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Salinization mechanism in the Coastal Aquifer near Beer-Tuvia, Israel: reassessment based on updated data from new and existing wells

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The salinization process of the Quaternary sandstone aquifer in Israel (the Coastal Aquifer) has been known for many years, and threatens one of the most important natural water resources of Israel. The sources of the salts (and other contaminants) introduced into the aquifer include: (1) the seawater interface on the west; (2) saline water flow from Eocene rocks bordering the aquifer on the east; (3) intensive anthropogenic activities on the surface, above the aquifer, and (4) possible salt leakage from clay layers that form the base of the aquifer. Each of these sources plays a different role in different locations, and is affected by the pumping regime and the water balance in the aquifer. The understanding of the salinization mechanism and the evaluation of the salt contribution of each source is critical for the operation, maintenance and rehabilitation of the aquifer. The understanding of the mechanism also enables advanced and flexible design of production wells, in a way that allows the utilization of selected strata with specific water quality, while isolating undesired, contaminated ones. The technical design of the well structure and the selection of the drilling method also allow the characterization of the salt source in a given location during the construction of the well and the performance of the pumping tests.

Intensive salinization in many production wells within the Beer Tuvia region, located in the eastern part of the aquifer, has been observed for decades. Following gradual water production starting in the 1930's, increasing salinization processes were detected since the 1960's, eventually causing the abandonment of many wells and the degradation of this important fresh water source.

Several researches attempted to characterize the salinization mechanism in this region. Some indicated the anthropogenic activities on the top soil, especially intensive dairy farming, as the main source of salts, nitrogen and other contaminants. However, the prevailing opinion so far is that the most dominant mechanism in this region is the salt leakage from the aquifer base.

The present work summarizes several experiments and hydrological tests conducted during the construction of new wells near Beer Tuvia, which can give direct and indirect evidence regarding the sources of the salts in this region. In contradiction to the assumption of homogeneous aquifer that leads some of the previous works, we found that clayey and chalky rock layers vertically separate the aquifer in this region into at least two sub-units. Using the percussion drilling method while constructing new production wells, we were able to measure the salinity and the water head within different sub-units. The results clearly showed that the salinity of the lower sub-unit, near the aquifer base, is lower than the salinity of the upper sub-unit. Additional non-routine hydrological tests, including conductivity logs, variations in the pump depth and comprehensive chemical and isotopes analyses were conducted in new and existing wells. The results of these tests further support the conclusions of the drilling tests, that the contribution of the salt from the aquifer base is much less than what is expected according to previous works, and that the salt comes either from the top soil, from the eastern boundary of the aquifer or from both.

These results have substantial significance and are essential for the technical design of new wells, the future utilization of the aquifer in this region, and the rehabilitation plan of the southern part of the Coastal Aquifer.