

## **The long-term impacts of anthropogenic and natural processes on groundwater deterioration in a multilayered aquifer**

### **ABSTRACT**

In many regions around the world, there are issues associated with groundwater resources due to human and natural factors. However, the relation between these factors is difficult to determine due to the large number of parameters and complex processes required. In order to understand the relation between land use allocations, the intrinsic factors of the aquifer, climate change data and groundwater chemistry in the multilayered aquifer system in Malaysia's Northern Kelantan Basin, twenty-two years hydrogeochemical data set was used in this research. The groundwater salinisation in the intermediate aquifer, which mainly extends along the coastal line, was revealed through the hydrogeochemical investigation. Even so, there had been no significant trend detected on groundwater salinity from 1989 to 2011. In contrast to salinity, as seen from the nitrate contaminations there had been significantly increasing trends in the shallow aquifer, particularly in the central part of the study area. Additionally, a strong association between high nitrate values and the areas covered with palm oil cultivations and mixed agricultural have been detected by a multiple correspondence analysis (MCA), which implies that the increasing nitrate concentrations are associated with nitrate loading from the application of N-fertilisers. From the process of groundwater salinisation in the intermediate aquifer, could be seen that it has a strong correlation the aquifer lithology, specifically marine sediments which are influenced by the ancient seawater trapped within the sediments.

**Keyword:** Groundwater chemistry; Natural processes; Anthropogenic factors; Land use; Multiple correspondence analysis