

# WATER RESOURCES AND STRATEGY IN NORTH AFRICA

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## INTRODUCTION

North Africa is bordered at the North by the Mediterranean sea and in the south by the Sahara. This induces a particular climate where countries have a rainy part in the north, some times few kilometres large as in Libya or Egypt and the rest of the country is a desert. Inhabitants are concentrated into a dashed line which follows the Nile, the Mediterranean coast, from Cairo to Morocco then the Atlantic coast. 97% of Egyptians live in 3% of the territory.

Going inside these countries there is almost nothing, a big desert, very rare water and very little life.

In North Africa we expect to find large disparities between regions, problems of water storage, water transport and water quality. Excess salinity is a concern not only for water but also for soil. Diseases due to waste water are present in many countries of the region.

The North African region may be also an example by the fact that, a such well defined space has a limited and quasi constant water resources, the problem is then how to prepare future with a high demographic growth.

**Table 1: Presentation of North Africa Countries**

		Tunisia	Algeria	Morocco	Libya	Mauritania	Egypt
<b>Area country</b>	<b>Total Millions Km<sup>2</sup></b>	0,163	2,38	0,4465 +0,266	1,76	1,025	1,00
	<b>Cultivated area %</b>	30	3,5	21	1,2	0,5	3
<b>Population</b>	<b>Total (millions)</b>	10	32,3	31	5,7	3	73,4
	<b>rural population %</b>	36	41	42	13	37	58
	<b>Annual growth rate %</b>	1,2	1,6	1,7	2,2	2,2	1,8
	<b>% active population</b>	42	37	42	36	45	38

## RAINFALL CONSIDERATIONS AND WATER RESOURCES

Table 2: Rainfall variation between different countries and in the same country.

	Tunisia	Algeria	Morocco	Libya	Mauritania	Egypt
<b>Average Precipitations in mm</b>	207	89	346	56	92	51
<b>North of the country</b>	600-1500	800-1600	800	300	0	200
<b>Middle country</b>	200-400	100-400	400			
<b>South of the country</b>	<200	<100	150	<100	450	0

Precipitations are relatively important in Morocco and Algeria. The Atlas mountain chain plays an important role. Clouds come from the Atlantic Ocean, often via Spain, and meet the Atlas mountain chain. Rainfall is very important at the north of Morocco, north of Algeria and the North West of Tunisia, in these regions precipitations rise up to 1600 mm. On the contrary, the south receives less than 100 mm. See table 2. Unlike the other countries, Mauritania receives its only rains at the south, this region is bordered by the Senegal river which is the main water resource of the country.

Table 3, Renewable water resources in the North AFRICA by country ( Issued from the FAO statistical data )

Country	Average precipitation 1961-1990 Km <sup>3</sup> /year	Note	Groundwater produced internally (Km <sup>3</sup> /year)	Surface water produced internally (Km <sup>3</sup> /year)	Water resources total renewable (natural) Km <sup>3</sup> /year	Water resources total renewable (actual) (Km <sup>3</sup> /year)	Dependency ratio %	Water resources total renewable (actual) (m <sup>3</sup> /capita/year)	Exploitable water resources (Km <sup>3</sup> /year)
Tunisia	33.9	b	1.5	3.1	4.6	4.6	9.0	482	3.6
Algeria	211.5		1.7	13.2	14.3	14.3	2.9	473	7.9
Morocco	154.7		10.0	22.0	29.0	29.0	0.0	971	20
Libyan Jamahyria	98.5	b	0.5	0.2	0.6	0.6	0.0	113	0.63
Egypt	51.4	b	1.3	0.5	86.8	58.3	96.9	859	49.7
Mauritania	94.7		0.3	0.1	11.4	11.4	96.5	4 278	-

On table 3, the first column indicates “Total rain precipitations”. The third and the fourth columns show “Ground water produced internally” and “ Surface water produced internally” . These values correspond to the quantities of rain water which serve to feed the ground reserves or which can be stored by means of natural or artificial hydraulic infrastructure. We note that the proportion of the renewable water is approximately the tenth part of the rainfall ( 4,6 to 33,9 Km<sup>3</sup> in the case of Tunisia). Morocco which has an important system of dams keep more water than Algeria ( 29 to 154 for Morocco and 14 to 211 for Algeria).

In the case of Libya, Egypt and Mauritania, water precipitations are absorbed by soil, or evaporated, before being gathered in reserves or infiltrated in ground. So, When we see that the renewable water resources of Libya are only of 0.6 Km<sup>3</sup>, it is less than 1% of the precipitations.

For Egypt water resources are more than precipitations, the dependency ratio of 96,9 % shows that water come from outside the country, that to say Nile River. Mauritania is similar to Egypt with the Senegal River.

Libya contains 16 dams in operation with a total storage capacity of 385 million m<sup>3</sup> , however it is estimated that the real average water resource made up by the existing dams does not exceed 30 to 40 million m<sup>3</sup>/year. Currently, aquifers are recharged only in the northern regions.

**Table 4 : Water consumption of the North African countries**

		Tunisia	Algeria	Morocco	Libya	Mauritania	Egypt
<b>Water withdrawal</b>	<b>Natural renewable water Resources Km<sup>3</sup></b>	4,6	14	29	1	11	58
	<b>Total withdrawals Km<sup>3</sup></b>	2,8	5	11,5	4,2	1,6	66
	<b>Withdrawal per capita m<sup>3</sup>/year</b>	320	201	399	870	642	1055
	<b>Withdrawal per capita / water resources %</b>	54	42	42,6	801%	14,9	127 %
<b>Drinking water</b>	<b>Urban area %</b>	94	92	99	72	63	100
	<b>Rural area %</b>	60	80	56	68	45	97

Egypt and Mauritania withdraw their water from the Nile and the Senegal river. On the contrary, Libya uses only the underground reserves. The total abstraction of 4 200 million m<sup>3</sup>/year is about 8 times the annual renewable groundwater resources and therefore Libya depends heavily on fossil groundwater. The coastal aquifers are the only ones that are being recharged by rainfall but uncontrolled groundwater development from these aquifers exceeds the annual replenishment. This has caused severe water level

decline and seawater encroachment, which makes the coastal groundwater resources almost unusable because of their high salinity.

"The Great Manmade River Project" (GMRP) is the solution adopted by the Libyan authorities to solve the water demand of Libyans. It will transport 2 300 million m<sup>3</sup> of fossil water from the Libyan South, where a huge amount of fossil groundwater has been stored since the late Quaternary, to the North, where the water is needed.

The GMRP is planned in five phases. For Phase I, two well fields in the Assarir - Al Kufrah Basin must supply 730 million m<sup>3</sup> of water per year to the coastal areas extending from Binghazi to Sirt. Phase II consists of several well fields in the Jabal Hasawna area, designed to transport some 910 million m<sup>3</sup> of water per year to the Jifarah plain around Tripoli.

The two phases are now in operation and contribute effectively to satisfy the water withdrawal which reaches now 4300 millions of m<sup>3</sup>.

Three other phases are projected, the total volume transported at 2025 will be 6,5 Km<sup>3</sup> by year (6500 millions m<sup>3</sup>). If the demographic growth remains as it is, the water demand will at this date be between 10 and 15 Km<sup>3</sup> and the water volume transported by the GMRP will satisfy less than 50% of the demand.

On table 2, and table3, we remark the case of Egypt which seems to go over its possibilities. Table 3 shows that the water withdrawal exceeds the renewable resources: 66 Km<sup>3</sup> used whereas the renewable resources are estimated to 58,3. The calculated ratio is 127%. This country is characterized by a high demographic growth, in the future serious changes in the habits are to be expected.

In the case of Mauritania, the withdrawal per capita represents only 14,9% of water resources. This is due to a lack of infrastructure, there are two important dams in share with Senegal and the transport of water to the inside of country is insufficient. Improvement of the water supply is possible.

We note also that the south has not solved health problems, mainly diseases due to insects and non treated waters.

## **NON CONVENTIONAL RESOURCES**

- Waste water treatment

The treatment of waste water is an imperative for to prevent health risks and to preserve environment. Treatment installations are located around towns and important tourist regions.

However water recycle is often very low. In fact currently it is not performed completely and further operations, such as bacterial decontamination have to be better controlled. Actually treated water is reused in town cleaning and green spaces, in hotels to water gardens, golf greens and in agriculture for fodder culture.

Table 5 : Non conventional water resources

		Tunisia	Algeria	Morocco	Libya	Mauritania	Egypt
Non conventional Water	<b>Total waste water Millions m3 /year</b>	187	820	650	546	-	3750
	<b>Treated waste water</b>	148	-	40	40	0,7	2970
	<b>Reused waste water</b>	21	-	40	40	0,7	2970
	<b>Desalination Mm3/year</b>	40	64	3	70	1,7	100

In Tunisia, 75 treatment stations are now in use and the major part of the waste water is processed.

Egypt reuses large quantities in agriculture, see table 5, this a traditional act as the use of the Nile rising.

Waste water occurrence is going to increase, in Tunisia 250 Millions m3 are expected to be gathered and treated at 2030 ( instead of 187 in 2000).

Until this date, and in order to improve the trust of farmers and users, much progress on the purification and control of water must be done. New uses , as in industry, are to be initiated.

- Water desalination

Water desalination is adopted when it is the unique solution to solve the water problems of a given region. It is the case for isles such as Kerkenna or Djerba in Tunisia. It is also the case for far locations which have only saline ground water.

Large regions of Tunisia have easy accessible ground water containing 1,5 to 4g of salt per litre. Four desalination stations are now operating, they produce 60 000 m3/day which are used in domestic use. Other stations are installed inside phosphate plants. The whole desalinated water reaches 40 millions m3 /year. 28 desalination projects are in preparation, they will bring water to rural or isolated agglomerations having more than 4000 inhabitants. In Egypt desalination units are located on the red sea for tourist hotels.

## WATER USE

The North African inhabitants are traditionally rural, initially they were farmers and they live owing to their own productions. Besides Egypt, where irrigated cultures are ancestral, in the other countries irrigation was limited to the use of individual wells. Intensive irrigation appears in the last decades, first in Morocco and then in Tunisia. The latter had an irrigated area of 145 000 ha at 1975, it reaches now 345 000 ha.

Table 6 gives the active population in agriculture compared to total active population. The ratio of farmers is very high in Mauritania because there is very little other employment, animal breeding is the essential work. On an other hand, only 9% of active population in Libya are farmers. This is due, first to the low benefits which could be made in agriculture and second to the oil production which allows people to live with food importation.

For all the North African countries, agriculture is the first user of water. The case of Algeria is particular, agriculture has been neglected for a long time. Algeria thought in a moment that it was sufficient to develop industry to improve population life. Very few dams were constructed so that water penuries, evening in domestic use, were observed. This situation is going to be corrected.

Table 6 : Place of the agriculture in the economy of North African countries

		Tunisia	Algeria	Morocco	Libya	Mauritania	Egypt
<b>Place of the agriculture in the economy</b>	<b>Cultivated area : Millions ha</b>	4,9	8,2	9,3	2,2	0,5	3,4
	<b>Cultivated area/ total country area %</b>	30	3,5	21% S	1,2	0,5	3
	<b>active pop in agriculture / total active pop %</b>	23%	23	33%	5	52	31
	<b>% of agriculture in PIB</b>	12,9	11,1	18%	9	19	
	<b>% Agricultural products in importations</b>			16,5			
	<b>% Agricultural products in exportations</b>	20%		23			
<b>Water use</b>	<b>Agriculture %</b>	83,4	52	88	83	88	82
	<b>Domestic %</b>	11,6	34	10	14	9	7
	<b>Industry %</b>	5	14	2	3	3	11

In the term of industry, we have put the water need of tourism, for example, water needs in Tunisia are given in table 6, we see that tourism cannot be neglected. It is an important pole of water consumption specially in Egypt.

Table 7: Water needs in Tunisia for 1998  
( data from Agriculture Ministry)

	Drinking water	Agriculture	Industry	Tourism	Total
Total water needs In millions of m3	290	2090	104	19	2503

## **WATER STRATEGY**

All the considerations about strategy must turn around three axes: improving the existent resources, looking for new resources and making the use of water more rational,.

- Improve of the water existing resources:

The storage of more water precipitations is particularly possible in Algeria. In Mauritania it is possible to use more water from the Senegal River. But all of this is devoted to the action of states and is dependent of the financial capacities of the countries.

Connections between different dams allow to store more water and to improve quality by mixing different sources.

- Introduction of new water resources

Treatment of waste water and the reuse of this water is an imperative not only to have more water but also to save environment.

It is foreseen that water desalination is also going to increase, particularly when it is associated to renewable energy. Small prototypes working with solar or wind energies are in study into the universities of the region.

- Rationalization of water use

Rationalization could mean either saving water or using it in a better efficient way. These two ideas are a constant concern for all governments.

- There are many improvements in the water adduction and distribution.

-Customers are invited to save water by applying gradual tariffs. Prices increase every 20 m<sup>3</sup>. Rural inhabitants remain at low tariffs.

- The use of efficient techniques for irrigation is encouraged by government who pays a part of equipment.

## **PERSPECTIVES**

### **- Internal factors:**

The demographic growth is very high everywhere in North Africa, except in Tunisia which adopted a well defined politic since 1956, year of independence. Egypt, for example, follows a frightening growth curve because of polygamy and other habits. Table 8 shows that the water demand is expanding except for Tunisia where the increase is very moderate.

As it is clear that water resources will not expand infinitely, all the countries have to adapt their demand to the water occurrence. Domestic use and also tourist water use will increase. Agriculture, which is the main user of water, will be touched the first.

Table 8: Evolution of the water demand, in millions of m<sup>3</sup>, between 2000 and 2020

Year	Tunisia	Algeria	Morocco	Libya	Mauritania	Egypt
2000	2500		12900	4300		
2020	2800		16000	10 000		

#### - External factors

The international trade will be free over the whole world. Morocco and Tunisia signed with Europe treaties which allow free circulation of goods, including agriculture products. It is evident that some agricultural products, which are produced in huge quantities in Europe, will invade North Africa. Countries, such as Libya which has limited and non renewable water resources, will not spend their water to produce foods which are very cheap in the international market.

#### - Results

Finally, we see that both the internal and the external factors go to the same direction: the depletion of agriculture production as it was practiced until now.

In fact we expect that a new deal will take place: cereals, milk, meat and large cultures will be produced in the north, early vegetables and bio culture will be produced in south. Nowadays, tons of flowers are exported from Morocco to France because they are produced one month before the same items in Europe, the farmer who produces flowers makes much more profit than if he had cultivated cereals.

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