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An assessment of recharge possibility to North-Western Sahara Aquifer System (NWSAS) using environmental isotopes

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SUMMARY

A comprehensive understanding of the groundwater dynamics of a transboundary aquifer system is highly needed for any successful transboundary cooperation policy. Moreover, an analysis of the NWSAS can be of particular interest for policy makers and researchers. This paper aims to reveals and to assess the renewability of North-Western Sahara Aquifer System (NWSAS) as one of the major transboundary multi-layered aquifer system, in North Africa, shared by Algeria, Tunisia, and Libya and is often referred to as the Système Aquifère du Sahara Septentrional (SASS). The paper is primarily intended for exploring whether it receives a considerable fraction of modern water as recharge or it is at risk of being depleted and excessively pumped, where the main challenge for NWSAS, is that it should be abstracted rationally for equitable use.

Environmental isotopes data of $\delta^{18}O$, $\delta^{2}H$, ^{3}H, ^{14}C as well as characteristics of *d*-excess are used to illustrate whether NSWAS is renewable or non-renewable resource. Geochemical, hydrological and statistical evidences supporting the renewability of NWSAS are provided through pairs of cross-plots.

The study has clearly indicated that NWSAS is receiving a considerable fraction of modern water as recharge to the aquifer because of the following reasons: Firstly, the moderately depleted delta values of $\delta^{18}O$ and $\delta^{2}H$ of water from Sahara Atlas in Algeria and the Dahar and the Dj. Nefoussa in Tunisia and Libya with $\delta^{18}O$ content (−6.0‰ to −5.0‰) compared with that of palaeowater (−7.0‰ to −9.0‰) indicate an appreciable fraction of modern water recharging NWSAS. This appreciable fraction of modern water should be attributed to originate from the present-day precipitation (−6.5‰). Secondly, the presence of significant amount of $^{14}C > 2\%$ and $^{3}H > 5$ TU, frequently found in data should be attributed to a mixing with shallow and modern water, where old water practically contains no ^{14}C.

The foregoing facts are in good agreement with the results of conventional hydrologic approach. This would contradict the assumption that the NWSAS is non-renewable water resource. In this context, the NWSAS is being located in one of the driest regions on the planet; these huge resources have been recognized to be of great importance to the socio-economic development of its riparian countries. So the present paper addresses the necessity of identifying specific cooperation problems which evolve out of these hydro geological attributes and prevalent use patterns.

Accordingly, the description of NWSAS as non-renewable, devoid of any meaningful recharge, a rather stagnant water body, disconnected from any surface water body in addition to its classification as "non-renewable" would therefore be misleading and represents one of the most obvious inaccuracy as well.

1. Introduction

The North-West Sahara Aquifer System (NWSAS) often referred to as the Système Aquifère du Sahara Septentrional (SASS) is one of the major North-African transboundary groundwater basins in Africa. The huge groundwater reservoir of the North-West Sahara Aquifer System (NWSAS) is being shared by three North African countries of Algeria, Tunisia and Libya (Fig. 1). The NWSAS covers an approximately half the size of the Nubian Sandstone Aquifer System, shared by Egypt, Sudan, Libya and Chad and it is predicted to cover around one million km^2 and reaching a scale of 1800 km from east to west and 900 km from north to south (Besbes, 2004).

The NWSAS can be categorized as a multi-layered system of aquifers which embodies a huge stock of non-renewable, fossil water. It displays a mostly porous and fissured/fractured structure, Struckmeier and Richts (2006). This basin comprises a series of aquifer layers which have been grouped into two reservoirs called the Continental Intercalary (CI) and the Complex Terminal (CT). It

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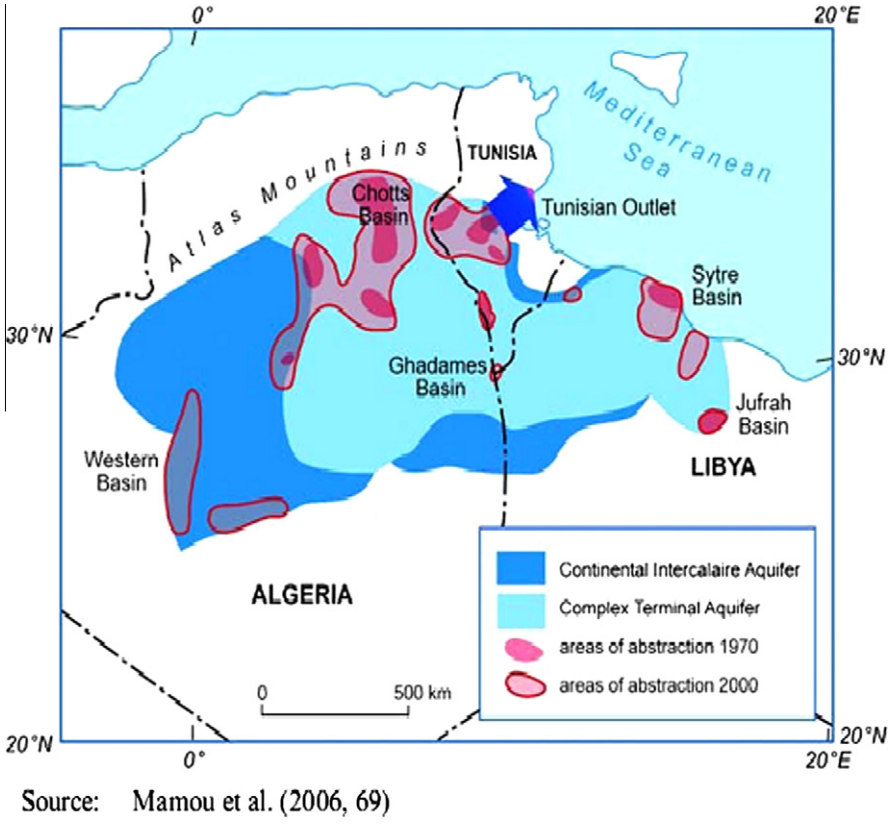

Fig. 1. Groundwater flow dynamics for North-Western Sahara Aquifer System (NWSAS).

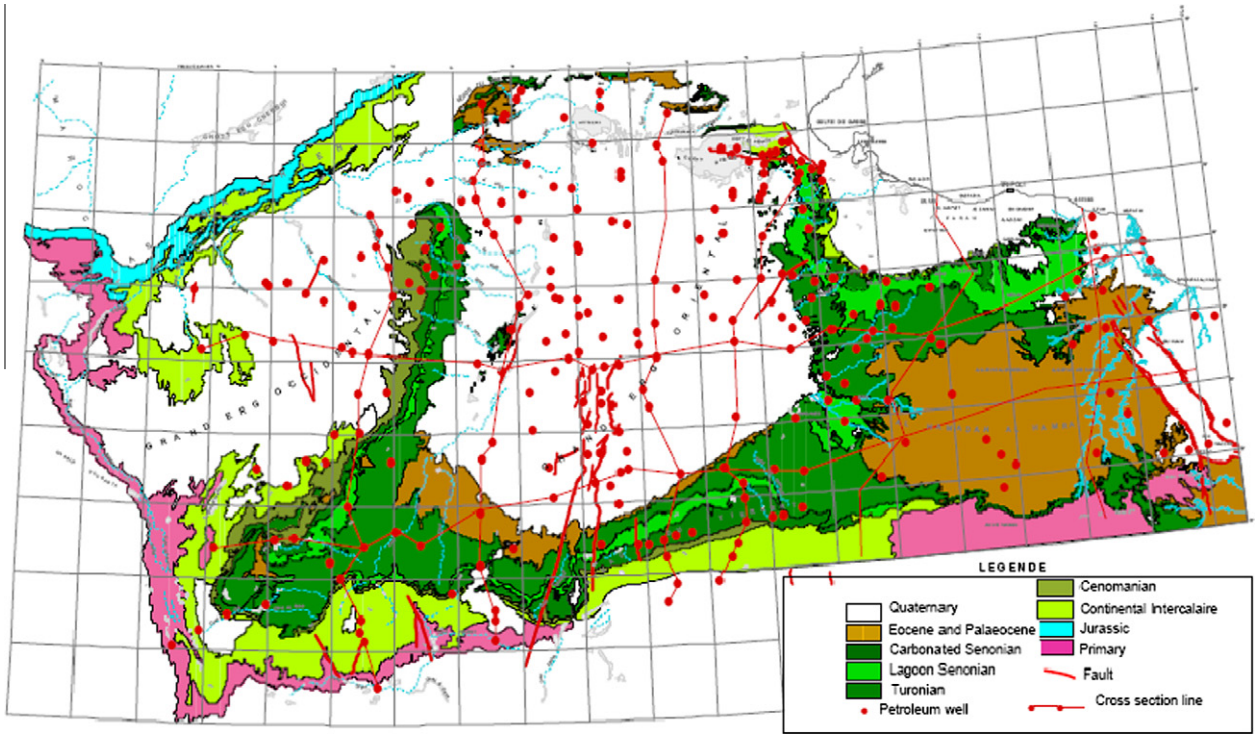

Fig. 2. Geological map of North-Western Sahara Aquifer System (NWSAS) (OSS internal report).

has a thickness of many hundreds of meters and is found in depths ranging from around 400 up to 2000 m below ground. According to Besbes (2004) the CI contains a set of layers with very differing lithology, comprising mainly continental sandstone in alternation with marine limestone and clay formations (Fig. 2). As for the CT is concerned, it consists of a fairly little homogeneous set including carbonated formations of the Upper Cretaceous and detritus episodes of the Tertiary and, mainly, the Miocene.