Dilemma of fossil water management within Southern Tunisia oases: vulnerability to salt under intensive use context

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Abstract

In southern Tunisia oases, water is the most important natural resource. The survival of those ecosystems is conditioned by the availability of such resource. Under an arid climate, oases inhabitants acquired secular traditions in water management. These oases observed a lightening development. The improvement in drilling techniques reinforced their capabilities to provide for the expansion of urban water needs and irrigation requirements. Despite being fossils, underground water resources are sustaining an overexploitation that definitely compromises the sustainable development of the whole ecosystem. Such scenario leads to a continuous decrease in their level that approaches those of *chott*. This enhances their vulnerability to contamination risks coming from salty drainage water. Indeed, this presentation focuses on the major factors and consequences of such risk. It highlights also the impact on underground water resources availability.

Keywords

Ecosystem; urban water; sustainable development; management; water resources

INTRODUCTION

Tunisia is typified by a Mediterranean climate; the mean rainfall is estimated to 207 mm/year with a minimum equaling the third and a maximum as the triple of this value. Beyond the variability in time, important differences occur in the spatial distribution. The main annual rainfall varies between 594 mm in the North, 296 mm in the centre, 156 mm in south and less than 100 in extreme south. Nearby 80 % of the precipitation is concentrated between October and March. The annual evaporation ratio varies from 1 200 mm in the north, to 1 800 mm in the south (FAO, 2005)[1].

In southern Tunisia oases (Figure1), the acuity of the water deficit that's prevailing contributes to enhance pressure on the underground water resources for both of irrigation and drinking water purposes. De Haas (2002) defined the oasis as "agricultural sites in arid environment where agriculture is normally impossible without irrigation". Indeed, to supply the growing water demand in the oases, drillings had been multiplied and spread across the oases. The development of the water distribution network has led to extend the irrigated area in the agriculture sector.

[1] FAO, Aquastat, 2005, available at http://www.fao.org/nr/water/aquastat/countries/tunisia/indexfra.stm

Whereas the underground water resources are sustaining a chronic overexploitation, major of the existing oases in southern Tunisia observed their area duplicating. The urbanization of such ecosystems modified also considerably the local inhabitant's behavior towards water management. The implementation of drinking water networks facilitated the access to water and sewage disposal networks have been developed as well as the waste water treatment station that flourished around the oases.

Figure1: Localization of southern Tunisia oases (Adapted from Prinz and Loeper, 2008)

Available water resources

In the arid area of the southern country, the only potential water resources available provided from the *SASS* (System Aquifer of the Sahara Septentrional). It deals with sedimentary basin holding huge underground water volumes and extended over an area of one million km2 across three countries; Algeria (700 000 km^2), Lybia (250 000 km^2) and Tunisia (80 000 km^2). During the previous decades, the water mobilization from this basin has considerably enhanced from 0,6 in 1970 to a current ratio of 2,5 millions km^3.
Nevertheless, regarding the climate aridity, the recharge of the aquifers building this basin remains low, less than 1 million km^3 across the entire basin area. These resources are currently used from about 8 800 drillings. There are distributed respectively as 6 500 in Algeria, 1 200 in Lybia and 1 100 in southern Tunisia. There are mainly two deep aquifers that are building the SASS: the Complex Terminal (CT) aquifer, with a depth ranging between 100 to 500 m and the Continental Intercalary (CI), with a depth that can reach 2800 m. the mean salinity between the both aquifers, varies between 2,5 to 5 g/l (Prinz and Loeper, 2008).

In Tunisian oases, these two aquifers (Figure 2), provide considerable resources for agriculture and drinking water supply. Their mobilization assumes a great importance for the development of these regions.

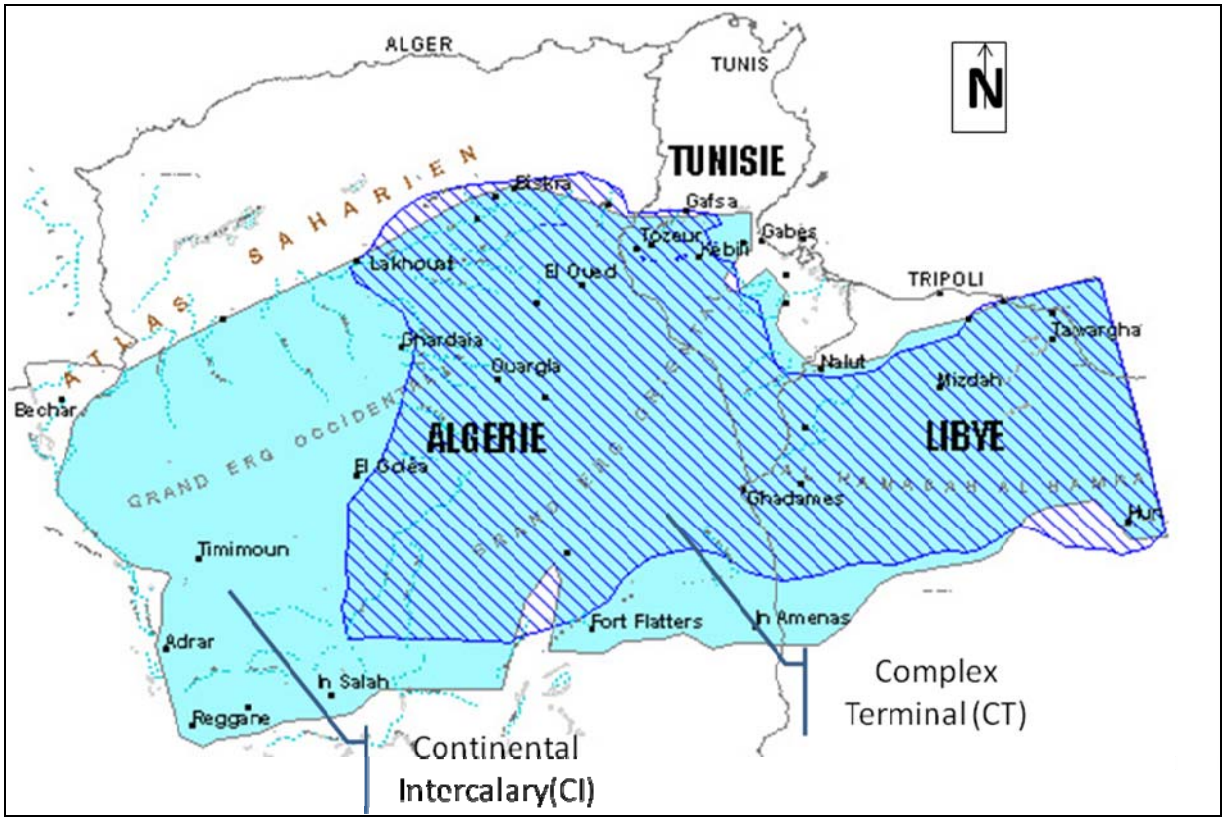

Figure 2: SASS aquifers in Northern Africa (Adapted from Puyoô, 2007)

Agriculture requirements

More than 80 % of the water allocation from the SASS aquifers is provided to agriculture purposes. Unfortunately, an efficient water management inside oases is facing several technical and even cultural hindrances. The traditional irrigation methods still widely used within farmers parcels. The absence of any field leveling and the over application of water amounts during irrigation, until the triple of the real crops requirements cause relevant water losses (Mechergui and Van Vuren, 1998). The water excess supplies shallow water table that rises to rather inacceptable level and create a water logging context (Prinz et al, 2005). The extension of the irrigated area in the oases is occurring without any assessment of water resources capabilities.

Indeed, private parcels that are being created from the own initiative of farmers, are supplied in water by illegal wells that are drilled without any approval from the development authorities. This phenomenon contributes definitely in the water demand rise and accentuates more the severe pressure on the exploited aquifers. Besides the technical aspect, farmer's commitment to the introduction of saving water inside parcels still insufficient. Despite the governmental grants allowed to the introduction of water saving equipments inside oases parcels (40 %, 50 % and 60 % respectively for the large, medium and small parcels) (Hamdane, 2004), they still attached to perpetuate irrigation methods that spread large water amounts over wide surfaces. At this purpose, the *PHD* work is focused to studies the improvement of irrigation efficiency in the oases of Nefzaoua region. Indeed, despite several rehabilitation works undertaken by the development authorities in these regions, the assessment following those interventions revealed very high water consumption inside parcels (SAPI, 2005). Furthermore, latent conflict situation between farmers remain, concerning water turn and their effective irrigation water allocation.

The survey is conducted on the main soil occupation (date palm), monitoring the impacts of several water saving techniques on both soil and crop yields quality evolution.

Urban consumption

In southern Tunisia, the national society of drinking water delivery (SONEDE) estimated the consumption per capita of water provided from the saharian basin as 65l/day in 2003. Under the growing demand of domestic water use, the ratio per capita is called to reach 200l/day in 2015. Furthermore, the urban consumption component is forecasted to enhance in the coming decades from 27 millions m^3 in 2004 to more about 39 millions m^3 in 2016 and nearby 59 millions m^3 in 2030. On the other hand, prospective studies on the water demand for the tourism in these regions based on a daily ratio of 700l/s per bed forecast an enhancement in water demand in this sector to 27 millions m^3 while it approached 10 millions m^3 in 2003 (OSS, 2009).

As an example of the main oases tributary to such water resources, the Nefzaoua region's where the urban water consumption provided from the CI aquifer enhanced from 3,11 millions m^3 in 1997 to more than 4,33 millions m^3 in 2007. Nearby 42,4 % of the distributed water has a salinity ranging between 1,5 and 2g/l. The implementation of three desalination stations had been undertaken and they are planed to be operational in 2010 with a treatment capacity of 6000 m3/day in *kebili*, 4000 m3/day in *Douz* and 6000 m^3/day in *Souk Lahad* delegation's. Added to the drinking water requirements, the SASS water provides also the industrial sector in southern Tunisia. The evolution demands for this purpose is called to enhance from 6,19 millon m^3 to nearby 35 million m^3 in 2015 and more than 51 million m^3 beyond 2030 (OSS, 2009).

Which changes impacts?

After successive decades of fossil water mobilization to meet the oases development and the populations water demand rise, the impacts became already perceptible. As a concrete example, the salinisation of Hssay drilling's in Douz, Southern Tunisia. The salinity reached already 6 g/l. Based on the piezometric level and monitoring supervised by the OSS for the whole basin and for the Tunisian case, exploitation scenarios had been modeled until the horizon 2050. It fosters impacts of additional mobilized water volumes on both the piezometric level decrease. Indeed, for the CT aquifer, the continuous decreases will still occurring until reaching 10-15m depth under chotts levels (Figure 3). Furthermore, the artesianism is expected to considerably decrease in the extreme country south (Mamou, 2009).

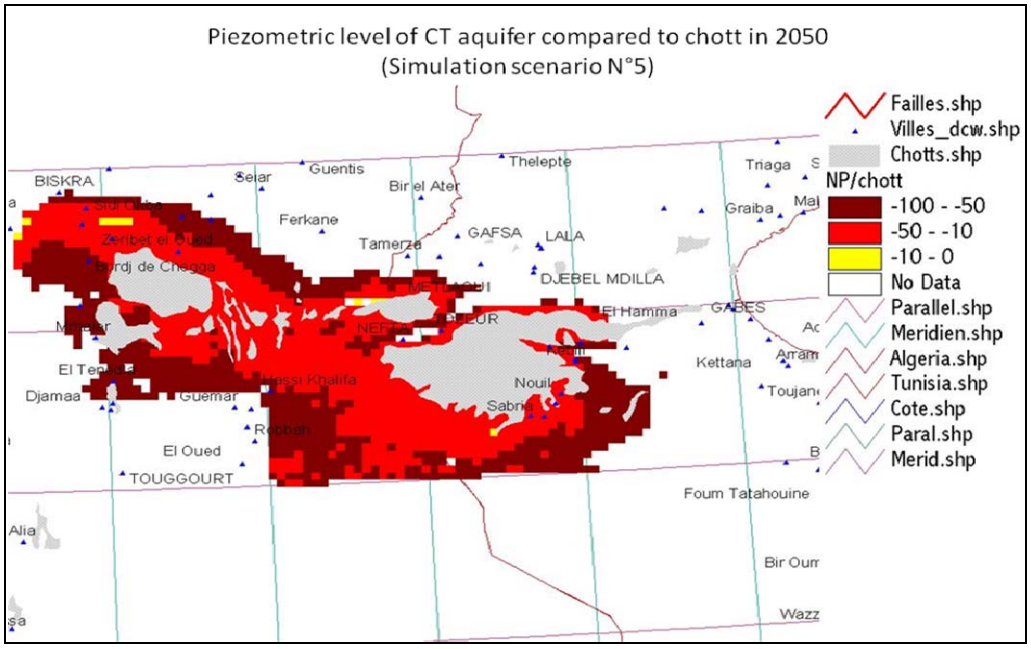

Figure 3: Piezometric level decrease simulation in Southern Tunisia for the CT aquifer (Adapted from Mamou, 2009)

In the Nefzaoua region oases, Zammouri et al (2007) simulated three scenario of pumping strategies from the CT aquifers. The main results emphasized a common impact as the water quality deterioration across the whole Nefzaoua regions. Indeed, the current practices followed to mobilize the fossil water in these regions are enhancing risks of land salinization, their fertility is irreversibly affected. In such context, the abandon of agricultural activities in these oases will condemn any social life over these area and they will be exposed to accurate desertification process.

Obviously, the risks of underground water resources degradation, coupled to the changes resulting from the ecosystems mutations (biodiversity decrease, intensive urbanization inside oases, and progressive decline of the oasis effect on the climate aspects) require urgent assessment of the water mobilization approach in those areas.

CONCLUSION

Long desired for their natural prosperity, the southern Tunisia oases have been for a long time self reliant ecosystems. Traditional knowledge in water resource management played a key role in the adaptation of such regions to the global environmental changes. Now, these oases became real cities where the urbanization advances as well as the irrigated area extend around the habitations. Under such context, the pressure on water demand increased definitely coupled with un-sustainability factors and risks inherent to fossil water management. Indeed the salt contamination by the chotts stills the main threat that compromises the future of those regions. The water use patterns should be drastically reconsidered within the framework of rational exploitation.

The agricultural sector that consuming more than 80% of these resources is called to enhance irrigation efficiency within farmers parcels where major water losses still occurring. The extension of illegal perimeters around the oases should be further closely supervised.

Furthermore, the multiplication of deep wells in private parcels that use the CT water should be strictly prohibited. The drainage water amounts that are collected downstream these oases should be valorized otherwise risks of their backflow towards the irrigated perimeters remain ultimately imminent. The urban water sector performance is embedded in these practices, the improvement of the distribution network have been already engaged. It aims to replace the integrality of the old connections. The networks monitoring and the regular water losses detection campaigns conducted will definitely improve the water saving process.

This practices panel requires the commitment of all stakeholders involved in the underground water resources management in southern country. In absence of such awareness, the intensive use of these fossil water, will lead oases inhabitants to experience relevant difficulties in efficiently managing scarcer and less reliable underground water resources. Improving the scientific understanding of local water management practices, capacity building and water saving technology transfer could bring to bear more efficient solutions to face such water problems.

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