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A REVIEW- TANK AND ITS ROLE IN RECHARING GROUNDWATER

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ABSTRACT

The tanks occupy vital role in the irrigation as well as local ecosystem in the semi-arid regions of South India. A tank can be used as multipurpose like source of drinking water for rural and urban communities, livestock, fish culture, recharge of ground water, control of floods etc. But tanks after the independence which are in multi use has drastically decreased due to several socio-economic and institutional factors, particularly the changes in ownership pattern, caste, class configuration and importance given to canal systems and over exploitation of groundwater. Today there is an alarm that these valuable and extensive resources are in a state of collapse, contributing to increased drought vulnerability. Therefore this study has been taken upto show how tanks help in recharging groundwater. As a result of this review paper, different author's methods towards finding out the increase in groundwater level and socio economic benefits were discussed.

Key words: Irrigation Tanks, Groundwater Recharging, Ponds

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1. INTRODUCTION

Tanks are water harvesting structures constructed across or near streams to impound rainwater and to retain it for a longer period of time to increase the opportunity time for infiltration. Tanks are generally classified into system and non system tanks. System tanks are those which receive water from nearby major streams or reservoirs in addition to water from their own catchments and are not connected to the river system and usually single crop is raised.

Tanks have existed in India from time immemorial and have been an important source of irrigation, especially in the southern peninsular. Majority of irrigation tanks (eri) were built from 6th to 10th century of our era during the dynasty of pallavas. One will understand the importance of these systems of irrigation by noting that about a third of the surface area of the state is actually irrigated by these omnipresent tanks (about 40000 such tanks), the two thirds of water needs comes from the exploitation of groundwater [1].

It was observed that the land irrigated by these tanks (known in Tamil as ayacut) have seen an increase in their fertility due to the water which is rich in nutrients. In addition, the beds of the tank were cleaned regularly and mud was utilized in the fields, bringing better fertility. This practice continued until the beginning of the 20th century. The irrigation tanks played a decisive role to guarantee the food production but also in maintaining ecological balance, to control the floods, to prevent erosion, to recharge the water table and to limit the valuable water loss during the large rains. The presence of eri allowed a favourable microclimate at local level. Moreover, without eri, the development of rice cultivation which staple diet of the people would not have been possible.

Even though the share of tanks is decreasing part of it is replaced with groundwater irrigation in the tank command areas. Besides variation in rainfall and tank filling several factors such as siltation, encroachment and channel obstruction have reduced tank irrigated areas over the years. Ground water is precious finite but rechargeable resource. But due to its easy availability and more usage of electric pump, no incentives allotted to maintain the traditional water bodies all these factors have contributed to the declining tank water usage [1] [2]. It has been felt that the effective maintenance of tank system will improve the ground water table in the surrounding area.

2. METHODS TO FIND ARTIFICIAL RECHARGE

2.1. WATER BALANCE METHOD

Tyagi (1999) [2] took this study to assess the quantum of seepage to the aquifers through the percolation pond and the zone of influence of the pond. Uralipatti and Vialipatti percolation ponds in Dindigul district of Tamilnadu were selected for the study. The seepage losses from the ponds were assessed using water balance method. In case of Uralipatti pond nine dug wells were located in the vicinity of the pond. The wells were monitored twice a month for water level fluctuations from Nov 1991 to dec 1994. The pumping test was conducted in well No.3 which provided the value of transmissivity and hydraulic conductivity as 178.5m^2/day and 37m^2/day. In Viralipatti pond twelve dug wells were monitored from the period of Jan 1990 to may 1990. The value of transmissivity and hydraulic conductivity for the well no.5 and steady infiltration inside the pond are 94.77 sq m per day, 16.63 m per day and 0.53cm per hr respectively. It is been found that seepage rate in Uralipatti pond varies from 34.7 to 16.3 cum per day for storage between 1500 to 300 cum during 1991 and from 180.1 to 19.7 cum per day for storage between 2700 to 260 cum during 1993. In Viralipatti pond it varies from 137 to 20.4 cum per day for storage between 1090 and 2830 cum. The average rate of seepage is 41.06 and 45.84 cum per day for Uralipatti and Viralipatti pond respectively. Over the observation period of 123 days in Uralipatti pond, the total pond storage of 5734 cum of which 683 cum is the evaporation loss and 50.51 cum forms seepage losses. In Viralipatti pond over an observation period of 119 days the storage of 8351 cum, the evaporation and seepage losses are 2860 and 5455 cum. Hydrographs of the pond and observation wells groundwater table contour maps are used to assess the zone of influence of the pond. It is been found that in Uralipatti pond the wells located within the radius of 340m downstream of the pond gets adequate recharge from the pond, where as wells with in radius of 840m and 950m gets moderate recharge. In Viralipatti pond the well located in the downstream within the radius of 200m gets moderate recharge but only a marginal recharge at 305m. It's been found that percolation ponds are very useful in recharging the shallow groundwater aquifer.

2.2. CHLORIDE MASS BALANCE METHOD

Tianming Huang (2010) [3] took up this study in Guyuan and Xifeng in china to find the groundwater recharge following land use change using chloride mass balance method. Comparison was made between chloride concentration in the soil water from the base of the root zone to the base of the chloride – concentrated zone, for pre-converted and converted land use as the background for comparison. Soil profiles from Guyuan show that the groundwater recharge beneath sparse small – grass was 100 mm/year, and the conversion to winter wheat more than 100 years ago has resulted in reduced ground water recharge, to 55 mm/year. At Xifeng, the conversion from winter wheat (with the recharge rate of 33 mm/year) to apple orchards 7 years ago has led to chloride being concentrated in the soil profile from land surface to about 5 m depth, suggesting the recharge rate has decreased. Strong water – resources implications for the Loess Plateau of China lie in the fact that regional afforestation and other land use conversions to vegetation with higher water demand many have caused soil – water depletion and solute concentration and are therefore, not favorable to groundwater recharge and ecosystem restoration.

3. METHODS BY USING MODFLOW

Purjenaie et al., (2012) [4] conducted this study in Sarze Rezan plain in Iran to predict the aquifer draw down. MODFLOW was used to predict the present status of the aquifer. The study area of 7600 hectares is discretized into 103 columns and 40 rows respectively with grid dimensions of 150 m x 150 m. The aquifer was assumed to be unconfined and of a single layer. Aquifer boundaries, designed grid, and cell types

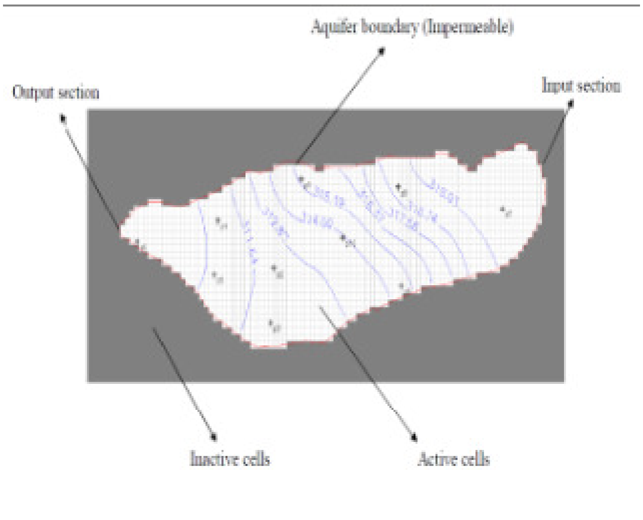

Figure 1 Aquifer boundaries, designed grid, and cell types

The model was calibrated using PEST code in an unsteady state over a period of 2001 to 2010. It was found that there exists a good match between the observed and computed groundwater heads. The RMSE between observed and computed head is 0.854 with a correlation co efficient of 0.94 between them, which shows excellent agreement with aquifers natural state. In order to predict the aquifer drawdown three scenarios were generated if the pumping rate is kept constant during 8yrs the draw sown will be 10.56m after 8yrs, also the aquifer drawdown will decrease to 6.3 m if the pumping value decrease to 20% during 8yrs and aquifer drawdown will decrease to 4.5m if the pumping rate decreases to 40%. The most drawdown was noticed in the western part of the plains since high concentration of wells and pumping of wells was noticed.

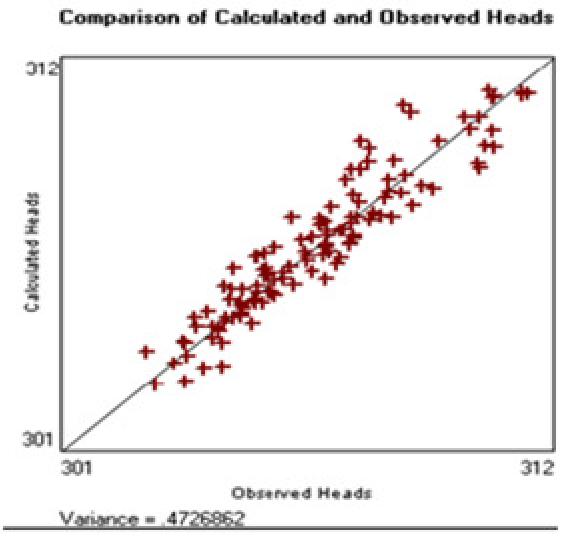

Figure 2 Comparison of the calculated and observed heads in Piezometer of 4

Sayana et al., (2010) [5] made study to examine the impact of rain water harvesting on the groundwater dynamics and storage in an educational campus in Avadi near Chennai. A number of wells have been dug in the area to meet the water requirements of the campus. It was totally twelve wells with one shallow well and eleven deep bore well. Seven wells were dug using rotary method while the open well has been excavated using dug in method. A percolation was excavated having an area of one hectare and an average depth of five meter. Rain water harvesting during monsoon season through the roof top harvesting was collected and stored in the percolation pond. Pumping test was conducted in one of the observation well to access the hydraulic conductivity of the aquifer. The aquifer has been divided into three layers. The first layer is taken as the top layer and all the wells are covered fully in the second layer and some wells are considered for third layer as they deep. Ground water flow dynamics has been carried out to study the flow direction in the aquifer during 2004 to 2007. A three layer hydro geological model was applied in visual MODFLOW 4.1 and the model fit was found to be 84% between the observed and the predicted values R2 = 0.844. In 2007 they observed that there is an improved recharge, change in the direction of groundwater flow and discharge of water from the southern part of the campus was noticed.

Senthilkumar et al., (2000) [6] conducted a study in lower palar basin to understand the hydrodynamics of the basin and provide a mechanistic description of the flow of water in the aquifer. The finite difference computer code MODFLOW with Groundwater Modeling Software (GMS) as pre and post processor, was used t simulate the groundwater flow. The study area of 392 km2 is discretized into 2400 cells with 40 rows and 30 columns and vertically by two layers. Steady state model calibration was used to minimize the difference between the computed and field water level condition. Root mean square error was minimized to 0.76 m and the mean error was minimized to 0.12 m through numerous trail runs. It was found that observed groundwater head from 29 wells mostly matches with the computed groundwater heads. Mismatch max of 1m was observed in some wells.

4. ECONOMICS OF TANK RESTORATION

Amaranth et al., (2006) [7] carried out this study in Madurai district of Tamil Nadu to show the costs and benefits of tank rehabilitation and financial feasibility of investment in tank rehabilitation. They found that total annual income is higher in the case of rehabilitated tanks than the non-rehabilitated tank and amongst the rehabilitated tanks; panchayat tanks with community well have depicted the highest annual income. The investment analysis had revealed that net present worth to be positive, the B-C ratio to be more than 1.5 and the internal rate of return to be more than the opportunity cost of capital. It shows that all the three investments in tank rehabilitation are economically viable. Finally it's been suggested that rehabilitation undertaken in all the non rehabilitated tanks also. Besides efforts should be made to provide supplemental irrigation to crops and to improve the PWD tank management regime.

Anuradha et al, (2012) [8] carried out this study to show the impact of tank. Rehabilitation on improved efficiency of storage structures. They carried out this study in Vengal village in Tamil Nadu. A total of 20 percent of respondent were selected irrespective of their land ownership. The yr 2003 – 2004 and 2009 – 2010 has been considered for the post and pre rehabilitation period. Pilot survey was conducted and on the basis of it a detailed questionnaire survey was prepared. They have used SPSS software to analyze the collected data. Before rehabilitation heavy silting up and stagnation problems were observed in the eastern field channels. The main distributor channels were lined up during the rehabilitation phase. The conveyance efficiency got increased to 16.36%, 12.49%, 0.81% and 19.28% respectively and the percentage of loss of flow in tank also reduced to 2.39%. The post and pre rehabilitation period was taken into account for 100m length of field channel.

Table 1 Details of Increased Efficiency in Vengal Tank

Sl.no	Particulars	Pre project (%)	Post project (%)	Test length (m)
1	Conveyance efficiency	59.64	74.17	100
2	Field channel efficiency	83.67	90.96	100
3	Irrigation efficiency	39.88	52.29	100
4	Time of Travel	5.85 min	3.28 min	100

It's been found that before the rehabilitation work the time required by the water to pass through the channel 6.15 minutes which got reduced to 3.28 minutes after rehabilitation. Around 160 wells in Vengal tank command area got recharged. The period of supply has been doubled after the rehabilitation works. The average yield in kg/ha is increased by 920 kg/ha and the net return is also increased for Rs 2519 in post rehabilitated period. Before rehabilitation, the farmers raised only one paddy crop through tank irrigation. But now they can able to go for second crop with tank water in early stage and well in the later stage. They have said that it's impossible as well as not necessary to create a new tank but a voluntary group effort is required to maintain these tanks in order to restore the environment.

Table 2 Crop Yield and Efficiencies Related To Water Use

Sl.no	Description	Pre project	Post project
1	Crop yield average kg/ha	3980	4100
2	Water use efficiency kg/ha cm	22	23.97
3	Relative water supply	1.51	1.42
4	Rainfall during the crop calendar year (mm)	1256.4	1087.8

4. CONCLUSION

The studies on different author's perception have shown that tanks helps in increasing the groundwater and various methods that are available to find out the recharge rate. It is clearly understandable when a tank is maintained properly such as strengthening of bund; removal of siltation in channel, reeds, grass and water hyacinth etc, the water table has adequately increased. The wells have become an integral part of the tank system. Yearly a huge sum of money is spent by the farmers in deepening the wells in search of water [8]. So the proper maintenance of tank helps in increased crop yield, water use efficiency. Additional income can be made out of dairy product as the animals will be supplied with adequate amount of water. In some places it is seen that the desilted soils are used for making bricks etc. thus restoration of tanks helps economically as well as maintaining the local eco system.

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