اقتصاديات الموارد المائية في ليبيا: الواقع الحالي وآفاق المستقبل

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المستخلص:

تعد ليبيا واحدة من الدول الأكثر جفافاً في العالم ، حيث تتراوح معدلات سقوط الأمطار السنوية بين 01 إلى 005 ملم. ولهذا السبب ،فان ندرة المياه هي المشكلة الرئيسية التي تواجه تحقيق التنمية الاقتصادية والاجتماعية والبيئية. وتعد ندرة المياه تهديدًا كبيرًا لاستدامة إمدادات المياه في تحقيق ألتنمية حيث تمثل نسبة الزيادة في الطلب على المياه العذبة في ظل محدودية العرض من المياه مشكلة رئيسية في وضع الخطط والبرامج المستقبلية لتنمية الاقتصاد المحلى وخاصة القطاع الزراعي الذي يعتبر القطاع الاكثر استهلاكا للموارد المائية المتاحة.

ورغم اكتشاف احتياطي كبير من المياه الجوفية العذبة ونقلها من الصحراء إلى ساحل البحر المتوسط حيث يعيش معظم الناس وحيث يمكن استخدام المياه. غير ان عدم التوازن بين العرض والطلب علي المياه مع زيادة معدلات الاستهلاك بكميات كبيرة وعدم الالتزام بالتشريعات والقوانين للمحافظة علي الموارد ألمائية عليه تناول الجانب التحليلي من الورقة البحثية دراسة

العرض والطلب على المياه في ليبيا ،و مشاكل إمدادات المياه وآفاق إدارة الطلب على المياه. وتوضيح حجم الفجوة بين العرض والطلب واقتراح بعض التوصيات التي قد تساعد متخذ القرار في مجال تعزيز ادارة الموارد المائية بما يساهم في استغلالها بكفاءة لتلبية الطلب المتزايد على المياه في جميع الأغراض.

الكلمات الرئيسية: الموارد المائية. جانب العرض والطلب ، ليبيا.

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efficiency, development of potential natural resources, improvement of irrigation systems and agricultural practices, introduction of water pricing, emphasizing the application of legislative measures, and most importantly increasing public awareness and population growth control.

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natural water resources for the future. In spite of this, they have not been developed properly in some parts of the country. They also suffer from neglect and inefficiencies in the areas close to wadis and in old oases.

9. SUGGESTED SOLUTIONS

Avoiding the problems that will be faced by the water sector in Libya, or at least reduce their effects, it is necessary to concentrate actions in the following areas:

1. Reduce, in a gradual manner, the consumption in the agricultural sector, to a safe level. That level should be no more than the sum of renewable surface and groundwater resources and treated wastewater. The proposed agricultural strategy should be followed.

2. Conservation of water use in arid regions is of a paramount importance. Although some conservation efforts (public awareness programs, television and other public media messages etc.) were made in the past, there is urgent need to do more. Actions needed include the use of drip irrigation, increase prices for water and require drainage water recycling.

3. Give priority in government spending to wastewater treatment plants construction and to distribution and pumping facilities for transporting treated wastewater. This will result in more treated wastewater being available for different uses. Hence, some of the demands for agriculture and industry can be met from this resource.

5. Increase production of desalination sea water and carry on more research in the area of desalination especially on methods and materials that will help to reduce costs.

10. Conclusion

Libya is facing a critical water shortage, which could lead to a serious crisis in the future. The country is increasingly depleting its precious groundwater resources, most of which are non-renewable. In addition, growing demand for water for agriculture and human purposes requires the adoption to secure continuous supply of this essential resource, specifically from basins in central and southern parts of the country. However, the imbalance between supply and demand, low standards of service, water quality deterioration, inefficiency in use and institutional and administrative difficulties are among the various problems of the water sector. Certain actions have been taken to overcome these problems. They include legislative measures, inter-basin water transfer and development of non-conventional sources. Further action should include upgrading of water use

allow widespread misuse of water in agriculture, despite water shortages. This has been mainly due to a failure to recognize the economic value of water and the real cost of water services.

7.3. Irrigation Efficiency and Water Conservation

Water conservation and efficient water use have not received the attention they deserve in Libya. However, as agriculture is by far the largest water user, efficient irrigation management will undoubtedly be a major conservation option in the future. The major causes of the current low irrigation efficiencies are factors such as leakage, percolation, and evaporation. Libya needs to find appropriate means to achieve greater efficiency and equity in irrigation systems, as this would help not only to achieve greater levels of agricultural production with less water but also to solve some of the major environmental problems: water logging and salinity, declining groundwater tables, and shrinking lakes and seas. But finding such methods would require developing, testing, and implementing a wider range of alternative approaches, such as small-scale irrigation and conjunctive use and reuse of unconventional water resources (Chambers, 1988).

8. Issues of Water Development In Libya

Water supplies and demands in any developing country face many difficulties and problems. Libya provided the water supplies with its utmost attention. However, certain problems continued to bother planners and there will be probably worse in the future if no solutions are introduced. The most serious problems are:

1. Demand for water in the agricultural sector has grown to a level much higher than the renewable resources of the country. This meant that major aquifers were mined at a very fast rate. If this trend continues in the future, nonrenewable groundwater resources will be depleted soon. The government, however, has introduced some measures to reduce to some extent the excessive pumping from groundwater reserves. The proposed agricultural strategy is the most important development in this direction.

3. Treated wastewater represents a very important source to be utilized for many purposes in Libya. However, the amounts actually used are now small. This is mainly due to slowness in wastewater treatment plants construction and in providing necessary facilities to transport treated wastewater to areas where it can be efficiently used.

4. Surface water and renewable groundwater represents the most important

Table 6, summarizes the water resources available in the country and the water balance, although these values are expected to change with time as a result of improvement in the state of knowledge of aquifer conditions.

Table 5: Water balance for Libya: 1995-2025

YEAR	1995	2000	2005	2010	2015	2020	2025
Supply ($\times 10^6 m^3$)	3 820	3 820	3 820	3 820	3 820	3 820	3 820
Demand ($\times 10^6 m^3$)	3 885	4 493	5 128	5 794	6 495	7 236	8 022
Balance ($\times 10^6 m^3$)	-65	-673	-1 308	-1 974	-2 675	-3 416	-4 202

Food and Agriculture organization(2005): water supply and Demand, Libya Regional Report.

7. Managing Water Demand

7.1. End Use Efficiency

End use efficiency means doing more in economic terms with less water. Water saving strategies and technologies can be adopted in all economic sectors to achieve end use efficiency. Sprinkler and drip irrigation are the most common irrigation methods. Their average efficiencies are estimated at 60-75% and 80%, respectively. In large-scale irrigation projects using central pivots the efficiency is slightly lower. Although no tendency for over irrigation is reported, application rates per hectare are among the highest in the region due to unsuitable climatic and soil conditions. The per capita water consumption is fairly high, compared with other North African countries with similar social, economic and climatic conditions.

7.2. Water Pricing and Cost Recovery

Most irrigation projects in Libya are subsidized to support agricultural production. But recent budget constraints and increasing water scarcity and demand have led to reduce such subsidies to make irrigation schemes responsible for generating enough revenue for their operation and maintenance reduce the burden on the government budget, and create incentives for farmers to invest in water-saving irrigation technologies and move away from crops with high water requirements.

Water pricing is a sensitive issue, but could be an effective instrument, if properly understood and applied. Principle 4 of the Dublin Conference states that “Water has an economic value in all its competing uses and should be recognized as an economic good” (ICWE, 1992). However, irrigation charges are a very important prerequisite to good management because current irrigation management practices

time as a function of income. For future estimates of domestic water use, an average per capita consumption of 207 Liter/day, with annual rate of increase of 1.25 percent, can be assumed. The resulting figures are shown in Table 4.

Table 4: Projected Domestic Water Consumption

YEAR	1990	1995	2000	2005	2010	2015	2020	2025
Population (million)	4.4	4.8	5.1	5.6	6.25	7.0	7.8	8.3
Domestic water consumption (million m^3)	356	364	457	573	708	870	1 060	1 280

General information and documentation (2010) water consumption in Libya

The urban water demand is growing rapidly and will need to be met increasingly by the transfer of water from irrigated agriculture to domestic use. This implies that in the Jifarah Plain, the domestic water demand in the year 2025 will exceeds two million m^3/day which is almost presents the whole amount of the planned water transport from Jabal Hasawna to the Jifara Plan . This indicates, that the planned utilize of the GMRP water for agriculture will have to be progressively but drastically reduced. The only manner to avoid this would be through expanding the use of desalination technology.

6.3. Industrial Use

As a developing economy, the Libyan Industrial sector consumes low quantities compared with other sectors, by a current share of about 4 percent. As result of a large number of industries depend on private sources for water supply, including desalination of seawater, such as chemical, petrochemical, steel, textile and other industries. At present, total industrial water use is estimated at 145 million m^3/ year, and the annual rate increase in this sector is about 4 percent. Therefore, total consumption in the industrial sector is estimated to be 261 million m^3 and about 470 million m^3 in 2025.

6.4. Libya's Water Balance

In order to evaluate the water resources available for use in Libya, it is necessary to analyses, both conventional and non-conventional sources, including non-renewable groundwater resources. The last-named are those fossil resources contained in the large sedimentary basins of the southern half of the country, and which could contribute to development schemes by allowing an acceptable rate of water level decline without exposing them to serious deterioration in quality.

6. Water Demand

Despite the scarcity of water resources, consumption is on the rise as a result of improving economic conditions, urbanization, and improving standards of living. Irrigated agriculture is expanding in the north as well as in the oases. At present it is estimated that between 350,000 and 400,000 ha under irrigation. Their water requirements vary from less than 10 000 m^3/ha to over 20 000 m^3/ha, depending on the location, type of crop and irrigation method.

6.1. Agricultural Use

Agriculture is the dominant user of water, and this sector will continue to be the major water consumer. It represents about 87% of the current water demand and despite the use of pressurized irrigation techniques in practically all farming areas, application rates are still among the highest in the world. This is mainly due to the unsuitable climatic and soil conditions. Different scenarios can be presented for the estimation of future water demand by the agricultural sector. A reasonable one is that shown in Table3.

Table3: Projected Agricultural Irrigated Areas, Demand and Supply Size, and Water Deficit in Libya

YEAR	1995	2000	2005	2010	2015	2020	2025
Irrigated area('000 ha)	350	400	450	500	550	600	650
Water demand (million m^3)	3 376	3 860	4 342	4 825	5 307	5 790	6 272
Water Supply (million m^3)	3 820	3 820	3 820	3 820	3 820	3 820	3 820
Water Deficit (million m^3)	+444	-40	-522	-1005	-1487	-1970	-2452

General Authority for water, (2005): Economic and social indicators, Libyan Development Plans.

6.2. Household Demand

In Libya, 85% of population lives in urban centers, varying in size from 5 thousand to over one million inhabitants, depending for their domestic water supply on municipal sources with house connections. However, the average water consumption per capita is in the range of 150 to 300 liter/day. As a result of the Domestic water consumption rates are generally increasing with

5. Water Supply

5.1. Groundwater

Being an arid zone country, Libya depends heavily on groundwater, which accounts for more than 97% of the water used. In the past, groundwater was easily extracted through large-diameter wells, dug using traditional tools, since water levels were very near to the surface.

Table 2: Libya's Water Supply

Source	Quantities (million m3)
Renewable groundwater	650
Non-renewable groundwater:	3000
* Gefara Plain	25
*Jabal Akhdar Plain	25
*Kufra & Sarir Plan	1 300
*Hamada Plan	150
*Murzuk Plan	1 500
Surface water	170
Total Supply	3820

General Authority for water (2006): Water Situation in Libya, PP-27-35.

5.2. The Man-Made River

In the extremely dry areas of North Africa, every country relies heavily on water drawn from the large shared aquifer systems that characterize this region. In Libya, the "Man-Made River Project" provides a classical example of this dependence, where the large volumes of water drawn from the Nubian Sandstone Aquifer (shared by Chad, Egypt, Libya, and Sudan) contribute over 90 percent of Libya's national water budget (Kuwairi, 2004: 8).

Irrigation development in Libya is linked to the implementation of the project to transport fossil water from the aquifer below the desert. Through the MRP, consisting of five phases, the total volume of water to be transferred and redistributed within the country will amount to about 6 million cubic meter/ day for a period of at least 50 years.

3- Economic Outline:

Despite low population density, Libya experiences income inequality among its citizens. In real terms, the per capita income in the early 1970s was $2500, increased sharply to $7600 in 2005 to become the highest per-capita income in Africa. Meanwhile, the GDP was estimated at $5 billion in the year 1970, increasing to $39.5 billion in the year2000, and to $46 billion 2005. The oil sector contributed almost 40 per cent on GDP.

With regard to oil revenues, however, Libya has desired to reduce its dependence on oil by investing in other economic sectors such as agriculture. However, some important changes were seen in the contribution of non-oil sectors. The contribution of agricultural sector which witnessed high attention through the different economic development plans increased from 5.5 per cent in 1970 to 9.6 percent in 2004 (C.B.L 2005: P.34).

4- Population Growth:

According to the last census of 2006, the Libyan population is 5.6 million, of which 51% are males and 49% are females, 64% of the population is over 15 years old. This population constitutes about 900.000 households.

Geographically, the Libyan population is concentrated along the coastal belt and in a few inland cities and oases. In fact, over 50% of the total population lives in the Gefara plain and Jabal Nafusa, making the population density over 120 /km^2. Where, in the central and southern parts of the country, the population density is below 1 /km^2.

Table1: Population Growth, and fresh Water in Libya

Year	Population (million)	Population Growth Rate	% Of Population living in Urban Area	Per Capita Annual Renewable Fresh Water m3
1970	2.0	4.2	62	302
2001	5.2	2.3	86	114
2025*	8.3	2.1	89	70

Agricultural Research Center(2005), «The Situation of Water in Libya», Tripoli- Libya.

1. Introduction:

Libya has a total area of about 1.76 million km^2. It is bordered in the north by the Mediterranean Sea, in the east by Egypt and Sudan, in the south by Chad and Niger, and in the west by Algeria and Tunisia. Four physiographic regions can be distinguished. The climatic conditions are influenced by the Mediterranean Sea to the north and the Sahara desert to the south, resulting in an abrupt transition from one kind of weather to another. The annual rainfall is extremely low, with about 93 percent of the land surface receiving less than 100 mm/year. The highest rainfall occurs in the northern Tripoli region (Jabal Nafusah and Jifarah Plain) and in the northern Benghazi region (Jabal al Akhdar), these two areas being the only ones where the average annual rainfall exceeds the minimum value (250-300 mm) considered necessary to sustain rain fed agriculture. Rainfall occurs during the winter months, but great variability is observed from place to place and from year to year. Average annual rainfall for the country as a whole is 26 mm.

In spite of the tremendous efforts made by the government to develop the water supplies in the country, the consumption of water in Libya has reached high levels. The objective of this paper is to seek sustainable management for water resources in the Libya through the following:

1. Review charges in supply and demand for water during the last few decades.
2. Predict future supplies and reserves as well as demands (for all sectors) up to the year 2025. This was done using different scenarios and assumptions.
3. Discuss major future problems facing water resources management in the country and suggest possible solutions to meet these problems.

2- Research problem

The research problem focuses on the limited water resources in Libya compared to the increasing volume of consumption, which led to the widening gap between demand and supply in light of the poor use of water resources, low water revenues and the problem of pricing, which contributed to the inability of the competent authorities to develop and reduce water consumption and conservation of water resources

The Economics of water Resources in Libya: Current Status and Future Prospects

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Abstract

Libya is one of the driest countries in the world, with an annual rainfall ranging from just 10 to 500mm. for that reason, Water scarcity will be the main problem for future generations and will undermine the economic, social, and environmental foundations. Water scarcity is a great threat to the sustainability of the water supply and potentially to development. The increase in the demand for fresh water in the mostly desert country of Libya is the main concern to sustain the local economy, especially the agriculture sector, that exceeds its traditional supplies.

After the discovery of fresh groundwater reserves, a plan was conducted to pump and transport water from south aquifers in the desert to Libya's Mediterranean coast where most of people live and where the water can be used. The construction of the Great man-made river began in the mid 1980s in order to carry around 6 million cubic meters per day to the coastal area and the project has reached its final phases.

Based on an economic analysis for Libya's water supply and demand, this paper, however, examines the problems of water supply and the prospects of water demand management. It focuses especially on the gap between supply and demand and the most recent adopted by Libyan authorities in the field of promoting water resources to meet the increasing demand for all purposes.

Keyword: Water Resources; Supply-side and Demand-side, Libya.

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