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Evaluation of Hydrogeological Properties in Calcarious Sedimentary Rocks: Area of Bhaskar Rao Kunta Watershed, Nalgonda District, India

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Abstract: Pump test account in evaluation and assessment for groundwater potential and design of wells for drinking, irrigation and industrial purposes. In the study area, pumping test was carried out for twenty five selected bore wells, under short duration, constant rate conditions were examined independently. The aquasituation of the drawdown data was interpreted by Jacob method. The results of transmissivity varied from 2.67 to 236.9 m^2/day with mean of 37 m^2/day whereas the specific capacity varied from 5.47 to 451.63 m^3/day/m with a mean of 76 m^3/day/m. Correlation analyses between time versus drawdown and specific capacity versus transmissivity was coefficient of determination R^2 equals to 0.57 and 0.99 in Power trend model, it is indicating good fitted curve.

Key words: Bhaskar Rao kunta watershed · Transmissivity · Specific capacity · Correlation analyses

INTRODUCTION

Quantitative understanding of most problems in hydrogeology [1], evaluation of aquifer parameters, namely transmissivity (T) and storage coefficient (S), from aquifer test data has been a continual field research [2]. Well test analyses in porous and fractured geologic media continue to be a topic of great importance because the parameters estimated from such tests have a direct bearing on the field-scale prediction of groundwater flow and contaminant transportation [3]. Reasons for conducting pumping tests for groundwater potential and design of wells for sustainable development in the basin, there are two types of pumping test evaluation methods for determining aquifer characteristics (i) drawdown and (ii) recovery methods. The drawdown methods are adopted in this study area, due to field limitations single well test was conducted and other neighboring wells could not be used as observation wells. In single well test drawdown in a pumped well is influenced by well losses as well as well-bore storage. In the present investigations twenty five pump tests were carried out at selected borewells in the study area (Fig. 2).

Study Area: Semi-arid region of Bhaskar Rao kunta watershed geographically lies between northern latitudes from 16° 42' 25" to 16° 37' 58" and eastern longitudes from 79° 28' 15" to 79° 32' 30" of the Krishna lower basin. The watershed elevation ranges between 80 to 140 m above the mean sea level, slightly undulating terrain with slight to moderate slopes (2 to 3%) and annual normal rain fall is 737 mm. The average maximum and minimum temperature was being 40°C and 28°C respectively. The drainage system was showing dendritic to sub-dendritic pattern, governed by regional slope, homogenous lithology and relief, were exhibited by 146 streams (1^{st}, 2^{nd} and 3^{rd} order streams) and curved with contribute the flow of mostly dry except for seasonal run-off. Soils are covered with red sandy and black clay.

Geology: The study area, part of the Kurnool group of Palnadu sub basin (Upper Proterozoic period of Vindyan rocks), is partially covered by Srisailam succession of Kadapa Super Group (Pre-Cambrian period of Archaean rocks) (Fig. 1). Srisailam sub basin rocks are exposed with Quartzites, the Quartzites are inter bedded with thin siltstone units and are usually thick bedded, dense and fine to medium grained. Palnadu sub-basin rocks are

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Table 1: Results of Aquifer Parameters of Twenty Five Bore Wells

Well No:	Longitude	Latitude	Pumping Duration (m)	SWL (m)	Drawdown (m) Min.	Drawdown (m) Max.	Discharge (m^3/day)	Specific Capacity (m^3/day/m)	Jacob method (m^2/day) T
1	79.49647	16.65505	300	5	16	29.8	130	4.36	3.65
2	79.50739	16.65481	300	1	2.9	4.9	726	148.16	69.98
3	79.50102	16.67697	300	5.8	13.3	26.95	473	17.55	16.98
4	79.50397	16.67645	300	6	4.25	11.4	453	39.81	16.59
5	79.50464	16.68597	300	1	2.5	29.6	162	5.47	2.67
6	79.50807	16.68584	300	1	2	13.9	466	33.53	12.91
7	79.50756	16.681	300	0.2	2.6	14.55	602	41.37	16.22
8	79.51269	16.69034	300	6	1.15	2.85	971	451.63	236.9
9	79.51018	16.68932	300	7.15	1.35	6.75	773	114.52	54.17
10	79.50772	16.68337	300	1.5	7.65	15.76	456	29	9.73
11	79.51383	16.69013	300	1.3	1.4	2.3	869	377.83	186.15
12	79.49282	16.67097	300	6.8	9.45	22.58	359	15.9	7.07
13	79.49533	16.67745	300	0.2	18.6	35	272	7.77	5.41
14	79.49313	16.67626	300	6.2	12.3	28.3	188	6.76	6.53
15	79.49422	16.66754	300	2.1	1.6	4.55	727	199.18	102.39
16	79.49602	16.66941	300	4	16.2	31	250	8.06	4.82
17	79.51485	16.70207	300	6	0.15	13.5	227	16.81	5.21
18	79.51736	16.70021	300	1.2	2.3	5.4	512	94.81	52.13
19	79.51853	16.69924	300	0.2	2.5	6.6	455	68.94	26.01
20	79.49066	16.68038	300	3.5	0.2	12.7	557	43.86	8.43
21	79.49333	16.6786	300	7	8.2	25.2	235	9.36	10.26
22	79.49269	16.67135	300	7	0.8	12	173	14.42	6.14
23	79.50566	16.68317	300	6	14.1	24	225	9.38	5.87
24	79.50364	16.68322	300	6	0.6	7.6	413	54.34	20.43
25	79.50709	16.68381	300	6.2	1.7	13.3	216	17	5.31

Table 2: Summary Statistics of Aquifer Paramers of Twenty Five Borewells

Statistical Parameters	SWL (m)	Drawdown(m) Minimum	Drawdown(m) Maximum	Discharge (m^3/day)	Specific Capacity (m^3/day/m)	Jacob method (m^2/day) T
Minimum	0.20	0.15	2.30	130.00	5.47	2.67
Maximum	7.15	18.60	35.00	971.00	451.63	236.90
Mean	3.89	5.33	15.45	448.33	76.06	37.01
Median	4.90	2.50	13.40	454.00	31.27	11.59
Standard Deviation	2.67	5.66	9.93	233.54	115.76	59.55
Standard Error	0.54	1.16	2.03	47.67	23.63	12.16
Sample Variance	7.13	32.02	98.55	54539.45	13400.64	3546.32
Kurtosis	-1.83	-0.04	-1.03	-0.41	5.57	6.09
Skewness	-0.20	1.14	0.48	0.67	2.43	2.52
Confidence Level (95.0%)	1.13	2.39	4.19	98.61	48.88	25.15

exposed with Calcareous sedimentary rocks of quartzites, shales and flaggy-massive limestones [4]. General sequence of sub-surface strata encountered: the top soil, weathered/semi weathered layered shale inter bedded with quartzite.

Hydrogeology: In the study area groundwater occurs mainly along the bedding planes, cleavages, solution channels, cavernous formations and joints. Aquifers often have different hydraulic heads, caused by various surface topographic undulations or cap rock structures. Aquifers are under confined to semi-confined conditions with shallow to deep zones. The shallow aquifer depth and thickness range 30 to 40 m and 5 to 25 m (Kotturu, Kalvakatta Villages), respectively. Deep aquifer depth and thickness range 40 to 60 m and up to 60 m (Banjaranagar Thanda, Gonina Thanda, Champla Thanda, Ham Thanda and JK Thanda) respectively. It has been found that, most of the aquifer zones are encountered within 40 to 60 m depth. The depth of open wells ranges 5 to 20 m, where as the bore wells are about 60 m deep. An average yield is 448 m^3/day (Table 1). Due to

Fig.1: Study Area Location Map

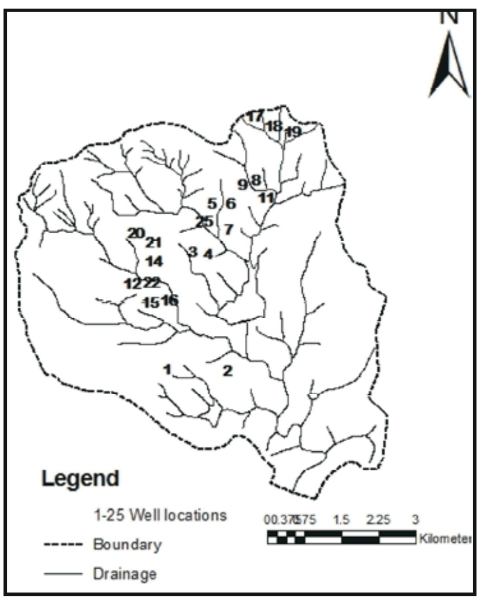

Fig. 2: Pump Testing Locations Map in the Study Area

fluctuations of the groundwater in the monsoon pattern, static water levels were changed in depth from 1 to 7 m below ground level.

MATERIALS AND METHODS

Acquisition of Data: In the study area, twenty five pumping tests data were collected and carried out in selected bore wells (Fig. 2). The average depth of bore wells is 60 m below ground level. Submersible pump of 7.5 HP is lowered to a depth of 40 m. Static water level and drawdown was recorded with automatic water level indicator. During duration pumping test for 300 min, to ensure uninterrupted power supply a stand by 15 KV diesel generator was used. 200 liter drum was used for measuring discharge. In the present study a single well drawdown test was adopted, as an aquifer pre-test to determine an optimal pumping rate of the wells and neighboring wells could not be used as observation wells due to field limitations. In single well test drawdown well is influenced by well losses as well as well-bore storage. Pumping test data was statistically analyzed by MS Excel-2007 version.

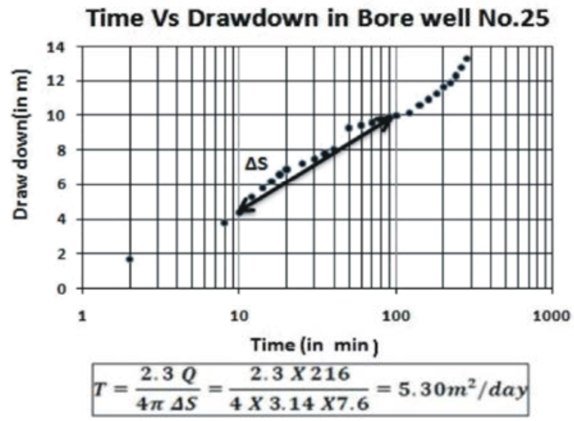

Fig. 3: Data Interpretation on Log-Log Graph in Jacob Method

Data Interpretation: The pumping test data was interpreted by Jacob straight line method [5], to determine transmissivity, on the semi-log paper plot the values of 'drawdown' against the corresponding values of 'time' and draw a straight line through the plotted points and determine the slope of the straight line '?S' the drawdown difference over one log cycle of time (Fig.3). The transmissivity is determined from the following equation:

$$T(\text{Transmissinvity}) = \frac{2.30}{4p?\,s}$$

Where, T=Transmissivity in m^2/day, Q=Pumping well discharge in m^3, Δs= Slope of time vs drawdown plot.

RESULTS AND DISCUSSIONS

The results of transmissivity varied from 2.67 to 236.9 m^2/day with mean of 37 m^2/day whereas the specific capacity varied from 5.47 to 451.63 m^3/day/m with a mean

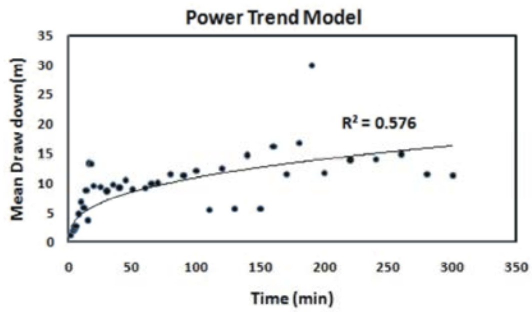

Fig.4: Correlation of Time Vs Drawdown

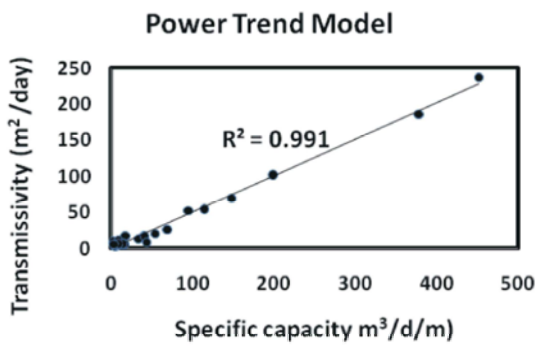

Fig. 5: Correlation of Specific Capacities Vs Transmissivity

of 76 m^3/day/m. The correlation analysis has been carried out for the 25 bore wells of time versus mean drawdown has been taken; R square is the coefficient of determination, is the squared value of the multiple correlation coefficients. The values of 'R' squared range from 0 to 1.The 'R' squared values determine to help in finding weather model fitted is good or not. The correlation between time verses drawdown is 'R' squared calculated value is 0.57 which explains that the model data normal manner (Fig 4). The correlation between specific capacities versus transmissivity coefficient of determination R^2 equals to 0.99 which explains that the model data good manner (Fig. 5).

CONCLUSION AND RCOMMONDATIONS

In the study area, for evaluate groundwater the twenty five borewells pump test data aquisituated and interpreted by Jacob method. The results of transmissivity varied from 2.67 to 236.9 m^2/day with mean of 37 m^2/day whereas the specific capacity varied from 5.47 to 451.63 m^3/day/m with a mean of 76 m^3/day/m. In the correlation relation between time versus drawdown and specific capacity versus transmissivity coefficient of determination R^2 equals to 0.57 and 0.99 in power trend model. In this study, findings are for more understand the aquifer characteristics in the study area (i) an extensive pumping test (long time) and (ii) observation well is required.

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