# Underground Water Recharge through Rainwater Harvesting Using Remote Sensing

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**Abstract -** *Groundwater is one of the most valuable natural resources, which supports human health, economic development and ecological diversity. Overexploitation and unabated pollution of this vital resource is threatening our ecosystems and even the life of future generations. With the advent of powerful personal computers and the advances in space technology, efficient techniques for land and water management have evolved of which RS (remote sensing) and GIS (geographic information system) are of great significance. These techniques have fundamentally changed our thoughts and ways to manage natural resources in general and water resources in particular. The main intent of the present paper is to highlight RS and GIS technologies and to present a comprehensive review on their applications to groundwater hydrology. A detailed survey of literature revealed six major areas of RS and GIS applications in groundwater hydrology: (i) exploration and assessment of groundwater resources, (ii) selection of artificial recharge sites, (iii) GIS-based subsurface flow and pollution modelling, (iv) groundwater-pollution hazard assessment and protection planning, (v) estimation of natural recharge distribution, and (vi) hydrogeologic data analysis and process monitoring. Although the use of these techniques in groundwater studies has rapidly increased since early nineties, the success rate is very limited and most applications are still in their infancy. Based on this review, salient areas in need of further research and development are discussed, together with the constraints for RS and GIS applications in developing nations. More and more RS- and GIS-based groundwater studies are recommended to be carried out in conjunction with field investigations to effectively exploit the expanding potential of RS and GIS technologies, which will perfect and standardize current applications as well as evolve new approaches and applications. It is concluded that both the RS and GIS technologies have great potential to revolutionize the monitoring and management of vital groundwater resources in the future, though some challenges are daunting before hydrogeologists/hydrologists.*

## 1. INTRODUCTION

Groundwater recharge or deep drainage or deep percolation is a hydrologic process where water moves downwards from surface water to groundwater. Uses of groundwater especially for irrigation may also lower the water tables. It's an important process of sustainable groundwater management.

Ground water is an important factor in soil conservation service operations. Large amount off is being last by run off and evaporation in the same areas where ground water supplies of being depleted. Added emphasis is needed on the conservation and use of excesses run off where there are possibilities for increase underground storage. Groundwater recharge is but unfacing the management of a groundwater basin, in some areas, long term with drawl exceeds long term recharge and water is being "mined". Without proper management to obtained a sustained yield, artificial recharge becomes a mere stop gap measure. It may be possible to manage a groundwater reservoir like a surface reservoir. That is, water is placed in storage in periods of excess and withdrawal in periods of storage.

### 1.1 LITERATURE REVIEW:

Ground water is a valuable resource often used for industry, commerce, agriculture, and most importantly drinking water. In the 1980's, ground water provided 35 percent of the municipal water supplies in the United States and 95 percent of the rural, domestic drinking water. Except for turning on the faucet, most of us who use water often take for granted its availability and don't really know where our water comes from or recognize why it may be so vulnerable to contamination. In the 1970's and 1980's, the United States Environmental Protection Agency (USEPA) established national guidelines for safe drinking-water standards in response to a large number of reports of diseases caused by contaminated ground water. The USEPA developed the concept of Wellhead Protection which focuses on protecting and preserving the quality of ground-water supplies. Following USEPA guidelines, many states, including Tennessee, established local Wellhead Protection programs and rules for ground-water supplies that were used by the public. The Wellhead Protection programs are based on a thorough knowledge of the geologic and hydrologic characteristics of ground-water occurrence and flow. Scientists of the U.S. Geological Survey (USGS) and other organizations use their skills and expertise to provide such information to communities that depend primarily on ground water for their drinking-water supply.

### 1.2 GROUNDWATER CRISES:

In thondamanthur area are mostly cultivate sugarcane basically water need much more average can yield sugarcane 193 per hectare

### 1.3 LITERATURE REVIEW:

**S. Bhagavathi Perumal**

The monitoring of groundwater levels in the observation wells in Kanyakumari district indicates that, generally water levels tends to rise during monsoon, indicating good recuperation irrespectively of the water table condition so as to avoid deterioration of water quality and it future helps to sustain the groundwater potential during non-monsoon periods. Integrated study pass through the hydro chemical analysis of study reveals that the groundwater in Tirupur region is hard to very hard, fresh to brackish and alkaline in nature. The order of abundance of major cat ions and anions or in following order $Na^+ > Ca^{2+} > K^+ > Mg^{2+} = HCO_3^- > Cl^- > SO_4^{2-} > NO_3^- > CO_3^{2-}$. The alkalis ($Na^+$ and $K^+$) and exceed the alkaline earth ($Ca^{2+}$ $Mg^{2+}$) and $Cl^-$ exceed the other anions this leave to a NaCl type of groundwater. A total of 40.235 of groundwater of study exceed the permissible limit of TH. About two third of groundwater of study area exceeded the recommended limit of TDS as per the international drinking water standard the concentration of potassium ion is not within the permissible limit for drinking purpose except in some location.

**N.B. Narasimha Prasad** and **O.A. Mansoor**

Ground being the only source of fresh water, the demand increasing every year. However, groundwater potential is every year however the groundwater potential is very limited. Salinity, total hardness, fluoride and coli forms are the critical water quality parameters. The quality of groundwater with respect to salinity and hardness is found to be generally good in post-monsoon season compared to monsoon and pre-monsoon season. In this of scenario, groundwater conservation and management techniques have to be adopted to control future deterioration of the groundwater condition in this island.

**S. Ramanaiah** and **K. Niranjan Kumar**

To assess source of groundwater pollution through the study of coefficient of variation of the parametric ratio among the influencing parameters of groundwater samples. The usefulness of this approach has been demonstrated by applying this technique to about 25 samples collected in the vicinity of cuddappah town in Andhra Pradesh. Nitrates, chlorides and calcium are found to be contributed by local pollution source, i.e., domestic wastewater, whereas remaining parameters are of geological origin.

**R.Venkatasubramani, K. Murali** and **T. Meenambai**

In Feb 2006 states that the groundwater quality of different wards of Coimbatore east zone was assessed by examining various physic- chemical parameters. The water quality index (WQI), calculated for five parameters of these samples, ranged between 75 and 100. The result shows that the water is suitable for domestic purpose.

**J.D. Sharma, P. Jain** and **D. Sohu**

In June 2005 deals the potable water samples were collected in clean polyethylene bottles from village of Sanganer Tehsil in Jaipur District. The physic- chemical analysis of samples was carried out in laboratory using standard techniques.

**T. Usha Madhuri** and **Geetika Bhadani**

It is found that the groundwater was grossly polluted in the areas located near the coast, slum areas and the sites influenced by earlier solid waste dump yard.

### 2. METHODOLOGY:

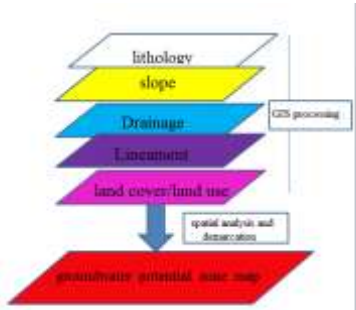


**Fig -1**: **GIS technology used in spatial integration and analysis to demarcate basin groundwater recharge potential zone**

### 2.1 Groundwater recharge potential factor establishment and spatial analysis:

This study analyzed the hydrologic and geographic attributes of the basin, and identified five major factors influencing groundwater recharge potential, namely lithology, land use/cover, lineaments, drainage, and slope. Each factor was examined and was assigned an appropriate weight.

### 3. WATER HARVESTING TECHNIQUES

### 3.1 Direct surface recharge:

Direct surface recharge techniques are among the simplest and most widely applied methods. In this method, water moves from the land surface to the aquifer by means of percolation through the soil. Most of the existing large scale artificial recharge schemes in western countries make use of this technique which typically employs infiltration basins to enhance the natural percolation of water into the subsurface (Dewan Mohamed et al., 1983). Field studies of spreading techniques have shown that, of the many factors governing the amount of water that will enter the aquifer, the area of recharge and length of time that water is in contact with soil are the most important (Todd, 1980). In general, these methods have relatively low construction costs and are easy to operate and maintain. Direct subsurface recharge techniques convey water directly into an aquifer. In all the methods of subsurface recharge, the quality of the recharged water is of primary concern. Recharged water enters the aquifer without the filtration and oxidation that occurs when water percolates naturally through the unsaturated zone.

### 3.2 Subsurface recharge:

Direct subsurface recharge methods access deeper aquifers and require less land than the direct surface recharge methods, but are more expensive to construct and maintain. Recharge wells, commonly called injection wells, are generally used to replenish groundwater when aquifers are deep and separated from the land surface by materials of low permeability. All the subsurface methods are susceptible to clogging by suspended solids, biological activity or chemical impurities. Recharge wells have been used to dispose of treated industrial wastewaters, to add freshwater to coastal aquifers experiencing saltwater intrusion, and to force water under pressure into permeable bedrock aquifers to arrest land subsidence resulting from extensive withdrawals of groundwater, although with variable success (CGWB, 1994). In many places, including the United States, Japan and Thailand, the use of injection wells is still considered experimental

### 3.3 Recharge well:

Saltwater intrusion is a major concern commonly found in coastal aquifers around the world. Saltwater intrusion is the induced flow of seawater into freshwater aquifers primarily caused by groundwater development near the coast. Where groundwater is being pumped from aquifers that are in hydraulic connection with the sea, induced gradients may cause the migration of salt water from the sea toward a well, making the freshwater well unusable. Because fresh water is less dense than salt water it floats on top. The boundary between salt water and fresh water is not distinct; the zone of dispersion, transition zone, or salt-water interface is brackish with salt water and fresh water mixing.

### 3.4 Recharge shaft:

Recharge pit of variable dimensions are used to recharge water to unconfined aquifer. Most of the time, especially in case of agricultural field, a layer of less permeable soil exist. Due to the existence of the less permeable permeable strata, the surface flooding methods of recharge do not show satisfactory performance. For such type of cases, recharge pit can be excavated which are sufficiently deep to penetrate the less permeable strata. On the other hand recharge shaft is similar to the recharge pits, but the cross sectional size of the recharge shaft is much lesser than the recharge pits.

## 4. METHODS OF RECHARGING:

### 4.1 Spreading methods:

- In this method water is spreads over the surface of permeable open land and pits from where it is directly infiltrates to shallow aquifer.
- In this method water is stored in shallow ditches or spread over open area by constructing low earth dykes.
- Rate of recharging depends upon permeability of spread area and depth of water stored.
- Also some chemicals are added in soil to increase rate of recharging.

### 4.2 Recharge well method:

- In this method water is injected into the bore holes.
- Water is fed into recharge wells by gravity or pumped under pressure.
- Ordinary wells also perform the work of recharging water during off season.

### 4.3 Induced infiltration methods:

- In this method water table gradient is increased from source of recharge.
- In this method special type of wells are constructed near the banks of river having radial collector.
- The percolating water is collected from radial collector and the discharge as recharge in to lower level aquifer 'B'

### 4.4 Artificial ground water recharge :

- Artificial recharge to ground water is a process by which the ground water reservoir is augmented at a rate exceeding that obtaining under natural conditions or replenishment. Any man-made scheme or facility that adds water to an aquifer may be considered to be an artificial recharge system.

## 5. CONCLUSIONS

This study produced a groundwater recharge potential amp for study area. The results indicate that the most effective groundwater recharge potential zone is located on east-north part of the study area. In this region, the alluvium soil, burried pediplain and agricultural land have high infiltration ability. Also the concentration of drainage also indicates the ability of stream flow to recharge the groundwater system. The southern region of study area is least effective for groundwater recharge, mainly due to its steep sloping topography and mountain soil spread.

The occurrence and recharge of groundwater in the study area is prominently controlled by the geomorphology, soil type, land use land cover and slope (%) as revealed from GIS analysis. Remote sensing and GIS technique used to integrate various thematic maps proves to be very important to map the groundwater occurrence and movement for recharge potential mapping and management plan on a scientific basis. Overall result demonstrates that the use of remote sensing and GIS technique provides powerful tool to study groundwater resources and design a suitable exploration plan for recharge of groundwater in study area. The integrated groundwater recharge potential zones map for the study area has been categorized into three zones viz. 'poorly suitable', 'moderately suitable' and 'most suitable', on the basis of the ranks and weightages assigned to different features of the thematic maps. From this study it is observed that remote sensing and GIS technique can be used effectively to delineate groundwater recharge potential zones map, which can be used for improvement in the groundwater recharge and holding for the study area and later on may be for various purposes like identification of location of structures for artificial recharge, locations of new tube wells and efficient groundwater management for betterment of the society.

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