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3D electrical structure definition of aquifer systems in the Kalahari basin in Southern Angola based on legacy data reprocessing

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ABSTRACT

The Kalahari-Ohangwena transboundary aquifer system, recently identified in Northern Namibia, comprises 3 major aquifers with very different characteristics. The shallowest is discontinuous and with limited reserves, but it has local importance in water supply for the population, since it is easy to reach, and often presents good hydrochemical quality. An intermediate deeper aquifer is characterized by high salinity while the deepest aquifer, also mostly saline, can present zones with fresh water. However, the latter is located at considerable depths and is shaped by the bottom of the basin basement. There hasn't been a systematic hydrogeological data acquisition for decades in this area of Angola, but legacy electrical resistivity data reprocessing from geophysical surveys conducted >50 years ago in the Cunene Province allowed the construction of a quasi-3D geoelectrical model for the Angolan side of KOH aquifer system in the Cuvelai-Etosha basin. This model is based on 482 vertical electrical soundings carried out in 1966–67, using the Schlumberger array, that contribute to confirming the presence of the Kalahari-Ohangwena aquifer system in Angola. The obtained quasi-3D model highlights the geoelectrical features of hard bedrock and is validated with other hydrogeological and geophysical information. The quasi-3D electrical resistivity data is interpreted using selected boreholes and two time-domain electromagnetics transects carried out in Namibia, in the 2000s. Although both geophysical data acquisitions were >40 years apart, the results show a very good correlation between the deeper aquifer and the aquitard separating the intermediate aquifer from the deeper aquifer either with the results from Namibia or the borehole data. This is a direct result of the lack of alteration in the hydraulic conditions over these decades, without significant anthropogenic activity and negligible extraction from deep wells. Based on this analysis, the original dataset was considered a reliable source and this quasi-3D model was validated. Furthermore, the model can be considered in the future as an important tool for groundwater resources management, as well as a good starting point for further hydrogeological research in the province of Cunene.

1. Introduction

Cunene is a southern Angolan province bordering Namibia that suffers from severe, pluriannual and recurrent droughts. Although the rainy season from November to April provides a significant amount of rain that lightens the effects of the dry season (between 10 and 120 mm/m^2 (Climate Change Knowledge to the interval between 1991 and 2016, 2019)), the water supply does not respond to the needs of the local populations. Instead, in the last years, pluriannual drought events have been a major concern for the local, regional, and national Angolan administrations, with thousands of refugees trying to escape the social and economic impacts. The humanitarian concern has become so evident and serious that United Nations (UNO) (e.g. WFP, 2021; UNO, 2022) and several non-governmental organizations (NGOs) developed on-field actions to help authorities to minimize the effects on the population directly affected by the drought. Nevertheless, after the drought

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