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Groundwater Recharge Techniques – A Case Study

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Abstract

Artificial groundwater recharge is the process of intentionally replenishing groundwater through human interventions. It involves planned activities aimed at increasing groundwater availability by enhancing the natural infiltration or percolation of surface water into aquifers through engineered structures. The primary objective of artificial recharge is to augment groundwater storage by modifying the natural flow of surface water using appropriate infrastructure.

This well-structured approach facilitates groundwater replenishment, improving water availability for various purposes. The movement of water from the surface into subsurface areas is a crucial hydrological process that enhances the groundwater table. This downward movement of water is referred to as groundwater recharge, deep drainage, or deep percolation.

Groundwater recharge can occur naturally or through artificial methods involving human-induced processes. Understanding and implementing effective recharge techniques are essential for sustainable groundwater management.

Introduction

Groundwater is a vital freshwater resource essential for agriculture, ecosystems, and human societies. However, excessive water consumption and unsustainable extraction practices have led to global aquifer depletion and widespread groundwater degradation. Restoring groundwater levels and improving aquifer health through natural or artificial replenishment is referred to as groundwater recharge. This study reviews existing groundwater recharge strategies, examining their benefits, limitations, and challenges in both artificial and natural systems. Additionally, it explores the hydrogeological, socioeconomic, and environmental factors that influence the selection and implementation of recharge methods. Furthermore, it identifies gaps in current research and outlines potential future directions for sustainable groundwater recharge techniques.

Groundwater serves as the primary source of freshwater for domestic, agricultural, and industrial sectors. It plays a crucial role in providing safe drinking water and supporting food security, especially in densely populated regions. In rural areas, groundwater sources supply approximately 70% of the total water consumption, while in urban and commercial areas, they account for around 50% of the water used.

Groundwater recharge is influenced by various factors, including climate conditions, land surface characteristics, biosphere interactions, and subsurface properties. Human interventions, such as groundwater abstraction, artificial recharge, irrigation management, hydraulic infrastructure, and flood management, also play a critical role in shaping groundwater availability. To ensure effective water resource management, various estimation techniques have been developed to measure groundwater recharge and assess its impact on the water table.

Aim & Objectives

Aim: Groundwater Recharge Techniques – A Case Study

Objectives

- To Maintain a reliable groundwater source for domestic, agricultural, and industrial use.
- To Enhance water purity by allowing natural filtration through soil and rock layers.
- To Reduce waterlogging and prevent excessive surface water loss by enabling infiltration.
- To Support wetlands, rivers, and biodiversity by maintaining stable groundwater levels.
- To Prevent the movement of seawater into freshwater aquifers, especially in coastal areas.

Research Wrok

There are some techniques in artificial recharge are as follows:

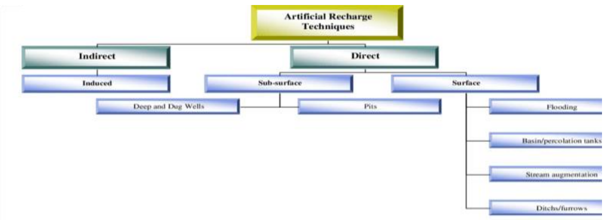

Fig.1 Artificial Recharge Techniques

Induced Method In Indirect Method

This indirect recharge method pumps from aquifers connected to surface water, inducing recharge. When the cone of depression reaches the river's boundary, a hydraulic connection forms, allowing surface water to contribute to pumping. It facilitates water flow but does not create an artificial aquifer.

Deep And Dug Wells In Sub-Surface Method

Dug wells are manually bored for groundwater extraction, typically 10–30 feet deep with an initial diameter of 1.5 meters, reducing to 1.2 meters after lining. Due to their shallow depth, they are prone to contamination, requiring protective measures.

Pits In Sub-Surface Method

Recharge pits, measuring 1–2 meters in width and 2–3 meters in depth, facilitate shallow aquifer replenishment by allowing water to percolate through layers of stones, sand, and boulders. To maintain efficiency, regular cleaning is essential to prevent clogging. For trapezoidal pits**,** steep slopes are necessary to minimize silt accumulation and enhance performance.

Flooding In Surface Method

The flooding method spreads water over permeable land for groundwater recharge. It is effective in sandy or gravelly areas using water from natural sources. Proper land grading is required to prevent waterlogging and inefficiency in impermeable regions.

Basin/Percolation Tank In Surface Method

A percolation tank is a man-made structure with a permeable reservoir that enhances groundwater storage by allowing runoff infiltration. Its size depends on the bed's percolation capacity and typically stores 0.1 to 0.5 MCM of water. A 3 to 4.5 cm column is included for ponded water regulation.

Stream Agumentation In Surface Method

Stream augmentation replenishes groundwater by diverting treated wastewater, storm water, or runoff into streams, promoting natural infiltration. This process helps restore depleted aquifers and sustain water availability during dry seasons. Proper water quality management is essential to prevent contamination and ensure safe recharge.

Ditchs/Furrows System In Surface Method

The Ditch and Furrow System promotes groundwater recharge by utilizing shallow ditches on permeable land to reduce runoff and enhance infiltration. It is cost-effective and well-suited for moderate slopes and agricultural areas. To maintain efficiency, regular maintenance is necessary to prevent clogging.

Case Study – 01

Artificial Recharge in Sikheri, Mandsaur Block, Mandsaur District, Madhya Pradesh. In Mandsaur block, depletion of water levels is taking place due to over development of ground water. Water levels have declined in the range of 1.25- 4.60 m in last 20 years. Level of ground water development is about 119%. A percolation tank is proposed to be constructed. In Sikheri, located within the Mandsaur Block of Mandsaur District, Madhya Pradesh, significant groundwater depletion has been observed due to over-extraction.

Fig No.17. Sikheri, Mandsaur Block, Mandsaur District, Madhya Pradesh

Salient Features:

- Location: Sikheri, Mandsaur Block, Mandsaur District, Madhya Pradesh.
- Groundwater Decline: A reduction in water levels ranging from 1.25 to 4.60 meters over the last 20 years.
- Over-Development: Groundwater development level at approximately 119%, indicating extraction surpassing sustainable limits.
- Recharge Strategy: Implementation of a percolation tank to facilitate artificial groundwater recharge.

CASE STUDY – 02

Shreeram Vatika Phase 2 incorporates rainwater harvesting, as indicated by the search results. This means that the design likely includes features to capture and direct rainwater from these catchment areas to recharge groundwater.

SALIENT FEATURES

- District: Indore ,M.P.
- Location : silicon city,shree ram Latika phase l
- Normal Rainfall:1000 mm to 1200 mm
- SOURCE OF WATER: Rainwater and Narmada river water
- DEPTH OF WATER TABLE: variable
- YEAR OF CONSTRUCTION: August 2022
- YEAR OF COMPlETION: Possession date in April 2025
- RISE IN WATER LEVEL :Replenishment.
- COST : Approx Rs 20 lakh

Fig No.18. Shreeram Vatika Phase 2

Conclusion

With the increasing demand for water, water managers and planners must explore strategies to enhance water management and expand water supplies**.** The Groundwater Recharge Committee identifies artificial recharge as a viable approach within an integrated water management strategy. It emphasizes that, with proper pretreatment, soil-aquifer treatment, and post-treatment tailored to the source and site conditions, impaired-quality water can be effectively utilized for groundwater recharge. Artificial recharge using impaired-quality water is particularly effective for controlling saltwater intrusion, mitigating ground subsidence, and maintaining stream water tables. It is especially suitable for non-potable applications, such as landscape irrigation, where health risks are minimal, and public acceptance is high. However, when recharged water is intended for potable use, careful consideration of health risks and uncertainties is essential.

Studies in North-East Haryana have demonstrated that recharge tube wells can maintain continuous performance for two monsoon seasons**,** with an average recharge rate of 10.5 l/s and a radius of influence of approximately 100 meters. Consequently, the recommended spacing between two recharge tube wells should exceed 100 meters for optimal efficiency. The knowledge and technological advancements generated through these scientific efforts will significantly contribute to the planning and implementation of artificial groundwater recharge projects in the near future.

Future Scope

Groundwater resources are limited and require careful protection against overuse and pollution, making their conservation a critical global environmental priority. Most artificial recharge systems are simple, allowing communities to develop and maintain them independently without external reliance. However, the effectiveness of artificial recharge under various physical and socioeconomic conditions remains understudied, with benefits often based on anecdotal evidence.

To ensure sustainable groundwater management, a comprehensive and well-informed approach is essential. Artificial recharge strategies should be guided by clear criteria to help individuals, communities, governments, and NGOs determine where these techniques can provide meaningful solutions to water challenges**.**

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