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Hydrochemical zonation of the western part of Göksu Delta aquifer system, Southern Turkey

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In general, coastal areas are preferred places for human settlement, especially at places where infrastructure routes benefit from rivers, streets, or harbours. As a result, these areas usually suffer from rising population and endure increasingly high demand on natural resources like water.
Göksu Delta, located in southern Turkey, is one of the important wetland areas of Turkey at the Mediterranean coast. It is divided into two parts by Göksu River. The western part of the delta, which is the subject matter of this study, hosts fertile agricultural fields, touristic places and a Special Environmental Protection Area. These properties of the region lead to a water-dependent ecosystem where groundwater has widely been used for agricultural and domestic purposes. When the exploitation of groundwater peaked in the middle of 1990s, the groundwater levels dropped and seawater intruded. General Directorate of State Hydraulic Works tried to stop seawater intrusion by building irrigation channels connected to Göksu River and banned drilling of new wells for groundwater exploitation, although it is hard to control the drilling of wells without official permit.
Geological studies show that the delta is composed of terrestrial sediments including clay to coarse sand deposited during Quaternary. The heterogeneous sediments of Göksu Delta cause hydrogeological features of the aquifer systems to be heterogeneous and anisotropic. Hydrogeological investigations, therefore, indicate mainly two different aquifers, shallow and deep, separated by an aquitard. The shallow aquifer is under unconfined to confined conditions from north to south while the deep aquifer is under confined conditions.
This study focuses on hydrogeochemical zonation in terms of hydrochemical processes that affect the Göksu Delta aquifer systems. For this purpose, hydrogeochemical and isotopic studies are conducted to understand the salinisation and softening processes of groundwater. The physicochemical and hydrochemical features of the water (EC, TDS, HCO_3-, SO4-2, Cl-, Na+, Ca+2, Mg+2, K+, Br-, B+3, Sr+2, NO_3-, PO4-3) were evaluated and composition diagrams were plotted (e.g. ion vs Cl-, ion vs TDS, Na+ vs Ca+2, HCO_3/Cl vs Cl-). Ratios of HCO_3/Cl, Na/Cl, Ca/Cl, SO4/Cl, Br/Cl, B/Cl were calculated and isotope analyses (δ18O, δD and Tritium) were conducted. By these methods, it is possible to differentiate the effects of agricultural land use, seawater intrusion, ion exchange, and softening processes.
Hydrochemical analyses indicate that the dominant anion is HCO_3- and the dominant cation is Ca+2 for the northern part and Na+ for the southern part of the aquifers. Both EC values (417-2890 μS/cm), Cl- (16-320 mg/l) and Na+ (490,68-558,58 mg/l) concentrations of groundwater increase along the flow path from north to south for the aquifer system. Combined evaluations show that seawater intrusion is still dominant in the southern part of the study area while ion exchange and softening processes control the central part. Both NO_3- (up to 19,6 mg/l) and PO4-3 (up to 11 mg/l) contents as well as Br/Cl ratios indicate agricultural pollution at some locations in the study area.