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RESTRUCTURING WATER SECTOR IN LEBANON: LITANI RIVER AUTHORITY-FACING THE CHALLENGES OF GOOD WATER GOVERNANCE

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SUMMARY – The new organization of the water sector in Lebanon is governed by three laws: Law 221 issued on May 29th 2000, corrected by the Law 241 issued on August 7th 2000, and amended by Law 377 issued on December 14th 2001. Lately, Decree No 8122, dated on July 3rd 2002, has defined some application processes of Law 221, particularly relating to the merging of water bodies. The spirit of this law is to separate clearly between the macro and micro management of water, and to strengthen the policy of the decentralization by granting more autonomy to regional authorities involved by day to day management of the water supply. This Law encourages implicitly the regional water authorities to manage their establishment on commercial basis and to be ready to deal in the future with the private sector. The nature and the level of private public partnership could be defined accordingly to the needs, to the improvement of requested services and by taking into account the socio-economic situation. The Law 228 issued on May 31st 2000 aimed to support the restructuring of the water sector by regulating privatization activities and defining their conditions and applications. The Litani River Authority (LRA) is partially involved in this reform. It is still functioning according to its creation Law issued on August 14th 1954. Its mission has been extended recently to the Hasbani watershed. Beside the main hydroelectricity and irrigation missions, the competencies covered by LRA are: the agricultural research, the rural development, studies and construction of dams and irrigation projects, the management of hydrometric gauge stations on all the Lebanese rivers, the monitoring and the prevention of pollution. Water policy and allocation, different programs, and their implementation take into account the highest social benefits compatible with the most economical investment and expenses. It is a permanent challenge to fit these objectives: procure a good welfare and an acceptable level of water and food securities to the people.

Keywords: Lebanon, water governance, restructuring water sector, water bylaws, water sector reform, water and food security, Litani River authority, master plan, minimization of energy cost

1. HISTORICAL

During the antiquity, the great civilizations have taken up close to water points and rivers for many reasons: water being, on the one hand the main factor of life and development and, on other hand, the surface water was easier to be harnessed and could play a big role in the relationship among people.

With the increasing of the water demand through the centuries, it became necessary to control its usage by regulations and laws. In the beginning, ways and customs have been the main sources of inspiration.

In Lebanon, water is considered as public good. This principle is the root of by laws governing the field of water during the course of the different periods of its history. There is not a precise date about the first regulations in Lebanon. It is sure, that these ways and customs go back before the 18th century.

1.1. At the time of the Ottoman Empire

Abdallah Caralli is the author of the first written document known. Its edition goes back to 1733, under the title of "Summary of the law in Lebanon at the period of the Chehab princes". The others documents have been published between 1870 and 1878 in the journal called "Medjelle". This journal is a large compiling legal document taken from the ways and customs, the "shariaa", and the Napoleon Code. The most important Articles are represented by the Articles 1281 to 1291 of the Chapter 6 concerning the "Haram" or the protection areas of water resources. In 1913, the code of irrigation has been published. The Law concerning the rehabilitation of irrigations canals has been issued on 1918.

1.2. At the time of the French Mandate

This period occurred after the First World War. Many documents have been elaborated among others: Order 144/S issued on June 10th 1925 and Order 320 issued on May 29th 1926. The Orders can be considered as the fundamental documents related to the water in Lebanon and are in use until now. The first one is dealing with public domain and associated legal dispositions. The second one, concerns the protection and use of water and public domain. Many others orders, decrees and laws have been promulgated during the French Mandate.

1.3. Post independence period

After the independence of Lebanon on November 22nd 1943, a very huge number of decrees and laws have been promulgated. One can mention some of them like for example: Decree 10276 issued on August 7th 1962 concerning the delimitation of water resources protection zones. Decree 14438 issued on May 2nd 1970 concerning the organization, prospecting and use of ground water. Decree-Law 108 issued on September 16th 1983 concerning the standardization and the organization of the operation of water and refreshment bottling.

From management point of view there are many issued documents.

Before the independence, the Bureau of Hydraulic, that became later the Department of Hydraulic, was in charge of water resources, under the authority of the French High Commissionership.

After the independence and before 1959, this Department was promoted to the rank of General Directorate within the Ministry of Public Works. It became, the General Direction of Hydraulic and Electric Affairs, with a mission of tutelage and control of Autonomous Offices and Concessions, including the Port of Beirut. The Decree-Law 111 issued on June 12th 1959 created the Ministry of Hydraulic and Electric Resources.

- Law 20/66 issued on May 29th 1966 have instituted, effectively, the Ministry of Hydraulic and Electric Resources, designated nowadays by Ministry of Energy and Water.
- Decree-Law 6650 issued on June 6th 1973 has amended the previous Law.

In 1870, an Ottoman Edict has granted to the French engineer Thevenin a concession for 40 years to supply potable water from the "Dog" River, to Beirut. In 1876, M. Thevenin bought this concession to a British company managed by Colonel Grantley Norton who has created the "Water Company of Beirut". In Year 1909, this concession gone to Elias and Ibrahim Sabbagh and remains like that until 1949.

Early 50th, the Lebanese Government began to buy the water concessions. The first Autonomous Authority was created by Decree 3971 issued on January 17th 1951, to supply potable water to Beirut area.

- Between 1951 and 1995 many Autonomous Authorities have been created. At the end of 1995, there were 22 Autonomous Authorities (with the Litani River Authority "L.R.A") and around 220 Commissions and Projects managing potable water and irrigation water.
- Decree-Law 3375 on May 25th 1972 has reduced the number of Water Authorities to 6 Authorities with the L.R.A.
- Decree 4517 on December 13th 1972, has organized the Autonomous Authorities, and the relationships with their relevant Ministries of tutelage.
- Decree 4537 on December 15th 1972, has created the Higher Council for Water, but it didn't operated.

1.4. Situation until year 2000 – institutions and management

1.4.1. Ministry of hydraulic and electric resources

The Ministry of Hydraulic and Electric Resources was dealt with main following tasks concerning:

- The preparation and implementation of water general policy, master plan, hydraulic and electric projects equipment.
- The tutelage of Autonomous Authorities and control of concessionary companies.

The Article 1 of the law 20/66 mentions the following duties:

- Extend hydraulic and electric projects to the whole Lebanese country, and execute them or control their execution and exploitation.
- Enforce rules and by laws concerning the protection of public waters and their usage.
- Exert an administrative tutelage over Autonomous Authorities, Public Establishments and other bodies working in the hydraulic and electric fields.
- Exert the control over hydraulic and electric concessionary companies.
- Enforce rules and by laws concerning quarries and mining.

To comply with these duties, two general directorates were created:

- The General Directorate of Hydraulic and Electric Equipments involved in the planning, study, and execution of hydraulic and electric projects, and in the control of their execution, also in the enforcement of by laws and rules concerning the preservation of public waters, their wise use and the good governance and in the draining of rain and waste water.
- The General Directorate of Exploitation undertakes the administrative tutelage over the bodies operating in the fields of water and electricity and also over the public establishments, when it is decided by the Council of Ministers. It executes also the control of concessionary companies providing hydraulic and electrical services and also the control of all companies as per Council of Ministers decisions. In the same time, it makes sure that rules and by laws are well enforced. This General Directorate gives also technical advices about quarries permits before to obtain a final authorization by the Ministry of Interior.

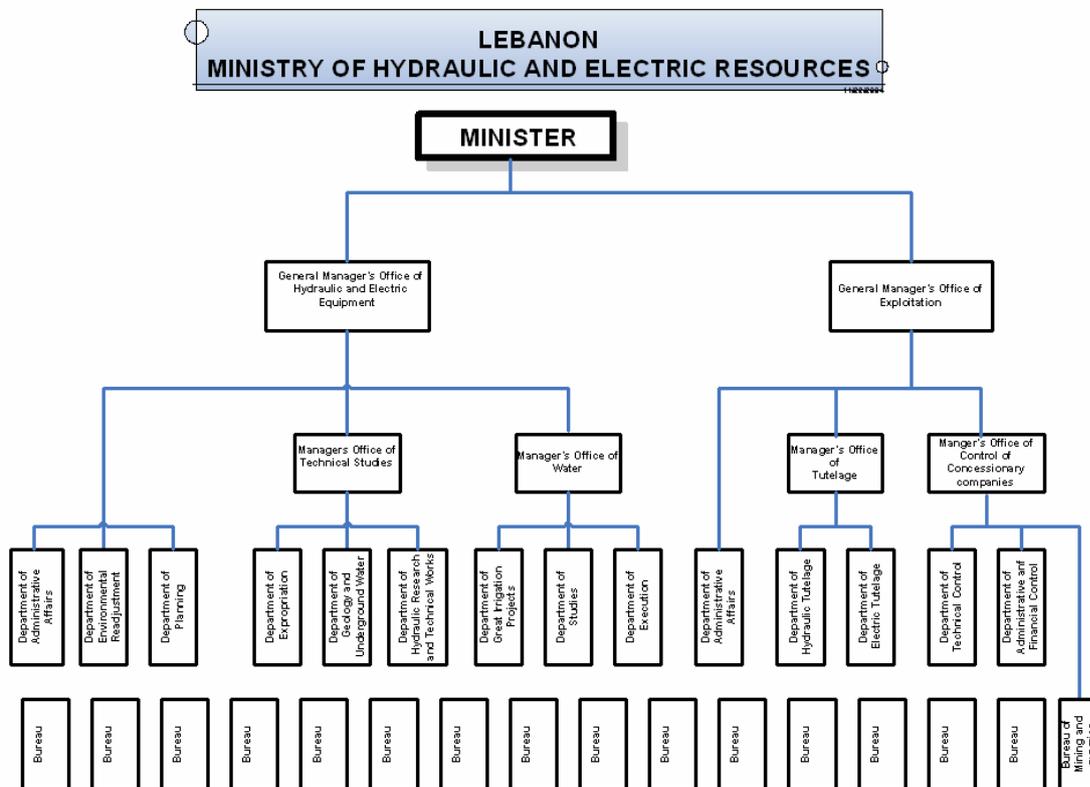


Figure 1. Chart organization of the ministry of electric and water resources. This ministry became ministry of water and energy

1.4.2. Water authorities

The organization of Autonomous Authorities and their relationships with the M.H.E.R are governed by the Decree 4517 issued on 1972. Their assignments are to operate hydraulic and electric projects undertaken by the M.H.E.R and under its tutelage. They enjoy the use of the status of moral person, the use of administrative and financial autonomy within the limits stipulated by the Articles of the previous Decree. Two main entities are involved in the management of these authorities: the Board of Directors who has the decision-making power, and the General Directorate assisted by the employees have the executive power. The financial tutelage falls within the competence of the Ministry of Finance.

The administrative tutelage differs from the civil tutelage by the fact that it approves or rejects the public establishments' decisions, but it cannot modify them. The responsible remain in control of these decisions, even after their approval. They can reconsider or don't implement them, and bring modifications if it necessary to submit them for a new approval.

1.4.3. Actors dealing with water

There are many actors dealing with water, around 31 specific entities. But each entity could have more than one institution. Also, we can observe around 38 main duties accomplished by these entities, and the total operation undertaken by the actors is around 140. In this case it is obvious to observe problematic situations due to the redundancy and the overlapping. The table below shows the list of the water actors.

Table 1. List of water actors

CM	Council of Ministers
MHER (MEW)	Ministry of Hydraulic and Electric Resources later Ebergy and Water
ME	Ministry of Environment
MPH	Ministry of Public Health
MIRA	Ministry of Interior and Rural Affairs
MHC	Ministry of Housing and Cooperatives
MFA	Ministry of Foreign Affairs
MJ	Ministry of Justice
MF	Ministry of Finance
M	Municipalities
MAR	Ministry of Administrative Reform
WA	Water Authorities
LRA	Litani River Authority
CV	Civil Service
LC	Local Commissions
CS	Council of South
CDR	Council of Development and Reconstruction
NCSR	National Council for Scientific Research
UNDP	United Nations for Development Programme
UNICEF	United Nations Children Funds
FAO	Food and Agriculture Organization
ESCWA	Economic and Social Commission for West Asia
UNESCO	United Nations Educational Scientific and Cultural Organization
PM	Pontifical Mission
MM	Movi Mondo
YMCA	Young Men's Christian Association
MC	Mercy Corps
AMEC	Assembly of Middle East Churches
LNGO's	Lebanese NGO's
E	Embassies
D	Donors

2. REORGANIZATION AND RESTRUCTURING OF WATER SECTOR

2.1. Lebanon facing to satisfy needs in space and time

There are many scenarios to estimate the available annual volume of water from existing data. This estimation is quite difficult knowing that the hydrological losses couldn't be known with a high accuracy, in the presence of highly karstic soil (more than 60%) and underground linking with neighbouring basins especially in the case of international basins. Also there are a big number of submarine springs.

The Lebanese hydrography is divided into 17 main watershed arranged in a distinguished compartments linked between them by 15 inter-basins. One of the optimistic scenarios, from a mechanist and stochastic models, gives an estimation of around 3.5 Billions CM per Year for the theoretical water availability in an average wet year. In reality, it is quite difficult to exploit, in an average wet year, more than 2 Billions CM at an acceptable cost with the available technical means and tools and thus, for many reasons such: the bad properties of soils to store water, and the occurrence of the rain during around only 100 days the year. This volume will decrease tremendously in a dry year, reaching around 1.2 Billions CM per year. In these circumstances, the management of water resources becomes very hard; especially if we have to meet the future needs.



Figure 2. Lebanon – Comparison between needs year 2020 and effective optimistic available water resources, average dry year scenario

In terms of water and food security, the results are worrying. The study and the modelling of this problem by introducing several parameters like: the population growing, the domestic, industrial and irrigation needs per unit use, the economic and financial situation, the irrigated or to be irrigated area and the agricultural aspects, the geography and cadastral situation, the legal context, the social conditions, the technical level etc, give a good approach to estimate the percentage of security.

Actually, the percentage of water security is bounded between 31% and 74%, and the percentage of food security is bounded by 10% and 39%. In year 2020, the percentages will decrease to attain the following limits: "between 23% and 54%" for the water security and "between 5.6% and 27.6%" for the food security. To improve these percentages many significant actions must be undertaken at all levels. In the same time it will necessary to make very large investments.

Table 2. Lebanon – example of minimum, maximum water security

Inhabitants (x 1000)	3500	4000	4500	5000	5500	6000	6500	7000	7500	8000	8500	9000
Max. water security (%)	84.6	74.2	66.1	59.6	54.3	49.9	46.1	42.9	40.1	37.7	35.6	33.7
Min. water security (%)	35.7	31.2	28.1	25.4	23.2	21.4	19.9	18.6	17.4	16.4	15.5	14.7

Table 3. Lebanon – example of minimum, maximum food security

Inhabitants (x 1000)	3500	4000	4500	5000	5500	6000	6500	7000	7500	8000	8500	9000
Max. food security (%)	44.7	38.8	34.2	30.6	27.6	25.1	22.7	20.5	18.6	16.9	15.4	14.1
Min. food security (%)	13.0	10.5	8.5	6.9	5.7	4.6	3.7	2.9	2.3	1.7	1.2	0.8

2.2. Some deficiencies in the administrative and financial operating systems

The water resources management is affected mainly by two major problems:

- The projects of equipment implemented by the manager's office of the equipment are financed by the National Budget. In this case, the studies could not really take into account the financial impact of these projects on tariffs and on operation and management cost. Also, the Ministry was obliged to spend all the assigned money during the same year; otherwise, the Ministry of Finance will reduce drastically for the coming year the allocated amount of money for water projects. These procedures are responsible of the small awareness about projects feasibility.
- The Autonomous Authorities take into consideration, in the tariff structure, only the salaries and part of the operation cost and maintenance. That didn't express the real cost of water services. The major interest of these Authorities was to supply water in more and more increased quantity according to the increasing of demand, in absence, in most of the cases, of a real management of needs and water availability. This behaviour came from the principle that these Authorities didn't have to recover the investment and renewal costs. The tariffs don't include until now the removal and the treatment of the waste water. Also, they remain below than 50 cents US per CM. In the same order, most of the Water Authorities are following the public accounting which includes two main titles: the first one concerns the general expenses of operation and maintenance and the second one, is related to the investments and immobilizations. Since few years, some of them are following in parallel the commercial accounting.

2.3. Initiation of the reform

From 1975, Lebanon has suffered 15 years of violence accompanied by the destruction or the severe worsening of its infrastructure. In the same time, that was the paralysis of public services and the departure of a great number of employees. In front of this alarming situation, Lebanese government conscious, that was vital to attain very quickly an acceptable level of services, to catch up the lost time, and urged by the World Bank and Funds Agencies to begin a wide action of reform, has started an ambitious program with the cooperation of the Ministry of Administrative Reform. The first meeting report is dated on March 1996.

2.3.1. For the World Bank

This reform must include two main issues:

- The preparation of a new water policy accordingly to the following principles:
 - The consumer has to pay the price of the services.

- The Policy and the Regulatory functions of the water sector have to be performed by National Institutions. While, the executive functions have to be done by local or regional establishments operating on a commercial basis.
 - These Establishments must operate in a smooth manner, in way to assure quick and good services.
 - The participation of the Private sector has to be encouraged, mainly in the field of operation and maintenance.
 - The consumers and the local authorities have to be consulted for the decisions concerning investment and improvement in general. Also, the local authorities could participate to the operation and maintenance activities.
 - The setting up of new technologies, wisely chosen and adapted to the real conditions is highly recommended.
- The aims of institutional reform request the improvement of the following institutions:
 - On a National level
 - ❖ A National Institution for water resources responsible for the strategic planning and allocation of these resources, under the tutelage of the Ministry Hydraulic and Electric Resources.
 - ❖ A Financial Regulatory Commission responsible for the setting up of the cost and tariff recovery, the policy of accounting plan and auditing, the financial performance of the management units and last, the review and the approval of tariffs for potable water, waste water and water for irrigation.
 - ❖ The Ministry of Hydraulic and Electric Resources could be in charge, for example, of the setting up of strategic planning including the control of the participation of Private Sector, the establishing of standards and norms for services, studies, operation and maintenance, bid regulations, projects.... Also, the Ministry could be responsible for technical assistance needs, financial needs in collaboration with the Financial Regulatory Commission, capacity building, and control and performance evaluation of operating units.
 - On a Regional level
 - ❖ Setting up of Regional Companies in charge of potable water, waste water, water for irrigation. For the South and South Beqaa, the Litani River Authority will remain handling water for irrigation.
 - ❖ These companies are autonomous, belonging to the Government or to the Private Sector and governed by the commercial law. They are managed by a board of Directors. They have to handle the planning, the studies and the implementation of local and regional programs and projects, within the frame of the strategy and master plan of the Ministry of Hydraulic and Electric resources. Also, they are in charge of the construction, operation and maintenance of installations, the management of water services, the proposal of tariffs, after their approval by the Regulatory Commission, their implementation, the training and the development of human resources, the technical assistance and the preparation of contract services.

2.3.2. *Lebanese government policy*

Since the 70th the Lebanese Government has undertaken several actions, and prepared many regulations and by laws to reorganize the water sector. The main goals were:

- Supplying water for the whole population.
- Irrigation of the maximum area of the arable land, at a special tariffs, to guarantee an optimum level of food security, to improve national economy, to reduce the danger of the desertification, to make sure a balanced ecosystems and to maintain rural population in their villages.
- Providing water for industrial needs by adopting preferential tariffs.

However, to reach these objectives many steps and actions are required:

- A good water resources management in space and time like: conservation and protection against the pollution, building dams and artificial lakes, artificial recharging of aquifers, control of the level of the ground water, springs' harnessing.
- A good management of needs by reducing technical and non technical losses, by installing meters which means that every unit of water consumed has to be paid and the lump sum

system has to be left gradually, by advising the utilization of water saving equipments and irrigation up to date systems.

- A rational Master Plan to reach as far as possible a balance between needs and demand.
- The improvement of water resources and all kind of networks, so that it can cover all needs in the various sectors of water use, as well in quantity as in quality.
- The administrative, legal and financial reform of water sector.

2.3.3. Head lines of the reform

Each reform constitutes a contribution or a specific solution to correct the deficiencies encountered in the management of any kind of resources. In the field of water sector, the head lines of the reform can be summarized as following:

- The Ministry of Hydraulic and Electric Resources keeps within its competencies: the national policy of water and electricity, the tutelage of Autonomous Authorities and the control of concessions, the approval of tariffs policy, the control of the running of public establishments and the assessment of their results. The study and the implementation of great projects like dams or big conveyors.
- The merging of water authorities (more than 200) in four regional companies for the North, Beirut and Mount Lebanon, South and Beqaa. These new regional companies will handle potable and waste water and water for irrigation. In the South, and West and South Beqaa, the Litani River Authority will remain responsible for irrigation water. Also, these companies will be in charge of the studies, implementation, management and the operation and maintenance of the projects within their particular area.

2.3.4. Actions undertaken by the Lebanese government

• Objectives

These objectives can be summarized by eight points:

- Restructuring and reorganization of the administration.
- Rehabilitation and reducing the losses of the potable water networks, in way to procure a better services.
- Reducing the cost of energy by giving priority to develop the distribution and the transmission lines by gravity.
- Reinforcement of the networks in way to forecast needs in the future.
- Developing new sources by the construction of dams, spring harnessing and aquifers management.
- Improving the irrigation methods.
- Mitigation of the risk of floods by the correction of the course of the rivers bed.
- Conservation of the environment and construction of waste water networks and treatment plants.

• Tenth year plan

The Ministry of Hydraulic and Electric Resources has prepared a tenth year plan that has adopted by the Lebanese Government through a Program-Law. The scheduled tasks concern four fields:

- studies,
- expropriations,
- execution works,
- control of the works execution.

The financial allocations have to cover a very big variety of projects:

- Dams and artificial lakes in order to store around 800 Millions CM.
- Around 50 harnessing works.
- Around 70 wells.
- Waste water networks and around 10 treatment plants.
- Potable water networks.
- Improvement of administrative work and the skills of employees.

• Restructuring actions

The governmental has focused its action in three main directions:

- The merging of some Ministries like the Ministry of Hydraulic and Electric Resources and the Ministry of Petrol in a new one called Ministry of Energy and Water.
- The restructuring of water sector accordingly to Law 221.
- The preparation of the participation of private sector as it is defined by the Law 228.

- **Law 221**

This Law issued on May 29th 2000 has defined the role and competencies of the Ministry of Hydraulic and Electric Resources and the new merged water authorities.

According to Article 2 of the Law 221, The Ministry of Hydraulic and Electric Resources assumes the following competencies and missions:

- 1- To collect, control, meter, establish statistics and study water resources, to evaluate water needs and field of usage over the Lebanese territory.
- 2- To control the surface and underground water quality and identify standards to be applied.
- 3- To establish the general planning project for hydraulic resources allocation, repartition among the drinking and irrigation water usage on the national level, as well as to prepare the National General Master-Plan and update it continuously.
- 4- To design, study and implement the large water installations and works such as dams, artificial lakes, tunnels, water courses rectification, water networks etc..., and to operate them.
- 5- To implement, when needed, artificial recharge of underground water reservoirs and to control water extraction.
- 6- To protect water resources from losses and pollution by elaborating legal texts and taking necessary measures and dispositions to avoid water pollution as well as to bring these water resources back to their former natural quality.
- 7- To give licenses and permits for water survey, public water usage and temporary occupation of public properties and to finalize all necessary formalities according to the laws and by-laws in force.
- 8- To implement studies, and hydraulic, geological and hydrogeological researches, to collect technical data relative to hydraulic matters, to establish technical maps concerning these studies, researches and data and to update them regularly.
- 9- To carry out control and tutelage over public Establishments and other bodies operating in the water field, according to the present law dispositions, texts and stipulations relative to each of the about mentioned establishments and institutions.
- 10- To ameliorate performances of the Water Exploitation Public Establishments (WEPEs) and to evaluate their performances on the basis of indicators mentioned in the action plans, which have been approved according to legal procedures.
- 11- To establish standards to be adopted in the studies conducted by the WEPEs as well as in their works implementation. To establish conditions and regulations for surface and underground water extraction and use and their quality standards and control.
- 12- To prepare and carry out expropriation formalities relative to the MHER and WEPEs submitted to its tutelage according to the laws and regulations in force.
- 13- To express a technical opinion on quarries and mines licenses and permits concerning their impact on water resources.
- 14- To provide public relations with the population and to inform the people of all necessary information concerning the water matters and to provide adequate orientation toward a rational use.

The chart organization of the MHER is also changed: the two Manager's Offices for Water and Technical Studies are suppressed, also the three Departments of Great Irrigation Projects, Studies and Environment Readjustment. The merging of the MHER and the Ministry of Petrol has incorporated the General Directorate of Petrol in the responsibility of the MHER.

This new organization allows to give more responsibilities to the Regional Establishments and to focus the main purpose of the Ministry of Energy and Water on the National issues like: the water policy or the control of the sector operations for example.

The creation of Water Public Establishments is delineated by the Article 3. Five Establishments are created as follows:

- Beirut and Mount Lebanon Water Establishment – main office: Beirut.
- North Lebanon Water Establishment – main office: Tripoli.

- South-Beqaa Water Establishment – main office: Zahleh.
- North-Beqaa Water Establishment – main office: Baalbeck.
- South Lebanon Water Establishment – main office: Saida.

These Establishments have the status of moral person and they operate within an administrative and financial autonomy within the perimeter fixed by the present law.

Duties and competencies of Water Establishments are described by the Article 4. These Establishments have to:

- Carry out studies, implementation, operation, maintenance and renewing of projects for drinking and irrigation water distribution, (except for irrigation water in the South and South Beqaa that remains under the responsibility of the Litani River authority), within the frame of General Master-Plan according to a Ministry's prior permit to use public water resources.
- Propose tariffs for drinking and irrigation water services taking into consideration general socio-economic conditions of the Country.
- Control the quality of the drinking and irrigation distributed water.

These Water Establishments are operating under their own regulations. Also, they have to hire the services of an audit company concerning their financial status. They are also managed by a board of Directors constituted by a President and six members.

According to Article 6, the WEPEs are submitted to the "posteriori" control of the Account Court. Also, the activities of the WEPEs are assessed by a Performance Evaluation Committee constituted by the Minister of Hydraulic and Electric Resources as president and 7 members: the General Director of the Ministry of Finances, the General director of Exploitation in the MHER, the General Director of Hydraulic and Electric Equipment in the MHER, a hydraulic engineer, an economy graduate, a law graduate, and a second category functionary from the General Directorate of Exploitation as "rapporteur".

The merging of the Water Authorities should be completed within a period of two years. Meanwhile, the actual Water Autonomous Authorities and Committees will continue to manage drinking and irrigation water.

- **Law 241**

This law issued on August 7th 2000 has brought a correction to the Article 3 of law 221 by creating one Water Establishment for the Beqaa instead the two establishments of North and South Beqaa as per law 221.

- **Law 377**

This law issued on December 14th 2001 is an Amendment of Laws 221 and 241. In the Article 1, the new version of paragraphs 3 and 11 of Article 2 concerning Law 221 incorporates the responsibilities of the waste water within the competencies of the Ministry of Hydraulic and Electric Resources. Article 2 gives the same amendment for Water Establishments duties by incorporating the handling of the waste water in the subparagraphs of Article 4 of Law 221.

The Article 3 replaces the name of the Ministry of Hydraulic and Electric Resources mentioned in the Article 5 first paragraph of Law 221, by the corresponding terms; "Ministry of Energy and Water".

The Article 4 brings, in addition to the previous modification relative to the MHER, another new appellation:

- General Director of Hydraulic and Electric Equipment is replaced by General Director of Hydraulic and Electric resources.
- Public Water Establishments are replaced by Public Water and Waste Water Establishments PWWEs.

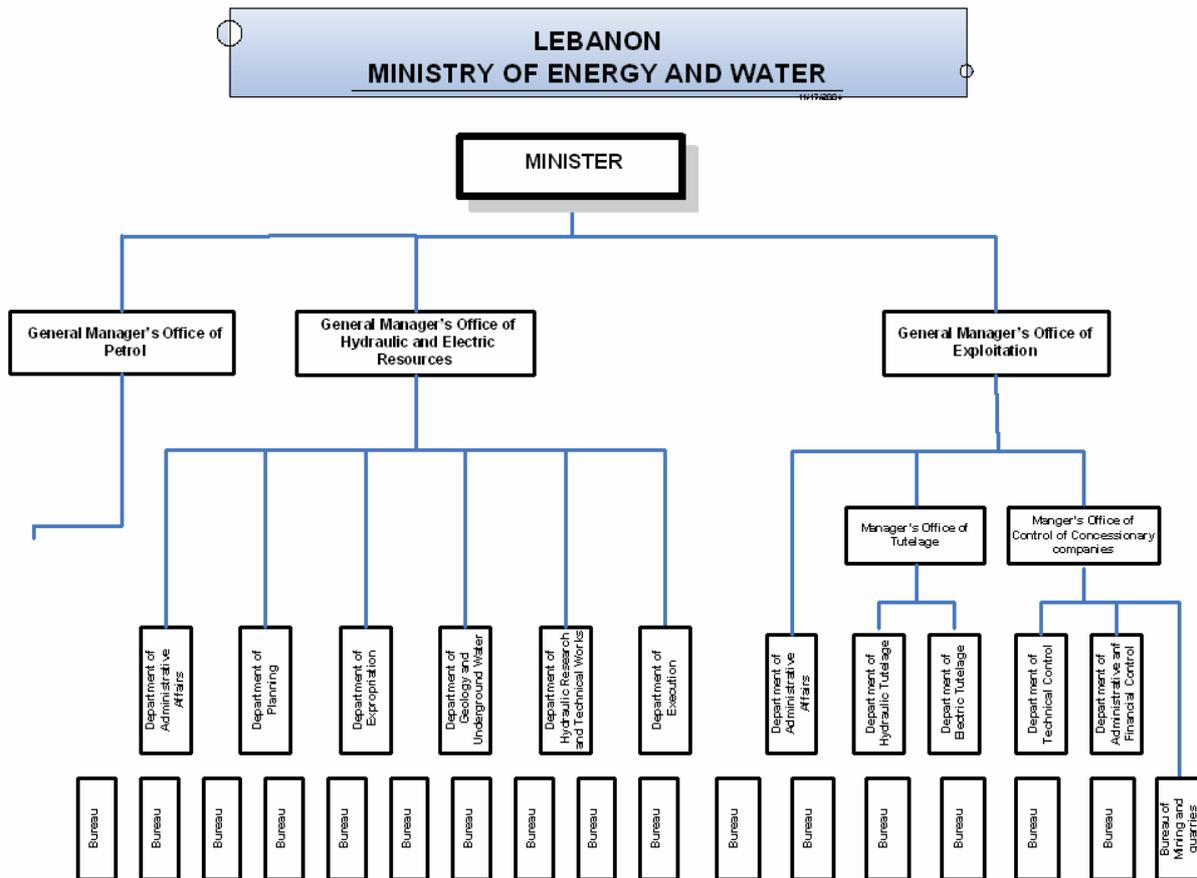


Figure 3. New chart organization of the ministry of energy and water- general directorate of petrol belong to the previous ministry of petrol that has been integrated to the ministry of energy and water

- **Decree 8122**

This Decree, issued on July 3rd 2002, defines some application process of the Law 221. In application of the merging of the Water Authorities as mentioned in the Law 221, the work stopping date of each one is fixed by the Minister of Energy and Water on the proposal of the concerned Public Water Establishments' Board. Meanwhile, all the Water Authorities will keep carrying on with their functions.

The Board of Directors undertakes the decision power in all water authorities and the General Director the executive authority. Employees who have any prerogative or titles are joined to the Public Water Establishment and are appointed to vacant positions in the establishment, provided that each one of the employees fulfils the extra particular conditions, in order to be recruited for the said position. This process goes on, without altering the employee's rank or category along with keeping his promoting right.

- **Law 228**

To encourage the participation of the private sector, the Lebanese Government has issued on May 31 2000 law 228 to regulate privatization activities and defining its conditions and applications.

The partial or complete transfer of a public project or its partial or complete management is decided by a law specifically issued for this purpose. This law has to regulate the economic sector involved in the transaction and identifies the basis for the transfer and the monitoring of privatized projects through independent regulatory bodies created especially for this purpose. The law specifies also the duration of the transaction pursuant to Clause 89 of the Constitution. Is one share "Golden Share" in a newly established company pursuant to a privatization transaction, to which the Government may grant specific voting rights.

The planning and executing of the privatization is devoted to a Higher Council for Privatization. This Council includes the President of the Council of Ministers as President, the Minister of Justice, the Minister of Finance, the Minister of Economy and trade, the Minister of labour and for each privatization transaction, the Minister with jurisdiction over the subject matter of the transaction is also legally a member of the Council. Council work rules are determined by Decrees adopted in the Council of Ministers.

The Council may also seek support from inside or outside the public sector as well as local and international expertise specialized in privatization, in addition to the support of banks and financial institutions with expertise in preparing privatization transactions and promoting its shares in the market.

All Privatization transactions are abided by regulations:

- to entertain competition in activities,
- to protect consumers rights in terms of prices, quality of goods and services, through regulatory bodies,
- to insure labour rights to nationals working,
- to protect the Public Purse in accordance with International, Financial and Economic terms, abiding with rules and regulations guaranteeing transparency and competition and making information available to the public upon request,
- to protect Treasury and Consumers rights through the control of pricing, tariffs and Government revenues.

The first contract of services is operated today within the Water Authority of Tripoli in the North Lebanon. The contractor is the French firm Ondeo. The results are until now encouraging and the Government is studying the opportunity to extend this experience to the other Water Authorities.

3. LITANI RIVER AUTHORITY

3.1. Litani river

Litani River is the most important River in Lebanon. It is a totally national river, without any link with the Jordan Basin, as we have verified by mechanist and stochastic models. It is situated in the Beqaa Valley located in the centre of Lebanon, and it takes roots near the town of Baalbeck at 1000m of elevation approximately. Its total length is about 170 km which 70 km are located in the Beqaa Valley and 100 km between the Beqaa and the coast. Its average slope in the Beqaa is around 0.25% and around 0.8% between the Beqaa and the coast.

The percentage of karstification in the watershed is around 65%. Its average annual discharge is around 750 Millions CM in the case of an average pluviometry of around 750 mm/year for an average wet year.

In 1964, the Lebanese Government has achieved the construction of the Qaraoun Dam. Its maximum storage water volume is around 220 Millions of CM for an elevation of 860m. Its length is about 12 km and the area of the Reservoir is about 12.3 km².

3.2. Creation law and objectives

The Litani River Authority has been created by the Law issued on August 14th 1954. Its duties and competencies are, as per the previous law, as follows:

- The execution of the Litani project for irrigation and drainage, for potable water and electricity production within the integrated Master Plan for Water in Lebanon and pursuant to the studies undertaken by the Lebanese Government assisted by the American Technical Commission.
- The installation of a network for the electricity plants in Lebanon.
- The erection of transformation stations, transmission and distribution lines in the whole Lebanese regions.

This Authority has the status of moral person and it operates within an administrative and financial autonomy.

Two days after the implementation of August 14th Law, the first Board of Directors was designated by the Decree 5997 issued on August 16th 1954. On year later, three new Laws were issued on December 30th 1955 concerning three main issues to consolidate the start up of LRA. The first one, was ratified the agreement signed on August 25th 1955 to guarantee the loan of the International Bank for Development and Reconstruction to the LRA. The second one, has given to LRA, the right to exploit all the parts of the Litani project as well from technical point of view as from financial aspects, It constitutes an Amendment to the LRA creation Law . The third one has decided the advance of the Public Treasury to the LRA.

3.3. Administrative organization

The Litani River Authority is governed by the same laws governing the other Autonomous Water Authorities, like Law 4517. This Authority is managed by a Board of Directors for three years. The chart organization of the LRA shows the main executives responsibilities constituted by a general Manager, four managers handling the administrative, technical, irrigation and hydroelectricity aspects. They are assisted by 16 departments and 42 bureaus.

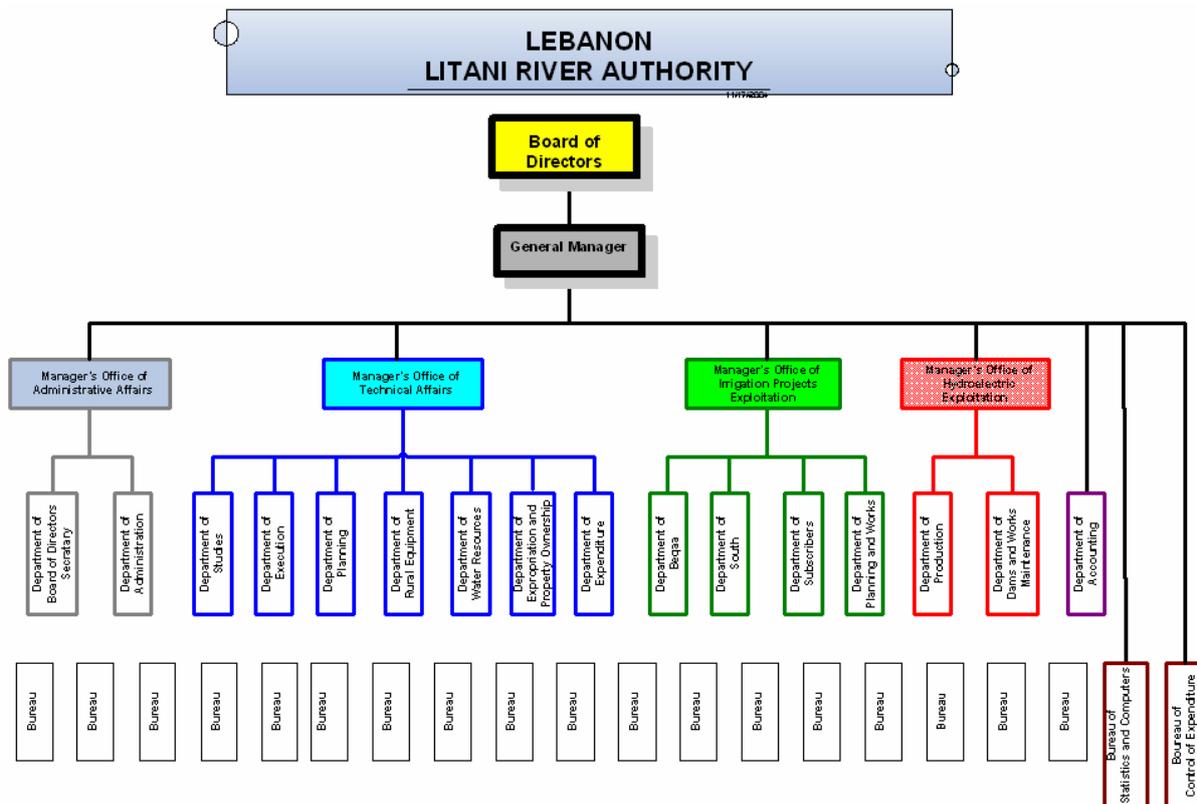


Figure 4. Litani river authority chart organization

3.4. Main projects

3.4.1. Actual activities

- **Hydroelectricity**

There are three Power Plants:

- Abdel Aal Power Plant:
Elevation 658 m;
Maximum discharge 22 m³/s;

Installed Power 34 Mw.

- Awali Power Plant
Elevation 228.5 m;
Maximum discharge 33 m³/s;
Installed Power 108 Mw.
- Joun Power Plant
Elevation 32 m;
Maximum Discharge 33 m³/s;
Installed Power 48 Mw.

- **Irrigation**

- Project of Quasmieh et Ras el Ain
It has been built in 1943;
It is handled by the LRA since 1974;
Area 3250 Ha;
Subscribers 1280.
- Pilot Project between Saitaniq and Awali Rivers
It has been built in 1969;
Area 1200 Ha which 350Ha are exploited;
Subscribers 770;
Supplied villages 21.
- West Beqaa Project – Conveyor 900
Today under construction;
Area 6700 Ha;
2000 Ha are achieved.
- Project of Rural Development and Agronomic Research
Located at the village of Khirbet Kanafar in the West Beqaa.

- **Water Resources**

Management of 53 Hydrometric gauge stations on all Lebanese Rivers

3.4.2. Master Plan, first phase

- **Irrigation of West Beqaa.**

Area 28000 Ha
From conveyor 900
Chamsine spring
Underground Water
Massa Dam

- **Irrigation of South West slopes.**

3 Elevation Levels:

- High altitude between elevations 800 m and 400 m.
Area 14700 Ha
From conveyor 800
Ain el Zarqa spring
20 Mm³/year for potable water
- Middle altitude between elevations 600 m and 350 m.
Area 18000 Ha
From conveyor 600 Anane
Khardaleh dam
Underground water
- Low altitude between elevation 200 m – 0 m.

Area 6000Ha
 From Kfarsir dam
 Qasmieh conveyer
 Ras el Ain and Rachidieh springs
 Bisri dam to supply Great Beirut with potable water

- **Irrigation in the Hasbani Basin.**
 Area under study
- **Agronomic research at Khirbet Kanafar.**
- **Rehabilitation and implementation of an up to date network of hydrometric gauge stations.**
- **Campaign to protect Qaraoun Lake from pollution.**

3.4.3. Examples of optimization approach

- **Network optimization in terms of minimizing energy cost.**

This approach requires a good knowledge of whole systems operation, namely:

- Supply methods.
- Lengths of different lines.
- Diameter of the lines.
- Pumping group characteristics.
- Network particular characteristics.
- Real and definite supply flows.
- Real demand and future needs.

Let i be the symbol of any production stations,
 Let j be the symbol of any consumption zones,
 Let F be the function $F(\alpha_{ij}, H_i, H_j, Q_i, L_{ij}, D_{ij}, C_i)$

With:

- F : electrical energy function cost
- Q_i : hourly quantities coming from station i
- C_i : average energy cost by m^3 from stations i
- H_i : stations i altitudes
- H_j : supply zones j altitude
- L_{ij} : distance between i and j
- D_{ij} : line diameter between i and j
- α_{ij} : supply weighted coefficient of zone j from stations i
- B_j : zones j needs
- M : production stations number
- N : consumption zones number

We should determine Min F

With:

$$i = 1 \text{ at } M \quad \sum_{j=1}^N \alpha_{ij} \leq 1$$

$$\sum_{i=1}^M \sum_{j=1}^N \alpha_{ij} Q_i \leq \sum_{i=1}^M Q_i$$

$$j = 1 \text{ at } N \quad \sum_{i=1}^M \alpha_{ij} Q_i \leq B_j$$

with all the α_{ij} : $\alpha_{ij} \leq 1$ and $\alpha_{ij} \geq 0$.

- **Energy cost optimization global approach**

This methodology requires the studying of the contribution of whole points to supplying many suburbs. Each group of towns and villages is represented by its centre of gravity.

Let i be the symbol of any production stations,
 Let j be the symbol of any consumption zones,
 Let F be the function $F(\alpha_{ij}, C_{\Delta i,j}, H_i, H_j, Q_i, L_{ij}, C_i)$.

With:

- F: electrical energy function cost
- Q_i : hourly quantities coming from station i
- C_i : average energy cost by m^3 from stations i
- H_i : stations i altitudes
- H_j : supply zones j altitude
- L_{ij} : distance between i and j
- α_{ij} : supply weighted coefficient of zone j from stations i
- B_j : zones j needs
- M : production stations number
- $C_{\Delta i,j}$: head losses coefficient between i and j

We should determine $\text{Min } F$

With:

$$\sum_{i=1}^M \alpha_i \leq M$$

$$\sum_{i=1}^M \alpha_i Q_i \leq B_j$$

with all the α_i : $\alpha_i \leq 1$ and $\alpha_i \geq 0$.

- **Priority allocation by main resources**

Applying the global method allows defining the percentage of different resources contribution to the water demand by town concentration centre. By taking each production unit, it would be interesting to the consumption points that would mainly depend on it.

Then a function should be defined that would allow estimating the weighting associated to priority dependency between different consumption points and retained production centres. Given $F(H_i, H_j, L_{ij})$ as this weighting function:

- H_i : elevation of stations i ,
- H_j : elevation of supply zones j ,
- L_{ij} : distance between i and j .

By applying this function to all consumption points, considering respectively each production point, classifying these weightings in descending order highlights priority dependencies between production and consumption points.

- **Example of geographical distribution of demand and resources**

- - Horizontal distribution

Horizontal distribution reveals a group of points that adjoin and superimpose sometimes. The appearing harmony in the close relationships between production and consumptions points can be considered as very reassuring. However, system's management is complicated, not very rational, and could affect this apparent security. Running the system could be conceivable with limited production zones without sacrificing the required security level. The diagrams hereunder illustrate the observations.

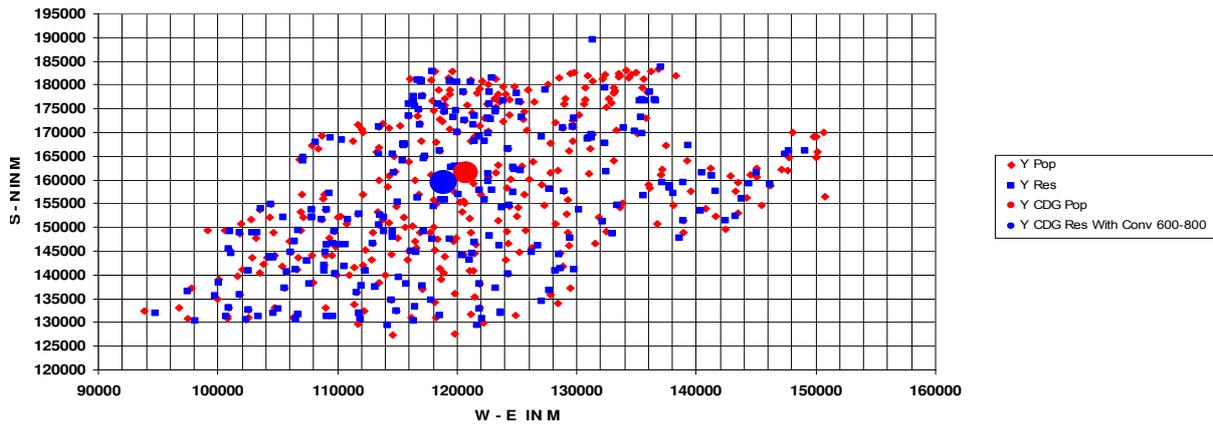


Figure 5. South Water Authority: geographical distribution of resources and demand

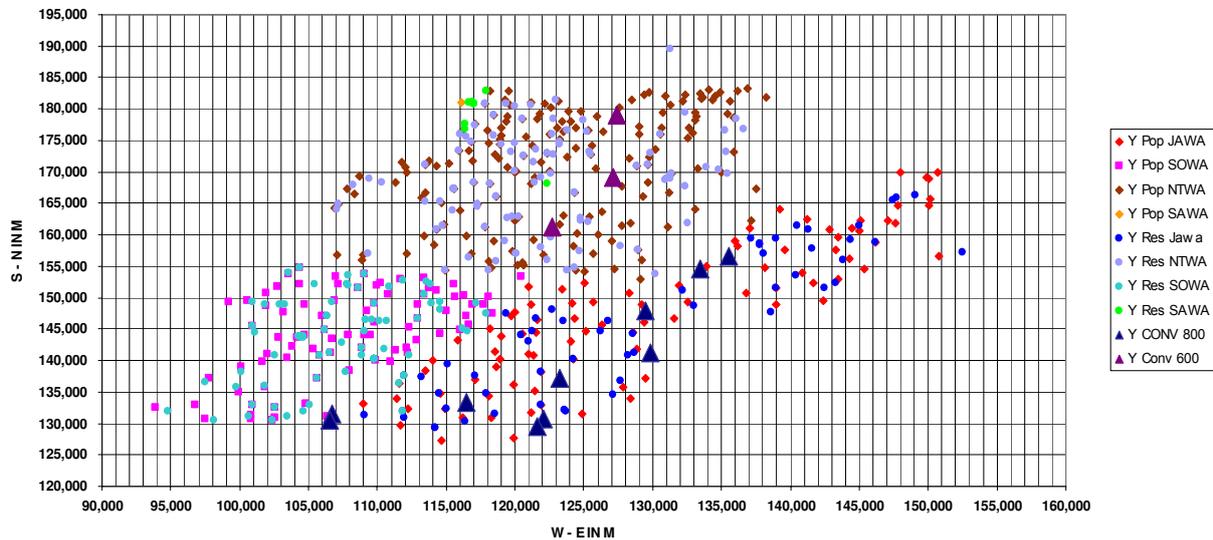


Figure 6. South Water Systems – geographical distribution of resources and population by subsystem

- Vertical distribution

The vertical distribution is one of the essential elements to determine pumping energies and their related costs. The meant region is divided into altitude strips 100m away from one another. The G.P.S includes three components of three- dimensional area. This allows setting up daily quantity supply into 100m brackets.

If the resource distribution is more than demand, the latter is satisfied. If it is on the left of the demand, this is translated by a pumping necessity to provide for the needs. On the other hand, a shifting to the right means that the supply is possible by gravity. When the demand exceeds available resources, then there is a resource gap that has to be filled

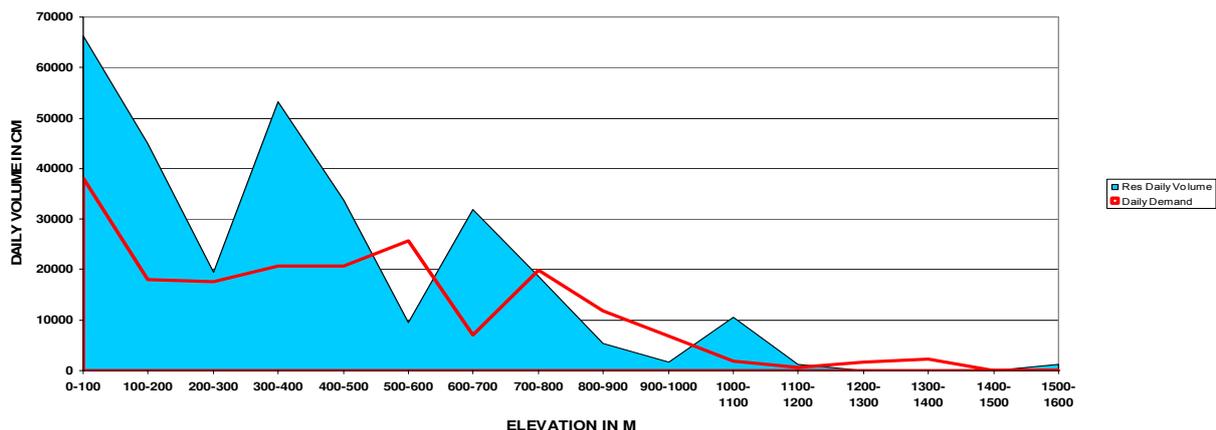


Figure 7. South Water Systems – demand and available resources distributed by elevation

4. CONCLUSION

In Lebanon water is considered as public goods. Ways and customs have played since a long time an important role in the management of water. These ways and customs were also accompanied by the water rights that are always in force until now. But with the increasing of demand and the necessity to organize this field many Laws and Decrees have been issued by creating the Institutions and the Authorities that have to be deal with water. In the beginning, there were many problems of overlapping, redundancy, duplication, lack of coordination, some confusion in the duties, an unrestrained multiplication of different kinds of bodies handling services, uses related to water resources.

In this context and, with the development of irrigation, industry and potable water consumptions, the first forerunner have been felt by the shortage crisis and by the threat to not meet to the future needs. Lebanon could be considered as having a certain acceptable potential of available resources. Indeed, Lebanon is facing many problems linked with the short rain period, the high karstification of its soil, the encountered difficulties to store water, to the high slopes of its bed rivers. Without a real water management system, each new needs was called to a new resources instead to reduce losses and to try to rationalize the water use.

The reform and the restructuring of water sector became urgency. Lebanon, assisted by the local and external expertise has undertaken a wide restructuring operation by redefining the competencies and duties of the Ministry of Hydraulic resources, and Water Authorities. All national management issues, as water policy, control, standards, and great projects were assigned to the Ministry who became later, after its merge with the Ministry of Petrol, Ministry of Energy and Water. Water Authorities were merged in four Public Establishments with more responsibilities about local problems, projects and services. In this way, their action became more effective with a higher quality of services. In the same time, a particular attention is done to the participation of Private Sector. The Law 228 has been issued for this purpose.

In parallel to the administrative aspects, the technical problems in terms of quantity and quality has been developed through the tenth year programs in addition to many studies and projects implementation. The worry to reach the optimum level of water and food security could be considered as the principle leitmotiv behind this reform. Many scenarios have been studied and the results are pessimistic.

At another scale, the management of the Litani River is quite similar to the national problems. The mainly water use is the irrigation and the hydroelectricity production. Meanwhile the activities of the Litani River Authority managed by a Board of Directors, a General Director and managers extend also to the rural development and agronomic research, to water resources measurement and environment conservation. The allocation of water takes into accounts many parameters related to geographic ones, energy cost, land, socio-economic situation, crops and agriculture and irrigation technical aspects. In this way, it is reasonable to reach a certain level of optimization.

Actually Lebanon is launching a new management approach based on a clear duties repartition of duties with the empowerment of local actors, on enforcing the public action, on encouraging the private initiative. Also, Lebanon is managing needs and resources on an integrated approach, in a manner to optimize the use, and to insure a sustainable development. We are now at the beginning of a long way. All efforts have to be undertaken for a better use of water.