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Delineation of groundwater potential zones at micro-spatial units of Nagaon district in Assam, India, using GIS-based MCDA and AHP techniques

Manash Jyoti Bhuyan[1] · **Nityananda Deka**[2]

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Abstract
Groundwater is one of the most precious natural resources in the densely populated regions of the world. The ever increasing population in the developing countries like India and the concurrent growth of industrial and urban centres along with modern agricultural systems have caused tremendous pressure on groundwater. In the present day context of groundwater depletion and degradation, it is necessary to identify and map the groundwater potential zones (GWPZs) of an area to manage and utilize them sustainably. The present study is, therefore, an attempt to employ the GIS-based multi-criteria decision analysis (MCDA) and analytical hierarchy process (AHP) techniques to derive the GWPZs in Nagaon district of the middle Brahmaputra valley agro-climatic region of Assam, India. Here, ten multi-influencing groundwater potential factors, including geology, lineament density, geomorphology, slope, soil texture, LULC, rainfall, drainage density, NDWI, and TWI are considered for the delineation of GWPZs. These criteria are assigned weightages using AHP wherein geology has been given the highest weight, followed by lineament density and the others. Based on these techniques, the GWPZs of the district are classified into four zones, namely, low, moderate, high, and very high which include 20, 301, 218, and 392 villages, respectively. The results are validated with the groundwater levels of 28 tube wells and 5 ring wells distributed throughout the district, and as such, an area under the curve value of 86.9% is found. The results, thus, validated imply that the methodology adopted in deriving the GWPZs is highly reliable, which can help in sustainable utilization, development, and management of groundwater resources in the district. Besides, the identification and mapping of village-wise GWPZs are very essential for the planning of water resource management and water risks mitigation which ultimately help in sustainable rural development.

Keywords Groundwater potential zones · Micro-spatial unit · GIS · MCDA · AHP · Nagaon · Assam

Introduction

The origin of human civilizations in the big river valleys of the world, where people used the river water for various productive purposes reflects the importance of water as one of the most vital natural elements for human sustenance (Ladhar 1998; Mansell 2003; Liu et al. 2014; Bhuyan, and Deka 2021). In the early phases of human civilization, people did not face the issues of water risks, water stress, water shortages and groundwater depletion. People, at present, use water from both the surface and groundwater sources to meet their water demands for various purposes. Notably, the exponential increase of the human population with the concomitant growth of industrial and urban centres along with the advent of agricultural modernization in some developing countries like India has caused tremendous pressure on both the surface and groundwater sources (Gnanachandrasamy et al. 2018). Moreover, in India, the rapid exploration of groundwater through ring wells (RWs), tube wells (TWs), diesel water pumps (DWPs), and electric motor pumps (EMPs), particularly after the Independence has changed the water use scenario of the country (Das 2011).

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✉ Manash Jyoti Bhuyan
manashjyotibhuyan451@gmail.com

Nityananda Deka
nityageog@yahoo.co.in

[1] Department of Geography, Nowgong Girls' College, Nagaon, Assam, India

[2] Department of Geography, Gauhati University, Guwahati, Assam, India

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