MANAGEMENT OF WATER RESOURCES AT SOUK-AHRAS REGION (ALGERIA)

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ABSTRACT

It has been shown in the literature that the lack of water resources does not constitute a major cause of the insufficiency in many cases .Most than often; the problem is related more to the bad management of the resources. In this context, it becomes a priority to develop a strategy to identify and quantify water resources so as to be able to exploit them in a rational manner and in good quality.

One of the tools that gained large acceptance in dealing with planning and management of water resources is the WEAP program (water evaluation and planning system). Weap is a microcomputer tool for integrated waters resources planning developed by the Stockholm Environment Institute along with a number of internationally distinguished professional organization. Weap can calculate water demand, supply, runoff, infiltration, crop requirements, flows, storage, and pollution generation, treatment, discharge and in stream water quality under varying hydrologic and policy scenario. It being used many areas around the world.

We propose to use WEAP for the first time in North Africa to evaluate the effect of different water offer and demand scenarios. This is done by applying it to the water system in the department of Souk-Ahras though a series of scenarios with varying climate data, demographics, economic factors, water price, and water quality parameters.

One of the main products is a decision support and analysis tool that will assist decision makers in evaluating water management alternatives under different scenarios.

Keywords: WEAP, Scenarios, Planning, Management of water

INTRODUCTION

The shortage of water in the world, the mobilization and management of water resources is one of the most crucial problems of the 21st century. Algeria is in the poor countries in water resources under scarcity threshold set by the UNDP or the scarcity by the World Bank to 1000 m^3 / person /day. It has been shown in the literature that the lack of water resources does not constitute a major cause of the insufficiency in many cases. Most than often; the problem is related more to the bad management of the resources. In this context, it becomes a priority to develop a strategy to identify and quantify water resources so as to be able to exploit them in a rational manner and in good quality. While the situation is worsening, until now, no serious studies have been conducted to evaluate water management scenarios taking into account current and future probable conditions.

One of the tools that gained large acceptance in dealing with planning and management of water resources is the WEAP program (Lévite et al., 2002). In this study we use it for the first time in Algeria to evaluate the effect of different water offer and demand scenarios. This is done by applying WEAP to the water system in the Department of Souk-Ahras though a series of scenarios.

WHAT IS WEAP?

The WEAP software was developed by the Stockholm Environment Institute at Boston. It is an object-oriented computer modeling package designed to simulate water resources systems and trade-off analysis. WEAP stores information characterizing a water system in a transparent and easy-to-use database. Characterization includes water use patterns, losses, environmental flows, priorities for the demand side, supply sources, hydrologic flow patterns, surface and groundwater storage, costs, and operation and allocation rules for the supply side. Rivers, canals, demand sites, water and wastewater treatment plants, conveyance and pumping facilities, local water sources, surface and groundwater reservoirs comprising the water system are quickly drawn and linked in a graphical interface and can be organized to match real geographic locations with the help of imported GIS map layers (Lévite et al., 2002).

It has been applied in water assessments in dozens of countries in North America, Europe, Asia, and Africa. WEAP applications generally involve the following steps (Yates et al., 2005):

- Problem definition including time frame, spatial boundary, system components and configuration.
- Establishing the ‘current accounts’, which provides a snapshot of actual water demand, resources and supplies for the system.
- Building scenarios based on different sets of future trends based on policies, technological development, and other factors that affect demand, supply and hydrology.
- Evaluating the scenarios with regard to criteria such as adequacy of water resources, costs, benefits, and environmental impacts.

DESCRIPTION OF THE STUDY REGION

The Medjerda subwatershed is situated in the far east of Algeria and is part of the larger Medjerda Mellugue watershed, Figure 1. The later is shared between Tunisia and Algeria. The runoff from its upstream part is collected in the Ain Dalia dam. The later is an important dam whose actual 76 Mm^3 (from the original 92 Mm^3) capacity provides drinking water for the region of Souk-Ahras as well as several other important localities (Guasmi, 2004). Its main characteristics are as follow (Guasmi, 2004):

- The rainfall is irregular and varies between 325 mm in the south to over 900 mm in the north of the watershed with an average rainfall depth of 395 mm yearly.
- Average annual temperatures are generally moderate; they vary between 8 and 30 °C 90% of the time.
- Winds are mainly light with speeds generally below 50 km/hr.
- The average annual evaporation over the period 1962 to 1990 is 1369 mm.
- Humidity varies between 55% and 70% during winter, and between 40% and 55% during the summer.

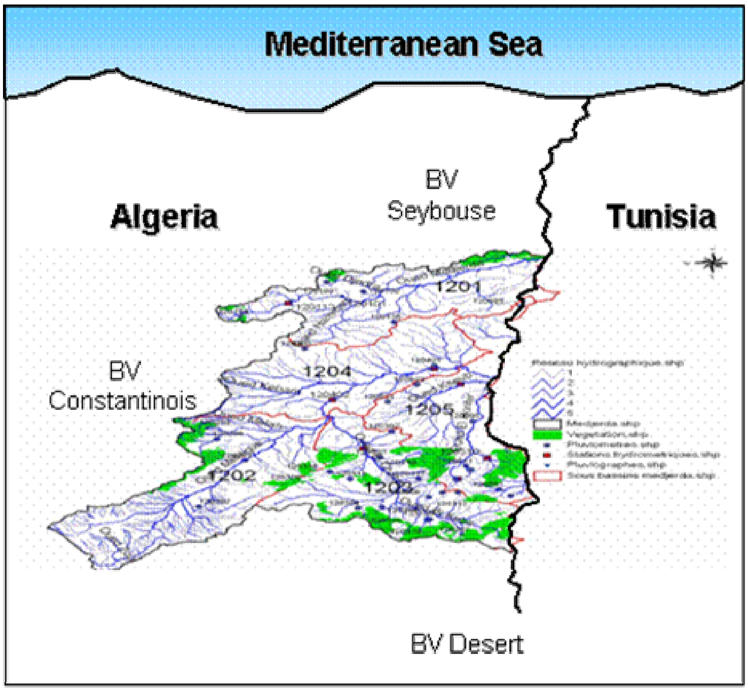

Figure 1 : The Medjerda watershed.

SETTING UP THE WEAP MODEL

The characterization of the water system (Figure 2) involved collecting and entering in WEAP the following Data:

- Water uses like demand and resources (Table 1) sites which were summed up at two demand sites or regions called Souk-Ahras and Taoura centers, respectively.
  - Souk-Ahras centre is supplied mainly from surfacewater in the Ain Dalia dam. It has a population of 175 000 person.
  - Taoura center supplied mainly from groundwater and has a population of 91 000 person.
- Reservoirs: location, capacity and operation rules.
- Flow gauging station, flow requirement and usage.
- Precipitation and Medjerda river head flows (Khoualdia et al., 2008).

As stated earlier, typical scenarios modelling effort in WEAP consist of three steps. The current account represents the average yearly precipitation with average monthly rain over the record length, i.e., from 1976 to 2005 (Figure 2).

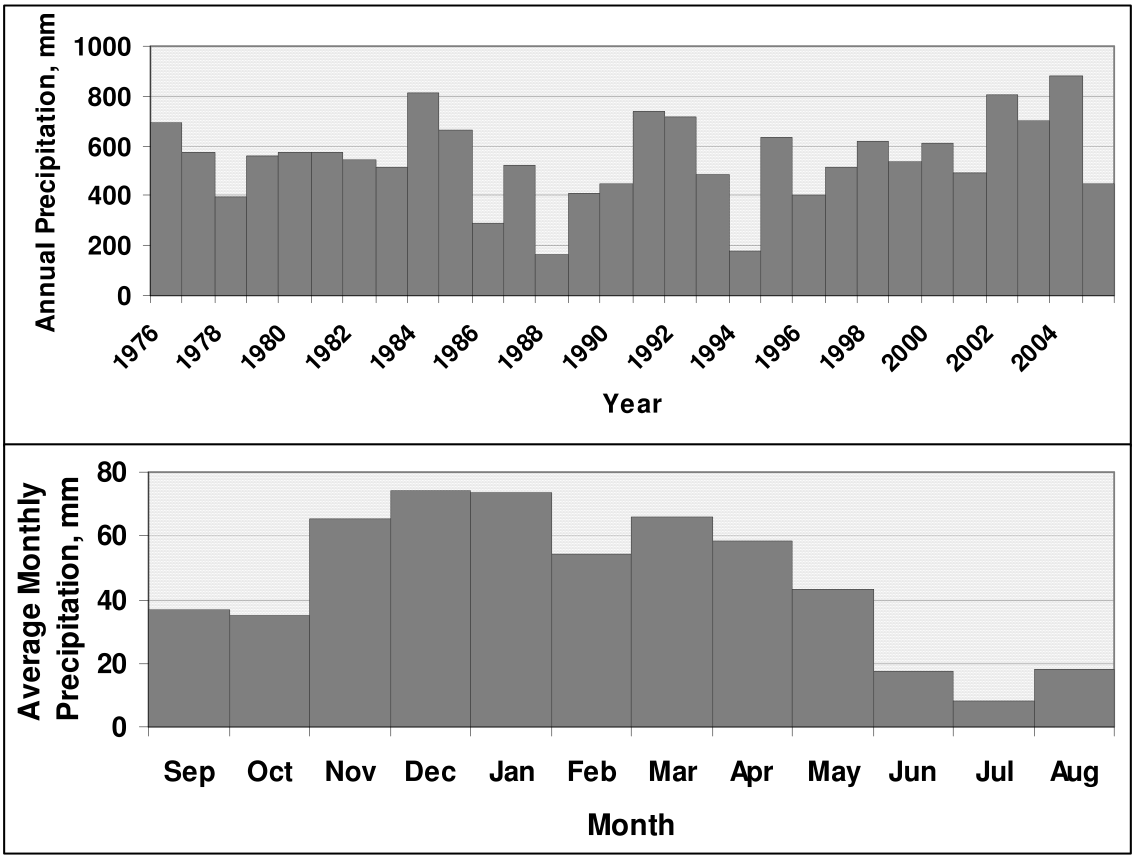

Figure 2: Average annual and monthly precipitation in the Medjerda Watershed.

Table 1 Water resources AT Souk-Ahras region

Type of Production	Sources (Production)	Annual Production (Mm^3)
Groundwater	1- Groundwater :	
	• Taoura	1.30
	• Other	0.65
	Total Forages	**1.95**
	2- Sources: Sedrata, Mechroha, Hennancha, …etc.	0.65
	Total Sources	0.65
	Total groundwater	**2.60**
Surface Water	1- Dam Ain Dalia:	
	• Souk-Ahras	11.38
	• Mechrouha	0.32
	• Sedrata	1.06
	• M'Daourouch	0.63
	• Oude Kbarit	0.14
	• Zouabi	0.07
	Total surface Water	**13.60**
	Total, Mm^3	**16.20**

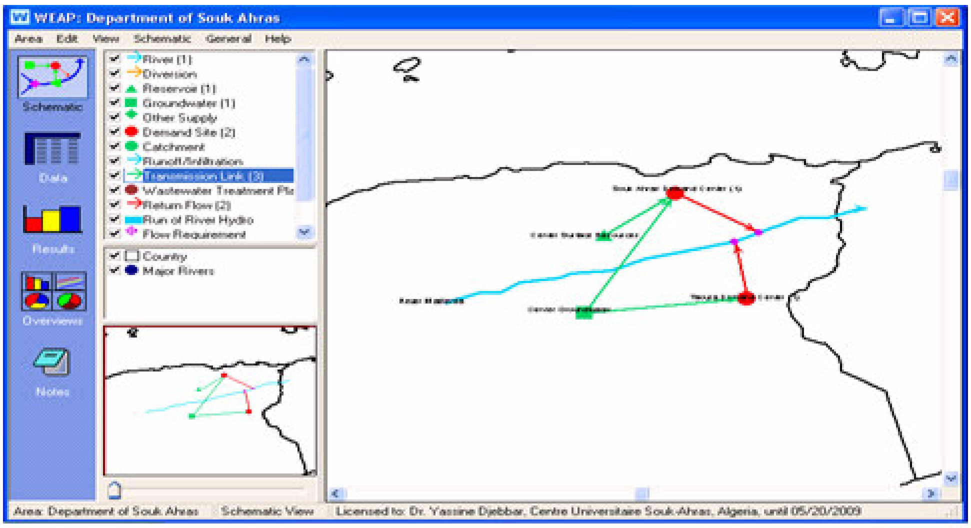

Figure 3: WEAP schematisation of the study area

This will serve as the base year for the model. Second, a reference scenario is established from the current account year to simulate likely evolution of the system in the projection period, from 2008 to 2037, i.e., over 30 years. Finally, what if scenarios can be created to alter the reference scenario and evaluate the effects of changes in policies and or other management parameters (Marion et al., 2005). This study evaluated two groups of scenarios representing different group of factors as follow:

- The first group evaluated changes in the demand side and looked at decreases in the population growth rate, a decrease in water losses rate, and the impact of climate change.
- The second group of scenarios looked at the changes in resources side through the evaluation of the impact of water availability though probable climate change.

First set of scenarios – Demand side

The first set of scenarios looked at demand side options by investigation the following three conditions:

- Reference scenario which assumes that the future will be similar to the past with higher demand due to population growth. Figure 4 shows inflow volumes to both regions reservoirs based on surface runoff simulation for Ain Dalia Dam and subsurface flow for Taoura. The simulations using WEAP assume that future precipitation will be similar to past ones. Figure 5 shows unmet water demand at both sites using reference scenarios.
- The second scenario consists in reducing water losses from the distribution system. The later is estimated to be 40%. An economically and technologically achievable water losses level is between 10 and 15%. A loss rate of 15% will be assumed be reached over a period of 5 years improvement program.
- The third scenario consists in reducing the population growth rate from the official 2.5% to 1.6%, the observed growth rate over the last five year period. It is Important to note that future growth rate is expected to reach 1.21%, i.e., the proposed rate is very likely to happen (ONS, 2008).

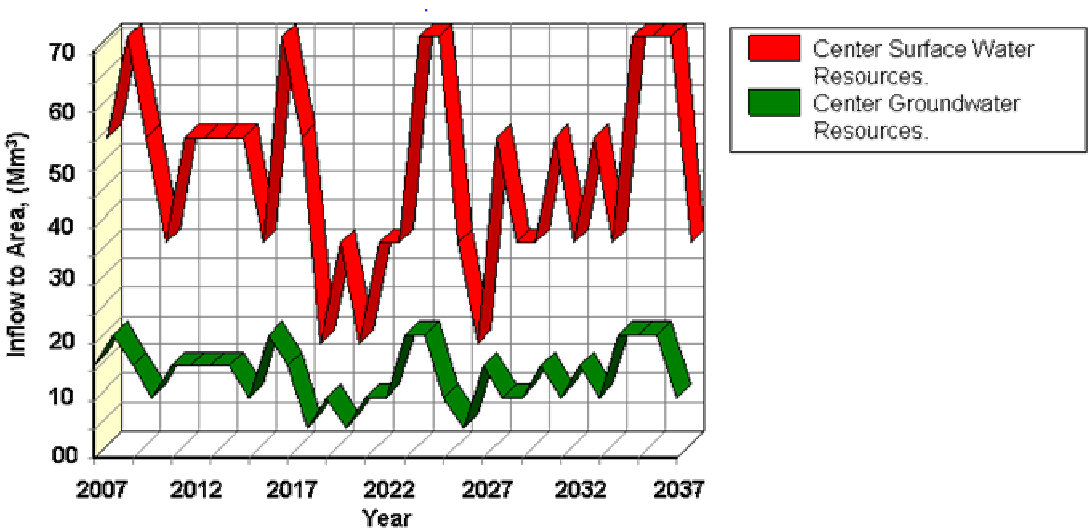

Figure 4: Annual water inflow to both groundwater and surfacewater reservoirs (in Mm^3).

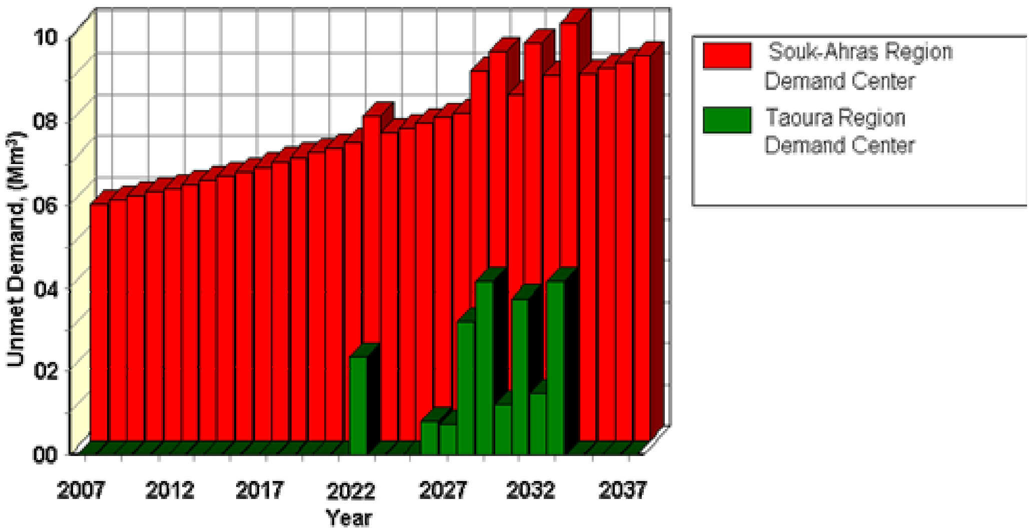

Figure 5: Unmet demand at both Taoura and Souk-Ahras centers for the reference scenario.

Currently, the allocation of water in the region of Souk-Ahras is estimated at 104 litres per person per day, which is below the international minimum standard estimated at 135 litres per person per day. The unmet demand in the region of Souk-Ahras is 6 Mm^3 and will be 9.3 Mm^3 in 2037 based on the reference scenario (Figure 5). To make up for the shortfall of water in this region, the following alternatives were considered.

Reduce water losses from the system to acceptable level. Water loss is a serious problem in the distribution system. Water losses in Algeria are estimated to be about 40% due to less than acceptable level of maintenance and management of the system (Guebaili et al., 2008). Technically and economically achievable level of losses are said to be between 10 and 15%. We propose to gradually reduce the losses by 5% per year over 5 year period to the level of 15%. In doing so, the unmet demand will be 7.6 Mm^3, Figure 6.

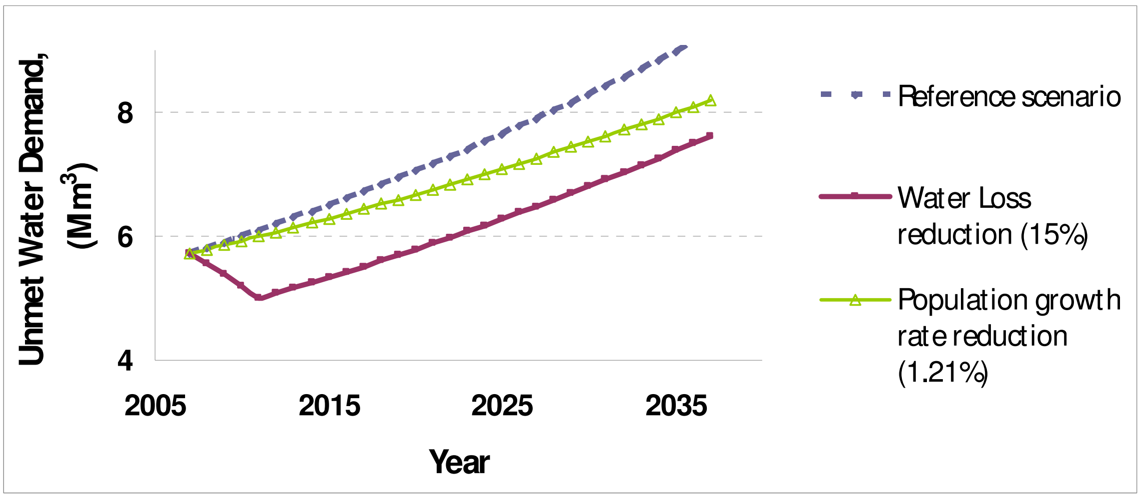

Figure 6: Unmet water demand at Souk-Ahras region using different senarios.

For a long time, population high growth rate has been a serious threat to sustainable development and hampered any effort to better life condition of Algerians. Growth rate has been relatively high during the first three decades after independence. Fortunately, it has been diminishing in the past few years. Indeed, the period between 1987 and 1998 recorded a growth rate of 1.63%, well below those of the two previous periods 1966-1977 and 1977-1987, which were 3.21 and 3.06%, respectively. In recent years, the growth rate has been steadily on the decline, and is estimated to be 1.21% (ONS, 2008).

A scenario was designed using a growth rate of 1.21% shows that unmet demand at the region of Souk-Ahras will be 8.2 Mm^3, Figure 6.

Second set of scenarios - Resource side

In this scenario we evaluated the impact of resources availability through probable climate change in the region and looked at how natural variation in climate data will impact water resources in the face of future demand. Here, the Water Year Method in WEAP is used. The Water Year Method is a simple means to represent variation in climate data such as stream flow, rainfall, and groundwater recharge. The method first involves defining how different climate regimes are characterized such as very dry, dry, very wet, etc. These scenarios will be compared to normal or average historic year. Khoualdia et al. (2008) indicated in there study that the climate in the region alternate between cycles with different precipitation regimes with an average duration of seven years. However, they were not able to prove a change in the climate due to limitation in there rainfall record length which covers 32 years only. Research is continuing to include more data and further investigate the climate change. Other global studies indicated that climate in the North African region will result in a reduction of precipitation in the order of 15%. This reduction is used here to evaluate the long term impact of such scenario (Khoualdia et al., 2008).

The result of the analysis in both Taoura and Souk-Ahras regions shows that Ain Dalia dam will not be able to meet the demand over the study period. The unmet demand in 2007 is already 6 Mm^3 and will reach 9 Mm^3 in 2037. As well, Taoura will start feel the shortage in water starting from 2017, where the unmet demand will reach 3 Mm^3 in 2022 and will reach 4 Mm^3 in 2037. The impact of climate change on the dam of Ain Dalia is serious and will reach 12 Mm^3 in 2037.

By combining both scenarios (losses reduction and growth rate of 1.21%), and including the climate change, a positive unmet demand will occur starting from 2015 and will reach 5 Mm^3 in 2037.

- It appears that new resources will be necessary to meet future demand. These resources are currently used or planned to be used for irrigation and to provide water for other users. These include Benouir and Oued Jedra dams. This is a simple but not the best solution since better management strategies could further improve the availability of water and postpone the need for other resources.

- Non-conventional water appears to be attractive. Guebaili et al (2008) looked at rainwater harvesting and showed that recovery of storm water in Souk-Ahras region would reduce water demand by as much as 40%.

It is clear that the Department of Souk-Ahras will face water shortage in the near future and serious and urgent solutions are required. WEAP has shown to be easy to use, flexible and meets the needs of such planning exercises. It is well suited as a planning and decision support system in this case. More research is ongoing to improve the data and include other management strategies.

CONCLUSION

Average rainfall and exiting water collection and storage infrastructure including natural groundwater reservoirs failed to meet current and future needs in Souk-Ahras Department. Pulling Taoura and Souk-Ahras resources together will postpone the need for other resources beyond the next ten years considering probable scenarios. Other management options will further ameliorate water condition, but it is urgent for water official to seriously engage in addressing this problem.

The study clearly demonstrates the framework provided by WEAP is powerful in evaluating current and future options in water resources. For the Souk-Ahras area, additional data would increase the accuracy of the analysis and enable validation of the results easily and quickly. Next step of this research, besides improving the data, will consider other aspects such as water quality and the cost of water services and their impact on water management in Algeria.

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