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MODELLING OF GROUNDWATER RECHARGE USING VISUAL MODFLOW

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Abstract – *Irrigation tanks plays important role in shaping the economic growth in semi arid regions of south India. It is a water harvesting system, which transfers water over the surface to the command area. However, after independence the importance of tank irrigation has drastically decreased due to several socio economic and industrial factors, particularly due to importance given to canal system and over exploitation of groundwater and the changes in land ownership pattern, caste etc. Today there is an alarm that these valuable and extensive resources are in a state of collapse, contributing to increase drought vulnerability therefore an assessment of surface water potential study has to be carried out for the major tanks. The Thenneri Hissa tank has been selected for the study. The main objective of this study is to estimate potential groundwater through tank recharge. Visual MODFLOW ver.4.2 has been used to find out the groundwater recharge potential. This model requires data such as rainfall, lithology, hydraulic conductivity and water level data. The rainfall data for the last five years have been collected from State Ground and Surface Water Resources data Centre. The water level data from year 2009 to 2011 were used for calibration purpose. The results have shown that wells located within the radius of 200 m get adequately recharged. Because of sufficient head is not available due to siltation of tank the wells that are located far away are not adequately recharged.*

Key Words: Simulation, Irrigation Tanks, MODFLOW, Groundwater, Hydraulic Conductivity.

1. INTRODUCTION

Blue water which is present beneath the surface of the earth is one of our precious resources. Availability of free electricity and usage of electric pump by the farmers, lack of incentives to maintain the traditional water bodies all these factors have contributed to disintegration of tank irrigation. Integrated Water Resources Management is a nucleus of ecological sustainability, economic efficiency and social equity. Augmentation of groundwater is within the principles of Integrated Water Resources Management. The augmentation of groundwater through tank recharge helps to increase the productivity as well as income of the farmers. It also helps the farmer to grow food crops especially paddy which requires water throughout the growing season. Therefore, this study is taken up to demonstrate that the tank helps to recharge groundwater and also to assure economic and social benefit out of such augmentation.

1.1 Objectives

- To assess the potential for groundwater recharge in surrounding wells.
- To analyze the possible economic impact of tank recharge through sociologic survey.

1.2 Study Area

Walajabad block of kanchipuram district lies between 12°47′21.62″N to 79°49′20.92″E. According to 2001 census the walajabad block has a total population of 124753. It covers 61 revenue villages. A total number of 150 tanks exist in kanchipuram district. In which 83 numbers of tanks are present in walajabad block. 40 tanks are system tanks and 43 are non-system tanks. For detailed study walajabad block of Kanchipuram district is selected as study area as shown in Figure 1.

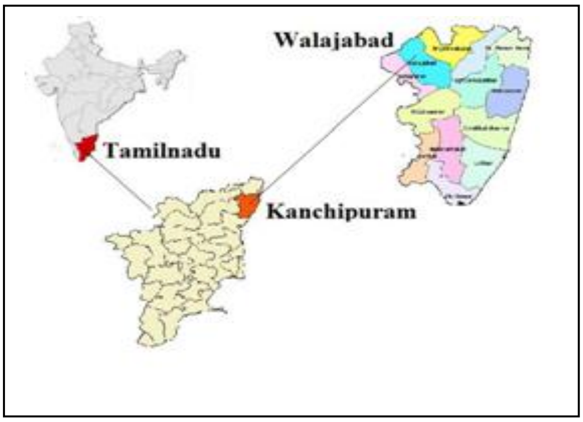

Fig 1:

Index Map

The tank selected for the study is Thenneri Hissa tank which is located between the geographical coordinate latitude 12°47′00″N, longitude 79°51′42″E and altitude 58.610 m as in Fig. 2.

Fig 2: *Watershed Map*

It is situated about 0.20 km of Thenneri village in kanchipuram taluk of kanchipuram district in palar basin. The tank receives drainage from the catchment of 46.28sq.km and intercepted catchment 157.49 sq.km. The registered ayacut area of the tank is 2286.72 ha. The hydraulic particulars of the tank are listed in Table1.

S.No	Description	Details
1	Full tank level (F.T.L)	+58.670m
2	Maximum water Level (MWL)	+58.75m
3	Top Bund Level (TBL)	+60.85m
4	Free board	1.820m
5	Length of bund	3889m
6	Height of bund	8.09m
7	Top width of bund	2m
8	Side slopes : Front	1:05:01
	Rear	2:00:01
9	no of fillings	2
10	Useful yield	34.62Mm^3
11	Original capacity	34.62Mm^3
12	Live storage capacity	29.57 Mm^3
13	Dead storage capacity	Nil
14	Maximum depth of storage	6.24m
15	Surplus arrangements	
I	Types of wear	Paved by wash
		Boat cut stone
		Paved crest upright
		Calingulah
ii	Total length of weir	9.42m
iii	Crest level	58.67m
iv	Flood lift	0.10m

2. DATA AND METHODOLOGY:

For detailed study the watershed 4C2A2C has been delineated from the walajabad block. Climatologically the year is divided into four seasons and average rainfall received is 1067.41mm. The watershed is underlined by different types of soil such as loam, clayey, fine loam etc. The aquifer system consists of charnockite, gravel, and sand as shown in Fig. 3. The major part of the watershed is made up of pediplains followed by alluvilial and flood plain.

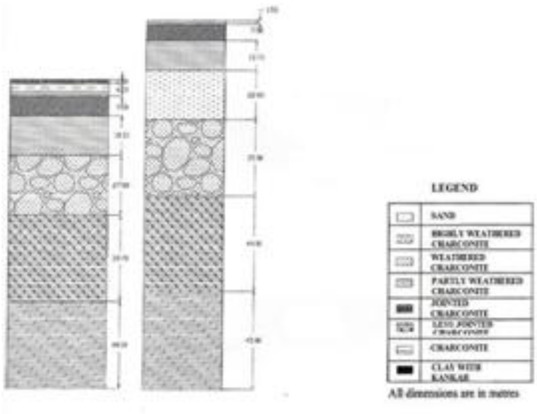

Fig 3: *Aquifer Properties of the well*

Total no. of sluices is seven and the deepest sluice is sluice no.3 (52.43m) and the highest sluice is sluice no.2 (56.35m). The maximum length of the supply channel is 15500 m taking of surplus Enathur tank. About fifteen wells have been selected in the study area to monitor the impact the tank recharge. The latitude and longitude of the fifteen selected wells is listed below in Table. 2 The water levels for both pre monsoon and post monsoon for the year 2013 have been recorded. The water level data from the year 2009 to 2011, collected from State Ground and Surface Water Resources data Centre, Chennai, Tamilnadu is used for calibration.

Wells	Latitude	Longitude
Well No.1	12°52'53°60''N	79°50'08.25''E
Well No.2	12°53'04°66''N	79°52'05.49''E
Well No.3	12°52'16''N	79°51'36''E
Well No.4	12°51'45''N	79°52'32''E
Well No.5	12°52'00''N	79°51'40''E
Well No.6	12°51'19''N	79°51'13''E
Well No.7	12°49'11.28''N	79°51'29.31''E
Well No.8	12°50'08.42''N	79°51'09.69''E
Well No.9	12°48'36''N	79°49'48''E
Well No.10	12°48'33''N	79°49'47''E
Well No.11	12°46'50''N	79°51'24''E
Well No.12	12°47'00''N	79°49'50''E
Well No.13	12°47'02''N	79°46'56''E
Well No.14	12°50'1.00''N	79°51'7.02''E
Well No.15	12°51'66''N	79°51'36''E

4. METHODOLOGY:

Methodology is a key important factor in determining the accuracy of the result. This chapter discusses the methodology adopted for the study using Visual MODFLOW as in Fig. 4.

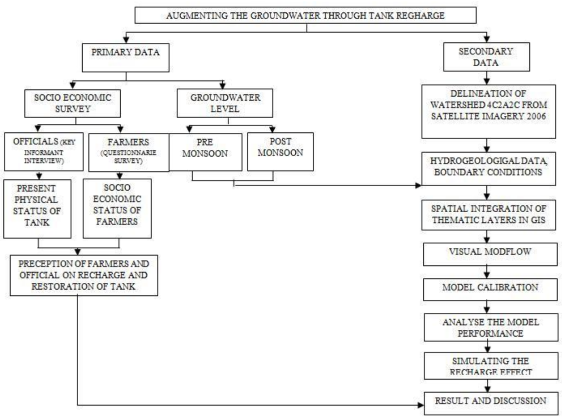

Fig 4: *Methodology*

5. VISUAL MODFLOW

5.1 Model Simulation

At first the study area map is imported into the model and discretized into an orthogonal grid of 30 rows and 40 columns and vertically by 2 layers as shown in Fig. 5.

Fig 5: *Study area map with grid*

The details about observation wells and water levels during the period 2009 to 2011 were imported into the model as shown in Fig. 6.

Fig 6: *Observation wells in the model* Hydrologic properties like hydraulic conductivity and storage coefficients were imported as shown in Fig.7.

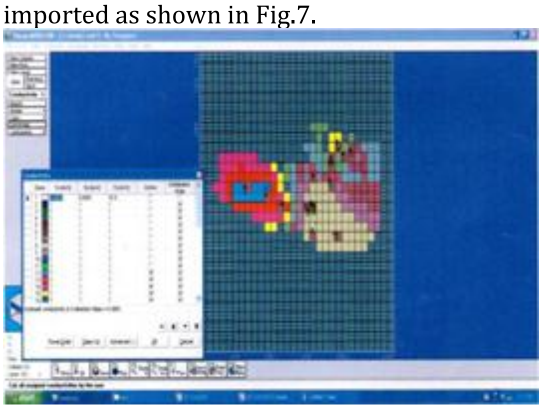

Fig 7: *Hydraulic Conductivity*

5.2 Boundary Conditions

Every model requires appropriate boundary conditions to represent the system relationship with the surrounding area. The boundary condition in the study area is general head boundary and recharge boundaries were assigned as shown in Fig.8.

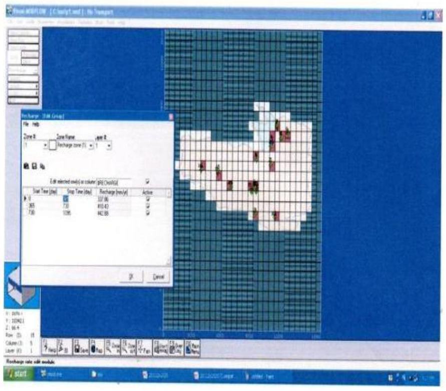

Fig 8: *Boundary Conditions*

5.3 Model Calibration

The calibration strategy was to initially vary the best known parameters as little as possible, and vary the poorly known or unknown values the most to achieve the best overall agreement between simulated and observed. The calibration of deterministic groundwater models is often accomplished through a trial and error adjustments of the model input data(aquifer properties, sources and sinks, and boundary and initial conditions) to modify the models output. Steady state model calibration was carried (2009 to 2011) out to minimize the difference between the computed and field water level condition. The direction of flow in the study area is as shown in Fig. 9.

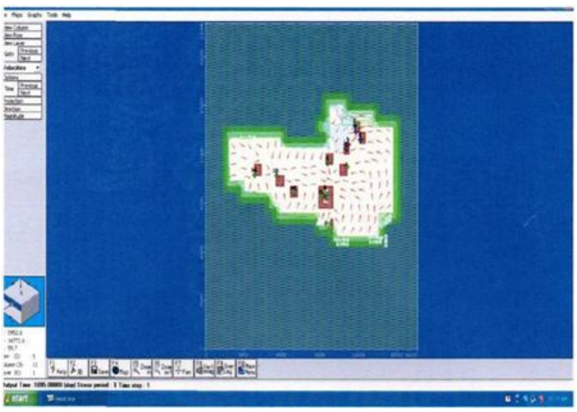

Fig 9: *Flow Direction in the Study Area*

The Fig. 10 indicates that there is a very good match between and observed water head in most of the wells of the study area. RMS (root mean square) error was minimized to 3.09 through numerous trial runs. Based on the close agreement between measured and computed heads at 15 observation wells throughout the aquifer, the model was considered to be calibrated satisfactorily. The wells near to the tank are adequately recharged than the wells locate away from the tank. This is because sufficient head is not available due to siltation of tank to recharge the wells that are located far away.

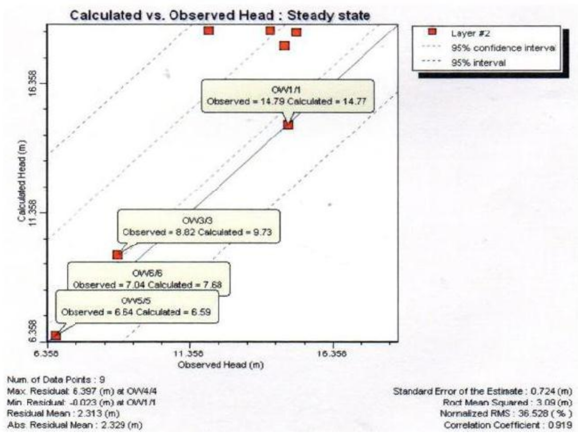

Fig 10: *Calculated Vs Observed Head for 1095 days*

6. RESULT AND DISCUSSION:

6.1 Questionnaire Survey

The questionnaire survey was conducted to the farmers near deepest sluice no.3 and highest sluice no.2 to know the constraints of the farmers. 45 farmers from the deepest sluice and 30 farmers from highest sluice were chosen by random sampling method. The results revealed that due to reduced capacity of the tank about 25% of the irrigated area has been reduced. The yield has been considerably reduced due to lack of monsoon and reduced capacity of the tank. Especially in the tail end as only about 15% of the farmers owned wells in the tank. Most of the farmers are marginal farmers each having less than a hectare and it is expensive for them to invest in well to meet the supplemental water requirement. About Rs.25, 000 to Rs 30,000 every year were spent by the farmers in deepening their wells by five to ten feet. Farmers who cannot afford such a huge expenditure have moved to nearby urban area for their livelihood.

6.2 VIEWS EXPRESSED BY OFFICIAL

Farmers in the nearby villages especially in Alapakkam village which is very near to Thenneri tank are doing cultivation within the water spread area of the tank. Only preventive maintenance is made so most of the area is also occupied by natural flora such as reeds, grass and water hyacinth etc. So the area of the tank got considerably reduced.

7.CONCLUSION

An attempt has been made to find the groundwater development in the command area of the Thenneri tank. The visual MODFLOW is used to model the groundwater recharge the output of the model is within the acceptable limit. Hence it can be confidently say that in Thenneri tank groundwater development is 82.6%. On finding the groundwater development in Thenneri tank it was decided to find the perception of farmers within Thenneri tank command and also the PWD official on the status of water storage in tank, use of well water, maintenance of tank etc. the Thenneri Hissa tank command area have 40% of small farmers (less than 1 hectare), 30% of small (between 1-2 hectare) and 30% of large farmers (above 2 hectares). About 55% of farmer said the reason for water shortage is reduced capacity of the tank comparing to the year 2012 the yield got reduced, as the year 2013 was rainfall deficit. Paddy is the main crop grown in the area. PWD official has said due to encroachment and shortage of rainfall the capacity of the tank reduced. No fund was allocated by the government. From this study it can be concluded that Thenneri tank needs to be restored to its original capacity so that groundwater recharge is achieved and marginal farmers can use surface irrigation to take up cultivation.

8.REFERENCES:

NGO Report:

[1]Policy brief (3) of DHAN foundation'.

Journal article:

[1] Amaranth J S., Karthik Raja P., (2006), 'An Economic Analysis of Tank Rehabilitation in Madurai District of Tamil Nadu', Agricaltural Economics Research Review, Vol. 19: pp 187-194.

[2] Anuradha B., Ambujam N K., (2012), 'Impact of Tank Rehabilitation on Improved Efficiency of Storage Structure', International Journal of Engineering Research and Application, Vol. 2: pp 1941-1943.

[3] Deivalatha A., Ambujam N K., Karunakaran K.,(2009), 'Improvement in efficiency of irrigation tanks through Restoration Programmes with Integrated Approaches' 60th International Executive Council Meeting and 5th Asian Regional Conference, New Delhi, India.

[4] Elango L., Jayakumar R., (2001), 'Modeling in Hydrogeology', International Hydrological programme.

[5] Huang T., Pang Z.,(2010), ' Estimating groundwater recharge following land use change using chloride mass balance of soil profiles: a case study at Guyuan and Xifeng in the loess plateau of china',

[6] Khushwaha R., Pandit M K., and Goyal R.,(2009), 'MODFLOW Based Groundwater Resource Evaluation and Prediction in Mendha Sub- Basin, NE Rajasthan',Journal of Geological Society of India, Vol.74,pp.449-45.

[7] Marie A.,(2010), ' Estimating groundwater recharge using the chloride mass balance method in the West Bank,Palestine',HydrologicalSciences Journal,55(5),780-791.

[8] Purjeanaie A., Moradi M., and Majidi A., (2012), 'Prediction of Aquifer drawdown using MODFLOW Mathematical Model (Case Study: Sarze Rezvan Plain, Iran)'Sakthivadivel R., Ramaswamy. (2009), 'Groundwater Recharge Movement in India'

[9] Sakthivadivel R., Ramaswamy. (2009), 'Groundwater Recharge Movement in India' Singh J., Awasthi M K., Sharma R K., (2004),'Quantification of percolation from percolation tank',Journal of Soil and Water Conservation India 3(3 and 4):128-132

[10] Singh J., Awasthi M K., Sharma R K., (2004),'Quantification of percolation from percolation tank',Journal of Soil and Water Conservation India 3(3 and 4):128-132

[11] Sohrabi N., Chitsazan M., Amiri V., (2013), 'Evaluation of Groundwater Resources in Alluvial through MODFLOW Program, case study: Evan plain (Iran)', International Journal of Agriculture and Crop Sciences