Environmental Science and Pollution Research
https://doi.org/10.1007/s11356-021-13467-8

RESEARCH ARTICLE

Hydrochemical characterization and groundwater quality in Cauvery deltaic fluvial plains of Southern India

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Received: 29 September 2020 / Accepted: 11 March 2021

Abstract

Groundwater sources are drastically changing in their quantity and quality depending on local and regional level natural and anthropogenic factors, influencing their suitability for drinking and irrigation purposes. The objective of this study is to characterize the hydrochemistry and assess the groundwater quality in the fluvial deltaic plains of Cauvery river basin, Tamil Nadu, India. A total of 50 georeferenced groundwater samples were collected across Needamangalam block of Thiruvarur district and analyzed for major ions and hydrochemical processes. The results showed an ionic sequence of $Cl^- > Na^+ > HCO_3^- > Mg^{2+} > Ca^{2+} > CO_3^{2-} > SO_4^{2-} > K^+$ based on their relative proportions. The scatter diagram indicated that groundwater chemistry was mostly influenced by weathering dominance followed by evaporation and silicate weathering. The dominant hydro-chemical facies were Na^+-Cl^--HCO_3^- type, Na^+-Mg^{2+}-Cl^--HCO_3^- type, Na^+-Cl^--HCO_3^--CO_3^{2-} type and Na^+-Mg^{2+}-Cl^--HCO_3^--CO_3^{2-} type influenced by the ion-exchange reaction. Most of the groundwater samples are suitable for drinking and irrigation except few with higher Na^+ and Cl^- content caused by the mixing of salt from fluvio-marine sources or agriculture return flow. The high sodium content in irrigation water may affect the soil hydraulic and nutrient properties in the long run.

Keywords Groundwater quality · Hydrochemistry · Irrigation suitability · GIS techniques · Cauvery fluvial plains · South India

Introduction

Groundwater is the only available resources for agricultural and other domestic sectors in many countries whereas, rivers and drainage systems are in constraints to provide sufficient water supply due to climate change (Thornton and Herrero 2009), insufficient precipitation (Anthony Nyong 2005), and population growth (Gosain et al. 2006; Rao et al. 2017; Marghade et al. 2019;), etc. In India, groundwater is the major source for drinking, irrigation, and industrial purposes, and the whole country uses about 230 ckm (cubic kilometers) of groundwater per annum, which is the largest user of groundwater in the world (Fienen and Arshad 2016; Kaliraj et al. 2019). Besides, 60 per cent of the irrigated agriculture and 85 per cent of drinking water supplies depend on groundwater sources (World Bank 2012). However, groundwater sources are drastically decreasing in quantity and quality in various parts of Peninsular India that become increasingly serious problems for livelihood especially in the arid, semi-arid, and sub-tropical regions (Subba Rao et al. 2014; Smilovic et al. 2015; Kaliraj et al. 2019). In many river basins of India, the groundwater resources are shortage in a variety of their aquifers due to failure of monsoonal rains (Khadri and Kanak 2014), poor infiltration due to human interferences (Sullivan et al. 2005; Stamatis 2010; Kaliraj et al. 2019), overexploitation (Kelepertsis 2000; Siegel 2002), and in some cases, lack of recharge (Post 2005; Perrin et al. 2012).

Groundwater quality varies spatially as well as temporally based on the source of aquifers and rock formations which interact together along with the external source of pollutants and other chemical substances (Garrels and Mackenzie 1967; Kelly 1963; Lyles 2000; Apodaca et al. 2002; Elango

Responsible Editor: Xianliang Yi

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Published online: 14 April 2021