Chapter 2

Integrating GALDIT and GIS for Assessing Sea Water Intrusion Susceptibility in the Akermoud Coastal Water Table, Morocco: Implications for Sustainability

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ABSTRACT

The Akermoud coastal aquifer, situated in the northern region of Essaouira, Morocco, is an aquifer that has an important productive capacity, mainly used for irrigation. However, uncontrolled exploitation has increased the risk of sea water intrusion, leading to deteriorating water quality and threatening agricultural sustainability. In this research, in order to access susceptibility to sea water intrusion (SWI), six elements derived from diverse databases are used. Variables were combined in a GALDIT and GIS models, resulting in the analysis of 40 groundwater samples from wells. Results highlight the imminent threat of sea water encroachment into the coastal groundwater system. The resulting GALDIT index map indicates a notably high susceptibility index along a 3 km coastal band, between Tensift Oued and Bhaybeh Beach, enlarging southwards up to 5 km. Saline intrusion patterns are particularly observed between Zaouiet El Kourati and Ouled El Fequih villages, where the merging of saline and fresh waters amplifies salinization, affecting approximately 24% of the study area.

I. INTRODUCTION

Groundwater is vital for ecosystem balance (Gholami et al., 2010; Humphreys, 2006) and is a primary water source in coastal areas (Amiri et al., 2016; Ma et al., 2020). However, groundwater quality in these regions is deteriorating, posing environmental challenges, especially in semi-arid and arid areas (Bahir and Ouhamdouch, 2020; Ez-zaouy et al., 2022; Moumane et al. 2021). Over-extraction of aquifers increases mineral content (Alabjah et al., 2018) and harms freshwater ecosystems (Mirzavand et al., 2020). Seawater intrusion, a major issue in coastal regions, is driven by groundwater recharge, discharge, and geological structure (Kumar, 2006; Seddique et al., 2019), disrupting the freshwater-seawater balance (Xue et al., 1999). Over-extraction lowers groundwater levels, triggering saline water intrusion (Pinder, 1973; Pulido-Leboeuf, 2004), which raises total dissolved solids (TDS) and renders water resources unusable (Sherif and Hamza, 2001). This issue is exacerbated by sea level rise and excessive coastal pumping (Werner and Simmons, 2009; Moujabber et al., 2006; Seddique et al., 2019).

Additional factors like agriculture (Zalidis et al., 2002), tourism (Ez zaouy et al., 2022), population density (Erostate et al., 2020), and climate change (Benini et al., 2016; Ez zaouy et al., 2022) further degrade groundwater quality in coastal regions. Salinization of coastal aquifers has garnered global attention, with various studies using models like GALDIT, coupled with hydro-geochemical analysis, to understand salinity causes and impacts (Hermans and Paepen, 2020; Ez zaouy et al., 2022).