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Innovating Groundwater Recharge using a BoreCharger Technology in Khalad Area, Pune District, India

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Abstract

Groundwater is absolutely vital for sustaining over 80% of agricultural irrigation in India, underscoring its critical importance in food production. However, ensuring groundwater sustainability remains a pressing challenge, particularly in regions with hard rock, such as the Deccan basalts. Formed millions of years ago through volcanic eruptions, this terrain is characterized by complex geological formations with variable basaltic layer thicknesses, classified into two types: 'simple' and 'compound'. Effective groundwater management in such settings requires integrated hydrogeological studies that rely on rainfall patterns, geological structures, and hydrographic data. To address these challenges, innovative approaches, such as BoreCharger, have been introduced. BoreCharger technology involves detailed hydrogeological investigations and perforation of borewell casings to enable recharge of deeper aquifers with freshwater from unconfined aquifers. This process enhances groundwater availability, improves quality, and revitalizes low-yielding or failing borewells, paving the way for sustainable water management. The present study, conducted at Khalad, Purandar, Maharashtra, demonstrates the positive outcomes of the BoreCharger application. Results show that BoreCharger-equipped borewells consistently sustain water levels until late March, ensuring a reliable supply for both agriculture and drinking purposes. Water quality has also shown significant improvement, with no adverse effects observed on groundwater levels or in nearby wells and water bodies. BoreCharger emerges as a powerful solution to combat the challenge of groundwater sustainability in basaltic terrains. Its ability to enhance both quantity and quality of groundwater highlights its potential for wider application beyond the study area.

Keywords: Artificial Recharge, BoreCharger, Impact, Water Level, Khalad Area, Pune District

Introduction

Water is fundamental to sustaining life, supporting agricultural practices, and driving economic growth (USGS, 2024). Despite covering approximately 71% of the Earth's surface, a mere fraction is accessible as usable freshwater. Of the total global water supply, less than 2.5% constitutes freshwater, with only about 1% available for direct human consumption (USGS, 2024; IAEA, 2012). The increasing demand for water, coupled with mismanagement and the impacts of climate variability, has precipitated a significant global water scarcity crisis that affects billions of individuals (EPA, 2015). In India, the situation is particularly dire, with the agricultural sector consuming nearly 80–90% of the nation's total water resources (CGWB, 2023). Groundwater has emerged as the predominant source for irrigation, sustaining over four-fifths of the cultivated area. However, unregulated extraction practices have led to widespread aquifer depletion and degradation of water quality (CGWB, 2023; Bhanja *et al.,* 2017, 2019). Projections indicate that per capita water demand in India may escalate from the current average of 99 liters per day to approximately 167 liters per day by 2050, which is poised to exacerbate the ongoing crisis (ADRI, 2024). The complexity of water resource management is further amplified in basaltic terrains, such as those found in the Deccan Traps of Maharashtra. These volcanic formations are characterized by alternating simple and compound flows, exhibiting considerable variability in thickness and fracturing patterns (Kulkarni *et al.*, 2000; Krishnamurthy, 2020). In these geological contexts, aquifer storage and transmission are significantly influenced by secondary porosity stemming from weathering, jointing, and fracturing processes (Mishra *et al.*, 2023; Dongare *et al.*, 2024). This intrinsic heterogeneity presents formidable challenges for groundwater management, rendering conventional recharge techniques often ineffective (Saha *et al.*, 2022; Sufyan *et al.*, 2024). In response to these challenges, innovative solutions such as BoreCharger technology have emerged. BoreCharger encompasses a comprehensive hydrogeological assessment and the strategic perforation of borewell casings at suitable geological depths. This process facilitates the recharge of deeper, confined aquifers using freshwater from shallow sources (Sufyan *et al.*, 2024). The implementation of this method not only enhances groundwater availability but also has the potential to rejuvenate underperforming

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