CHAPTER 6

ISSUES IN WATER RESOURCES MANAGEMENT

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6.1 National Policy and Strategy for Water Resources Management

Since the water is scarce over the country and is indispensable for satisfying basic human needs as well as social and economic activities such as industry and agriculture, a minimum level, at least, of water consumption must be secured by the public administrations. In planning water management approaches in order to optimize the use of limited volume of water resources, a more integrated manner is required from both supply augmentation and demand management sides. Within the limits of available volume of water and prevailing constraints on quality, benefits of water resources are to be maximized.

Integrated Water Resources Management means the adoption of a comprehensive approach with respect to the management of the water resources of every basin, simultaneously taking into consideration all aspect which are of relevance to these resources in terms of their sources, uses, and demands for various purposes... in such a way that all of these aspects are integrated with the goals, plans and programs of socio-economic development in the basin, and without undermining the sustainability of these resources or damaging their qualities.

Water Resources Policy: Objectives

Water policy involves all principles, which are adopted by the State regarding the optimal use of water resources, their management and development to achieve certain economic, social and environmental goals. A framework of water resources policy should include the following objectives;

- Augmentation of water supply to satisfy demand
- Management of water demand under better efficiency of water use
- Allocation of water resources to meet requirement from various water users
- Sustainable development of water resources
- Protection and conservation of water resources

Water Resources Strategy: Measures to realize objectives

Water resources strategy means the measures to translate the objectives given the water resources policy into realistic actions. To formulate such a strategy, water resources are assessed, database system is prepared, major water issues are extracted, extracted major issues are analyzed and ranked, development options are prepared and evaluated, and the best options are selected and implemented. The formulation of Water Resources Management Strategy requires iterative process of a long-term with periodical updating, revision and testing.

Water Resources Assessment

All the factors that influence water resources supply, utilization, development and management are examined. This process include evaluation of existing, on-going and planned water resources development and management projects, preparation of data and information basis regarding water-related items and assessment of water-related issues.

Database System

In the database system, all the items that influence water supply and demand are involved.

- Meteorological and hydrological data including climatic factors such as precipitation, temperature, humidity, wind, sunshine, and hydrological parameters such as discharges of rivers, and springs, groundwater extraction and rate of use
- Population, its growth rate, per capita consumption of water, service rates and water supply networks
- Industrial development and water-use intensity
- Irrigation area, cropping pattern, water consumption per unit area and status of irrigation drainage
- Efficiency rate of water distribution and conveyance
- Water tariff
- Water quality data and standards
- Water use facilities
- Flood protection measures and facilities
- Hydro-power, tourism and recreational requirements
- Operational data of water sources such as dam
- Reuse of effluent treated wastewater and of sludge

Selection of Major Issues

Major problems and critical issues involved in the water-related sectors are investigated and selected.

Analysis and Ranking of Major Issues

Selected major problems and issues are put into analysis to project future trend and potential on the basis of relevant data stored in the database. Cases of different development scenarios are given in analysis in order to assess the response of factors to be reflected to the output. Ranking of the issues follows this procedure.

In the new institutional arrangement of the water sector, the MEW stays overseeing and in a controlling position, except in the case of large scale hydraulic projects which MEW directly plans or implements (article 2 of Law No.221 of May 29, 2000, amended by article 1 of Law No. 337 of December 14, 2000)

The mission of MEW, which assumes jurisdiction over the water resources in Lebanon, is as follows;

- Protect and develop hydraulic natural resources
- Study supply and demand, and global situation of 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 groundwater
- Exercise administrative supervision over water authorities (WAs) and LRA
- Apply laws and regulations concerning preservation of water resources
- Practice the authority of administrative tutelage over autonomous WA and other entities active in the water domain
- Practice a supervisory authority on WAs
- Render opinion over mines and quarries water resources
- Grant permits and licenses for water drilling and the use of public water
- Control the surface and groundwater quality, and determine needed standards

The MEW is made up of two General Directorates, the Directorate General of Hydraulic and Electric Resources (DGHER) and the Directorate General of Operations (GDO). The DGO is expected to perform technical, administrative and financial control over the autonomous water authorities, whereas the DGHER is expected to perform the following functions:

For potable water
- Collect water from sources, transport it, and use it
- Drill wells, transport the water and exploit it
- Construct reservoirs to collect water and distribute it
- Install water transport and distribution lines
- Construct water distribution networks
- Install water treatment plants

For irrigation
- Maintain and rehabilitate existing irrigation channels
- Study and improve existing channels
- Study and implement large irrigation projects
- Promote new irrigation techniques

For flood water and drainage
- Improve river channels and protect abutting property
- Drain flood and surface water and build reservoirs to collect surface drainage for use in irrigation

It is expected that, under DGHER, Department of Groundwater and Geology keeps register of groundwater wells, and records hydro-geological behaviors of aquifers, Department of Land Acquisition and Water Rights keeps register data on water rights.

Besides the role of the MEW, Law No. 190 dated January 4, 1993 defined the mission and essential functions of the Ministry of Displaced (MD). The mission of the MD revolves around ensuring the return of displaced persons to their original areas and homes in Lebanese cities and villages. The following functions contribute to accomplish the ministry's mission.

- Conduct socio-economic surveys and studies to evaluate the requirements of reintegration of displaced people.
- Contribute to the rehabilitation and reconstruction programs of the infrastructure and the agricultural sector in locations that suffered from displacement.

The law of August 14, 1954 and its consecutive amendments created the Litani River Authority (LRA). LRA is now a planning and operating agency for irrigation water supply of the Litani basin. In this context, its function may include those of 4 WAs, and the Council of the South. By replacing the Ministry of General Planning, the Council for Development and Reconstruction (CDR) was created in 1977 (Law 5, January 31, 1977 and its consecutive amendments). It is attached to the Presidency of the Council of Ministers, which is headed by the Prime Minister. At present, sectors relevant to water resources management (water supply, wastewater and irrigation) account for 12.7% of all the CDR projects. Unlike other public institutions, the CDR is privileged to maintain direct contracts with foreign countries and multilateral investment agencies by bypassing the Ministry of Foreign Affairs, while the responsible ministries are assumed to be the executing agencies only nominally.

To support decision making procedure for formulation of water resources management master plan, JICA Study aims at construction of a Digital Balancing Model (DBM) linked with a Hydrological Circulation Model and consisting of three sub-models for 1) water demand projection, 2) water supply assessment and 3) water balance between supply and demand, all controlled by a GIS platform linked with a database. To fulfill this purpose, it is needed to enter all of collected data into a rational database compatible with GIS and models are to be calibrated by use of actual data of meteorology, hydrology and water use. Details concerning these models are given in Chapter 4 of this report. On the Basis of the comprehensive understandings of the existing conditions related to water resources management in Lebanon, and under the present circumstances where data to establish the above system are inadequate quantitatively and also qualitatively, JICA Study provides provisional plans of water resources management based on currently available data, and conducts counterpart training so as to enable the counterpart to operate, maintain and update the system periodically by themselves, on the basis of the most up-to-date data and information on socio-economic frame and hydrology at that point of time.

A list of references

- *Current Water Policies and Practices in Selected ESCWA Member Countries*, ESCWA, UN, October 1999

- *Policy Transformation and Implementation in the Water Sector in Lebanon*, Emmanuelle Kunigk, Occasional Paper No.27, Water Issues Study Group, School of Oriental and African Studies, University of London, 1998/99

6.2 Water Budget

As discussed in Chapter 4, surface water development potential and groundwater development potential available for the future water demand are estimated at 1,387.06 million m^3/year and 590.76 million m^3/year, respectively. Those potentials are the volume of water that can be developed by intakes (surface water development by direct intake), dams and hill lakes (surface water development by storage facilities), and wells (groundwater development). Thus, the total development potential of 1,977.82 million m^3 can be realized by construction of the above facilities.

Although the demand projection was conducted from 2002 to 2030, the target year, the present actual consumption or intake volume by water resources could not be identified due to the lack of data. For example, the present coverage of public water supply, varying from 49% in Akkar Caza to 95% in Hasbaiya Caza, induces water exploitation by individuals and most of industries rely on their own water resources, mainly wells. Besides, a long cease of government water resources development due to the civil war stimulated extension of private water resources in the field of irrigation. Those private water resources are hard to identify. Even for the water resources managed by the government, observation of intake volume is not periodically conducted. Thus, the identification of present intake volume requires a considerable improvement of water resources monitoring system.

In this Study, the present intake volume was assumed to be equal to the water demand in 2002. The following conditions explain the validity of assumption.

- The total water demand projected for the year of 2002 is 1,250.18 million m^3, while data collected from the water authorities show that water resources available for the public water supply during the summer and winter in 2001 were 832.20 million m^3 and 1,162.04 million m^3, respectively. However, some of water resources used for irrigation, such as Qaraoun dam with the development potential of 159.98 million m^3, are not included in the above figures. If the water of Qaraoun dam were added to the water authorities resources during the summer, 80% of the demand in 2002 would be satisfied. Therefore, an assumption that the rest of 20% relies on the private water sources is considered not to deviate from the reality.
- The demand projection in 2002 is based on the study to identify the actual consumption. Thus, factors associated with the water demand, such as unit consumption rate, population, number of industries, net irrigated area and so on, are considered to reflect the actual conditions.

Figure 6.2-1 shows the river basin units to compare the future water demand with water development potential and examine the necessity of water resources development to satisfy the future water demand. Since the water demand in 2002 is assumed to be equal to the water resources utilized at present, the water demand in 2002 was subtracted from the future water demand. Thus, the surface water and groundwater potentials were compared with an increment of water demand until the target year, 2030. The result of comparison (Demand vs. Potential) is summarized in Table 6.2-1 by river basin units.

Although the priority and implementation schedule of water resources development were supposed to be determined during the Phase II, they were not determined due to the cease of Phase II study. Therefore, it is assumed that all dams and hill lakes start their operation in 2010, while surface water development by direct intake and groundwater development are available from 2005.

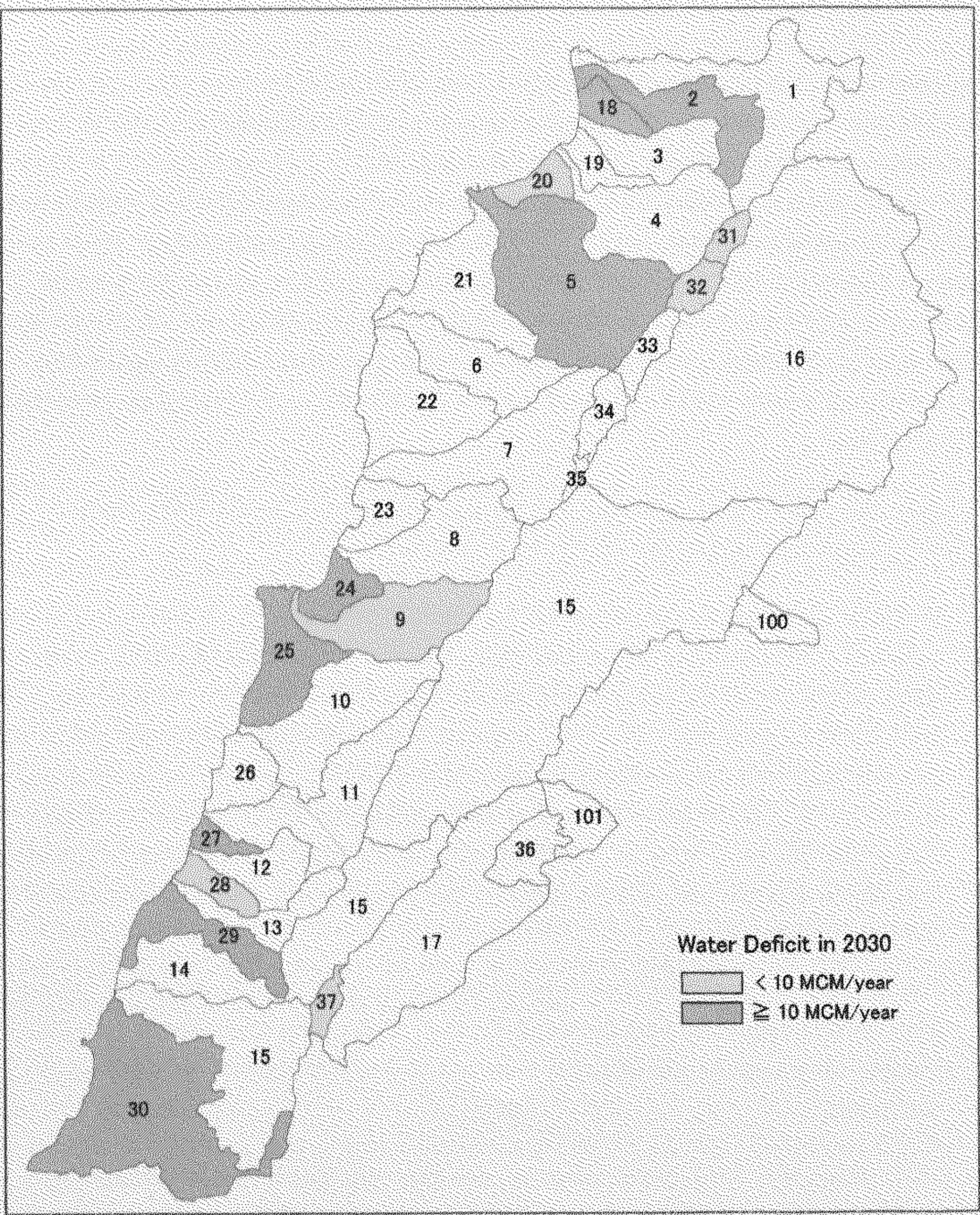

Figure 6.2-1 River Basin with Water Deficit

Table 6.2-1 Development Potential vs. Demand (1/4)

Unit: MCM (million m^3)

Name	Category		2005	2010	2015	2020	2025	2030
1 El Kabir	Supply	Surface water	35.31	35.31	35.31	35.31	35.31	35.31
		Dam	0.00	297.55	297.55	297.55	297.55	297.55
		Groundwater	18.60	18.60	18.60	18.60	18.60	18.60
		Total	53.91	351.46	351.46	351.46	351.46	351.46
	Demand	Total	0.29	3.18	3.70	9.61	9.80	9.92
	Balance		53.62	348.28	347.75	341.85	341.65	341.54
2 El Ostouene	Supply	Surface water	3.18	3.18	3.18	3.18	3.18	3.18
		Dam	0.00	1.70	1.70	1.70	1.70	1.70
		Groundwater	(18.72)	(18.72)	(18.72)	(18.72)	(18.72)	(18.72)
		Total	(15.54)	(13.84)	(13.84)	(13.84)	(13.84)	(13.84)
	Demand	Total	0.16	0.56	0.85	4.17	4.28	4.34
	Balance		(15.70)	(14.40)	(14.68)	(18.01)	(18.11)	(18.18)
3 Arka	Supply	Surface water	11.31	11.31	11.31	11.31	11.31	11.31
		Dam	0.00	1.00	1.00	1.00	1.00	1.00
		Groundwater	(6.48)	(6.48)	(6.48)	(6.48)	(6.48)	(6.48)
		Total	4.83	5.83	5.83	5.83	5.83	5.83
	Demand	Total	0.12	0.44	0.66	3.27	3.35	3.40
	Balance		4.71	5.39	5.17	2.56	2.47	2.43
4 El Bared	Supply	Surface water	4.84	4.84	4.84	4.84	4.84	4.84
		Dam	0.00	279.28	279.28	279.28	279.28	279.28
		Groundwater	(13.68)	(13.68)	(13.68)	(13.68)	(13.68)	(13.68)
		Total	(8.84)	270.44	270.44	270.44	270.44	270.44
	Demand	Total	0.14	0.92	1.26	3.16	3.31	3.42
	Balance		(8.98)	269.52	269.17	267.28	267.12	267.02
5 Abou Ali	Supply	Surface water	15.98	15.98	15.98	15.98	15.98	15.98
		Dam	0.00	0.95	0.95	0.95	0.95	0.95
		Groundwater	(20.52)	(20.52)	(20.52)	(20.52)	(20.52)	(20.52)
		Total	(4.54)	(3.59)	(3.59)	(3.59)	(3.59)	(3.59)
	Demand	Total	1.10	5.12	10.73	16.25	19.35	22.05
	Balance		(5.64)	(8.72)	(14.32)	(19.84)	(22.94)	(25.64)
6 El Jouz	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	83.43	83.43	83.43	83.43	83.43
		Groundwater	3.72	3.72	3.72	3.72	3.72	3.72
		Total	3.72	87.15	87.15	87.15	87.15	87.15
	Demand	Total	0.17	0.78	1.42	1.99	2.17	2.29
	Balance		3.55	86.37	85.73	85.16	84.98	84.86
7 Ibrahim	Supply	Surface water	0.72	0.72	0.72	0.72	0.72	0.72
		Dam	0.00	60.08	60.08	60.08	60.08	60.08
		Groundwater	(16.50)	(16.50)	(16.50)	(16.50)	(16.50)	(16.50)
		Total	(15.78)	44.30	44.30	44.30	44.30	44.30
	Demand	Total	0.29	1.23	2.43	3.55	4.21	4.75
	Balance		(16.07)	43.07	41.87	40.75	40.09	39.55
8 El Kelb	Supply	Surface water	2.46	2.46	2.46	2.46	2.46	2.46
		Dam	0.00	79.56	79.56	79.56	79.56	79.56
		Groundwater	(3.42)	(3.42)	(3.42)	(3.42)	(3.42)	(3.42)
		Total	(0.96)	78.60	78.60	78.60	78.60	78.60
	Demand	Total	0.57	2.64	4.97	7.19	8.56	9.72
	Balance		(1.53)	75.95	73.63	71.41	70.03	68.88
9 Beirut	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.55	0.55	0.55	0.55	0.55
		Groundwater	19.68	19.68	19.68	19.68	19.68	19.68
		Total	19.68	20.23	20.23	20.23	20.23	20.23
	Demand	Total	1.38	6.01	11.49	16.83	20.26	23.25
	Balance		18.30	14.22	8.74	3.40	(0.03)	(3.02)
10 Damour	Supply	Surface water	2.94	2.94	2.94	2.94	2.94	2.94
		Dam	0.00	79.06	79.06	79.06	79.06	79.06
		Groundwater	(3.60)	(3.60)	(3.60)	(3.60)	(3.60)	(3.60)
		Total	(0.66)	78.40	78.40	78.40	78.40	78.40
	Demand	Total	0.34	1.64	3.41	5.12	6.01	6.75
	Balance		(1.00)	76.75	74.98	73.28	72.39	71.65

Table 6.2-1 Development Potential vs. Demand (2/4)

Unit: MCM (million m^3)

Name	Category		2005	2010	2015	2020	2025	2030
11 Awali	Supply	Surface water	3.05	3.05	3.05	3.05	3.05	3.05
		Dam	0.00	164.81	164.81	164.81	164.81	164.81
		Groundwater	(3.00)	(3.00)	(3.00)	(3.00)	(3.00)	(3.00)
		Total	0.05	164.86	164.86	164.86	164.86	164.86
	Demand	Total	0.24	1.28	5.19	7.03	7.89	8.65
	Balance		(0.19)	163.58	159.66	157.82	156.96	156.20
12 Saitaniq	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	9.72	9.72	9.72	9.72	9.72	9.72
		Total	9.72	9.72	9.72	9.72	9.72	9.72
	Demand	Total	0.16	0.78	5.66	7.82	8.28	8.87
	Balance		9.56	8.94	4.06	1.90	1.44	0.85
13 Zahrani	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	9.90	9.90	9.90	9.90	9.90	9.90
		Total	9.90	9.90	9.90	9.90	9.90	9.90
	Demand	Total	0.06	0.37	4.95	6.02	6.14	6.47
	Balance		9.84	9.53	4.95	3.88	3.76	3.43
14 Abou Assouad	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	15.30	15.30	15.30	15.30	15.30	15.30
		Total	15.30	15.30	15.30	15.30	15.30	15.30
	Demand	Total	0.10	0.60	8.78	11.96	12.22	12.95
	Balance		15.20	14.70	6.52	3.34	3.08	2.35
15 Litani-North	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	167.31	167.31	167.31	167.31	167.31
		Groundwater	187.62	187.62	187.62	187.62	187.62	187.62
		Total	187.62	354.93	354.93	354.93	354.93	354.93
	Demand	Total	1.85	13.74	19.55	27.68	30.87	33.34
	Balance		185.77	341.20	335.38	327.25	324.06	321.60
15 Litani-Middle	Supply	Surface water	0.12	0.12	0.12	0.12	0.12	0.12
		Dam	0.00	1.20	1.20	1.20	1.20	1.20
		Groundwater	20.52	20.52	20.52	20.52	20.52	20.52
		Total	20.64	21.84	21.84	21.84	21.84	21.84
	Demand	Total	3.96	4.43	7.72	9.02	9.18	11.58
	Balance		16.68	17.41	14.12	12.82	12.66	10.26
15 Litani-South	Supply	Surface water	0.12	0.12	0.12	0.12	0.12	0.12
		Dam	0.00	204.91	204.91	204.91	204.91	204.91
		Groundwater	41.70	41.70	41.70	41.70	41.70	41.70
		Total	41.82	246.73	246.73	246.73	246.73	246.73
	Demand	Total	35.93	36.88	41.59	45.18	45.57	71.12
	Balance		5.89	209.85	205.15	201.56	201.17	175.61
16 El Assi	Supply	Surface water	143.86	143.86	143.86	143.86	143.86	143.86
		Dam	0.00	327.61	327.61	327.61	327.61	327.61
		Groundwater	192.30	192.30	192.30	192.30	192.30	192.30
		Total	336.16	663.77	663.77	663.77	663.77	663.77
	Demand	Total	0.72	43.25	44.83	46.28	47.02	47.56
	Balance		335.44	620.52	618.94	617.48	616.75	616.20
17 El Hasbani	Supply	Surface water	0.36	0.36	0.36	0.36	0.36	0.36
		Dam	0.00	34.78	34.78	34.78	34.78	34.78
		Groundwater	56.22	56.22	56.22	56.22	56.22	56.22
		Total	56.58	91.36	91.36	91.36	91.36	91.36
	Demand	Total	6.94	7.47	8.11	9.12	9.22	12.75
	Balance		49.64	83.90	83.26	82.25	82.14	78.61
18 El Olaiaat	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	(9.36)	(9.36)	(9.36)	(9.36)	(9.36)	(9.36)
		Total	(9.36)	(9.36)	(9.36)	(9.36)	(9.36)	(9.36)
	Demand	Total	0.05	0.17	0.26	1.29	1.32	1.34
	Balance		(9.41)	(9.53)	(9.62)	(10.65)	(10.68)	(10.70)

Table 6.2-1 Development Potential vs. Demand (3/4)

Unit: MCM (million m^3)

Name	Category		2005	2010	2015	2020	2025	2030
19 El Aabde	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	2.22	2.22	2.22	2.22	2.22
		Groundwater	1.80	1.80	1.80	1.80	1.80	1.80
		Total	1.80	4.02	4.02	4.02	4.02	4.02
	Demand	Total	0.05	0.17	0.25	1.23	1.27	1.28
	Balance		1.75	3.85	3.77	2.78	2.75	2.73
20 El Minie	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	(0.72)	(0.72)	(0.72)	(0.72)	(0.72)	(0.72)
		Total	(0.72)	(0.72)	(0.72)	(0.72)	(0.72)	(0.72)
	Demand	Total	0.33	1.35	2.83	4.33	5.31	6.22
	Balance		(1.05)	(2.07)	(3.55)	(5.05)	(6.03)	(6.94)
21 Chekka	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	56.92	56.92	56.92	56.92	56.92
		Groundwater	20.70	20.70	20.70	20.70	20.70	20.70
		Total	20.70	77.62	77.62	77.62	77.62	77.62
	Demand	Total	0.79	3.46	7.00	10.49	12.47	14.20
	Balance		19.91	74.16	70.62	67.13	65.15	63.42
22 Batroun-Jbeil	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	23.70	23.70	23.70	23.70	23.70	23.70
		Total	23.70	23.70	23.70	23.70	23.70	23.70
	Demand	Total	0.18	0.72	1.44	2.10	2.47	2.76
	Balance		23.52	22.98	22.26	21.60	21.23	20.94
23 Jounie	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	10.38	10.38	10.38	10.38	10.38	10.38
		Total	10.38	10.38	10.38	10.38	10.38	10.38
	Demand	Total	0.10	0.49	0.94	1.36	1.63	1.85
	Balance		10.28	9.89	9.44	9.02	8.75	8.53
24 Antelias	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	6.18	6.18	6.18	6.18	6.18	6.18
		Total	6.18	6.18	6.18	6.18	6.18	6.18
	Demand	Total	1.69	6.78	12.94	19.15	23.94	28.36
	Balance		4.49	(0.60)	(6.76)	(12.97)	(17.76)	(22.18)
25 Aaramoun	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	17.16	17.16	17.16	17.16	17.16	17.16
		Total	17.16	17.16	17.16	17.16	17.16	17.16
	Demand	Total	3.52	16.03	30.21	43.66	52.18	59.33
	Balance		13.64	1.13	(13.05)	(26.50)	(35.02)	(42.17)
26 Banja	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	3.90	3.90	3.90	3.90	3.90	3.90
		Total	3.90	3.90	3.90	3.90	3.90	3.90
	Demand	Total	0.08	0.43	0.99	1.54	1.87	2.17
	Balance		3.82	3.47	2.91	2.36	2.03	1.73
27 Saida	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.96	0.96	0.96	0.96	0.96
		Groundwater	(0.30)	(0.30)	(0.30)	(0.30)	(0.30)	(0.30)
		Total	(0.30)	0.66	0.66	0.66	0.66	0.66
	Demand	Total	0.67	2.65	6.15	9.79	11.98	14.41
	Balance		(0.97)	(1.99)	(5.48)	(9.13)	(11.32)	(13.75)
28 El Haziye	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	4.80	4.80	4.80	4.80	4.80	4.80
		Total	4.80	4.80	4.80	4.80	4.80	4.80
	Demand	Total	0.05	0.27	3.20	5.03	5.18	5.41
	Balance		4.75	4.53	1.60	(0.23)	(0.38)	(0.61)

Table 6.2-1 Development Potential vs. Demand (4/4)

Unit: MCM (million m^3)

Name	Category		2005	2010	2015	2020	2025	2030
29 Es Sarafand	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	1.02	1.02	1.02	1.02	1.02	1.02
		Total	1.02	1.02	1.02	1.02	1.02	1.02
	Demand	Total	0.09	0.54	8.05	11.75	11.98	12.54
	Balance		0.93	0.48	(7.03)	(10.73)	(10.96)	(11.52)
30 Sour	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	7.86	7.86	7.86	7.86	7.86	7.86
		Total	7.86	7.86	7.86	7.86	7.86	7.86
	Demand	Total	45.98	48.01	50.51	62.07	62.77	104.62
	Balance		(38.12)	(40.15)	(42.65)	(54.21)	(54.91)	(96.76)
31 Mari Hine	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	0.60	0.60	0.60	0.60	0.60	0.60
		Total	0.60	0.60	0.60	0.60	0.60	0.60
	Demand	Total	0.01	2.08	2.10	2.12	2.12	2.13
	Balance		0.59	(1.48)	(1.50)	(1.52)	(1.52)	(1.53)
32 Homr	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	0.90	0.90	0.90	0.90	0.90	0.90
		Total	0.90	0.90	0.90	0.90	0.90	0.90
	Demand	Total	0.02	3.03	3.05	3.08	3.09	3.10
	Balance		0.88	(2.13)	(2.15)	(2.18)	(2.19)	(2.20)
33 Barbariss	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	1.08	1.08	1.08	1.08	1.08	1.08
		Total	1.08	1.08	1.08	1.08	1.08	1.08
	Demand	Total	0.02	0.85	0.90	0.95	0.98	0.99
	Balance		1.06	0.23	0.18	0.13	0.10	0.09
34 Yammoune	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	4.49	4.49	4.49	4.49	4.49
		Groundwater	1.20	1.20	1.20	1.20	1.20	1.20
		Total	1.20	5.69	5.69	5.69	5.69	5.69
	Demand	Total	0.03	0.55	0.64	0.73	0.76	0.78
	Balance		1.17	5.14	5.05	4.96	4.93	4.91
35 Zainiye	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	0.18	0.18	0.18	0.18	0.18	0.18
		Total	0.18	0.18	0.18	0.18	0.18	0.18
	Demand	Total	0.01	0.09	0.12	0.14	0.15	0.16
	Balance		0.17	0.09	0.06	0.04	0.03	0.02
36 Kfar Kouk	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	1.00	1.00	1.00	1.00	1.00
		Groundwater	7.02	7.02	7.02	7.02	7.02	7.02
		Total	7.02	8.02	8.02	8.02	8.02	8.02
	Demand	Total	0.00	0.04	0.08	0.23	0.22	0.21
	Balance		7.02	7.98	7.94	7.79	7.80	7.81
37 Marjayoun	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	3.30	3.30	3.30	3.30	3.30	3.30
		Total	3.30	3.30	3.30	3.30	3.30	3.30
	Demand	Total	4.29	4.35	4.44	4.52	4.54	7.15
	Balance		(0.99)	(1.05)	(1.14)	(1.22)	(1.24)	(3.85)
Whole Lebanon	Supply	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
		Dam	0.00	0.00	0.00	0.00	0.00	0.00
		Groundwater	3.30	3.30	3.30	3.30	3.30	3.30
		Total	3.30	3.30	3.30	3.30	3.30	3.30
	Demand	Total	4.29	4.35	4.44	4.52	4.54	7.15
	Balance		702.51	2,441.02	2,340.98	2,237.57	2,200.46	2,092.20

Since there is no firm implementation schedule, an increment of water demand was compared to the total water development potential every 5 years, excluding the wastewater reuse. Although 14 basins out of 37 basins have a water deficit, in 23 river basins, the future water demand is satisfied by the development potentials of basin concerned. It means that those basins do not require any water conveyance from other basins.

The total water deficit amounts to 259.02 million m^3 by 2030 and its 25% arises in No. 24 (Antelias) and No. 25 (Aaramoun) where the Greater Beirut and its suburbs are located. The high population density and economic growth in the Greater Beirut stimulates the high consumption of water, despite the fact that water development potential is limited to only groundwater. Thus, those areas require the conveyance of water from other basins. This tendency is applicable to other two major cities in Lebanon, Tripoli and Saida. Tripoli and its suburbs are located in the downstream end of Abou Ali (No. 5) and El Minie (No. 20) basins, while Saida is located in No. 27 (Saida) basin. Water resources in those basins do not satisfy the future water demand and consequently those basins require the water conveyance from other basins.

Since new irrigation schemes with the total are of 29,000 ha are planned in the south, future water deficit in the south, No. 28 (El Haziye), No. 29 (El Sarafand) and No. 30 (Sour), appears. However, the water conveyance from other basins is not considered in this water budget, and actually water for those schemes is planned from Litani river basin. As show in Table 6.2-1, the residue in the Litani-South is large enough to satisfy the water deficit in those basins. Thus, if the water conveyance is considered, there is no water deficit in the south.

Negative groundwater development potential, for example –18.72 million m^3 in El Ostouene basin, means the excess exploitation and requires a replacement with other water resources to mitigate groundwater issues. Water deficit in the north, such as No. 2 (El Ostouene), No. 5 (Abou Ali) and No. 18 (El Olaiaat), is mainly due to this reason. At present, groundwater is over exploited; however, there are no alternatives of water resources in concerned basin.

Water budget in the whole Lebanon shows the large residue of water resources, 2,092 MCM in 2030. If the water budget is examined by each river basin, water deficit is anticipated in 14 basins. However, as long as the nationwide water budget and full-scale implementation of surface & groundwater development potentials are considered, there is no water deficit in future. Besides, the wastewater reuse is not required, except during severe drought. Water sources allocation, inter-basin water use in other words, is significant to determine the priority and implementation schedule of water resources development rather than development in individual basin.

6.3 Issues Concerning Water Resources Management

6.3.1 General Description

In Lebanon, the long-term water situation between possible supply and necessary demand is becoming uncertain steadily. Water balances tend to move towards serious deficit beyond the level of availability of renewable water resources by means of over-extracting groundwater aquifers. Water shortage will affect economic growth of the country adversely. Management of water resources effectively to reduce the gap between supply and demand and to ensure sustainability of such resources is therefore essential. National efforts have been made to restraint the water crisis at present and in future by the Government under the recognition of urgency of addressing the problems before it gets critical and serious considerations are now given to water policy and institutional reforms. Inadequate attention, however, was directed to maximize the benefit of the utilized unit of water and improving the efficiency of both water allocation and water use is not sufficient.

Major issues prevail in the water sector in Lebanon are summarized below;

<u>Supply Management</u>

Lebanon suffers from chronic shortage of water although having abundant precipitation. Sources of water for water supply and irrigation are springs and wells, surface water, hill lakes and reservoirs. Wells are drilled plentiful in certain areas of the country and excessive consumption of groundwater is the major cause of a dramatic drop of groundwater table and intrusion of sea water along the coastal areas. There has been almost no actual control on the withdrawal of groundwater due to the lack of monitoring and enforcement and the lack of the administrative capacity to practice direct control on water withdrawal. More than 800 million cubic meters of groundwater are emptying into sea without utilized and measures to use these water as well as program for artificial recharge are few. Surface water is not utilized fully at present, with intention of constructing reservoirs for the storage of several hundred million cubic meters of water in future. However, program requires heavy investment and therefore has suffered long delays. Assessment of the possible negative environmental impact of dam construction is inadequate. Irrigation infrastructure was damaged during the civil war requiring extensive rehabilitation. Irrigation is the largest user of water, using 60 to 70% of the total supply, however, returning only a small percentage to the national economy. In the light of scarcity and importance of water in Lebanon, high Irrigation efficiencies, 70% for sprinkler irrigation and 80% for drip irrigation, are adopted complied by both administration and farmers.

<u>Demand Management</u>

In order to support water use efficiency, options of demand management include restructuring of tariffs, metering, regulations, measures for water conservation, use of treated wastewater, education of users for better use of water, etc. A little effort is given by MEW and Water Authorities (WA) to demand management measures recently, however, not sufficient until now.

Water Quality

The discharge of raw sewage into the surface and groundwater is creating serious health problems and degrading water quality. Excessive use of fertilizer has led to nitrate leaching which has been detected in elevated concentration in groundwater. Unregulated application of pesticides has caused the contamination of surface and groundwater. Uncontrolled disposal of solid wastes in watershed has also led to the contamination of river basin due to leaching of chemicals.

System Losses

Water distribution systems have deteriorated and it is estimated that more than 50% of them are in need of rehabilitation or reconstruction. Unaccounted rate of water distributed is estimated to be high, however, all systems except Sedon are not metered, and so it is difficult to obtain a certain extent of losses and leakage. Other issues to be mentioned are that there are illegal connections of branch pipeline to the main network of water distribution, there exist considerable amount of evaporation losses from the reservoir surface and irrigation canal, there are losses due to insufficient irrigation operation, and that recycling of industrial water is insufficient.

Wastewater Management

Wastewater collection systems are few or old where exist, inadequately maintained and often undersized. In most areas where collection systems are available, the effluent is released directly into river channels and Mediterranean Sea. Lebanon has signed several agreements to protect its water body from wastewater pollution. This needs treatment of wastewater before discharging into the sea in cities with population of exceeding 0.1 million. Numbers of wastewater projects have been prepared for implementation along the coastal zones and in the hinterland.

Service Quality

Many of water supply network systems are deteriorated with problems that the system cannot deliver water to consumers in adequate quantity with acceptable quality. Systems are sometimes undersized for increasing demand, inspection procedures are absent and proper accounting is rare. In addition, there is a growing risk of contamination from wastewater leaking into the pipeline network system.

Data Management

The lack of a comprehensive database is one of the principal factors to restrict formulation of a proper and effective water resources management plans, since actual figures of both supply potential and demand required are not clear for decision makers. Having a detailed and accurate assessment of the different sources of water supply as well as of the projected demand for various water users is the basic information to evaluate current and anticipated water problems based on which proper measures are planned and implemented. At present, river discharge measurements remain quite limited and groundwater flow measurements are not available. The reliability of data collected is also uncertain. Meteorological and hydrological data are often incomplete and distributed over different authorities, and are not publicly accessible. Most of the data are not computerized making it difficult to use them for any kinds of analysis.

Institutional Issue

There is no central organization responsible for the coordination of decisions and actions related to the water sector, and its administrative structure is complicated. The water sector is managed mainly by three administrative organizations; the Ministry of Energy and Water (MEW) responsible for the general management of water resources and controls groundwater uses with respect to water rights, the financing of infrastructure projects and supervision of the Water Authorities (WA), the Council for Development and Reconstruction (CDR) responsible for provision of technical and financial assistance to different authorities and selection of parties to implement infrastructure projects, and WA responsible for provision of potable and irrigation water to consumers and operation/maintenance of infrastructure facilities provided by MEW. In addition the Litani River Authority (LRA) in association with irrigation authorities and local water and irrigation committee is responsible for development and management of water resources mainly for irrigation and hydro-power generation in the Litani river basin and an extended geographic area covering South Bekaa and South Lebanon. The Ministry of Environment and the Ministry of Public Health play monitoring and control function of water resources, while the Ministry of Public Works undertakes data collection and the Ministry of Interior and Municipalities together with various municipalities are responsible for the collection of wastewater.

Building the institutional capacity to create the socio-economic environment needed for a sustainable water resources is not advocated fully by the government, as brought up by many studies ever conducted.

A list of references

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6.3.2 Problems Related to Water Resources Management

(1) Meteorological Observation System

As aforementioned, there were 150 historical meteorological stations in 1974 in Lebanon, however at present, 48 stations only were reconstructed, rehabilitated or newly reconstructed and being operated. Since the meteorological data, especially precipitations including snowfall, are the foundation of the estimation of water resources potential, it is inevitably needed that the observation network of meteorological factors are consolidated as early as possible with plenty numbers of rain gauge stations over the country. In this concern, installation of meteorological stations is recommendable to be made at the same locations as the old ones, so that the combination of old and new sets of observed data at the same location could be a base for analyzing complicated phenomenon of climate over the country.

(2) Hydrological Observation System

As aforementioned, there operated 75 hydrological stations before the civil war in Lebanon. During the long period of almost 15 years from 1975 to 1990, hydrological observation data are almost none at all. Currently 32 stations were reconstructed and 6 were newly constructed for operation. Since the accurate and as long data as possible are the foundation for evaluation of potential and available water resources based on which a proper plan of water resources development and management is formulated, accumulation of such data is important and urgent. One third of the area of Lebanon is considered not covered yet by hydrological observation system. It is therefore recommendable to set up a program for construction of hydrological observation network and then to speed up the installation works of hydrological stations.

Furthermore at present, collected data from hydrological stations are transferred to Hydrological Department of LRA for further processing. HYDATA system is used to convert water levels into discharge and to compute daily flow hydrograph, flow duration curve, flow statistics such as mean flow, peak flow, highest daily mean, lowest daily mean, and a mean flow and runoff. However accumulated data in the HYDATA system are unusable for other data processing or analysis. This system is recommendable to be replaced by more flexible system.

(3) Groundwater/spring water managing system

In Lebanon, all of groundwater and spring water are managed by the Ministry of Energy and Water as a rule. In the private sector, every one who wishes to construct production well must submit their construction plan to the Ministry for his approval. While, in the public sector, the water of River Litani combined with Awali, inclusive of groundwater or spring water in their basins, are controlled by LRA. In all of other areas such as the Coastal Region excepting above mentioned area and River Assi Basin, both surface and groundwater are directly under control of the ministry. However, four regional Water Authorities have actually developed and managed springs and groundwater sources. Problems related to groundwater/spring water management would be summarized as follows.

Problems due to the natural conditions (must accept as they are):

- Biased rainfall in winter season,
- Large scale groundwater channels (discovered or not yet),
- Submarine spring, and
- Groundwater flow to the outside of country.

Problems due to the social conditions (possibly improved):

- Existence of huge numbers of illegal wells,
- Contamination of spring sources by lacking of proper protection,
- Contamination of groundwater by human activity,
- Missing of old data and information, and
- Ineffective data and information managing.

Problems due to the poor managing system (must be improved):

- No groundwater monitoring system covering whole country,
- No systematic observation of spring flows,
- Sea water intrusion by over-pumping,
- Lacking in well inventory,
- Lacking in spring inventory (partially existing), and
- Lacking in snowfall measurement system.

As briefly noted in each item, some problems are just come from natural system, mostly impossible to improve, only some countermeasures to mitigate them shall be considered. However, the problems caused by improper social system or institutional defects may be improved or must make an effort to mitigate them. Finally, the problems due to the poor or inappropriate groundwater management system must be improved. In particular, the groundwater monitoring system, as well as the systematic spring flow observation, is inevitably required for the groundwater study.

(4) Water Use Management

Water use management targets 1) to improve efficiency to convey and distribute the water from source to users, 2) to optimise the volume of water consumed and 3) to increase the available water by recycling, leading to a result that the limited water is utilized effectively and efficiently. Since 1994, the Lebanese government has focused on rehabilitation and modernization of water sector, particularly domestic water supply and irrigation. Water use management practiced at present is discussed below to identify problems associated.

<u>Domestic Water</u>

After the damage assessment survey of the existing water supply and wastewater treatment in 1992, a 3-year National Emergency Rehabilitation Program (NERP) was formulated. NERP 1 (urgent rehabilitation) was already completed, and NERP 2 (rehabilitation) and NERP 3 (expansion) are currently under implementation. NERP has been contributing to mitigate leakage in the distribution network. In 1997, the leakage ratio estimated was 59% in average, while the present leakage ratio estimated by the JICA Study is approximately 45%, implying the great improvement in the last 5 years. Although there is still plenty scope of improvement, its cost will increase exponentially as the leakage ratio decreases. As long as the cost is concerned, a new water resource development may be economically feasible to satisfy an increase in water demand, compared to the further mitigation of leakage. An optimum ratio of leakage should be considered in terms of overall water resources management. Since mitigation of leakage involves not only replacement of network but also O/M (operation and maintenance), it is necessary to improve administrative and technical capacity of water authorities that are reformed recently. Besides, the current water tariff system charging on the base of orifice size but not volume consumed induces another reason for high leakage ratio. Subscribers are responsible for leakage in internal plumbing and saving water; however, the present tariff system leaves them careless. In Saida, the water authority has applied a meter system to observe the volume of water consumed and has a plan to install a meter to 100% of subscribers within the next few years. Its success will be a good example to change the water tariff system in order to save water.

Industrial Water

Most of industries rely on private wells and there is no regulation to monitor and control volume/quality of water source. This results in no attempt by industries to save water and re-use the wastewater. Saving water and recycling of wastewater are generally associated with the cost and benefit. If industries were linked with the public water supply system, they would save the water to minimize the cost and also invest money to re-use of wastewater. Thus, encouraging the industries to shift from private water source to the public supply system by enforcement of laws/regulations is one of ideas for water use management.

Wastewater

Coverage of sewer network is 36% in terms of population and the rest uses septic tank or drain sewage directly to the environment, such as rivers, small streams, valleys and so on. There is one wastewater treatment plant that conducts preliminary or physical treatment only. Therefore, even where there is a sewer network, almost 100% of wastewater is just drained to the environment without any treatment. It is estimated that 50% of wastewater is drained to the river channel and the rest is drained on the land. Since the agriculture in Lebanon requires irrigation during the summer, it can be assumed that wastewater drained to the river is utilized for irrigation in downstream. Re-use of wastewater is conducted without intension. As long as the discharge is relatively high, the wastewater can be diluted till no negative effect on crops. However, most of rivers in Lebanon have low discharge during the summer and some of dams to collect the winter water are located downstream from the populated areas. Therefore, periodic monitoring of river water is essential to maintain this system.

Irrigation

Irrigation is the largest sector in water consumption of Lebanon. Since the most of irrigation schemes are not equipped with monitoring of intake volume and consumption at field, the actual consumption rate is not available. However, according to the estimate, gross consumption, (intake volume) varies from 15,000 m^3/ha/year to 6,000 m^3/ha/year, depending on climate, topography, soil properties, crops, irrigation efficiencies and so on. Since spatial variation of crop water requirement is small, irrigation efficiencies, such as conveyance, distribution and application, dominate the variation. For the design of irrigation schemes, the overall efficiencies adopted are 60% for surface irrigation with good supply network and 70% and 80% for pressurized sprinkler and drip irrigations respectively. Improvement of efficiencies will drastically reduces the irrigation water.

Thus, policy and strategy to be considered in the integrated water resources management would be as shown in Table 6.3-1.

Table 6.3-1(1) Policy and Strategy to be Considered in Water Resources Management (1/2)

Policy and Strategy	No.	Measures	Projects/Programs
Supply Management			
➢To maximize use of surface water	1-1	To make an inventory of springs	➢Spring inventory survey
	1-2	To accumulate reliable hydrological data	➢Improvement project of hydrological observation & monitoring system
	1-3	To assess water resources potential	➢Operation/updating of the models
	1-4	To develop surface water resources	➢Surface water diversion projects ➢Dams/hill lakes projects ➢Trans-basin diversion projects
	1-5	To reinforce retarding effect of melting snow	➢(Snow dam construction)
	1-6	To reinforce retaining effect of rain water on ground surface	➢Reforestation
	1-7	To develop submarine springs	➢Submarine springs development projects
➢To sustainablly use groundwater	1-8	To make an inventory of wells	➢Well inventory survey
	1-9	To accumulate reliable groundwater data	➢Construction of hydro-geological observation & monitoring system
	1-10	To assess groundwater resources potential	➢Operation/updating of the models
	1-11	To sustainablly develop groundwater resources	➢Groundwater development project
	1-12	To reibforce groundwater recharge/storage	➢Recharging well/Underground dam
➢To conserve environment	1-13	To assess impacts of water resources development projects	➢IEE and EIA
➢To use non-conventional source of water	1-14	To promote wastewater treatment and reuse	➢Construction of wastewater collection and treatment system
Demand Management			
➢To maximize water use efficiency	2-1	To reduce unaccounted-for-water in distribution system	➢Rehabilitation of distribution facility
	2-2	To save industrial water	➢Promotion of industrial water recycling
	2-3	To save irrigation water	➢Rehabilitation and modernization of irrigation infrastructure
➢To conserve use of water	2-4	To conserve piped water	➢Installation of universal metering devices ➢Introduction of water priariffcing and t ➢Water legislation with penalty for illegal use of water ➢Public education
	2-5	To conserve irrigation water	➢Monitoring of water consumption for irrigation ➢Research on less water intensive or salt tolerant crops ➢Improvement of irrigation operation

Table 6.3-1(2) Policy and Strategy to be Considered in Water Resources Management (2/2)

Policy and Strategy	No.	Measures	Projects/Programs
Water Quality Management			
➢To preserve/improve water quality	3-1	To accumulate reliable water quality data	➢Construction of water quality observation & monitoring system
	3-2	To strengthen laboratory capacity of water samplings	➢Capacity building for water analysis
	3-3	To undertake pollution control	➢Water quality legislation and enforcement
Data Management			
➢To consolidate reliable database	4-1	To construct, operate and maintain database	➢Related to 1-2, 1-9 and 3-1
	4-2	To construct, operate and maintain supporting tools for formulation of water resources management master plan	
	4-3	To strengthen administrative capacity for data management	➢Establishment of water resources management center
Institutional, legal and legislative Management			
➢To strengthen and reinforce institution and legislation related to water sectors	5-1	To establish and reinforce water legislation	➢Legislation including particularly groundwater
	5-2	To strengthen water related institution	➢Strengthening including reform and capacity building of water related institutions
	5-3	To develop water resources management strategy	➢Water resources management center
Watershed Management			
➢To preserve sustainable water resources	6-1	To preserve watershed desirable for water resources management	➢Implementation of reforestation program
	6-2	To conserve environment	➢Environmental conservation program

6.3.3 Operation and Institutional Support

Operation and Maintenance of a Database

The present master plan study on water resources management in Lebanon collected most of available data and integrated into a GIS database. It will be an efficient tool in formulation of strategy for planning and management of national water resources by grasping the global supply and demand, and simulating impacts of a specific input or a scenario (e.g. a new water source development, etc.), if it is properly maintained.

The proper maintenance of it will require a continuous updating of data and information that reflect the entire supply and demand of water resources in Lebanon. Such data and informations should be: (1) collected continuously or periodically by various data collecting points in a coherent manner and in their entirety, (2) transferred timely to the database center through established channels, and (3) inputted promptly after careful evaluation and harmonization. This mechanism supported by many sub-systems should be established and maintained.

Historically in Lebanon, however, hydrological data including precipitation and surface flow were not entirely measured during the war, and hydrogeological data have not been measured in the past. While much of infrastructure has been reconstructed since ceasefire and reintegration of the nation, majority of hydrological data collecting points have not been recovered and no firm reconstruction plan has been formulated. Data collected in the present study, therefore, lack their entirety, that should be complemented in the immediate future. Activities required for operation and maintenance of the database, therefore, shall be twofold: to reconstruct or develop data collecting points to cover the entire Lebanon on the one hand, and to collect available data and update the information in the database on the other.

According to variety of data, they should be collected daily, weekly or monthly, seasonally and annually. They are, inter alia:

- Daily: most of meteorological data, particularly precipitation including snowfall
- Weekly or monthly: flow and quality of springs and rivers
- Seasonally: demand for water (crop patterns, operational record of water supply systems), quality of water supplied
- Annually: level and quality of groundwater, if not seasonal, growth of population and hence supply and demand; and increments in land use, deforestation, reforestation or vegetation in general

Data and Data Collecting Points

Required data can be classified into two in principle, i.e., supply data and demand data.

Supply data should include meteorological data, data on surface water including spring water, data on groundwater and other background data.

Most important ***meteorological data*** are precipitation including snowfall. Subordinate data may be temperature, humidity, wind, sunshine, evapotranspiration and so on. They will be collected by meteorological stations under the Meteorological Division.

Surface water including spring water is measured by hydrological stations under LRA. Volume of flow shall be measured frequently and water quality with less frequency.

Groundwater shall be measured at monitoring wells. Monitoring wells shall be designed to measure static level, pH value and electric conductivity of groundwater continuously.

Regarding the groundwater monitoring, however, development of a comprehensive well inventory is prerequisite. Inventory of 2,000 wells are completed under the present master plan study. Other 8,000 wells, if number of the officially registered wells is approximately 10,000, shall be surveyed and recorded in the inventory succeedingly by MEW. Other wells, unregistered or illegal, shall also be surveyed. To do this, reform of groundwater legislation or formulation of operational decrees is indispensable.

The background data that can significantly influence global supply situation shall also be collected and updated. Such data may include construction of dams, hill lakes, river diversion and reserve for river maintenance, and less significantly will include increments of vegetation, deforestation and reforestation, etc. They will be collected in the relevant institutions including Ministry of Agriculture, Ministry of Environment, etc.

Demand data should include water demand for domestic, industrial and irrigation purposes, and basic data that influence these water demand comprising increments of population, industry and cropping patterns. A demand projection upto year 2030 is presented in the present master plan study as a result of sectorwise, seasonal and spatial demand projections. This demand projection can be used as the basic demand data for the time being. Renewal or updating of these data, however, is required when and if more reliable data become available through actual measurement.

Demand for domestic and industrial use of water shall be collected most conveniently from the water supply service providers. Such providers comprise four regional water authorities (WA), other water authorities and committees, and LRA, which is supplying domestic water to the water committees in the Bekaa and the South. Volume and quality of produced and distributed water shall be measured, and its seasonal fluctuation shall be recorded. More importantly in the long run, growth of the served population and the served area, or planned expansion of treatment plant and distribution network shall be noted and reported. MEW shall be in a position to project growth of the water supply services in all areas.

Demand for irrigation water shall be measured and reported by the irrigation service providers such as MEW and LRA. Measurement shall be made practically by volume of water supplied. While the government irrigation schemes are implemented by MEW and LRA, farmers themselves irrigate vast cultivated areas. Demand for such private irrigation that was developed individually or collectively by farmers shall also be counted for.

The background data in the demand forecast would be growth of population and industry, change in cropping patterns and expansion of irrigated area. They may be provided by census and statistics, Ministry of Industry, Ministry of Agriculture, etc.

<u>Current Constraints in the Data Collection</u>

As described above, plural number of ministries, and plural number of agencies even under a single ministry operate data collecting points. Ministries and their agencies concerned are:

- Ministry of Public Works and Transport operating meteorological stations
- Ministry of Energy and Water in tutelage of water authorities and LRA, and keeping well registry. It may create a groundwater monitoring unit.
- Ministry of Agriculture rendering the hill lake construction through the Green Plan and agricultural research through the Agricultural Research Institute. It is assumed to perceive privately irrigated farms as well as cropping patterns of agriculture in overall Lebanon.
- Ministry of Environment, which perceives vegetation, deforestation, reforestation, etc.
- Ministry of Public Health responsible for quality of drinking water
- Other ministries, which undertake population census, industrial statistics

Complexity due to large number of participants in the data collection is apparent, and appropriate measure to streamline the process needs to be taken in design of the data channel. Beside such complexity, each agency or organization is facing various constraints in collecting the data required.

Meteorological Division is operating currently only 48 stations out of some 150 established before the war. It does not have firm reconstruction plan. As number of stations and their dispersion seem insufficient, MEW shall consider to install number of the precipitation measuring points required to assess the gross precipitation into each catchment.

Water authorities are in transition to amalgamated 4 Regional WA's, which are not functional for the time being. Most of 21 water authorities do not properly record volume and quality of produced and distributed water and its seasonal fluctuation. As they hardly have technical resources to measure these data, it would be necessary for MEW to provide them with assistance to establish the required discipline. Besides these 21 water authorities, there are 209 water committees who provide water supply services. MEW shall also account for volume of their supply, and therefore need to create some means to monitor them.

LRA maintains 38 live hydrological stations now and has some 90 stations damaged. A comprehensive reconstruction plan has yet to be established. To grasp catchment wise global surface water discharge, 38 gauge points are not too sufficient. Suitable number of complementary flow gauging units will have to be installed as soon as possible.

LRA and ***Irrigation Department*** of MEW provide the government irrigation schemes and in positions to measure volume of irrigation water supply to these schemes. Therefore, they are expected to record volume of actual supply by measurement at the water intake. Daily measurement would be preferable. Volume of water to the private irrigation should not be left out. To estimate the volume as accurately as possible, Irrigation Department and LRA need to work closely with Ministry of Agriculture.

Groundwater Unit, Geology Department of MEW, maintains registry of groundwater wells. It, however, lacks facilities to assess discharge or yield of groundwater globally. It, therefore, needs to establish monitoring wells. Number and dispersion of monitoring wells shall be such that may cover all the sub-catchments or sub-basins. The Groundwater Unit, also, needs to be enhanced in terms of technical and human resources, or a groundwater monitoring unit shall be created, while proceeding with and expediting the groundwater legislation and reform.

6.3.4 Considerations on Reuse of Wastewater from the Viewpoint of Water Quality

Wastewater is used as a source of irrigation water as well as a source of plant nutrients, allowing farmers to reduce or even eliminate the purchase of chemical fertilizer. Recent wastewater use practices range from the piped distribution of secondary treated wastewater (i.e. mechanical and biological treatment) to peri-urban citrus fruit farms (e.g. the city of Tunis) ("Water Quality – Guidelines, Standards and Health: Assessment of Risk and Risk Management for Water-Related Infectious Disease, WHO Web Site). Agricultural reuse of wastewater is practiced throughout South America, Mexico and widespread in Northern Africa, Southern Europe, Western Asia (Arabian Peninsula), South Asia and US.

The use of human wastes contributes to food production and income generation in developing countries. However, where the waste is untreated or health protection measures are not in place, such practice is exposed to the risk of transmission of pathogens.

WHO established the microbiological quality guidelines for wastewater use in agriculture in 1989. Table 6.3-2 shows the recommended guideline applied for the exposed group of workers or public consumers.

Table 6.3-2 Recommended Microbiological Quality Guidelines for Wastewater Use in Agriculture (WHO 1989)

Category	Reuse Condition	Exposed Group	Intestinal Nematodes[1] (MPN/liter[5])	Faecal Coliform (MPN/100 ml[5])	Wastewater Treatment expected to achieve Required Quality
A	Irrigation of crops likely to be eaten uncooked, use in sports fields, use in public parks[3]	Workers, Consumers, Public	1	1,000	A series of stabilization ponds designed to achieve the microbiological quality indicated, or equivalent treatment
B	Irrigation of cereal crops, fodder crops, pasture and trees[4]	Workers	1	None Set	Retention in stabilization ponds for 8 – 10 days or equivalent helminth removal.
C	Localized irrigation of category B exposure of workers and the public does not occur	None	N/A	N/A	Pre-treatment as required by the irrigation technology, but not less than primary sedimentation

Remarks:

1) *Ascaris* and *Trichuris* species and hookworm
2) A more stringent guideline (200 faecal coliforms/100 ml) is appropriate for public lawns with which the public may come into direct contact
3) In the case of fruit trees, irrigation should cease two weeks before the fruit is picked and none should be picked off the ground
4) Arithmetic mean
5) Geometric mean

Currently, Ghadir wastewater treatment plant is the only large-scaled operating plant in Lebanon, which is located in the south of Beirut. The data on faecal coliform and Intestinal Nematodes which are discussed above, was not available from the plant. The plant provides only primary treatment of grit and scum removal, which cannot treat the faecal coliform and Intestinal Nematodes through the disinfection such as using chlorination. The equivalent concentration of microbiological concentration as raw wastewater will be anticipated.

6.3.5 Scoping for Initial Environmental Examination

(1) Development Scheme and Project Activity

Initial Environmental Examination (IEE) should be conducted for the possible alternatives proposed in JICA study in order to examine the requirement of Environmental Impact Assessment (EIA).

In Lebanon, the draft EIA decree is still under review by the Government Council and has not yet approved/enacted. However, the draft of EIA procedure is proposed. According to the draft decree, water development projects such as dams, reservoirs or development of wastewater treatment plant should require EIA procedures.

The Study is basically to examine the water supply development for irrigation, municipal and industrial purpose by utilizing the water resources of surface water, groundwater, springs, submarine springs and reuse of wastewater.

Table 6.3-3 summarizes the anticipated activity caused by the projects during construction and operation stages expected.

Table 6.3-3 Anticipated Activities caused by the Development Scheme

Development Scheme	Anticipated Projects	Activity	
		Construction Stage	Operation Stage
Development of Surface Water	• Dam • Reservoir • Canal • Intake • Pipelines • Pumping Station • Water Treatment Plant	• Land Acquisition • Construction of Access Road • Tree Cutting • Excavation • Concrete Placing	• Storage of River Water • Water conveyance
Development of Groundwater	• Well • Underground dam • Pumping Station • Pipelines • Water Treatment Plant	• Land Acquisition • Construction of Access Road • Tree Cutting • Excavation • Concrete Placing (including cutoff wall for underground dam)	• Water Pumping • Water conveyance
Development of Springs	• Pumping Station • Pipelines • Water treatment Plant	• Land Acquisition • Concrete Placing	• Water Pumping • Water conveyance
Development of Submarine Springs	• Pumping Station • Pipelines • Concrete Wall at Sea Bottom • Water Treatment Plant	• Land Acquisition • Excavation at sea bottom • Concrete Placing	• Water Pumping • Water conveyance
Development of Wastewater Reuse	• Pumping Station • Pipelines/Canal • Wastewater Treatment Plant	• Land Acquisition • Excavation • Concrete Placing	• Water Pumping • Water conveyance

(2) Scoping Matrix and Anticipated impacts

The summary of scoping matrix of the anticipated impact for each development scheme is summarized in Table 6.3-4. The potential impacts and their mitigation measures will be clarified in more details after the location and scope of the projects are actually formulated in the study.

Table 6.3-4 Scoping Matrix for Each Development Scheme

Environmental Elements / Development Scheme		Social Environment									Natural Environment								Pollution					
		Resettlement	Economic Activity	Traffic/Public Facilities	Split of Communities	Cultural Properties	Water Right/Right of Common	Public Health Condition	Waste	Hazard	Topography & Geology	Soil Erosion	Groundwater	Hydrological Situation	Coastal Zone	Flora & Fauna	Local Meteorology	Landscape	Air Pollution	Water Pollution	Soil Contamination	Noise & Vibration	Ground Subsidence	Odour
Development of Surface Water	C[1)]	A	B	B	B	B	A	B		B	B					A		B	B	B		B		
	O[2)]						A	B						A		A				B		B		
Development of Groundwater	C			B			B	B			B		A						B	B		B		
	O						B	B					A	A		A				B		B	A	
Development of Springs	C			B			B	B			B		B						B	B		B		
	O						B	B						A		B				B		B		
Development of Submarine Springs	C			B			B	B						B	B	B			B	B		B		
	O						B	B							B	B				B		B		
Development of Wastewater Reuse	C			B			B	B											B	B		B		
	O						B	A	B					B						B		B		

Remarks:
"C" indicates construction stage.
"O" indicates operation stage.
"A" indicates that the development scheme is foreseen to have strong impact on the environmental element.
"B" indicates that the development scheme is foreseen to have some impact on the environmental element.

The outline of the anticipated impacts is given as follows.

Development of Surface Water

Negative impacts:

- Social impacts such as resettlement caused by land acquisition in the submerged areas in case of dam construction
- Problems on traffic issues/public facilities
- Impacts on the cultural properties in case of dam construction
- Problems on water right/right of common
- Impacts on water-borne infectious disease in case of water supply project for domestic water
- Influence on the hydrological situation of the relevant river catchment area.
- Impact on the loss of forest caused by the water impounding, and the impact on the aquatic ecosystem in the existing water area

- Noise problem of the pumping station during the operation stage.

Positive impact:
- Some impact on local economy during construction stage

Development of Groundwater

Negative impacts:
- Problems on water right/right of common
- Problems on traffic issues/public facilities
- Impacts on water-borne infectious disease in case of water supply project for domestic water
- Impact on the river situation at the river catchment depending on groundwater in case of excess use of groundwater
- Impact on flora and fauna caused by the water table change in case of developing groundwater (e.g. underground dam)
- Ground subsidence in case of excess use of groundwater during operation stage

Positive impact:
- Some impact on local economy during construction stage

Development of Springs

Negative impacts:
- Problems on water right/right of common
- Problems on traffic issues/public facilities
- Impacts on water-borne infectious disease in case of water supply project for domestic water
- Impact on the river situation at the river catchment depending on spring water in case of excess use of spring water
- Impact on flora and fauna caused by the discharge change

Positive impact:
- Some impact on local economy during construction stage

Development of Submarine Springs

Negative impacts:
- Problems on water right/right of common
- Problems on traffic issues/public facilities
- Impacts on water-borne infectious disease in case of water supply project for domestic water

- Impact on the river situation at the river catchment depending on groundwater in case of excess use of groundwater
- Impact on flora and fauna caused by the water table change in case of developing groundwater (e.g. underground dam)
- Ground subsidence in case of excess use of groundwater during operation stage
- Impact on the hydrological situation, coastal zone, marine ecosystem and water pollution due to the marine development

Positive impact:

- Some impact on local economy during construction stage

Development of Wastewater Reuse

Negative impacts:

- Problems on traffic issues/public facilities
- Impact on water quality for the downstream water area

Positive impact:

- Some impact on local economy during construction stage

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