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Anthropogenic wetlands due to over-irrigation of desert areas; A challenging hydrogeological investigation with extensive geophysical input

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Abstract:
During the last century, many large irrigation projects have been initiated in arid lands worldwide. Despite a tremendous increase in food production, a common problem when characterizing these zones is land degradation in form of waterlogging. As results, large volumes of water are lost due to surplus irrigation in regions where water availability is extremely challenging for both population survival and economic development. The Nubariya depression, Western Desert (Egypt), is a clear example of this mechanism. Following the reclamation of desert lands for agricultural production, an artificial brackish and contaminated lake developed in the area in the late 1990s and presently extends for about 2.5 km^2. Available data provide evidence of a simultaneous general deterioration of the groundwater system. With the main objectives of understanding the hydrological evolution of the area, characterizing the hydrogeological setting and developing scenarios for artificial aquifer remediation and recharge, an extensive hydrogeophysical investigation was carried out in this challenging environment using Magnetic Resonance Sounding (MRS, also called surface NMR) and ground-based Transient EM (TEM). The integrated interpretation of the geophysical surveys, properly calibrated with a number of boreholes, provides a clear hydrogeological picture of the upper 100 m sedimentary structure, in terms of both lithology and groundwater quality. The information is then used to set up a regional groundwater flow and a local density-dependent flow and transport numerical model to reproduce the past evolution of the aquifer system and develop a few scenarios for artificial aquifer recharge using the treated waters provided by a nearby waste-water treatment plant. The research outcomes point the hydrological challenges that emerge for an effective management of water resources in reclaimed desert areas and highlight the effectiveness of integrating advanced geophysical and modeling methodologies.

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