

УДК 502.5

**Hassan Zgheib**

Belarusian State Technological University

**WATER RESOURCES IN LEBANON AND THEIR IMPACT  
ON THE DYNAMICS OF AGRICULTURAL DEVELOPMENT**

The article presents an analysis of water consumption problems in Lebanon. Analytical data are put forth on the annual intake of fresh stock in Lebanon, as well as its consumption by different sectors. Particular emphasis is placed on agricultural production risks in case of a further situation deterioration of in water supply and water shortages emergence, such as reducing food insecurity; slowing down the country's economic development; rising prices for agricultural products; reducing the area of crops and the quality of products produced. The author examines the current government programs aimed at water supply development in Lebanon, in particular: the project to expand the water supply in Lebanon and the strategy of the Ministry of Agriculture for 2015–2019. Conclusion is drawn about the insufficiency of the measures applied, since the population of Lebanon is rapidly increasing due to the flow of refugees and the general growth of the population's need for fresh water. On the basis of the revealed destructive moments in the water sector of Lebanon, the following possible ways of their elimination are offered: structural redistribution of water resources between the country's territories, ensuring compliance with existing water regulations (fines), ensuring payment for water supplied to agriculture, strengthening of state control over water consumption.

**Key words:** water resources, agriculture, water consumption, agricultural risks, climate change.

**Introduction.** The countries of West Asia and Northeast Africa are facing serious socio-economic pressure due to the limited ability to exploit water resources. This has a negative impact not only on the standard of living for the population, but also on the development of the economy, because the problems of water supply directly affect the agriculture of Lebanon. This problem is particularly acute in the agricultural sector, since water supply issues are key to the production of agricultural products. According to experts (National Council for Scientific Research, Ministry of Agriculture, World Bank), this problem will only get worse as the population grows and water consumption increases. In addition, climate change is a significant factor complicating the process of forecasting water consumption and redistribution. Lebanese scientists agree that in most arid and semi-arid regions of the world there may be an acute shortage of water [1–4]. Climate change in Lebanon is projected to increase rainfall and surface water fluctuations, as well as decrease snow cover and glaciers [1]. Extreme weather events, such as droughts and floods, will also be more frequent. It is suggested that agricultural production will be less dependent on freshwater resources than before [3]. Combined with these changes, Lebanese farmers will face inefficient use or pollution of water resources, which will ultimately affect the country's economy.

The purpose of this article is to identify the features of water consumption in Lebanon and to assess the possible risks of the agricultural sector in case of water scarcity.

**Main part.** Water resources in the Middle East are insufficient to meet people's needs, and their

scarcity is a subject of discussion in many scientific discourses [1–3, 5]. However, it should be clarified that Lebanon has an atypical topography that distinguishes it from the surrounding countries. Its small area is characterized by mountainous terrain, outlined by several systems of valleys. Two mountain ranges (Mount Lebanon in the West and Anti-Lebanon in the East) extend parallel to the Mediterranean Sea and are separated by the Bekaa plain, which includes a relatively wide depression. Moreover, Lebanon has many sources of surface water, including rivers, springs and lakes. In addition, there are many aquifer rock formations and karst canals where groundwater can accumulate as a result of seepage. There are also specialized reservoirs. The total number of licensed individual private wells is estimated at 20,000 wells in the Greater Beirut area. In addition, there are approximately 60,000 illegal wells. Surface water storage capacity in Lebanon is very small, accounting for only 6% of total water consumption. Therefore, it is no exaggeration to say that the state of the water sector has not improved over the past three decades, even though there are an excessive number of projects, studies and government programs in this area [6].

An analysis of recent data in the Lebanese water sector shows that today there is a tendency for water demand to increase, and it is also quite dynamic (table). The increase in water consumption in Lebanon is largely due to population growth because of the flow of refugees from hot spots (Syria, Iraq, etc.).

Although Lebanon has a lot of water compared to Jordan, Palestine and Syria, the volume of

renewable water in the region has decreased to 1000 cubic meters a year per person.

#### Water consumption in Lebanon for 2005–2017 [7]

| Index   | 2005   | 2011   | 2017   | Growth rate, % (2017/2011) |
|---|--------|--------|--------|----------------------------|
| Population, mln. people                       | 3.99   | 4.14   | 6.10   | 152.9                      |
| Annual freshwater intake, bln. m <sup>3</sup> | 1.36   | 1.31   | 1.31   | 96.3                       |
| Water consumption per person, c.m.            | 340.85 | 316.43 | 214.75 | 67.9                       |

However, the water crisis affecting Lebanon precedes the arrival of Syrian refugees. Decades of civil unrest and lack of investment, and then a number of military conflicts caused by regional and sectarian tensions led to a split of the population of cities and towns, to the detriment of the country's existing water infrastructure that delivers water to the cities.

According to experts, the domestic demand in 2017 was 467 m<sup>3</sup>/year. Demand in 2030 is projected to be 1258 m<sup>3</sup>/year for the domestic market, increasing from 163 to 440 m<sup>3</sup>/year for industrial production and from 900 to 1220 m<sup>3</sup>/year for agriculture [6].

Lebanon's scientific institutions, Government and water utilities are working to address the problems of infrastructure and water resources that underlie the water crisis.

This includes upgrading infrastructure for water and wastewater treatment systems. However, complaints about the lack of understanding of the unbalanced water supply in Lebanon are often the subject of controversy, and budget expenditures to address these problems have not yet been properly calculated.

In addition to the problems of water scarcity and the deterioration of its quality, the problems of water resources in Lebanon's agriculture are only getting worse. At the farm level, businesses are small and fragmented, which increases the cost of installing irrigation systems. The current irrigation systems are old and inefficient. Farmers do not realize the value of water and its rational use, which exacerbates the problem of water loss when it is consumed free of charge.

Agriculture consumes 85% of available water resources, and the increasing demand for water puts additional pressure on irrigated agriculture, leading to an increase in abandoned land due to lack of water or diminished investment opportunities.

Lebanon's agriculture plays an important role not only in shaping the country's GDP, but also

supports a certain level of food security in the region. In this regard, it is necessary to indicate the possible risks in reducing the water supply of agriculture in Lebanon:

- reduction of food security;
- slowdown of the country's economic development;
- price increase for agricultural products;
- reducing the area of crops;
- reduction in the quality of products produced;
- environmental risks: water and soil pollution.

In recent years, the Lebanese government has taken many initiatives to improve water management, including the adoption of the National Water Strategy, which included increasing irrigated land from 90,000 to 170,000 hectares and had launched the Canal 800 project to irrigate southern Lebanon [8, p. 24].

New irrigation technologies that improve the efficiency of water use and distribution at the market level are now being actively introduced into the work of Lebanese agricultural enterprises. In addition, there is a sewage infrastructure that allows the collection and treatment of wastewater and its reuse in irrigation, as well as the possibility of increasing groundwater recharge.

The weaknesses of the state regulation of the Lebanese water sector are the lack of long-term plans for the implementation of modern irrigation systems in the agricultural areas of the country, as well as a detailed assessment of the necessary investments for this. The limited number of local and national programs in the field of water resources management can also be indicated, in particular in the field of irrigation. There are no legislative acts on creation and management of water resources by the Association of water users. All this adds complexity in carrying out scientific researches and distribution of their results in practical activity of bodies of the government and economic entities [8, p. 25].

Today in Lebanon, measures to ensure the safety and improvement of water resources are becoming a priority. National and foreign organizations, including public and private institutions, have recently paid attention to this, and this is confirmed by the implementation of new programs and projects developed by regional and international organizations (UNDP, USAID, IDRC, etc.). These programs contain actions and plans adopted by the Lebanese government, in particular: implementation of law no. 221. It was adopted to divide the boundaries between public policies in the water sector and the provision of water services. As part of the implementation of this law, four new water treatment canals have been established for various regions of Lebanon.

Till 2014, the Lebanese Council for Development and reconstruction (CDR) did achieve a remarkable step by approving the implementation of agricultural projects. These projects were prepared in the past several years after the implementation of sectorial development programs beginning with the urgent rehabilitation plan and in coordination with the responsible ministries.

The European Community has funded the implementation of the Agricultural Planning Support Project. This resulted in the development of the elements and guidelines of the agricultural policy according to the Technical Support Project for the agricultural statistics that we imposed by the council. This resulted in the development of the Lebanese Ministry of Agriculture strategy and work program for five years (2005–2009).

In the field of irrigation, a World Bank loan for rehabilitation of irrigation projects allows the rehabilitation of 27,000 hectares of agricultural land [9].

The loan was also financed through contracts to strengthen the capacity of the Ministry of Energy and Water and the Litani Authority, which include the provision of vehicles, equipment, consultancy contracts, training and studies that facilitated the implementation of these projects.

According to the USAID project, the Deir Al Ahmar area which is located in AL Bekaa valley, has a very limited resources, and using the traditional irrigation, a lake of local springs and collected rain water cannot irrigate this 300,000 meters area, it can barely irrigate 10% of the total area. But, with the help of the new project that is financed by USAID program and named as Lebanon Water Project, it is possible to irrigate all of these lands from the same lake. Around 30 to 35 farmers will be able to benefit from this project. The drip irrigation, allow Lebanese people to enjoy a better quality crop and greater yield.

In 2017, the Committee of Agriculture and Tourism in the Lebanese Parliament declared the measure of small farmers. Increasing the irrigation efficiency for small farms by providing them the supporting irrigation equipment, and encouraging them to use the renewable irrigation projects, which leads to the increase the irrigated agricultural land by 15% in 5 years, and secure and install the drip integration equipment for 1,000 hectares of agricultural land every year, and reduce the cost of operating irrigation systems by supporting solar power generation system (estimated total cost of 12 billion over a period of 5 years).

“Phosphorus” – a fiber optic irrigation sensor project is heading to the final stage. Lebanon cooperates with Italy and Switzerland representatives in nine major international scientific bodies, to create the first intelligent irrigation system, that use sensors based on fiber-optic technology. These

sensors are designed to measure variables like temperature and humidity, concentration of fertilizers and pesticides, as well as enzymes in the soil, allowing for optimal irrigation, which increases yields. Besides saving water, this also reduces the cost per hectare from USD500 to USD60, according to the project calculation.

The key programs aimed at increasing the level of water supply in Lebanon today are the following:

- Law no. 221;
- Lebanon water supply expansion project;
- Strategy of the Ministry of Agriculture for 2015–2019.

The challenges that lie ahead are extremely complex and locally diverse. It is necessary to focus on policies to improve the efficiency of water use in agricultural production, significantly reduce the impact of the sector on freshwater consumption and increase its resistance to water risks. This will require, at every level (state, commercial and public), the adaptation of consumers to specific water systems.

At the level of farms and small agricultural enterprises in Lebanon, the government has to develop the following actions:

- the creation of information systems at the farm level on water resources;
- to encourage farmers to adopt water-saving and risk-tolerant technologies and practices;
- to contribute to improving farm management practices that can internalize environmental costs on the basis of the “polluter pays damage” principle.

At the water supply level, the Lebanese government can:

- improve information systems for assessing water quality and the geographical location of groundwater flows, which will help limit risks in agricultural production;
- determine the property rights associated with water intake, water discharge and provision of the ecosystem;
- develop flexible and reliable water distribution systems that allow fluctuations in both price and quantity of consumption – through market mechanisms, for example, in response to seasonal conditions and climatic shocks;
- use regulatory, economic and collective measures to control the intensive use of groundwater in agriculture and water pollution.

In economic terms, a favorable environment for the efficient use of water resources in Lebanon, in my opinion, should be formed on the following suggestions:

- ensuring compliance with existing water regulations, with sanctions and fines being imposed if they are not followed;
- ensuring payment for water supplied to agriculture. It means, it should reflect the full cost of

supply and ideally cover the alternative cost of water intake. Lebanon's social policy on water consumption should compensate the poorest farmers in the event of climate disasters to facilitate the necessary consolidation in the affected sectors;

- development of risk management tools that will increase the resilience of farmers to uncertainties associated with weather and climate change;
- abolishing non-water policies that distort prices, such as agricultural and energy subsidies;
- creation of transparent and open markets that will allow to engage in agricultural production where it will be cost-effective and environmentally sustainable.

**Conclusion.** Lebanon is a country experiencing water scarcity and the depletion of water resources is becoming a dominant phenomenon. Lebanon is located in arid region with climate variability that is, with rising temperatures and changing rainfall patterns, as well as with a marked increase in the population, accompanied by increased demand for water. Poor wastewater management, treatment and the

high cost of managing water treatment plants have led to the direct use of untreated wastewater in irrigation, posing risks to public health and the environment. In addition, the excessive pumping of water in several coastal areas has led to the mixing of sea water with fresh water. Polluted, poor-quality water prevents the use of some new technologies. Climate change and the additional number of residents, due to the massive movement of refugees from Syria to Lebanon, contribute to the further depletion of water resources.

Despite of government's programs, projects, strategy Lebanese water management needs to upgrade information systems for assessing water quality, property rights, water distribution systems, control system of use of groundwater in agriculture and water pollution.

The main measures should be developed in payment for water supplied to agriculture, compliance with existing water regulations sanctions and fines, risk management tools, abolishing non-water policies.

### References

1. Arkadan A. Climate change in Lebanon: prediction uncertain precipitation events. Do climatic cycles exist? In book on: Climatic changes and water resources in the Middle East and North Africa. Verlag Berlin Heidelberg, Springer, 2008, pp. 59–71.
2. Bou Zeid, El-Fadel E. Climate change and water resources in Lebanon and the Middle East. *Journal of Water Resources Planning and Management*, 2002, no 128:5 (343), pp. 343–355.
3. Shaban A. New Economic Policies: Instruments for Water Management in Lebanon. *Hydrology: Current Research*, 2016, no 7:1, pp. 1–7.
4. Shaban A. Physical and Anthropogenic Challenges of Water Resources in Lebanon. *Journal of Scientific Research and Reports*, 2014, vol. 3, issue 3, pp. 164–179.
5. Doummar J., Massoud M., Khoury R., Khawlie M. Optimal Water Resources Management. *Case of Lower Litani River*. Lebanon, 2009, vol. 23 (11), pp. 2343–2360.
6. CNRSL (National Council for Scientific Research, Lebanon). Regional Coordination on Improved Water Resources Management and Capacity Building. Regional project. GEF, WB, 2015. 240 p.
7. Water in Agriculture. 2019. Available at: <https://www.worldbank.org/en/topic/water-in-agriculture> (accessed 11.02.2019).
8. Strategy of the Ministry of agriculture for 2015–2019. 2019. Available at: <http://www.agriculture.gov.lb/Arabic/NewsEvents/Documents/MoA%20Strategy%202015-19%20-%20English-for%20printing.pdf> (accessed 14.02.2019).
9. World Bank. 2019. Available at: <http://www.worldbank.org> (accessed 11.02.2019).

### Information about the author

**Zgheib Hassan** – PhD student, the Department of Business Technologies and Sustainable Development; Belarusian State Technological University (13a, Sverdlova str., 220006, Minsk, Republic of Belarus); teacher in an official school manager in AL alasdikaa station Agricultural investment (Main Road, Younin Village, Baalbeck, Lebanon. E-mail: [hasan\\_1986\\_a@hotmail.com](mailto:hasan_1986_a@hotmail.com)

Received 15.09.2019