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# Studies on Estimative Methods and their Role in Artificial Ground Water Recharge

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**Abstract:** Ground water plays a crucial role in the country in increasing food and agricultural production, providing drinking water and facilitating industrial development. Ground water meets nearly 55% of irrigation, 85% of rural and 50% urban and industrial water needs. In most of the states the ground water extraction has exceeded annual recharge and water table has gone down. The growing needs of population and urbanisation have generated an urgency to evolve innovative methods for holding up of the ground water resources through appropriate recharge activities. Ground water recharge is the process by which water percolates down to the soil and reaches the water table, either by natural or artificial methods. In this paper, various methods of estimating artificial ground water recharge are outlined which can be adopted to improve the ground water situation.
Key words: Artificial Ground Water Recharge, Estimative Methods.

## Introduction

Water is indispensable to all life on earth. However, fresh water is constantly formed newly through a phenomenon known as hydrological cycle. This is due to the fact that all the water on earth, either as water vapour in the atmosphere, as subsurface water in streams, lakes, seas and oceans or as ground water in the interstices in the sub-soil, is not at rest, but in a continuous circulatory movement known as the hydrological cycle. In view of increasing thrust on development of ground water resources, there is an urgent need to augment these depleting resources in active recharge zone. Ground water recharge may be explained as the process where by the amount of water present in or flowing through the interstices of the sub-soil increases by natural or artificial means. Rainfall is the main source of both types of recharge. Other sources include recharge from rivers, streams, irrigation water etc. The amount of moisture that will eventually reach the water table is defined as natural ground water recharge, which depends on the rate and duration of rainfall, the subsequent conditions at the upper boundary, the antecedent soil moisture conditions, the water table depth and the soil type. As the rainfall occurrence in different parts of India is limited to a period ranging from about 10 to100 days. The natural recharge to ground water reservoir is restricted to this period only and is not enough to keep pace with the excessive continued exploitation. Since large volume of rainfall flows out in to the sea or gets evaporated, artificial recharge has been advocated to supplement the natural recharge. Artificial Recharge is the process by which the ground water reservoir is augmented through increased infiltration by using artificial structures.

### Advantages of Artificial Recharge

Following are the main advantages of artificially recharging the ground water aquifers :

- No large storage structures needed to store water. Structures required are small and cost-effective.

- Enhance the dependable yield of wells and hand pumps.
- Negligible losses as compared to losses in surface storages.
- Improved water quality due to dilution of harmful chemicals/ salts.
- No adverse effects like inundation of large surface areas and loss of crops.
- No displacement.
- of local population.
- Reduction in cost of energy for lifting water especially where rise in ground water level is substantial.
- Utilizes the surplus surface runoff which otherwise drains off.

**Methods of Artificial Recharge**

These can be broadly classified as:

- **Spreading Method**
  - Spreading within channel
  - Spreading stream water through a network of ditches and furrows.
- **Pending over large area.**
  - Along stream channel viz. Check Dams/ Nala Bunds.
  - Vast open terrain of a drainage basin viz. Percolation Tanks.
- Modification of village tanks as recharge structures.
- Recharge Shafts
  - Vertical Shafts.
  - Lateral Shafts.
- Injection Well.

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**Channel Spreading**

This involves constructing small 'L' shaped bunds within a stream channel so that water
moves along a longer path thereby improving natural recharge as shown in Figure 1.1.

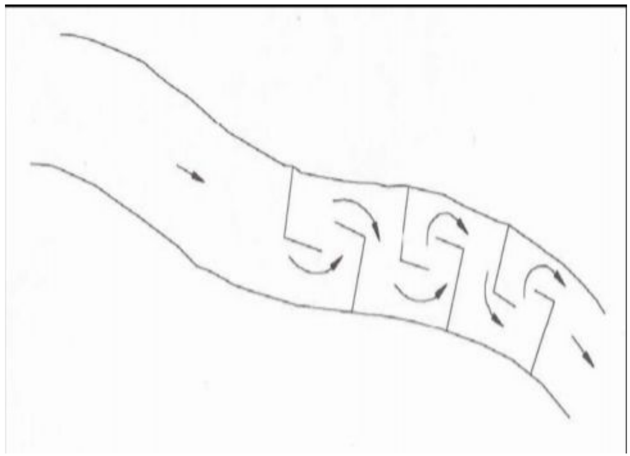

**Figure 1.1 : Channel Spreading**

This method is useful where a small flowing channel flows through a relatively wide valley. However this is not useful where rivers/ streams are prone to flash floods and the bunds may be destroyed.

**Ditch and Furrow Method**

In areas with irregular topography, shallow, flat-bottomed and closely spaced ditches or furrows provide maximum water contact area for recharge water from source stream or canal. This technique requires less soil preparation than the recharge basins and is less sensitive to silting

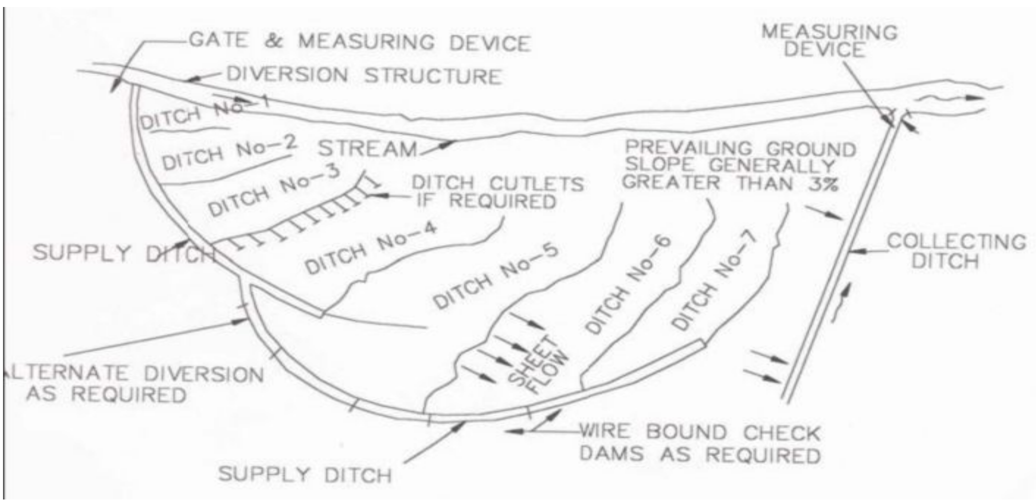


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**Figure 1.2 : Ditch and Furrow Method**

Figure 1.2 shows a typical plan or series of ditches originating from a supply ditch and trending down the topographic slope towards the stream. Generally three patterns of ditch and furrow system are adopted.

**Modification of Village Tanks as Recharge Structures**

The existing village tanks, which are often silted up or damaged, can be modified to serve as recharge structures. A village tanks can be converted into a recharge structure by desilting its bed and providing a COT on the upstream end of the bund. Several such tanks are available which can be modified for enhancing ground water recharge. Some of the tanks in Maharashtra and Karnataka have been converted.

**Recharge of Dug Wells and Hand Pumps**

In alluvial as well as hard rock areas, there are thousands of dug wells, which have either gone dry, or the water levels have declined considerably. These dug wells can be used as structures to recharge the ground water reservoir (Figure 1.3). Storm water, tank water, canal water etc. can be diverted into these structures to directly recharge the dried aquifer. By doing so the soil moisture losses during the normal process of artificial recharge, are reduced. There charge water is guided through a pipe to the bottom of well, below the water level to avoid scouring of bottom and entrapment of air bubbles in the aquifer. The quality of source water including the silt content should be such that the quality of ground water reservoir is not deteriorated. Schematic diagrams of dug well recharge are given in Figure 1.3. In urban and rural areas, the roof top rainwater can be conserved and used for recharge of ground water. This approach requires connecting the outlet pipe from rooftop to divert the water to either existing wells/tubewells/borewells or specially designed wells. The urban housing complexes or institutional buildings having large roof areas can be utilised for harvesting roof top rainwater for recharge purposes (Figure 1.3).

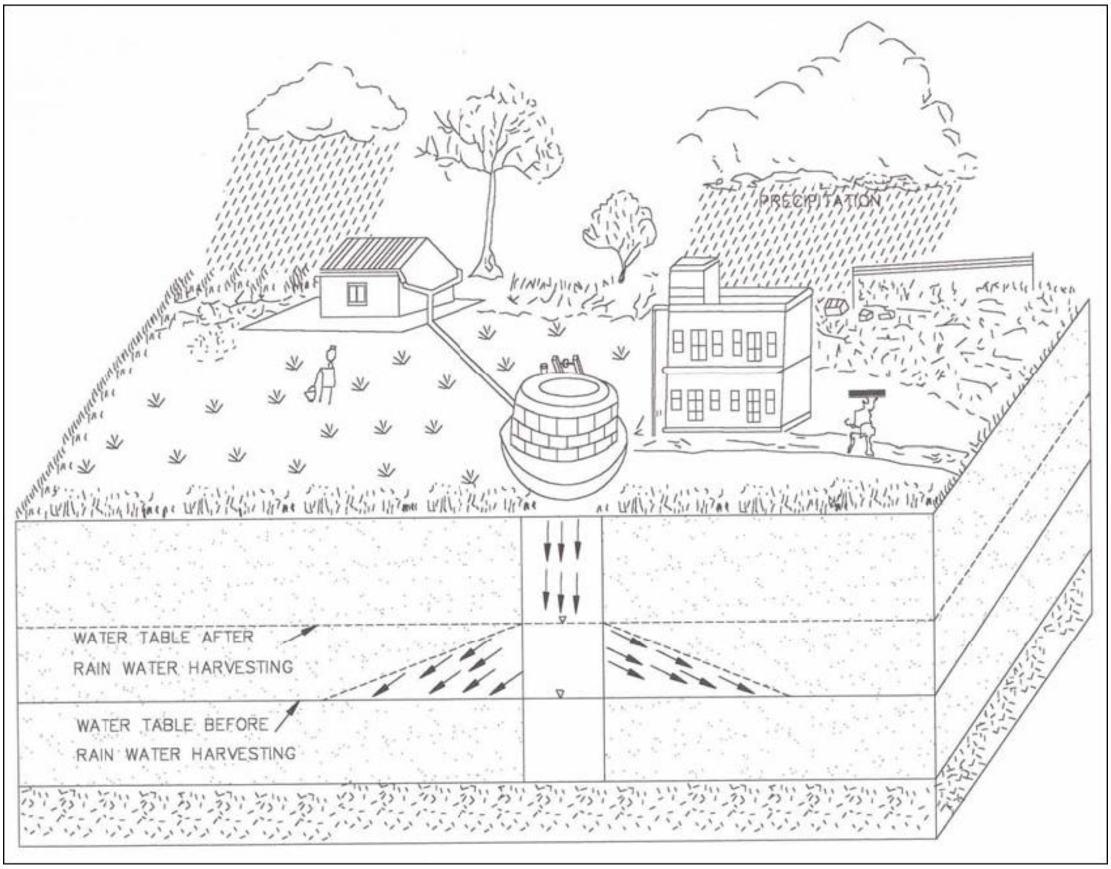


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**Figure 1.3: Recharge of Dug Wells through Roof Top Rain Water Harvesting**

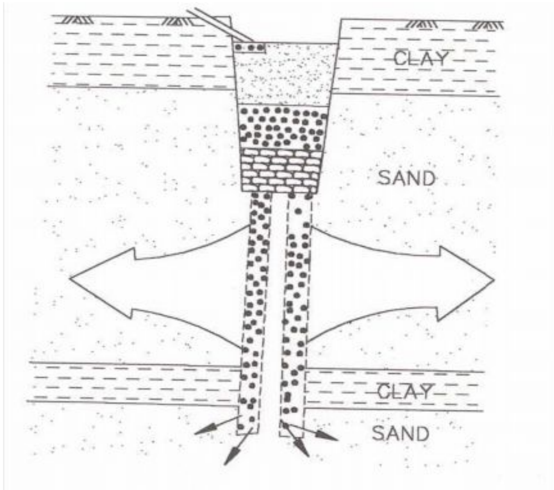


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**Figure 1.5 : Vertical Recharge Shaft With Injection Well**

**Recharge Shaft**

The main advantages of this technique are as follows:

- It does not require acquisition of large piece of land as in case of percolation tanks.
- There are practically no losses of water in the form of soil moisture and evaporation, which normally occur when the source water has to traverse the vadose zone.
- Disused or even operational dugwells can be converted into recharge shafts, which does not involve additional investment for recharge structure.
- Technology and design of the recharge shaft is simple and can be applied even where base flow is available for a limited period.
- The recharge is fast and immediately delivers the benefit. In highly permeable formations, the recharge shafts are comparable to percolation tanks.
- The recharge shafts can be constructed in two different ways viz. vertical and lateral.

**Lateral Recharge Shaft**

- Ideally suited for areas where permeable sandy horizon is within 3 m below ground level and continues up to the water level – under unconfined conditions (Figure 1.6)
- Copious water available can be easily recharged due to large storage and recharge potential
- Silt water can be easily recharged

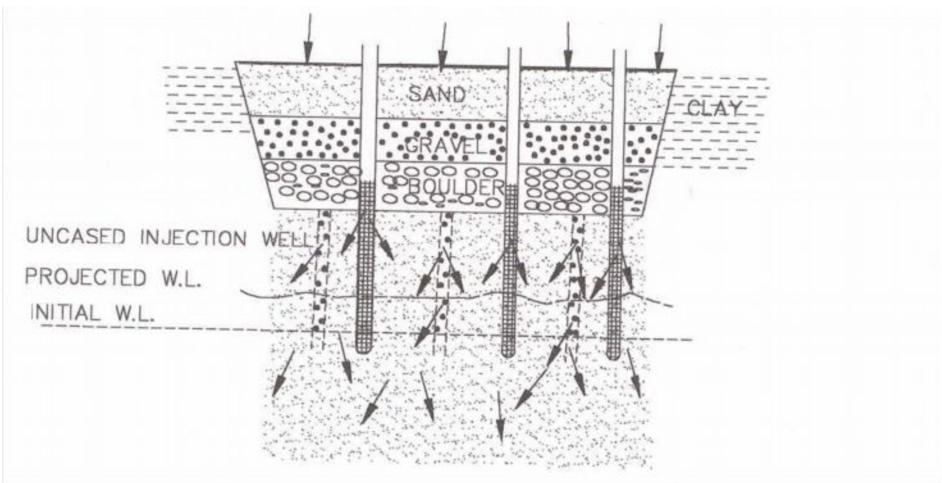


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**Figure 1.6 : Lateral Recharge Shaft**

## Artificial Recharge through Injection Wells

Injection wells are structures similar to a tube well but with the purpose of augmenting the ground water storage of a confined aquifer by pumping in treated surface water under pressure (Figure 1.7). The injection wells are advantageous when land is scarce.

### Injection Method

Water is led directly into the depleted aquifers by providing a conduit access, such as tube well or shaft or connector wells. Recharge by injection is the only method for artificial recharge of confined aquifers or deep-seated aquifers with poorly permeable overburden. The recharge is instantaneous and there are no transit and evaporation losses. Injection method is also very effective in case of highly fractured hard rocks and karstic limestones but very high permeability is not suitable, as they do not allow the water to be retained for long periods for use during dry season. However, it is necessary to ensure purity of the source water as well as its compatibility with aquifer to prevent frequent clogging of injection structures, by bacterial growth, chemical precipitation or deposition of silt. Dual-purpose injection wells i.e. injection cum pumping wells are more efficient. Connector injection well where saturated shallow aquifer and over-exploited confined aquifers are tapped in a single well, allows freefall of water from shallow aquifer into the deeper aquifer, thereby reducing cost of injection. Injection method is also used as a "Pressure Barrier Technique" to arrest or reverse saline water ingression.

## Conclusion

Thus it can be concluded that developing artificial recharge model structure yields encouraging results in terms of arrest of rate of decline in ground water levels, reduction of runoff, increased availability of ground water especially in summer month, increase in irrigation, revival of springs, improvement in ground water quality. Yet even with full development of artificial recharge, ground availability would remain limited. If it is treated as an open access resource and its extraction continues as at present, pace over extraction would result in the end. It is therefore, critical to find ways to limit the use of ground water to keep it sustainable. Though ground water recharge scheme either naturally or artificially may not be the final answer, but they do call for the community effort and create the spirit of cooperation needed to subsequently manage sustain ably ground water as a community resource.

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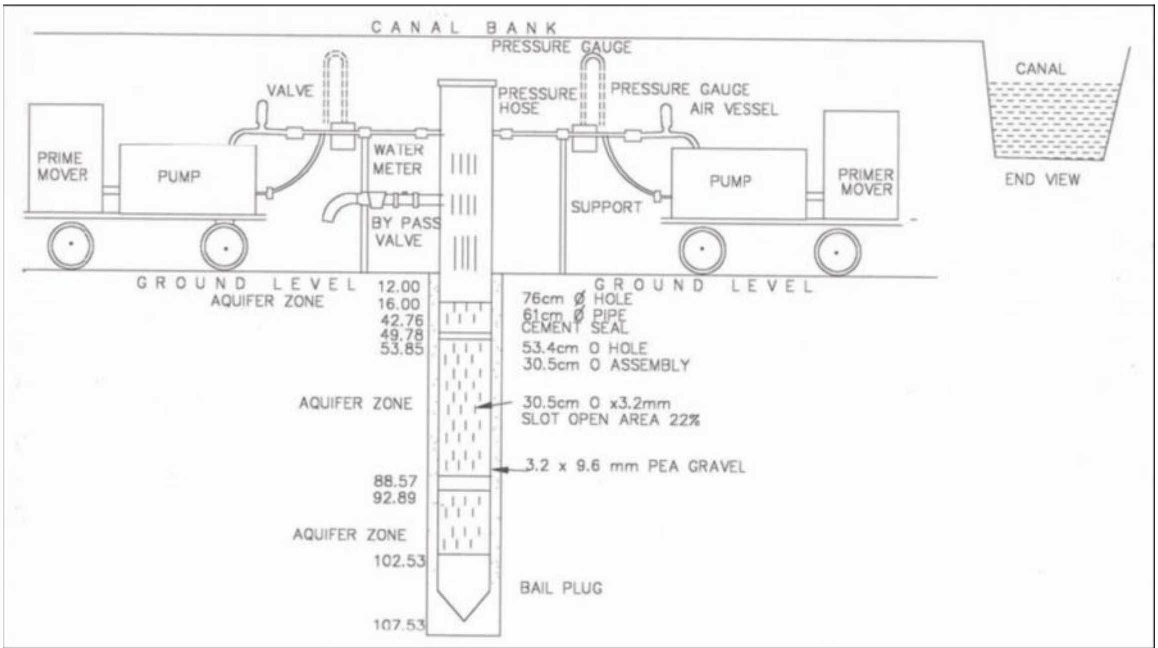


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**Fig 1.7 : Artificial Recharge through Injection Well**

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