Journal of Applied Geochemistry
Vol. 18, No. 2 (2016). pp. 203-214

IMPACT OF THE GEOLOGICAL SETTING AND ANTHROPOGENIC ACTIVITIES ON GROUNDWATER SALINIZATION: A CASE STUDY ON SEMI-CONFINED COASTAL AQUIFER IN MAZANDARAN PROVINCE, NORTHERN IRAN

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Abstract

Hydrogeochemical data of the semi-confined coastal aquifer (~2300 km^2) (SCCA) located in the terrain between Amol and Ghaemshehr townships in Northern Iran reveal salinization of fresh groundwater (FGW). The saline groundwater zone starting from the eastern half of the aquifer's coastal boundary extends inland for more than 40 km and is oriented at an angle (~45^o) to the flow direction of FGW. Data pertaining to the location, depth of water sampling spots and imbalance between discharge and recharge indicate that salinization of FGW is caused due to (1) excessive withdrawal of groundwater from closely spaced bore wells in the eastern half of the coastal (northern) region of the SCCA, leading to both lateral seawater intrusion and upconing of the underlying palaeobrine interfaced with the FGW and (2) excessive withdrawal of groundwater from deep bore wells in the central region of the SCCA, leading to the upconing of the underlying palaeobrine into the FGW zone. While salinization of the FGW at two sampling locations in the northern unconfined region of the SCCA is due to irrigation return flow, one sampling location in the southern unconfined region of the SCCA is caused by the inflow of saline water from Garmroud river which, in turn, is getting continuously polluted at its origin by large quantities of highly saline water discharging from the Lalezar spring. Further, the SCCA is prone to periodical seawater intrusion associated with sea level rise of the land-locked Caspian Sea; one such documented recent event is the sea level rise of 2.4 m during a period of 17 years starting from 1977. Present-day practice of over exploitation under the existing geological setting with two natural saline water sources one, at the northern boundary and the other beneath the SCCA is mainly responsible for salinization of ~20 vol. % groundwater resource of the SCCA.

Keywords: Coastal aquifer, Salinization, seawater intrusion, palaeobrine, Mazandaran Province, Northern Iran

1. Introduction

Groundwater is a vast reservoir of freshwater which has been exploited for many purposes since the onset of civilization. Accelerated groundwater resource development has brought major social and economic benefits over the past 20 years in various forms such as urban water supply, and in rural livelihoods, including irrigated agriculture, but poor groundwater management has lead to aquifer degradation and negative impact on resource sustainability (Foster and Chilton, 2003).

The mechanisms and significance of three semi-independent facets of aquifer degradation are (i) depletion of aquifer storage and its effects on groundwater availability, terrestrial and aquatic ecosystems; (ii) groundwater salinization arising from different processes of induced hydraulic disturbance and soil fractionation; and (iii) vulnerability of aquifers to pollution from land-use and effluent discharge practices related to both urban development and intensification of agriculture (Foster and Chilton, 2003). Salinization in waters caused by faulty irrigation, increased evapotranspiration and rise in sea-level as well as groundwater over pumping has attracted the attention of many researchers (Liu et al., 2003; Scholten and Szabolcs, 2006; Han, 2015; Badaruddin and Werner, 2015). In addition to these sources, the origin of saline groundwater is also attributed to uprise of the connate saline water that was trapped during the transgression and regression history of the sea (Khairy and Janardhana, 2013a). Thus, in many coastal aquifers around the world, modern seawater intrusion commonly occurs because of the above mentioned natural flow controls or because of flows induced by extensive freshwater withdrawals (Jones et al., 1999).

The present paper deals with salinization of groundwater in the Amol-Ghaemshahr plain located in the Mazandaran Province of Northern Iran. The study brings to light the diverse causative sources for the salinization of groundwater viz., over exploitation, seawater intrusion, irrigation return flow and upcoming of ancient saline water.