

**STUDY OF HYDROCHEMISTRY AND  
SEAWATER INTRUSION OF MANUKAN  
ISLAND, SABAH**

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## ABSTRACT

### STUDY OF HYDROCHEMISTRY AND SEAWATER INTRUSION OF MANUKAN ISLAND, SABAH

A detailed groundwater, seawater and sediment study were undertaken to examine the evolution of groundwater in the shallow aquifer of Manukan island, Sabah, Malaysia. Its aquifer is often exposed to heavy pumping and that could lead to seawater intrusion. The continuous pumping of groundwater on this island has contributed to enrichment of some constituents found in seawater. As a consequence of indiscriminate exploitation, the groundwater quality of this island has deteriorated. Major ion chemistry analysis shows that the groundwater quality of the island experiences some changes attributed to seawater intrusion. Simple mixing between seawater-freshwater is complicated by the cation exchange process and highly associated with groundwater withdrawal. This study indicates that the groundwater is classified as Na-Cl and Ca-Cl types. The groundwater has undergone a compositional change from Ca-rich to Na-rich which can be explained mostly by the cation exchange process. This study shows that the rise of Na and Cl composition in the groundwater is not only controlled by seawater intrusion, but also controlled by rapid cation exchange processes. Strong correlations exist among the major elements (Na, Mg, K, Cl and SO<sub>4</sub>) and salinity with/or EC suggest that the impact of seawater intrusion to these major elements are more significant due to highly competitive relationship between ions. These relationships clearly identify the main elements contributing to the groundwater salinity and their tendency to depict a similar trend of salinization pattern. From the PHREEQC calculation, calcite, dolomite and aragonite solubility showed positive values of the saturation indices (SI), indicating supersaturation that lead to mineral precipitation condition of water by these minerals. Intensive exploitation of groundwater from Manukan Island's aquifer has disturbed the natural equilibrium between fresh and saline water, and has resulted in the increase of groundwater salinity and leap to the hydrochemical complexities of freshwater-seawater contact. It was observed that the mixing between freshwater-seawater created diversity in the geochemical processes of Manukan Island's aquifer and altered the freshwater and seawater mixture away from the theoretical composition line. This explained the most visible processes taking place during the displacement. The results from reactive transport modelling confirmed that the migration of seawater into the fresher parts of the aquifer apparently leads to a calcification of the aquifer despite the seawater being supersaturated for carbonate minerals and shows that the composition of the near coast zone and further landward area may vary and have a significant effect on the processes during the intrusion.

**Keywords:** groundwater, hydrochemistry, PHREEQC, seawater intrusion, small island