

Geostatistical Analyses for Validation of Hydrogeochemical Behaviour of Groundwater from Neoproterozoic Aquifers of Chandrapur District, Central India

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Abstract

The study area, signifying the rural part from Central India, has the groundwater as the only source for all water-utilities. Here, the Neoproterozoic Penganga limestone forms the main groundwater-bearing aquifer systems. The three factors are resulted from geostatistical analysis; wherein the 47.334% has been regarded as the geogenic factor, 24.298% represents anthropogenic input and 14.374% is alkalinity factor. The phenon line at $r = 0.55$ value illustrates three distinct clusters as an outcome of factor analysis responsible for above mentioned factors. The high values of EC and TDS (1016 to 2519 $\mu\text{S}/\text{cm}$ and 650.2 – 1612.2 mg/l, respectively) signify the involvement of multiple combinations of cations and anions, undoubtedly from the both geogenic and non-geogenic sources. Silicate weathering is found to be a major geogenic reason responsible for the release of solute; while the non-geogenic inputs are introduced through the household waste, irrigation-return-flow, animal wastes and the use of agricultural and soil nourishments.

Keywords: Geostatistical Analyses, Hydrogeochemical Behaviour, Groundwater, Neoproterozoic Aquifers, Chandrapur District, Central India

Introduction

The hydrogeochemical behaviour of the groundwater is the consequential of the interaction between the chemical-ions of minerals phases, released from the aquifer-rocks at the rock-water interface (Das *et al.*, 2012; Xu *et al.*, 2018; Mahanta and Goswami, 2024). This complex process, which governs the groundwater-chemistry has also the geogenic-control in deciding groundwater quality (Si *et al.*, 2009; Li *et al.*, 2011; Mahanta and Goswami, 2024). The anthropogenic interventions also pose further deterioration of the groundwater quality (Ravikumar *et al.*, 2011; Agoubi *et al.*, 2013; Bauder *et al.*, 2014; Amiri *et al.*, 2015; Adimalla and Qian 2019; Eyankware *et al.*, 2020; Murkute *et al.*, 2025).

In recent investigations, it has been pointed out that groundwater-contaminants are the carriers of hazards to human health and hence the studies are concentrated on apprehension of geostatistical, geochemical as well as health related complications (Hirojeet *et al.*, 2015; Zhang *et al.*, 2019; Eyankware *et al.*, 2020; Gogulothu *et al.*, 2022, Hota *et al.*, 2025; Divya *et al.*, 2026). In fact, such interconnected investigations will contribute in framing the policies and strategies for remedial measures, planning, regulations

to alleviate groundwater contamination, done by geogenic as well as anthropogenic-inputs.

The present investigation focuses on PG2 watershed representing the Penganga River catchment from Chandrapur district, Maharashtra, Central India; wherein the source for all water-utilities is the only groundwater. The groundwater quality tests have been carried out from the adjoining catchments; however, there is unsatisfactory information on groundwater-quality-characters. Thus, it is attempted here to examine the groundwater hydrogeochemistry of involving geostatistical approach. Accordingly, the factor as well as cluster evaluations have comprehensively been initiated to recognize the numerous governing factors of hydrogeochemical characteristics (Hota *et al.*, 2023, Chatterjee *et al.*, 2023). In addition, the multiple regression analysis and human health risk assessment have also been considered (Wu and Sun, 2016; Subba Rao, 2020; Gogulothu *et al.*, 2022; Das *et al.*, 2023). Present study paves the initial step in understanding the hydro-geochemistry of the study area and its implications in quality issues pertaining to health risk analysis.

Study Area

The PG2 watershed, named after the River Penganga, lies 90 km on southwest tip of Chandrapur city (latitude - 19°38'32":19°48'23" N and longitude - 78°50'12":79°05'51" E) and