

b. low irrigation efficiency and very low adoption rate of water saving technologies. It is estimated that around 70 percent of the irrigated area relies on furrow irrigation). Therefore water saving technologies should be gradually introduced;

c. degradation of water quality and pollution of surface and ground water with waste water, industrial waste, and excessive use of chemicals in agriculture. A prime example of this is the high level of pollution in the Qaraoun reservoir (chapter 6 deals with this aspect);

d. uncontrolled well drilling and pumping, and illegal removal of flow limiting devices by users in some areas, resulting in a significant lowering of the water table, increased salinity, and salt-water intrusion; and

e. lack of reliable data on water resources availability due to the lack of accurate meteorological and hydro-geological information that are essential for planning purposes. To this end, the MOEW and LRA should improve the meteorological and hydrological data collection and analysis.

5. Current State of Water Quality and Pollution Control

Data on surface and ground water quality in Lebanon is limited as there is no comprehensive monitoring program for water resources. Major pollution sources of the water resources are direct discharges of municipal and industrial wastewater, uncontrolled solid waste disposal as well as leaching of pesticides and fertilizers from agricultural lands. Another source of water pollution that is under-estimated is sea water intrusion as a result of over exploitation of groundwater.

Measurements of Electric Conductivity (EC) of rivers (10 no) and springs (210 no) that were recently conducted indicate that EC range from about 200 to 2000 µS/cm with an average of about 500 µS/cm, thus showing that water resources in Lebanon are generally suitable for irrigation as far as salinity is concerned, although precautions have to be taken in few cases (Jouzy and Partners 2003). Nevertheless, pollution is widespread and there are several documented reports confirming the pollution of several if not most water resources. For instance, the United Nations Children's Fund (UNICEF) report on the Quality of Potable Water in Lebanon has indicated that 60 to 70 percent of all natural water sources are affected by bacterial contamination (Jurdi 1998). Contamination of springs appears to be lower than that of rivers. Results of water quality analyses conducted by Jouzy & Partners for 17 springs and 16 rivers revealed that only two springs have coliform counts above World Health Organization (WHO) permissible limit for irrigation of crops to be eaten raw, while 90 percent of tested rivers exceed the WHO limit.

The pollution of Litani River, which is the largest river in Lebanon, is becoming a serious issue. The discharge of untreated municipal and industrial effluents, the drainage from agricultural lands, and the uncontrolled discharge of solid wastes directly into the river and its tributaries have considerably degraded the water quality of Litani and limited its use. Results of water quality analyses of Litani and Qaraoun catchment area revealed that in many spots, concentrations of COD (250 mg/l and higher) are sometimes similar to untreated wastewater (MVM Konsult AB 2000).

Wastewater Networks. An important percentage of the population, especially in urban areas is served by sewerage systems. However, most of the existing wastewater networks are either damaged or are undersized. Rehabilitation works are taking place and wastewater collection designs are under preparation for major cities. However, until now all collected wastewater is discharged without any treatment into rivers, streams, groundwater (through open wells), wadis and coastal water. Wastewater disposed into rivers is used downstream for irrigation and in some cases for drinking purposes. This has resulted in the spread of waterborne diseases such as typhoid, dysentery and diarrhea. Laboratory analyses conducted by Jouzy & Partners in July 2002 and January 2003 for JICA, to assess water quality in ten rivers, revealed high levels of total coliforms (up to 55,000 MPN/ml in one case) and electrical conductivity (up to 1297 µS/cm in another case). An increase in coliform counts and salinity levels between the upstream and downstream of most rivers was observed, which confirm the presence of various sources of pollution along the rivers. In the absence of a continuous water quality-monitoring program along rivers, it is difficult to identify the time period and to delineate the exact parts of the rivers that are not polluted and that could be used without restriction.

Wastewater Treatment. The only operating wastewater treatment plant in Lebanon is the Ghadir treatment plant which, was designed to serve 300,000 persons and includes only primary treatment. The feasibility of upgrading this treatment plant to provide secondary treatment is being assessed. In parallel, more than

25 wastewater treatment plants have been planned to serve major cities of which seven are under construction. Details of the planned treatment plants are provided in table A3.1. Several municipalities and communities have also made arrangements to improve wastewater collection and disposal. Through the assistance of international donors and NGOs, a number of small-scale wastewater treatment plants have been implemented in various communities. To date more than fifteen of these plants are operational, they provide a secondary treated effluent that is being used for irrigation. Implementation of wastewater treatment plants by the Government and by the communities is therefore on going and it is expected that by 2006 more than 25,000 m3/day of treated effluent could be made available to irrigate around 300 hectares as most of the treated water from the major coastal cities would be discharged to the sea as per GOL decision. In the long-run, the maximum area that could be irrigated using treated sewage effluent is estimated at present at about 3,000–5,000 ha.

Industrial Wastes. Industrial wastes are also discharged without any treatment into various receiving water bodies. The estimated volume of untreated industrial effluent discharged is around 35 MCM/year with an estimated BOD load of 5,000 tons/year (Teboddin 1998). Industries are concentrated along the Mediterranean coast and in the Bekaa valley and include various types of industrial activities. In the Bekaa area, major water sources such as the Qaraoun Lake, Litani and Berdawni rivers are heavily contaminated as they receive untreated industrial effluents from sugar-beet factories, paper factories, lead recovery plants, limestone crushers, agro-industries, poultry farms, tanneries and slaughterhouses. In the absence of a pollution control strategy with the necessary legal and regulatory instruments, industrial discharges remain an important pollution source. Finally, there is no major re-use of treated wastewater. However, the use of raw sewage for irrigation has been reported in several areas. According to the UNICEF report around ten percent of the wastewater is used for irrigation.

Agricultural Pollution. Over-abstraction of groundwater for irrigation has resulted in considerable decline in the water table level and increase in salinity. Data reported by the American University of Beirut (AUB) Water Research Center, indicate that chloride and sodium concentrations in several wells across the country are relatively high and would not allow the use of such water for un-restricted irrigation, as it would have a negative impact on crop production. The use of such water for irrigation purposes would necessitate selecting salt tolerant species, leaching of the soil to avoid salt build up, providing adequate drainage and selecting appropriate irrigation techniques. As shown in table 5.1, higher levels of sodium and chloride are reported along coastal wells and are attributed to seawater intrusion as a result of water abstraction rates higher than the rate of recharge. In addition, the use of fertilizers and pesticides are poorly regulated and monitored. It was reported that in 1999 Lebanon imported 1,530 tons of pesticides and around 32,000 tons of fertilizers. Although there is no systematic and regular monitoring of ground water quality, there are several indications of ground water pollution by agro-chemicals. Groundwater surveys conducted by the AUB, revealed that nitrate concentrations in locations adjacent to agricultural areas are exceeding the Lebanese maximum permissible limit of 45 mg/l for drinking water. Pesticides residues were also detected in trace concentrations, however at concentrations less than the advisory limits set by United States Environmental Protection Agency (USEPA).

Pollution Control. In spite of the rising official and public awareness about the state of the environment and the pollution of surface and ground water, the ten years water strategy developed by the MOEW does not address water quality or the need to protect and preserve water resources from pollution and there is no comprehensive framework for pollution control. One of the most important requirements for developing a comprehensive water quality management and pollution control plan is to establish a well functioning water quality-monitoring network. Such a plan has not been developed and there are no monitoring sites along streams, rivers, springs or irrigation channels. Another important requirement is to establish and implement the polluter/payer concept whereby industries and consumers should be encouraged to pay the Regional Water Authorities (RWAs) or any other responsible bodies for the pollution they generate.

Table 5.1 Chloride and sodium concentrations in 31 wells across the country

Area	*No. of Wells*	*Sodium (mg/l)*	*Chloride (mg/l)*
Inland Wells			
Brital	3	33	550
HE Sneid	1	35	235
Qsarnaba	1	36	250
Sadneyal	2	78	383
Niha	1	62	240
Coastal Wells			
Cheka	3	1437	415
Selaatah	1	15	140
Batroun	2	273	153
Houboub	1	720	345
Berbara	1	2700	950
Remeyleh	3	3100	637
Jiyeh	3	503	458
Choueifat	8	460	204
FAO Degree of Restriction on Use			
▪ None		< 68.97 mg/l	< 141.6
▪ Slight to Moderate		68.97 to 206.91	141.6 to 354.0
▪ Severe		>206.91	>354.0

Legal and Regulatory Framework. Existing laws and regulations for water quality and for the protection of water resources in Lebanon date as back as 1925. These laws were neither updated nor complemented with additional laws and application decrees. Moreover, there are very limited laws related to wastewater disposal and reuse, solid waste discharge, industrial wastewater discharges, agriculture drainage and other water polluters. A list of available laws for the pollution and protection of water resources is given in Appendix table A3.2. Recently, Decision No. 8/1 dated March 2001 reviewed the previously issued wastewater standards to cover the discharge of wastewater to the sea, to surface water and to sewerage systems (Ministry of Environment, Lebanon 2001). However there are no national irrigation water quality standards or guidelines.

The main agencies in charge of water quality monitoring are the MOEW and the Ministry of Public Health (MOPH). The RWAs are also responsible for monitoring the quality of drinking water, irrigation water and wastewater. All RWAs face major operational and staffing problems. The RWA for Beirut and Mount Lebanon is the only water authority that has a well-equipped laboratory for measuring various water quality parameters including trace metals and pesticides. However, it does not have sufficient financial and human resources to undertake proper monitoring for water, wastewater and irrigation. In addition, the MOE is responsible to fight pollution from all sources by taking protective measures including conducting studies regarding ways and means for waste and wastewater treatment. The ministry is also responsible for setting water standards, permitting the establishment of various classified establishments and enforcing legislation. However, the MOE lacks resources and has limited capacities in monitoring and enforcement.

RECOMMENDATIONS

Water Quality Monitoring. The Government will have to make a major effort to improve water quality monitoring in order to ensure proper water management. In this respect, a reconnaissance survey of the status of water quality and the sources of pollution should be conducted to enable the development of a sustainable and cost-effective water quality-monitoring program. Currently public institutions and research centers conduct sporadic and intermittent water quality analyses, and these efforts concentrate on monitoring drinking water quality. Little attention is given to the quality of irrigation water and its ultimate impact on agricultural production and public health. Moreover, available water quality data is localized in time and space and therefore cannot be used for a meaningful analysis of trends. All concerned public and private agencies need to work together to establish a national water quality program for monitoring surface and ground water resources.

A pilot project to develop and establish a monitoring network for water quality in the Litani Basin is highly recommended. This monitoring program could include:

- standards that should be applied or revised and/or prepared;
- locations and activities to be monitored;
- parameters to be measured and the frequency of measurement;
- actions and mitigation measures to be implemented under various conditions;
- an enforcement mechanism;
- personnel and equipment;
- public awareness campaigns;
- identification of irrigation requirements for different water quality; and
- a reporting mechanism.

Wastewater Reuse. The Government has made some progress in the execution of wastewater collection and treatment networks; however, considerable efforts are still required. The development of cost-effective technologies for collecting, treating and disposing/reusing wastewater in small, rural communities should be a priority issue. Local solutions to wastewater management in small rural communities would offer a sound measure for reducing the pollution of water resources and an alternative source of water for irrigation. So far, a variety of treatment techniques have been adopted by some communities to implement smallscale wastewater treatment plants, however the capability of these treatments plants to produce a treated effluent that can be safely used for irrigation is questionable and there are still several rural communities lacking such facilities. Large-scale use of treated wastewater in irrigation does not appear to be viable in many areas because of high production and conveyance costs. The most likely places for its use are along the coast where vegetables and some fruits are grown. However, treated wastewater will not be used for vegetables for both sanitary and cultural considerations. The institutional set up for wastewater reuse requires special attention through better organization and regulation on the basis of well defined standards and specifications as well as practical guidelines and operational rules. At present there is no regulatory framework for the reuse of treated wastewater. Finally potential environmental and health impacts associated with the reuse of treated effluent should be properly disseminated to all concerned stakeholders. Training of government officials and farmers on the management of irrigated agriculture using treated effluent should be considered. Pilot projects for testing different technologies and practices for the reuse of treated effluent from municipal treatment plants are also recommended.

Capacity Building. The capacities of the MOEW, the RWAs and the LRA in terms of organization, staffing and equipment for water quality management require immediate attention. Strengthening the capacities of these authorities for water quality testing, data analysis, quality assurance and control as well as databases and reporting is needed. A survey of available laboratory capacities should be conducted to identify required laboratory equipments for conducting a proper water quality monitoring. The capacities of the MOE for pollution abatement and enforcement of legislation should be also strengthened. A program for strengthening national capacities should also be developed and shall include the provision of technical assistance and training programs in water quality management with special emphasis on:

- Planning and management of irrigation water;
- Re-use of treated wastewater for irrigation;
- Irrigation techniques and requirements for different water quality;
- Establishment of a data base on water quality and pollution sources;
- Dissemination of information on water quality;
- Communities and private sector participation; and
- Public awareness.

6. Institutional Aspects

WATER LAW AND WATER RIGHTS

FAO provides an overview of existing laws and their administration, most of which were formulated by the Ottoman Empire and modified and used by the French Mandate, who introduced the first water laws in Lebanon in 1925 and 1926 (Caponera, 1973). These laws refer to the organization and description of "water rights" for individual water owners (for more details refer to **Appendix 5**).

There is certain lack of defined set of laws governing water ownership and use. The first law declaring water resources as a public property, aside from established water rights, was issued in 1925. In 1926, the French Mandate introduced a new law, which refers to the organization and describe "Water Rights" for individual water owners. In 1930, the GOL issued a decree, which considers that all water in privately owned land is the property of the landowner and is privately owned, thus changing what was stipulated in the previous laws. A large number of concessions and water committees have been created in the few decades before and after the end of the French Mandate over Lebanon. Since 1951 the GOL issued some 22 decrees dealing with the creation of water authorities in the country. The aim was to take ownership of water resources from individuals, organize water use and solve, at least temporarily, water use problems in order to cope with economic and industrial growth in Lebanon.

Water Rights. Lebanese legislation considers that all kinds of water resources are public owned except for the rights that were vested before 1925, i.e., the period when the Ottoman rules were still applicable. The vested interests upon water resources are considered as a principle in the Lebanese society, because they are related to the customs and traditions, through many generations. In addition the 1925 law considers that anyone used to consume water resources for his own profit without any disputes, "i.e. the consuming of the water resources, must be apparent" will have a water right (not personal), but the decision never determined the period of this water right. Finally, a decision of a civil appeal court in 1968 considered that: "There's a possibility of consuming the non flooded water wells that are excavated in the private property, and flows daily up to l00 m^3 without a governmental permission" and individuals can not consume the stream's water when it flows for more than 100 m^3.

ORGANIZATION OF THE WATER SECTOR

Numerous governmental, autonomous and semi autonomous agencies are involved in the water sector. Their responsibilities are inter-related and therefore it is difficult to discern a clear authoritative system linking promulgated decrees to the corresponding and appropriate agencies (MOEW, LRA, MOA, etc.).

Historical perspective

The main institutions involved in the water sector are described here below.

Ministry of Energy & Water (MOEW). Created in 1966**,** the Ministry of Hydraulic and Electrical Resources (MOHER), now MOEW, has the following mandates:

- protect and develop hydraulic natural resources;
- assume jurisdiction over the water resources in Lebanon;
- study supply and demand, and global situation of the water resources in Lebanon;
- prepare the national water master plan;
- design, implement and operate large hydraulic facilities;
- conserve and control the water resources including surface and underground water; and
- exercise administrative supervision over the WAs and the LRA.

MOEW has two General Directorates (figure 6.1). The largest of the two: the Directorate General of Hydraulic and Electric Resources (DGHER) is responsible for research, studies and implementation of large-scale projects. The second one is the Directorate General for Operations is responsible for overseeing the public establishment, for administration and financial aspects and for mines and quarries. MOEW exercises administrative supervision over the RWAs, the autonomous Water Boards and Local Committees through the Directorate General of Operations (DGO). MOEW has about 212 staff against 578 assumed positions (2002 figures) including 60 engineers. Due to the ban on new recruitment by the public sector, the average age of MOEW staff is quite high. In recent years, some new recruitment and transfer from the other ministries were made on exceptional basis. MOEW's average yearly budget is about US$85 million and irrigation represents ten percent of this total budget.

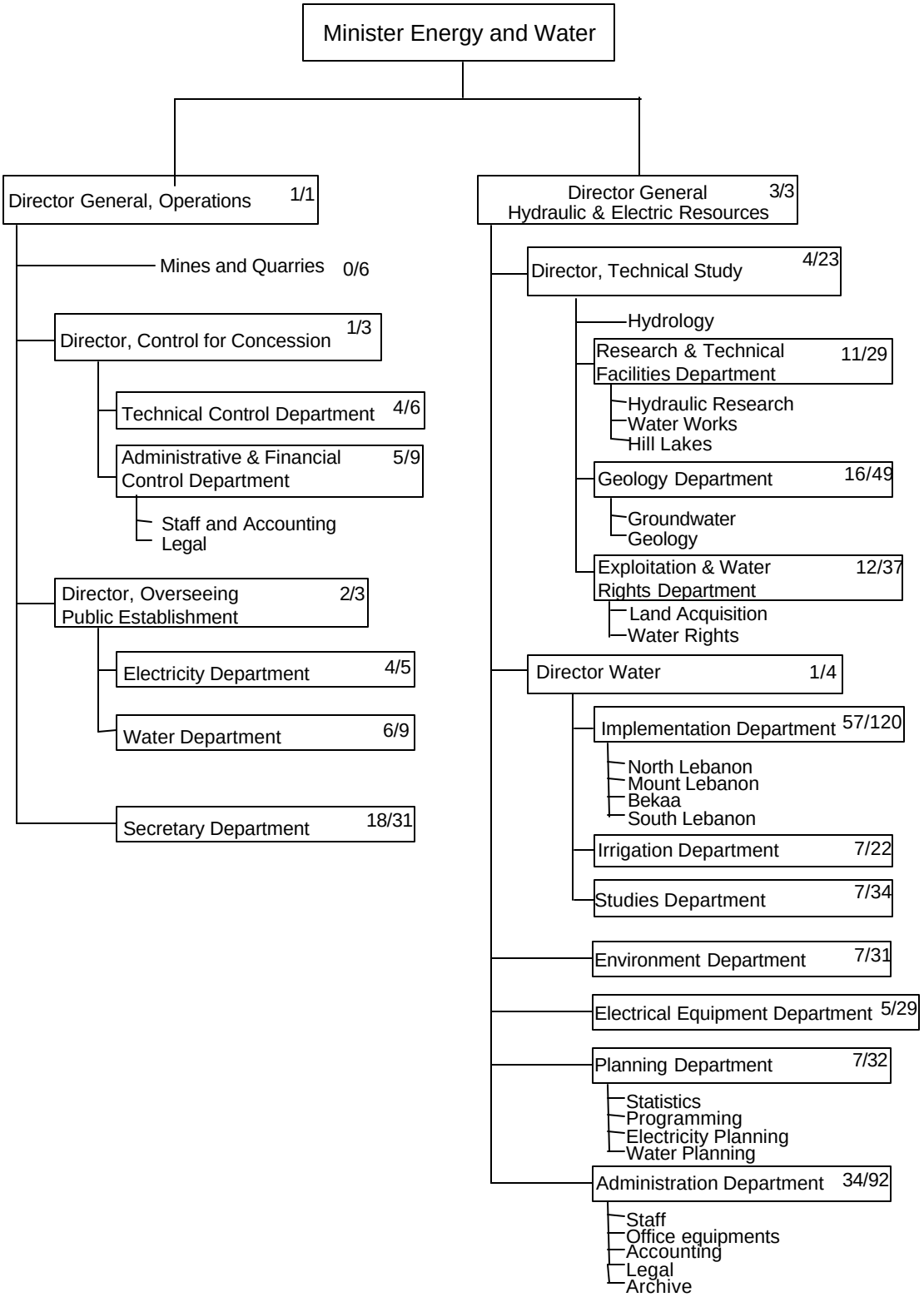
Water Authorities. Under MOEW tutelage, and before the establishment of the four Water Authorities (WAs) in 2002, the Litani River Authority (LRA) and the 22 Regional Water Authorities—RWAs (table 6.1) operated with various degrees of autonomy. In addition, there are 209 local water and/or irrigation committees, which were formed between 1984 and 1990 (table 6.2). These local committees are under the tutelage of the RWAs. Out of these 209 committees 18 percent are for potable water, 60 percent are for irrigation, 14 percent for both potable water and irrigation and eight percent have no clear mandate. The 22 RWAs were/are mainly charged with management of potable water, under the supervision of the MOEW, except for two RWAs (Barouk and Baalbek/Hermel which also deal with Irrigation). About 15 percent of these water committees are jointly run with the municipalities. These RWAs are responsible amongst other for setting the water fees for potable, irrigation and industrial uses which are approved by MOEW. According to available data they serve about 3.5 million people. The RWAs are created by governmental decrees and their board members, usually between seven and nine, are appointed by the Council of Ministers; whereas the Local Committees are created by a ministerial decrees and their Board members, usually five, are appointed by the Minister of Energy and Water. Table 6.1 also shows the number of the Irrigation Water Boards and Regional Committees, the population they serve and their location. Only Beirut Water Office, Tripoli Water Board and the Litani River Authority were given the power to study and develop their systems.

Table 6.1 Regional water authorities

No	*Regional Water Authority/Committee*	*Caza*	*Population*
North Lebanon Mohafazat			
1	Tripoli Water Board	Tripoli & Akkar	481,000
2	Nabaa Al-Ghar Water Committee	Koura	77,000
3	Kubayat Water Board	Akkar	31,000
4	Nabaa Al-Kadi Water Committee	Zgharta	59,000
5	Becharre Water Committee	Becharre	33,000
6	Batroun Water Committee	Batroun	50,000
7	Akkar	Akkar	*
8	Danniyeh	Tripoli (Danniyeh)	*
Beirut Mohafazat			
13	Beirut Water Board	Beirut, Metn & Baabda	805,000
14	Ain el Delbeh Water Board	Mount Lebanon	
Mount Lebanon Mohafazat			
9	Barouk Water Board	Baabda, Aley & Chouf	239,000
10	Keserouane Water Board	Keserouane	45,000
11	Metn Water Board	Metn	149,000
12	Jubail Water and Irrigation Com.	Jubail	74,000
South Lebanon Mohafazat			
15	Sour and Surroundings Water Board	Sour	185,000
16	Saida Water Board	Saida	132,000
17	Ain Ed-Delbeh Water Board	Baabda, Aley & Chouf	420,000
18	Jabal Amel Water Board	Marjayoun, BentJbail, Hasbaya Sour	117,000
19	Nabaa El-Tasseh Water Board	Saida Jezzine, Nabatiyeh & W. Bekaa	218,000
Bekaa Mohafazat			
20	Zahle and Surroundings Water Board	Zahle & West Bekaa	146,000
21	Baalbek Hermel & Irrigation Board	Baalbek & Hermel	200,000
22	Chamsine Water Board	Zahle, W. Bekaa, Rachaya & Hasbaya	85,000
Total			**3,546,000**

*Included with Tripoli

Figure 6.1 Organization of Ministry of Energy and Water



Numbers in the boxes reflect the number of existing/assumed staff. The total for DG Operations is 41/73, for DG H&ER, it's 171/505. Names with no boxes are sections or units of H&ER. Source: DG Operations and DG as of August 2002.

Local Committees. Table 6.2 describes the 209 Local Committees (LCs) with their locations and functions. These Committees were mainly established after the civil unrests of the 1980s. In general, the role of these Committees is restricted to the operation, maintenance, rehabilitation and renovation of the networks and equipment. This keeps the responsibility for studying water requirements, development of water resources and design and execution of extension of existing networks with the MOEW. Out of these 209 LCs, there are 25 Irrigation Committees, which are at present efficiently undertaking the O&M tasks (out of a total of 120). These Committees could easily form the nucleus of the proposed new organization based on Water Users' Associations.

Table 6.2 Local water committees formed between 1984 and 1990

		Number of Committees Serving Each Purpose				
Mohafazat	***Caza***	***Potable***	***Irrigation***	***Potable + Irrigation***	***Undetermined***	***Total***
North Lebanon	Akkar	2	10	4	1	17
	Batroun	1	6	3	-	10
	Becharre	2	3	5	1	11
	Koura	-	2	-	-	2
	Tripoli	1	6	4	2	13
	Zgharta	2	6	2	1	11
	Akkar*	-	-	-	-	-
	Danniyeh*	-	-	-	-	-
Sub Total North Lebanon		**8**	**33**	**18**	**5**	**64**
Beirut	Beirut	-	1	-	-	1
Sub Total Beirut		**0**	**1**	**0**	**0**	**1**
Mount Lebanon	Aley	2	7	1	1	11
	Baabda	3	1	-	1	5
	Chouf	3	16	1	2	22
	Jubail	3	10	2	2	17
	Keserouane	-	5	1	-	6
	Metn	-	8	-	-	8
Sub Total Mount Lebanon		**11**	**47**	**5**	**6**	**69**
South Lebanon	Bent Jubail	1	1	-	-	2
	Hasbaya	-	-	-	-	-
	Jezzine	2	3	-	2	7
	Marjayoun	1	-	-	-	1
	Saida	-	1		3	4
	Sour	-	-	-	-	-
	Nabatiyeh	1	1	-	1	3
Sub Total South Lebanon		**5**	**6**	**0**	**6**	**17**
Bekaa	Baalbek	2	18	-	-	20
	Hermel	-	8	-	-	8
	Rachaya	-	2	-	-	2
	Bekaa West	8	5	-	-	13
	Zahle	4	8	3	-	15
Sub Total Bekaa		**14**	**41**	**3**	**0**	**58**
Total		38	128	26	17	209

The Litani River Authority (LRA). In 1954, the LRA was established to:

- develop the Litani River Basin domestic, irrigation and hydropower water schemes;
- develop a national interconnected power grid, and
- build electrical power stations and distribution networks in all Lebanese territory.

In 1955, the LRA was given the technical and the financial power for operating and exploiting all Litani River Basin related projects. In 1962 this power was expanded to include a water development plan for all the Litani/Awali basins and the area between the international Beirut—Damascus road and the southern Lebanese boundary.

The LRA has four departments (Irrigation Operation, Hydropower, Technical and Administrative) and an Accounting Unit. In 2002, LRA had 275 employees including 21 engineers. Due to ban of new recruitment in the public sector, the average age of staff is quite high and their number is gradually decreasing. LRA 2003 budget amounted to approximately US$17 million. Irrigation related expenditures are approximately estimated at US$3.75 million or about 15 percent of the whole budget.

Council for Development and Reconstruction (CDR). The CDR is the principal economic and physical planning and development agency of the central government. In 1977, the law gave CDR the responsibility of selecting, in cooperation with line ministries, the institution or combination of institutions required for implementation of projects financed by donors.

Municipalities. In 1997, the law reaffirmed that the municipalities will be responsible for preparing general plans for works related to sanitary and water projects, as well as for the establishment of sewage disposal facilities, and for matters concerning protection of the environment and pollution control. The Ministry of Interior & Municipalities is the tutelage ministry of municipalities.

Wastewater. There is not a single specialized authority that is responsible for all wastewater activities in Lebanon, and charged with setting standards and criteria for design, construction and disposal, and to plan future development. Overlapping of responsibilities is one of the major factors that lead to the inefficiency of the governmental institutions responsible for wastewater. The MOEW has the main responsibility for wastewater and its Directorate of Hydraulic and Electric Equipment is responsible for the design and execution of storm-water and flood control projects. In 1972, MOEW was given the responsibility for studying, collecting and disposing of storm-water and wastewater. In 1973, an Environmental Improvement Department in the MOEW was established with particular responsibility for the disposal of wastewater. Its responsibilities included both study as well as implementation.

Other Organizations. There are also other organizations dealing to a lesser extent with irrigation such as the MOA and the Green Plan (GP). MOA deals with aspects such as research, extension and training while the GP deals with land and water conservation, land reclamation, rural roads and construction of small hill lakes.

The current situation

In 1972, the Lebanese Government issued a decree aiming at organizing all the water authorities into four Authorities following the administrative boundaries of the Mohafazats. It also created a Superior Water Planning Board within the MOEW; the "National Water Council" presided by MOEW's Minister to ensure the coordination between all the water authorities and other administrations and to establish a water policy. This decree was never implemented and as the management of all these large number of regional water authorities, committees, etc. became very difficult as each one tried to develop its own resources, to conduct its own activities single-handed, assisted in few instances by the MOEW. As a consequence, the MOEW was not able to oversee the work and assess the activities of these authorities

and committees. In 1998, a new decree was issued organizing all Regional Water Authorities into four authorities: North Lebanon, Beirut & Mount Lebanon, South Lebanon and Bekaa (table 6.3).

Table 6.3 Recently created water authorities

New Water Authority	*No.*	*Old Water Authority*	*Local Committees*		
			Potable	*Irrigation*	*Total**
1 – North Lebanon	1	Tripoli Water Board	8	51	64
	2	Nabaa Al-Ghar Water Committee			
	3	Kubayat Water Board			
	4	Nabaa Al-Kadi Water Committee			
	5	Bcharri Water Committee			
	6	Batroun Water Committee			
	7	Akkar			
	8	Danniyeh			
2 – Beirut & Mount Lebanon	1	Barouk Water Board	11	52	69
	2	Keserouane Water Board			
	3	Metn Water Board			
	4	Jubail Water and Irrigation Committee			
	5	Beirut Water Board			
	6	Ain el Delbeh Water Board			
3 – South Lebanon	1	Sour and Environs Water Board	5	6	17
	2	Saida Water Board			
	3	Ain Ed-Delbeh Water Board			
	4	Jabal Amel Water Board			
	5	Nabaa El-Tasseh Water Board			
4 – Bekaa	1	Zahle and Environs Water Board	14	44	58
	2	Baalbek & Hermel Water and Irrig. Board			
	3	Chamsine Water Board			

* Including undetermined Committees.

Again in April 2000, the Lebanese Parliament approved a new law (No. 221) concerning the organization of the water sector. The law (appendix 5) deals mainly with the following issues:

a. the MOEW mandate;

b. the creation of the four new Public Investment Authorities (known as Water Authorities—WAs; including Greater Beirut) with their mandates and their internal organization;

c. the creation of a committee responsible for the evaluation of the WAs performance; and

d. the continuation of the present arrangement with the Regional Water Authorities and Local Committees for the next two years until they could be fully incorporated in the newly established WAs.

Although the law was published in year 2000, The presidents and the six members of the WAs Boards were only appointed late in 2002 delaying the effective application of the law.

These WAs are supposed to take over the management of the irrigation, potable water and sewerage schemes, but due to the technical, administrative and financial constraints described below, they are physically not able to undertake these tasks bestowed upon them by the law. The management of the

irrigation as well as the sewerage schemes is still in the hands of the Irrigation Boards, the Local Committees, etc. and there are no immediate plans to shift the management of these schemes to the WAs.

Weaknesses of the present system

The water sector in general, and the irrigation sector in particular, have several weaknesses that need to be addressed to mitigate the impact of water scarcity that will face Lebanon in the coming two decades. Following the review of water laws and water rights, and the establishment of the four WAs, a number of weaknesses or constraints became apparent. These weaknesses can be grouped into three categories: institutional/administrative, technical, and financial, as briefly discussed below.

The GOL has taken an important step in consolidating water resources management namely, municipal and industrial water, irrigation water, and wastewater, under the same management in each of the 4 newly established WAs (with the exception of areas that fall within the jurisdiction of LRA). This represents a very important and necessary step towards adopting a holistic approach for managing water resources.

The main institutional and administrative issues affecting the irrigation sector, include:

- delays in issuing executive regulations and bylaws of the new WAs to empower them with administrative and financial autonomy;[6]
- fragmentation and lack of cooperation or coordination of agencies in charge of water resource management: MOEW, LRA, WAs, RWAs and local water committees are involved in water resource management with overlapping functions;
- the new WAs lack adequate technical staff needed to manage water resources, and have an excess of administrative staff; the WAs have focused their current efforts on supply of water for municipal and industrial uses;
- lack of participation by the stakeholders in project design, implementation, or O&M, and the absence of Water User Associations—WUAs (although some of the local water committees play a similar role);
- laws and regulations governing the water sector were promulgated under Ottoman and French codes have not been updated to deal with emerging issues such as acquired water rights, and legal framework for the establishment and operation of WUAs; and
- lack of enforcement of existing regulations regarding issuing permits for well drilling, distances between wells or drilling near springs.

All WAs share several common problems: delays in issuing their bylaws and standardizing legal, financial, and staffing affairs; delays in approval of proposed bylaws and WAs organigrams by the MOEW; the dearth of technical staff; very low procurement limits; inadequate budget and indebtedness; customers unpaid bills, lack of financial resources to improve the present networks and add new ones; many employees are near retirement; lack of maps showing water supply networks; high network losses; low collection rates (25 percent in Zahle, minimal in Baalbek, 45 percent in Tripoli); high debts and customers unpaid bills. In short, although WAs in principle have autonomy, they cannot yet operate on a commercial basis. For details of the WAs present situation refer to **table 6.4**.

[6] As an illustration, the chairman of the Beirut and Mount Lebanon, the largest WA, has the authority to spend only LL1.0 million (US$670) on procurement without bidding (LL3.0 million for the board); beyond that, he has to follow bureaucratic procedures and red tape.

It is worth mentioning that WAs are actively seeking a greater participation by the private sector in water resource management. The WA for North Lebanon has reached agreement with, and handed over to, a French company, the management of water distribution, O&M, and collections for the potable water system in Tripoli on a trial basis for one year. The USAID will finance a study for the WA for South Lebanon to improve performance and financial position as a perquisite for privatization of management of the potable water system in Sidon. The chairman of the WA for the Bekaa expressed the desire for the private sector to assume responsibility for managing the water supply systems in Zahle and Baalbeck.

All WA chairmen share the same vision of eventually handing over management of the potable water systems in the main cities to the private sector. Furthermore, they expressed the need for farmers and their local water committees to assume O&M functions of schemes that serve them through the establishment of WUAs, to ensure their sustainability, since government has stopped subsidizing these schemes. However, this requires a legal framework to govern WUAs.

RECOMMENDATIONS

The GOL and MOEW are commended for passing legislations for the planning, consolidation and improvement of water resource management. However, some areas still need attention. The present Note recommends the following:

a. Accelerate issuing the executive regulations and bylaws to empower the WAs with the autonomy envisaged by Water Law No. 221 of May 2002. The spending limit by the Chairman and the Board should be raised and reviewed periodically to enable the WAs to operate on a commercial basis;

b. Give WAs autonomy to appoint key technical staff to fill gaps in the present organization, and gradually phase out redundant administrative staff;

c. pass legislation to update the laws regulating the water sector and provide a legal framework governing Water Users' Associations, and addressing the issue of acquired water rights, among other things

d. Involve stakeholders in the O&M functions (refer to Chapter 7);

e. enforce regulations and payment of penalties regarding well drilling and abstraction, including distance between wells and from springs;

f. start/complete the computerization of customers data base including connections, Billings and collections; and

g. enforce regulations related to water quality standards.

Table 6.4 Water Authorities General Characteristics

New Water Authority	*No.*	*Old Water Authority*	*Offices*	*Committees*				*No. Irrigation Schemes*	*Subscribers*		*Employees*		*Financial (US $ million)*				
				Domestic	*Domestic & Irriaation*	*Irrigation*	*Total*		*Domestic (1,000)*	*Irrigation (1,000)*	*Total*	*Engineers & Technicians*	*Salaries (US$ mio)*	*Annual Budget*	*Debts*	*Unpaid Bills*	*Recovery Rate (percent)*
1 – North Lebanon	1	Tripoli Water Board	9	8	18	33	64	10	105	9	350	45	2.4	10.6	12.0	16.6	15-20
	2	Nabaa Al-Ghar Water Committee															
	3	Kubayat Water Board															
	4	Nabaa Al-Kadi Water Committee															
	5	Bcharri Water Committee															
	6	Batroun Water Committee															
	7	Akkar															
	8	Danniyeh															
2 – Beirut & Mount Lebanon	1	Barouk Water Board	20	11	5	48	70	14	450	6	1,170	120	11.3	75.0	6.0	54	50-60
	2	Keserouane Water Board															
	3	Metn Water Board															
	4	Jubail Water and Irrigation Committee															
	5	Beirut Water Board															
	6	Ain el Delbeh Water Board															
3 – South Lebanon	1	Sour and Environs Water Board	9	5	0	6	17	5	114	0	135	30	3.6	20	1.8	32	15-20
	2	Saida Water Board															
	3	Ain Ed-Delbeh Water Board															
	4	Jabal Amel Water Board															
	5	Nabaa El-Tasseh Water Board															
4 – Bekaa	1	Zahle and Environs Water Board	7	14	3	41	58	18	51	14	364	31	1.2	6.2	20.0	21.5	15-20
	2	Baalbek & Hermel Water and Irrig. B.															
	3	Chamsine Water Board															
TOTAL	22	7RWDO	45	38	26	128	209	47	720	29	2,019	226	18.5	111.8	39.8	124.1	20-30

7. Operation and Maintenance, Tariffs, and Cost Recovery

OPERATION AND MAINTENANCE

Despite the various irrigation and potable water projects implemented in Lebanon, much remains to be done in the way of sustainable and long-term water management. The MOEW has last year, and for the first time, initiated steps aimed at setting a general policy for the management of Lebanon's water resources and formulated a long-term plan for water and wastewater management, and is carrying out a water master plan for Lebanon. This is an important step towards proper, sustainable and comprehensive water resource management. Meanwhile, there is a need to review, consolidate and update the fragmented and the outdated water codes in Lebanon to allow better and more efficient distribution of water resources and create a legal framework that is suited to the demand for more efficient O&M arrangements.

As described previously, there are several organizations responsible for O&M in Lebanon (MOEW, LRA, WAs, RWAs, Local Committees, Municipalities). The newly created WAs are supposed to oversee the planning, the design, the implementation, as well as the O&M of water and wastewater infrastructure, with budgets derived from revenues of public shareholders. The MOEW, is expected to supervise all these WAs in the areas of planning, of formulation of strategies for water monitoring and distribution. Moreover, the ministry is responsible for devising specifications of water development and service levels, establishing supervision regulation, evaluating quality of water services and setting water tariffs and pricing mechanisms. In principle, the RWAs, the Local Water Committees, the Water/Irrigation Boards and the Municipalities are responsible for establishing prices and charges, the O&M as permitted by their financial resources, and collection of fees.

Existing Arrangements: The existing O&M arrangements for the irrigation schemes rehabilitated and modernized under the current Irrigation Rehabilitation and Modernization Project are given in the appendix 5. A 1995 MOEW study gives also the O&M arrangement for 45 schemes, as shown in appendix 5. From these two appendixes, it is clear that the Local Committees and farmers' groups are the ones most involved with the O&M of the small and medium irrigation schemes. Of the total schemes, about twenty are operated and maintained by farmers groups. This is a clear indication that introduction of formal Water Users Associations (WUAs), as an efficient and sustainable way for organizing O&M is possible and could be successful.

The management of irrigation schemes requires qualified personnel to supervise the conveyance and distribution operations, to supervise the maintenance as well as the rehabilitation works, to provide extension services and training of farmers in order to improve operational efficiency and to collect fees for the O&M services and to keep financial records. In general, maintenance of irrigation systems includes: (i) maintenance of the civil works such as canals, reservoirs, pumping stations, tube wells, operational facilities and infrastructure including project offices and staff housing. The economic life of most civil works of this kind are from 30 to 50 years and the annual maintenance cost of the civil works is normally taken as one percent of the investment costs; and (ii) electromechanical equipment and water control equipment such as outlets and hydrants which will have life spans ranging between 10 to 20 years for moving parts (more than 2,500 hrs operating time per year) for which the annual maintenance will cost about 5 percent of investment cost and, other equipment with life span of 20 to 40 years (for the

small and large equipment respectively) with a maintenance cost ranging between 2 percent and 5 percent respectively and automatic and electrical equipment with life spans of 10 years and annual maintenance costs of 5 percent of investment.

It is estimated that over one-half of irrigation schemes in Lebanon do not have adequate O&M, which could impact the future sustainability of these schemes. Most of the small and medium irrigation schemes do not have a formal organization or unit in charge of O&M. The two large schemes, Qasmieh Ras el Ain and South Bekaa I, modernized under the IRMP are managed by LRA. Their O&M, undertaken by LRA staff, are properly executed.

WATER TARIFFS AND COST RECOVERY

A pricing policy should take into consideration economic efficiency, ability to pay, equity in access to services and distribution. While there is a wide range of laws and regulations, which regulate water use and disposal in Lebanon, there are no references to a policy on cost recovery. Each RWA has its own procedures and arrangements for setting and recovering water charges. Water charges for supply of irrigation water are determined by the Boards of the Authorities and are subject to ratification by MOEW and the MOF. Responsibility for the enforcement of the law falls with the RWAs or Committees. These organizations are only responsible for the assessment and collection of charges within "public" collective schemes.

It is useful to distinguish among various types of charges, which make up the pricing regime. Two tariffs are generally used in Lebanon:

- *Area Charges.* These are lump sums periodic charges based on area irrigated (a fixed charge per ha, which depends on the crop grown and whether pumping is used or not; it increases if the farmer wishes to receive water more frequently than his allotment (examples: Qasmiyeh Ras el Ain, Yammouneh, Akkar el Bared, Danniyeh, and Barouk/ Safa Irrigation Schemes). In this case water tariffs are indirectly related to the volume of water consumed by adjusting charges on the basis of crops grown. Most schemes operate under the "area charge" system.
- *Volumetric Charges.* This type is used in case of pressurized networks, where the hydrants are equipped by with water counters and usually parcels have direct access to an outlet. This tariff is appropriate for schemes using sprinkling, drip or others modern methods of irrigation (example, South Bekaa Irrigation Project Phase 1 -- 2000 ha). A variation of this system is based on an hourly charge for water delivery (i.e. number of hours multiplied by the discharge).

The law authorizes public institutions to collect fees and levy charges for the facilities they operate and the services they provide. In principle, the Regional Water Authorities and the Local Water Committees are responsible for establishing prices and charges, to achieve a balanced budget, consistent with recovering anticipated operations and maintenance costs and in some cases proportion of systems rehabilitation and development costs.

O&M Costs. Amongst these are the personnel costs. These include staff salaries and overtime, bonuses, family allowances, transportation allocations and social costs paid to the National Social Security Fund (if any). Other costs include: (i) depreciation cost of infrastructure facilities occupied for O&M of the schemes; (ii) vehicle and equipment O&M expenses; (iv) general expenses (including electricity, water, heating and air conditioning, telephone bills and office upkeep and cleaning). In addition, other annual costs include: (i) extension services and assistance to farmers; (ii) overheads i.e. organization and project management; (iii) energy costs, which might include for example cost of main pumping from wells or surface reservoirs in addition to booster pumps to provide the necessary working heads in pressurized piped irrigation systems; and (iv) irrigation systems canals maintenance.

Existing Irrigation Schemes Tariffs. A 1994 MOEW study gives the tariffs applied in the 45 schemes (Appendix 5). Despite the diversity of these schemes, four main categories were observed:

a. Tariffs fixed by the LRA (Qasmiyeh scheme), or by the RWA such as Jbeil Water Authority (2 schemes), Barouk Water Authority (two schemes), Qoubayat scheme, Bekaa WA (two schemes). This is the case of eight schemes of a total of 45 schemes reviewed. The tariff range from LL250,000/ha/year for gravity irrigation to LL425,000/ha/year for pumped irrigation (or US$154 to US$253/ha/year in 1994 exchange rate).

b. Tariffs range from LL50,000/ha to LL150,000/ha, (US$30 to 90/ha/year). This is the case of 10 to 12 small schemes.

c. Tariffs are fixed by the number of irrigations (LL5000/irrigation/ha or US$3.2/irrigation/ha). This case is rare, and has only occurred in the Machghara scheme.

d. No tariffs at all, but farmers sometimes pay in emergency situations.

The LRA tariffs for Qasmiyeh Ras el Ain Project and the proposed ones for South Bekaa I range between US$300 and 400/ha/year. This is justified by the high water use and ability to pay in the coastal area of Qasmiyeh and by the pressurized system of South Bekaa I.

The status of irrigation schemes is strongly correlated with the availability of funds for O&M. The schemes that charge adequate tariffs are well maintained and managed. In case of no tariffs (category iv above), the MOEW used to pay appointed local water committees some subsidies to partially cover any shortfall in O&M costs, and also to rehabilitate those schemes, according to budget availability and political pressure. In 2003, the MOEW stopped paying subsidies to Local Water Committees, which are obliged now to collect fees from farmers for maintenance and water guards.

It is to be noted that apart from the schemes which manage to collect adequate O&M fees (such as those which falls under category I and those under the LRA), a number of other small and medium schemes are well maintained (for example: Minnieh, Bcharré, Barouk, Safa and Aanjar Chamssin schemes). The last example being for a schemes well maintained by farmers' group. However as already said, almost 50 percent of the schemes suffer from lack of proper maintenance and unless appropriate and sustainable solutions are found and applied, further deterioration of the schemes would be unavoidable.

MOEW's Irrigation Tariffs Study. The MOEW study mentioned above, developed a mathematical model, using a large number of variables, such as: size of the scheme (equipped and irrigated area), winter and summer irrigation, cropping intensity, length and nature of networks and density of canals in the scheme, and finally the ability of farmers to pay, in order to define the level of tariffs needed to achieve O&M cost recovery. Despite the diverse conditions of schemes, two main categories/zones were distinguished: the Coastal Plains and the Interior Zone (Mountainous Zone, South & North Bekaa Zones). The final and simplified recommendations of the study in terms of tariffs were as follows:

- Coastal Plains: LL370,000/ha (equivalent to US$220/ha in 1994 exchange rate)
- Interior Zone: LL270,000/ha (equivalent to US$161/ha in 1994 exchange rate).

These tariffs were based on 1995 prices and if calculated for the current year, they would almost be in line with those currently applied by the LRA for the two large schemes of Qasmiyeh Ras El Ain and South Bekaa I. Although these tariffs were never implemented and the exercise remained theoretical, nevertheless it gave a good indication of the optimal tariff levels.

Any tariff should take into consideration the socio-economic conditions, the water availability, the method of irrigation, the cropping intensity, etc. and should of course take into account the beneficiaries views and wishes. Each scheme tariff should be considered separately by the organization responsible for its O&M taking into consideration the above conditions. However, a minimum fee should be fixed in

order to cover, at least, the water guards' salaries and the small repair. The application of any proposed higher water tariffs should be gradual over a period of four to five years. The creation of sound and well trained WUAs should very much help in the organizing water charges collection and would certainly help reducing these relatively high charges by introducing direct farmers involvement in the O&M activities either by labor or by material contribution.

O&M costs vary among the various schemes, and have to be estimated for each scheme. To determine the appropriate levels of tariff, a separate study is needed to estimate the O&M costs of the various schemes. Such a study could be undertaken either separately, or within the framework of a Public Expenditure Review (PER) of Lebanon. Due to lack of data on actual O&M costs and collection rates, it was not possible to estimate the financial and fiscal gap involved.

The main financial issues related to the sector are as follows: (i) insufficient allocation of funds by government for the proper maintenance and rehabilitation of the main irrigation water supply and distribution systems; (ii) in many areas, lack of a uniform and rational methodology for setting and revising water tariffs periodically; (iii) low water tariffs that threaten the long-term sustainability of irrigation schemes, which do not encourage more efficient water use; (iv) low collection of water tariffs in most small and some medium schemes; (v) lack of up-to-date list of subscribers in some WAs; and (vi) lack of accurate accounts and records for calculating the costs of production and O&M of potable water and irrigation water. Any shortfall by the local water authorities or local water committees was until recently covered either by the MOEW, the municipality, or both.

Sustainability Outlook. The outlook for physical sustainability of Lebanon's irrigation network is promising. Schemes operated by LRA achieve full cost recovery. Many small schemes, which are operated by local water committees already finance part of O&M costs, and now have to finance the subsidy provided by MOEW. In other schemes, O&M charges and collections need to cover O&M costs, in line with recommendations given in this Note.

RECOMMENDATIONS

The need for a proper management of scarce water resources and the associated infrastructure are widely recognized in Lebanon. To this end, the following are some recommendations:

a. Water should be viewed as an economic commodity and not as a public good. Establishing an appropriate pricing structure will allow full cost recovery of O&M costs as well as part of the initial investments, if required.

b. Any proposed water tariff should take into account, amongst others, the social and financial conditions, the water availability and the intensity of production. It should also be easy to apply and administer. Volumetric water charges are easiest to apply in pressurized irrigation networks (but can also be used for gravity irrigation). A two-tier system could be applied: a fixed part for overhead expenses and a variable part based on water volume to improve efficiency. Fees should be raised and periodically adjusted to cover all the O&M costs.

c. Institutional strengthening and administrative reforms of water management agencies through reduced government involvement and bureaucratic control should be pursued (see para 6.3.9).

d. It is imperative at this stage, to start as soon as possible with the creation of formal WUAs, not only on a pilot basis, but also on a larger scale (if possible) in all the Mohafazats (covering both MOEW and LRA projects). This will necessitate concerted and sustained efforts from all interested parties. WUAs should eventually replace the different organizations currently in charge.

e. The creation of the formal WAUs will necessitate a legal framework, which does not yet exist in Lebanon. To prepare the legal framework would need not less than 6-12 months of work by number of different experts not only legal but technical, financial, social, etc. A framework, where the roles and responsibilities with respect to water management (including quality management) of the WUAs and other partners, would need to be prepared in close cooperation with the intended beneficiaries and other interested groups. It is the WAs, with the help of the MOEW, that should provide the legislative framework for the WUAs. They should try to convert many of the Local Water Committees to formal WUAs. The WUA's should be elected bodies for fixed term and should be accountable to the farmers who elected them.

f. As indicated earlier, the newly created WAs are in favor of this approach and would support the establishment of the WUAs as this will reduce their workload and financial burden. However, the WAs should remain in charge of the O&M of larger main canals, intake structures and pumping stations which are sometimes well above the farmers' capacities.

g. MOEW should continue to assist the WAs and regional and local committees in the O&M of the schemes especially those which are in bad state of repair. However, this assistance should be limited in time (5 years maximum), as well as in scope, waiting for the WAs to properly organize themselves. Large civil works would remain the MOEW responsibility.

h. For schemes to be managed by WUAs, it will be up to the members to set the tariffs. But it should be made clear to them that if they do not collect enough funds for maintenance, then the WUAs could take over the O&M activities while charging the proper fees.

i. In irrigation schemes where farmers have access to both surface and groundwater (South Bekaa), water tariffs should be set lower than or equal to the private cost of pumping groundwater in areas that benefit from both sources of irrigation water, for fear that farmers would only use groundwater.

j. Members of the WUAs should determine what level of service they need their WUA to provide and they should pay for. Members of the WUAs should be responsible for the O&M of their schemes, for the collection of water fees, (and imposing sanctions if needed) and for the payment of fees to the authority responsible for providing the bulk water and any other services.

k. Each WUA should keep accurate and transparent accounts to keep track of the various services provided. These accounts should be made available to the members and to the WAs.

l. Any rehabilitation or improvement irrigation projects to be carried out using external funds should introduce the concept of formal WUAs as an institutional strengthening component. Design and supervision of the works should be carried out in close cooperation with, and with the full agreement of, the WUAs.

m. Necessary and well-focused training related to the establishment and management of WUAs should be provided to all involved parties. Training of the WUAs members, as well as the personnel of the WAs and MOEW, on aspects such as participatory approach, management, accounting will be necessary. Donors, NGOs, or any other specialized parties can provide training.

8. Financial and Economic Aspects

Policy impact on irrigated agriculture. Economic policy impacts agriculture in several ways: (i) *water tariffs* for irrigation schemes; (ii) *macro-economic policy* through exchange rate and interest rate policies; (iii) *agricultural subsidies* on exports and credit; and; (iv) *trade policy* and trade agreements.

Water tariffs and cost recovery. Water laws or regulations do not govern water tariffs, and there are no provisions for recovery of irrigation investment costs in irrigation schemes, and private irrigation schemes do not pay any water tariffs. Water tariffs in the main irrigation schemes are far below the marginal cost of water, estimated in 1999 by the United Nations' Economic and Social Commission for West Asia (ESCWA) to be in the range of $0.20-0.25/m^3, comparable to marginal costs in the West Bank (ESCWA 1999). Although this may be a conservative estimate, it is nevertheless far above water tariffs in most of the irrigation schemes, and charges are mostly based on irrigated area rather than water volume, and hence do not provide an incentive to improve efficiency of water use. Low water tariffs and low collection rates threaten the sustainability of irrigation systems, do not provide an incentive for conservation of irrigation water, and increase the fiscal burden.

Macroeconomic policy. This policy impacts agriculture mainly through both the exchange rate and interest rate levels. By most accounts, the Lebanese currency is overvalued, and has unofficially been pegged to the United States dollar. It is estimated that the real effective exchange rate of the Lebanese currency appreciated by 58 percent between 1993 and 1998 (World Bank, Social Protection Note). This appreciation vis-à-vis currencies of Lebanon's trading partners in the Gulf region and in the European Union countries has an adverse impact on the export sectors, namely, manufactures, agriculture, tourism, and services, although it has a positive impact on the prices of imports, which make up a sizable portion of domestic consumption. The over-valued exchange rate was maintained through a high interest rate on the Lebanese currency, which discourages productivity-increasing capital investment that carries embodied technological improvements. The exchange rate has recently depreciated as a consequence of a falling United States dollar vis-à-vis the major European currencies, which should encourage exports, but its magnitude is not known due to the lack of empirical data on the elasticity of agricultural exports to the exchange rate.

Kafalat corporation. To improve access to commercial bank lending of small and medium enterprises in agriculture and other sectors, Kafalat Corporation, a joint venture between the National Deposit Guarantee Corporation (75 percent) and commercial banks (25 percent), provides government guarantee for 75 percent of loans provided by commercial banks for new investments and for working capital for enterprises in agriculture, industry, tourism, information technology, and handicrafts. The loan ceiling is $200,000 and the borrowing rate is around 3.5 percent. Of the 715 loan guarantees issued by *Kafalat* through December 2001, 45 percent were in agriculture, and 39 percent were in industry; as of that date, the total loan portfolio was LL63 billion ($42 million).

Investment Development Authority of Lebanon (IDAL). This agency was established in 2001 as an autonomous agency to promote private investment, particularly in the less-developed regions of Lebanon through tax holidays of up to ten years, and providing support to private investors (by serving as a one-stop agency for issuing investment permits, licenses, and work permits to employees, carrying out pre-feasibility studies to attract potential investors, etc). In addition, *IDAL* launched the *Export-Plus* program to promote the export of agricultural products. The export subsidy depends on the kind of product and

mode of transportation, and is based on weight rather than value and hence is mainly a transportation subsidy; hence it does not promote the production of high value-added crops. The export subsidy allocation for 2001 was US$33 million. The major export markets are the Gulf countries, particularly Saudi Arabia and Kuwait. Three international firms supervise quality control. As a condition for accession to the WTO, Lebanon should eliminate exports subsidies, which threatens the sustainability of this program.

COMPETITIVENESS AND SUSTAINABILITY OF IRRIGATED AGRICULTURE

Irrigated agriculture in Lebanon supports a wide variety of crops, particularly fruits and vegetables grown in the field and in greenhouses, which are the main export crops. There has been a shift towards intensification of production of fruits, vegetables, and industrial crops, at the expense of cereals and pulses. This shift has been largely due to a rise in irrigated area, increased production in green houses that have higher productivity and produce off-season crops, and producer subsidies for industrial crops. A 1999 ESCWA study concluded that in terms of efficiency indicators, Domestic Resource Cost, Nominal Protection Coefficient, and Effective Protection Coefficient (DRC, NPC, and EPC), "there are a number of agricultural products where Lebanon has a comparative advantage" (ESCWA 1999 and World Bank 2003a). In this context, Lebanon has a comparative advantage in high value horticultural crops, but is not competitive in field crops. Competitiveness is enhanced by the diversity of its climatic zones, proximity to the Gulf and European markets, and advantageous terms negotiated in the EU Association Agreement. Nevertheless, Lebanon faces strong competition in vegetables and fruits from neighboring countries. Hence improving competitiveness is key to the future of agriculture in Lebanon.

Lebanese agriculture has a high cost structure for several reasons: the mountainous nature of many agricultural lands that produce fruits and some vegetables; a limited domestic market and small and fragmented holdings that do not allow for economies of scale; a high proportion of hired labor (around 30 percent, mostly foreign labor); wasteful irrigation practices such as furrow irrigation in many areas; low conveyance, distribution, and on-farm irrigation efficiency; and high usage of fertilizers and pesticides that are encouraged by input suppliers.[7] This is partially offset by high yields that are comparable to Egypt and Turkey.

The domestic market is limited and is very competitive, and the export market has a good potential, while a large part of Lebanese agricultural exports consists of traditional crops, such as tomatoes, cucumbers and potatoes. Competition will become more intense as regional and international trade agreements come into effect.

Recommendations. Lebanon is or can be competitive in high value added crops (fresh fruits and vegetables) geared mainly for the export market, but this potential is not fully exploited at the present. To exploit this potential, the main options for improving competitiveness lie in reducing the cost structure, improving irrigation efficiency, producing higher value added and organic crops of high quality that meet the standards of the European and other markets, export market development, and improving the efficiency of domestic markets. Establishing a regulatory environment that enhances the role of farmer organizations and cooperatives to improve quality, efficiency, competitive price formation, and reduce market risks, would help.

[7] At first glance, this implies that using cheaper foreign labor would reduce costs. However, it is reported that agricultural wages for foreign labor in Lebanon, mainly Syrians, are around US$ 10/day; agricultural wages I n Syria are around US$ 3-4/day, which contributes to higher relative production costs in Lebanon.

Costs can be reduced through the following measures: (i) increasing cropping intensity of irrigated areas and improving yields. The present cropping intensity does not exceed 130 percent on average in areas irrigated by wells, but this can be raised to higher levels; (ii) technology transfer for using less fertilizers and pesticides and increasing yields (FAO Investment Centre 2000a);[8] (iii) more efficient irrigation techniques and increased mechanization where feasible; and (iv) in the longer term, a concerted effort is needed to mitigate the structural impediments in agriculture: voluntary land consolidation through the legal system, and analysis of the land tenure system.

In the area of macroeconomic policy, government commitment to a stable exchange rate vis-à-vis the US dollar is strong, at least in the short term. Over the medium and long term, the adoption of a more flexible exchange rate regime, in addition to phasing out of subsidies, need to be seriously considered. The pros of a more flexible exchange rate that encourage exports, have to be weighed against the cons of raising import prices and its impact on fixed income groups in Lebanese currency, and social considerations, all within the framework of GOL's overall macroeconomic policy, and the ability of the central bank to maintain a relatively stable exchange rate. The competitiveness of Lebanese agricultural and food exports has recently witnessed a boost as the Lebanese currency has depreciated considerably in tandem with the US dollar, but its magnitude is not known due to the lack of empirical estimates of the elasticity of agricultural exports to the exchange rate. Moreover, interest rates have fallen following the Paris II donors' meeting in late 2002. Lebanese exporters should be able to exploit this opportunity to expand exports.

Overall, irrigated agriculture is deemed to be sustainable in the long term for the following reasons:

a. agriculture in Lebanon does not provide the only, or in many cases even the major, source of livelihood for households, but rather supplements family income. Hence even though agriculture contributes only about 6-7 percent of GDP, it will continue to survive, and the challenge is to make it more competitive and efficient.[9]

b. the EU Partnership Agreement provides a unique opportunity and potential market for high value horticultural produce, provided Lebanon complies with health and quality standards. As mentioned earlier, the Agreement provides technical assistance for harmonization of health and quality standards between Lebanon and the EU;

c. Lebanon can expand the export of processed food and specialty products, in which it is competitive, and also expand the domestic market; and

d. irrigated agriculture contributes to poverty alleviation in some of the poorest Cazas in Lebanon where new irrigation schemes are proposed, such as Baalbeck (Al Assi); Akkar/Minnieh/Danniyeh (Noura Al Tahla and El Bared); South Lebanon (Conveyor 800 m); and South Bakaa.

To enhance the sustainability of agriculture, complimentary initiatives are needed to improve competitiveness, and export market development (GOL is in the process of establishing an Export Development Agency). In addition, more effective extension and research functions, and domestic market improvement are required to make agriculture more efficient and competitive.

A bright area for Lebanon is high quality processed food products, where Lebanon is competitive, as evidenced by exports to Arab countries, the United States, and some European countries. It can be

[8] It is estimated that the cost of fertilizers and pesticides can be reduced by 20-30 percent, and yields may be increased by about 25 percent.

[9] For further analysis, refer to the report Lebanon, Perspectives on Agriculture Sector Issues, being finalized by MNSRE.

concluded that Lebanon possesses the potential to be competitive in high value added crops and processed food products, geared mainly for the export markets.

AGRICULTURAL MARKETING

In Lebanon, marketing agricultural produce, particularly fresh fruits and vegetables, faces several challenges. First is the inadequate marketing infrastructure (wholesale markets, cold storage and packing facilities suffered damage during the civil war) and poor access roads in certain areas. Second is the lack of official grades and standards and of labeling standards. Third, are the inefficiencies and high margins in the wholesale markets.[10] Fourth, high post-harvest losses are estimated to exceed 30 percent and lead to a deterioration of quality. Fifth, is the lack of accredited laboratories for certification of pesticide levels in fruits and vegetables for export. Finally, there is the lack of an efficient market information system, both for access and dissemination.

Furthermore, Lebanese producers have not kept pace with changes in consumer demand and they still produce aging fruit varieties; golden and red delicious apples are the staple of the apple industry in Lebanon, while consumer demand in Europe has shifted towards other varieties such as Granny Smith, Gala, etc. A main shortcoming of the agricultural marketing system is the lack of market data on demand, supply, and prices in the export markets, quality and health standards, tariffs, quotas, and permits.

Recommendations. Despite these challenges, Lebanese fresh produce has many advantages. Lebanon produces a wide variety of high quality fresh produce and their derivatives, such as apples produced at high elevations, cherries, fruit juices, wines, etc. By focusing on select products for export, Lebanese exporters can develop credible branded products. Lebanon has a good potential for organic farming; already some crops are being produced under organic farming conditions, such as almonds, figs, and some grapes, and cherries, which have found a niche in the domestic market. Organic farming has a good export potential in Europe and the budding industry in Lebanon needs to be nurtured and developed by entrepreneurs to take advantage of export opportunities. Certification of organic products by a credible agency is essential to penetrate export markets.

AGRICULTURAL SERVICES: RESEARCH, EXTENSION AND CREDIT

Agricultural research

Agricultural services in Lebanon are weak. The research programs of the Agricultural Research of Lebanon (ARIL) cover a wide variety of themes: irrigation water efficiency, plant protection, tissue culture, integrated pest management (IPM), and others. ARIL is completing the rehabilitation of its research facilities, financed under the IRMP, following the civil war.

I*ssues.* ARIL is challenged by its focus on traditional crops and its lack of a farming systems approach. In fact it lacks technical packages for non-traditional crops that have the best export potential;. ARIL also has insufficient qualified technical staff and equipment, including irrigation equipment. Finally, has inadequate administrative and financial autonomy.

Recommendations. Lebanon needs to develop a national export-oriented research strategy that addresses farmers' needs where the country is or can become competitive, including non-traditional niche crops, such as certified seeds. The farming systems approach to research should be adopted. An *ad-hoc* panel

[10] It is reported that wholesale markets are characterized by market imperfections and monopolistic features (CDR, 2002)

should be established to periodically evaluate ARIL's research strategy, priorities, and programs. Finally, the government should grant more autonomy to ARIL.

Extension

Issues. Extension and technology transfer programs by the public sector are practically non-existent. Farmers receive advice mostly from input suppliers who may recommend excessive use of fertilizers and pesticides. Extension to improve irrigation use efficiency is lacking, along with proper advice on plant protection, new production practices, and new varieties of apples and other fruits. There is no link between extension and research programs of ARIL, and hence some research programs are not demand-driven.

Recommendations. The Bank recommends a limited but more effective role for the extension service, where the public extension service would provide an overall strategic framework and enabling environment for private sector operation, and assume a supervisory role such as monitoring private sector advice to farmers to avoid excessive use of inputs. Cooperation between the private and public sectors should be nurtured, making full use of universities, international organizations, and qualified NGOs. Core specialists in the major fields should be retained on a regional basis to serve as resource persons for field extension workers. The linkage between extension and research activities should be strengthened based on a participatory needs assessment, so that research programs would be more demand-driven. Applied research should be strengthened to provide extension services with needed advice and to train farmers' leaders. Finally, cost-effective dissemination of technical packages should be promoted through mass media and other channels.

To ensure the sustainability of sources of finance for agricultural and rural credit in the future, it is envisaged that the newly established ESFD, which has responsibility for development of small and micro enterprises, would mobilize funds for agricultural and rural development, including credit for small and medium enterprises.

AGRICULTURAL TRADE AND TRADE AGREEMENTS

In 1998, Saudi Arabia imported 42 percent of Lebanese exports of fruits and vegetables, and Kuwait accounted for 17-20 percent (ESCWA 1999). Over one third of Lebanese agricultural exports were destined for Gulf Cooperation Council (GCC) member states in 1999 (table 8.1).

Over the medium and long term, the adoption of a macroeconomic policy that allows a more flexible exchange rate needs to be explored, within GOL's overall macroeconomic policy. The recent slide in the value of the US dollar has helped the competitiveness of Lebanese exports to the European Union, and exporters should be able to take advantage of this opportunity.

Table 8.1 Imports and exports of agricultural products (LL Billion), 1999-2001

	Imports			*Exports*		
Category	***1999***	***2000***	***2001***	***1999***	***2000***	***2001***
Plant Products	564.9	533.3	588.8	118.2	106.9	135.8
Animal Products	541.3	519.3	555.4	2.9	1.9	3.2
Total	1106.2	1052.6	1144.2	121.1	108.8	139.0

Source: MOA, Agriculture in Lebanon, 2000-2001, May 2002 (Arabic).

9. The Public Investment Program in Irrigated Agriculture

Public investment in the irrigation sector in Lebanon has so far been carried out by two agencies, MOEW and LRA. Once they become fully operational, the newly established WAs will have responsibility for executing potable water projects and small projects in irrigation, but the design and implementation of dams and major projects remain under the jurisdiction of MOEW. Based on its mandate, LRA will retain responsibility for irrigation projects in areas where it is currently operating in the South Bekaa and South Lebanon, and for countrywide monitoring of water resources. This section will briefly discuss the investment programs of MOEW and LRA

MOEW INVESTMENT PROGRAM

Following implementation of the IRMP (Ln. 3769 LE) for the rehabilitation and modernization of about 25,000 ha of irrigation networks, the focus of MOEW shifted to the construction of dams and some hill lakes to harness part of the 0.7 BCM of runoff rain water that is currently lost annually to the sea, and which is urgently needed, particularly in the dry summer months, when Lebanon already faces a shortage. MOEW's irrigation investment program through 2030 carries a total cost of nearly US$530 million, of which US$320 million goes for the construction of dams and hill lakes, and US$210 million for construction or modernization of distribution networks for the proposed dams, or for existing irrigated areas. (see table 10.1)

Only one dam in Lebanon, Chabrouh (at a cost US$50 million), is under execution with government funding, which will provide around eight MCM for potable water only, and a contract has been signed for the Yammouneh lake scheme (cost $6 million).

In addition to providing irrigation water to about 12,150 ha, MOEW's investment program includes the rehabilitation or modernization of another 11,000 ha. Lebanon and Syria have reached agreement on sharing the waters of the Al-Assi River, which originates in Lebanon, and flows into Syria. The Al-Assi scheme is a joint undertaking between Lebanon and Syria for irrigation, potable water, and power generation. The project will be implemented in two phases. The first phase (diversion dam, three pumping stations, and network for irrigation of about 3,000 ha), will be tendered in 2003/2004. Bidding on the main phase (construction of a 37 MCM dam—Lebanon's share -- and three pumping stations, irrigation network for 3,600 ha, and the hydro-power plant) is planned for 2004. The Noura Al Tahta dam scheme is also a joint project with Syria on El Kabir River, to allow the storage of 70 MCM (about 35 MCM for Lebanon), mainly for irrigation (90 percent); it will also provide water for domestic purposes. The El Bared dam and reservoir project, with a storage capacity of 40 MCM, will provide about 20 percent of the water for domestic uses in Tripoli and surrounding areas, and about 80 percent for irrigation.

The Iaal dam and reservoir project allows the diversion of water from Abu Ali River to fill a ten MCM reservoir for potable water for Zghorta and surrounding areas, and will provide excess water for irrigation. The Younine dam and lake in Baalbek *caza* will provide storage of seven MCM: for irrigation (80 percent) and for potable water (20 percent).

Table 10.1 MOEW's investment program, 2003-2030

		Capacity MCM		*Gross irrigated area (ha)*			*Cost US$ Million*		
Project	***Location***	***Total***	***Percent irrigated***	***Total***	***New***	***Rehab.***	***Dams, Lakes***	***Distrib. network***	***Total***
Phase I, 2002-2015									
Noura Al Tahta Dam	Akkar	35*	90	10,000	2,000	8,000	26.5*	40	66.5
Al Assi Dam Project	Baalbeck	37*	90	6,600	6,600	0	122.5	130	252.5
El Bared Dam & Reservoir	Akkar/ Minieh	40	80	3,000	0	3,000	46.5	0	46.5
Hill Lakes (10 no)		10		1,250	1,250	0	50	Included	50
Phase II, 2016-2030									
Iaal Dam & Reservoir	Zghorta	10	10	1,300	1,300	0	46.5	20	66.5
Younine Dam/ Lake	Baalbeck	7	80	1,000	1,000	0	21	20	41
Yammouneh Lake***	Baalbeck	1.5	100				6.3	0**	6.3
Total		**140.5**		**23,150**	**12,150**	**11,000**	**319.3**	**210**	**529.3**

*Jointly with Syria; figure represents Lebanon's share. ** Distribution cost by beneficiaries. ***Night storage, no new irrigated area. ****Excluding Yammouneh Lake

Source: MOEW

Several projects in MOEW's irrigation investment program are either at the project identification stage or the preliminary study phase. This includes the Noura Al Tahta, El Bared, Iaal, and Younine schemes, and all the other small and medium schemes. No feasibility studies have been carried out for these schemes. Furthermore, foreign funding has not been secured. Preliminary analysis shows that Noura El-Tahta could be economically feasible for irrigation purposes, and that El-Bared scheme, which has a higher cost but can be used for both potable water supply and irrigation, might also be justified. It should be noted that these are just first rough estimates based on cost of storage/m^3, which ranges between US$0.41/$m^3$ and US$9.8/$m^3$ It is imperative to carry out feasibility studies to determine the technical and economic/financial feasibility of each of the proposed dams and hill lakes.

LRA INVESTMENT PROGRAM

LRA investment program (table 10.2) through 2030 costs US$817 and includes the following main projects: (i) Canal 800m Conveyor Phases I and II; (ii) Annan-Nabatiyeh Conveyor; (iii) the South Bekaa Phase II; (iv) Khardaleh dam; and (v) the left bank of the Litani river and north zone schemes, in addition to other smaller projects.

The center-piece of LRA's investment program is the Canal 800m Conveyor Project, Phases I and II, at a total cost of US$460 million, which would serve areas between elevations 800m and 400m in South Lebanon. This is a multi-use project that would provide 90 MCM to irrigate a net new area of 13,230 ha

Table 10.2 LRA's investment program, 2003-2020

Scheme/Project	*Purpose*	*Net Irrigated Area (ha)*	*New Additional Area (ha)*	*Rehabilitation Area (ha)*	*Cost $ Million**	*Status*
South Lebanon 800m Conveyor Phase I	I & PW	0	0	0	217	Financed by Arab Fund, Kuwait Fund
South Lebanon 800m Conveyor Phase II	I &PW	13,230 (Phase I&II)	13,230		243	Preliminary studies
Annan-Nabatiyeh Conveyor	I & PW	4,700	4,700	0	105	Preliminary studies
South Bekaa II Left Bank	I	6,700	0	6,700	45	Feasibility study being updated
South Qaraoun Reservoir Scheme	I	800	800	0	5	Feas. Study prepared
Qasmieh Ras El Ain Phase II**	I	2,100	2,100	0	15	Storage capacity 10-12 MCM Kfarsir
Khardale Dam Project	I	9,000	9,000	0	150	Storage capacity 128 MCM
Right Bank of Litani, North Zone	I	12,800	0	12,800	25.6	
Saida Jezzine	I	1,200	1,200	0	5.8	
Hydrometric Data Monitoring	I				3	
Qaraoun Reservoir Pollution Control	I				1	
Agr. Exp Station					2	
Total		**50,530**	**31,030**	**19,500**	**817.4**	

I= Irrigation PW=Potable Water. * Includes distribution network. ** Including Kfarsir dam.
Source: LRA

from the Qaraoun dam by gravity, in addition to providing 20 MCM of potable water annually when Phase II is completed, for over 500,000 inhabitants in nearly 100 villages. It is to be noted that the Qaraoun Dam reservoir has adequate storage capacity to supply water for 20,000 ha of the proposed 50,000 ha proposed by the GOL. Phase I, with a cost of US$217 million, is financed by the Arab Fund for Economic and Social Development (AFESD) and the Kuwait Fund for Arab Economic Development (KFAED), which together finance US$165 million, while government finances US$52 million. LRA officials informed the Bank that preliminary discussions indicate that the same donors may finance Phase II of the project. On a prorated basis, the cost of irrigation water would be around US$376 million, or US$28,000/ha.[11] This cost is extremely high and the main justifications may be the production of very

[11] Total cost of $460 million is prorated on the basis of 90 MCM for irrigation and 20 MCM for potable water supply. However, since potable water would have first priority in dry years, it can be argued that its share in project cost should be higher.

high-value added cash crops, water use for municipal and industrial purposes for 500,000 inhabitants, and social benefits by encouraging residents who left the region during the Israeli occupation to go back to their villages.

The Annan-Nabatiyeh Conveyor Project would convey Qaraoun dam water for irrigation and potable water by gravity from Annan basin through an open canal and pipes to areas in Zahrani and Nabatiyeh. It would irrigate a new area of 4,700 ha and provide potable water for 46 villages. A preliminary study has been carried out, but the breakdown of the $105 million cost between irrigation and potable water is not available. A feasibility study is needed to determine if the project could be justified on the basis of providing potable water in addition to irrigation water.

The updated feasibility study for the South Bekaa Irrigation Scheme Phase II Project (Left Bank) carried out in 2002 showed that the project is viable. Phase I, funded by the Bank and government, has already been completed, and provides irrigation for 2,000 ha, in addition to investments in the major infrastructure which will provide water for Phase II (dam, pumping station, pipeline, 14.5 km main canal, etc.). Phase II would improve irrigation in an area of 6,700 ha on the left bank of the Litani river, from the Qaraoun dam, to bring the total area irrigated by the project to 8,700 ha. About 75 percent of the costs of the pumping station and Canal 900m have already been implemented during the seventies, and Phase II would build on this sunk cost and is expected to be viable.

"The rationale for the South Bekaa Project development was mainly to ensure water availability and reliability during the dry season, and to introduce a more efficient and controlled irrigation system" (FAO 2000a). The project would allow the transition from mainly private pumping of groundwater for irrigation water, where owners have acquired water rights, to a more efficient system of collective and controlled pressurized irrigation system. It would thereby replace the uncontrolled pumping of groundwater that threatens the sustainability of groundwater sources, and encourage farmers to participate in the scheme, on a voluntary basis through water tariffs, which are lower than pumping costs, in covering the O&M costs of the scheme.

The South Qaraoun Irrigation Scheme would irrigate 800 ha, at a cost of US$5 million. A feasibility study is being carried out, but the results are not yet available. The Qasmieh Irrigation Scheme Phase II (including construction of Kfarsir dam) would increase the irrigated area by 2,100 ha at elevations 100-200m above sea level. Equipment for Hydrometric Data Monitoring is urgently needed since little hydrometric data was collected since the beginning of the civil war. This project would supplement equipment procured under the IRMP (Ln. 3769 LE), and would enhance the national database for policy and planning objectives. The Qaraoun Reservoir Pollution Control Scheme, with the assistance of Sweden, aims to reduce the serious pollution of the reservoir, which is threatened by solid and liquid wastes, heavy metal pollution, and micro-organisms. The strategy is to improve water management through increased monitoring and establishing an institutional arrangement to disseminate timely data to the public and private sectors. This scheme, which costs US$1 million, is a vital step for pollution control of the Qaraoun dam water. LRA has one Agricultural and Animal Experiment Station at Lebaa to carry out trials and research on new varieties and cropping patterns suitable for South Lebanon, and on new irrigation techniques. It also has a training center for farmers and vocational students. LRA plans to upgrade these facilities and to establish another research station in the Bekaa in collaboration with ARIL, at a cost of US$2 million. Although research is mainly the responsibility of ARIL, the dearth of research activity in the South warrants this activity.

Lebanon's irrigation investment program is summarized in table 10.3 below, which combines MOEW's and LRA's programs.

The total cost of the public irrigation investment program is US$1,346 million. MOEW's share, or nearly US$530 million, over 28 years, translates into an annual expenditure of US$19 million. LRA's investment program of $817 million envisages annual expenditures of US$29 million. However, this

program is front-ended; consequently, expenditures during the early period are higher than the average as a result of implementation of the Conveyor 800 and the Al-Assi projects, and could exceed the annual average considerably.

Table 10.3 Summary of Lebanon's current irrigation investment program, 2002-2030

Category	*Capacity MCM*	*Total Irrig. Area Ha*	*New Irrig. Area Ha*	*Irrig. Rehab. Area Ha*	*Cost US$ Million*	*Average Annual Investment $ Million*
MOEW	140.5	23,150	12,150	11,000	529	19.0
LRA	140	50,530	31,030	19,500	817	29.0
Total	280.5	73,680	43,180	30,500	1,346	48.0
NGOs, Priv.	-	-	6,820*	-	Na	Na

* Could be using treated sewage effluent.

Currently, the irrigation investment programs of both MOEW and LRA do not provide for stakeholder participation in the identification, design, implementation, or management of O&M functions in irrigation projects. This irrigation investment program is quite optimistic and ambitious, especially for LRA, considering past experience. To achieve the program requires quick mobilization of human resources that are needed for timely implementation, a high level of institutional capacity of the implementing agencies, a strengthening of the newly established Water Authorities, strong farmer participation through the formation of Water User Associations, the presence of effective support services in agricultural research and extension, a fast pace of mobilizing donor financing and availability of counterpart funding that have a critical impact on achieving these targets. In view of these constraints, the current size of the public debt, and the need to develop export markets to absorb the incremental agricultural production, Lebanon's irrigation investment program represents a high-end scenario.

A medium or low-end scenario that involves expenditures that do not exceed US$35 million per year is more realistic and is proposed. If government accepts this scenario, MOEW and LRA need to prioritize their investment programs. This could include, but not necessarily be limited to, exclusion or delay execution of expensive hill lakes unless they are urgently needed for municipal purposes, and the postponement of the Khardaleh dam and the Annan-Nabatiyeh Conveyor. This would reduce the new irrigated area to 36,300 ha, instead of the proposed 50,000 ha, and the total irrigated area to around 126, 300 ha instead of 140,000 ha by 2030.

In addition to the above investment programs, treated sewage effluent could be used to irrigate about 3,000-5,000 ha. NGO's and the private sector should be allowed to use this water for irrigation.

Increasing the irrigation potential in Lebanon by 30-50 percent in the next 30 years would add a substantial agricultural production in the market, which will need to be absorbed. With the present population growth rate of about two percent annually, a large proportion of this new production would be absorbed by the local market. However, the aim of increasing the irrigation potential is also to produce high-value crops for the international markets. It is believed that some of the increase in production generated by the expansion in the irrigated areas could very well be exported, if proper mechanisms are in place as discussed in previous chapters.

RECOMMENDATIONS

The Bank recommends that the Government, particularly MOEW and LRA, as well as the newly established WAs, should consider scaling down the investment programs to a more manageable level, particularly by LRA, so that annual expenditures do not exceed US$35 million. This would help avoid a sizable increase in the public debt, which already absorbs over one-half of the annual budget, and it would bring the irrigation investment programs in line with the capacity of the implementing institutions. The Bank also recommends limited the construction of hill lakes to areas that urgently need potable water, as they are too expensive to use for irrigation. MOEW and should prioritize their investment programs based on technical and economic/financial feasibility studies, as well as the social priorities in beneficiary areas. The implementing agencies should involve local stakeholders in O&M functions through Water User Associations to promote ownership and encourage greater financial contributions by beneficiaries. A priority action should be the immediate completion of the legal framework for WAs and upgrading their human resource and financial capacities to enable an orderly transfer of O&M functions to WAs. Finally, the Government should give serious consideration to privatizing the services of the WAs over the long term.

This study commends MOEW for giving the highest priority to potable water supply projects, followed by dual-use projects (potable water and irrigation). Moreover, MOEW and LRA are commended for including the rehabilitation of irrigation networks in the investment program, where investments are usually smaller, benefits are realized sooner, and economic and financial returns are viable.

It is imperative that implementation of the irrigation investment program should be accompanied by effective water demand management measures for both irrigation schemes and groundwater pumping. An effective mechanism is needed for enforcing existing laws and regulations, or new laws should be enacted when needed, to regulate groundwater abstraction in private schemes; volumetric metering could be introduced in vulnerable basins to reduce water abstraction to more sustainable levels. In public irrigation schemes, it is important to adjust water tariffs periodically and enforce cost recovery in order to ensure their future sustainability.

A legitimate concern arises if a large part of the 50,000 ha is brought under irrigation (in addition to rehabilitation of 30,000 ha in existing networks), namely, the ability of the domestic and/or export markets to absorb the incremental production over 30 years. The domestic market is limited, and competition in the domestic and export markets is strong and increasing. Although population growth and demand for higher quality produce associated with rising income would mitigate the effect of a limited market, the main options lie in reducing costs of production (more efficient use of irrigation water, using less fertilizers and pesticides, increasing yields, etc.), and export promotion through the production of higher value added crops of good quality that meet the standards of the European markets. Another good potential is the export of high quality processed food products, where Lebanon is competitive. The export potential of Lebanon has been enhanced by a falling exchange rate in tandem with the US dollar, and exporters should be able to expand exports, particularly to the European Union.

A scaled down irrigation investment program, export market development, cost reduction, improved irrigation efficiency, agro-processing of agricultural produce, and a falling exchange rate should enable the economy to accommodate the increased production arising from implementation of the revised irrigation investment program that would bring the total irrigated area to 126,300 ha by 2030, or 1,300 ha per year and the total storage capacity to about 360 MCM and a total storage of about 360 MCM.

10. Strategic Choices Facing Irrigated Agriculture

Government Strategic Objectives and Priorities. The main objectives of GOL in the irrigation sector derive closely from related objectives for overall water resource management in Lebanon. These objectives, which were identified during extended discussions with officials of MOEW, LARI, and other agencies, can be summarized as follows: (i) ensure the availability and sustainability of water resources for future generations for irrigation, drinking, industry, and tourism; (ii) ensure adequate operation and maintenance of the national irrigation network to guard against degradation of irrigation schemes and avoid expensive early replacement; (iii) strengthen the institutional capacity of agencies in charge of water resource management; (iv) increase stakeholder participation in the management of O&M functions and reduce the fiscal burden, through the establishment of WUAs and providing the legal framework required for their operation; and (v) protect the environment.

A strategy to achieve these objectives could follow four parallel tracks to address technical, financial/economic, institutional, and environmental aspects as summarized below:

TECHNICAL ASPECTS

Lebanon faces a seasonal water shortage and may soon face an overall shortage. For national water resource planning, the ongoing Water Resources Master Plan (WRMP) being prepared by MOEW with JICA assistance, is critical for assessment of the future water demand for all uses, including irrigation, in order to adopt strategies and policies to meet any expected water shortage. Tentative findings indicate that Lebanon will have a water shortage in the dry months of 2004 that could exceed 700 MCM by 2030. Moreover, the annual water balance would go into deficit shortly after 2020, if no additional water storage capacity is built. At the same time, over 700MCM of surface water are lost to the sea annually. In this regard, it is important to improve meteorological and hydrological data needed to arrive at reliable estimates for use by policy makers.

Augmenting water storage capacity is essential for sustainability. GOL has an ambitious irrigation investment program to increase water storage capacity to meet future demand from the present 220 MCM to around 500 MCM by 2030. The cost of the program, excluding contingencies, is around US$1,346 million, representing annual expenditures of US$48 million. The investment program is front-ended. About US$217 million have been committed for the 800m Conveyor Project, Phase I, and US$243 million are likely to be committed by the same donors soon. Moreover, bidding for Phase I of the Al-Assi project, jointly undertaken with Syria, is due before the end of 2003, and bidding for Phase II is expected in the summer of 2004 (at a total cost of US$252 million).

The irrigation investment program is quite ambitious. These projects are considered high priority for GOL for economic and social considerations. Beyond that, the PN recommends the following actions: (i) scale down the investment program to no more than US$35 million per year to mitigate any increase in the high public debt, and taking into consideration the capacity of implementing agencies; and (ii) prioritize the investment program and postpone the Khardaleh dam and the Annan Nabatieh Conveyor (US$255 million), and expensive hill lakes. These actions, if adopted, would increase the irrigated area by around 36,000 ha over 30 years, increase farm income, and allow a more orderly marketing of incremental production in the new irrigated areas.

Treated wastewater could be a valuable resource for agriculture. There is only one large wastewater treatment plant in Lebanon, in addition to around 15 smallscale plants. GOL has a long term plan to build 25 new plants for the major cities, which is being delayed by a tight fiscal situation. It is recommended to develop cost-effective smallscale wastewater treatment plants for rural communities as a priority, and treated wastewater can be used in agriculture. However, this requires a an economic evaluation and regulatory framework, setting health standards for the use of treated wastewater, and public awareness campaigns targeting all stakeholders, to explain the risks and benefits, including the health and environmental impact of using treated wastewater. Training of GOL staff (particularly MOE or MOA) and farmers on using treated wastewater is also necessary.

Improving irrigation efficiency saves water and cost. Irrigation efficiency can be improved through incentives for water-saving technologies (duty free imports for drip and sprinkler equipment), technology transfer through effective applied research and extension services to improve on-farm irrigation efficiency, and raising cost recovery in irrigation schemes in addition to rehabilitating and modernization of the irrigation schemes main networks.

FINANCIAL AND ECONOMIC ASPECTS

Cost recovery and demand management are essential compliment to increasing supply. A critical aspect of water resource management is a more efficient use of water, and ensuring the sustainability of irrigation networks through providing adequate O&M functions. Currently, water charges collected from beneficiaries are not sufficient to provide proper O&M functions in about one half of the irrigation schemes, which threatens their future sustainability.

To improve irrigation water demand management and cost recovery, and consequently the sustainability of irrigation schemes, the following measures are recommended: (i) raise irrigation water tariffs to cover as a first step O&M costs, and over the long term cover at least part of the investment costs; (ii) periodically review and adjust water tariffs to reflect actual costs; (iii) base water charges on the volume of water used rather than area, which does not provide an incentive for more efficient water use. Volumetric charges can be introduced in LRA irrigation schemes, starting with the pressurized irrigation system in the South Bekaa Phase I, and in the future in Phase II, and can later be expanded to other schemes. Where metering is not feasible at this time, base water charges on a combination of a fixed charge to cover the basic services, and other charges which can be used as a proxy for the volume of water used, such as crop grown and/or hourly use of water. A combination of these systems is currently used in some schemes in Lebanon; (iv) enforce the existing regulatory framework including licensing of wells to reduce construction of new illegal wells (by one estimate, there are 10,000 legal and about 40,000 illegal wells), ensure safe distances between wells and from springs, and impose and enforce heavy penalties for violations; (v) at the level of farmers, empower beneficiaries of irrigation scheme to participate in, and take control of, O&M management, at the system level agreed upon, through the establishment of WUAs. This would simultaneously promote project ownership and reduce the fiscal burden; and (vi) carry out periodic public awareness campaigns by MOEW, LRA, and WAs to inform policy makers and the public of water shortages that could be faced in the next thirty years, and the need for water conservation for irrigation, as well as for domestic and industrial uses.

Improving competitiveness of agriculture is key. Lebanese agriculture is less competitive and has a higher cost structure than neighboring countries. Improving competitiveness is key to the future of agriculture in Lebanon. Recommendations in this regard include: produce high value added crops such organic food, wines, medicinal plants and herbs, in addition to high value fruits and vegetables, reduce costs through increasing cropping intensity of irrigated agriculture, use less agro-chemicals, adopt more efficient irrigation technology (increase drip and sprinkler use), and over the long term mitigate the impact of

structural obstacles such as small and fragmented holdings and the land tenure system. The role of the extension and research services of the MOA in this regard will be essential. Lebanon has a good potential to expand the export of high quality processed food products to the EU, the Gulf, and the US. The falling exchange rate should also improve the competitiveness of agricultural and processed food products.

Export market development is necessary to absorb increased production. GOL has in place policies to stimulate agriculture and the other productive sectors (Kafalat, IDAL, and the Export Plus scheme). Lebanon has made a good start in hiring three international firms for quality control of agricultural produce for export. But more efforts are needed, including improving product quality to meet EU and international standards, certification of pesticide levels in exports by an internationally accredited laboratory, waging an aggressive marketing campaign and hiring a European firm by exporters for market development, and provide real time market data and information by IDAL or Chambers of Commerce on tariffs, country of origin, and other export requirements in the destination markets.

INSTITUTIONAL ASPECTS

The institutional capacity of the Water Authorities needs strengthening. The four WAs were established to incorporate the 22 RWAs and 209 local water committees in the water sector. Although WAs in principle have administrative and financial autonomy, the executive regulations and bylaws governing them have not been issued yet, and as a result, they face serious staffing and financial constraints. Their first priority is potable water, and they have not been able to oversee all the RWAs and water committees. In view of their limited administrative and financial capacity, WAs have expressed the need for farmers to assume responsibility for the O&M functions of irrigation schemes through the formation of WUAs, which is strongly endorsed by the Note.

Other actions are also needed, including: (i) accelerate issuing the executive regulations and bylaws to empower WAs with the autonomy envisaged by Water Law No. 221 of May 2002, and enable the WAs to operate on a commercial basis and appoint key technical staff to fill gaps in the present organization; (ii) pass legislations to update laws regulating the water sector, and in particular provide a legal framework governing WUAs, and addressing the issue of acquired water rights; and (iii) start/complete computerization of customer data base including connections, billing, and collections. Moreover, the capacities of the MOEW, of the RWAs, and of the LRA need strengthening in the areas of water quality testing and monitoring, data analysis, quality assurance and control, and database and reporting, which are urgently needed.

A bigger role for the private sector is needed. GOL is commended for its policy of, and commitment to, a public-private partnership in water resource management in Lebanon. As evidence of WA commitment to private participation in water resource management, the WA for the North has already signed a contract with a French company for assuming the functions of operation and maintenance of the distribution network and collection of bills for potable water in Tripoli on a trial basis for one year, the WA for the South is preparing the groundwork to improve its performance and financial position as a pre-requisite to privatization of the management of the potable water supply system for Sidon, and the chairman of the WA for the Bekaa endorses private sector management of the potable water supply systems in Zahle and Baalbeck. GOL goes even further and is seriously considering the potential for privatization of the services of WAs (which manage both domestic and irrigation).

WUAs are the way to go. Furthermore, best practice has shown that the most successful projects are those that involve stakeholder participation in the design and management of the project. Since GOL has stopped subsidizing O&M of irrigation schemes, it becomes necessary for farmers to manage their own schemes. In this connection, the Note has the following recommendations:

a. It is imperative to start as soon as possible the creation of formal WUAs, not only on a pilot basis, but also on a larger scale (if possible) in all the different Muhafazats. This will necessitate concerted and sustained efforts from all concerned parties. The WUAs should eventually replace the different organizations currently in charge of O&M functions of irrigation schemes;

b. the creation of the formal WAUs necessitates the presence of an enabling legal framework, which does not yet exist in Lebanon. This involves different experts in the legal, technical, financial, and social fields. The framework, where the roles and responsibilities with respect to water management (including quality management) of the WUAs and other partners, needs to be prepared in close cooperation with the intended beneficiaries and other interested groups;

c. WUAs would be responsible for the O&M of their schemes, for the collection of water fees, and for the payment of fees to the authority responsible for providing the bulk water and other services; and

d. well-focused training related to the establishment and management of WUAs should be provided to all involved parties.

The newly established WAs are in favor of this approach and would support the establishment of the WUAs as this would reduce their administrative and financial burdens. However, the WAs would remain in charge of the O&M of larger main canals, intake structures and pumping stations which are often well above the farmers' capacities. Also, the institutional capacity of WAs and WUAs should be upgraded to enable them to play an important role in water quality management and pollution control.

Moreover, MOEW should continue to assist the WAs and regional and local committees in the O&M of irrigation schemes, especially those which are in bad state of repair, until the WAs become fully operational. Large civil works should remain the MOEW responsibility.

Private-Public partnership should be considered. The PN proposes another option for consideration by GOL, which has been implemented in Morocco and Egypt. The proposal involves giving a role to the private sector as a potential partner in public investment, and/or management by an irrigation scheme, which can be designated as a pilot, and if successful can be replicated. In this option, a private firm would be in charge of O&M functions of the scheme, and in partnership with stakeholder, would decide on the level of service needed by farmers, and set irrigation water tariffs to cover those O&M services. It should be noted that GOL is also considering the construction of the El Bared dam and reservoir scheme on a BOT basis.

ENVIRONMENTAL ASPECTS

The main environmental issues relating to irrigation/water have been discussed earlier: most of the wastewater networks are either damaged or undersized and collected wastewater is discharged without treatment into rivers, springs, groundwater, and the sea; wastewater treatment facilities are in severe shortage; industrial wastes are discharged without treatment into various water bodies; and excessive pumping and use of agro-chemicals increase salinity and pollute aquifers. There is only intermittent monitoring of water quality, and there are only a few laws dealing with pollution. Moreover, MOE has a weak institutional capacity, and an enforcement mechanism is lacking.

Environmental mitigation measures are essential for improving water quality. The main recommendations in this regard are: (i) establish a national water quality program for monitoring surface and groundwater resources, and in particular the Litani basin; (ii) start pilot projects for testing different technologies and practices for the reuse of treated effluent from municipal plants; (iii) establish and implement the "polluter pay" concept to be commensurate with the degree of pollution; and (iv)

strengthen the capacity of agencies dealing with water quality testing, data analysis, quality assurance and control, as well as establishing and maintaining databases on water quality.

AREAS OF POSSIBLE BANK SUPPORT

Based on review of the public investment program in irrigation, discussions with GOL officials, and in particular the staff of CDR, MOEW and LRA, and on assessment of the institutional capacity of implementing agencies, it was possible to identify some areas for possible Bank support in the irrigation sector in Lebanon, as shown below

South Bekaa Phase II Project. This project would improve irrigation on 6,700 ha which are currently irrigated through uncontrolled private pumping. The 2002 updated feasibility study showed that the project is viable, since a significant proportion of the major investments in basic infrastructure have already been made in Phase I that was financed by the Bank and GOL. In addition to providing irrigation water to farmers below the cost of private pumping, the project has a positive environmental impact by reducing the spread of uncontrolled well drilling, and improving the efficiency of irrigation water through a pressurized irrigation system. This project also facilitates the application of volumetric-based water charges. The total cost of the project, excluding contingencies, is US$45 million. The implementing agency is LRA, and the implementation period is four to five years.

South Qaraoun Irrigation Scheme. A feasibility study is underway, and its results will be provided to the Bank when completed. At an estimated cost of US$5 million, the project would irrigate an area of 800 ha from the Qaraoun reservoir. LRA would implement the project in two years.

El Bared Dam and Reservoir Scheme. The project consists of the construction of a storage dam on the El Bared river with a storage capacity of 40MCM and rehabilitation of the irrigation conveyance and distribution network. The project provides drinking water (20 percent) in addition to irrigation water (80 percent). Although a feasibility study has not been carried out, the project is expected to be viable since it capitalizes on existing infrastructure, and includes rehabilitation and/or modernization of the existing irrigation network. The importance of the project is two-folds: it would provide water to irrigate around 4,000 ha (assuming irrigation requirements of 8,000 m3/ha), in some of the poorest *Cazas* in Lebanon (Akkar, Minieh, and Dannieh), in addition to providing drinking water for Tripoli and surroundings. The estimated cost of the project is US$45 million, to be implemented by MOEW over a period of 4 years. GOL and donors are expected to finance the storage dam, or the dam could be implemented on a Build-Operate-Transfer (BOT) basis. The Bank could finance rehabilitation and modernization of the irrigation network for around 4,000 ha.

Institutional Support to WAs/WUAs. One of the main findings of the Policy Note is the widespread support of WAs and MOEW for the establishment of WUAs. The Bank can play an extremely useful role in this regard by providing technical support for establishing the legal framework needed for the operation of WUAs, the formal creation of WUAs, possibly in all the *Muhafazats*, and training of staff of concerned agencies. This is now more urgent since GOL stopped subsidizing O&M of irrigation schemes operated by local water committees. WUAs would eventually replace other organizations in charge of O&M functions of irrigation schemes.

For the success of WUAs, some principles should be observed (Dinar and Subramanian 1997): (i) determine the level of service required and agreed by beneficiaries; (ii) estimate the O&M costs and allocate costs for the desired level of service; (iii) involve beneficiaries at an early stage in determining the level of service and in allocation of costs; (iv) assess willingness and capacity of users to cover O&M costs; (v) determine the appropriate mechanism for charging users. It is important that the fee structure should be simple to administer and equitable; and (vi) there should be a direct link between the payment

of fees and services provided by the WUA (in some schemes, user fees are paid to the Treasury). The proposed project could support WAs, MOEW, and LRA in addressing these aspects.

Another area of possible Bank support involves human resource capacity building of MOEW and LRA in the technical and management, fields to enable them to carry out their proposed investment programs.

Evaluating the Feasibility of Proposed Irrigation Schemes. Many irrigation schemes proposed by MOEW or LRA are at the preliminary study phase. Before any irrigation scheme is undertaken, it is imperative to carry out a full-fledged feasibility study to determine the economic feasibility of the proposed project, taking into consideration the social aspects of the project. The World Bank can assist GOL in this regard through review of terms of reference for consultants, selection of consultants, and review of feasibility studies.

Agricultural Services. In addition to the above, any new investment by the Bank in the irrigation sector should be accompanied by parallel investments in the agricultural sector in order to ensure that high value horticultural crops are being produced (through better extension and research) and that their marketing channels are ensured (through better quality control and marketing information).

Appendix 1 Overview of Irrigation Schemes in Lebanon

Table A1.1 Existing schemed irrigation

Code	*Scheme name*	*Equipped area (ha)*	*Net irrigated area (ha)*	*Surface irrigation (ratio)*	*Sprinkler irrigation (ratio)*	*Drip irrigation (ratio)*	*Cereals winter wheat (ratio)*	*Fruit trees (ratio)*	*Vegetables (ratio)*
1	Akoura-Laqlouk	1,100	990	0.000	0.000	0.000	0.06	0.64	0.30
2	Qartaba & Surroundings	250	230	0.000	0.000	0.000	0.06	0.64	0.30
3	Lassa, Ghabat, Mezarib, Mghairi, Afqa & Surroundings	120	110	0.000	0.000	0.000	0.06	0.64	0.30
4	Ehmej and Surroundings	700	630	0.000	0.000	0.000	0.06	0.64	0.30
5	Adonis (Kesserouan)	400	360	0.000	0.000	0.000	0.02	0.65	0.33
6	Kfardebian and Faraya	540	490	0.000	0.000	0.000	0.02	0.65	0.33
7	Mayrouba and Hrajel	340	310	0.000	0.000	0.000	0.02	0.65	0.33
8	Nahr El Kalb - El Wata	80	70	0.000	0.000	0.000	0.02	0.65	0.33
9	Beskinta-Sannine and Bekaata	320	290	0.000	0.000	0.000	0.00	0.81	0.19
10	Antelias	100	90	0.000	0.000	0.000	0.00	0.81	0.19
11	Hammana - Tarchich-Aintoura & Surroundings	200	180	0.000	0.000	0.000	0.00	0.81	0.19
12	Dayshounieh- Hazmieh & Surroundings	100	90	0.000	0.000	0.000	0.00	0.77	0.23
13	South Beirut Suburbs	300	270	0.000	0.000	0.000	0.00	0.77	0.23
14	Wadi Chahrour & Surroundings	200	180	0.000	0.000	0.000	0.00	0.77	0.23
15	Nabaa Es Safa	860	770	0.000	0.000	0.000	0.02	0.77	0.21
16	Jahiliye	150	140	0.000	0.000	0.000	0.02	0.77	0.21
17	Dammour Plain	400	360	0.000	0.000	0.000	0.02	0.77	0.21
18	Jiyeh	100	90	0.000	0.000	0.000	0.02	0.77	0.21
19	Nabaa El Barouk	280	250	0.000	0.000	0.000	0.02	0.77	0.21

Table A1.1 Existing schemed irrigation

Code	*Scheme name*	*Equipped area (ha)*	*Net irrigated area (ha)*	*Surface irrigation (ratio)*	*Sprinkler irrigation (ratio)*	*Drip irrigation (ratio)*	*Cereals winter wheat (ratio)*	*Fruit trees (ratio)*	*Vegetables (ratio)*
20	Bouqaiaa	1,100	990	0.000	0.000	0.000	0.35	0.17	0.48
21	Mashta Hassan-Mashta Hammoud-Chadra	810	730	0.000	0.000	0.000	0.35	0.17	0.48
22	Akkar El Attica	560	500	0.000	0.000	0.000	0.35	0.17	0.48
23	Akkar Highland Farms - Karm Sbat & Surroundings	200	180	0.000	0.000	0.000	0.35	0.17	0.48
24	Fneideq-Mechmech	990	890	0.000	0.000	0.000	0.35	0.17	0.48
25	Joumeh Area- Rahbeh - Takrit & Surroundings	400	360	0.000	0.000	0.000	0.35	0.17	0.48
26	Akkar Plain and Arka River	8,000	7,200	0.000	0.000	0.000	0.35	0.17	0.48
27	Akkar El Bared	800	720	0.000	0.000	0.000	0.35	0.17	0.48
28	Minieh	1,220	1,100	0.000	0.000	0.000	0.17	0.59	0.24
29	Tripoli	200	180	0.000	0.000	0.000	0.17	0.59	0.24
30	Zgharta	500	450	0.000	0.000	0.000	0.11	0.78	0.11
31	Danniyeh	5,000	4,500	0.000	0.000	0.000	0.17	0.59	0.24
32	Ehden	450	410	0.000	0.000	0.000	0.11	0.78	0.11
33	Bcharre	840	760	0.000	0.000	0.000	0.05	0.87	0.08
34	Tannourine	330	300	0.000	0.000	0.000	0.06	0.62	0.32
35	Kfarhilda	80	70	0.000	0.000	0.000	0.06	0.62	0.32
36	Batroun Plain	100	90	0.000	0.000	0.000	0.06	0.62	0.32
37	Saida-Jezzine	390	350	0.000	0.000	0.000	0.19	0.66	0.15
38	Qasmieh - Ras El Ain	4,440	4,000	0.000	0.000	0.000	0.19	0.66	0.15
39	Hermel High land Farms	1,100	990	0.000	0.000	0.000	0.50	0.09	0.41
40	Marjhine	160	140	0.000	0.000	0.000	0.50	0.09	0.41
41	Hermel Watershed	650	590	0.000	0.000	0.000	0.50	0.09	0.41
42	Assi Plain	400	360	0.000	0.000	0.000	0.50	0.09	0.41
43	El Qaa	3,000	2,700	0.000	0.000	0.000	0.36	0.28	0.36
44	Oyoun Taqtaq	100	90	0.000	0.000	0.000	0.50	0.09	0.41
45	Ras Baalbeck	300	270	0.000	0.000	0.000	0.36	0.28	0.36

Table A1.1 Existing schemed irrigation

Code	*Scheme name*	*Equipped area (ha)*	*Net irrigated area (ha)*	*Surface irrigation (ratio)*	*Sprinkler irrigation (ratio)*	*Drip irrigation (ratio)*	*Cereals winter wheat (ratio)*	*Fruit trees (ratio)*	*Vegetables (ratio)*
46	Laboue	2,080	1,870	0.000	0.000	0.000	0.36	0.28	0.36
47	Chaat & Surroundings	800	720	0.000	0.000	0.000	0.36	0.28	0.36
48	Younine	100	90	0.000	0.000	0.000	0.36	0.28	0.36
49	Oyoun Orghosh - Barqa-Nabha & Surroundings	400	360	0.000	0.000	0.000	0.36	0.28	0.36
50	Yammouneh	5,600	5,040	0.000	0.000	0.000	0.36	0.28	0.36
51	Wadi Nahle & Surroundings	150	140	0.000	0.000	0.000	0.36	0.28	0.36
52	Iaat Plain	270	240	0.000	0.000	0.000	0.36	0.28	0.36
53	Baalbeck Plain-Douris & Surroundings	2,000	1,800	0.000	0.000	0.000	0.36	0.28	0.36
54	Haouch Barada - Majdaloun & Surroundings	1,000	900	0.000	0.000	0.000	0.36	0.28	0.36
55	Talia & Surroundings	1,000	900	0.000	0.000	0.000	0.36	0.28	0.36
56	Yahfoufa, Jenta, Seraain & Surroundings	1,670	1,500	0.000	0.000	0.000	0.17	0.22	0.61
57	Maaraboun & Ham	120	110	0.000	0.000	0.000	0.36	0.28	0.36
58	Rayak, Ali Nahri & Surroundings	870	780	0.000	0.000	0.000	0.17	0.22	0.61
59	Terbol - Delhamieh & Surroundings	1,500	1,350	0.000	0.000	0.000	0.17	0.22	0.61
60	Zahle & Surroundings	2,000	1,800	0.000	0.000	0.000	0.17	0.22	0.61
61	Chtaura - Qab Elias Plain	2,000	1,800	0.000	0.000	0.000	0.17	0.22	0.61
62	Anjar-Chamsine & Surroundings	1,500	1,350	0.000	0.000	0.000	0.17	0.22	0.61
63	South Bekaa (Phase I), Left Bank	2,220	2,000	0.000	0.000	0.000	0.17	0.22	0.61
64	Iqlim El Touffah	320	290	0.000	0.000	0.000	0.43	0.20	0.37
65	Nabatiyeh (Al Midane Plain)	220	200	0.000	0.000	0.000	0.43	0.20	0.37
66	Marjeyoun & Khiam	620	560	0.000	0.000	0.000	0.61	0.08	0.31

Table A1.1 Existing schemed irrigation

Code	*Scheme name*	*Equipped area (ha)*	*Net irrigated area (ha)*	*Surface irrigation (ratio)*	*Sprinkler irrigation (ratio)*	*Drip irrigation (ratio)*	*Cereals winter wheat (ratio)*	*Fruit trees (ratio)*	*Vegetables (ratio)*
	Plain								
67	Hasbani	500	450	0.000	0.000	0.000	0.44	0.45	0.11
	Total	65,600	59,070						

Source: Area: JICA Study based on the reference shown in "Reference Sheet" and interview with authorities concerned
Ratios of irrigation method, irrigated crops and water source: MOA and FAO census (2000)

Table A1.2 Proposed and/or ongoing irrigation schemes

No	*Scheme name*	*Irrigated area (ha)*	*New irrigated area (ha)*	*Impl. Authority*	*Cost estimates Us$ million (including studies and supervision)*	*Remarks*
1	Noura Tahta	10,000	2,000	MOEW	66.5 (Lebanon's share)	Dam on River El Kabir with Syria; Storage 70 MCM; For PW & I.
2	El Assi	6,600	6,600	MOEW	122.5 (excluding networks, estimated at a further US$ 130 million)	In two phases on river El Assi to utilize Lebanon's share of water. Incl. 2 diversion dams, 6 pump stations and a 37 MCM storage and hydropower dam. For I , PW & P.
3	El Bared	3,000	-	MOEW	46.5	Dam on river Bared with 40 MCM storage capacity for PW and I (including PW for Tripoli).
4	Iaal	1,300	1,300	MOEW	46.5	Diversion of water from Abu Ali river to fill 10 MCM reservoir for PW and I.
5	Hill Lakes (20 No.)	2,500	2,500	MOEW	150.00	Program for construction of 20 hill lakes for multipurpose uses to be implemented by 2020, at the rate of one to two per year.
6	Other Dams	TBD	TBD	MOEW	119.0	Including yammouneh dam & reservoir, Qarqaf dam, El Jenna dam, youneen dam for multipurpose uses
7	Sout Bekaa II	6,700	-	LRA	45.0	Funding to be determined. Continuation of project funded by WB/GOL
8	South Qaraoun Irrigation	800	800	LRA	5.0	Funding from LRA budget

Table A1.2 Proposed and/or ongoing irrigation schemes

No	*Scheme name*	*Irrigated area (ha)*	*New irrigated area (ha)*	*Impl. Authority*	*Cost estimates Us$ million (including studies and supervision)*	*Remarks*
9	South Bekaa Right Bank and North	12,800	-	LRA	(25.6)	Rehabilitation and Modernization assumed to be carried out from 2020 to 2030
10	South Lebanon Conveyor 800: Phase 1	-	-	LRA	216.78	Consulting services and implementation of 51 km main canal, 69 km secondaries to provide water for 12 sectors. Co-financing Arab and Kuwait Funds (US$165 million). Conveyance of 90 MCM/year for irrigation and 20 MCM/year PW
	South Lebnon Conveyor 800: Phase II	13,230	13,230	LRA	242.47	Irrigation networks for 13, 230 ha in 12 sectors and provision of PW. Co-financing anticipated from Araba and Kuwait Funds
11.	Conveyor Anane-Nabatieh	4,700	4,700	LRA	104.85	Including 1,200 ha in Awali-Sainiq sector and northern pipeline to Kharoob province for PW
12.	Saida-Jezzine	1,200	1,200	LRA	5.80	Rehabilitation of Pilot Project, of which 330 ha currently irrigated
13.	Qasmieh-Ras El Ain II	2,100	2,100	LRA	15.0	To increase irrigated areas between elevations 100 and 200 above MSL
14.	Khardale Dam Project	9,000	9,000	LRA	8.0	Dam with storage capacity of about 128 MCM at level 230 above mean sea level to irrigated areas between elevations 200 and 500 above mean sea level. Funding not secured to date
15.	Kafarsir Dam Projet	(1,000)	(1,000)	LRA	8.0	Dam with storage capacity of 10-12 MCM to irrigated areas between sea level and 100 meters above mean sea level. Funding not secured to date
16.	Misc. Small Private Development	6,200	6,200	Private Sector, NGOs with grant aid	12.50	Small developments of irrigation areas by NGOs assisted by grant funding etc.
Total		**80,530**	**50,000**		**1,356,000**	**Storage 160 MCM**

Appendix 2 Water Resources and Use in Lebanon

Table A2.1 Crop water requirements

(mm/month)

Crop	*JAN*	*Feb*	*Mar*	*Apr*	*May*	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Vegetable					70.9	108	166	202	107			
Potato					59.1	87.3	217	166	45			
Cereal					35.5	52.4	171	235	125			
Sugar beet					41.4	61.1	200	194	96.9	31.4		
Cotton				14.9	51.3	63.1	185	215	109	62.1		
Tobacco					59.1	106	206	115				
Olive	25.2	31.1	42.6	58.1	73.3	90.2	94.1	89.4	71.6	51.7	35.532.7	26.7
Grape	32.7	40.5	55.4	75.6	95.3	117	122	116	93	67.3	46.1	34.7
Banana	45.3	56	76.8	105	132	162	169	161	129	93.1	63.9	48.1
Citrus	37.8	46.7	64	87.2	110	135	141	134	107	77.6	53.2	40.1
Wheat	40.3	45	68.2	107	176	122					27.5	42.8

Table A2.2 Effective rainfall

(mm/month)

Region	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
N. Lebanon	133.3	96.6	92.3	48.5	15.9	1.0	0.3	0.7	11.1	49.2	88.0	128.6
N. Mountain	147.6	138.4	111.4	60.6	30.4	5.0	1.0	1.0	5.0	30.4	79.2	118.1
C. Lebanon	133.4	116.1	80.6	47.7	18.4	2.0			5.9	43.5	104.1	129.4
C. Mountain	154.2	151.0	138.5	77.4	34.4	2.0	0.5	5.0	5.0	42.5	104.7	147.7
S. Lebanon	135.0	111.4	72.5	39.4	6.9	0.7	0	0	4.6	32.4	68.9	131.5
Inland Assi	81.3	69.8	48.5	29.5	13.7	1.0	0	0	1.0	6.9	43.5	65.2
Inland Litani	112.9	93.7	69.7	37.7	14.6	0.7	0	0	0.7	20.9	53.7	99.3
Inland Hasbani	133.4	128.6	102.4	64.5	24.9	1.0	1.0	1.0	3.0	23.1	77.8	120.0
Average	128.9	113.2	89.5	50.7	19.9	1.7	0.4	0.4	4.5	31.1	77.5	117.4

Table A2.3 Field water requirements

(mm/month)

Crop	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Vegetable					53	107	166	201	102			
Potato					41.2	85.9	216	166	40			
Cereal					17.5	51	171	235	120			
Sugarbeet					23.4	59.7	200	194	91.9			
Cotton					33.4	61.7	184	214	104	28.3		
Tobacco					41.2	105	205	115				
Olive				9.3	55.4	88.8	93.9	89.1	66.6	18		
Grape				26.7	77.3	116	122	116	88	33.5		
Banana				55.8	114	161	169	161	124	59.4		
Citrus				38.4	92	134	141	134	102	43.8		
Wheat				57.7	158	121						

Table A2.4 Diversion water requirements for surface irrigation

(MCM/year)

Region	*Veg.*	*Potato*	*Cereal*	*Sugarb*	*Cotton*	*Tob.*	*Olive*	*Grape*	*Ban.*	*Citrus*	*Wheat*
N. Leb.	9083	7850	8600	8350	9083	6717	6017	8383	12050	9983	4900
N. Mount.	10317	9033	9717	9317	6933	7700	6767	9350	13683	11050	5550
C. Leb.	10967	9567	10283	9917	10917	8167	7817	10633	15683	12633	6917
C. Mount.	8100	7083	7700	7317	7950	5967	5033	6883	10300	8250	3650
S. Leb.	9833	8567	9400	8950	9617	7167	6217	8350	12317	9875	4233
Inl. Assi	13350	11833	12683	12650	13717	10033	9800	13150	19083	15517	7633
Inl. Litani	12033	10600	11400	11133	12183	8967	8517	11450	16633	13450	6617
Inl. 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 A2.5 Diversion water requirements for sprinkling irrigation

(MCM/year)

Region	*Veg.*	*Potato*	*Cereals*	*Sugarb*	*Cotton*	*Tobac.*	*Olives*	*Grapes*	*Ban.*	*Citrus*	*Wheat*
N. Leb.	7786	6729	7371	7517	7786	5757	5157	7186	10329	8557	4200
N. Mount.	8843	7743	8329	7986	5943	6600	5800	8014	11729	9471	4757
C. Leb.	9400	8200	8814	8500	9357	7000	6700	9114	13443	10829	5929
C. Mount.	6943	6071	6600	6271	6814	5114	4314	5900	8829	7071	3129
S. Leb.	8429	7343	8057	7671	8243	6143	5329	7157	10557	8464	3629
Inl. Assi	11443	10143	10817	10843	11757	8600	8400	11271	16357	13300	6543
Inl. Litani	10314	9086	9771	9543	10443	7686	7300	9814	14257	11529	5671
Inl. 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 A2.6 Diversion Water Requirements for Drip Irrigation (MCM/year)

Region	*Veg.*	*Potato*	*Cereals*	*Sugarb*	*Cotton*	*Tobac.*	*Olives*	*Grapes*	*Ban.*	*Citrus*	*Wheat*
N. Leb.	6813	5888	6450	6263	6813	5083	4513	6288	9038	7488	3675
N. Mount.	7738	6775	7288	6988	5200	5775	5075	7013	10263	8288	4163
C. Leb.	8225	7175	7713	7438	8188	6125	5863	7975	11763	9475	5188
C. Mount.	6075	5313	5775	5488	5963	4475	3775	5163	7725	6188	2738
S. Leb.	7375	6425	7050	6713	7213	5375	4663	6263	9283	7406	3175
Inl. Assi	10013	8875	9513	9488	10288	7525	7350	9863	14313	11638	5725
Inl. Litani	9025	7950	8550	8350	9138	6725	6388	8588	12475	10088	4963
Inl. Hasbani	3648	6330	6875	6568	7550	5300	5113	6938	10175	8238	3888
Average	7364	6838	7402	7162	7544	5792	5342	7261	10623	8601	4189

Appendix 3 Pollution and Treatment of Water Sources in Lebanon

Table A3.1 Expected and planned wastewater treatment plants

Caza	*Location*	*Capacity (m^3/day)*	*Type of Treatment*	*Disposal Mean*	*Expected Starting Year*
Under Execution					
Chekka	Chekka	2,700	Secondary	Sea	2005
Batroun	Batroun	2,900	Secondary	Sea	2005
Jbail	Jbail	5,300	Secondary	Sea	2005
Chouf	Coastal Chouf	6,240	Secondary	Sea	2005
Saida	Saida	36,700	Primary	Sea	2005
Nabatieh	Nabatieh	8,228	Secondary	Drainage	2005
Baalbek	Baalbek	12,412	Secondary activated	Drainage/re-use	2004
Yammounah	Yammouneh		Secondary	Drainage/reuse	2005
Tripoli	Tripoli	134,500	Secondary	Sea	2006
Under Preparation					
Akkar	Michmich	7,400	Secondary	Drainage/re-use	2008
Bakhoun	Bakhoun		Secondary	Drainage/reuse	2008
Jbeil	Kartaba	1,435	Secondary	Drainage/re-use	2007
Kesrouane	Hrajel		Secondary	Drainage/re-use	2008
Chouf	Mazraat Chouf	30	Secondary	Drainage/re-use	2009
Hermel	Hermel		Secondary	Drainage/re-use	2009
Baalbeck	Laboue		Secondary	Drainage/re-use	2008
Zahleh	Zahleh	37,000	Secondary	Drainage/re-use	2005/2006
Anjar/Majdal Anjar	Anjar		Secondary	Drainage/re-use	2008
West Bekaa	Karaoun	3,600	Secondary	Drainage/re-use	2009
Joub Jannine	Joub Jannine	10,700	Secondary	Drainage/re-use	2007
Saghbine	Saghbine	600	Secondary	Drainage/re-use	2007
Hasbaya	Hasbaya		Secondary	Drainage/re-use	2009
Nabatieh	Jbaa		Secondary	Drainage/re-use	2009
North Beirut	Bouri Hammoud Jbaa	330,000	Secondary	Sea	2007
South Beirut	Ghadir	290,000	Secondary	Sea	2009

Table A3.2 Laws relating to the pollution and protection of water resources

Document	*Date*	*Subject*	*Responsible Ministry*
Order No. 144	10.06.1925	Protection of Surface and Ground Water Resources	MOEW
Order No. 320/26	26.05.1926	Protection of Catchment Areas	MOEW
Decree No. 639	26.03.1942	Protection of Nabaa Al Assal Spring, Faraya	MOEW
Decree No. 10276	07.10.1962	Protection Zones for Water Sources and Recharge Areas	MOEW
Decree No. 14438	02.05.1970	Restrictions on the Depth of Unlicensed Boreholes	MOEW
Decree No. 8735	23.08.1974	Pollution from Solid and Liquid Wastes	MOI/MOE
Law No. 64	18.08.1988	Pollution from Hazardous Wastes	MOI/MOE
Decision No. 2528/C	28.05.1996	Protection of Ground Water at El Kneisse	MOEW
Decree No. 680	15.09.1998	The Preservation and Protection of Boreholes	MOEW

Appendix 4 Historical Review of Water Laws in Lebanon

CODIFIED LAW

While appreciating the evolution of water use regulations, guided by precept, but modified by region and custom, the primary concern of contemporary water-use specialists is with written regulations of legal standing, since these are fundamental to modem irrigation projects. Thus, it is appropriate to present details of the codification process, the Ottoman civil code, which applied to most of the Near East region, and some modern trends in water legislation in this region. The FAO publication "Irrigation and drainage paper 20/1 & 2 edited by Caponera states that: "The codification of the Moslem law was initiated during the Ottoman Empire period (1300 - 1922 AD). It rested originally on the *Shari'a* or Moslem religious law, and the *Qawanin-hukm*, or decrees and ordinances issued by the sultans". Early codes remained in force until 1839, the year in which reforms (*transmit*) were undertaken. During a second period or reforms (1845 - 1876), the civil law was codified in what became known as the Mejelle Code. Separate sections covered the law of contract, part of the law on real property ownership, and the law of civil procedure.

The condition of Moslem religious law (*Shari'a*) was, however, restricted to penal law and procedure. The Penal Code was subsequently modified along the lines of European models. The Mejelle Code was framed on the basis of the Napoleon Code by Ottoman legislators, who selected from its rules those in conformity with or upholding Moslem law principles and which were, at the same time, most easily adaptable to existing social needs. This law was implemented in Lebanon in 1870, when a decree was issued by the Sultan to transport water from the Kalb river to Beirut city for drinking purposes. This caused a legal problem between the owners of water rights and the exclusive company entrusted with the execution of the project.

THE OTTOMAN CIVIL CODE

Although the Mejelle Code itself has now been superseded, a number of its provisions, nevertheless, still govern legislation of some countries, which had formed part of the Ottoman Empire. An analysis thereof is of a more than purely historical interest.

Definition of Water. The Mejelle Code "Nicolaides D. La Medjelle, Code Civile de l'empire ottoman, Corps de Droit ottoman, Constantinople, 1881 - 1888" defines water as a non-sellable commodity to which everyone has a right (mubah). Ground-waters as well belong to the community. The definition of water as a non-sellable, publicly owned commodity applies to running water, which has not been appropriated, to water contained in wells dug by unknown persons, and to water of the sea and large lakes. Rivers are divided into two categories, those forming part of the public domain the beds of which are not privately owned, and privately owned rivers flowing on private land.

Water Ownership and Use. Water ownership is acquired by gift, inheritance or occupation on condition that the land is occupied with the intention of taking procession thereof. The Ottoman Code recognized two basic legal principles:

- Water for Drinking and Animal Watering (*hakki chefe*): Everyone may quench his thirst from both public and privately owned rivers.

- Water for Irrigation (*Hakki Chirb*): In the case of rivers and lakes forming part of the public domain, and since such water constitutes a public commodity, everyone is entitled to use it for irrigation purposes, provided the rights of third parties are not infringed upon. The use of privately owned waterways is restricted to riparian landowners.

Sale of Water Rights. The sale of rights of way, of irrigation rights, and of overflow water from conduits is permitted as part of the sale of the land.

Maintenance of Waterways. The maintenance of waterways is also governed by the Civil Code. The maintenance of rivers forming part of the public domain is the responsibility of the State. The maintenance of privately owned waterways is the responsibility of the owners, and all co-owners must contribute to initial expenses.

LAW 221: ORGANIZATION OF THE WATER SECTOR – 2000

The law is composed of 11 articles, the most interesting of which are the fourth, fifth and sixth.

In its fourth article, the law defines the responsibilities of the Water Authorities (WAs) as follows:

- Study, execution, operation and maintenance of potable water supply and irrigation projects according the General Master Plan or as per the instructions of the MOEW.
- Proposing water tariffs for potable water supply and irrigation taking into account the socio-economic conditions.
- Control of the water quality.

It also stipulated that they should contract and independent Auditor to audit their accounts.

In its fifth article, the law stipulates that the management of the WAs is through Managing Boards composed of a President and six members who are nominated by the Council of Ministers upon propositions made by the Minister of Energy and Water. The President of the Board is also the Director General.

In its sixth article, the law stipulates that "post" financial controls of the WAs are to be undertaken by the Lebanese "Cour des Comptes" and that an evaluation commission is to be created within the MOEW to evaluate the performances of the WAs.

Appendix 5 Operation & Maintenance of Irrigation Systems

Table A5.1 Existing Operation & Maintenance Administration and Tariffs (2003)

		Administration				
Scheme Designation	***Irrigated Area (ha)***	***Water Authority***	***Water Committee***	***Municipality***	***Miscellaneous***	***Tariffs***
Yammouneh	4,500	**X**	-	-	-	$1 W/hour, (5) $1.33 Sp/hour, $1.67 Sm/hour
Akkar El-Bared	1,400	-	**X**	-	-	$1.65/ha/year
Qasmieh	3,500	**X**	-	-	-	$367/ha/year for gravity and $400/ha/year for pumping.
South Bekaa Phase I	200	**X**	-	-	-	$308/ha/year
Danniyeh	2,500	**X**	-	-	-	$67/ha/year fixed + $ 1 to $13/ha/year for maintenance
Minieh	1,211	**X**	-	-	-	NA
Laboueh	2,078	-	-	-	**X**[(1)]	NA
Tannourine	324	-	-	**X**[(2)]	-	None
Kfar Helda	78	-	-	-	**X**[(1)]	None
Bcharré	837	**X**[(3)]	-	-	-	$7/hour
Akkar El-Aatiqa	983	-	-	-	**X**	None
Bouqaiaa	1,101	-	-	-	**X**[(4)]	None
Mashta Hassan Ham Chadra	1,028	-	-	-	**X**[(4)]	None
Fneideq	1,291	-	-	-	**X**[(4)]	None
Baskinta	120	-	**X**	-	-	$83/ha/season
Kfarzebiane	480	-	**X**	-	-	$10/y/h & $16.7/y/h
Aaqoura Laqlouq	764	-	**X**	-	-	None
Safa	861	**X**	-	-	-	NA
Barouk	215	**X**	-	-	-	NA
Iqlim El-Touffah	402	-	**X**	-	-	None
Hasbani	419	-	**X**	-	-	None
Total	**24,292**					

[(1)] Farmers agree to share O & M costs. Every group of farmers irrigating from the same canal is responsible of its O & M costs.; although MOEW participate sometimes in covering maintenance costs. [(2)] Municipality is in charge of water distribution, MOEW covers mainly maintenance costs. [(3)] O & M costs and revenues are for Bcharre village only; surrounding villages are included to the scheme, farmers undertake and directly finance O & M. [(4)] Every farmer is responsible for O & M costs of the canal that serves his land. (5) W=winter crop, Sp=spring crop and Sm=Summer crop. (6) Official Water Committees are those created by MOEW with the consent of the beneficiaries. (7) Misc. are those managed by group of farmers with no formal or official mandate.

Table A5.2 Operation & Maintenance Arrangements and Tariffs (1995)

No	*Project Name*	*Equipped Area (ha)*	*Irrigated Area (ha)*	*Project Administration & Exploitation Organism*	*Tariffs*
1 - North Lebanon					
1	Akkar – Caza Akkar	795	682		na
2	Machta Hassan – Machta Hammoud – Caza Akkar	480	230	Ministerial Committee	na
3	Qoubayat – Caza Akkar	795	795	Water Authority (WA):	na
4	Aakkar – Aakkar – Caza Akkar	380	286	Ministerial Committee & Cooperative	na
5	Fneideq – Michmich – Caza Akkar	580	580	Ministerial Committee	na
6	Minieh – Caza Tripoli	1400	1156	Municipality & Ministerial Committee	91,00L.LL/ha or 97,000L.LL/ha with cleaning.
7	Zghorta – Caza Zghorta	667	667	Ministerial Committee	na
8	Ehden – Caza Zghorta	410	410	Ministerial Committee	na
9	Becharre – Caza Becharre	1480	1480	Ministerial Committee	na
10	Tannourine - Caza Batroun	1400	1400	Ministerial Committee	na
2 – Beirut & Mount Lebanon					
1	Adonis – Caza Kesrouane – Jbeil	737	484	Jbeil Water Authority (WA):	LL300,000/ha/year for Gravity & LL425,000/ha/year for Pumping.
2	Kfar Helda - Caza Batroun	100	100	Ministerial Committee	na
3	Aqoura – Laklouk – Caza Jbeil	700	700	Ministerial Committee	na
4	Qartaba – Caza Jbeil	1000	1000	Ministerial Committee	na
5	Faraya - Mazraat Kfar Debiane – Caza Kesrouane	1090	1090	Ministerial Committee 2	na
6	Mairouba – Hrajel - Caza Kesrouane	340	340	Ministerial Committee & Cooperative	na
7	Baskinta Sannine – Caza Metn	377	377	Ministerial Committee	na
8	Nabaa El-Safa – Caza El-Chouf	970	970	Barouk Water Authority (WA):	LL10,000/ha/year.
9	El-Barouk - Caza El-Chouf	494	494	Barouk Water Authority (WA):	LL10,000/ha/year.

Table A5.2 Operation & Maintenance Arrangements and Tariffs (1995)

No	*Project Name*	*Equipped Area (ha)*	*Irrigated Area (ha)*	*Project Administration & Exploitation Organism*	*Tariffs*
10	Lehfed – Caza Jbeil	30	25	Water Authority (WA) & Ministerial Committee	na
11	Ehmej – Caza Jbeil	20	15	Farmers Group	na
12	Fawar Antelias – Caza Metn	350	260	Ministerial Committee & Farmers Group	LL50,000/ha/year.
13	El-Jahlieh - Caza El-Chouf	50	50	Ministerial Committee	According to the necessity of maintenance and cleaning.
14	Bsaba – Caza Baabda	160	30	Farmers Group:	na
3 – South Lebanon					
1	Qasmieh Ras El-Ain - Caza Saida – Sour	4017	3500	Litani River Authority (LRA):	For Gravity = $250/ha/year and for pumping uS$370/ha/year
2	Ouadi El-Laymoun – Caza Jezzine & Saida	55	50	Ministerial Committee & Farmers Group	na
3	Nabatiyeh – Caza Nabatiyeh	242	121	Farmers Group	na
4 – Bekaa					
1	Hermel – Caza Hermel	830	590	Municipality, Ministerial Committee & Farmers Group	LL250,000/ha/year.
2	Chtaura – Taalabaya - Caza Zahleh	1575	1020	Ministerial Committee 2	LL20.000/ha/year
3	Ouadi Nahleh – Maqne - Caza Baalbeck	2450	410	Ministerial Committee & Farmers Group	LL20,000/ha/year for spring irrigation & No tariff for summer.
4	Marjhine – Caza Hermel	550	350	Ministerial Committee:	na
5	El-Massateb - Caza Hermel	122	122	Ministerial Committee & Farmers Group	na
6	Aanjar – Chamsine – Caza Zahleh	815	815	Water Authority (WA) & Farmers Group	LL50,000/ha/year.
7	Laboueh – Qaa - Caza Baalbeck	2957	1527	Ministerial Committee & Farmers Group	LL2,500/Hhour/year or LL25,000 /ha/year.
8	Haouch El-Oumara – Mouaalaka – Caza Zahleh	2082	552	Ministerial Committee	na
9	Yahfoufa – Torbol – Saraaine - Caza Zahleh & Baalbeck	2845	2045	Ministerial Committee 2	LL20,000/ha/year.
10	Ras El-Ain (Baalbeck) - Caza Baalbeck	2500	2043	Water Authority (WA) & Ministerial Committee	na
11	Machghara - Caza Bekaa Ouest	250	250	Farmers Group	LL5,000/Irrigation or LL500,000/ha/year.
12	Bab Mareh - Caza Bekaa Ouest	80	40	Municipality	na

Table A5.2 Operation & Maintenance Arrangements and Tariffs (1995)

No	*Project Name*	*Equipped Area (ha)*	*Irrigated Area (ha)*	*Project Administration & Exploitation Organism*	*Tariffs*
13	Aitanit - Caza Bekaa Ouest	240	138	Municipality & Farmers Group	LL50,000/ha/year.
14	Kherbet Kanafar - Caza Zahleh	700	700	Farmers Group	LL70,000/ha/year.
15	Ras Baalbeck - Caza Baalbeck	90	50	Farmers Group	According to maintenance cost.
16	Ain Zebdeh - Caza Bekaa Ouest	230	230	Farmers Group	LL50,000/ha/year.
17	Saghbine - Caza Bekaa Ouest	50	25	Municipality & Farmers Group	LL150,000/ha/year.
18	Qab Elias – Caza Zahleh	800	800	Municipality	LL30,000/ha/year.
	Total	**19166**	**11707**		

Note: For schemes where no tariffs are imposed, the farmers pay the water guards salaries and canal cleaning.

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