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Hydraulic parameters estimation by using an approach based on vertical electrical soundings (VES) in the semi-arid Khanasser valley region, Syria

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ABSTRACT

A new alternative approach based on using Vertical electrical sounding (VES) technique is proposed for computing the hydraulic conductivity *K* of an aquifer. The approach takes only the salinity of the groundwater into consideration. VES measurements in the locations, where available water samples exist, are required in such an approach, in order to calibrate and establish empirical relationships between transverse resistance Dar-Zarrouck *TR* parameter and modified transverse resistance *MTR*, and between *MTR* and transmissivity *T*. Those relationships are thereafter used to extrapolate the transmissivity even in the VES points where no water samples exist. This approach is tested and practiced in the Khanasser valley, Northern Syria, where the hydraulic conductivity of the Quaternary aquifer is computed. An acceptable agreement is found between the hydraulic conductivity values obtained by the proposed approach and those obtained by the pumping test which range between 0.864 and 8.64 m/day (10^{-5} and 10^{-4} m/s). The Quaternary aquifer transmissivity of the Khanasser Valley, has been characterized by using this approach and by adapting the *MTR parameter*. The transmissivity varies between a minimum of 79 m^2/day and a maximum of 814 m^2/day, with an average of 283 m^2/day and a standard deviation of 145 m^2/day. The easy and inexpensive approach proposed in this paper can be applied in other semi arid regions.

1. Introduction

The most important parameter in hydrogeology is the hydraulic conductivity, which is used for groundwater modeling to predict aquifer behavior during the different stages of water extraction.

The pumping tests used to determine the hydraulic conductivity is expensive, and yield to low spare resolution maps.

Geophysical methods substantially contribute in providing specific relationships between hydro-geological and geophysical parameters (Heigold et al., 1979; Frohlich, 1994; Frohlich et al., 1996; Yadav and Abolfazli, 1998; Salem, 1999; De Lima and Niwas, 2000; Niwas and De Lima, 2003; Dhakate and Singh, 2005; Lesmes and Friedman, 2005; Asfahani, 2007b, 2007c, 2010a,b; Aretouyap et al., 2015).

A practical approach based on the use of VES technique for computing the hydraulic conductivity is proposed in the present paper. The advantages of using such VES technique is that no ground perforation is required, and the dense VES soundings give high resolution maps and faster information regarding the hydraulic conductivity distribution. The new proposed approach which takes into consideration only the groundwater salinity is consequently tested and applied for computing the hydraulic conductivity and characterizing the Quaternary aquifer transmissivity in the semi arid Khanasser valley region, Northern Syria, Fig. 1. Empirical equations between transverse resistance Dar-Zarrouk parameter (*TR*) and modified transverse resistance (*MTR*) and between (*MTR*) and transmissivity (*T*) are established while constructing the proposed alternative approach to extrapolate the transmissivity in the VES locations, even where no available water samples exist. The *TR* is considered as a powerful tool in the interpretation of groundwater survey data (Zohdy et al., 1974).

This paper is a part of an integrated geophysical researches carried out in the Khanasser Valley international research program, in which three scientific organizations; Bonne University, Germany, International Center for Agriculture Research in the Dry Areas (ICARDA), and Syrian Atomic Energy Commission have been collaborated. The objective of this research program was to solve

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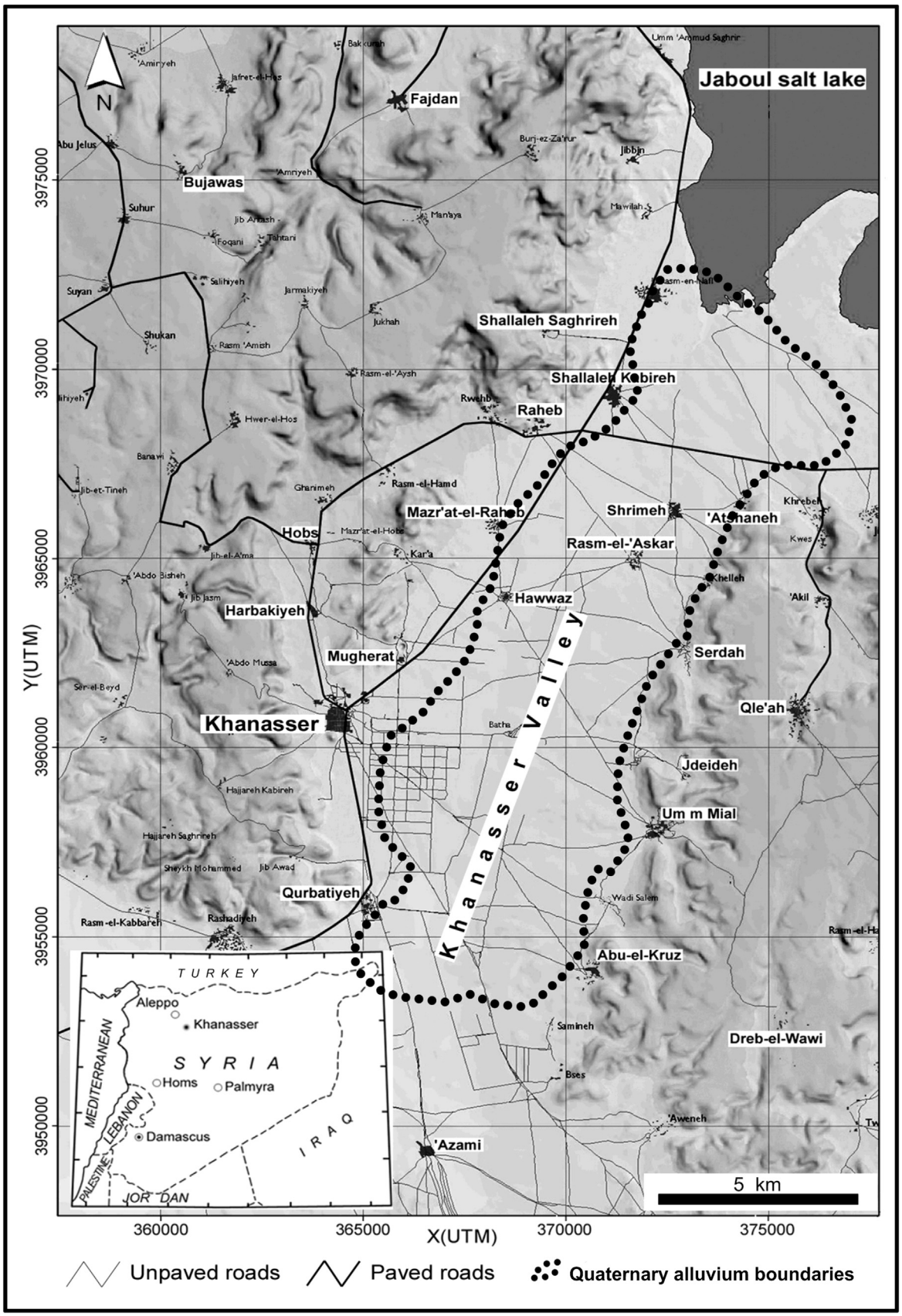

Fig. 1. Topographic photo of the studied area, Khanasser Valley, Northern Syria.