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Artificial Ground Water Recharge By Innovative Method

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ABSTRACT

Artificial groundwater recharge is an effective solution to address the growing water scarcity and depletion of groundwater resources caused by excessive extraction and urbanization. Traditional recharge methods, such as percolation pits, trenches, and rainwater harvesting systems, are widely used but often achieve only 60–70% efficiency, which is insufficient to meet increasing water demand. This study explores innovative methods for enhancing groundwater recharge, focusing on indoor and outdoor techniques that maximize percolation and optimize water usage. The indoor method involves the installation of an Excess Water Line (EWL) in residential buildings to divert unfiltered water from water purifier directly into borewells through connectivity of Excess water line. The outdoor method utilizes funnel-shaped or trapezoidal structures with deep perforated pipes to infiltrate rainwater, river overflow, and runoff into the ground, with sensors and water meters monitoring discharge and groundwater levels. A case study of a residential society with 164 tenements demonstrates that EWL implementation can save over 1.1 million liters of water annually, with potential savings scaling to several thousand million liters in urban areas. These innovative approaches not only replenish aquifers efficiently but also reduce dependence on municipal water supply, prevent land subsidence, and support sustainable water management for future generations.

Keywords: *Rainwater Harvesting, Groundwater Recharge, Percolation Methods, Excess Water Line (EWL), Water Conservation Techniques*

1. INTRODUCTION

Groundwater is a vital resource that supports domestic, agricultural, and industrial water needs. However, excessive extraction and unsustainable usage have led to a significant depletion of groundwater levels, creating a major concern for future water security. Ensuring sustainable groundwater availability requires effective recharge methods that can restore aquifer levels and maintain ecological balance. Artificial groundwater recharge has emerged as a key solution to address these challenges, providing a controlled approach to replenish underground water resources.

Traditional methods of groundwater recharge, such as percolation pits, trenches on mountain slopes, and rainwater harvesting in residential or commercial areas, have been widely practiced. While these methods contribute to water replenishment, their efficiency is often limited to 60–70%, which is inadequate to meet the growing water demand in urban and peri-urban areas. Factors such as urbanization, paving, deforestation, and increased surface runoff further reduce natural infiltration, making innovative recharge techniques essential for enhancing groundwater sustainability. Innovative artificial recharge methods, including funnel-shaped recharge wells, Excess Water Line (EWL) systems, and borewell-connected rainwater harvesting kits, allow large volumes of water ranging from small residential societies to systems handling up to 3 million liters per day (MLD) to infiltrate into the ground efficiently. These approaches not only increase groundwater levels but also help mitigate water scarcity by capturing rainwater, river overflow, and stormwater runoff. By integrating technology, monitoring systems, and strategic site selection, artificial recharge ensures effective groundwater management, prevents over-exploitation, and provides a sustainable solution for securing water resources for future generations.

2. LITERATURE REVIEW

"A CASE STUDY ON ARTIFICIAL RECHARGE OF GROUND WATER"

Artificial recharge of groundwater is accomplished through placing surface water in basins, furrows, ditches, or different centers wherein it infiltrates into the soil and actions downward to recharge aquifers. synthetic recharge is an increasing number of used for short- or lengthy-term underground garage, where it has several blessings over floor storage, and in water reuse. artificial recharge requires permeable surface soils. in which these are not available, trenches or shafts in the unsaturated sector can be used, or water can be at once injected into aquifers via wells. To design a machine for artificial recharge of groundwater, infiltration rates of the soil have to be determined and the unsaturated area among land floor and the aquifer ought to be checked for good enough permeability and lack of polluted regions**.**

"REVIEW OF LITERATURE ON ARTIFICIAL RECHARGE OF GROUNDWATER USING REMOTE SENSING AND GIS"

Groundwater is a major source for all purposes of water requirements in India. More than 90% of rural and nearly 30% of urban population depend on it for drinking water. It accounts for nearly 60% of the total irrigation potential in the country, irrigating about 32.5 million hectares. The dependency on the ground water is expected to increase in future due to increase in population. As per the estimation of Central Ground Water Board, the dynamic groundwater resource, i.e. utilizable ground water resource, which is meant for meeting the water requirements according to National Water Policy is about 43.2-million-hectare meters. The static groundwater resource also known as fossil water available in the aquifer zones below the zone of water level fluctuation is about 1081.2-million-hectare meters. The dynamic resource gets replenished every year through natural recharge, so that the balance is maintained. However, the occurrence and distribution of the ground water is not uniform throughout the country and varies significantly based on geology, rainfall and geomorphology. India is a vast country comprising of diversified geology, topography and climate. The prevalent rock formations range in age from Archaean to Recent and vary widely in composition and structure. Similarly, the variations in the landforms are also significant.

Groundwater recharge is increasingly recognized as a critical component of sustainable water management, particularly in areas facing severe water scarcity. Dillon et al. (2020) provided a comprehensive review of Managed Aquifer Recharge (MAR) practices, highlighting historical developments, current applications, and future perspectives globally. Similarly, Shrestha, Mishra, and Kumar (2024) emphasized the role of MAR in maintaining groundwater sustainability, discussing new developments and challenges, and underscoring the importance of integrating innovative technologies to enhance recharge efficiency. Akhter and Sharma (2025) explored the specific challenges of implementing MAR in developing countries, noting that socioeconomic, technical, and environmental factors often limit the effectiveness of conventional recharge methods. These studies collectively suggest that enhancing groundwater recharge requires both technical innovation and strategic planning.

Traditional methods of artificial groundwater recharge, such as percolation pits, trenches, and rainwater harvesting systems, have been widely applied but often deliver limited efficiency. Shikhare and Patil (2021a, 2021b) examined conventional and engineered recharge structures, including borewell-connected rainwater harvesting kits and watershed-based techniques, highlighting their effectiveness in urban and semi-urban contexts. Sharma and Gupta (2022) further investigated innovative groundwater improvement techniques, demonstrating how these methods can significantly increase infiltration rates and recharge volumes. Reddy and Kumar (2020) presented a case study evaluating artificial recharge structures such as percolation ponds and check dams, confirming their potential to enhance groundwater storage in local aquifers. These studies show that while conventional recharge methods are useful, innovation and site-specific adaptation are essential for maximizing benefits.

Emerging approaches emphasize the integration of technology, data analysis, and sustainable urban planning for effective groundwater recharge. Prasad and Rao (2021) highlighted the use of geoinformatics and GIS for identifying suitable recharge sites, ensuring more precise and efficient implementation. Rani and Kumar (2020) explored case-specific recharge techniques in watershed projects, emphasizing adaptation to local hydrogeological conditions. Li, Wang, and Zhang (2022) demonstrated innovative urban recharge systems that utilize stormwater and runoff management to sustainably replenish aquifers. Together, these studies underscore the need for combining conventional methods with technological innovation and monitoring systems to achieve reliable and large-scale groundwater recharge, ensuring water security for future generations.

3. OBJECTIVES

Enhancing water security wih the help of groundwater recharge which aims to enhance the resilience of water supply systems, especially in areas that depend heavily on groundwater.

Recharge reduces the vulnerability to droughts, seasonal variations, and climate change by maintaining groundwater reserves as a buffer during times of surface water shortages.

Preventing of land subsidence by excessive groundwater extraction which can cause land subsidence, where the ground sinks due to a loss of underground water pressure.

Recharge helps to maintain the structural integrity of the ground and prevents land subsidence, which can damage infrastructure like roads, buildings, and pipelines.

Enhancing the water scarcity performance mainly in peak days of summer for survival of human beings with minimum cost for operating and maintaining of EWL.

Not only for recharging the ground water we can also use for gardening, flushing instead of using STP treated water, lots of funds are wasted for using STP treated water in every society.

4. METHODOLOGY

Newly idea about ground water recharge is percolation of water into ground deeply by two methods indoor. In indoor method installation of EWL (Excess Water Line) is simple method which we can use in our daily life throughout year with minimum cost and very beneficial for ground water recharge. Concept behind (EWL) is to divert excess water through indoor water filter which is major source for water wasting. We can save lac litres of water monthly by installing EWL in newly construction site through every tenement. Actual process of EWL is to provide separate CPVC line from kitchen to directly borewell for direct ground water recharge in between this cpvc line we have to provide water flow meter for actual discharge of water to borewell. Method is simple but very useful for upcoming days. Installation of EWL is beneficial at the time of construction because this method is non-dependable on rain water and can be use throughout the year.

Another use is that we can reuse water which is harvested from excess water line for washing, flushing, gardening except drinking. As per MEP consultant we have to install a separate CPVC line near to kitchen where one end of excess water line is connected to underground tank and other end is connected to water filter in between these actual flow meter is connected to measure discharge.

Mostly in new construction it is easy to install & operate with minimum cost as compare to old society. Above method can be use anywhere like Residential, Commercial, Industrial, Institutional, etc.

Application and Utilization of Indoor & Outdoor Methods)

The indoor method utilizes an Excess Water Line (EWL) system to collect excess filtered water and reuse it for non-potable residential purposes such as flushing, gardening, washing, and other domestic uses except drinking, thereby reducing dependence on municipal water supply and achieving significant annual cost savings.

The indoor EWL system operates throughout the year and is independent of rainfall, making it suitable for residential, commercial, industrial, and institutional buildings across diverse geographical locations.

The outdoor groundwater recharge method is seasonal in nature and is effective only during the rainy season, as it relies entirely on rainwater, floodwater, and surface runoff for groundwater replenishment.

Due to its dependence on surface water availability, the outdoor method is not recommended for non-perennial rivers or regions with inconsistent rainfall patterns.

The combined implementation of indoor reuse and outdoor recharge methods ensures optimized water utilization, reduced pressure on municipal water supply systems, and enhanced groundwater sustainability.

Fig 1. Typical water filter running with excess water continuously

Fig 2. Home collection sample of excess water through water filter

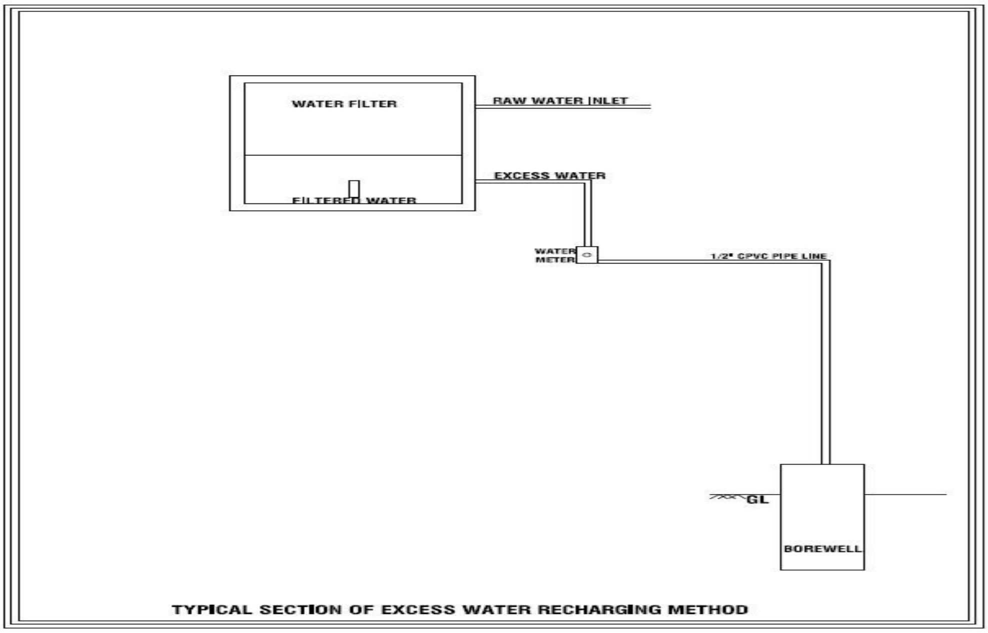

Fig 3. Typical Section of Excess Water Recharging System

HYPOTHESES/RESEARCH QUESTIONS

i) How to increase ground water level with maximum potential

ii) To use excess water harvested for flushing, gardening, or for residential use (except drinking)

iii) We have taken a research area of Ivana Society which basically resides in Thergaon, Tal-Mulshi, Dist-Pune, below are some details of Society which are considered for our project research

Name of society :- Ivana Society

Address of society :- S.No-17/4, Wakad Road, Thergaon, Pune-33

Type of society :- Pure Residential

Number of tenements in society :- 164 Tenements

Source of Water :- PCMC + Water Tanker

Daily Requirement of Water :- (164*135*5)= 1,10,700 litres

Daily Supply of water from PCMC- Near about 60 to 70,000 litres, rest of water supply is done by water tanker i.e 10,000 litres of one water tanker is ordered by society for Rs.700 each like that everyday 3 to 4 tankers are ordered daily.

Monthly Costing of water supply from pcmc= Rs.4.5 for 1000 litres.

Total monthly supply of water from pcmc= near about 21,00,000 lacs litres (2.10 MLD)

Monthly water bill from pcmc to society= Rs.9450/- to 10,500/-

Monthly water tanker bill = Rs.700*3*30 = Rs.63,000/-

Total costing of water monthly= Rs.73,000/- (Near About)

Total costing of water yearly = Rs.8,76,000/-

Total Overhead water tank capacity= 1,10,700.00 Litres

Total Underground water tank capacity= 1,66,050.00 Litres

Total overhead fire tank capacity= 50,000.00 Litres

Total Underground water tank capacity= 1,00,000.00 Litres

Number of Buildings in Society= 3 (A, B & C)

Number of floors per building= P+12

Fig 4. Research Society Area

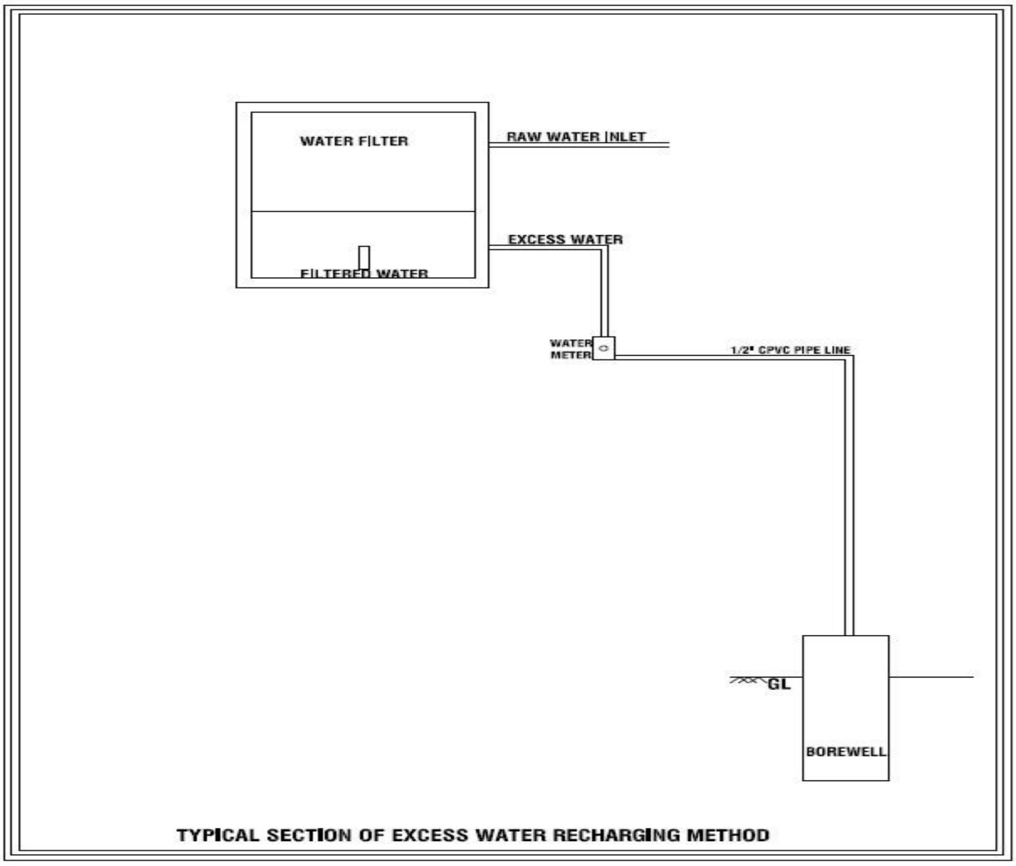

Fig 5: Typical Section of Excess Water Recharging System

5. RESULTS

As per standard 5 persons are calculated per tenement. In our project we have given an example of 164 tenements society where every flat holder uses water filter to drink water safely but the filter which we use actually filtered only 50% safe water from raw water and 50% water goes waste which is uncountable if we not take it serious.

225 ml of water gets waste in every 1minute, that means in single hour 13.5 litres of waters get wasted and averagely water filter runs for 1 to 1.5 hours daily.

13.5 litres x 1.5 hours = 20.25 litres per day per tenement

20.25 litres x 164 Tenements = 3321.00 litres per day

3321.00 litres x 30 days = 99,630.00 litres per month

99,630 litres x 12 months = 11,95,560.00 litres per year from a single society

If we consider 4000 society of minimum 164 tenement in a single town.

Then calculation will be of this type with changing the face of water scarcity

20,77,920.00 litres x 4000 = 4782.24 MLD

If we mandatory the above method in all construction sector like Residential, Commercial, Industrial, Institutional, etc The change will occur with good change with maximum positive results.

6. DISCUSSION

The innovative artificial groundwater recharge methods presented in this study, particularly the Excess Water Line (EWL) system and funnel-shaped outdoor recharge structures, demonstrate significant improvements over conventional recharge techniques. Traditional methods such as percolation pits, trenches, and rooftop rainwater harvesting typically achieve 60–70% efficiency (Shikhare & Patil, 2021a, 2021b) and are largely dependent on seasonal rainfall. In contrast, the EWL system enables continuous year-round operation independent of rainfall and allows excess filtered household water to be reused for non-potable purposes such as flushing, gardening, and washing, in addition to groundwater recharge. This dual utilization significantly reduces dependence on municipal water supply systems and results in substantial annual cost savings. The case study of Ivana Society indicates that EWL implementation can save over 1.1 million liters of water annually, demonstrating considerable scalability when applied across urban residential, commercial, industrial, and institutional developments. Comparatively, Dillon et al. (2020) and Shrestha et al. (2024) highlight the effectiveness of Managed Aquifer Recharge (MAR) systems for large-scale water sustainability but note that high costs, land requirements, and technical complexity often limit their widespread adoption. Similarly, Reddy and Kumar (2020) reported that percolation ponds and check dams enhance groundwater storage but are constrained by seasonal availability of rainwater and are unsuitable for non-perennial water sources. In contrast, the EWL approach requires minimal space, involves low installation and maintenance costs, and can be easily integrated into both new and existing buildings, making it particularly suitable for dense urban environments. While outdoor recharge structures remain effective during the monsoon season using rainwater and floodwater, their application is inherently seasonal. Therefore, the combined implementation of indoor water reuse and outdoor recharge methods offers a balanced, cost-effective, and sustainable strategy that benefits both society and government by optimizing water utilization, reducing municipal water demand, and enhancing long-term urban water resilience, in line with the findings of Li, Wang, and Zhang (2022).

7. CONCLUSION

The above method is perfect for ground water recharge with 90% result. More study on above method will be more precise and workable.

Above method is non-dependable on rain water and work throughout the year. The above method runs on basic principle of excess water which we can use directly for recharging the ground without any cost.

Above method plays an important role in the field of construction management which gives more idea to replenish the groundwater recharge.

Totally money & water saving idea for every society, apartments, buildings &

bungalows, etc

Above excess water line method is completely fit & fine for every tenements in society.

Excess water line method is newly method in construction sector for upcoming builders.

Excess water line method is simply & technology free method for unskilled labours &

easy to understand.

Easy to install & Operate

Statements and Declarations

Ethical Approval

“The submitted work is original and not have been published elsewhere in any form or language (partially or in full), unless the new work concerns an expansion of previous work.”

Consent to Participate

“Informed consent was obtained from all individual participants included in the study.”

Consent to Publish

“The authors affirm that human research participants provided informed consent for publication of the research study to the journal.”

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Competing Interests

“The authors have no relevant financial or non-financial interests to disclose.”

Availability of data and materials

“The authors confirm that the data supporting the findings of this study are available within the article.”

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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