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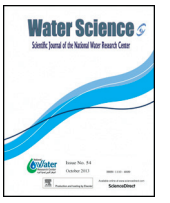

Identification of salinization by bromide and fluoride concentration in coastal aquifers near Chennai, southern India

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Abstract

This study aims to use fluoride as an additional indicator for seawater intrusion apart from the known effective geochemical indicators such as EC, TDS, sodium, chloride and bromide. Groundwater in a coastal part of Arani-Koratalaiyar river basin located north of Chennai, Tamil Nadu, India was assessed to determine its suitability for domestic purpose and to delineate the region affected by seawater intrusion. Fluoride concentration in groundwater samples from forty nine locations varied from 0.02 mg/l to 2.9 mg/l with an average of 0.5 mg/l. As per the Bureau of Indian Standards, the permissible range of fluoride in drinking water is 0.6–1.5 mg/l. Fluoride concentration in groundwater of this area exceeds 1.5 mg/l in 6% of the groundwater samples and is below 0.6 mg/l in 74% of the groundwater samples. There is no known geological source for fluoride in this area. Spatial variation in fluoride concentration in groundwater indicates that the coastal areas have comparatively high fluoride due to seawater intrusion which was similar in comparison with EC and bromide concentration measured in groundwater. This study indicates that fluoride can be used as an indicator of seawater intrusion in coastal areas.

Keywords: Coastal area; Electrical conductivity; Bromide; Fluoride; Sea water intrusion

1. Introduction

Groundwater salinization is a common threat in coastal parts of the world (Giménez-Forcada, 2014; Camp et al., 2014). Many researchers have identified seawater intrusion along the coastal regions and proposed different indicators that can help to easily identify the groundwater quality degradation by geochemical analysis of groundwater including isotopic signatures (Khaska et al., 2013; Yamanaka et al., 2014), geophysical investigation (Choudhury et al., 2001) and

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also sophisticated numerical modelling (Narayan et al., 2007; Cobaner et al., 2012). Of these methods, the simplest, cost-effective and rapid determination is through the measurement of electrical conductivity (EC) of groundwater in the coastal regions. Other geochemical indicators for seawater intrusion known historically are the presence of high concentration of sodium, chloride and bromide concentration in groundwater.

Presence of high fluoride in groundwater used for drinking purpose is a serious issue which is recognized worldwide. However, low fluoride in drinking water i.e. <0.6 mg/l (WHO, 2004; BIS, 2012) is also a concern as it may cause tooth decay. Groundwater used for drinking purpose having fluoride concentration above the maximum permissible limit of 1.5 mg/l (WHO, 2004; BIS, 2012) may cause dental and skeletal fluorosis. Many times the sources of fluoride are natural i.e. from the rocks that are rich in fluoride bearing mineral which weathers during rock and water interaction (Reddy et al., 2010; Brindha and Elango, 2011). The other sources of fluoride in groundwater include agrochemicals (Motalane and Strydom, 2004; Farooqi et al., 2007) and combustion of coal (Jha et al., 2008). The presence of high concentration of fluoride i.e. above the maximum permissible limit of 1.5 mg/l has been reported earlier in many parts of the world (Ahn, 2012; Reyes-Gómez et al., 2013). In India too, fluoride poses a challenge to groundwater quality (Brindha et al., 2011; Sharma et al., 2012; Brindha and Elango, 2013). All these studies emphasis on the importance of studying the occurrence of fluoride in groundwater as it is a potential contaminant that causes health impacts in humans. It is essential to determine the fluoride in groundwater of the areas where it is used by the people for drinking and domestic purposes without proper treatment.

This study was carried out in an area which forms a part of Arani-Koratalaiyar river basin located north of Chennai, Tamil Nadu, India with an objective to ascertain the suitability of groundwater for domestic purpose based on the fluoride concentration in groundwater and using fluoride as an indicator to determine the area affected by seawater intrusion. EC, total dissolved solids (TDS) and bromide which have served as established indicators for seawater intrusion has also been studied for comparison.

2. Materials and methods

The base map was prepared from Survey of India toposheets (1:50,000) and the geology map was prepared from the maps obtained from Geological Survey of India (1:125,000). Initially, a survey was carried out to understand the types of wells, pumping pattern and the local hydrogeology. Based on this, forty nine representative wells (Fig. 1) were chosen for monitoring the groundwater quality. Groundwater samples were collected from these 25 bore wells and 24 open wells in clean polyethylene bottles of 500 ml capacity during June 2011. Prior to the collection, water was

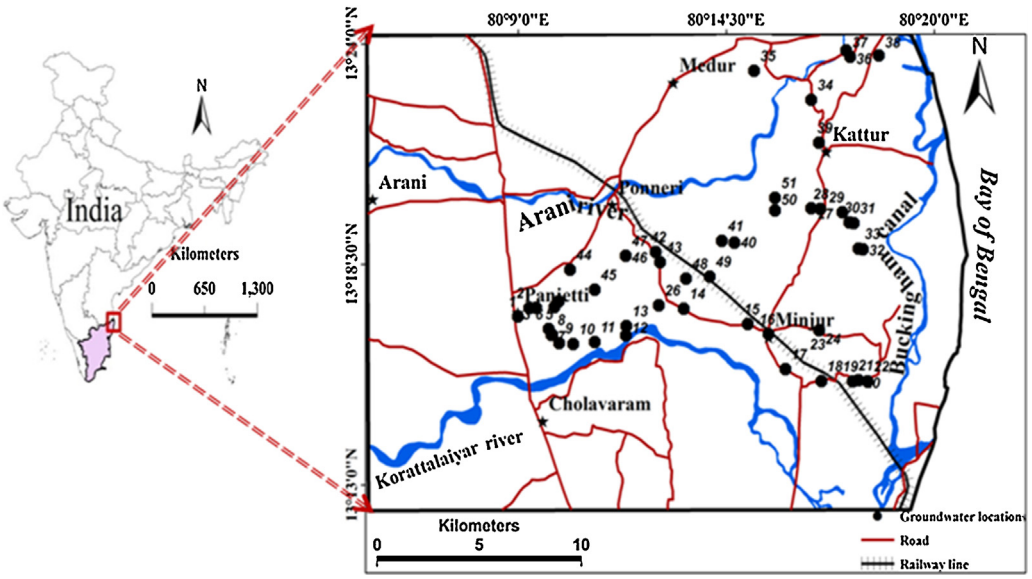

Fig. 1. Location of the study area and monitoring wells.