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## HARMONIZATION AND INTEGRATION OF WATER SAVING OPTIONS IN LEBANON

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**SUMMARY** - In 2020, the water balance in Lebanon could be negative if concern entities in water management do not apply the water saving options. Ministry of Energy and water is the responsible of water policy and Water Authorities are the responsible for execution of his master plan. At the end users level in agriculture sector, the Ministry of Agriculture has the responsibility on farm level. The absence of Water User Associations and extension in water management, bad maintenance and water pollution are the major causes of water losses. Legislation, law enforcement, research and education center activation, tariff policy, stakeholder's capacity building are the main factors for water management enhancement. The creation of the High Council for water is a major step on coordination of decision maker's activities, sharing knowledge and exchange of experience. His role will be decisive on updating and adjustment of Water National Master Plan.

**Keywords:** Water Authorities, Water User Associations, High Council of Water, education and research center, Tariff policy, Legislation and Law enforcement.

### INTRODUCTION

Experts warn that the impending water crisis will be the major environmental problem of the next decade. Population growth, irrigation development and urbanization are key factors underlying the enormous growth in the demand of water and increase environmental degradation.

Lebanon is the most urbanized country in the Middle East region-with more than 88% of its population in urban areas in 2005 (State of Food and Agriculture, 2005). The annual population growth rate is high (about 1.62%) (Country Report, FAO, 2005). Actual irrigated area represents only 42% of the total irrigation potential. With great efforts on technical improvement, to:

- Rehabilitate and improve efficiency of actual irrigation and domestic water network.
- Ameliorate "on farm" irrigation efficiency.
- Limit degradation and ameliorate the water quality.
- Reuse treated wastewater.
- 

Water balance will be at borderline in 2020; even though total water needs will grow by 83% from the actual water needs (Litani River Authority, 2001). Of course, this figure takes in consideration the execution of new irrigation and domestic and expanding existing water projects

Actually, in Lebanon, water scarcity becomes a daily feeling for the population. Population growth, limited water management capacity, fragmented organizational structures; inadequate water planning, management, and conservation are among the contributing factors. In addition, pollution of water resources will decrease dramatically water availability.

Many efforts are previewed or ongoing to prevent possible water balance deficit before 2020. Needed actions are undertaking by many actors in water management in Lebanon. Close collaboration between these actors is needed to harmonize water saving options and to integrate them in their actions plan.

### Water Management Stakeholders

Decision Makers in water sector: The law 221, dated 8<sup>th</sup> of June 2000 reformed water sector in Lebanon. Under the governance of the Ministry of Energy and Water (MEW), 22 water authorities are regrouped in four regional authorities beside the existing Litani River Authority (LRA). All water authorities along with LRA are under the patronage of MEW. The law plans the constitution by MEW

and the Ministry of Finance of a committee for the evaluation of proceeding and works of water authorities. According to Law 221 duties will be describe below.

The Ministry of Energy and Water (MEW): Has the main responsibility of water policy in Lebanon (Surface and Underground ); MWE is the responsible for:

- Water flow measurements on rivers and springs, quality water control, assessment on total water needs, planning, and water allocation on national level. However, due to some administrative constrains, the LRA is still achieving water flow measurements on surface water all around the country.
- All technical studies and investigations to improve actual and find new water resources
- Water master plan at national level and it is continual updating
- Underground water recharge
- Studies and execution of watercourses rehabilitation and maintenance, main hydraulic structures (Dams, ponds, reservoirs, main networks); at national level out of LRA area responsibility

Council for Development and Reconstruction (CDR) share these activities with MEW and LRA in case of foreign funds

- Water domain legislation: Preparing law drafts, law application and enforcement, and management (by mean of Water Authorities)
- Patronage of Water Management Authorities and supervision of their activities

Water Authorities: The span of responsibility is on Geo-administrative regional basis (Mount Lebanon and Greater Beirut; South Lebanon; North Lebanon and Bekaa). Regional Water Authorities (RWA) are responsible for integrated water Management: Domestic, irrigation and wastewater. RWA and LRA are responsible for direct water Management. Their responsibilities include:

- Studies, execution, operating and maintenance of water projects
- Water tariff policy
- Water quality monitoring

In matter of irrigation, repartition between LRA and RWA is summarized in the following table:

Table1 Repartition of irrigation projects by area in ha

Designation	Irrigated	Ongoing & Proposed	Total
Total Lebanon Schemes	60,900	82,000	142,900
LRA Schemes	16,530	60,330	76,860
LRA in % of Lebanon	27.14	73.75	53.79

After five years from the constitution of RWA, MEW published in 2005 organizing decrees. RWA experience in irrigation, wastewater and water quality control is still modest.

Actually, all RWA networks irrigation schemes are open channel and traditional irrigation system with a low efficiency. Great efforts must be undertaken in order to ameliorate on farm and network efficiencies.

1.1. Litani River Authority: Control domain over the Litani river basin in South Bekaa Valley, and South Lebanon regions. LRA is responsible to:

- Manage water resource on Litani River and tributaries, springs in the Litani River Basin, and underground water in south Bekaa.
- Study and construct main hydraulic structure in Litani River Basin: Dams, ponds, reservoirs, networks etc.
- Manage existing irrigation schemes in south Bekaa and south Lebanon (Action Domain of two others water authorities: Bekaa and South Lebanon Water Authority).
- Study and execute irrigation projects in south Bekaa and south Lebanon.
- Provide domestic water for a part of south Lebanon. (20 MCM per year)

All executed schemes by LRA and new projected projects are pressurized network and on farm pressurized irrigation system.

LRA has experiences since:

- 1962 in study and execution of irrigation and water structures (Dams, ponds irrigation networks) and Measurement of Water Flow (All Lebanese Rivers and main springs)
- 1968 in extension and services to farmers
- 1999, in water quality assessment
- Recently LRA (2006) create his Water Quality Department and launched in collaboration with Abdel Aal Association, water quality awareness for local communities.

## 2. Others Concerned Institutions in water management:

2.1. The Ministry of Agriculture (MOA): Is concerned as water management as official responsible on agriculture policy in Lebanon. In addition, the extension service in MOA is responsible on farmers training in irrigation techniques on farm level.

Under the patronage of MOA, two autonomous institutions are acting:

- Irrigation Department in Lebanese Agriculture Research Institution: Researches on all themes related to irrigation: Crop-soil-climate interactions, fertigation, irrigation techniques etc.
- Green Plan who have responsibilities on:
  - Water harvesting by construction of mountain ponds
  - Land reclamation: The construction of terraces, which is in close correlation with irrigation technique at farm level.

The Ministry of Environment: Is responsible for all environmental policy at national level, by:

- Formulating a general strategy and long-term plans for environmental management and natural resources use
- Preparing law Drafts
- Developing detailed plans for environmental protection, including monitoring plans, and control of all sorts of pollution caused by solid waste, industrial waste, domestic wastewater, and air pollutants.

Education institutions and Research Center: Four agriculture faculties are operating in Lebanon at Lebanese, American, Saint Joseph and Holly Spirit Universities. Two research centers in water are active:

- "Centre de recherches sur l'eau"(CREEN), Saint Joseph University
- Water and Energy Research Center (WERC), Notre Dame University

Many technical schools are formatting agricultural technicians where irrigation is a part of this formation.

Farmers: Farmers as end Users are the base of water saving policy. They can be divided in two groups of users regarding their water sources:

- Individual well: For this category of users, the energy cost is an incentive to use pressurized irrigation techniques. A detailed study in South Bekaa (Litani River Authority, 1999) show, for farmers using private wells, that 77.66 % of the area is irrigated by sprinkler, 11.58% by trickle and 10.75% by traditional techniques. Irrigation modules are excessive and many problems are encountered in the farm network (IRWA, 2006). For this category, the main problem is excessive pumping from underground water. Actually, no laws restrict the water quantities withdraw from wells. Beside the extension necessity on farm, legislation on underground water is need.
- Collective Schemes: Surface source of water is shared between farmers by public networks. Total irrigated area served by 67 schemes is 59000 hectares (MEW, 2003). Only two schemes (2300 ha), executed by LRA, have pressurized network and use on farm pressurized irrigation techniques. Water saving process will have two main objectives: Shifting towards pressurized irrigation techniques and rehabilitation of the already existing networks.

**Actually, water user associations in Lebanon do not exist.** Some water comities, created by the MEW, have a very restricted role: Water distribution between beneficiaries and very limited intervention in channel rehabilitation.

At legislation level, existing law 320/S (dated1926) is the only text concerning "Syndical Association" in water users. This law is very old and focuses on protection from flooding. It gives the

possibility to create water user associations in irrigation, but must be revised in order to be modernized and adapted to irrigation and gives more details on creation procedures.

### **Objectives of integrated water management in Lebanon:**

Many studies, plans and actions have been undertaken without an integrated water management plan at national level. In the following a short description of this works and that to must do.

**Rehabilitation of existing schemes:** The number of small and medium schemes in Lebanon is 67 schemes. Equipped area is 65600 ha and potentially irrigated area is 59070 ha. The effective irrigated area is evaluated at 40000 ha. This area decrease is related to miss maintenance of these schemes. With a loan from BIRD, Lebanon achieved the rehabilitation of five medium and ten small schemes representing a total equipped area of 27200 ha. The remained areas, representing about 58% from the total area, still need rehabilitation. These schemes are the responsibilities of RWA and LRA.

The main objective of this rehabilitation is the increasing of network and water collect structure efficiencies.

**Water Storage Capacity improvement:** Lebanese government has approved the Ten-year action plan for the construction of dams, reservoirs and mountain ponds (MEW, 2003). The new constructions will add 743 MCM/year to the existing storage capacity. MEW and LRA (in his area of responsibility) are in charge for this plan.

**Water Resources Quality Protection:** Water control and monitoring are the responsibility of MEW and Water Authorities. Main problems and related actions in water quality protection are:

**Wastewater Treatment:** The government of Lebanon elaborates a master plan for secondary level wastewater treatment. Previewed wastewater treatment plants will serve 87.9% of the total Lebanese population and their capacities will be valuable until 2015. This plan prevents the pollution of underground and surface water. Without this plan, population still connected to sewage network or septic tanks. Raw sewerage are directly evacuated into the environment, including rivers and streams, dry riverbeds, and underground (though dry wells).The polluted water is lost for use and can affect seriously available water resources.

**Agricultural pollution:** Regarding the intensively agriculture exploitation, the main agriculture region concerned by this pollution is the Bekaa Valley. Excessive use of fertilizers and pesticides affect water quality. Investigations results show high levels of nitrates in groundwater and Pesticides were below the detection limits (Litani River Authority, 2005). Resolving this problem is the duty of agriculture extension services.

**Solid waste:** In many regions, riverbeds, streams, dry riverbeds are frequently used as landfill. This practice has two effects: Flooding by decreasing the flow in riverbeds and leach problems. However, adopted land filling processes in many municipalities may cause serious environmental impacts in liquid and gas emissions, which can pollute underground and surface water. To prevent this contamination, liquid must be collecting, controlled in quality and treated before sending to watercourses.

**Sea water intrusion:** Underground water use is not legislated in Lebanon. In coastal areas, the domestic water shortage, incite to an over pumping from underground water by individual entities. This cause a degradation of water quality by seawater intrusion. To remediate this problem two action are needed: Decrease well use by legislation and improve water resources for Water Authorities. Well use can be restricted to collectivities and Water Authorities. Pumped water from well must be limited and controlled by MEW.

**Industrial pollution:** Many factories discharge their wastewater in riverbeds or wastewater network without any treatment. To protect from this pollution, Ministry of Environment was prepared concerning laws. Law enforcement can resolve the major problems of industrial pollution.

The delay on application decrees preparation is, may be, the main cause of retard related laws applying.

**Unconventional water Reuse (Karaa, 2004):** Total possible collected wastewater for treatment in Lebanon was evaluated in 2015 at 213 MCM. All treatment plants are planned to work on secondary treatment. This treated water represents 10% of water needs in Lebanon. The topographical, demographic and urban conditions and economical considerations incite to a master plan where the major part of wastewater (55%) is collecting on the coastal area; 36% of treated wastewater is lost for crops irrigation in agriculture. A third treatment is necessary to recuperate this part and use it in domestic water.

**Improving on farm irrigation:** The main encountered problems in irrigation at farm level are:

Irrigation Equipments: In absence of water user associations, service irrigation centers and qualified extension service; the main designer for on farm network are the private market providers. Some of these providers have low qualifications in design matter. To be in the save side, they advice clients with an over sized equipments. Some farmers that do not have the possibility to equip their farm once a time, they purchase needed equipments in several times according to their needs. Consultants in this matter are the neighbor's farmers. In many regions and for annually crops, farmers are hiring the land for a seasonal time. In Bekaa region for an irrigated region of 8500 ha, only 29.37% of the area is exploited directly by owners (Karaa, 1999). Changing parcels without know how in adapting equipments can be a serious reason for using no adapted equipments. In all cases, the results will be the disparity of used equipments (Sprinklers, nozzles, etc.). Especially in farms using sprinkler equipments, very low uniformity is observed. To remediate to this bad uniformity, farmers use overdose of water. Without any predefined module of irrigation, direct visual observation by farmers is the criteria to stop irrigation; the time is defined when water is inundate the parcel surface.

Schedule and Dose of Irrigation: In general, the used irrigation technique, in traditional gravity schemes is furrow irrigation. The common characteristic for all these schemes is he excessive use of water by irrigation. When pressurized irrigation technique is used, water saving is visible. Chebli and col. found that used module is less then calculated ETC if farmers must use pumping and pressurized technique (Shebli et al., 1998)<sup>11</sup>. In other case the use of non-adapted equipments and bad maintenance causes losses and increase the irrigation dose. In many cases, a part of used water is drain. In all used irrigation techniques, schedules tend to use a high irrigation dose with a long interval between irrigations. This practice can be the cause of bad water productivity.

Enhance Water Economic Return: On farm level, the target is to optimize regulated deficit irrigation (RDI) practices. Some experimentations and studies are ongoing or done. Examples are:

In Lebaa center (Litani River Authority, 1998), a study conducted in collaboration between LRA and Lebanese Agricultural Research Institute (LARI), for cucumber and tomatoes in green houses. The used technique is trickle irrigation. For two years, the results shown that farmers can save up to 40% from used water.

LRA and LARI are partners in EU research and dissemination project, "Sustainable orchard irrigation for improving fruit quality and safety" begin in July 2006. The main objective is the regulated deficit irrigation for citrus in coastal area and peach in inland region.

To improve on farm irrigation practices must focalize on:

- Extension services improvement. Until now, RDI research results are not disseminating and their acceptance by farmers will be very difficult. These results must be a focal chapter in extension.

- Developing applied research on practical irrigation schedules and doses for different crops. Special attention to regulated deficit irrigation research is need.

- Water tariff policy can be use in water irrigation saving by:

- Shifting, in traditional scheme, to on farm pressurized irrigation technique. This can be done by offering some advantages to farmers: In Qasmieh scheme, LRA establish a preferential tariff (reduction of 20% from normal tariff) for farmers using on farm pressurized technique

- Using a binomial tariff where a fix part by hectare is related to maintenance and variable part is function of used water volume. This tariff must and can be apply in pressurized irrigation schemes.

- Complete and renew the legislation in order to encouraging the establishment of water users associations. Their role is very in application of previews actions.

## CONCLUSIONS

In order to implement an effective integrated water management plan at national level where the saving water policy became reality, the following tasks must be achieved:

1. Integrated master plan by MEW with a main target of Water Equity in Allocation between regions and farmers. This plan must be review in function of needs and new resources or saved water.

2. Creation of a National High Council for Water (NHCW) as planned in 70s, who will be the coordinator between different water decision makers. Its role is different from the MEW and will be in charge for knowledge dissemination and exchange of experience between its partners.

3. Editing a law organizing the creation of water user associations and consortium between associations. Water Authorities have a principal role in encouraging farmers to be associating. WUA shall be the major partners and actors with the Decisions Makers to build a sustainable policy on Integrated Water Management.

4. Harmonization of research and education efforts: NHCW can be the focal point where exchange and harmonization of knowledge in water matter. Via this Council, different faculties and research centers can establish an annual plan for research themes, masters and PHD theses. NHCW database for water management facilitate the knowledge transfer to decision makers and extension services. NHCW will be the coordinator between research and extension.

5. Transformation of LRA to a River Basin Management Authority: An overlapping in duties remain between LRA and MEW and two RWA (South Lebanon and Bekaa). With this new status LRA can keep the management of all function related to Basin Agency as water provider:

- Control and management for all its water resources including underground water, water resources for domestic purposes water resulting from treatment plants.
- Execution of main structures and projects and transfer the management of executed and working projects to Water Authorities or Water User Associations.
- LRA keep the management of main structure (Dams, pounds, conveyers, main pumping stations, etc.) under its responsibility.

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