Integrated geophysical, geospatial and multiple-criteria decision analysis techniques for delineation of groundwater potential zones in a semi-arid hard-rock aquifer in Maharashtra, India

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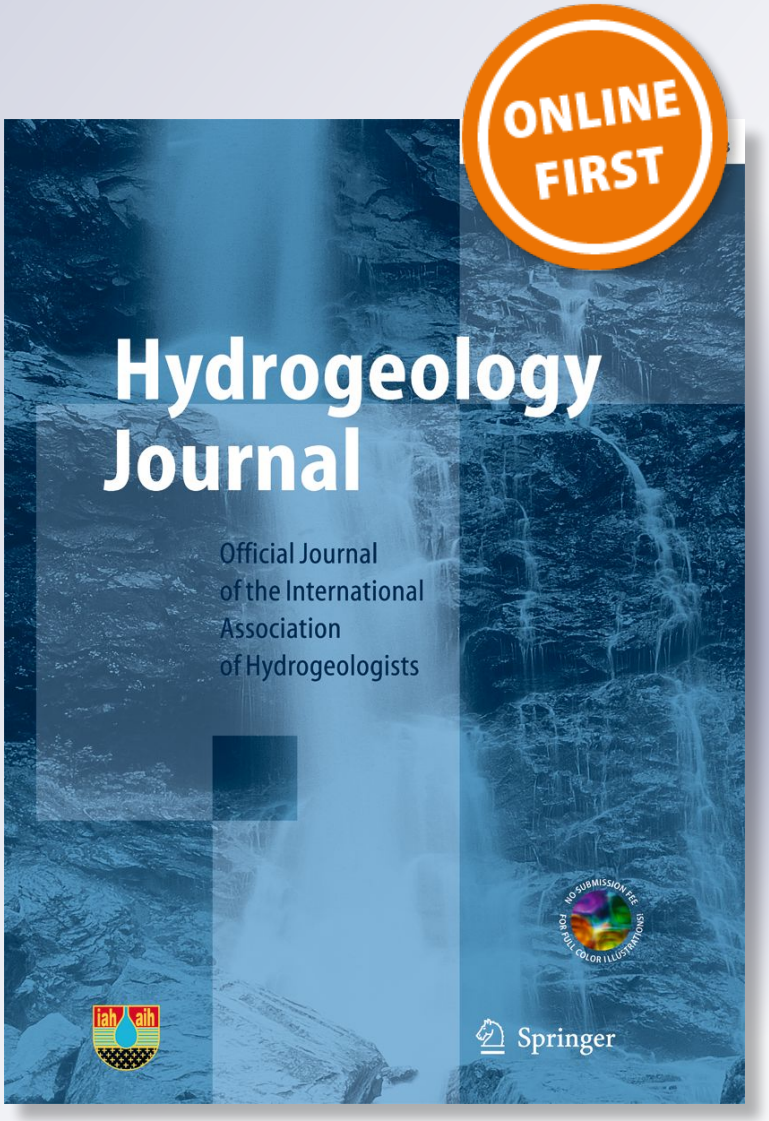
Hydrogeology Journal
Official Journal of the International Association of Hydrogeologists

ISSN 1431-2174

Hydrogeol J
DOI 10.1007/s10040-018-1883-2



Springer

Hydrogeology Journal
https://doi.org/10.1007/s10040-018-1883-2

REPORT

Integrated geophysical, geospatial and multiple-criteria decision analysis techniques for delineation of groundwater potential zones in a semi-arid hard-rock aquifer in Maharashtra, India

G. Shailaja[1] · A. K. Kadam[2] · G. Gupta[1] · B. N. Umrikar[3] · N. J. Pawar[3]

Received: 16 February 2018 / Accepted: 17 October 2018

Abstract

A novel framework has been developed for delineating groundwater potential zones (GWPZ) using fuzzy datasets and the analytical hierarchical process (AHP) integrated with hydrogeological, geophysical and geospatial data for a hard-rock trap-covered terrain in Maharashtra, India. This approach is based on the consideration of ten factors that influence groundwater potential: aquifer resistivity, aquifer thickness, transverse resistance, electrical anisotropy, drainage density, lineament density, rainfall, slope, geology and land use/land cover. The ranks and weights were obtained by fuzzy and AHP techniques and assigned to these layers and their feature class. The reclassified layers were integrated in a geographical information system environment to delineate the GWPZ of the study basin. The findings reveal that the areas of very high groundwater potential are located in the plateau region and plains of the basin that occupy about 11.5% of the total study area. These results are further validated using the relative operating characteristics technique, wherein area under the curve is 0.83, indicating good accuracy. The study highlights that such an integrated approach is reliable and can be applied in other semi-arid regions of the world to help hydrogeologists manage groundwater resources.

Keywords Fuzzy logic · Analytical solutions · Groundwater potential · Hard-rock aquifer · India

Introduction

Groundwater occupies a key position in the irrigation sector of India because of its major contribution in stabilizing agriculture (Rajaveni et al. 2017). However, the dependency on groundwater has increased progressively due to the introduction of high-yielding varieties of cash crops and adoption of multi-cropping patterns, both requiring timely and assured water supply (Ahmed et al. 2015). This enhanced use of groundwater for irrigation has led to the lowering of water tables thereby reducing its potential for future use. The impacts of groundwater mining include increase in salinity and reduction in base flow, directly affecting agricultural productivity, water users and the environment (Naik and Awasthi 2003).

Appraisal of groundwater to infer its different characteristics is generally achieved using geophysical, geological, geomorphological or geochemical data. Interpretation of such datasets reveals the subsurface features, geomorphology and geochemistry of the region. These conventional methods are being used extensively to study areas of concern related to delineation of groundwater potential zones. It is advocated by Lewis Brent (2001) that an image of the subsurface can be easily and inexpensively obtained using a variety of non-intrusive surface geophysical methods.

Of all the nonintrusive geophysical techniques, electrical resistivity profiling and vertical electrical sounding (VES) are widely used to differentiate the different subsurface layers

✉ A. K. Kadam
kadamajaykumar1@gmail.com

G. Shailaja
shailajageophysics@gmail.com

G. Gupta
gupta_gautam1966@yahoo.co.in

B. N. Umrikar
bnumrikar@gmail.com

N. J. Pawar
dr.njpawar@gmail.com

[1] Indian Institute of Geomagnetism, New Panvel (W), Navi Mumbai, Maharashtra 410218, India

[2] Department of Environmental Sciences, Savitribai Phule Pune University, Pune, Maharashtra 411007, India

[3] Department of Geology, Savitribai Phule Pune University, Pune, Maharashtra 411007, India

Published online: 21 November 2018