EUROMED

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(Egypt, Lebanon, Morocco, Syria and Tunisia)

Identification and Removal of Bottlenecks for extended Use of Wastewater for Irrigation or for other Purposes

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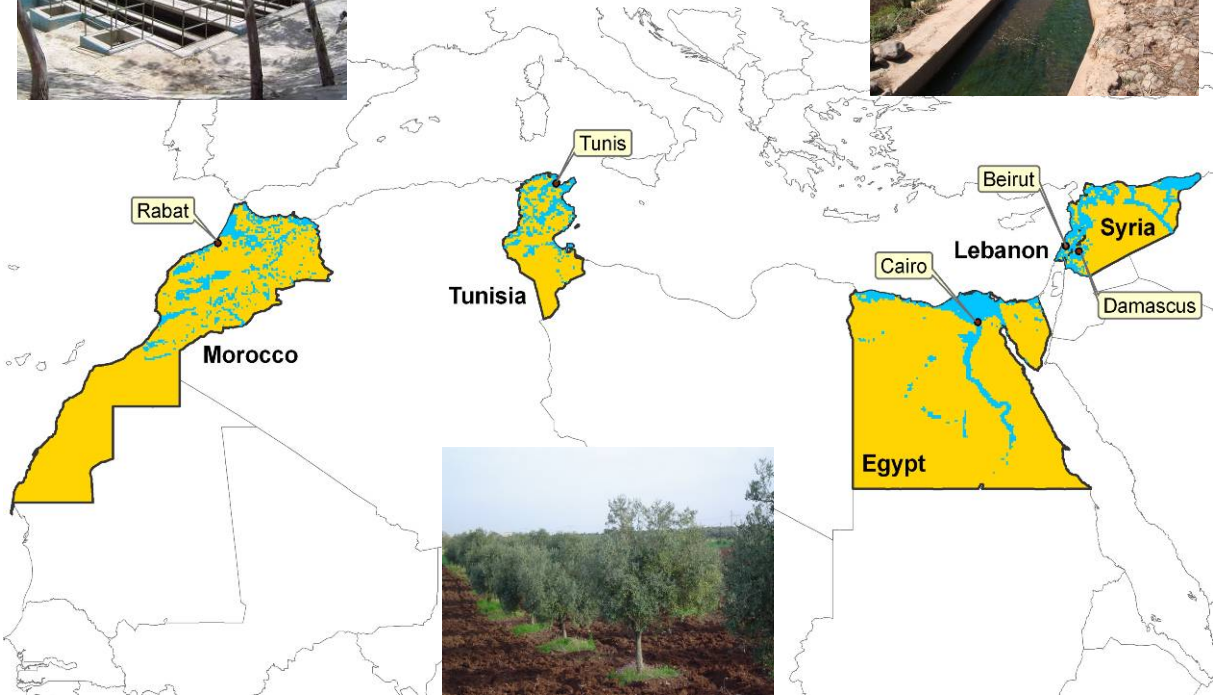
LEBANON
COUNTRY REPORT

Final Version



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List of Abbreviations and Acronyms

AFD	French Development Agency
CBA	Cost Benefit Analysis
CDR	Council for Development and Reconstruction
CPCP	Coastal Pollution Control Programme
DGHER	Directorate General of Hydraulic and Electric Resources
DGO	Directorate General for Operations
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EU	European Union
EUR	EURO
FAO	Food and Agricultural Organisation
FEMIP	Facility for Euro-Mediterranean Investment and Partnership
FP	French Protocol
GDP	Gross Domestic Product
HDI	Human Development Index
ha	Hectare
IDB	Islamic Development Bank
IDRC	International Development Research Centre
IGDC	Italian Government Development Cooperation
IWRM	Integrated Water Resource Management
JBIC	Japan Bank for International Cooperation
KfW	KfW Bankengruppe
LRA	Litani River Authority
MECTAT	Middle East Center for the Transfer of Appropriate Technology
Mm^3	Million m^3
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoHER	Ministry of Hydraulic and Electrical Resources
MoPH	Ministry of Public Health
MSC-IPP	Management Support Consultant Investment Planning Program
NCSR	National Council for Scientific Research
NEAP	National Environmental Action Plan
NERP	National Emergency Reconstruction Programme
NGO	Non-governmental Organisation
NSEQ	National Standards for Environmental Quality
O&M	Operations & Maintenance
TWW	Treated wastewater
UN	United Nations
UNDP	United Nations Development Program
USAID	United States Agency for International Development
WB	World Bank
WE	Water Establishments
WRPP	Water Resources Protection Programme
WW	Wastewater
WWR	Wastewater reuse
WWT	Wastewater treatment

WWTP	Wastewater treatment plant
YMCA	Young Men's Christian Association

Executive Summary

The Republic of Lebanon is situated on the eastern coast of the Mediterranean Sea with a total area of 10,500 km². The country is characterized by its specific topographic and climatic features. A Mediterranean climate prevails in the coastal zones accompanied by sufficient precipitation, while, divided by the Mount Lebanon mountain chain, the Beqaa plateau is characterized by a desert climate. The majority (80%) of the population (4.8 million) lives in the urbanized coastal strip. The population growth rate is estimated at 1.15% per year. The Lebanese economy is dominated by the service sector contributing 75% to the GDP of USD 24 billion. About 25% of the total area (248,000 ha) is used for agriculture, but its share at the GDP is only 5%. The agricultural production focuses on fruit trees and is concentrated on the Beqaa plateau, which stands for 42% of the cultivated land.

Compared to other countries in the Middle East, Lebanon has a relatively favourable position regarding its water resources due to its positive water balance. There are projections indicating a water deficit within the next 20 years, but already today there are seasonal and location specific water deficits. The average annual precipitations of 840 mm result in an exploitable water supply of 2,000 Mm³. Almost 80% of all households are connected to a water supply network, but water supply is irregular. For that reason, most households have private wells. Total water demand amounts to 1,257 Mm³, out of which 64% are used for irrigation and 26% to satisfy the domestic demand. Projections for 2030 indicate that domestic water demand will exceed the agricultural demand due to population increase and increased per capita consumption. The agricultural production in Beqaa requires 412 Mm³ of irrigation water. The core problem of the Lebanese water sector is incomplete wastewater collection and insufficient wastewater treatment. Estimates of 2001 assume that 249 Mm³ of domestic wastewater and 43 Mm³ of industrial wastewater are generated. The majority is discharged without any prior treatment either into the sea or into open water bodies. There are around 53 sea outfalls, but no information about outflow volumes is available.

Although 67% of all households have access to wastewater collection systems, the treatment capacity and performance of wastewater treatment plants is insufficient. There are a high number of incomplete, abandoned, and not properly functioning wastewater treatment plants. Countrywide, only two large-scale WWTP and a few small-scale WWTPs are functional. Their design capacity is 77 Mm³ allowing the treatment of only 31% of the generated domestic wastewater, but only primary treatment is provided. At present, there are five new medium- and large-scale wastewater treatment plants constructed, but not operational. In addition, there are about 40 small-scale plants in rural areas. Due to low performance of the wastewater treatment plants the described design capacity is not applicable and the share of treated wastewater available for reuse is significantly low. There are efforts of the Lebanese Government and international institutions to rehabilitate existing and construct new wastewater collection and treatment facilities.

It is estimated that at present less than 1 Mm³ of treated wastewater are reused for irrigation, but to an unknown extent raw wastewater is used directly or indirectly for irrigation. So far, a controlled wastewater reuse is non-existent in Lebanon.

Hindrances of Wastewater Reuse

- **Water sector policies**: The entire water sector is supply and not demand oriented: all plans and policies focus on mobilising available water resources to increase the water supply. Neither the water supply fees nor the sewage related taxes are based on volumetric charging. There is no pressure to economise the use of fresh water or to substitute fresh water by treated wastewater. The fees in the water sector do not cover the actual costs of

O&M of the related facilities. Limited operating budgets lead to irregular and low quality services. Further, irrigation programmes do not consider reuse as source of irrigation water. The National Decennial Strategic Plan for the Water Sector (2000-2010) includes wastewater related components, but there is almost no implementation of these plans.

- **Outdated laws**: Laws and regulations governing the water sector are outdated and are not suited to deal with emerging issues such as water rights and legal frameworks for the establishment of Water User Associations and participation of stakeholders in planning reuse schemes.
- **Non-existent regulations**: In Lebanon, there is no legal basis for reuse of wastewater. There are no regulations, guidelines and standards for the reuse of treated wastewater for different purposes.
- **Institutional weaknesses:** The institutional structure of the Lebanese water sector suffers from fragmentation, overlapping functions, and lack of cooperation or coordination of ministries and agencies in charge of water resource management. The regional Water Establishments are the operational agencies for water sector, but these agencies have insufficient know-how and skills. There is no institution promoting wastewater reuse.
- **Collection and treatment infrastructure:** Within the water sector, reconstruction of the water supply system has a higher priority than wastewater collection and treatment. However, a proper functional wastewater sector is the prerequisite of reuse schemes, but this is not the case in Lebanon.
- **Geographic disparity of wastewater generation and irrigation water demand:** Lebanon is geographically and topographically unfavourable for wastewater reuse. Domestic wastewater is mainly generated in the coastal zones, where about 80% of the population lives. The domestic wastewater generated in the administrative region of Mount Lebanon including Beirut exceeds by far its irrigation water demand. On the other hand, about 42% of the agricultural land is located in Beqaa (divided from the coastal zones by the Mount Lebanon mountain chain) and the generated domestic wastewater equals only 8% of the irrigation water demand. Transfer from surplus to deficit areas is non-existent.
- **Topographic features:** Especially in the mountainous areas, wastewater treatment plants are located at lower altitudes in order to use gravity for sewage flow, but most agricultural areas are located on higher altitude requiring expensive pumping.
- **Water balance:** Although there are substantial water losses from water supply network leakages (35%) and inefficient irrigation systems (irrigation efficiency of 67%), the Lebanese water balance is still positive. Since the amount of these losses exceeds the generated domestic wastewater quantities, improvements in the efficiency of water use are more promising than substituting fresh water resources by treated wastewater.
- **Public Opinion:** Where accessible, raw wastewater is used for irrigation, but this fact is nearly unknown to the public. There is neither public, economic, nor institutional pressure to substitute raw wastewater by treated wastewater.

Recommendations on Wastewater Reuse

- **Water sector policies reforms:** Elaborate a Water Master Plan that reforms the entire water sector towards demand management to ensure a more efficient use of water. That includes the reform of the current water tariff system and competitive tariffs for reuse schemes.
- **Infrastructure:** Rehabilitate existing and construct new wastewater collection and treatment facilities in urban and rural areas. Consider wastewater reuse already in the planning stage of future facilities.

- **Legal reform:** Update the legislation for the water sector and prepare regulations to establish a legal framework for wastewater reuse.
- **Institutional reform:** Set clear definitions of responsibilities of water/reuse related institutions supported by training measures of relevant ministerial staff, operators, and water users. Strengthen operators of water sector facilities to ensure proper O&M of all wastewater related facilities. Training needs could be satisfied by establishing a 'Capacity Development Centre'.
- **Feasibility studies:** Identify and analyse (CBA, EIA) technically and economically feasible sites for wastewater reuse schemes for irrigation purposes and analyse other forms of reuse (industrial, aquifer recharge), especially in or around the urban centres along the coast. Pilot wastewater reuse schemes at selected sites are recommended to demonstrate and promote the benefits of wastewater reuse.

1 Rationale

Growing population, increasing urbanisation and economic development lead worldwide to a rising demand for scarce water resources. The Mediterranean Region is no exception. In addition, climate change effects for the Near East Region as well as for the Maghreb countries are known to lead to more erratic distribution of precipitation and an increase of aridity which cohere with more extreme weather events.

In certain cases, water demand for domestic supply, industry and agriculture already exceeds or will in the near future exceed current supplies from renewable resources. These trends will lead to increased water pollution and increased quantities of wastewater requiring additional investments in wastewater collection and treatment facilities. As traditional water supply management efforts increasingly reach their limits, water demand management will become the dominating factor in reducing and economising future demand trends.

In addition, the search for alternative water sources, for example, desalination or by identifying options for reuse of treated effluents in a safe manner and investigating their potential for freshwater replacement are possibilities to respond to the growing water scarcity, becomes increasingly important. However, experiences over the last years have shown that in many countries the existing potential for reuse of treated effluents is only insufficiently exploited.

The reasons for this situation are manifold and vary among the individual countries and depend on site specific features. In general, there is a combination of several factors explaining the low level of official wastewater reuse. The most important are:

- Insufficient political commitment to implement water saving and demand management oriented policies,
- Legal insufficiencies and institutional weaknesses,
- Lack of clear regulatory frameworks for wastewater reuse and water quality standards,
- Lacking sanitation infrastructure,
- Insufficient technical performance and water quality control of existing wastewater treatment plants,
- Insufficient know-how and skills of operating staff,
- Inadequate tariff setting for water supply and sanitation services,
- Unfavourable economic conditions due to subsidized irrigation water tariffs and agricultural price policies,
- Supplementary costs for additional treatment, storage and conveyance to potential users,
- Insufficient know-how and lacking equipment for correct use of reclaimed water,
- Sanitary problems and cultural unacceptability,
- Insufficient institutional set-ups for monitoring water, soil, groundwater and product quality parameters and health standards, and
- Availability of cheap fresh water resources, etc.

Therefore, the FEMIP Trust Fund - through the European Investment Bank (EIB) - finances this comparative study to examine the current state of reuse of wastewater in selected Southern Mediterranean countries. It shall identify bottlenecks preventing a more extensive use and analyse how these bottlenecks can be removed or reduced. The study focuses on five of the nine FEMIP partner countries: Egypt, Lebanon, Morocco, Syria and Tunisia. This report will present the findings for Lebanon.

The document is intended for use by those without specific training in water resources management such as technical specialists, policymakers and managers working on water sector related investments within the Bank; practitioners from bilateral, multilateral, and nongovernmental organizations; and public and private sector specialists interested in environmentally sustainable water resources management.

2 Country Profile

2.1 Geography, Topography, and Administrative Affiliation

The Lebanese Republic is located in the Middle East at the coast of the Mediterranean Sea. It is bordered by Syria to the east and north and by Israel to the south. Lebanon is divided into six administrative regions, called Mohafaza, which are further divided into districts, called Cazas. The administrative regions of North Lebanon, Mount Lebanon, Beirut, and South Lebanon cover the costal zones, while Beqaa and Nabatieh are located inland (Map 1).[1]

Map 1 Administrative map of Lebanon

Despite its relatively small area of 10,500 km² Lebanon exhibits well-differentiated geomorphologic regions. The country can be divided into four regions: A relatively flat and narrow coastal strip, the Mount Lebanon mountain chain with its elevations of 2,200 m peaking to 3,020 m, the Beqaa plateau with an average altitude of 900 m, and the Eastern Lebanon Mountain Range or Anti-Lebanon reaching elevations of 2,814 m.

2.2 Climate

The location along the shores of the Eastern Mediterranean Sea results in temperate climate, but the conditions are not uniform throughout the country. The average annual precipitation of about 840 mm is above the average of its neighbours, and varies from a low of 200 mm in the northern inland extremes of the Beqaa plateau to more than 1,500 mm at the peaks of Mount Lebanon. Therefore, 70% of the precipitation occurs on the western slope of the Mount Lebanon mountain chain. Winters at the coastal area are cool and rainy while summers are hot

[1] The are various kinds of spelling of each location.

and humid. In the mountainous areas it can freeze and snow, while summers are warm and dry. Usually, precipitation occurs during a short period of about 90 rainy days. The average annual temperature at sea level ranges between 19°C and 22°C, while at 1,000 m it is about 15°C. The average humidity is about 70% along the coast and decreases with inland progression.

Global climate changes are expected to further exacerbate existing water shortages. Although precipitation is not predicted to decrease, but due to predicted temperature increases of 0.6 to 2.1°C higher evapotranspiration rates reduce available water resources. About 15% decreases in available water are projected by the year 2020 [1].

2.3 Demography and Socio-economic Situation

Lebanon has about 4.7 million registered inhabitants. Estimates of population development consider an average annual growth rate of 1.15% [2]. More than 80% of the population is concentrated in a narrow coastal strip with Beirut at its centre and the share of urban population reaches 88%. In 2007, Lebanon hosted a population of refugees and asylum seekers comprising nearly 10% of its population, of which are about 416,000 registered Palestine refugees [3]. It is also estimated that 50,000 Iraqis live in Lebanon. There are 12 official refugee camps and all suffer from insufficient infrastructure, overcrowding, poverty and unemployment [4].

The country suffers from political confrontation with its neighbours as well as from internal conflicts between its population groups. However, at present the HDI for Lebanon is 0.772, which ranks the country as 88th out of 177 countries.[2] The Lebanese Civil War from 1975 to 1990 seriously damaged Lebanon's economic infrastructure, and ended Lebanon's position as a Middle Eastern trade and banking centre. Since the end of the war much of its damaged infrastructure had been rebuilt and the country faced periods of economic stagnation and unemployment, but since 2002 the GDP growth rates increased to 6 percent. The 2006 Lebanon War stopped this economic recovery.

The gross national income per capita in 2007 was about EUR 4,100. The income distribution by social status is unequal, with bottom 20% of the Lebanese population accounting for 7% of all income, and the richest 20% of the population accounting for 43% of all income. About 8% of the Lebanese population live under extreme poverty (less than EUR 2.0 per day). In terms of religion, there is an estimated distribution of 60% Muslim and 39% Christian, but there are 18 accepted religious groups. Lebanon is governed by a confessional system, which distributes government posts among the recognized religious sects in the country. No census has been undertaken in Lebanon since 1932, because of political sensitivities related to power sharing among the religious communities. Lebanon is additionally not a signatory to the 1951 Refugee Convention and does not have any domestic refugee laws, because it fears that naturalizing refugees could upset the country's sensitive religious balance. This policy affects Iraqi and Palestinian refugee populations [5].

2.4 Economic Sectors

Lebanese economy is dominated by its service sector including banking, tourism, and transit. The 2007 estimates present a GDP of EUR 20 billion and around 75% originates from the services sector. Lebanon is lacking on raw materials and its activities are limited to small industries concerned with reassembling and packaging imported parts. The industrial sector ranks second in GDP with 20%. The agricultural sector as the major water consumer

[2] The Human Development Index (HDI) provides a composite measure of three dimensions of human development: life expectancy adult literacy and enrolment at the primary, secondary and tertiary level, and purchasing power parity.

contributes 5% to the GDP. There are no figures available about the labour force distribution among the sectors [2].

Agricultural Land Use and Major Crops

Present land use in Lebanon has not changed much despite the general urbanisation. Pasture for animal husbandry dominates the land use, accounting for 31% of the national area. Forests comprise 25% of the national area. About one quarter or 248,000 ha is used for agriculture, but Lebanon has the potential to double its agriculturally used area due to presently fallow and non-cultivated land.

Lebanon produces cereals, fruit trees, olives, industrial crops (e.g. sugar beet or tobacco), and vegetables. Fruit trees including olive trees occupy 45% of the total cultivated area, while cereals and vegetables cover about 20% each. Lebanese agricultural production is concentrated in the Beqaa plateau, which accounts for 42% of total cultivated land. Its western part is characterised by vineries, dairy production, and the cultivation of cereals and olive trees. In northern Beqaa mainly potatoes, cereals, and vegetables are cultivated. Across these areas many farmers have turned 6,470 ha of land over in 2007 to grow hashish plants [6]. In the coastal plains, fruit trees and vegetables are cultivated with water supplied from nearby rivers. Fruit trees and water supply from small springs characterize the agricultural cultivation in the mountainous areas.

2.5 Water Sector and Water Balance

2.5.1 Water Balance

Water Supply

In general, Lebanon is in a favourable position concerning its water supply, but there are strong seasonal and geographical variations. It is estimated that there is a 50% loss of the average annual precipitation of 8,600 Mm^3 through evaporation. Other losses include surface water flows to neighbouring countries and groundwater outflow leaving 2,000 Mm^3 of surface and groundwater as exploitable water. These figures consider readily available surface runoff of 1,600 Mm^3 and groundwater amounting to 400 Mm^3 [7].

Groundwater

In terms of groundwater supply, there are two major aquifer systems, which provide annually 400 to 1,000 Mm^3 of water [7]. Lebanon's groundwater table is generally high because of the high infiltration rate into widespread calcareous foundations. High precipitation and infiltration rates result in high seasonal flows of all springs. The number of springs in Lebanon is estimated at around 2,000. Community owned and operated public wells as well as private wells supplement the water supply from springs. The estimated total yield of all wells is about 400 Mm^3/year. Beside nearly 10,000 formally approved private wells, there are more than 40,000 illegal wells without any control over abstracted water quantities [8].

Rivers

Lebanon has 40 rivers of which 14 to 17 are classified as perennial rivers depending on the source of information [7]. All rivers have their source in the Mount Lebanon mountain chain and flow to the West into the Mediterranean Sea. In contrast, the Litani River flows from the North, Anti-Lebanon mountainous area, to the South, and drains the Beqaa plateau [8].

Dams

At present, Lebanon has two large dams, Qaraoun Dam in the Beqaa valley, with a storage capacity of 220 Mm³ and Chabrouh Dam in Mount Lebanon with a storage capacity of 8 Mm³. Lake Qaraoun is used for hydropower generation and water storage through the dry season. There are plans to build 12 dams and 18 hill lakes with a total capacity of 750 Mm³.

Desalinated Water

There are no figures available on the quantities of water that are produced through desalination as these are practiced on a private basis and not reported to the authorities. Desalinated water has never been used in Lebanon on a municipal scale [9].

Water Quality

In Lebanon, water quality is adversely affected by industrial, agricultural and domestic wastewaters. Agrochemicals (pesticides and fertilizers) cause ground and surface water pollution, while a wide range of chemical effluents in watercourses originates from the discharge of domestic and industrial solid and liquid wastes, as well as routine or accidental spills. Health impacts due to poor water quality are a major concern in Lebanon. In general, waterborne diseases, especially diarrheal diseases, are one of the leading causes of mortality and morbidity among children less than five years old. Health problems resulting from exposure to water pollutants often result in health care expenditures and income losses [8].

Uncontrolled construction of bore wells and inappropriate water abstraction from wells have led in many regions to a significant drop of the water table and ultimately caused saltwater intrusion along coastal plains. Saltwater intrusion poses a significant threat to the quality of fresh water in coastal areas, particularly at some locations where seawater has already intruded several kilometres inland into coastal aquifers [10].

Water Consumption

A proper estimation of water consumption suffers from the lack of operating flow meters. Therefore, the figures for the annual water consumption in Lebanon depend on estimates found in the literature. A World Bank report from 2003 indicates a total demand of 1,257 Mm³ for 2003 and a projection of 2,055 Mm³ for 2020 (Table 1) [11].

Table 1: Estimated and projected water demand by sector (Mm³/year)

	2003		2010		2020		2030	
Irrigation Water Demand	810	(64%)	900	(59%)	1,020	(50%)	1,120	(40%)
Domestic Water Demand	331	(26%)	467	(31%)	767	(37%)	1,258	(45%)
Industrial Water Demand	116	(9%)	163	(11%)	268	(13%)	440	(16%)
Total Water Demand	1,257		1,530		2,055		2,818	

Source The World Bank, 2003 [11]

All sources report that agriculture is by far the largest consumer of water in Lebanon accounting for 810 Mm³ or more than two-thirds of the total water demand, while it contributes only 5% to the GDP. The projection of the future demand describes a decrease of the agricultural consumption share, while domestic water demand shows a strong increase from presently 26% to 45% in 2030. In absolute figures, the projected domestic water demand in 2020 is already more than twice the amount of 2003. The estimates assume that within 20 years the domestic water consumption will exceed the agricultural consumption. Population growth in combination with economic development (higher industrial water demand and higher domestic water demand due to increased standard of living) and a higher water use efficiency from improved irrigation systems in the agricultural sector lead to that projected development.

The agriculturally dominated Beqaa plateau is currently the major water consumer inside the country. Its irrigation water demand of 412 Mm³ still exceeds the total domestic water demand of 331 Mm³, but the projection indicates a change of this position within a few years. Further, the irrigation water demand, estimated for the period 2002 to 2030, shows significant differences between administrative regions. There is a moderate increase in irrigation water demand in North Lebanon and in Beqaa, while this projection expects a strong increase in the southern regions of Nabatieh and South Lebanon (Table 2).

Table 2: Projected water demand for irrigation by administrative regions (Mm³/year)

	2002	2005	2010	2015	2020	2025	2030
Mount Lebanon	78	78	78	78	78	78	78
North Lebanon	158	158	158	158	175	175	175
South Lebanon	118	145	145	168	192	192	221
Beqaa	412	412	478	478	482	482	481
Nabatieh	16	102	106	118	118	117	173
Total	782	896	961	1,000	1,045	1,043	1,127

Source The World Bank, 2003 [11]

Current estimates, describing the water demand during the summer months from July to October, show that 88% of the water in Beqaa is used for irrigation, while in Mount Lebanon more than half of the water is used for domestic purposes. Irrigation in Beqaa is still the major water consumer, 30% of the water consumed during that period is used there (Table 3).[3]

Table 3: Estimated water demand during summer month for 2007 (Mm³/year)

	Domestic use	Industrial use	Irrigation	Total
North Lebanon	53 (25%)	13 (6%)	150 (69%)	216
Mount Lebanon	127 (54%)	30 (13%)	78 (33%)	235
North Beqaa	15 (10%)	4 (3%)	135 (88%)	154
Central and South Beqaa	17 (10%)	4 (2%)	153 (88%)	174
South Lebanon	38 (18%)	9 (4%)	159 (77%)	206
Lebanon	250 (25%)	60 (6%)	675 (69%)	985

Source Comair, 2007 [12]

In Mount Lebanon, second in water consumption during the summer month, the domestic use exceeds irrigation as major water consumer. However, the data source does not consider the administrative regions, but it clearly indicates that the domestic water demand occurs in the coastal zone around Beirut, while irrigation is the major water consumer in the Beqaa plateau and in southern Lebanon [12].

Domestic Demand

It is reported that the average delivery rate of potable water is 140 litres per capita and day, but there are average potable water losses in the conveyance and distribution system of 35% [8]. The estimated domestic water consumption of 331 Mm³ (70 m³/capita or 190 l per capita and day) presented in Table 1 includes additional water supply from the use of private wells.

In addition, Lebanon produces about 0.50 Mm³ of bottled potable water of which 85% or 0.42 Mm³ are consumed inside the country [13].

[3] The source does not consider the administrative regions, but the administrative region of Bekaa consists of North Bekaa, Central and South Bekaa.

Agricultural Demand

The agricultural sector is the main water consumer in the country. The cultivated area equipped with irrigation systems is approximately 110,000 ha or nearly half of the total cultivated land. The seasonal water demand of cultivated crops and the rainfall distribution lead to a water supply gap from May to September. For the Beqaa valley, it is known that raw wastewater is discharged into irrigation channels and that famers use raw wastewater directly for irrigation.

It is estimated that the irrigation water demand of 810 Mm^3 increases to 1,127 Mm^3 in 2030 due to intensification and extension of irrigated agricultural land. This projection considers a decrease in average consumption of water for irrigation including losses in conveyance and distribution networks from annually 10,000 m^3/ha in 2006 to 7,000 m^3/ha in 2030 due to improvements in irrigation techniques and water distribution systems [12].

At present, inefficient irrigation practices account for water losses of about 50%. The share of farms using ground water sources is slightly higher than that of surface water. As for methods of irrigation, surface systems such as furrow irrigation are adopted on 64% of the irrigated area, characterised by its low efficiency rate of just 55%. More efficient systems, such as sprinkler (75% efficiency rate) and drip systems (85% efficiency rate) are adopted on 28% and 8% of the irrigated land respectively. These figures result in an overall irrigation efficiency of 63%. Furthermore, farmers often use far more water than is required by crops [14].

Industrial Demand

Little is known about the quantity of water used by the industrial sector, but there are estimates that the industrial water demand including tourism would be maintained at 35% of the per capita residential consumption. In addition to receiving water through public water distribution systems, most industries are equipped with private (unmonitored) water wells and tap underground water at liberty, which is free of charge.

Demand of the Tourism Sector

The tourism sector in Lebanon flourishes in the summer season. The summer in Lebanon is dry and no precipitation is recorded during this season. The water quantities required to satisfy the highly active tourism sector is mostly drawn from wells. This poses significant pressure on the water supply and causes fluctuations in the groundwater table.

Water Balance

The figures for water supply and demand indicate still a water surplus (Table 4). Although there are differences according to the data source, and while the demand forecasts are conflicting, there is a general consensus that there will be a water supply deficit within the next 10 years [8].

Table 4: Estimated annual water demand and available supply (Mm^3 / year)

	2003	2010	2020	2030
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
Demand Dry Season	900	1,064	1,358	1,757
Supply Dry Season	900	945	990	1,035
Dry Season Water Balance	0	-119	- 367	- 722

Source The World Bank, 2003 [11]

Considering estimates from 2003, strong increases in water demand and only slight increases in water supply will result in a water deficit just after the year 2020. These projections take into account an increased water supply from groundwater sources [8]. Groundwater supplies of 900

Mm³ per year will be available during the dry four months of the year. During this period, 85% of the total irrigation water will be required. It is assumed that there is already now a water deficit during the four months period of the dry season [11].

2.5.2 Water Supply Management

The Council for Development and Reconstruction (CDR) is the major infrastructure constructing agency in Lebanon, while the regional Water Establishments (WE) are the operating agencies of water related facilities. At present, most of these recently established regional WE still lack sufficient financial and human resources to ensure proper O&M of water related facilities.

Water Production Plants

There are 15 water production plants in operation to extract and treat water from surface water and/or groundwater. Figures for 2001 present a treated water supply of about 250 Mm³ [8].

Water Distribution Systems

In 2004, it was estimated that almost 80% of the households are connected to a water supply network. In addition, private water supply from wells counts for about one third of the supply for domestic water consumption. For many years, households in urban and rural areas received water from public water authorities only up to three times a week, for about 8 to 12 hours a time. The rest of the time, groundwater was pumped into urban buildings, including hospitals and schools, using individually fitted pumps. This water is then stored in tanks [8]. The average water supply delivery rate shows a broad regional variation and there are estimates that losses in the distribution system from leakages amount on average to 35% [11], ranging from 15% to more than 50% in some rural areas [9].

Potable Water Quality

Regional water authorities are responsible for procuring, treating and distributing potable water to households. Either water is chlorinated directly at source or it is treated at a centralized water treatment plant. However, potable water quality may then deteriorate during distribution from cross contamination by wastewater network or rusting water conduits. Thus, potable water is not always safe for consumption.

Water Pricing

Domestic Use

The regional water authorities are empowered by Law 221 to set and collect water tariffs for domestic and agricultural use. Subscription fees for domestic water supply do not depend on water consumption measured by water meters, but vary among water boards. During the year 2001, tariffs ranged from EUR 48 to EUR 169 per year for one m³ of water per day gauge subscription. Differences are partly due to water availability and distribution costs. In Beirut, where water tariffs are highest, water is transported over long distances and pumped from deep wells. In mountainous areas of the Beqaa plateau, where water tariffs are lowest, water is available from springs and delivered by gravity [8].

Especially during the summer months, it is common to buy potable water, either bottled water or households have a water tank. The price to refill a water tank of 2 m² is usually EUR 13.

Agricultural Use

Within governmental irrigation systems, irrigation water is subsidized and charged at a flat rate per planted area, except in the modern pressurized irrigation schemes of the Litani River Authority in South Beqaa and Saida-Jezzine where volumetric metering is applied. At present, for the Qasmieh-Ras El Ain coastal scheme, water charges are fixed at EUR 230 per ha for

farmers who irrigate by gravity extracting water directly from the canal. In the Danneyeh scheme and the Akkar scheme, in the north, water charges range from EUR 25 to 100 per ha [8].

Estimates of operation and maintenance costs are EUR 30 per ha and year for small schemes with gravity surface irrigation. Medium schemes cost from EUR 80 per ha and year for gravity surface irrigation to USD 450 per ha and year for private wells. Large schemes cost annually from EUR 300 per ha for private pumping from rivers to EUR 450 per ha for tube wells [8].

2.5.3 Wastewater Management

The General Director of Hydraulic and Electric Resources of the Ministry of Energy and Water (MoEW) stated in 2007 that during the past few years the administration, mainly the CDR as construction agency and the regional Water Establishments as operators, did limited work in constructing new wastewater treatment plants (WWTP), primary and secondary conveyors, and wastewater (WW) drainage networks [12].

Since water supply has the key priority and the regional WE have insufficient allocation of financial and human resources to operate wastewater related facilities, the CDR has included into all construction contracts an O&M component for the first 3 years.

An analysis on decentralised wastewater management in rural areas showed that technologies selected for WWTPs are often beyond the technical capabilities of local people to be operated effectively and efficiently [15].

Lebanon does not have a wastewater fee which is related to the amount of WW generated. Wastewater collection and treatment is charged separately from water supply fees by a municipality tax [16]. There are estimates that wastewater treatment costs are around EUR 0.8 per m³, which would result in water tariffs of EUR 250 per year covering all water supply and wastewater treatment related O&M costs, but excluding capital costs of the water facilities.

Wastewater Generation

The estimates of WW generation depend on data source and vary between 200 and 300 Mm³/year. The World Bank report of 2003 estimates a total WW generation of 200 Mm³/year [11]. The EMWater report of 2004 estimates a domestic WW generation of 249 Mm³/year and an industrial WW generation of 43 Mm³/year. Similar to the population distribution, the costal regions generate about 80% of the WW (Table 5) [8].

Table 5: Population and estimated domestic wastewater generation

	Population[17]		Domestic WW generation 2001 (Mm³/year)[8]	
Beirut	460,000	(10%)	25.1	(10%)
Mount Lebanon	1,731,000	(37%)	93.8	(38%)
North Lebanon	927,000	(20%)	50.2	(20%)
Beqaa	750,000	(16%)	33.6	(13%)
South Lebanon	540,000	(11%)	29.4	(12%)
Nabatieh	316,000	(7%)	17.1	(7%)
Lebanon	4,724,000		249.3	

Source population data from Wikipedia, 2008 [17], wastewater generation data from EMWater, 2004 [8]

Due to the location of Lebanese industries, the majority of industrial WW is generated in the coastal administrative regions, but there are no detailed data available.

Wastewater Collection

The rehabilitation of sewer networks of Lebanon is part of the National Emergency Reconstruction Programme (NERP). In 2004, half of the cities had a sufficient sewage network and two-thirds of houses were connected to public sewage networks, but there was a broad

variation. In general, there is poor wastewater collection in rural areas. Due to the Beirut Coastline Wastewater Collector Project in the administrative region of Beirut nearly all houses were connected to a sewage network (99%), while in Nabatieh this rate was only 18%. The remaining areas either use the traditional household sanitary pits or are draining WW into boreholes in bedrock. However, figures for 1998 reported that less than 40% of the buildings are connected to a sewage network, but there are no data available which consider damages from the 2006 war [18]. In 2006, an EC report describes that sewage networks and WW collection systems in the major cities are not fully completed and in most cases still under construction [19]. There is no separate network for stormwater and due to stormwater discharged into the sewer network the amount of wastewater is usually beyond the treatment capacity of WWTPs.

Wastewater Treatment

Lebanon has about 40 WWTPs that are already constructed, under construction or in planning process. Their design capacity amounts to 359 Mm^3, which is equal to the domestic water demand in 2003. A recent inventory of wastewater treatment facilities listed only 7 constructed WWTP of which only two are operating. Ghadir WWTP (50.4 Mm^3) in the south of Beirut is the only operational large-scale WWTP, but it provides only primary treatment and disposes all the effluent into the Mediterranean Sea. In addition, Saida WWTP (25.6 Mm^3) became operational, but it is limited to primary treatment as well. According to the inventory of WWTPs presented by the EU Water Sub-Group, all other WWTP under construction or under preparation have biological treatment components (Annex 2 Table 1) [20].

However, even if the design capacity of all constructed WWTPs including those not operating yet, would be considered, the share of treated wastewater effluent would be 57% of the domestic wastewater generated in 2001. In other words, the treatment capacity of constructed WWTPs is 40% of the design capacity of all WWTPs completed, under construction, or currently under preparation (Table 6).

Table 6: Estimated capacity of operating WWTP and rate of WW treatment

	constructed WWTP	operating WWTP
Baalbeck WWTP	4.6 Mm^3	
Chekka WWTP	0.6 Mm^3	
Ghadir WWTP	50.4 Mm^3	50.4 Mm^3
Nabatieh WWTP	3.6 Mm^3	
Nabi Youmes / Jiyeh WWTP	2.2 Mm^3	
Saida WWTP	25.6 Mm^3	25.6 Mm^3
Tripoli WWTP	49.3 Mm^3	
other small scale WWTP	5.8 Mm^3	1.2 Mm^3
Total	142.1 Mm^3	77.2 Mm^3
Treatment Rate (% of 249 Mm^3 generated WW)	57%	31%
Operating Rate (% of 359 Mm^3 WWTP design capacity)	40%	21%

Source EU Water Group, 2009 [20]

The treatment capacity of the operating WWTP provides a 31% treatment rate and a 21% operating rate. Since nearly all treated wastewater receives primary treatment and is discharged directly into the sea, there is currently no option to reuse this large amount of wastewater.

In addition, several NGOs constructed small-scale WWTPs in remote villages and towns. The MEDAWARE report from 2005 describes 42 community-based WWTR, of which only 26 were found operational. By inspection in 2004, the Ministry of Environment (MoE) reported 20 of the operational plants as not effectively treating the sewage. The total design capacity of these small community-based WWTP is around 5.8 Mm^3 [9].

Wastewater Discharge

The majority of raw sewage is discharged directly into the sea or inland watercourses without treatment prior to disposal. There are approximately 53 outfalls along the coast, but there is no information about actual outflow available [8]. Rural areas lack properly constructed and maintained on-site sanitation facilities. In most cases individual sewage disposal units such as septic tanks, seepage pits, cesspools are used, discharging their effluents into ground or surface water bodies.

3 Legal and Institutional Framework

3.1 National Policies and Legislation in the Water and Wastewater Sector

3.1.1 National Water Programmes

At present, Lebanon has no integrated water resources management plan. The current programmes are limited to subsectors of the water sector.

Water Supply Programmes

In 1999, the General Directorate of Hydraulic and Electric Resources (GDHER) of MoEW has prepared a 10 year plan, the National Decennial Strategic Plan for the Water Sector (2000-2010), with the objective to mobilise the necessary funds for the study and execution of works in order to satisfy the water needs of the population in the following sectors:

- Creation of additional water resources based on the construction of new dams and the recharge of aquifers;
- Potable water projects, based on rehabilitation and network development, and the reduction of unaccounted for water;
- Irrigation projects, rehabilitation and new development schemes;
- Wastewater projects: sewer lines, WWTPs and sea outfalls;
- Alignment and rectification of rivers for flood mitigation in Saida, Chekka, Batroun, Jbeil, the Chouf coastal area, Baalbek and Nabatieh.

The draft National Environmental Action Plan (NEAP) of 2005 refers on wastewater to a draft Policy for the Above-Ground Use of Reclaimed Domestic Wastewater. Both documents are not yet approved. According to the draft NEAP of 2005, the proposed strategy fails to address several relevant issues to this study:

“One of the strategy’s principal deficiencies, however, is its failure to address water quality or the need to preserve and protect water resources from pollution. Another key element missing from the plan is a comprehensive demand management plan which addresses in detail such demand aspects as leak detection and prevention, irrigation practices, water use habits, etc.”

Wastewater Programmes

The draft NEAP establishes quality standards and operational requirements for four classes of reclaimed wastewater, each with permitted levels of reuse. The draft NEAP recommends: “the Ministry of Agriculture (MoA) should be resourced to provide extension advisory services to farmers and major landowners. Pilot schemes to illustrate ‘best practice’ in wastewater and sludge application should be established and trained field staff made available to advise on reuse and the procedures for permitting.”

The draft NEAP also mentions the following pressing issues:

“Development of Related Legal Framework

- Good water governance is critical for sustainable water management and as such pricing schemes must fall within a proper legal framework:
  - Legislation defining water as a public good must be revised;
  - A penal code to prevent, restrict, and penalize all acts of illegal exploitation of water resources. An important component of the code is the control of well drilling and illegal abstraction.

- No code is useful without enforcement clauses. Foremost is the enforcement of payment of charges, tariffs and penalties by the users. Enforcement of issues related to groundwater, such as well-logging and issuance of licenses for well drilling, must be stressed.

The Ministry of Energy and Water (along with the WE), and in related issues the Ministry of Finance, must carry out this action within a period of two to five years. The Ministry of Interior and Municipality is responsible for enforcement."

The plans of the Lebanese government in the wastewater sector are based on two key principles: first, compliance with the provisions of the Barcelona Convention to protect the Mediterranean from pollution; and second, protection of inland water resources from pollution. In 1995, a damage assessment report was prepared to formulate a policy framework for the wastewater sector. Implemented over three phases, the resulting National Emergency Rehabilitation Programme (NERP) launched two major programmes:

- Coastal Pollution Control Programme (CPCP), representing Lebanon's commitment to fulfil the requirements of the Barcelona Convention and its protocols;
- Water Resources Protection Programme (WRPP), for the rehabilitation of water treatment plants and water sources (springs and wells), and the rehabilitation and construction of transmission and distribution networks.

The NERP programme proposed the construction of 12 WWTPs along the coast. With the execution of these coastal wastewater plants, more than 65% of the wastewater problems in Lebanon are expected to be solved by the year 2020. In addition to the coastal plants, 20 major inland WWTPs are proposed. With the construction of these 20 WWTPs, Lebanon is planning to treat 80% of its WW by the year 2020. The WWTPs proposed under NERP are either in operation, under construction, or still searching for funding. The remaining areas that house 20% of the population will require about 100 small WWTPs. A detailed action plan for rural wastewater has been developed under the EC-MEDA sponsored Management Support Consultant Investment Planning Program (MSC-IPP) Environment Project [9]. The CDR is the lead agency charged with the planning and construction of these plants.

3.1.2 Relevant Laws and Regulations

Water Resources Regulations

Existing legislation for the protection of water resources in Lebanon dates back to 1925. However, these laws were neither updated nor complemented with additional laws and application decrees. The main regulations directly related to wastewater are listed below, but guidelines for wastewater reuse do not exist:

- Order No. 144, 1925: Protection of Surface Water and Groundwater Resources;
- Decree No. 2761, 1933: Article 11 rules that "industrial wastewater should not be discharged in sewer lines without the permission of the Directorate of Health, and after it is adequately treated";
- Order No. 8735, 1974: Pollution from Solid and Liquid Waste;
- Law No. 64, 1988: Pollution from Hazardous Waste;
- Decision No. 2528/C, 1996: Protection of Groundwater at El Kneisse Mountain;
- Decree No. 680, 1998: The Preservation and Protection of Boreholes;
- Law 221 (29/5 2000): Regional water authorities set and collect water tariffs for domestic and agricultural use. Subscription fees for domestic water supply vary among water boards. The law contains no procedures, competences nor standards for the reuse of wastewater;

- Decision 8/1 (1/3/2001) of Ministry of Environment on the National Standards for Environmental Quality (NSEQ), covering air and liquid emissions of all sectors, and replacing corresponding standards under Decision 52/1 of 1996;
- A framework law for the protection of the environment was adopted in 1988 and amended in 2002 (Law 444, 8/8/2002), which defines the basis and norms for environmental protection. Already the Law 444 for the Protection of the Environment is promulgated in 29/7/2002. Chapter 4 of this Law, in items No. 21-23, refers to the need for conduction of Environmental Impact Assessment (EIA) for development projects, including WWTP. The new law was not yet proposed to the Parliament;
- Decision 3/1 (6/8/2005) about environmental guidelines for the establishment and/or operation of small WWTP;

A Water Code has been prepared in 2004 with support of the French Ministry of Foreign Affairs and was handed over to MoEW in 2008, but the Lebanese Parliament did not yet ratify it.

Wastewater Standards in Lebanon

There are no regulations and guidelines for the reuse of wastewater for irrigation, but there are only standards for its discharge into surface water and seawater (Annex 2 Table 2). The Ministerial Decision No. 1/52, July 1996, lists standards for water quality and wastewater discharge. The implementation of the standards proved difficult; therefore, they were revised and amended under decision no. 8/1, January 2001. It has set national standards for water, air, and soil standards for urban wastewater and allowed standards for discharging wastewater into surface and underground water bodies and into the sea (Annex 2 Table 3) [21].

At present, a project related to watershed management and water quality is under elaboration between the MoEW, FAO, World Bank and CDR. The guidelines for reuse of treated wastewater in the irrigation sector are expected to be elaborated during project implementation [22].

Water Rights in Lebanon

There is certain lack of defined set of laws governing water ownership and use. An order from 1925 defines public property and includes surface and groundwater, lakes, rivers, and lake and riverbanks. Further, it stated that such properties might not be sold or profited from. However, in the late 1960s, the legislation was amended to exclude wells drilled on private lands with a low output. Innumerable wells are found throughout Lebanon, especially in the Litani river watershed, and for various reasons enforcement of existing laws is very lax to non-existent.

3.1.3 Water Quality Standards

In Lebanon, minimum standards exist to assure the quality of drinking water and environmental limit values for regulating the discharge of wastewater, but there are no standards for irrigation water. Industrial wastewater is discharged without any treatment into various water receiving bodies. In the absence of a pollution control strategy with the necessary legal and regulatory instruments, industrial discharges remain an important source of pollution.

The ten years water strategy developed by the MoEW addresses neither water quality nor the need to protect and preserve water resources from pollution and there is no comprehensive framework for pollution control. A comprehensive water quality management and pollution control plan has not been developed and there are no monitoring sites along streams, rivers, springs or irrigation channels.

3.2 National Bodies Involved in the Water and Wastewater Sector

There are several government agencies involved by varying degrees in water resource management in Lebanon, often with overlapping functions. The main agencies are the MoEW and its subordinated institutions, the Litani River Authority (LRA) and the four regional Water Establishments (WE). Furthermore, the CDR, the MoE, the Ministry of Public Health (MoPH) and the Ministry of Agriculture (MoA) are involved in the water sector.[4]

To date, management of the wastewater sector is ineffective. The roles and responsibilities are dispersed between various ministries and several authorities making it difficult to discern clear sectoral responsibilities, and functional monitoring and enforcement systems.

3.2.1 Ministry of Energy and Water (MoEW)

The Ministry of Energy and Water (MoEW) is the major authority dealing with water and has the following mandates:

- Protect and develop hydraulic natural resources;
- Assume jurisdiction over the water resources in Lebanon;
- Study supply and demand, and assess 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;
- Exercise administrative supervision over the WE and the LRA.

MoEW has two General Directorates:

- The Directorate General of Hydraulic and Electric Resources (DGHER), responsible for research, studies and implementation of large-scale projects;
- The Directorate General for Operations (DGO), responsible for overseeing the public establishment, for administration and financial aspects and for mines and quarries. Further, MoEW exercises administrative supervision over the WE, the autonomous Water Boards and Local Committees through the Directorate General of Operations (DGO).

3.2.2 Regional Water Establishments (WE)

Since the year 2000, the water sector has been reorganized: four regional Water Establishments (WE) were created and replaced 22 regional water authorities and about 210 local water committees:

- Water Establishment of Beirut and the Mount of Lebanon (head office: Beirut)
- Water Establishment of North Lebanon (head office: Tripoli)
- Water Establishment of the Beqaa (head office: Zahleh)
- Water Establishment of South Lebanon (head office: Saida)

The regional WE are supervised by the MoEW, but enjoy financial and administrative autonomy in their perimeters. The responsibilities for the wastewater sector are transferred to the MoEW and this sector is entrusted to the WEs. In general, the WEs are responsible for O&M of water production plants, water distribution systems, wastewater collection systems, and wastewater treatment plants. Further, the WEs have the following duties and competences:

[4] A detailed overview on Lebanese authorities responsible for the water and wastewater sector can be found in the EM Water Project Report 2004, “Prospects of efficient Wastewater Management and Water Reuse in Lebanon” [8].

- To carry out studies, implementation, operation, maintenance and renewing of projects for drinking and irrigation water distribution within the frame of General Water Master Plan or according to Ministry's permit to use public water resources;
- To propose drinking and irrigation water services tariffs;
- To control drinking and irrigation distributed water quality.

The allocation of human and financial resources to the regional WE as the main operating agencies is insufficient for an adequate operation of all water related facilities. Currently, the key priority of these operators is water supply and there are no capacities for other responsibilities. Further, the employment policies hinder to employ or to release employees.

3.2.3 The Litani National Authority (LNA)

The Litani National Authority (LNA) is a public establishment, which is under the tutelage of the MoEW and has the following countrywide duties:

- Exploitation of hydroelectric power plants;
- Construction of irrigation schemes;
- Preliminary studies and the construction of dams;
- Management of water resources.

The Water Resources Service is part of the Direction of Studies in the Litani National Authority. The functions of this service are the gauging of all important rivers and springs in Lebanon and the study of underground water resources in South Lebanon and South Beqaa. The Water Resources Service has four regional offices (Beirut, Tripoli, Chtaura and Saida).

3.2.4 Council for Development and Reconstruction (CDR)

The Council for Development and Reconstruction (CDR) was established in 1977 and was granted unprecedented power to avoid any administrative routine that could delay the reconstruction process, especially in the financial field. The CDR is responsible for the implementation of the major infrastructure projects in the country, including irrigation, water networks, wastewater and solid waste facilities. The main tasks of the CDR can be summarized as follows:

- General plans for the country, investment and implementation programs for reconstruction and development projects;
- Mobilizing external financing for priority projects;
- Implementing projects by appointment from the Council of Ministers;
- Rehabilitating the public administration, reconstruction of the infrastructure and negotiating foreign financing agreements.

CDR has prepared and is currently updating the "Horizon 2020" plan, which calls for USD 18 billion of public investment through 2007 in coordination with all ministries involved. It has mobilized over USD 3 billion of external funding and is increasingly involved in monitoring, tendering, and implementing priority reconstruction and development projects, primarily in sectors including power, health, education, water supply and wastewater, solid waste treatment, telecommunications, transportation, roads and highways.

The current wastewater policy of CDR for future sanitation infrastructure considers secondary treatment and UV disinfection in combination with a reservoir to include the opportunity of WWR, while tertiary treatment is not foreseen in the near future.

3.2.5 Ministry of Environment (MoE)

The Ministry of Environment (MoE) is responsible for the protection of the environment in general, through providing studies on wastewater treatment, environmental impact assessment and natural resources management and conservation. This Ministry is also responsible for proposing legislation that ensures the implementation of relevant measures. The ultimate long-term objectives of MoE are summarized below:

- Prepare the appropriate legislative framework to enforce environmental practices;
- Initiate working plans and programmes setting the accurate indicators and standards in environmentally-affected sectors (private and public);
- Launching public awareness campaigns through core academic curricula and through different audio-visual media;
- Impose application of Environmental Impact Assessment (EIA) on vital development projects, and substitute problematic plans with environmentally friendly ones;
- Empower local NGOs' role in the civil society.

Four general policy principles have been set: Regionally balanced development, protection through prevention, the Polluter Pays Principle, and integration of environmental policies into other sectoral development policies.

3.2.6 Ministry of Agriculture (MoA)

The mandate of the Ministry of Agriculture (MoA) is to develop the agricultural sector including irrigation and to protect and manage natural resources. The MoA has the mandate to undertake reforestation projects, to protect, supervise and manage natural resources.

3.2.7 Ministry of Public Health (MoPH)

The Ministry of Public Health (MoPH) is responsible for the psychological and physical safety of people. Its major water related activities are to:

- monitor water quality (via department of Sanitary Engineering);
- set standards for drinking water;
- propose specifications for drinking water and wastewater networks;
- recommend action for pollution prevention;
- operate water quality equipment such as chlorinators.

3.2.8 Municipalities

Municipalities in Lebanon are responsible by law for building and maintaining local infrastructure (sanitation, local roads, and sidewalks) and providing basic services (solid waste management, WWT, and construction permission). Unfortunately, most municipalities still lack the human and financial resources, environmental awareness, management capabilities, and/or political commitment necessary to fulfil their mission in an environmentally sound manner. Municipalities located inside the Governorate report to the Governorate on all municipal works and acquisitions. Municipalities are also responsible for controlling the occurrence of violations due to improper waste disposal. As a result, several municipalities were chosen both for implementation and for follow-up of actions such as the construction of WWTPs.

3.2.9 Research Institutions and Universities

The National Council for Scientific Research (NCSR) is the umbrella public research institution in Lebanon. It has working relationships with local, regional and international agencies. Locally, it cooperates with several ministries, public agencies, and private research institutions. One of the three main centres of the NCSR is the National Center for Remote Sensing (NCRS), which is currently undertaking several projects related to the use of databases. These projects cover different topics including natural resources, geo-environmental hazards, land use and its impacts. The NCRS is working on mapping of all water springs and all coastal areas showing water run-offs into the sea. Other research issues are monitoring and combating desertification, erosion control, and forest fires.

With regard to the water sector, various universities such as Lebanese University, Notre Dame University, Université Saint-Joseph, or American University of Beirut are involved in research projects dealing with monitoring, managing and assessing water resources, with wastewater management and irrigation issues. They are increasingly offering environmental courses, but the extent and depth of environmental education is variable.

3.2.10 Non-governmental Organisations

At present, about 100 environmental NGOs are registered with the Ministry of Interior and Municipalities. Mostly funded by USAID, those NGOs working in water related fields have constructed community based small-scale WWTPs, but as mentioned already the treatment efficiency is reported be to insufficient (see chapter 4.1.2). The Lebanese Appropriate Technology Association (LATA) conducts a greywater treatment project (see chapter 4.1.3).

3.3 International Organisations Involved

International donor agencies are playing an important role in financing environmental project activities. Projects cover a wide range of issues and areas of intervention, including institutional strengthening, resource management and conservation, biodiversity, rehabilitation and construction of public infrastructure such as water supply, WWTP and energy. Several international organisations are involved in the wastewater sector, but currently there are no activities focusing exclusively on wastewater reuse. The most important international organizations and their activities in the field of WWT are described hereafter.

3.3.1 World Bank (WB)

Over the past fifteen years, the World Bank has supported Lebanon in a wide range of sectors. The emphasis of the Bank’s assistance is currently on the medium-term public expenditure and social reform agenda, with a particular focus on energy, water and social protection reforms.

In 2006, the World Bank has financed 21 operations in the country for a total original commitment of about EUR 800 million. At present, the World Bank implements the following projects: Baalbeck Water and Wastewater Project (see chapters 3.3.2 and 4.1.1), Community Development Project, Cultural Heritage and Urban Development Project, Education Development Project, First Municipal Infrastructure Project, and Urban Transport Development Project.

The Government of Lebanon has received a loan from the International Bank for Reconstruction and Development in 2009. It intends to spend part of the funds to cover eligible payments under the Contract for "Construction of Additional Sewer and Potable Water Distribution Lines and their House Connections in Baalbeck City, El Khodr, Nabi Chit and El Khreibe in Baalbeck Caza".

3.3.2 Food and Agriculture Organisation of the United Nations (FAO)

Recently, the Lebanese government has requested FAO for technical assistance in the Water sector. Clear guidelines for the reuse of treated wastewater in irrigation are expected to be elaborated during the implementation of this project that includes: a strategy on the reuse of treated effluent, integrated river basin management, and water quality management.

Furthermore, it includes assistance in the implementation of a pilot project on WWR for the Baalbek wastewater treatment plant, which was constructed through a World Bank loan (see chapter 4.1.1). FAO will assist in the implementation of the environmental management plan that was prepared for the wastewater treatment plant. The assistance will focus on developing guidelines and building national capacities to maximize the benefits and minimize the risks of the reuse of treated effluent and sludge from the Baalbek wastewater treatment plant. Currently, this project is under preparation and not yet signed [23].

3.3.3 United Nations Development Program (UNDP)

UNDP's cooperation with Lebanon aims to support the people and institutions by means of programs that focus on balanced regional development, sound environmental management, institution building, and strengthening human development. UNDP Lebanon works in cooperation with CDR and different ministries, and develops collaborative action with civil society and other UN organizations. So far, UNDP-Lebanon has no programs with a special focus on water or wastewater.

3.3.4 World Health Organization (WHO)

In the water sector, the WHO Lebanon office supports the national wastewater management plan, risk assessment of environmental health factors with focus on water quality and sanitation, surveys and training for water quality assessment and workshops, conferences and training sessions in basic water supply and sanitation.

3.3.5 European Union (EU)

The main priorities of EU co-operation with Lebanon are to support the economic reform process, sustainable development, environmental protection, development of human resources and the improvement of human rights. Environment is one of the priorities of the cooperation between the EU and Lebanon as it has a social and economic dimension and a positive impact on population's health. The objective is to preserve the natural resources, to optimize their utilization, to reduce industrial pollution as well as pollution linked to solid waste and wastewater. The following projects cover the wastewater sector:

- **EMWater (completed in 2008):** The project analysed efficient management of wastewater, its treatment and reuse in the Mediterranean countries;
- **MEDAWARE (completed in 2008):** This project developed tools and guidelines for the promotion of sustainable urban wastewater treatment and reuse in agricultural production in the Mediterranean countries. It includes country studies, training, awareness, and guidelines mostly provided by American University of Beirut;
- **Sewage Network and Wastewater Treatment Plant (2007-2011):** The purpose of the project is the construction of three wastewater schemes for villages in Southern Lebanon. The villages' ultimate need consists of developing a sewage collection network since they are still operating on septic tanks. The construction of a treatment plant shall solve the problem of wastewater streams that flow in their valleys and pollute their aquifers. The objective is to preserve underground water and soil from pollution stemming from damaged septic tanks.

3.3.6 European Investment Bank (EIB)

The European Investment Bank (EIB) is a long-standing partner of Lebanon, which had provided financing of more than EUR 1.1 billion since the start of its activities in 1978. In the field of water supply and wastewater, the bank is involved (often in cooperation with other donors) in the following projects:

- **Greater Beirut Wastewater (ongoing):** The construction of a wastewater treatment plant and primary treatment in Dora, rehabilitation or reconstruction of existing sea outfall and construction of related main collectors, stormwater networks, and wastewater networks;
- **South Lebanon Wastewater (ongoing):** Upgrading and extending the sewerage infrastructure of the coastal cities of Saida and Sour and their surroundings in Southern Lebanon including the construction of main collectors, treatment plants (primary for Saida, secondary for Sour), and sea outfalls;
- **Tripoli Wastewater (ongoing):** The construction of a wastewater treatment plant and related sea outfall, the rehabilitation and expansion of the sewerage system, and the construction of a stormwater drainage network for the greater Tripoli area, which comprises the municipalities of Tripoli, El Mina and El Bedawwi;
- **Kesrwan Water and Wastewater (under appraisal):** The EIB financed the wastewater treatment plant in Jounieh/Tabarja, main wastewater collectors, inland sewer network, and a sea outfall (Phase I). Further, network and house collections are under appraisal (Phase II).

In 2007, the bank has announced that it will fund the recovery, reconstruction and reform plan drawn up by the Lebanese Government up to EUR 960 million over the next 5 years by financing key projects under the Public Investment Programme, supporting both private sector activity and public investment. In all areas, the EIB will work closely with the European Commission, bilateral European development, and the World Bank. The funding will be provided under the Bank's Facility for Euro-Mediterranean Investment and Partnership (FEMIP):

- With EUR 400 million in support of priority infrastructure projects the Bank will continue its commitment to the transport, wastewater and energy sectors, encouraging the necessary sectoral reforms. Additionally, technical assistance grants will facilitate the preparation and implementation of privatisation programmes.
- EUR 560 million of new financing will be channelled into the private sector in tandem with local banks by means of innovative structures such as debt securitisation and the financing of private investment under public-private partnerships. In addition, the EIB will foster the development of a venture capital market supporting Lebanese companies.

3.3.7 Selected Bilateral Cooperation

French Development Agency (AFD)

The French Development Agency is starting soon the following projects:

- **Water Supply and Sanitation in North Lebanon (starting soon):** This programme includes construction of sanitation networks for 3 cities (total 100,000 equivalent habitants) and a wastewater treatment plant (50,000 equivalent habitants).
- **Preparing By-laws for Water Code (starting soon):** A new Water Code, completing water law 2000/221, has been prepared and should be submitted to Parliament. Preparing the by-laws should facilitate quick implementation.

French Mission Economique

The French Mission Economique is involved in the following WWTP projects:

- **Nabatiyeh WWTP (completed in 2007):** Construction of one wastewater treatment plant in Nabatiyeh, South Lebanion (100,000 equivalent inhabitants).
- **Ras Nabi Younes WWTP (completed in 2007):** Construction of one wastewater treatment plant in Ras Nabi Younes, Chouf (88,000 equivalent inhabitants).
- **Chekka WWTP (completed in 2006):** Construction of one wastewater treatment plant in Chekka, North Lebanon (24,000 equivalent inhabitants).
- **Jbeil WWTP (ongoing):** Building of one wastewater treatment plant in Jbeil, North Lebanon (48,000 equivalent inhabitants).
- **Batroun WWTP (ongoing):** Construction of one wastewater treatment plant in Batroun (30,000 equivalent inhabitants North Lebanon.

KfW Bankengruppe (KfW)

The German KfW financed the construction of Ghadir WWTP (primary treatment) in 1999 and finished its activities in Lebanon in 2001, but resumed its engagement after the 2006 war. At present, KfW is involved in the following wastewater rated projects:

- **Al Ghadir Wastewater Project (starting soon):** The overall objective is to improve the hygienic conditions of the poor population as well as the ecological conditions of the Mediterranean Sea. The programme's objective is to improve the environmentally sound and hygienic wastewater disposal in the catchment area of the Ghadir River.
- **Rehabilitation of Water and Wastewater Infrastructure in Southern Lebanon (ongoing):** The overall objective of the Emergency Programme (Phase I & II) is to reduce the health risks arising from war related damages to the water infrastructure. Its objective is to contribute to the improvement of the continuous and hygienic supply of water and disposal of wastewater. The project will give priority to emergency and urgently needed measures.
- **Rehabilitation of Sanitation System in Northern Lebanon (ongoing):** Overall goal of the Emergency Programme (Phase III) is to improve the living conditions of the Lebanese population (6 municipalities) and the Palestinian refugees (two refugee camps) in northern Lebanon. Its objective is to improve the collection of wastewater in the project area in a hygienically and environmentally sound manner. The following components will be given priority: wastewater collector for Tripoli WWTP, secondary and tertiary wastewater collection systems in the “catchment area” including house-connections, and necessary accompanying consultancy services. The programme also includes the preparation of tender documents for additional wastewater networks in the catchment area to be executed by the Kuwait Fund.

GTZ

The GTZ programme "Technical Assistance to the Water Sector Reform / Rehabilitation of Water Supply and Wastewater Systems in Lebanon" provides demand-oriented technical assistance at all levels of the water supply and wastewater sector. Strengthening of technical and management capacities in all of the four WEs is the core element of the programme. In the MoEW the programme aims to strengthen the capacity of the ministry in its regulatory and policy roles. The programme promotes benchmarking based on performance indicators, outsourcing to the private sector, capacity building, know-how transfer, and the improvement of customer relations.

Italian Government Development Cooperation

The current Italian commitment of ongoing, approved and projects under preparation amounts to EUR 209 million. The lion share is taken by bilateral cooperation (soft loan) amounting to EUR 136 million which includes the following wastewater related activities:

- **Wastewater Treatment Plant and Sewage System in Zahle (approved):** The programme includes the extension of Zahle wastewater network and wastewater treatment plant including the network, operation and maintenance.
- **Water Supply and Wastewater Management in Jbeil Caza (approved):** The programme includes Jbeil Caza water supply system and wastewater, Qartaba wastewater treatment plant including the network and the operation and maintenance for two years.
- **Project Implementation Unit with CDR (ongoing):** The Project Implementation Unit is created in order to assist CDR in the implementation of the water and wastewater projects funded by the Italian Government for Development Cooperation.
- **Construction of Wastewater Treatment Plants and Networks in Michmich, Hrajel, Majdal/Anjar and Jbaa (under evaluation):** The programme includes the construction of four wastewater treatment plants and related sewer collection systems.

United States Agency for International Development (USAID)

In the water management and sanitation sector USAID is involved in projects to support planning, conservation and strengthening of the water infrastructure, to regulate water prices and distribution, and projects on wastewater management (see chapter 4.1.2). In cooperation with municipalities in the Beqaa, USAID is building small wastewater treatment systems to protect the upper Litani River basin and the health of local communities.

The ongoing Lebanon Water Policy Program is in its third phase. Its overall objective is to help the regional WE to solve their institutional and technical problems in order to become strong, viable utilities capable of attracting investment and providing responsive and high quality services to their customers.

4 Wastewater Reuse

4.1 Status of Wastewater Reuse in Lebanon

In comparison to other countries of this study, the safe reuse of treated wastewater in Lebanon is presently very limited due to a variety of hindrances (see chapter 5.1). Raw wastewater is used for irrigation in several regions of Lebanon, but there is no information about quantities of raw wastewater used or areas irrigated. There are only few reports describing reuse of treated wastewater. For Beqaa it is reported that sewers are purposely blocked to allow raw wastewater to be diverted for irrigation [8]. In case of limited fresh water resources, there seems to be a general acceptance and demand to use non-conventional water sources for irrigation.

The MEDAWARE Report of 2005 stated that Lebanon cannot boast any successful WWR story [9]. This situation has not changed as the following project examples show.

4.1.1 Large Scale Baalbeck WWTP

The construction of the World Bank financed WWTP in Baalbeck has been completed already in 2001, while the 150 km sewer network only in 2006. Up to now, only one third of all households are connected to it. The WWTP includes primary and biological treatment and has a sufficient design capacity of 4.6 Mm^3 to handle the greater Baalbeck area where around 150,000 people live generating about 3.65 Mm^3 of wastewater. The WWTP is fully operational, but there is no wastewater delivered for treatment. At present, a private contractor maintains the plant, which is part of the construction contract.

According to the discussion with local representatives, the WWTP faces the following problems:

- It was planned, that the municipality of Baalbeck would take over the O&M of the WWTP, but their current resource allocation does not enable them to provide an adequate O&M;
- One of the reasons that not all households are connected to the sewer network is the lack of funds. On average, the costs of underground connection amount to EUR 400 per house;
- Due to water scarcity the use of wastewater for irrigation has a long tradition in this area;
- Many households have connected their wastewater pipes to the surface irrigation channels;
- Upstream communities fear that they only deliver wastewater, but do not receive the same amount of treated wastewater for irrigation.

4.1.2 Community WWTPs

More than 40 small scale WWTPs have been constructed by several NGOs and financed by USAID, but at present none of them is working properly for several reasons. Mainly inadequate technology and insufficient support to the operators led to a failure of these systems. For that reason, USAID has changed its strategy. Currently, two WWTPs are under construction in Aitanit (1.8 Mm^3) and Fourzol (0.4 Mm^3). In the municipalities of Ablah and Chmistar two similar WWTPs (0.7 Mm^3) are under preparation. The WWTPs are designed to meet the MoE standards on effluents for surface water. Once the construction is completed, USAID is planning intensive training to ensure sufficient O&M by municipalities.

4.1.3 Greywater Treatment and Reuse

Since 2002, the Lebanese NGO Lebanese Appropriate Technology Association (LATA) in cooperation with the consulting company Middle East Center for Transfer of Appropriate Technology (MECTAT) conducted a project on greywater treatment and reuse, which was sponsored until 2008 by the Canadian International Development Research Centre (IDRC) and since 2008 by the Italian Government for Development Cooperation.

At present, 211 treatment units have been constructed. The project covers ten towns in Beqaa and two in South Lebanon. Each house is equipped with a 4- or 3-barrel treatment kit, in which anaerobic treatment of the collected greywater takes place during one or two days, and then it is pumped into a drip irrigation network installed in the garden. Based on a greywater recovery rate of 50 to 60% about 100 to 150 m³ of irrigation water is provided per household, which is sufficient for a common home garden. The average unit cost ranges between EUR 250 to 400 depending on household size.

The selection criteria for households are availability of a home garden and interest in gardening, scarcity of water at household level, absence of local sewer system, and technical feasibility of the system to use gravity for water flow. On average, participating households have a monetary benefit: their water bills for truck-delivered water were reduced by 20% and costs related to emptying of septic tanks fell by about 60%. Hindrances are operation of the treatment systems, changes in the washing habits, and low acceptance of non-users [24].

4.2 Plans and Ongoing Projects in Wastewater Reuse

The level of collection and treatment of wastewater is currently very low, but Lebanon plans to construct over 30 WWTPs with a design capacity of around 365 Mm^3. In addition, there are programmes to rehabilitate and expand the existing wastewater collection systems. The projects aim at a wastewater treatment rate of 80% by the year 2020.[5]

These plans create the preconditions for WWR, but the only planning document citing options for WWR is the National Decennial Strategic Plan for the Water Sector from 1999. It proposes irrigation and recharge of aquifer as applications for treated wastewater. The strategy differentiates between the coastal and inland areas [12]. As for the WWTPs that are being constructed in the coastal region, their effluents, which will form about 70% of the total treated wastewater, will be mainly discharged into the sea. Except for a small portion, there are no plans to use the effluent for irrigation purposes. A substantial portion of TWW can be used for groundwater recharge. The inland WWTP would increase considerably the amount of TWW available for irrigation [9].

Table 7 summarises the ongoing wastewater projects supported by international donors, which are described in chapter 3.3. The main target of these projects is to provide wastewater collection and treatment. None of the projects focuses exclusively on WWR, but according to the inventory of WWTPs presented by the EU Water Sub-Group, all WWTPs in Beqaa that are under construction or under preparation have envisaged WWR. For all other WWTPs reuse is not envisaged.

[5] These presented figures take into account a total amount of 456 Mm³ of wastewater, while the projections shown in Table 1 estimate a domestic water demand of 767 Mm³. Differences in data basis considered for projection or an assumed collection rate below 100% might explain these differences.

Table 7: Ongoing wastewater related projects supported by international donors

Donor	Project	Status
EC Delegation	Sewage Network and Wastewater Treatment Plant	Ongoing
EC Delegation	Set-up of Water Technical Management Tools	Ongoing
EIB	Greater Beirut Wastewater	Ongoing
EIB	South Lebanon Wastewater	Ongoing
EIB	Tripoli Wastewater	Ongoing, close to completion
EIB	Kesrwan Water and Wastewater	Under appraisal
AFD, France	Water Supply and Sanitation in North Lebanon	Starting soon
AFD, France	Preparing By-laws for Water Code	Starting soon
Mission Economique, France	Jbeil Wastewater Treatment Plant	Ongoing
Mission Economique, France	Batroun Wastewater Treatment Plant	Ongoing
KfW, Germany	Al Ghadir Wastewater Project	Starting soon
KfW, Germany	Rehabilitation of Water and Wastewater Infrastructure in Southern Lebanon (Emergency Programme, Phase I & II)	Ongoing
KfW, Germany	Rehabilitation of Sanitation System – Northern Lebanon (Emergency Programme, Phase III)	Ongoing
GTZ, Germany	Technical Assistance to the Water Sector Reform / Rehabilitation of Water Supply and Wastewater Systems in Lebanon	Ongoing
IGDC, Italy	Wastewater treatment plant and sewage system in Zahle	Ongoing
IGDC, Italy	Water Supply and Wastewater Management in Jbeil Caza	Approved
IGDC, Italy	Technical Assistance (set up of Project Implementation Unit with CDR)	Ongoing
IGDC, Italy	Construction of 4 Wastewater Treatment Plants and Networks in Michmich, Hrajel, Majdal/Anjar and Jbaa	Under evaluation
USAID, USA	Lebanon Water Policy Program	Ongoing
USAID, USA	Small Village Wastewater Treatment Plants Project	Under construction
UNICEF	“Environmental and WatSan Aid for the Adjacent Area of the NBC” Project, Sector A B C and E'	Ongoing
World Bank	Baalbeck Water and Sanitation Project	Ongoing

Source: EU Water Sub-Group, 2009 [25].

5 Analysis of Wastewater Reuse in Lebanon

5.1 Hindrances of Wastewater Reuse in Lebanon

The quasi absence of any controlled and safe reuse of treated wastewater in Lebanon can be explained by the following factors.

Wastewater Collection and Treatment Infrastructure

Reconstruction of the Lebanese infrastructure concentrates on electrical energy and fresh water supply systems. Wastewater collection or even wastewater treatment is of lower priority, while there are nearly no efforts in the field of reuse of treated wastewater. Prerequisite for WWR is, however, an operational sanitation and treatment infrastructure, which does not yet exist in Lebanon. Domestic households generate 249 Mm^3 of wastewater of which the majority is collected. On average, 67% of households are connected to the public sewage network, but the majority is discharged into the sea, often without any treatment. The design capacity of the operating WWTP is 70 Mm^3, equal to 31% of all generated domestic WW, but these WWTP are located at the coast and provide only primary treatment. Hence, there is no significant amount of treated wastewater available for reuse.

Performance of Existing Wastewater Treatment Plants

In Lebanon, there is a relatively high number of WWTPs, which are incomplete, abandoned, ineffective, or not functioning properly. Neither the large-scale Ghadir WWTP nor the small-scale community based WWTP provide an effluent quality, which would enable safe WWR projects. In general, the Lebanese wastewater treatment sector suffers from the poor performance of its WWTPs. Due to temporary electrical power outage, all WWTP require an independent power supply system.

Operation and Maintenance of Infrastructure Facilities

In the past, O&M of treatment facilities was not given much attention in Lebanon. In general, allocations of human and financial resources to the municipalities or regional WE as the main operating agencies are insufficient for an adequate operation of all water related facilities. Currently, the key priority of these operators is water supply and there are no capacities to fulfil other responsibilities.

However, CDR as main construction agency has recently started to include O&M for the first 3 years into all construction contracts before handing over the facility to the respective operators.

Wastewater Generation and Potential Treated Wastewater Demand

The geographical and topographical features of Lebanon show two fundamental unfavourable conditions. First, domestic WW is mainly generated in the coastal zones, where about 80% of the population lives, while the major agricultural areas are located across the Mount Lebanon mountainous chain in the Beqaa plateau. Agricultural production in Beqaa demands 52% of all irrigation water to irrigate 42% of the cultivated area. Second, in order to use gravity for sewage flow, WWTP are located at lower altitudes, but most agricultural areas are located on higher altitude. Energy demand and the related costs of pumping reduce its competiveness with other water sources.

Water Balance

Lebanon has sufficient water resources, but due to inefficient distribution and regional differences in water supply, there are location specific water shortages during the dry season. There is no countrywide water pressure forcing the consideration of WW as additional source of water. In fact, the estimated water balance for 2003 was positive, but a water deficit is projected

within the next 20 years. Presently, the total exploitable water supply is 2,000 Mm^3, while total water demand amounts to 1,257 Mm^3.

Sector Policy

There is no master plan for wastewater reuse and there is no governmental institution responsible for the promotion of wastewater reuse. Although the National Decennial Strategic Plan for the Water Sector (2000-2010) includes wastewater related components, there is almost no implementation of these plans.

Institutional Set-up

The Lebanese water sector suffers from its institutional weaknesses. There is fragmentation, overlapping functions, and lack of cooperation or coordination of agencies in charge of water resources management: MoEW, LRA, regional WEs, CDR, MoA, MoE, and local water committees are all involved in the management of the water and wastewater sector. Separate institutions undertake construction and operation of WWTPs. However, the regional Water Establishments being the operational agencies have insufficient know-how and skills for efficient operation, control and monitoring of WWT and are not familiar with WWR systems. In general, the WE lack on human resources (especially adequate technical staff), administrative and financial autonomy, and inadequate financial resources.

Legal Framework

Lebanon's legal basis for reuse of wastewater is non-existent. Laws and regulations governing the water sector are outdated and cannot deal adequately with emerging issues such as acquired water rights and the establishment and operation of Water User Associations. The new water code initiated in 2004 has not been proposed to the parliament commissions yet. The key deficits are missing legal regulations and guidelines for wastewater reuse and quality standards for different reuse purposes. There are only standards for the discharge of treated WW into the sea, but none for irrigation purposes. Another problem is the insufficient control and the low level of enforcement, e.g. regulations regarding issuing permits for well drilling, distances between wells or drilling near springs.

Economic Aspects

At present, the whole water sector is supply oriented, all activities focus on mobilisation of available water resources to increase water supply. None of them promotes a more efficient use of water. Neither the water supply fees nor the sewage related tax are based on volumetric charging. If there is no incentive to economise the use of fresh water, the motivation to substitute fresh water by treated wastewater is limited.

The current fees in the water sector do not cover the actual O&M costs of the related facilities. The tariffs for water supply are low, outdated, and not related to the quantities used. Further, there are weaknesses in the fee collection system; it is reported that about 50% of the bills are outstanding. The resulting limited budget leads to irregular and low quality services, but regular and effective services as well as sufficient operational facilities in the water sector are prerequisite for the establishment of a wastewater reuse sector.

Social Acceptance and Public Opinion

People regard water as a public good and do not consider distribution costs or service delivery fees. In addition, irritation water is highly subsidised. A water tariff reform is therefore a very sensitive political and social issue.

Wastewater is usually discharged into the environment or it is used directly for irrigation. Collection of fees for wastewater treatment or treated wastewater use might fail without an overall reform of water tariffs and information campaigns to convince the public about the benefits of wastewater treatment and to pay for the related service delivery costs.

In spite of the obvious use of raw wastewater for irrigation in some areas, the related risks are almost unknown to the public and there is no public discussion on the consumption of agricultural products irrigated with treated wastewater. There is neither pressure from the public nor from the administration to use only safe water for irrigation.

5.2 Estimated Potential of Wastewater Reuse in Lebanon

The degree of WWR in Lebanon is currently quite low and the unfavourable frame conditions for WWR limit the mobilisation of its potential. However, the use of raw wastewater for irrigation indicates in certain areas a demand for additional, non conventional sources of water, basically caused by the lack of permanent and sufficient supply of fresh water. In these areas, there seems to be neither religious nor cultural hindrances on the acceptability of WWR.

The potential of WWR depends on the amount of TWW provided and its economic competitiveness compared to other sources of water. The amount of potentially available wastewater is compared to the irrigation water demand, which is considered as reference system to evaluate the potential of WWR for each administrative region. Due to lack of data on TWW quantities, the generated and the collected wastewater are included in the following presentation (Table 8).

Table 8: Present status of domestic wastewater, collected wastewater, and irrigation water demand in selected administrative regions

	Lebanon (whole)	Mount Lebanon & Beirut	North Lebanon	South Lebanon	Nabatieh	Beqaa
Domestic wastewater (Mm³)	249[8]	119[8]	50[8]	29[8]	17[8]	34[8]
Domestic WW (% of IWD)[1]	*31%*	*152%*	*32%*	*25%*	*107%*	*8%*
Collected wastewater (Mm³)	167[a]	95[a]	31[a]	19[a]	3[a]	16[a]
Collected WW (% of IWD)[1]	*21%*	*122%*	*19%*	*16%*	*19%*	*4%*
Irrigation water demand (Mm³)	810[11]	78[11]	158[11]	118[11]	16[11]	412[11]

Note Data with [citation] base on considered source
[1] amount of water expressed as percentage of irrigation water demand (IWD)
[a] this estimate considers a collection rate of 67% for Lebanon, 80% for Mount Lebanon and Beirut, 61% for North Lebanon, 66% for South Lebanon, 18% for Nabatieh, and 46% for Beqaa [18]

Source EMWater Project, 2004 [8], The World Bank, 2003 [11], Hamamy, G., 2007 [18]

The analysis shows that the estimated losses from inefficient irrigation amount to 37% of the irrigation demand and exceed the countrywide generated amount of wastewater.[6] Second, there are huge differences between the administrative regions. Generated domestic wastewater expressed as percentage of irrigation water demand reaches in the urban administrative region of Mount Lebanon including Beirut 152%. In Beqaa, which is the major agricultural area in Lebanon, it is only 8%. Countrywide, the collected wastewater amounts to 21% of the irrigation water demand, but due to its low collection rate the amount of collected wastewater in Beqaa reaches only 4% of the irrigation water demand. Figures for North Lebanon, South Lebanon, and Nabatieh range around the countrywide average.

[6] The average irrigation efficiency amounts to 63%, see chapter 2.5.1

The forecast for the year 2020 assumes a countrywide wastewater treatment rate of 80% and a significant increase in domestic water demand, figures for 2020 are twice above the present level (Table 9). Due to new agricultural projects, there is also a significant increase of the projected irrigation water demand in South Lebanon and Nabatieh.[7] The projected TWW quantities could fulfil the demand of the irrigation sector by nearly 30% in the southern regions, while in North Lebanon it is more than 50%. The isolated inland administrative region of Beqaa remains the biggest consumer of irrigation water, but its generated TWW has the potential to contribute only 13% to the projected irrigation water demand.

Table 9: Projected status of domestic wastewater, treated wastewater, and irrigation water demand in selected administrative regions for the year 2020

	Lebanon (whole)	Mount Lebanon & Beirut	North Lebanon	South Lebanon	Nabatieh	Beqaa
Domestic wastewater (Mm³)	578[11]	275[a]	116[a]	68[a]	40[a]	78[a]
Domestic WW (% of IWD)[1]	*57%*	*352%*	*66%*	*35%*	*34%*	*16%*
Treated wastewater (Mm³)	462[b]	220[b]	93[b]	54[b]	32[b]	62[b]
Treated WW (% of IWD)[1]	*45%*	*282%*	*53%*	*28%*	*27%*	*13%*
Irrigation water demand (Mm³)	1 020[11]	78[11]	175[11]	192[11]	117[11]	482[11]

Note Data with [citation] base on considered source
[1] amount of water expressed as percentage of irrigation water demand (IWD)
[a] the projected domestic water demand and the present ratio between domestic water demand and generated domestic WW is considered to estimate to projected domestic wastewater
[b] this estimate considers the projected treatment rate of 80% [9]

Source The World Bank, 2003 [11], MEDAWARE, 2005 [9]

In Beqaa, improvements in irrigation efficiency are in general more effective in saving scarce water resources than WWR. However, decentralised WWR schemes at selected sites can contribute a more significant share of the irrigation water demand.

In the administrative region of Mount Lebanon including Beirut domestic water is by far the biggest consumer of water and its demand will more than double in 2020. In general, reuse of treated wastewater for irrigation purposes is here of minor importance, but in selected places it could substitute scarce fresh water resources. Another option in this region would be groundwater recharge to fight saltwater intrusion.

WWR could have a high potential in the irrigated agricultural production systems in North Lebanon and in the southern administrative regions. A considerable share of the irrigation water demand could be provided by TWW, but this requires a technically and economically feasible connection between the WWTPs and the irrigation schemes.

The previous analysis excludes economic costs considerations. Mobilisation of the WWR potential, apart from technical considerations, requires a cost benefit analysis of WWR and its competing water sources. These are extensions of existing or exploration of new water sources as well as methods of reducing water losses. Furthermore, in contrast to water saving methods, reuse of treated wastewater requires a distribution system from the WWTP to the irrigated fields, which generates additional costs.

Benefits of Wastewater Reuse Projects

Wastewater reuse can have a quantitative as well as a qualitative impact on water supply. The major benefit of treated wastewater reuse in Lebanon lays not in providing additional water for irrigated fields, but in its improvement of the water quality. The substitution of raw wastewater

[7] The Litani Project Level 800 aims to serve a population of 518,000 persons in southern Lebanon by 2030. The project will provide 90 Mm³ of water for irrigation and 20 Mm³ of water for drinking on an annual basis.

through treated wastewater discharged in various water bodies reduces the negative impact on human health and the degradation of environmental resources.

The present situation of insufficient wastewater collection and treatment leads to a serious degradation of environmental resources and health problems. The majority of wastewater is generated in the coastal zones and discharged through sea outfalls into the Mediterranean Sea. Inland raw wastewater is discharged into surface water bodies and to some extent directly or indirectly used for irrigation. Especially during the dry summer period, the highly polluted rivers and lakes cannot be used as safe sources of water. In addition, the polluted surface water causes pollution of groundwater resources. The use of polluted water for all domestic purposes and irrigation causes diseases and sanitary problems, especially to children.

Lebanon faces locally and seasonally water shortages on potable water, but in contrast to other countries in the region, it is still able to provide sufficient amount of fresh-water for all purposes. However, water supply and water use in Lebanon is characterised by inefficient water supply, e.g. network leakage, and inefficient water use, especially in the agricultural sector. Therefore, improvements in these fields are more promising than to consider the rather small amount of treated wastewater. However, at specific locations wastewater reuse can provide a significant contribution to face the problem of increasing water scarcity. Since the domestic water demand is projected to increase significantly and groundwater exploitation is already beyond a sustainable level, reuse of treated wastewater has a positive impact on water conservation through substitution of fresh water resources (for non-drinking proposes). In addition, treated wastewater has the potential to fight intrusion of saltwater into coastal aquifers, e.g. by aquifer recharge.

Profitability of Wastewater Reuse Investments

The major benefits of wastewater reuse are seen in the reduction of social costs, and not so much in generating individual benefits. Therefore, the profitability of wastewater reuse investments has to be analysed from the private as well as social point of view.

Private Profitability of Wastewater Reuse Investments

At present, wastewater is discharged into the sewer network, the environment, or used for irrigation free of charge. The principle of "polluter pays" is currently not adopted. Irrigation water is highly subsidised and only where water is scarce, wastewater is used for irrigation. This situation is quite unfavourable to transfer all or even part of the wastewater reuse related costs to those generating wastewater or those reusing wastewater. Wastewater related costs comprise investment and O&M costs of wastewater collection and treatment as well as storage and distribution costs to the place of reuse. For that reason, it its expected that water fee collection will be insufficient for private investments. Without a water tariff reform, accompanied by wastewater related laws and their enforcement, private investments are expected not to be profitable under the current frame conditions in Lebanon.

Social Profitability of Wastewater Reuse Investments

The degradation of environmental resources and negative impacts on human health causes social costs, e.g. costs for cleaning (wastewater treatment), medical costs, non-productive time of labour due to illness. The substitution of raw wastewater by treated wastewater can provide a significant contribution to the reduction of these costs. The evaluation of these benefits to estimate the social profitability of any investment in wastewater reuse requires a cost benefit analysis. It is expected that, from the social point of view, most investments are profitable.

6 Conclusions and Recommendations

6.1 Summary of Current Situation

The current situation in the water supply, sanitation and wastewater reuse sector in Lebanon can be summarised as follows:

- **Need for additional water resources/water reuse**: although Lebanon has today an overall positive water balance, local and seasonal water deficits already exist and projections indicate a water deficit within the next 20 years. Problems exist in particular in:
  - Certain agricultural areas, such as the Beqaa valley, where untreated wastewater is already used for irrigation;
  - at the coastline where severe saltwater intrusion is taking place mainly due to overexploitation of groundwater/excessive pumping.
- **Need for safe water**: the use of untreated wastewater and the discharge of wastewater into open water bodies causes negative impacts on human health and degradation of natural resources:
  - especially in Beqaa the use of untreated wastewater for irrigation of food crops leads to contaminated and unsafe food;
  - partially extreme pollution of surface waters through discharge of untreated wastewater, e.g. the Litani river.
- **Potential sources for reclaimed wastewater**: are not existing at present in the required quality for safe reuse, as
  - only about 31 % of the wastewater generated is currently undergoing a primary treatment and existing large-scale WWTPs are not operational, e.g. Baalbeck. 19 large-scale WWTPs (> 1.0 Mm^3) with secondary treatment are currently under construction or in the course of planning, however reuse potentials and opportunities are not part of project preparation;
  - although a considerable number of small-scale WWTPS has been constructed in rural areas, the majority of them is not operating properly, mainly due to lack of local capacities and inappropriate technologies applied;
  - separate collecting sewer systems for waste and storm water do not exist.
- **Legal framework**: neither explicit laws, decrees and guidelines nor standards for the reuse of wastewater or a wastewater reuse policy are currently in place.
- **Institutional set-up**: the existing operating structures in the water & sanitation sector - in particular the regional water establishments - are weak, understaffed and under financed. They focus today mainly on water supply as they have only very limited resources/capacities to deal with sanitation or even wastewater reuse.
- **Long-term financial viability**: the existing (lump sum) water tariffs cover only part of the water supply costs; no volumetric fees for the (usually more expensive) wastewater treatment are currently raised.
- **Concrete needs assessment for wastewater reuse schemes**: not carried out yet, but some approaches/ideas exist;
- **Low priority of wastewater reuse**: compared to water supply projects, the reuse of treated wastewater has a low priority inside the water policy of the Lebanese government and of international donors.

6.2 Project Proposals

A prerequisite of wastewater reuse is a functional wastewater collection and treatment system. Since this is not the case in Lebanon, a reform of the wastewater sector is the basis for all types of wastewater reuse schemes. Not only wastewater, but also the entire Lebanese water sector requires substantial changes. There is a need to elaborate an overall water resources management strategy looking at the entire water cycle and integrating environmental, social, and economic parameters. The current constraints faced by the water sector as well as the reuse of treated wastewater and consequently the proposed projects lay not only in the technical, but moreover in the institutional, political, legal, and financial field.

Lebanon faces a lot of problems in the water and sanitation sector, whereas wastewater reuse has currently a very low priority. As laid out above, the pre-requisites for the implementation of successful reuse schemes are currently not given. However, it is recognised by the authorities involved that wastewater reuse could/should play an important role in the future development of the sector within the frame of an integrated water resources management (IWRM).

The project proposals developed together with the official interview partners during the Consultant's mission to the country are hence quite pre-mature ideas on how to integrate wastewater reuse options in already planned sanitation projects and how to promote and support the IWRM approach on a broader scale.

The project ideas/proposals can therefore not be presented in the format of project profiles as in the case of the other four countries, but as a list of more or less concrete ideas, which have to be studied in further detail in order to elaborate sound proposals.

Based on the above conclusions, the following needs and related project proposals for the promotion of wastewater reuse in Lebanon were identified:

- Need for basic **capacity development** in the water, sanitation and reuse sector (= in Integrated Water Resource Management), in order to develop a stringent water policy/legal framework and to strengthen the institutions involved on all levels, in particular the operating water establishments;
- Introduction of a **sustainable water tariff structure** for water supply and wastewater treatment that consider social and regional related components to provide competitive tariff structure for reuse;
- Exhaustive **study on the groundwater/aquifer regime** as basis for the identification of potential groundwater recharge options to fight salt intrusion by seawater;
- **Rehabilitation/extension of large-scale WWTPs**, in order to get them fully operational as well as to introduce a secondary treatment;
- **Extension/completion of sewerage networks**, including household connections in order to feed existing WWTPs, via soft loans for municipalities (e.g. over a 'Municipal Fund') and/or microfinance systems for individual households;
- **Construction of storage facilities and distribution networks** to allow the reuse of reclaimed wastewater, as soon as and wherever WWTPs with secondary treatment and disinfection are operational and located close to those areas where agricultural reuse is possible and profitable;
- **Construction of small-scale WWTPs** with adjacent wastewater reuse schemes in rural areas, to be financed e.g. over a 'Municipal Fund' - including intensive capacity development on the spot;
- **Improvement of irrigation techniques** - promote safe and modern irrigation techniques for treated wastewater, to be financed e.g. over an earmarked fund (as in Syria) - including intensive capacity development on the spot;

- **Extension of grey water use** for big establishments / institutions as well as on household level including intensive capacity development on the spot.

6.2.1 Capacity Development Centre

A prerequisite for the introduction and operation of any sustainable wastewater reuse scheme is an appropriate legal framework and an according suitable institutional set-up. Properly cooperating institutions at all levels, providing sufficient resources, knowledge and experience to design, plan and operate/manage sound and safe wastewater reuse schemes as part of an Integrated Water Resources Management (IWRM) are currently very limited up to non-existing in Lebanon.

In order to overcome the current water sector problems, intensive capacity development at all levels (from ministries down to the local executing agencies) is needed, focussing on the following topics:

- **Institutional and legal framework**: definition of clear institutional responsibilities and forms of cooperation and procedures to respect, regulations including decrees and guidelines, law enforcement, supervision & monitoring systems, tariff system;
- **Financial management**: economic feasibility of planned projects, business plans for operation, accounting & controlling of water operating agencies, promotion of services;
- **Technical management**: identification of needs and adapted technical solutions within an IWRM approach, technical feasibility of planned projects, planning, construction, O&M of wastewater reuse schemes;
- **Stakeholder participation**: capacity building of stakeholders, cooperation with stakeholder associations (Water User Groups);
- **Public awareness**: information of the broader public, promotion of water saving & recycling approaches, acceptance of the use of reclaimed wastewater, e.g. in irrigation of crops.

In discussions with the Ministry of Water and Energy (MoEW), the CDR and the Litani River Authority the idea of an education, training, study and demonstration centre - a so-called **Centre of Excellence for Water** - has been developed. The promoter of such a centre could be the **MoEW**, as most concerned ministry.

This national Centre of Excellence could be organised as a kind of a training centre, offering tailor-made theoretical courses and practical programs for stakeholders involved at all levels, from decision makers to technical staff.

It should represent a platform for the exchange of knowledge and experiences needed for the development of a political framework, including a proper wastewater reuse/IWRM policy, an according legal framework with decrees and guidelines, law enforcement, supervision & monitoring systems, water & sanitation tariff systems and public awareness rising.

The precise offers of such a Centre of Excellence as well as the scope of activities have to be studied carefully in form of a feasibility study, including the:

- Institutional set-up, ministry/institution in charge, staffing, equipment, funding of investment and operational costs;
- Identification of target groups with their specific needs on policy, economic and technical level, including the estimation of the number of potential beneficiaries;
- Proposals of theoretical and practical training programs on the topics needed;
- Proposal on the organisation of a platform for information exchange and networking as base for the capacity development within the (national) governmental institutions involved in the sector;

- Identification of the needs and availability of teaching staff;
- Proposals of pilot projects (as small-scale plants, laboratories etc.);
- Identification of the size and equipment needed and proposal of an appropriate location;
- Economic evaluation, including the estimation of cost-covering training & service fees;
- Coordination of wastewater reuse activities and cooperation with international donors.

6.2.2 Study on Aquifer Recharge Options

Saltwater intrusion is a severe problem threatening local water supply by groundwater wells, in particular in the densely populated coastal region.

Aquifer recharge has proven to be an appropriate method **to fight saltwater intrusion**. In order to develop an efficient, operational and safe recharge system; the current hydro-geological situation has to be known in detail, which is not the case in Lebanon.

CDR proposed a comprehensive study, which should include - besides the necessary hydro-geological data describing the complete groundwater situation in sufficient detail - the definition of quality requirements for reclaimed/recycled water to be recharged. Wastewater has to be purified to a high extent (very low level of salts, nutrients, organic pollutants, heavy metals etc.) not to jeopardize the resource. Besides treated wastewater, storm water could be a less problematic source for aquifer recharge.

Apart from the water quality achieved, the specific recharge technique applied (e.g. indirect versus direct) has an importance impact on the safety of the system.

The proposed study should include an economic evaluation of different potential groundwater recharge systems, including the treatment, intermediate storage and distribution costs for the reclaimed water.

6.2.3 Rehabilitation/Extension of Large-scale WWTPs

A necessary precondition for the reuse in irrigated agriculture and for other purposes is the availability of sufficiently treated wastewater. This is currently not the case in Lebanon, where only two coastal large-scale WWTPs (Saida, Al Ghadir) are equipped with primary treatment facilities.

Those two could be **upgraded** with **secondary treatment facilities and disinfection for irrigation** purposes, and an additional **tertiary treatment for potential direct groundwater recharge**.

All other WWTPs currently planned or already under construction should consider wastewater reuse options and, wherever appropriate, include equipment with intermediate storage facilities and primary distribution networks. The most appropriate reuse options - as connections to irrigated agriculture, groundwater recharge or others, e.g. municipal use - have to be analysed and the required investment and operating costs identified in separate feasibility studies.

The **CDR** and the **MoEW** are basically in favour of such an integrated approach, whereas no explicit activities are envisaged so far.

6.2.4 Extension/Completion of Sewerage Networks

Besides the limited wastewater treatment capacities, it is also the **occurring lack of sewerage networks** - central sewers and household connections - which hinder the collection and treatment of wastewater, e.g. in Baalbeck, where a fully equipped large-scale WWTP isn't operational due to lacking household connections.

Although sewerage networks/connections are no proper reuse projects, their existence is a pre-requisite for any kind of central wastewater treatment and for subsequent reuse.

As limited financial resources in the municipalities concerned mainly cause the lack of sewerage systems, the set-up of a kind of **microfinance system for households** to finance their individual connections, complemented by a **Municipal Fund** for the financing of central sewers could be a promising project to be studied for specific local circumstances. Such a municipal fund could be located at/hosted by the **CDR**, having already experience with fund management, as the 'Economic and Social Fund for Development', funded by the European Union.

The Baalbeck case is already addressed by the EBRD, whereas other municipalities face similar problems, which have to be addressed in order to advance the sector.

6.2.5 Construction of Storage Facilities and Distribution Networks

At present, a number of large-scale WWTPs with secondary treatment are under construction or under preparation. So far, wastewater reuse is only envisaged for the WWTPs located in Beqaa, but for none of the remaining WWTPs. A **study** (promoted by the **CDR** and the **MoEW**) is therefore recommended to identify other WWTPs having the potential for wastewater reuse.

These could be **'pure' wastewater reuse projects**, investigating:

- Agricultural activities in the vicinity, suitable for irrigation with reclaimed wastewater (definition of quality criteria);
- Opportunities and ways to set-up so-called 'Water user Associations' (WUAs), which could organise the distribution of the reclaimed wastewater as well as contribute to the financing of the intermediate storage and distribution systems;
- User's acceptance, including governmental authorities involved, need for a public awareness raising campaign;
- Additional installations needed, as intermediate storage facilities and distribution networks, as well as appropriate irrigation techniques, supplemented by training and capacity development of all stakeholders involved (from the operators/water establishments to the end-users/farmers;
- Long-term economic viability, e.g. over cost covering water tariffs and/or over governmental subsidies.

6.2.6 Construction of Small-scale WWTPs in Rural Areas

Community based small-scale WWTPs are an important precondition for safe wastewater reuse in particular in remote rural areas. In rural Lebanon around 40 community based WWTPs had been constructed, but most of them failed due to inadequate technology and/or insufficient capacities of the operating agencies.

In spite of these experiences, it is proposed by the **CDR** to establish a **system/network of about 100 decentralised community based WWTPs**, being characterised by location specific **low-tech technologies** to fit the capacities of the local operators. For this purpose, a small range of technologies (e.g. maturation ponds/lagoons, different kind of batch reactors, constructed wetlands etc.) should be offered, adapted to the specific local conditions, and planned in a participatory way with the stakeholders concerned.

Appropriate low-tech technologies are easily available. The challenge lies in the careful planning, the adaption to the respective specific local situations, participation of stakeholders (Farmer Associations or Water User Groups), and the capacities of the local operators. Accompanying **capacity development** and **training-on-the-job** should therefore be an indispensable part of each investment project. Appropriate locations and concrete investment needs have to be studied in advance.

An approach to finance these decentralised small low-tech and low-costs treatment facilities could be the same as for the municipal sewerage systems, means a **Municipal Fund**, located at/hosted by the **CDR**.

6.2.7 Extension of Grey Water Use

Grey water projects have already been successfully implemented by a NGO in Lebanon on a small scale. As **grey water reuse** could be an important component of an integrated water resources management in remote areas with limited or even no treatment facilities, its broad-scale promotion is proposed as a potential project.

About 80% of households in rural areas are potential users for grey water reuse. In addition to private households, selected public buildings can be connected to grey water reuse systems.

Since water supply and wastewater infrastructure is rather poor in refugee camps, grey water reuse has a high potential to reduce negative health impacts and to enable safe cultivation of crops in a home garden.

The concrete opportunities of grey water reuse on a larger scale have to be studied, before setting up a concrete **program, consisting of construction of treatment and storage as well as distribution facilities** for individual households, bigger public establishments, refugee camps etc. Any future program should include accompanying capacity development and training-on-the-job activities for all stakeholders involved.

As such a study/program encompasses the whole water sector, it should be allocated at the **MoEW**.

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Annex 1:

Contact Persons

Meeting Schedule

13.02.2009	
10.00	Mr. Ismail Makki (Council for Development and Reconstruction)
16:00	Mr. Younes Hassib (GTZ) Mr. Daniel Neuwirth (KfW)
16.02.2009	
09:00	Dr. Fadi Georges Comair (Ministry of Energy and Water)
16:00	Mr. Raji Maasri (MORES Consulting)
17.02.2009	
10.00	Mr. Boghos Ghougassian (Middle East Center for Transfer of Appropriate Technology / Lebanese Appropriate Technology Association)
12:00	Ms. Laura Carpino (Italian Development Cooperation) Dr. Hassan Bitar (Italian Development Cooperation)
14:00	Mr. Youssef Karam (Council for Development and Reconstruction)
16:00	Dr. Ali Moumen (FAO)
18.02.2009	
9:00	Ms. Sana Saliba Khoury (USAID) Mr. Rami Wehbeh (USAID)
10:30	Mr. Hussein Nasrallah (Ministry of Agriculture)
11:30	Prof. George Ayoub (American University of Beirut)
14:00	Mr. Peter Christiaensen (EC Delegation) Ms. Mia Dubois-Boussaid (EC Delegation)
19.02.2009.	
	Site visit of WWTP Baalbeck Mr. Walid Atallah (UNDP sub office Beqaa) Mr. Charles Fakhoury (Contractor)
20.02.2009	
9:00	Dr Houssain Abouzaid (WHO)
10:30	Dr. Nabil Amacha (Litani River Authority) Dr. Mark Saadeh (consultant for the Litani River Authority)
14:00	Dr. Nadim Farajalla (American University of Beirut) Dr. Hamed Assaf (American University of Beirut)

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Annex 2:

Background Data on WWTP

List of Tables

Annex 2 Table 1: Inventory of Wastewater Treatment Facilities (2009)

Location	Treatment level	Financing organisation	Design Flow (Mm^3)	Status of WWTP
Al Ghadir, BML	primary	KfW	50.4	Operational
Jbeil, BML	biological	AFD	3.3	Construction completed
Qartaba, BML	biological	IGDC	0.4	Under preparation
Jiyeh, BML	biological	FP	2.2	Construction completed
Bourj Hammoud / Dora, BML-Metn	biological	EIB	118.6	Design
Keserwan / Tabarja, BML	biological	EIB	25.6	Tender process
Hrajel, BML-Kesrouan		IGDC	2.2	Design
Khenchara, BML	biological	Abu Dhabi	0.9	Design
Barouk, BML	biological	Arab Fund	0.7	Design
Aamatour, BML-Chouf	biological	USAID	0.3	Completed
Hammana, BML-Chouf	biological	USAID	0.4	Completed
Bater, BML-Chouf	biological	USAID	0.3	Completed
North Lebanon and Beirut (BML)			**205.3**	
Baalbek, Beqaa	biological	World Bank	4.6	Construction completed
Zahle, Beqaa	biological	IGDC	6.6	Under construction
Jib Jinnine, Beqaa	biological	IDB	3.8	Under construction
Saghbin, Beqaa	biological	IDB	0.2	Under construction
Majdal/Anjar, Beqaa-Zahle	biological	IGDC	16.2	Under preparation
Laboueh, Beqaa	biological	Iranian Fund	2.6	Under construction
Rachaya, Beqaa	biological	YMCA	0.2	Completed
Aitanit, Beqaa	biological	USAID	1.8	Completed
Fourzol, Beqaa	biological	USAID	0.4	Completed
Chmistar, Beqaa	biological	USAID	0.7	Under preparation
Ablah, Beqaa	biological	USAID	0.7	Under preparation
Beqaa			**37.8**	
Tripoli, NL-Great Tripoli	biological	EIB	49.3	Final stages of construction
Batroun, NL	biological	AFD	1.5	Final stages of construction
Chekka, NL	biological	FP	0.6	Under construction
Michmich, NL-Akkar	biological	IGDC	2.5	Under preparation
Koura, NL	biological	Arab Fund, AFD	4.0	Under design
Abdeh, NL	biological	Arab Fund	11.0	TD under preparation
Bcharreh and Hasroun, NL	biological	Arab Fund	1.3	Under preparation
North Lebanon (NL)			**70.2**	
Saida, SLN	primary	JBIC	25.6	Operational
Sour, SLN	biological	EIB	16.4	Tender documents
Nabatiye, SLN	biological	FP	3.6	Construction completed
Hebbaryeh, SLN-Hasbaya	biological	USAID	0.3	Completed
South Lebanon and Nabatieh (SLN)			**45.9**	
Total			**359.2**	

Note Reuse of effluent is envisaged for all WWTPs in Beqaa, but for non at remaining WWTPS

Source EU WATER GROUP, 2009 [20]

Annex 2 Table 2 Environmental Limit Values for Wastewater Discharged into Surface Water

Parameter	ELV for existing facilities	ELV for new facilities
pH	5-9	6-9
Temperature	30ºC	30ºC
BOD5 mg/l	100	25
COD mg/l	250	125
Total Phosphorus mg/l	16	10
Total Nitrogen mg/l	40	30
Suspended Solids mg/l	200	60
AOX	5	5
Detergents mg/l	3	3
Coliform Bacteria/100ml	2,000	2,000
Salmonellae	Absence	Absence
Hydrocarbons mg/l	20	20
Phenol index mg/l	0.3	0.3
Oil and Grease mg/l	30	30
Total Organic Carbon mg/l	75	75
Ammonia mg/l	10	10
Ag mg/l	0.1	0.1
Al mg/l	10	10
As mg/l	0.1	0.1
Ba mg/l	2	2
Cd mg/l	0.2	0.2
Co mg/l	0.5	0.5
Total Cr mg/l	2	2
Hexavalent Cr mg/l	0.5	0.2
Cu mg/l	1.5	0.5
Fe mg/l	5	5
Hg mg/l	0.05	0.05
Mn mg/l	1	1
Ni mg/l	2	0.5
Pb mg/l	0.5	0.5
Sb mg/l	0.3	0.3
Sn mg/l	2	2
Zn mg/l	5	5
Active Cl_2 mg/l	1	1
Cyanides mg/l	0.1	0.1
Fluoride mg/l	25	25
Nitrate mg/l	90	90
Phosphate mg/l	5	5
Sulphate mg/l	1,000	1,000
Sulphide mg/l	1	1

Source: MEDAWARE, 2005 [9]

Annex 2 Table 3 Effluent Specifications of Wastewater Treatment Plants Based on MoE Decision 8/1, 2001

Parameter	Effluent Specifications
pH	6-9
Temperature	<35ºC
Salmonellae	Absent (zero)
BOD5 mg/l	<25
COD mg/l	<125
Total Phosphorus mg/l	<10
Total Nitrogen (TN) mg/l	<15
Suspended Solids mg/l	<600
Oil and Grease mg/l	<50
Total Organic Carbon (TOC) mg/l	<750
Coliform Bacteria 37°C in 100ml	<2,000
Ammonia mg/l	<10
Odor	Absent (zero)

Source: MoE, 2001 [21]