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Assessment of Groundwater Quantity and its Improvement: A Case Study of the Tasgaon Region

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ABSTRACT: Groundwater is an essential resource for drinking water, agriculture, and industry, but it comes face-to-threats such as depletion, contamination, and unequal distribution. Effective groundwater improvement strategies are critical for guaranteeing sustainable water availability. This research studies several approaches to improving groundwater quality and recharge, such as artificial recharge techniques, rain harvesting, Managed Aquifer Recharge (MAR), and the use of permeable pavements. Groundwater purification technologies include bioremediation, phytoremediation, and enhanced filtering. Groundwater conservation relies heavily on sustainable management strategies such as controlled pumping and watershed management. By combining these strategies, we can increase groundwater sustainability and ensure long-term water security for future generations.

KEYWORDS: Groundwater, Recharge, Aquifers, conservation, Managed Aquifer Recharge (MAR),

I. INTRODUCTION

Groundwater is one of the world's most important natural resources, providing about half of all drinking water and approximately 40% of agricultural irrigation. However, excessive extraction, pollution, and climate change have resulted in a decrease in both groundwater quantity and quality. Addressing these concerns needs effective groundwater improvement measures that boost recharge, reduce contamination, and promote long-term use.

Groundwater enhancement approaches can be divided into three major categories:

1. Recharge Enhancement Techniques - Methods for natural or artificial replenishment of groundwater reservoirs.
2. Pollution Prevention and Remediation - Strategies for preventing contaminants from entering groundwater and removing existing pollution.
3. Sustainable Extraction and Management - Strategies for keeping groundwater use within safe and sustainable limitations.

II. LITERATURE REVIEW

Groundwater, an important resource for drinking water, agriculture, and industry, is frequently contaminated, depleted, and of poor quality. To address these issues, several groundwater enhancement techniques have been developed to increase the quantity and quality of groundwater resources. The purpose of this literature review is to highlight the primary approaches used to improve groundwater, with an emphasis on their effectiveness, obstacles, and possible applications.

A. Mishra (2016),(1)

A study was proposed on ground improvement approaches. The rapid growth of population, rapid urbanization, and increased development of infrastructures such as buildings, highways, trains, and other structures in recent years has resulted in a decrease in the availability of high-quality land. As a result, engineers have little choice but to use soft and weak soils by increasing their strength using appropriate current ground improvement techniques for construction activities. Currently current ground improvement techniques include soil replacement, vertical drains, stone columns, vibro compaction, dynamic compaction, soil reinforcement, vibro piers, in-situ densification, pre-loadings, grouting, and stabilization using admixtures. These strategies aim to increase soil carrying capacity while reducing settlement. Ground enhancement is performed by reinforcing the soil with steel fibers, glass, different polymers in the form of strips or grids, and geosynthetics. Geosynthetics can be permeable or impermeable in nature, depending on their composition and structure. Geosynthetic materials can be employed in a variety of applications. It can be used to strengthen, separate, filter, protect, contain, and limit soil to boost its bearing ability.

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B Di Salvo (2022),(2)
this study provides a review of papers that explicitly address the application of numerical and machine learning methods for groundwater level modeling. Machine learning models (also known as data-driven models) are utilized in the evaluated studies to improve prediction or speed up the current numerical modelling process. When long runtimes prevent the use of numerical models, machine learning models can be a viable alternative, saving model development and calibration time while maintaining detail accuracy in groundwater level predictions. The findings of this review show that machine learning models do not provide a complete representation of the physical system, such as flux estimates or total water balance, and thus cannot be used to replace numerical models in large study areas; however, they are cost-effective tools for improving predictions at individual observation wells.

GA Munfakha and DC Wyllie (2000),(3)
researched ground-improvement engineering issues and improvement selection criteria. The factors that influence the successful application of ground improvement in soil and rock are investigated, with a focus on the design, construction, and long-term performance of the improved ground. Over thirty technical issues are discussed, affecting twenty-four ground improvement techniques that represent the eight major categories of soil improvement: densification, consolidation, weight reduction, reinforcement, chemical treatment, thermal stabilization, electrotreatment, and biotechnical stabilization. Issues affecting rock integrity are also examined, including those connected to rock qualities as well as external variables such as water, climate, earthquakes, and so on. The report describes eight categories of rock degradation and suggests various remediation strategies for each, several of which involve the use of ground improvement. Several elements that may impact the choice of a ground improvement approach or combination of techniques are reviewed, and a case study is provided to explain the selection process.

JN Jha and H Singh (2012), (4)
the best buildable land has already been taken, so one must make the most of what remains. It is also projected that as the industry spreads into the interior, so will the people and foundation technologies in these isolated places. These are typically filled-in locations, such as low-lying waterlogged areas, waste lands, and creek lands with deep deposits of soft, saturated marine clays of low strength. The difficulty is exacerbated when the design loads are large and the site is located in seismic areas. Traditional foundation approaches in such a setting are proven to be more expensive than the superstructure, and in many cases, cannot be built at all.

KMNS Wani (2020), (5)
Microbial geotechnology is an innovative, environmentally friendly technique that uses microbes to enhance and strengthen weak or marginal soils. Bio-mediated ground improvement strategies have received a lot of interest from researchers during the last decade. This review article attempts to investigate the various factors that affect the overall biological improvement process, such as the type of microbes, quantity of microbes used, cementation solution molarity, pH of the system, treatment method, temperature, degree of saturation, soil density, nutrient availability, and so on. The enhancement in several qualities of the treated soil as reported by other researchers was studied and investigated, and appropriate conclusions were made while taking all considerations into account.

M.J. Asher et al. (2015),(6)
the geographically and temporally changing parameters and inputs to complicated groundwater models typically result in extended runtimes, limiting comprehensive calibration, sensitivity, and uncertainty analysis. Surrogate modeling seeks to create a simpler, and hence faster, model that replicates the stated output of a more sophisticated model in terms of inputs and parameters. In this review work, we classify surrogate modeling strategies into three types: data-driven, projection-based, and hierarchical-based approaches. Data-driven surrogates approximate a groundwater model using an empirical model that replicates the original model's input-output mapping.

III. METHODOLOGY OF PROPOSED SURVEY

Groundwater enhancement procedures are designed to improve water quality, boost availability, or repair contaminated groundwater resources. The methodology for these techniques differs depending on the purpose (treatment, recharging, or purification). Here's a general overview of approaches used in groundwater improvement:
We chose the Tasgaon region because the availability of water is limited, and we chose several strategies to improve groundwater in this location. The following techniques are listed below.

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1. Groundwater Recharge:

- Artificial Recharge: Infiltration basins, recharge wells, and percolation tanks allow surface water to percolate into aquifers, replenishing groundwater supplies.
- Flooded Agriculture: Controlled irrigation procedures assist recharge aquifers by allowing excess water to seep into the soil.
- Managed Aquifer Recharge (MAR): Is the intentional recharge of groundwater using technologies such as infiltration ponds, injection wells, and direct surface water diversion.

2. Rainwater Harvesting:

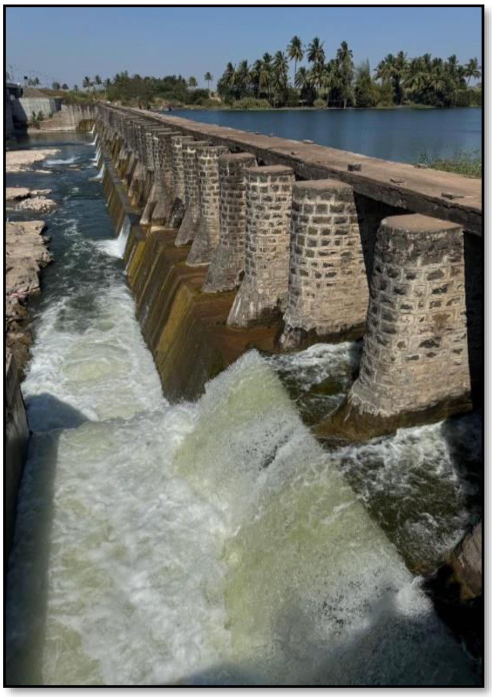
Rainwater harvesting is the collection and storage of rainwater for future use. This approach has been used for thousands of years throughout civilizations to provide a consistent water supply, particularly in areas where freshwater resources are few or seasonal. It entails collecting rainwater from rooftops or other surfaces and channeling it into storage systems such as tanks or reservoirs for future use in irrigation, household requirements, or even drinking after proper filtration and treatment.

3. Injection well:

Injection wells are a technique for improving groundwater quality and quantity that involves infusing water or other fluids into subsurface formations. This technology is widely used in water resource management, environmental remediation, and some industrial applications.

4. Surface Spreading Techniques:

Surface speeding techniques in groundwater enhancement are methods for enhancing the velocity or flow of water through the surface or near-surface layers of the ground. These methods are frequently used to improve water infiltration, distribution, and total groundwater recharge.Rainwater harvesting is the most practical and widely utilized practice throughout the region.



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IV. CONCLUSION

Groundwater enhancement strategies are crucial to ensuring sustainable water management and addressing water scarcity issues. Methods including recharge augmentation, rainwater harvesting, artificial recharge, and the use of water-efficient irrigation systems all help to improve groundwater quality and quantity. By employing these approaches, communities can not only secure a more stable water supply, but also improve aquifer resilience to environmental stressors. Long-term success also requires the integration of technological, regulatory, and community-driven methods. As water demand grows, implementing groundwater improvement methods will be critical to ensuring a stable and healthy water future.

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