Transboundary Resource and Good Neighbourhood: Case of joint management of fossil water layer in the South

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Abstract

Algeria, a vast territory, has border with nine countries. It shares with some of them, such as Tunisia, Libya and Marco, natural (water) resources. These resources are of two types, in the north, they are superficial and are the waters of Oued Medjerda in the East, and Tafna in the West of the country; in the south, they are groundwaters which constitute the fossils water layers shared between Algeria, Tunisia and Libya. The first category cannot be considered interesting except during rainy periods because that could provide water to downstream dams such as Ain Dalia at Souk Ahras. At Oued edjerda, in the east, water flows in the direction Algeria - Tunisia. The water flowing in the Oued Tafna, in the West, are in the direction Morocco - Algeria. On the waters enclosed by the basement of the South, they make an important reservoir that must be carefully managed because they are not easily renewable. For information, the stored volume reached 50 000 billion m^3. However, this resource is used by the three countries and is threatened by an over-use. For instance, the extracted volume in 1970 was 0.6 billion m^3, at the present time it is around 6 billion m^3. This requires the establishment of the SAS (Sahara Aquifer System), the managing system of this resource. For instance, in Algeria the use of this resource has begun slowly. Nowadays, the launch of various agricultural development plans which has trained the putting in value of farmland, requiring large amounts of water. At present, the Sahara Aquifer System is recognized and is used by nearly 9,000 water points : drillings, springs and foggaras. By country, these points are distributed as follows: 6500 in Algeria, 1300 in Tunisia and 1200 in Libya. This use, if not regulated, might cause problems such as the increase of water salinity is important, this resource will not be used; the water level has declined steadily, and its cost increases, as many farmers increase their depth of drilling; the natural outlets: artesian wells and springs dry up, it is the example of Tolga where the irrigation was done by the springs. The interference between different parts of the basin are sometimes important, there is often a change in the direction of flow. To avoid these constraints, the three countries should opt for the effective management of this resource.

Keywords: Resource, transboundary, SAS, CT, CI.

1. INTRODUCTION

The scientific studies have shown that the Sahara does not contain only the black gold, it contains also the blue gold with large amount. In fact, nowadays the Sahara does not evoke only the large arid and desert areas; the area is less watered and very hot. The few mm of water that fall (50-100 mm annual average), evaporate immediately. Thus, the surface water is almost nonexistent, but instead, it is very much in depth. It is the North Western Sahara aquifer, which extends over one million km^2 in Algeria, Tunisia and Libya. It contains about 31,000 billions m^3 of water. This water is used for more than a century; it is the cause of urban and agricultural development in the region, particularly the cities of the Saharian Atlas. From the seventies, and facing the agricultural and industrial development of southern cities, the demand of groundwater has increased which could lead to an over-use of the aquifer.

For information, deep wells and drillings (down to more than 1000 m) proliferated over the last thirty years. At the rate of nearly 10,000 work each year, more than 2.5 billion m^3 of water are

aspirated, against only 600 million in 1970. To avoid destocking of the water layer (CI and TC), the use of shared management of the resources between the three countries became inevitable.

2. MAIN FORMATIONS AND WATERSHED BOUNDARIES

An examination of the geological outcrop map (Fig. 1) defines the Continental Intercalary (CI) as the continental whole included between the Hercynian folds, which drove the sea from the Saharan platform, and the marine invasion of the Upper Cretaceous. This whole includes continental sandstone-clay formations of the Lower Cretaceous, marine or lagoon sediments, post-Paleozoic and pre-Cenomanian interspersed within the CI (Busson, 1970). This definition of CI, which is the most extensive aquifer in the region, determines the limits assigned to the study area of North-Western Sahara Aquifer System. These are:

- In the Northwest, the southern versant of the Saharan Atlas,
- At the west-south-west, the limit of the Paleozoic outcrops,
- In the South, the limit of the CI outcrops with the the Paleozoic
- In the North, the Southern Atlas accident in the north of the salt lakes, relayed to the Gulf of Gabes by the El Hamma - Medenine fault.
- In the North East, the outcrops of the Continental midsole at the Dahar and Jebel Nefusa.
- To the east, and passing to the Sirte Basin, the CI waters become briny: That is the passage which has been adopted as the limit of the aquifer's freshwater CI (Oss, 2003b).

The Terminal Complex (CT) group under the same name several aquifers situated in different geological formations (Senonian, Eocene and Miopliocene) because these layers are clearly part of a single hydraulic unit (Bel and Cuche, 1969), (Oss, 2003a,b), (Babasy, 2005). The interconnections between Senonian, Eocene and Mio Pliocene are evident throughout the basin, except the region of salt lakes where the impermeable middle and upper Eocene is interposed. The Turonian water layer is more individualized through the impermeable cover of the lagoon Senonian, but its levels compound with those of Senonian or Mio Pliocene at the border of the basin (Bouzian. M.T. et Labadi, A. (2009), Chebbah, M. (2007)..

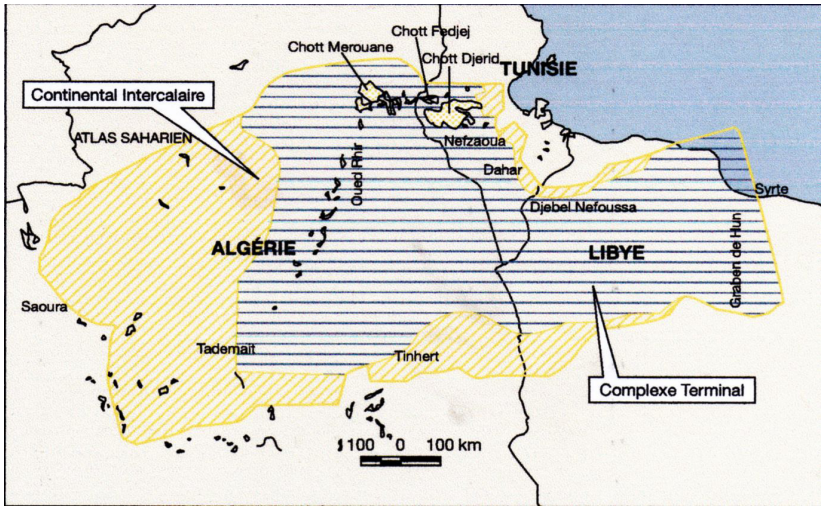


Fig. 1: Extension of the SASS formations

3. COMMUN MANAGEMENT OF TRANSBOUNDARY BASIN

Aware of the fragility of the system, Algeria, Tunisia and Libya, have opted for transboundary management of the aquifer system. This management is provided by the Sahara and Sahel Observatory, based in Tunis. The objective of this management is double:

- To master the individual explotation of each country,
- To Collect measurements made in drillings and wells (high level, amount of water pumped, salt content, etc..) integrate them into a numerical model simulating the evolution of the aquifer to control in real time takings and launch any alerts when pumping is excessive Fontes, J.C. (1976), Mamou, A. (1990) . All the challenge of this management is to adjust the supply to the demand, taking into account the demographics changing and the needs of water for drinking, industry and agriculture. However, this collaborative management will not save the aquifer, it will only increase a bit its longevity. From now, other solutions must be considered to fill the needs of a population which will reach about 8 millions by 2030.

4. PRESENT STATES OF THE EXPOITATION SYSTEM

The Saharan Aquifer System is recognized and exploited by nearly 8,800 water points, drillings and springs: 3500 at the Continental Midsole and 5300 Terminal Complex. By country, these points are distributed as follows: 6500 in Algeria, 1200 in Tunisia and 1100 in Libya.

The evolution of the number of drillings and their operating regime indicates very important increase of the exploitation (Fig. 2). It has now reached 2.2 billion m^3 /year [i.e, 1.33Milliard in Algéria1, 0.55 in Tunisia and 0.33 in Libya](**SASS, (2003)**. Because of this big large use, the first signs of water resources deterioration have already been noticed.

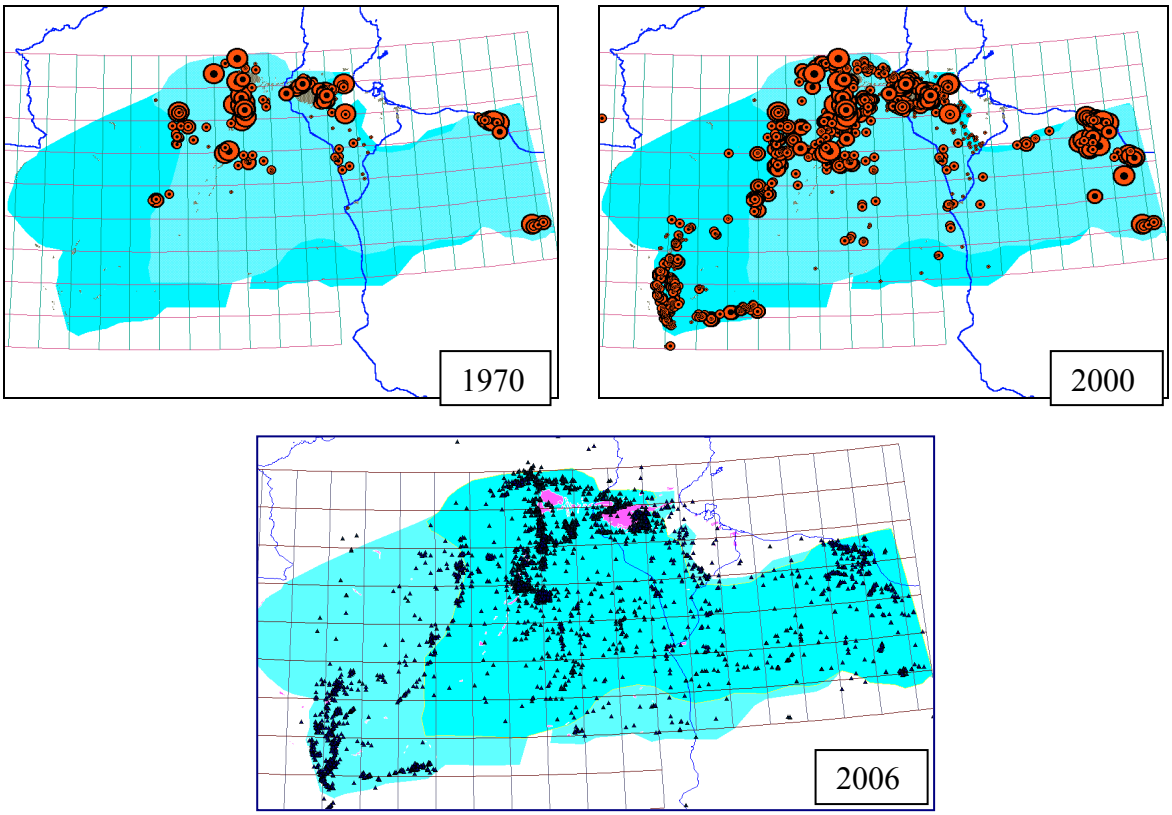


Fig. 2: Withdrawal by drilling in the SASS (1970 - 2000-2006)

In detail, we notice a significant increase of the use. This latter has increased in the early 80s especially in Algeria where it is estimated at 1.33 Billion, it is of 0.55 in Tunisia and 0.33 in Libya (Fig. 3).

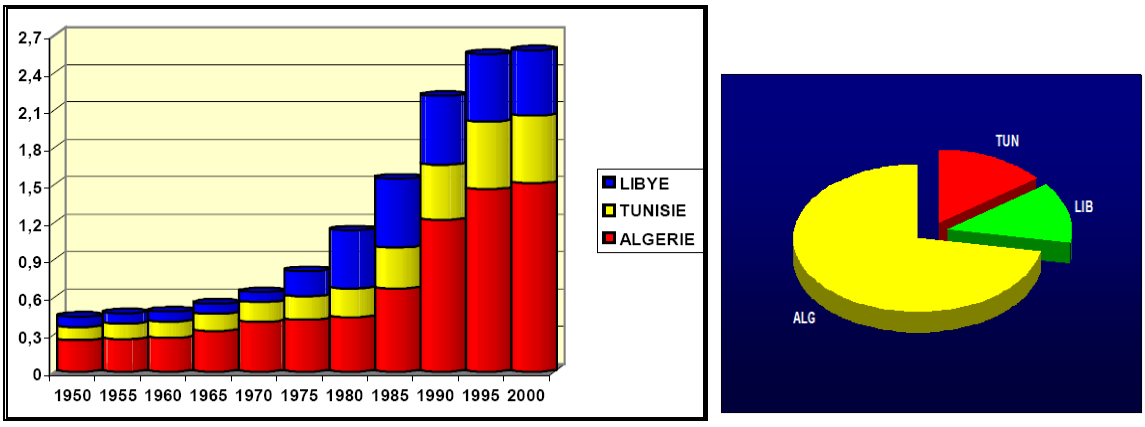


Fig. 3: Temporal variation of the aquifers use

The large use of the aquifers has prompted the three countries to opt for a joint management of this resource. However, it must be done according to the scheme developed by the three partners (Fig. 4). The diagram drawn by the ministers' board is known as SAS. In act, the three SASS countries have decided to create a permanent tripartite consultation mechanism for joint management of the aquifer. Its duties are multiple and focussed on the production of monitoring indicators. In detail, each country has designated a focal point for SAS; this will develop the databases and the promotion of study, research and training, and the reflection on the future evolution of the mechanism.

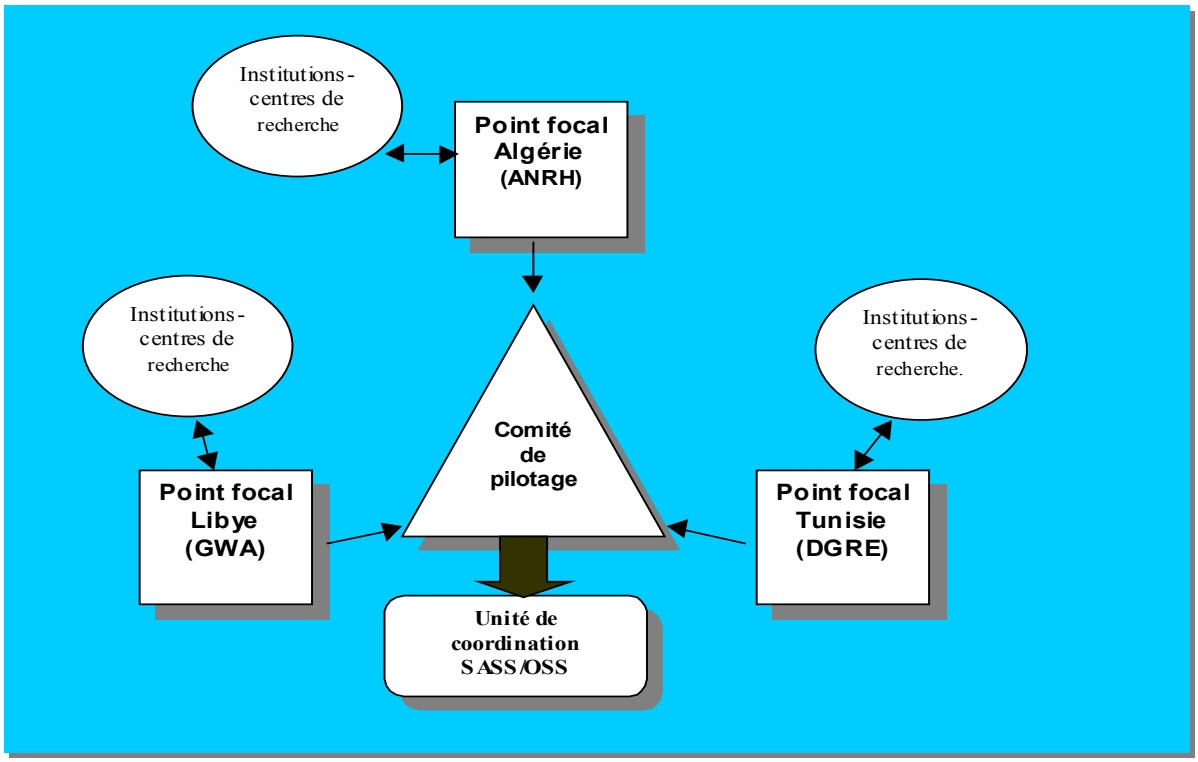
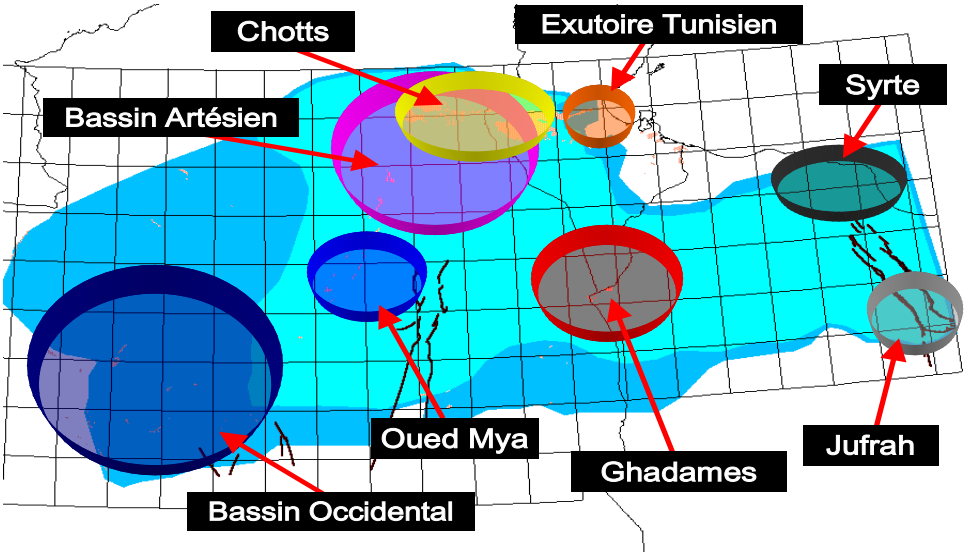


Fig. 4 : Mechanism of consultation Scheme.

This concerted management will reduce the proliferation of major risks in the strong interferences between countries, water salinization, artesianism disappearance, outlets drying up, and excessive pumping depths, as determined on the risk map (Fig. 5). Enumerated risks affect the whole extent of the aquifer and the three countries concerned. We also note:


Chotts
Exutoire Tunisien
Syrte
Bassin Artésien
Oued Mya
Ghadames
Jufrah
Bassin Occidental

Thus, a simultaneous representation of all layers was adopted (aquifers and aquitards) (Zammouri, M. (1990) , which allows to take into account the links and the hydraulic and chemical exchanges between all layers of the basin, and therefore the system behavior in medium and long term.

6.2. Exploratory simulations

The period chosen for the calibration was the historical period 1950-2000, with, as initial condition, the situation measured in 1950. A baseline scenario, called scenario zero was defined. It consists to maintain constant withdrawals made by drilling in 2000 and to calculate the evolution system corresponding to 2050.

6.3. Results of exploratory simulations

These exploratory simulations have put in evidence the nuisance and risks to which the water resource is exposed. To continue the use of the CI and CT water layers, these risks must be minimized and managed, which can be summarized as:

a) artesianism disappearance,
b) excessive pumping depths,
c) Tunisian outlets drying up,
d) excessive drawdowns interference between countries,
e) potential recharge by salt lakes.

6.4. Management

In Algeria, two scenarios:

a) A hypothesis, considered to be strong, representing an additional withdrawal of 101 m^3/s, which would bring the Algerian withdrawal to 42-143 m^3/s between 2000 and 2030;
b) A hypothesis, considered to be weak, for an additional withdrawal of 62 m^3/s, which would bring the withdrawal from 42 to 104 m^3/s.

In Tunisia: The scenario states that the savings through improving the irrigation efficiency will offset the additional demand for new irrigated areas, which corresponds to retaining the current.

In Libya: exploratory simulations concern two programs of the Great Artificial River Project [GARP]: the Ghadames-Derj pumping field, with an additional flow of 90 Mm^3/year, and capturing field of DJebel Hassaounah.

In terms of exploratory simulations, the principle adopted was to overcome the search of developping scenarios based solely on predictions of water demand, and to seek to build scenarios based on hydraulic, established on production capacities of SASS and minimizing the risk of identified nuisance.

7. CONCLUSION

The combined use of hydro geological knowledge and that of the model can make realistic conclusions about the ability of SASS to provide significant amounts of water while minimizing the risks on the resource. The results obtained show that it suits to jointly manage that resource. It is in order to prepare joint use that has been recommended by the OSS, from the launching of this project, to promote an awareness of the water and implement a "consultative mechanism".

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