Desalination 273 (2011) 436–446

Contents lists available at ScienceDirect

Desalination

journal homepage: www.elsevier.com/locate/desal

Assessment of groundwater quality in the northeastern coastal area of UAE as precursor for desalination

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ARTICLE INFO

Article history:
Received 8 October 2010
Received in revised form 23 January 2011
Accepted 24 January 2011
Available online 19 February 2011

Keywords:
Groundwater
Quality
Hydro-geo-chemical analysis
UAE

ABSTRACT

Extraction of brackish groundwater in coastal aquifers is believed not only to mitigate the effects of seawater intrusion but also to reduce the desalination cost of the extracted water. However, evaluation of the groundwater quality in coastal aquifers is an essential initial step before determining the locations of brackish water extraction wells and extraction rates. Therefore, this paper presents spatial and temporal assessments of the groundwater quality in the coastal aquifer of Wadi Ham located in northeastern part of UAE. This assessment is considered as precursor for evaluation of the aquifer potentiality as source for water desalination. A total of 245 water samples from 26 different observation wells were collected over the period from 1989 to 2006 to assess the origin and quality of the groundwater in this coastal aquifer. It was found that saltwater intrusion from the Gulf of Oman was not the main source of brackish water in several parts of the aquifer prior to year 2000. However, results also show that more recently seawater intrusion has become the leading factor of water salinity in the aquifer especially near the coast. It was found that seawater intrusion extended about 8 km inland from the coast of the Gulf of Oman.

1. Introduction

The importance of groundwater quality has been recognized particularly over the last two decades as development of groundwater continues to expand in the coastal northeastern area of UAE. Seawater intrusion is a natural phenomenon in which saline water from the sea or the ocean moves into the fresh groundwater in coastal aquifers. This behavior is caused because seawater has a higher density than freshwater. This density difference causes the weight of a column of seawater to be greater than that of a column with the same height of freshwater. If these two columns are connected at the bottom, then the pressure difference would cause a flow from the saltwater to the freshwater until the pressure equalizes. Seawater intrusion may cause serious consequences in terms of both environmental and economic impacts. Therefore, monitoring of the groundwater quality has become more important in order to assess the seawater intrusion phenomenon. This assessment could be very complex due to the influence of wide regional variations in geology and land usage. Despite that, assessment of relative concentrations of the chemical constituents in groundwater may provide information on the evolution of groundwater age (residence time), solubility, velocities, flow history, and sources of recharge. Older groundwater for example, is generally more mineralized than younger groundwater. Fresher groundwater is normally associated with recharge areas whereas groundwater in discharge areas is more mineralized. The greater part of the soluble constituents in groundwater comes from soluble minerals in soils and sedimentary rocks. The more common soluble constituents include calcium, sodium, bicarbonate and sulfate ions. Another common constituent is chloride ion derived from intruded seawater, which is considered as hydraulically connected with the modern sea, and connate water that is one buried in the paleohydrogeologically significant past. Additionally, evapotranspiration from unconfined zones leads to increased solute concentration both in shallow groundwater and in the soil profile (so-called sabkha-type secondary salinization). Sewage waste ions can exacerbate contamination originated from mineral dissolution and invasion of seawater. Nitrate can be a natural constituent but high concentrations often suggest a source of pollution. Therefore it is essential to distinguish on whether salinity of groundwater in a coastal aquifer is attributed to seawater intrusion or other salinity causing mechanisms. The geochemical features of brackish water within the transition zone of the seawater encroachment serve as an excellent tool to detect seawater intrusion.

The problem of seawater intrusion is very common in many parts of the world and has been reported by many researchers [e.g.,

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doi:10.1016/j.desal.2011.01.069

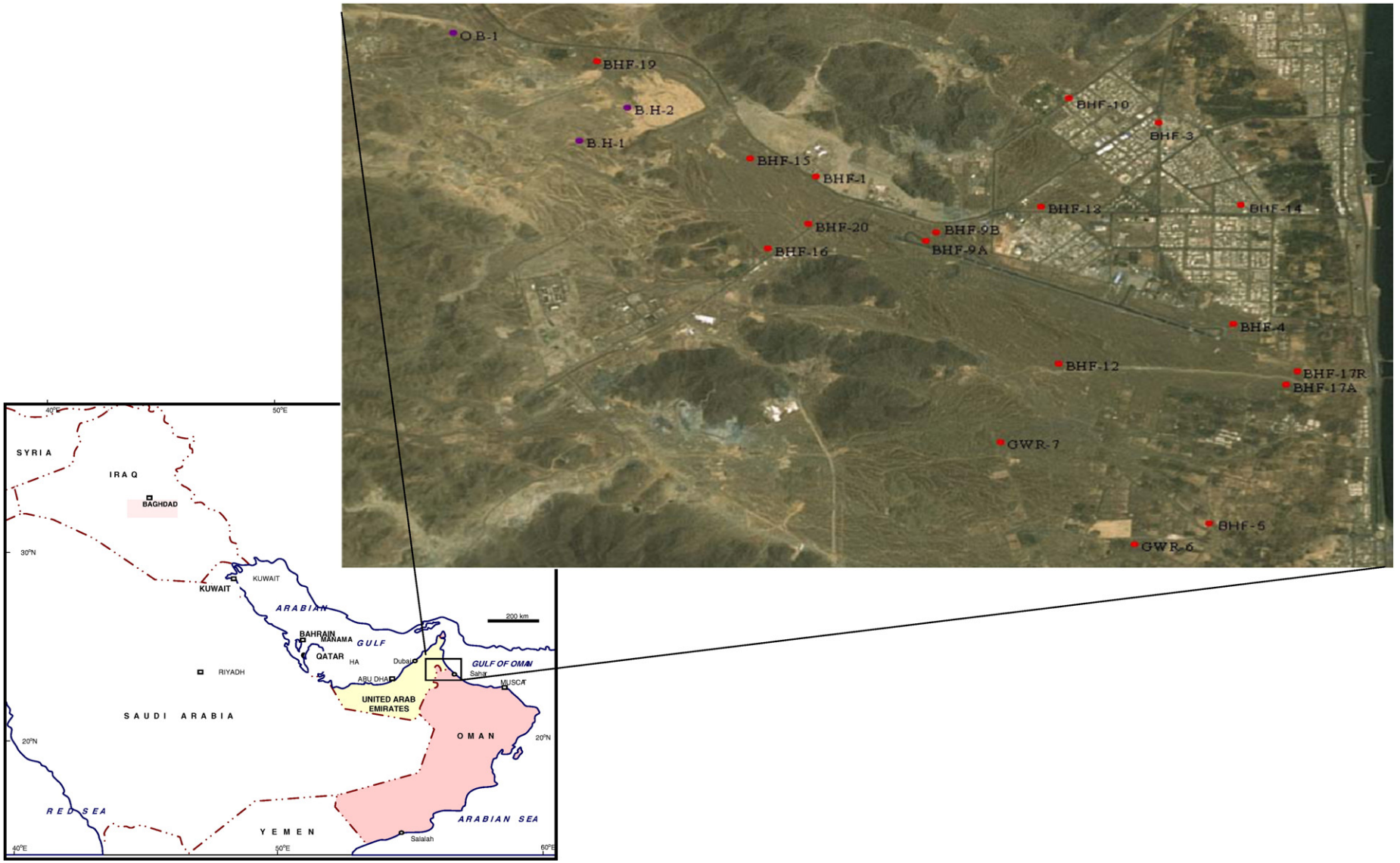

Fig. 1. Location map of study area in the United Arab Emirates including locations of observation wells in Wadi Ham.