Chapter 27
Monitoring of Groundwater Suitability for Irrigation Under Severe Arid Conditions:
Case Study of Aquifer in Rjim Maatoug, Tunisia

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ABSTRACT

Water quality assessment is a necessity for groundwater resource management, especially in arid regions. Nevertheless, many difficulties appear in choosing the most appropriate models for the evaluation of water suitability. The present study reports the groundwater (GW) suitability for irrigation purposes in Rjim Maatoug, Southwestern Tunisia, where the Complex Terminal (CT) aquifer is solicited by the growing population needs. To attempt the objective of this study, EFA-CFA method was undertaken using the hydro-chemical, hydro-geological, and statistical approaches. Based on water wells data, hydro-chemical results show that the rock-water interaction and climatic conditions are the main origins of water mineralization. The application of the EFA-CFA method to the groundwater allowed identifying two factors of water degradation: (1) natural, due to the water-rock interaction and climatic conditions, and (2) anthropogenic, mainly due to the excessive use of chemical fertilizers. The results show that the groundwater in the study area is considered unsuitable for irrigation.

INTRODUCTION

Water is a biological need as a support for life and a major factor to promote the local economy. Particularly, groundwater is considered to be a privileged vector of human activities (Adimalla & Wu, 2019; He *et al.,* 2015). It is required to meet the growing household, industrial and agricultural needs. Therefore, quality issues of groundwater and its management option need to be given high attention. However, in the last decades, it is in continuous degradation in terms of quantity and quality. This is due to the climatic conditions on one hand, as dry weather and high evaporation rate, anthropogenic activities such as intensive use of chemical fertilizers in agriculture (Ameur *et al.,* 2016; Hajji *et al.,* 2020), and the disorderly exploitation of water resources (Hajji *et al.,* 2020, Hajji *et al.,* 2018), on the other. The overuse of groundwater has led to the lowering of piezometric levels and the worsening of its quality. Groundwater chemical modifications make it unsuitable for the desired uses (Mapoma *et al.,* 2017). Groundwater quality is related to changes in its composition, it is controlled by many factors as the major mechanism controlling groundwater chemistry involves the rock–water interaction and oxydorèduction reactions during the percolation of water through the aquifers (Vasanthavigar *et al.,* 2013). Moreover, waterborne pathogens, the increase of chemical fertilizers in agricultural fields, toxic and nontoxic pollutants resulting from human activities are the major water contamination sources and pose health risks (Varol & Davraz, 2014). Besides, they also can lead to water resources quality degradation (Houatmia *et al.* 2016; He & Wu, 2019). Although the use of the traditional indices has answered numerous questions concerning the GW quality (Shadrin *et al.,* 2021; Kumar *et al.,* 2019; Wang *et al.,* 2018; Hajji *et al*, 2018), these methods cannot clearly express the water pollutant categories. Currently, there have been various methods for water suitability evaluation such as fuzzy inference system (Hajji *et al.,* 2021) including factor analysis method, and multivariate analysis (Hajji *et al.,* 2013; 2018; 2020; 2021).

Currently, Tunisia is faced with a lack of surface reserves and excessive exploitation of groundwater resources; added to this, many sources of contamination cause groundwater quality degradation. Moreover, taking into account the desertification phenomenon threatens more than 75% of the Tunisian territory affected by arid and semi-arid climatic conditions. Tunisia was among the first countries to develop a National Action Programme against desertification (2018-2030), taking place in the South of Tunisia. This program is considered among the rare Tunisian and African experiences in the field of the fight against desertification within the overall framework of sustainable development. It provides a set of activities and measurements to support and guarantee this project. It is particularly developed for Rjim Maatoug province. In these arid zones, water resources for agriculture are limited, especially when compared to the needs of local populations. Moreover, the extension and development of agriculture require the development of irrigated agriculture. However, while irrigation generally and rapidly contributes to increasing agricultural production and improving the quality of life of rural populations, its extension is often accompanied by serious threats to the preservation of the environment and especially the quality of water and soil. Given the importance of water resources in the medium and long term periods, several studies are devoted to the monitoring and the hydro-geochemical and isotopic characterization of the studied aquifer (Guendouz *et al.,* 2003, Haj Ammar *et al,* 2014), and many development projects were conducted in the Rjim Maatoug province. The objective of this study was to evaluate the quality of the water, to identify the groundwater hydro-chemical characteristics of the terminal complex at Rjim Maatoug.

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