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Quality of irrigation water in the region of In Salah, South Algeria

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Abstract

Water is a vital element for the survival of all living things on a planetary scale. It is also a priority factor for any socio-economic activity. The Algerian Sahara, which covers 2/3 of the country's surface area and extends over more than 2 million km^2, contains significant groundwater resources stored in two major aquifers: the Intercontinental Aquifer (CI) and the Terminal Complex (CT). The intercontinental aquifer covers most of the northern Sahara. The In Salah region is part of the western hydrogeologic sub-basin of the intercontinental aquifer and forms its southeastern boundary. Groundwater deserves special attention in the global debate on the sustainable use of natural resources. The problem of groundwater salinity, caused by various human and natural factors, causes serious irrigation problems. Groundwater is the only source of water for date palms in the In Salah region. The results from physico-chemical analysis show that the groundwater presents a poor quality with very high salinity. The continental intermediate aquifer represents the main source of irrigation, in which boreholes (FS40 and FS38) are located, but this will not be possible in the future, so it is necessary to think about integrated water management to conserve resources. In this study, the salinity and sodium content of two different boreholes in the In Salah area were calculated.

Introduction

Agricultural irrigation is becoming increasingly important due to increasing food insecurity and environmental changes [1]. However, polluted water use is a major problem on a global scale [2]. The Algerian Sahara has significant groundwater resources stored in two main aquifers, the Intercalary Continental (CI) and the Terminal Complex (CT). The Intercalary Continental aquifer covers most of the northern Sahara and the boundaries of its extension were used to define the area of the northern Sahara water resources study project.

The In Salah region is part of the western hydrogeologic sub-basin of the transcontinental aquifer and forms its southeastern boundary. The agricultural areas of In Salah are located at the northwestern end, near El Barka and northeast of In Salah. The former agricultural area is about 1,262 hectares and the APFA area is 8,104 hectares. The irrigated area is 834 hectares APFA (Access to land ownership). The number of palm groves is approximately 151,000. The former agricultural area is irrigated by 15 boreholes, while that of the APFA is irrigated by 26 boreholes [4]. Unfortunately, many regions of Algeria, especially those in the Sahara, face problems with the quantity and quality of water resources for drinking water supply and irrigation. According to FAO (1998), the water requirement of a crop represents the amount of water needed to cover water losses through direct evaporation from the soil and transpiration through the plant. This represents the evapotranspiration of a crop that realizes its production potential.

Groundwater deserves special attention in the global debate on the sustainable use of natural resources. The problem of groundwater salinity is caused by a number of human and natural factors and leads to serious irrigation problems. Groundwater is the only source of water for date palms in the In Salah region. In this study, salinity and sodium ratios of two different boreholes in In Salah were calculated.

Material and Method

Study area

The commune of In-Salah is one of the oldest communes in southern Algeria and is part of the prefecture of Tamanrasset. In Salah covers an area of 43,937.50 km^2 and has a land use percentage of 7.88% for the prefecture of Tamanrasset. The region is located in the south of the Algerian Sahara, north of Tamanrasset Prefecture. It is located 1300 km south of Algiers and 700 km from the capital of the Tamanrasset governorate, between the Tademaït plateau in the north and the edge of the Tidikelt in the south. The oasis is located at 27°11' north latitude and 2°28' east longitude. The In-Salah region consists of three geographical features: The Tidikelt plateau, the Tademaït plain and the Oued Djarret depression (Figure 1).

Figure 1. Location of study area

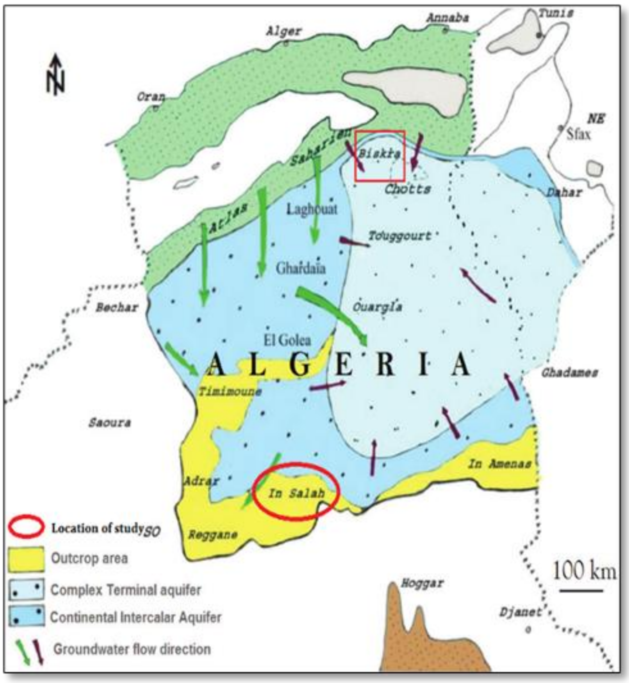

Figure 2: Map of groundwater resources (Intercontinental and Terminal Complex) [3]

Materials and methods

In order to prove and interpret the quality of water in the In Salah area, interest was shown in physico-chemical analysis of irrigation water. Sampling was carried out in two boreholes FS 38 and FS40 (Figure 3). Samples were taken by hand in plastic bottles. Analyses were carried out at ANRH in Adrar. The parameters analyzed were major cations, anions, and nitrates. The quality of the chemical analyses was checked using Diagramme software developed by the Hydrogeology Laboratory in Avignon (France).

Salinity is usually measured by electrical conductivity. The values of the analyzed samples are higher than 3000 µS/cm, indicating a severe salinity of the groundwater (FAO standard). According to Madani (2008), a soil is said to be saline when its electrical conductivity is greater than 4 dS/m. However, the salinity of a soil is best assessed by the behavior of plants, so this limit can vary greatly depending on the sensitivity of plant species.

High levels of sodium in irrigation water cause the soil structure to deteriorate and become water and airtight, which has a direct impact on the health and productivity of crops through the infiltration of irrigation water into the soil. High levels of calcium and magnesium relative to sodium exacerbate this problem. This relationship is expressed by SAR (sodium absorption rate) [6] (Equation 1).

$$\text{Adjusted SAR} = \frac{\text{Na}^{+}}{\sqrt{\frac{\text{Ca}^{2+} + \text{Mg}^{2+}}{2}}} [1 + (8.4 - \text{pHc})] \qquad (1)$$

Table 1. Geographical coordinates of boreholes

Geographic coordinates	Longitude	Latitude	Z (m)
FS 38	2° 26.913'E	27° 12.170'N	261
FS 40	2° 27.235'E	27° 12.703'N	262

Figure 3. Location of the two boreholes

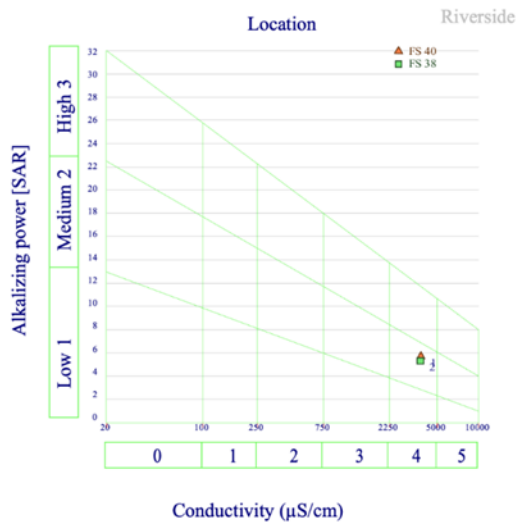

Figure 4. Riverside diagram

Concentrations are expressed in meq/l. The analyzed samples have SAR values ranging from 12 to 13 for FS 38 and FS 40 and are above the irrigation water quality limit.

Classification and characteristics of irrigation water

The graphical representation of the analyzed samples in the Riverside diagram [7] makes it possible to classify irrigation water (Figure 4) and therefore the various uses (crop types) (Table 2).

For the classification of irrigation water, we usually adopt the "Riverside diagram" of the US Department of Agriculture, which takes into account two main criteria: conductivity and SAR. Knowing the EC and SAR values of the water intended to irrigate our environment, we can assign a pair (C.S) that characterizes its quality. According to Servant [8], the different zones defined by the classification diagram of irrigation water are seven value levels (C1S1 - C1S2, C2S1 - C2S2, C1S3, C3S1 - C1S4, C2S3, C3S2, C4S1 - C2S4, C4S2, C3S3 - C3S4, C4S3 - C4S4).

Table 2. Classification and characteristics of irrigation water.

Pt water	SAR/ Conductivity	Ranking	Features
FS 38 FS 40	C4S2	Poor quality	Poor quality, to be used with great care only in light, well-drained soils, and for resistant plants, high risk of leaching and gypsum addition.

Conclusion

The physico-chemical study showed that the water analyzed for the two boreholes was very saline and had high mineralization. Irrigation of date palms shows that the water has a high risk of clogging, which characterizes its use for plants with good salt tolerance. Irrigation water in the In Salah area should be of great interest to those involved in the agricultural sector through a project for the drainage and reuse of wastewater, which should be used in agriculture with the knowledge that groundwater today is a non-renewable resource and needs to be conserved, which has recently been a consideration. The water required for the needs of plants must meet certain minimum quality standards. An excess of undesirable elements can be harmful:

- For crops, it results in lower yields and even the risk of poisoning consumers.
- Soil: risk of depletion, resulting in lower yields, but also risk of contamination of crops and groundwater.
- Groundwater, with risk of contamination for consumers.

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