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Conventional Method For Ground Water Augmentation Of Panamaruthupatti Block, Salem District, Tamil Nadu, India - A Case Study

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ABSTRACT: *Artificial groundwater recharge is a process by which the groundwater reservoir is augmented at a rate exceeding the augmentation rate under natural conditions of replenishment. In some parts of India, due to over-exploitation of groundwater, decline in groundwater levels resulting in shortage of supply of water, and intrusion of saline water in coastal areas have been observed. In such areas, there is need for artificial recharge of groundwater by augmenting the natural infiltration of precipitation or surface-water into underground formations by methods such as water spreading, recharge through pits, shafts, wells et cetera The choice of a particular method is governed by local topographical, geological and soil conditions; the quantity and quality of water available for recharge; and the technological-economic viability and social acceptability of such schemes. In our project our study area is mainly comprised of hilly terrain with the maximum elevation at 1184m at Bodamalai(melur). With other hillocks and hills are Jarugu malai, Bodamalai, Jalluthumalai and Perumal malai, etc. In the north west of the study area, a lake is situated namely Panamaruthupatti Lake. It is a natural lake surrounded by hills by which it receives sources of water. Panamaruthupatti lake is about 3500 acres in area which provides water to Salem town before the supply of Cauvery water from Mettur. Now this source of water is used to meet the requirements in some parts of southern suburbs of Salem city and Northern part of Namakkal District upto Rasipuram Town. This source of water will support to enhance the over all augmentation of sub surface water in the study area. Now a days the supply of Cauvery water is not fulfilling the needs of people and its sub urban because of increase in population. Any improvement in ground water condition of study area will have the chance of additional supply of drinking water and also the possibility of increase in agricultural activity in and around the said village. Hence we plan to do research and propose the ideas for recharging the water to Panamarathupatti Block by using conventional method.*

Keywords: *Conventional Method, Ground Water Augmentation, Panamaruthupatti Block, Salem District, Case Study*

I. INTRODUCTION

Artificial recharge is the planned, human activity of augmenting the amount of groundwater available through works designed to increase the natural replenishment or percolation of surface waters into the groundwater aquifers, resulting in a corresponding increase in the amount of groundwater available for abstraction. Although the primary objective of this technology is to preserve or enhance groundwater resources, artificial recharge has been used for many other beneficial purposes. Some of these purposes include conservation or disposal of floodwaters, control of saltwater intrusion, storage of water to reduce pumping and piping costs, temporary regulation of groundwater abstraction, and water quality improvement by removal of suspended solids by filtration through the ground or by dilution by mixing with naturally-occurring ground waters (Asano, 1985). Artificial recharge also has application in wastewater disposal, waste treatment, secondary oil recovery, prevention of land subsidence, storage of freshwater within saline aquifers, crop development, and stream flow augmentation

Our nation with strong agricultural background mainly depends upon sub surface water and this subsurface water necessity is more in South India. In Tamil Nadu based on the availability of surface water and its geographic nature leads to the increase the need for the sub surface water for their multiple demands. The demand for water has increased over the years and this has led to water scarcity in many parts of our country.

The situation is aggravated by the problem of water pollution or contamination. India is heading towards a freshwater crisis mainly due to improper management of water resources and environmental degradation, which has lead to a lack of access to safe water supply to millions of people. This freshwater crisis is already evident in many parts of India, varying in scale and intensity depending mainly on the time of the year.

Groundwater crisis is not the result of natural factors; it has been caused by the action of mankind. During the past two decades, the water level in several parts of the country has been falling rapidly due to an increase in extraction. The number of wells drilled for irrigation of both food and cash crops have rapidly increased. India's rapidly rising population and changing lifestyles has also increased the domestic need for water. The water requirement for the industry also shows an overall increase. Intense competition among users (agriculture, industry, and domestic sectors) is driving the groundwater table lower. The quality of groundwater is getting severely affected because of the widespread pollution of surface water. Besides, discharge of untreated waste water through bores and leachate from unscientific disposal of solid wastes also contaminates groundwater (Biswas, 2007), thereby reducing the quality of fresh water resources.

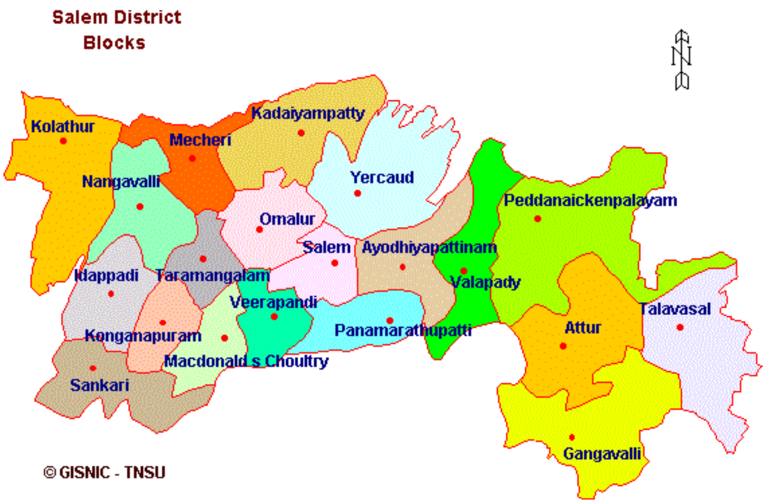
Water harvesting is an ancient art practiced in the past in many parts of North America, Middle East, North Africa, China, and India (Oweis et al., 1999). Geographic Information systems (GIS) can be employed to identify the regions of good recharge in the region (Ramaswamy and Anbazhagan, 1997; Saraf and Choudhury, 1998; Shankar and Mohan, 2005; Ragul and Kumar, 2006; Rao and Roy, 2007). Artificial recharge is achieved by putting water on the land surface where it infiltrates into the soil and moves downward to underlying groundwater (Bouwer, 1997, 1999).

II. STUDY AREA

The present study area Panaimarathupatti Block is situated near the suburbs of Salem City. It is a Panchayat town in Salem District, Tamil nadu. It is bounded by the North Latitudes between $11^0$39' south latitutde 11^0 31'and East Longitudes $78^0$10' and West longitude $78^0$14' and falls in parts of survey of India topo sheets 58I/2 and 58I/6 as per the version,C44A2 and C44A6 of 2005 updated topo sheet. It covers an area of 180 Sq. Kms.(Figure.2.1)

This study area is bounded by Mallur at west, Kamalapatti and other villages at East, Salem Taluk towards North , Rasipuram Taluk towards South. The over all climate at the study area is warm and dry. The average temperature of the area is around 30°C and it receives the rain fall during SW and NE mansoon periods. The following villages are in the Panamarathupatti Block are benefitted if the lake get recharged

- Kammalapatti
- Kuralnatham
- Kullappanayakannur
- Thippampatty
- Thumbalpatti
- Vedapatti
- Naliyam Pudur
- Melur
- Kitchipalayam
- Unjakattupudur



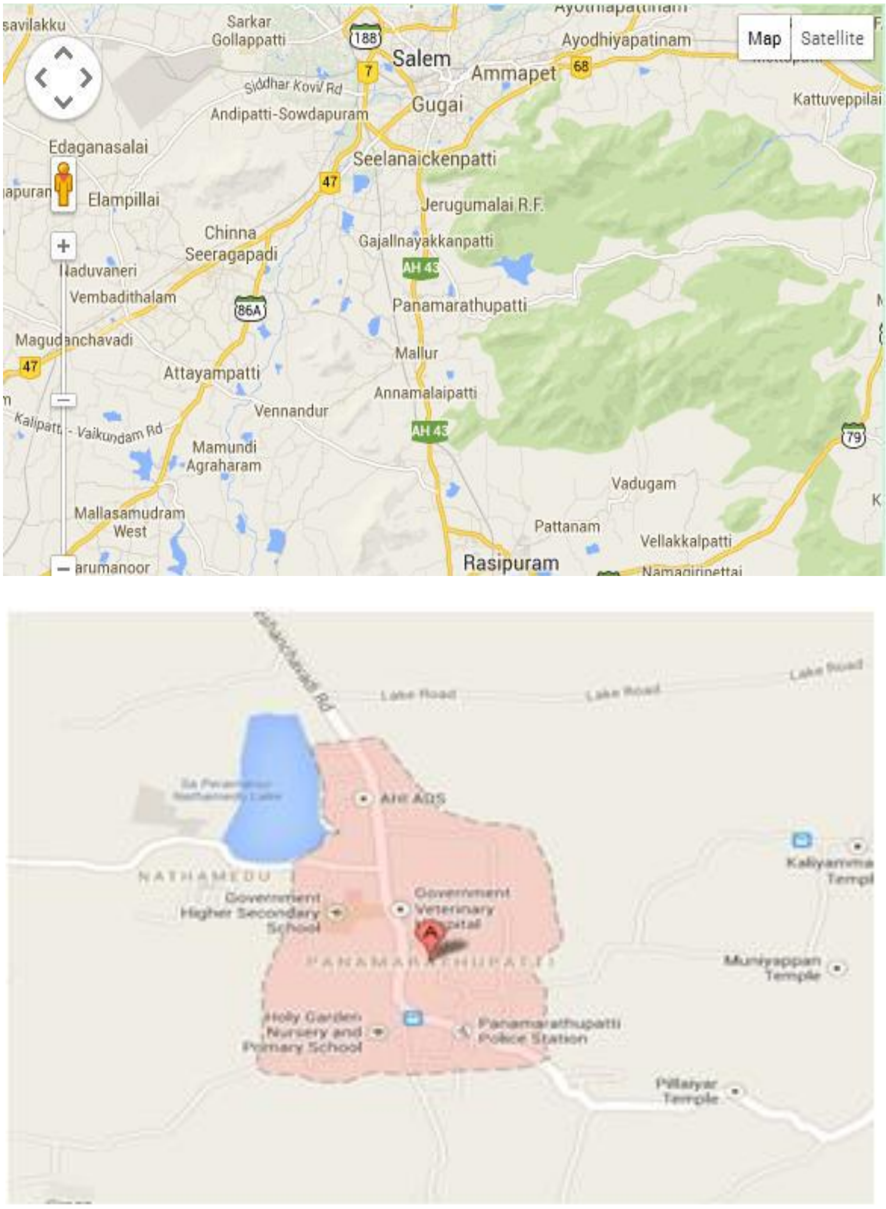


Figure.2.1. Location of the study area

Geology of the study area

Our study area is located on the high grade Precambrian terrain of south India with a network of shear zones of Neo to Early Proteorozoic age.The Salem-Attur shear zone, an extension of Moyar-Bhavani shear zone passes through this area. Charnockite, pyroxene granulite, Magnetite quartzite, Khondalite, calc granulite and younger granitoid are other rock units exposed in the area of our study is fully comprised with charnockit rock and lateritic soil. Geologically interesting nearby our study area:

- Ultramafics of Sitampundi Complex
- Iron ore deposits of Kanjamalai
- Magnesite deposit-Salem

2.1 IDENTIFICATION OF AREAS FOR RECHARGE

The first step in planning a recharge scheme is to demarcate the area of recharge. Such an area should, as far as possible, be a micro-watershed (2,000-4,000 ha) or a mini-watershed (40-50 ha). However, localized schemes can also be taken up for the benefit of a single hamlet or a village. In either case the demarcation of area should be based on the following broad criteria:

- Where ground water levels are declining due to over-exploitation

- Where substantial part of the aquifer has already been desaturated i.e. regeneration of water in wells and hand pumps is slow after some water has been drawn
- Where availability of water from wells and hand pumps is inadequate during the lean months
- Where ground water quality is poor and there is no alternative source of water

2.2 SOURCES OF WATER FOR RECHARGE

Before undertaking a recharge scheme, it is important to first assess the availability of adequate water for recharge. Following are the main sources, which need to be identified and assessed for adequacy:

- Precipitation (rainfall) over the demarcated area
- Large roof areas from where rainwater can be collected and diverted for recharge
- Canals from large reservoirs from which water can be made available for recharge
- Natural streams from which surplus water can be diverted for recharge, without Violating the rights of other users
- Properly treated municipal and industrial wastewaters. This water should be used only after ascertaining its quality

"In situ" precipitation is available at every location but may or may not be adequate for the recharge purposes. In such cases water from other sources may be transmitted to the recharge site. Assessment of the available sources of water would require consideration of the following factors:

- Available quantity of water
- Time for which the water would be available
- Quality of water and the pretreatment required

Conveyance system required to bring the water to the recharge site

2.3 INFILTRATION CAPACITY OF SOIL

Infiltration capacity of soil is an important factor that governs the rate of saturation of the vadose zone and thereby the efficacy or otherwise of a recharge scheme. Infiltration capacity of different soil types are done by field-tests by State Agriculture Departments and/ or the Land Use Survey Organizations. This data/ information together with maps showing infiltration rates is usually available in their departmental reports published periodically and are available with the District Agriculture Officer. At the district level, this information is available in the departmental reports of the Central and State Ground Water Boards.

2.4 AQUIFER SUITABILITY

This depends mainly on storage coefficient, availability of storage space and permeability. Very high permeability results in loss of recharged water due to sub-surface drainage where as low permeability reduces recharge rate. In order to have good recharge rate and to retain the recharged water for sufficient period for its use during lean period, moderate permeability is needed. Older alluvium, buried channels, alluvial fans, dune sands, glacial outwash etc. are the favorable places for recharge. In hard rock areas, fractured, weathered and cavernous rocks are capable of allowing high intake of water. The basaltic rocks i.e. those formed by lava flows, usually have large local pockets, which can take recharge water.

2.5 HYDRO-METEOROLOGICAL STUDIES

These studies are undertaken to understand the rainfall pattern and evaporation losses and thereby to determine the amount of water that would be available from a given catchment and the size of storages to be built. The main factors to be considered are:

- Minimum annual rainfall during the previous 10 years
- Number of rainy spells in a rainy season and duration of each spell
- Amount of rainfall in each rainy spell
- Rainfall intensity (maximum) 3 hourly, 6 hourly etc. as may be relevant for a region. As a general guide, the one, which causes significant runoff and local flooding, should be adopted.

This information/ data is usually readily available in District Statistical Reports published by the District Statistical Organization. However, the most important source is the India Meteorological Department. For the purpose of rainwater harvesting only readily available secondary data is adequate. The alternative sources of this data are the reports of major, medium or minor irrigation projects, which have been recently completed in the region or are under construction or are planned.

2.6 QUALITY OF SOURCE WATER

Chemicals and Salts

Problems which arise as a result of recharge to ground water are mainly related to the quality of raw waters that are available for recharge and which generally require some sort of treatment before being used in recharge installations. They are also related to the changes in the soil structure and the biological phenomena, which take place when infiltration begins, thereby causing environmental concerns. The chemical and bacteriological analysis of source water and that of ground water is therefore essential.

Sediment Load

A major requirement for waters that are to be used in recharge projects is that they be silt free. Silt may be defined as the content of undissolved solid matter, usually measured in mg/l, which settles in stagnant water or in flowing water with velocities, which do not exceed 0.1 m/hr.

2.7 PREVENTION OF CLOGGING OF SOIL PORES

This is one of the important considerations in planning an artificial recharge scheme. The usual methods to minimize the clogging are:

- Periodical removing of the mud-cake and dicing or scraping of the surface layer
- Installation of a filter on the surface, the permeability of which is lower than that of the natural strata (the filter must be removed and renewed periodically)
- Addition of organic matter or chemicals to the uppermost layer
- Cultivation of certain plant-covers, notably certain kinds of grass
- Providing inverted filter consisting of fine sand, coarse sand and gravel at the bottom of infiltration pits/ trenches are very effective

Clogging by biological activity depends upon the mineralogical and organic composition of the water and basin floor and upon the grain-size and permeability of the floor. The only feasible method of treatment developed so far consists in thoroughly drying the ground under the basin.

2.8 HYDRO CHEMISTRY

Quality of water is more important than its quantity. For determination of physiochemical parameters, 20 samples were collected from different wells. Various physical characteristics viz., pH, EC, TDS and the concentrations of major cations and anions ie ca, Mg, Na, K, CO3, HCO3, Cl and SO4 have been determined. Major part of the area possesses ground water suitable for domestic and most suitable for agriculture. However, ground water in some areas in unsuitable due to medium salinity. Low pH of the lake may be due to the excessive use of acid producing fertilizers. Evaluation of ground water quality for Agriculture use and drinking water purpose were carried out. Thematic maps depicting the spatial variation of various hydro chemical parameters were prepared. The major part of the area possesses ground water suitable for domestic, agriculture and industrial use.

2.9 WATERSHED MANAGEMENT

A watershed is an area of land where all of the water that is under it or drains off of it goes into the same place. The importance of healthy watersheds is explained by John Wesley Powell, scientist geographer "that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community". Our study area is divided in to 10 zones and by demarcating the individual blocks to identify the potential flow of water which is affordable for recharging the lake.

III METHODS OF AUGMENTATION

These can be broadly classified as:

• Spreading Method

- Spreading within channel
- Spreading stream water through a network of ditches and furrows
- Ponding over large area
  - (a) Along stream channel viz. Check Dams/ Nala Bunds
  - (b) Vast open terrain of a drainage basin viz. Percolation Tanks
  - (c) Modification of village tanks as recharge structures.

- Recharge Shafts
  - Vertical Shafts
  - Lateral Shafts
- Injection Wells
- Induced Recharge
- Improved Land and Watershed Management
  - Contour Bunding
  - Contour Trenching
  - Bench Terracing
  - Gully Plugging

3.1 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. 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 (levees) may be destroyed.

3.2 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. 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.

3.3 CHECK DAMS

Check dam is a small, often temporary, dam constructed across a swale, drainage ditch, or waterway to counteract erosion by reducing water flow velocity. Check dams themselves are not a type of new technology; rather, they are an ancient technique dating all the way back to the second century A.D. Check dams are typically, not always, implemented as a system, consisting of several check dams situated at regular intervals across the area of interest

3.4 PERCOLATION TANKS (PT)/ SPREADING BASIN

These are the most prevalent structures in India to recharge the ground water reservoir both in alluvial as well as hard rock formations. The efficacy and feasibility of these structures is more in hard rock formation where the rocks are highly fractured and weathered.. The percolation tanks are however also feasible in mountain fronts occupied by talus scree deposits..

3.5 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 structure. In general no "Cut Off Trench" (COT) and Waste Weir is provided for village tanks. 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.

3.6 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. 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. The recharge 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 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/ tube wells/ bore wells or specially designed wells. The urban housing complexes or institutional buildings having large roof areas can be utilized for harvesting roof top rainwater for recharge purposes.

3.7 RECHARGE SHAFT

These are the most efficient and cost effective structures to recharge the aquifer directly. These can be constructed in areas where source of water is available either for some time or perennially. Following are the site characteristics and design guidelines:

(i) To be dug manually if the strata is of non-caving nature.

(ii) If the strata is caving, proper permeable lining in the form of open work, boulder lining should be provided.

(iii) The diameter of shaft should normally be more than 2 m to accommodate more water and to avoid eddies in the well.

(iv) In the areas where source water is having silt, the shaft should be filled with boulder, gravel and sand to form an inverted filter. The upper-most sandy layer has to be removed and cleaned periodically. A filter should also be provided before the source water enters the shaft.

(v) When water is put into the recharge shaft directly through pipes, air bubbles are also sucked into the shaft through the pipe, which can choke the aquifer. The injection pipe should therefore be lowered below the water level.

3.8 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 The injection wells are advantageous when land is scarce.

3.9 INDUCED RECHARGE

It is an indirect method of artificial recharge involving pumping from aquifer, hydraulically connected with surface water, to induce recharge to the ground water reservoir. When the cone of depression intercepts river recharge boundary a hydraulic connection gets established with surface source, which starts providing part of the pumpage yield. In such methods, there is actually no artificial build up of ground water storage but only passage of surface water to the pump through an aquifer. In this sense, it is more a pumpage augmentation rather than artificial recharge measure. In hard rock areas the abandoned channels often provide good sites for induced recharge. Check weir in stream channel, at location up stream of the channel bifurcation, can help in high infiltration from surface reservoir to the abandoned channel when heavy pumping is carried out in wells located in the buried channel.

3.10 SITE CHARACTERISTICS AND DESIGN GUIDELINES

A collection well is a large diameter (4 to 8 m) well from which laterals are driven/ drilled near the bottom at one or two levels into permeable strata. The central well is a vertical concrete cassion in pre-cast rings, (wall thickness 0.45 m) sunk upto the bottom of aquifer horizon. The bottom of cassion is sealed by thick concrete plugs. Slotted steel pipes, 9 mm thick, 15 to 50 cm in diameter having open area above 15% and a tapered leading are driven laterally through portholes at appropriate places in the cassion. The successive slotted pipes are welded and driven using special hydraulic jacks installed at the bottom of the cassion. The number of laterals is usually less than 16, thus permitting minimum angle of 22°30”, between two laterals. The maximum length of lateral reported is 132 m and the total length of laterals from 120 to 900 m depending upon requirement of yield. The laterals are developed by flushing and if entrance velocity of water is kept less than 6-9 mm/sec, these do not get filled by sand. The effective radius of a collector well is 75 to 85% of the individual lateral length.

IV. CONCLUSION

Conventional method of augmentation was used to measure the quality and quantity of water in the Panamarathupatti Lake. It has been found that water can be used for domestic purpose and to some extent for agricultural purposes. Based on the findings, this study also identified sites for replenishing groundwater for suitable development, suitable policy intervention by the state and local people’s cooperation are essential for protecting the lake from water pollution and increasing water resources and these will ensure sustainable development in the study area. The method recharge is very useful for block wise ground water exploitation and recharge.

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