Study of Ground water quality of Noyyal River in Tiruppur District.

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ABSTRACT- *The textile dyeing units operating in Tiruppur have provided ZLD plants and the system is in operation for the past ten years. The ground and surface water quality data recorded by various government agencies such as PWD, TNPCB and CGWB for the past ten years was collected. Visual MODFLOW, a mathematical Model , is used as a tool in this study for studying the migration of contaminant in the ground water. The parameter, Total Dissolved solids(TDS) is used to represent the contamination level in the ground water. The study area, covering the cluster and upstream and downstream side of Tiruppur corporation was selected and using the data of the year 2008 to 2016 the Model was validated. The validated Model was used to made future prediction of ground water quality for the next ten years under different scenario. The results obtained from the study are discussed in this paper.*

KEYWORDS; **Total Dissolved Solids(TDS), MODFLOW, CETPs(common effluent Treatment Plant, ZLD(zero liquid discharge)**

I. INTRODUCTION

1.1 GENERAL

Noyyal River originates in Velliangiri hills of Western Ghats and flows through Coimbatore,Tiruppur, Erode and Karur Dist. and confluences with River Cauvery at Noyyal village of Karur Distct. The Noyyal River and the Orathupalayam Dam located at downstream side of Tiruppur city. It is popularly known for industrial pollution from the cluster of Textile dyeing units operating in and around Tiruppur Town. The indiscriminate discharge of effluent from the textile dyeing units has polluted the River basin and the Orathupalayam Dam and affects the Ground water quality. The Tamil Nadu Govt. insist the dyeing units, based on the contamination level of ground water implementation of ZLD technology by either collectively or individually. Presently the dyeing unit have installed

ZLD system collectively in 18 CETPs and individually in 48. The ZLD plants

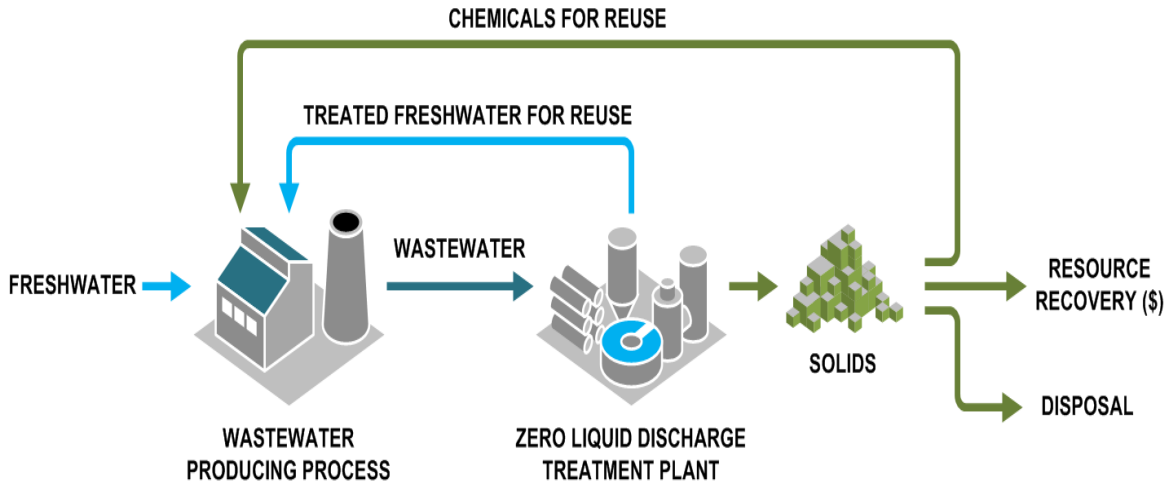

Fig 1.1: Zero Liquid Discharge (ZLD) processes

installed by these units are in operation for more than ten years and the Research scholar has made a study on the existing ground water quality around Tiruppur and future ground water quality trend was predicted under different scenario using Visual Modflow.

Visual MODFLOW is computer based software of graphical interface for the open source groundwater modelling. It is used for the study and prediction of aquifer system in a drought prone study area. The base map of the study area, various layers of the geological strata and their geological properties, boundary conditions, well data and recharge conditions were fed in to the model as inputs. The model was then calibrated and validated, after which future groundwater conditions were predicted.

1.2 Study area

The area selected for study mainly falls in Tiruppur district of Tamilnadu and covering 7.5KM distance on either sides of the River to a total distance of 40KM.(Size-L =40KM and width= 15KM). The Latitude and Longitude of the area are **$77^{o}14^{''}00$"E** to **$77^{o}35^{'}14$" E and$11^{o}01^{'}48$"N to $11^{o}10^{'}00$" N** respectively.

The following seven monitoring was selected covering upstream and downstream side of the cluster and other important points.

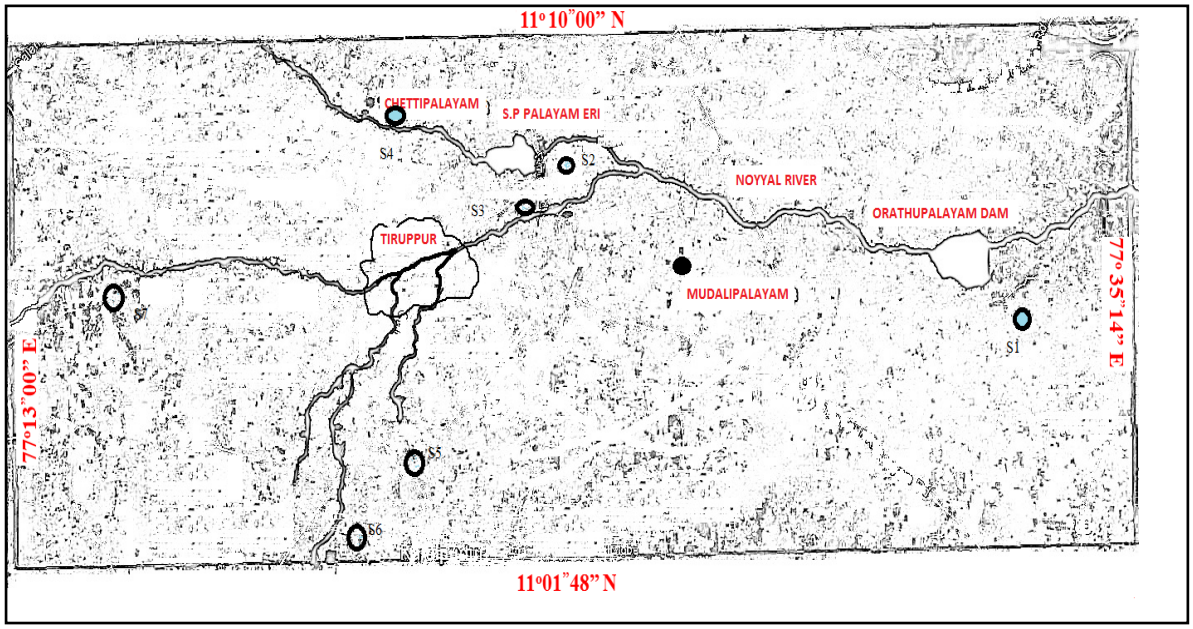

Fig 4.1 Flow of Noyyal River from Orathupalayam dam

II. DATA COLLECTION

2.1 Primary Data

The following seven monitoring wells were selected covering upstream and downstream side of the Tiruppur dyeing industry cluster and samples was collected and analysed for the year 2015and 2016 base line water quality was created.

The following are the locations of wells.

1. S1-Dugwell adjacent to Orathupalayam Dam (20km d/s)(11 º 05 ' 49 ” N:77 º32 ' 46 ” E)
2. S2-Dugwell at S.Periyapalayam (6km d/s).(11 º 08 ' 00 ” N:77 º24 ' 15 ” E)
3. S3-Murugasamy garden bore well(6km d/s).(11 º 07 ' 20 ” N:77 º23 ' 58 ” E)
4. S4-Boopathy’s Rrasi Thottam open well(11 º 08 ' 35 ” N:77 º20 ' 30 ” E)
5. S5-Corporation bore well – Veerapandy bus stop.(11 º 03 ' 47 ” N:77 º21 ' 06 ” E)
6. S6-Rajamani bore well – (11 º 02 ' 00” N: 77 º19 ' 28” E).
7. S7-Muthurathinam open well – (11 º 06 ' 23” N: 77 º15 ' 57” E).

2.2 Secondary data

1	PWD- Groundwater Division, Chennai	i). Tiruppur District groundwater profile ii). Monitoring well data
2	PWD – Irrigation division Erode	Noyyal River Water flow and quality
3	Loss of Ecology (P&PC) Authority	Report on assessment of loss of ecology and environment in Noyyal River basin
4	Central Ground Water Board, Chennai	i). Well water quality and level data ii). Exploratory tube well reports

5	Regional Meteorological Department, Chennai	Rainfall data for Tiruppur district
6	Survey of India, Chennai	Tiruppur district maps on drainage, soil, geology, geomorphology
7	TNPCB, Tiruppur (north)	CETPs, ETPs, STPs & River water analysis reports

2.3 Objective of the study.

- To carry out detailed assessment of existing groundwater quality on Noyyal river basin which is highly affected due industrial discharge?
- To predict the groundwater quality in this area over a period of next 10 years by using VISUAL MODFLOWl model under various scenarios.
- To suggest remedial measures so as to improve the groundwater quality in this area.

III Methodology

The study was carriedout using Visual MODFLOW.Visual MODFLOW provides professional 3D groundwater flow and contaminate transport modeling using MODFLOW, MODPATH, MT3D.MODFLOW simulates groundwater flow within the aquifer using block centered finite-difference approach. MODPATH tracks particle from one cell to the next until the particle reaches a boundary.MT3D is a Comprehensive three dimensional numerical model for simulating solute transport in complex hydro geologic settings.

The study area was divided into 200 m x 200m grid and 15000 cells were created. The input parameters such as ground level, aquifer characters, initial ground water level (2008 data from State ground water Board), Rainfall and boundary conditions were fed into the Model. The Ground water level computed by the Model for the year 2016 is compared with the values observed in the observation well and the Model was validated. A total Dissolved solid (TDS) in ground water was selected as particle and the initial concentration data of the year 2008 was fed into the Model and the recharge concentration details was fed into Model. The TDS concentration level computed by the Model for the year 2016 is compared with the values observed in the observation well and the Model was validated. By using the validated Model prediction of TDS concentration in the ground water was predicted under different scenario for the next ten years.

3.1 Pollution Load on the River system

At present about 400 textiles dying units are connected with common effluent plant treatment system (CETPs) and 50 dyeing units have provided individual treatment system (IETPs) with ZLD concept. There are several issues connected with the operation and maintenance of ZLD plants such as high capital and operational cost requires skilled man power for operation and problems associated with disposal of huge quantity of hazardous waste generation due to operation of ZLDS plant. For the purpose of the study it is assumed that about 10% of the pollution load generated from the dyeing units are left untreated and reaches the ground water either directly or indirectly.

Table 1 Effluent generation capacity of dyeing units in Tiruppur.

SL.NO	NAME OF THE CETP	DESIGN CAPACITY(KLD)	OPERATION LEVEL(KLD)
1	Andipalayam CETP	2730	820
2	Angeripalayam CETP	10000	4000
3	Chinnakarai CETP	8000	4000
4	Eastern CETP	6000	4500
5	Kallikadu CETP	3000	1500
6	Kaspalayam CETP	4400	3520
7	Mangalam CETP	3880	1164
8	Mannarai CETP	4165	2400
9	Park CETP	2500	2250
10	Rayapuram CETP	5500	2750
11	Sirupooluvapatty CETP	5000	2500
12	S.Periyapalayam CETP	1200	180
13	Tiruppur	9460	4730
14	Veerapandy CETP	11929	7160
15	Vettuvapalayam CETP	1300	195
16	Arulpuram CETP	5500	4950
17	Karaipudhur CETP	4500	3150
18	Kunnangalpalayam CETP	4500	2250
19	IETP	25000	25000
	TOTAL		77019 KLD

It is estimated about 77019Kilo litres/daily(KLD) is generated from the dyeing units in Tiruppur and the average TDS value of the raw effluent is about 6000 mg/l and assuming 10% TDS generated going into River system the estimated pollution load is 46.2 Tonnes//day.(=0.1 x 6g/l x 77019 x 1000 kg=46.2 Tonnes/day).

3.2 Prediction scenario

After validation of the Model Groundwater quality (TDS) was predicted for the next 10 years for the following scenarios

1. If the present scenario continues. In this it was assumed 10% of effluent generated and pollution is discharged into the River system.
2. If the pollution is doubled with 20% of effluent generated is discharged into River system. This may be under the condition of production is doubled due to industrial growth or more accidental discharge was made into the River system
3. If the groundwater recharge is increased by 1.5 times and ZLD by the industries. Presently duringflow in the River the water is not stored in the dam. If water is stored in the Dam and more water storage structures are created there by the recharge is increased by 1.5 times and the water quality is predicted,

IV Results & Discussion

4.1NoyyalRiver Flow

The PWD irrigation department is collecting daily inflow and outflow and the TDS value in the dam and the average values are given in the table and in the chart. The monthly average flow in the River at the downstream side of Tiruppur from the 2011 to 2016varies between 25 to 60 cusecs except one or two month, Further the River is always in dry condition on the upstream side and the flow is recorded only during rain. The flow recorded in the dam is mainly contribution from domestic sewage from Tiruppur corporation area and from dyeing and other garment industries which are all using considerable quantity of ground water for their usage and dischargingg into River system either directly or indirectly. The average value of TDS recorded during the study period varies from 2500 mg/l to 3000 mg/l and it reveals that there is a contribution of TDS from the dyeing units even though it is claimed that the units all have installed and operating ZLD plants and the assumption of 10 % discharge of pollutants into the River system is a valid assumption.

Table 4.1Average flow recordedin Noyyal River at Orathupalayam dam

YEAR / MONTH	2011	2012	2013	2014	2015	2016
JAN	122	161	28	40	83	82
FEB	64	130	42	34	40	45
MAR	63	64	26	19	49	34
APR	95	59	20	19	71	33
MAY	80	58	19	47	154	44
JUN	156	34	21	31	194	41
JUL	49	45	20	22	72	48
AUG	68	31	26	37	46	38
SEP	92	25	20	82	49	35
OCT	132	62	105	158	87	38
NOV	555	51	39	103	153	47
DEC	330	35	42	85	137	34

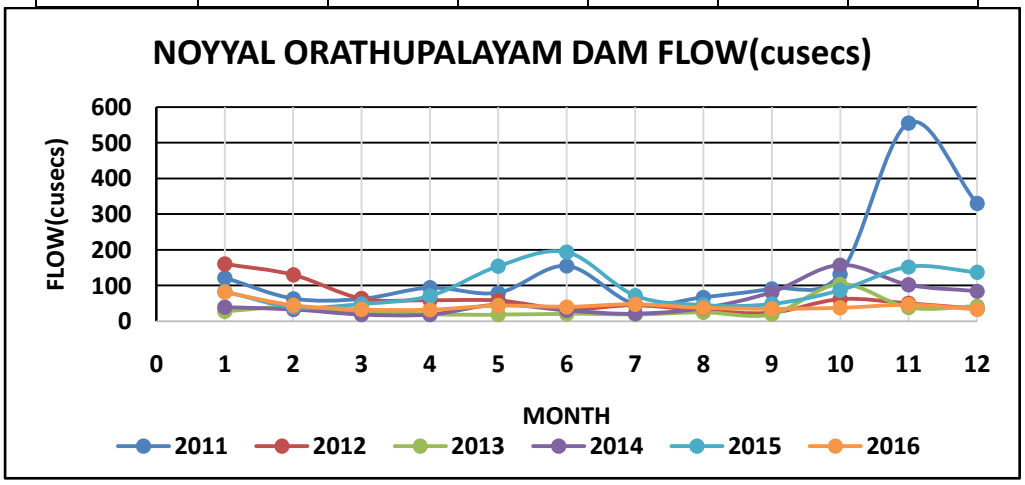

Fig 4.1 Average flow in Orathupalayam dam

Table 4.1 AverageTDS recorded in Noyyal River at Orathupalayam dam

Year / Month	2011	2012	2013	2014	2015	2016
JAN	4294	2726	2868	2629	3171	2994
FEB	4171	2697	2521	2629	3379	3472
MAR	3371	2784	2639	2990	2887	3584
APR	2767	2723	2630	2990	2740	3653
MAY	2752	2519	2616	2845	2461	3423
JUN	2263	2610	2630	2730	2397	3435
JUL	2603	2490	2726	2777	2555	3074
AUG	2594	2435	2523	2681	2774	3058
SEP	2300	2417	2610	2760	2693	2535
OCT	2316	2365	2426	2468	2129	2506
NOV	1947	2773	2627	2847	2170	2532
DEC	2390	3019	2652	3148	2523	2900

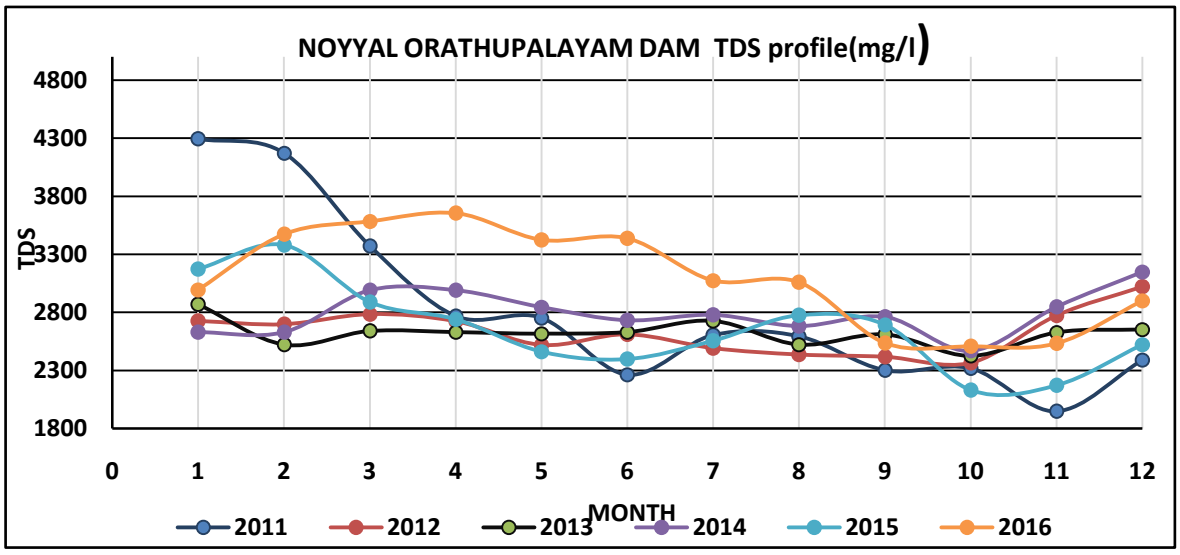

Fig 4.2 Average TDS in Orathupalayam dam

4.2 Ground water quality in the Monitoring wells.

Even though the study was conducted mainly for TDS value the other parameters Chloride, Sulphate, and Hardness was analysed during 2016 and the report of analysis (ROA) is given n table 4.2 and the said parameters follows the same pattern of TDS.. There is no organic pollution load in the monitoring wells and it is evident from the very low values observed in all seven monitoring wells of the parameters Total Suspended Solids, BOD, and COD.

Table 4.2Water quality in monitoring wells.

S.No	Parameters	S-1	S-2	S-3	S-4	S-5	S-6	S-7
1	pH	7.56	7.45	7.89	7.57	8.18	7.32	7.38
2	Total Suspended Solids	4	4	4	4	4	4	4
3	Total Dissolved Solids	3150	2500	3660	4816	2192	3612	5316
4	Chloride (as Cl)	1450	1210	1322	1923	673	1346	2067
5	Sulfate (as SO4)	650	533	725	947	475	825	1190
6	COD	35	61	41	32	24	203	97
7	BOD 3 days at 27C	5	6	3	2	2	18	8
8	Oil & Grease	<1	<1	<1	<1	<1	<1	<1
9	Ammonical Nitrogen	<5	<5	<5	<5	<5	<5	<5
10	Phenolic Compounds	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
11	Total Hardness	1215	710	600	1480	1880	980	1860
12	% Sodium	53	52	82	61	50	59	64

4.3 TDS profile in monitoring wells in scenario S1, S2,and S3

4.3.1S1-Dugwell adjacent to Orathupalayam Dam (20km d/s)

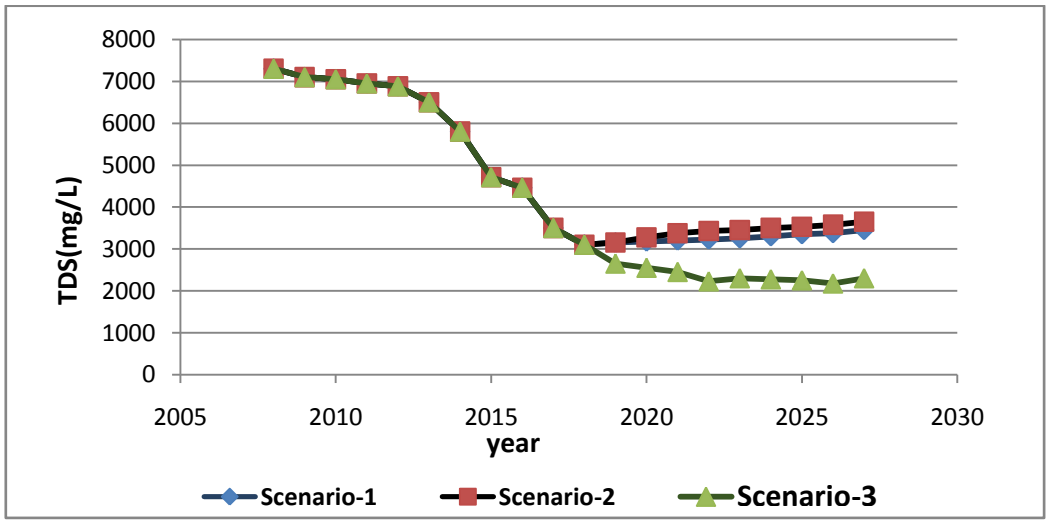

Fig 4.3.1 TDS profile in dug well adjacent to Orathupalayam dam

There is a drastic reduction in the values of TDS from the year 2008 to 2016. Water storage in the Orathupalayam dam has been completely stopped from the year 2004 and there is a gradual improvement in the ground water quality and drastic reduction in the TDS value are observed around the dam area. Further the ground water quality almost follows the same pattern for the next ten years in the scenario -1 and scenario-2 as there is no water storage is proposed in the dam in the near future. Further if rain water is stored in the dam for

improving recharge by making bypass arrangement for polluted water and it shows there is a improvement in the Ground water quality in the adjoining areas.

4.3.2 S2 and S3-wells located 6km d/s of industrial cluster.

The S2-Dugwell at S.Periyapalayam is located adjacent to S.Periyapalayam Eri and S3-Murugasamy garden bore well is located adjacent to the River and both wells are about 6km downstream of industrial cluster.

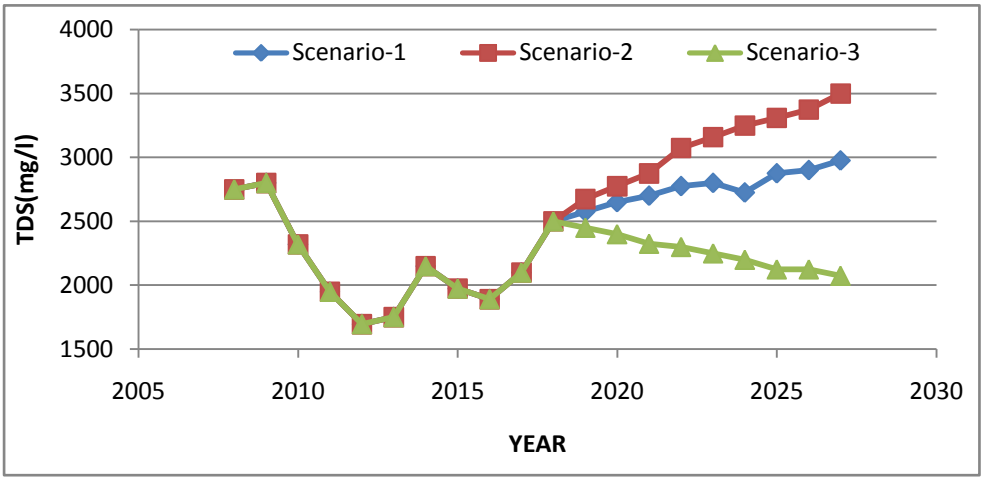

Fig 4.3.2 -S2 TDS profile in dug well adj to S.Periyapalaym

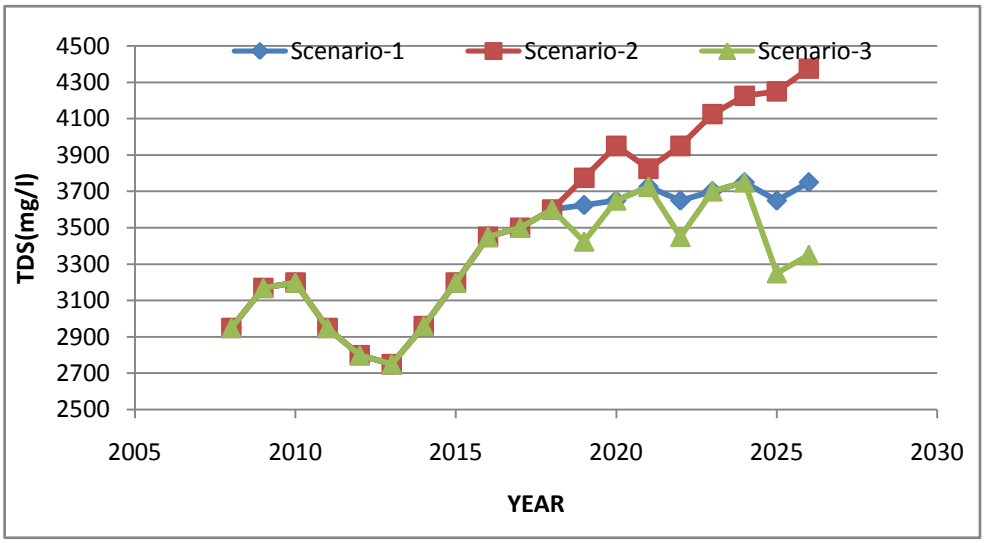

Fig 4.3.3 -S3.TDS profile in Murugasamy garden bore well.

Both wells follow the same pattern under the scenario -1 and scenario-2 and there is a slight increase in the TDS value and it reveals increase in the contamination level. Improving the recharge to 1.5 times by making suitable water storage structures in the River basin reduces the contamination level in the ground water under scenario-3.

4.3.3 S4, S5 and S6-TDS trend in wells in textile dyeing cluster.

These wells are located within Tiruppur corporation area and within dyeing cluster area.

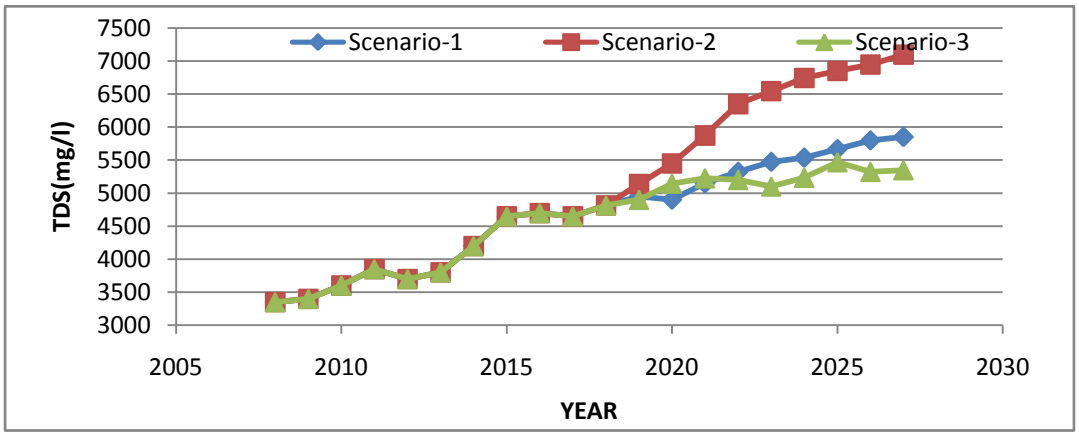

Fig 4.3.4- S4-Boopathy's Rasi Thottam open well

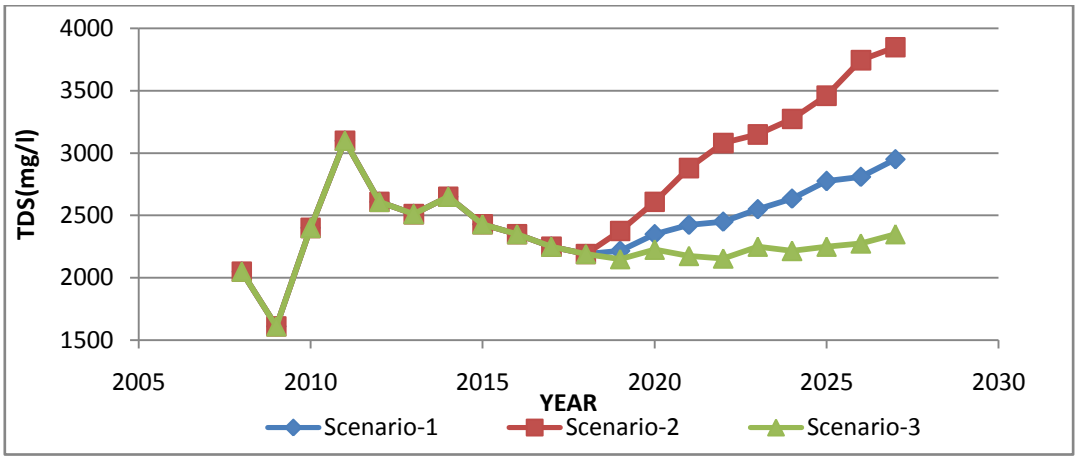

Fig 4.3.5-S5-Corporation bore well – Veerapandy bus stop.

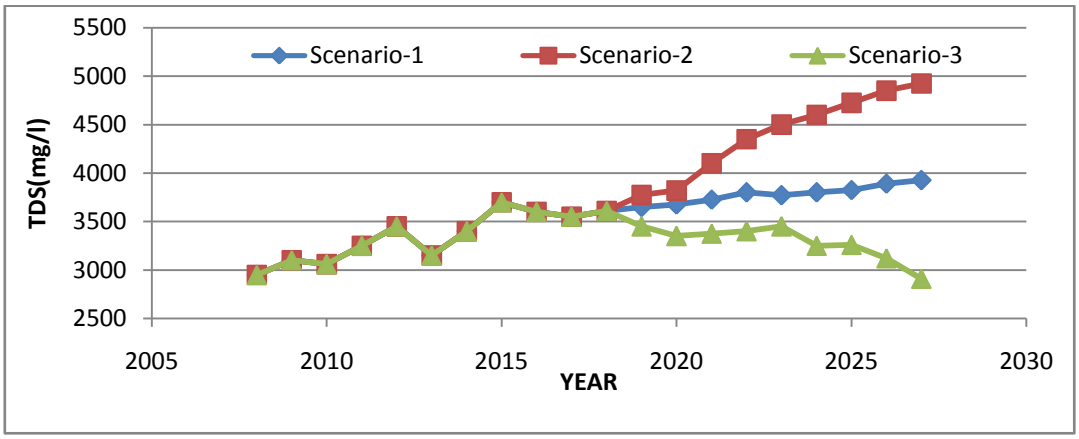

Fig 4.3.6-S6-Rajamani bore well

In all these wells from the year 2008 to 2016 there is a gradual increase in contamination level within the cluster area whereas the contamination level gradually reduces in other area away from the cluster specially in the dam area. This may be due to strict implementation of operation of ZLD plants by the enforcement agencies. The same trend continues in future also in the scenario-1 and scenario-2.

V SUMMARY

After the implementation of ZLD technology by dyeing units there is improvement of ground water quality in study area. There is a considerable reduction in TDS value around the dam area whereas the contaminant level increases within the cluster area. By providing adequate recharge structures in the River and storing rain water in the Dam and S.Periyapalayam eri will improve the recharge and improves the ground water Quality.

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