Final Report

Identification of source(s) of pollution (high TDS) in groundwater in north of Rasipalayam village, Sulur Taluk, Coimbatore district, Tamil Nadu

A Project Sponsored by TNPCB

Tamil Nadu Pollution Control Board

CSIR-National Geophysical Research Institute
Uppal Road, Hyderabad – 500007

April 2018

Technical Report
No.: NGRI-2018-GW-956

Identification of source(s) of pollution (high TDS) in groundwater in north of Rasipalayam village, Sulur Taluk, Coimbatore district, Tamil Nadu

Project Team

Dr. Devender Kumar
Dr. K. Rama Mohan
Mr. B. Kiran Kumar
&
Dr. D. V. Reddy
(Project Adviser)

CSIR-National Geophysical Research Institute
Uppal Road, Hyderabad – 500007

April 2018

Acknowledgements

We would like to thank the Tamil Nadu Pollution Control Board (TNPCB) for funding this project and extending all possible help in completing the same. We also thank Director, CSIR-National Geophysical Research Institute, Hyderabad for his constant encouragement and support during the execution of the project.

We are highly grateful to Dr. R. Rajamanickam, TNCPB, Chennai for his timely help. We place on record our sincere thanks to Mr. P. Manimaran, DEE, and Mr. K. Manivannan AEE, TNCPB, Coimbatore for their support to carry out the field work. We gratefully acknowledge the help provided by the local people of the area, specially Mr. A. K. Jaganathan, Mr. K. Madhan Kumar, Mr. G. Kanda Samy, Mr. V. Vishwanathan and Mr. Gunasekar Chandran. We thank Ms K. Gayathri of CSIR-NGRI for assisting in analysis of samples by Ion-Chromatography. Dr. N. C. Mondal deserves profound thanks for critically reviewing this report.

Contents

List of tables

List of figures

Identification of source(s) of pollution (high TDS) in groundwater in north of Rasipalayam village, Sulur Taluk, Coimbatore district, Tamil Nadu

1. BACKGROUND

The people of Rasipalayam village, Sulur Taluk, Coimbatore District made complaints to Tamil Nadu Pollution Control Board mentioning that the groundwater pollution in their area is due to the nearby industrial activities. The industrial units in that area have their own effluent treatment plants and recycling the treated effluents. However, few groundwater samples analyzed from different sites of the above mentioned area reveal that parameters like total dissolved solids (TDS), chlorides, and total hardness are exceeding the prescribed limits. Hence, the Tamil Nadu Pollution Control Board (TNPCB) made a request to the Director, CSIR-National Geophysical Research Institute (NGRI), Hyderabad, to conduct hydro-geochemical studies on groundwater from north of Rasipalayam village, Sulur Taluk, Coimbatore district of Tamil Nadu, leading to this short term project awarded to CSIR-NGRI.

2. **Objective(s)**

To identify the possible source(s) responsible for groundwater contamination (high TDS) in north of Rasipalayam village.

3. (a) Approach:

Geomorphological investigations of the study region are based on topo-sheet and GPS measurements. Hydrogeological set up has been carried by mapping the sub-surface and collating the hydrogeological information (wherever available) from open and bore wells in the area. Geohydrological investigations like groundwater flow direction have been attempted for possible pollutant movement direction, using the well inventory information.

(b) Scope:

- Detailed well inventory to be done with the help of GPS.
- Identification of hydrogeological features/barriers that control groundwater movement around the contaminated site.
- Preparation of groundwater level contour maps based on detailed well inventory and their elevations.
- Collection of water samples from all available sources (surface water bodies, dug

wells, bore wells etc.) in between the contaminated area and industries located around the contaminated area.

- Assessment of groundwater quality in between possible contaminate sources (industries) and contaminated area.
- Identification of source(s) of contamination.

4. Reconnaissance and Preliminary Assessment

- Reconnaissance, visual site inspection of contaminated area;
- Discussion with local people who are affected by groundwater contamination
- Basic features of the site, i.e. collection of available information on the site.
- Study of previous investigation reports on groundwater, if available;
- Visiting the suspecting industry/s and enquiring about their products, processes, raw material used, waste generation and waste disposal methods.
- Identification of previous and current land use pattern of the site;
- Conduct a drainage survey;
- Collection of random groundwater and surface water (if available) sampling for initial assessment
- Identification of areas where detailed sampling should be undertaken and explore the existing groundwater structures;

A reconnaissance visit was made by the CSIR-NGRI Scientist accompanied by the TNPCB official on August 22, 2017. This visit provided us with an overview of the physical, environmental, social and geological characteristics of the area. During discussions, local people told that their well water was contaminated with high TDS. The main agriculture activity in the area is of Coconut plantation. Groundwater levels are deep (> 20 m), may be due to overexploitation as a result of free power supply to the Agriculture pump sets. Visited the Industry (Pioneer Fertiliser Ltd), believed by the locals responsible for contaminating the groundwater. To get the first hand information on groundwater quality, 11 groundwater samples (including 2 samples from the premises of Pioneer Fertiliser Ltd.) collected randomly and also one surface water (Achchankulam Lake, the potential source of groundwater recharge for this area, Fig. 1). However, we could not get any historical reports of hydrochemical data of this region from any Government department or agency, except the data (about a year old) for a single well, based on which present work is initiated. Though people say that the increase of salinity (high TDS) started about 20 years back and is being continued.

Water samples collected during the reconnaissance were analysed for the major ion chemistry. TDS (1340 mg/l) of surface (lake) water sample is much higher than the normal surface water value of about 100 to 200 mg/l (Ramesh and Subramanian, 1988), which may be due to the mixing of polluted municipal waste water. TDS of collected 11 groundwater samples range between 940 to 8800 mg/l. Major ion chemistry of groundwater shows $Cl>SO_4>HCO_3$ and Ca=Na>Mg>K. High TDS in association with majority of major ions found around the dug well belongs to Mr. A. K. Jaganathan. However, two samples collected from the industrial area (suspected source of pollutant) has minimum ionic concentration and normal (for this region) TDS values.

5. Study area

For present investigations, the study area covers about 5.5 km in the east-west and 3.5 km in the north-south directions i.e., between 77° 5′ 727′′ and 77° 8′ 989′′ longitudes and 11° 2′ 798′′ to 11° 4′ 890 latitudes (Fig.2) with NH-47 (Salem-Coimbatore highway) marking its boundary in the NW and railway line in the SE. This area is located about 20 km north-east of Coimbatore city centre and about 8 km NE of Airport. Figure 1 provides an over view of the study area and its surroundings. The Noyil River originating in the Boluvampatty valley of the Vellingiri hills, broadly flows towards east but in the study area, it flows south-west to north-east and forms the southern boundary of the study area. As expected, the topographic gradient is towards river from both the sides i.e., NW and SE. The area is dominated by undulating surface topography with dome like structures having elevation of 410 m and 380 m exist in the NW and NE corners. In between these two dome structures, four small streams are originating and flowing towards south east. One first order and one second order streams from western side join to form a single stream which merges into the Noyil river. Due to the higher topographic gradient in the eastern side, stream path is not clearly demarcated. All these streams are ephemeral type.

The Coimbatore district receives the rainfall due to both southwest and northeast monsoons with major contribution from the former. Annual average rainfall of six stations in the district varies from about 550 to 900 mm with a minimum of 550 mm around Sulur (study area). District statistics (Department of Economics & Statistics, Govt. of Tamil Nadu (cross ref. from CGWB Repot, Subbaraj, 2008) indicate major source of irrigation though groundwater extracted from dug wells. In the Sulur Block, area irrigated under dug wells is about 3270 Ha and only 752 Ha under tube wells. However, in the study area present conditions, irrigation under bores increased enormously and many of the dug wells defunct.

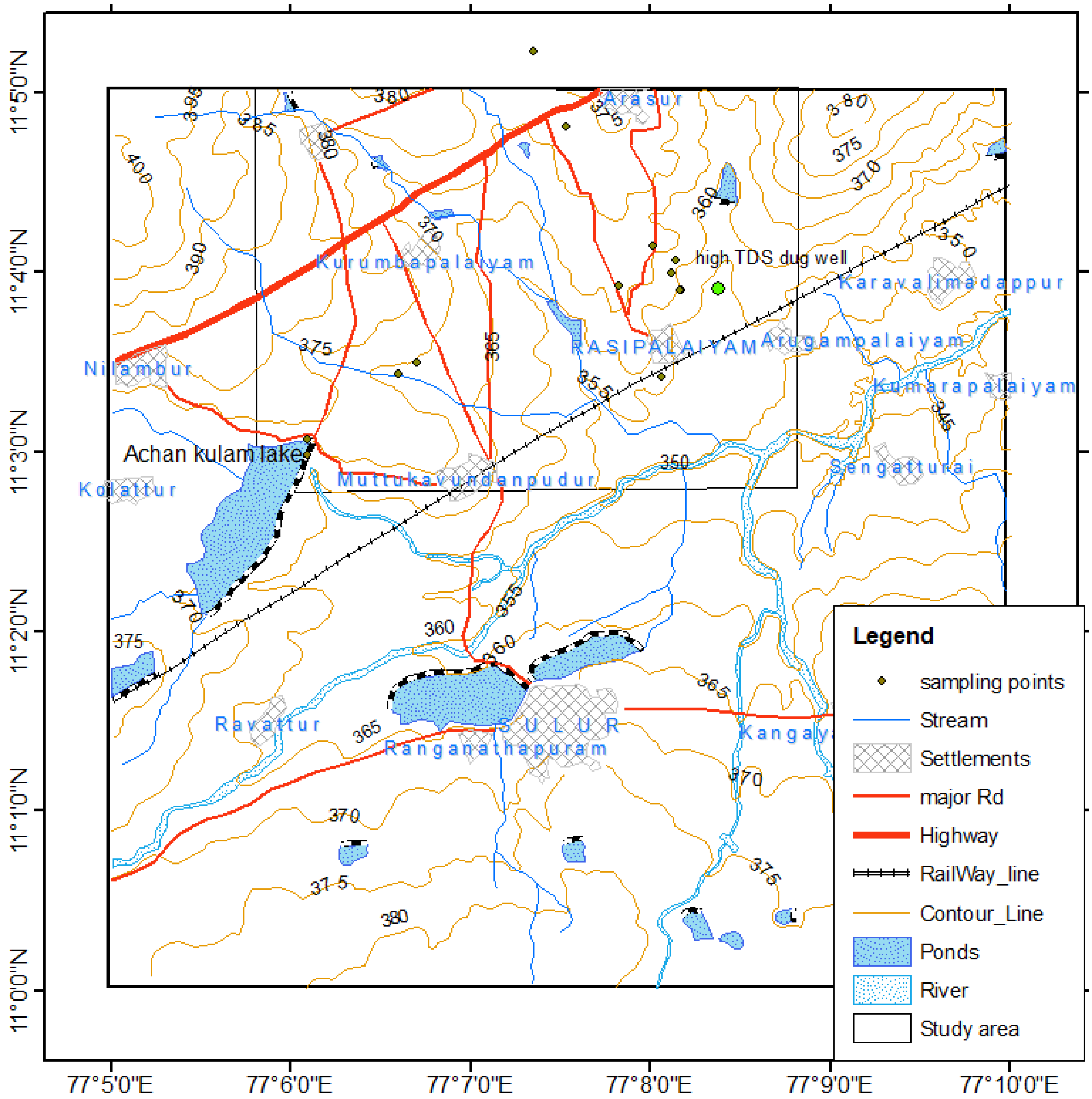

Fig. 1: Overview of the geomorphological features of study area and its surrounding. Water sampling made during reconnaissance visit shown in the map. (prepared after Survey of India 1:25000 scale toposheets 58E/4/SW and SE printed during 1996 based on the 1993-94 survey records)

Geologically, the study area is covered with hard consolidated crystalline rocks, represented by weathered and fractured Granite Gneisses and pink granites. About 60 per cent of the district is covered by red soils, of which red calcareous soil is predominant. Ground water occurs under phreatic conditions in the weathered mantle and under semi-confined conditions in the fractured zones.

6. Field observations and sampling

After awarding the project to CSIR-NGRI, a detailed field study was carried during January 8 to 13, 2018 which included:

- Interaction with the locals to find out the groundwater structures and their assessment of the groundwater quality.
- Observation of geomorphological set up and drainage system.
- Inventory of the available groundwater structures in the area.
- Labelling of different groundwater structures with the help of GPS.
- In field measurements of groundwater for initial quality assessment
- Collection of groundwater samples, wherever it required for detailed chemical analysis.
- Measurement of depth to groundwater level (with reference to ground surface) from all available dug wells in the area.
- Identification of Benchmark/Background samples;
- Outlining the extent of contaminated area through surfer or similar tools for generating maps.
- Development of conceptual site plan comprising of three elements (1) Potential ions of contamination, (2) Possible sources of contaminants and (3) Potential pathways linking the two

Overall this field work provided the data pertaining to the geology, hydrogeology and the Contaminants of Concern (CoC) and aided in creating a site-specific conceptual model.

During the field work, total 63 well (including 24 dug wells) water samples were scanned for TDS contents. Out of these, 47 samples were collected for detailed analysis in the laboratory (Fig. 2). Scanning/sampling was made both from dug wells as well as bore wells.

Depth of the dug wells, mainly distributed in the low lying areas, varies from 20 to 40 m. Many of these are no longer in use due to deep water table and low yield. Depth to groundwater level measured in these dug wells varies from 16 to 34 m (Fig. 3). Due to the 24 hour electrical power supply, groundwater is being pumped all the time subject to availability of water, hence the groundwater levels measured during the field excursion are not reflective of the true water table depth. Depth of the bore well vary from about 50 m to 100 m.

7. Companies visited around the study area

There are several small scale industries in the area. Medium scale industries located in and around the study area were visited along with TNPCB official, to find out the raw material used in the industry, chemicals involved at different stages, waste management measures adopted the company premises etc.

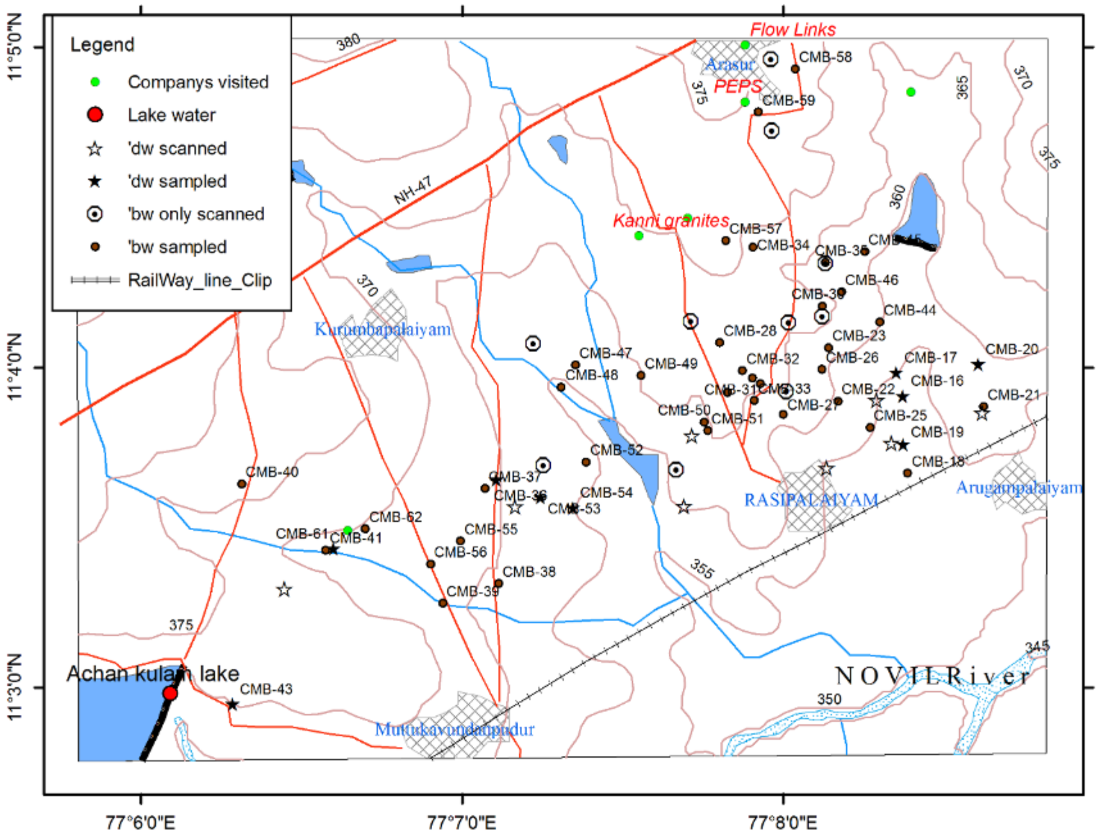

Fig. 2: Location of scanned/sampled wells. Sampled wells with their corresponding sample codes is shown in the figure.

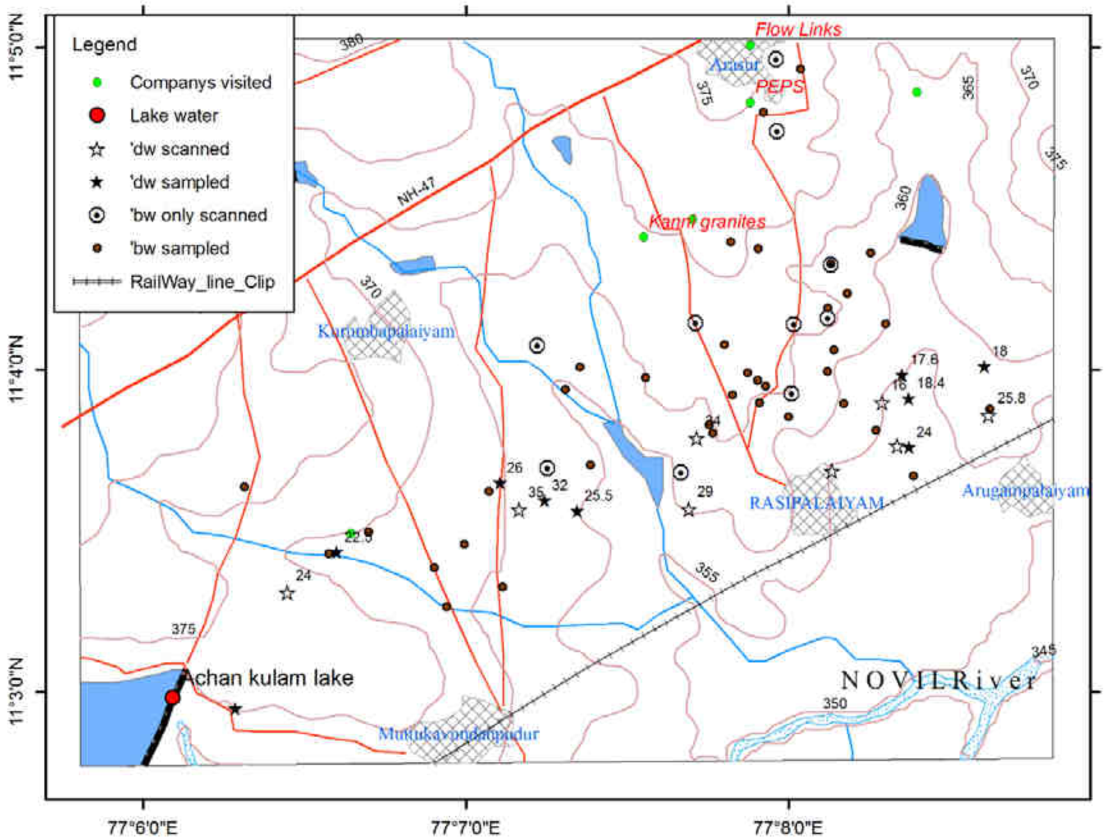

Fig. 3: Groundwater levels (approximate) measured in the dug wells during the field work (many wells pumps are in running condition).

Coimbatore Pioneer Fertilizer Ltd.:

This particular industrial unit (IU) is mainly doubted by the locals for groundwater contamination in the area. Established during 1965, their initial products were single super phosphate and sulphuric acid. However, they stopped producing sulphuric acid since last 10 years and are purchasing the same from other commercial units. Presently, the company is producing only single super phosphate from the rock phosphate as raw material and using the concentrated sulphuric acid in the processes. However, there is no liquid discharge from the company. Liquid waste generated in the cooling towers etc. is being evaporated in the tanks and solid waste generated in the evaporation process is sent to nearby Treatment, Storage, and Disposal Facilities (TSDFs). Overall, the factory premises are clean.

This IU is using groundwater from the big open well located in its premises for the company purpose and also for the adjacent colony. As per their records, though the TDS of groundwater is ~ 3300 mg/l, they are using that. The water from one bore well drilled in the premises is not being used. We collected samples from the dug well as well as bore well during reconnaissance and detailed sampling

Ranganathan Valves Ltd.:

The company established during 1999 and has two units. Unit I is foundry and Unit II is Machine shafts. They have been using the nitric acid and hydrofluoric acid in the processing, they are diverting these to settling tanks and finally evaporation tanks and sludge is stored in the drums, which goes to TSDFs. Within the Company premises, they have a bore well, from which the water is used for domestic purpose in the colony and RO water is purchased for using in the furnace cooling and drinking purposes. No liquid spillage found during the visit.

Flow Links Systems Pvt. Ltd.:

Flow Links too has two units. Foundry unit established during 1997 and Machine division during 2003. Raw materials, processes and products are same as for Ranganathan Valves Ltd. In the Company premises, each unit has 2 bore wells, however one in each unit has dried up. Groundwater is being used for raw works, gardening etc. and purchased RO water is used for the furnace cooling and drinking purposes. However, they say groundwater from bore wells is good quality. Samples were collected from two bore wells in operation.

PEPS industries:

The industry established during 2007 subsequently expanded in 2011 and 2015. It manufactures foam and mattresses. In the processes, no water is used and no liquid waste is generated. The company is using rainwater harvesting in their premises. One bore well is located close to rainwater harvesting structure and another one with poor yield are being used for routine needs while RO plant is installed for drinking water purpose.

8. Laboratory investigations: Hydrochemical measurements

pH, electrical conductance (EC) and TDS of the water samples were measured using the Consort C533 portable multi-parameter analyser. Carbonate alkalinity was measured by titration. Other anions and cations were measured using a Dionex Ion Chromatograph. An AS-14A Ion Pac was used with 8.0 mM sodium carbonate and 1.0 mM bicarbonate as eluent and H_2SO_4 as regenerent with a mixed standard of F, Cl, NO_2, Br, NO_3, PO_4 and SO_4 made in the required proportions from the standards purchased from Merck, Germany. A CS-17 column was used for cation separation with 6 mM methane-sulfonic acid as eluent, and a mixed standard of Li, Na, K, Mg and Ca prepared in accordance with the approximate sample values. As a result of the high TDS values (>600 mg/l), the samples were diluted to measure both anions and cations. Several routine checks on standards were made to ensure data quality. Measurements have a precision of ±5% of the total value. The majority of analysed samples had ionic charge imbalances of <5%.

9. Results and discussions

The problem reported from the study area is high TDS in groundwater. TDS in water represents sum of various ions, and is also called water salinity. Technically, it is defined as total mass in milligrams in a litre of water. Salt content is an important factor in water use. Different ions present in the water are responsible for changes in its taste and odour. Main source for any groundwater is rain water, which normally has very low TDS value. However, when the rainwater percolate through earth layers, soluble ions in the soil and earth strata get dissolved leading to high TDS value. TDS values of groundwater are mainly controlled by the local rock type, thickness of soil cover, weathering processes, residence time of groundwater, quantity of rainfall and above all, the climate of the area. Hence salinity always exists in groundwater but in variable amounts.

Apart from the above mentioned natural processes, TDS values may increase several folds due to human intervention, which can also be called as groundwater pollution. In most cases, the groundwater pollution originates due to waste dumps on the surface or beneath the ground, underground disposal of contaminated water or liquids mainly from industries. A large number of human induced sources like septic tanks, irrigated agricultural activity can also cause for high salinity or TDS.

Generally, salinity of groundwater is classified based on its TDS values (https://water.usgs.gov/edu/saline.html):

- Fresh water - Less than 1,000 mg/l,
- Slightly saline water - From 1,000 mg/l to 3,000 mg/l
- Moderately saline water - From 3,000 mg/l to 10,000 mg/l
- Highly saline water - From 10,000 mg/l to 35,000 mg/l
- By the way, ocean water contains about 35,000 mg/l of salt.

During the detailed sampling, measured TDS values range from 730 mg/l to 8000 mg/l (Fig. 4). Based on the above salinity classification, only one sample from the bore well contain fresh water. 50% of bore well waters and 30% of dug well waters indicate slightly saline conditions and the rest are under moderately saline condition. As the dug wells are located in the low lying areas, naturally they are more vulnerable to contamination.

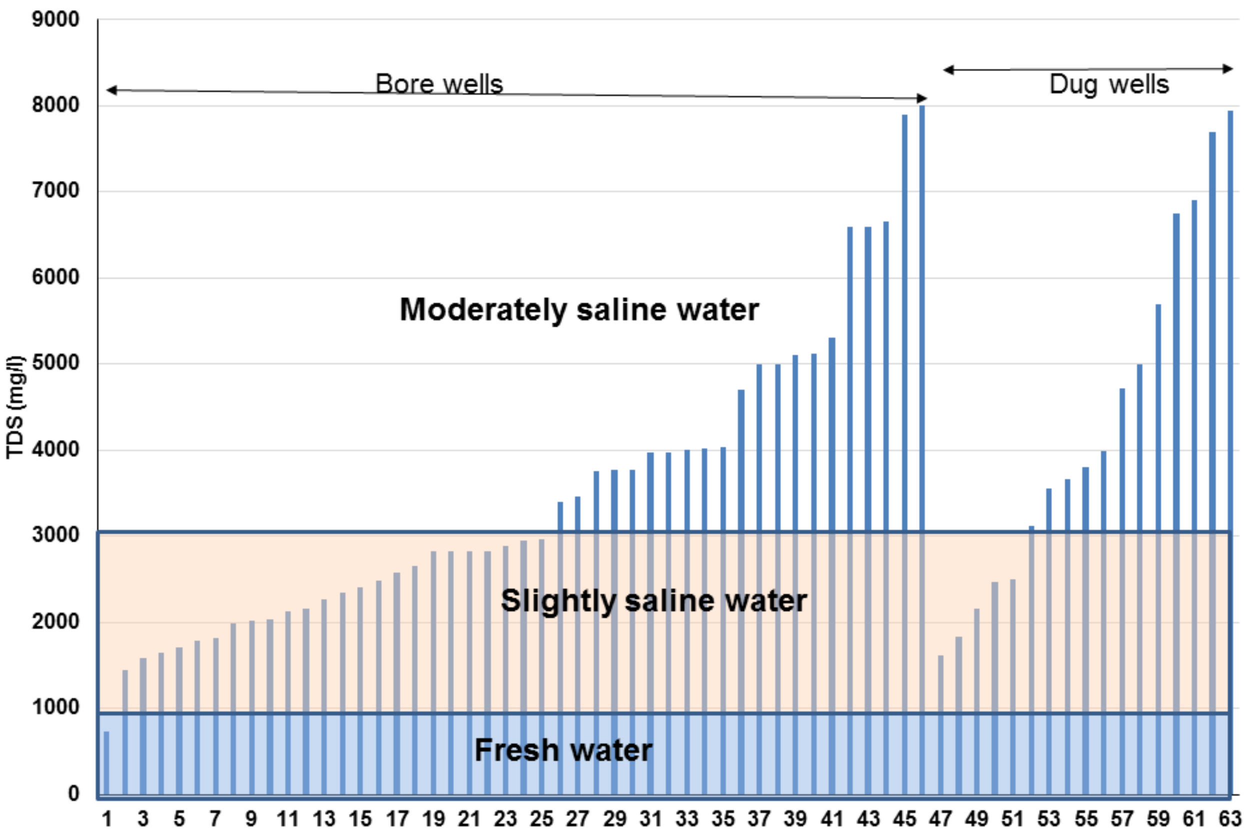

Fig. 4: Total dissolved solids (mg/l) in selected well waters in the study area.

Spatial distribution of TDS values and contours (Fig. 5 and Fig. 6) shows that moderate salinity (3000 to 8000 mg/l) spreads over about 1.6 km length in the NWW to SEE direction and about 700 m width at north of Rasipalayam village. Low salinity is observed in the west as well as in the northern side of the study area. Based on the samples availability, a gradual increasing trend of salinity is observed from west to east and a rapid change from north to south. By virtue of the north to south general topographic gradient in the study area, one can expect the natural groundwater flow direction from north to south. However, as the regional topographic trend is from west to east (evident by west to east flow of Noyil River), fracture system in the bed rock is also in the east-west direction. Surface water from the Achankulam lake located in the south-west corner of the study area, have the TDS value of 1030 mg/l indicating that it is highly contaminated.

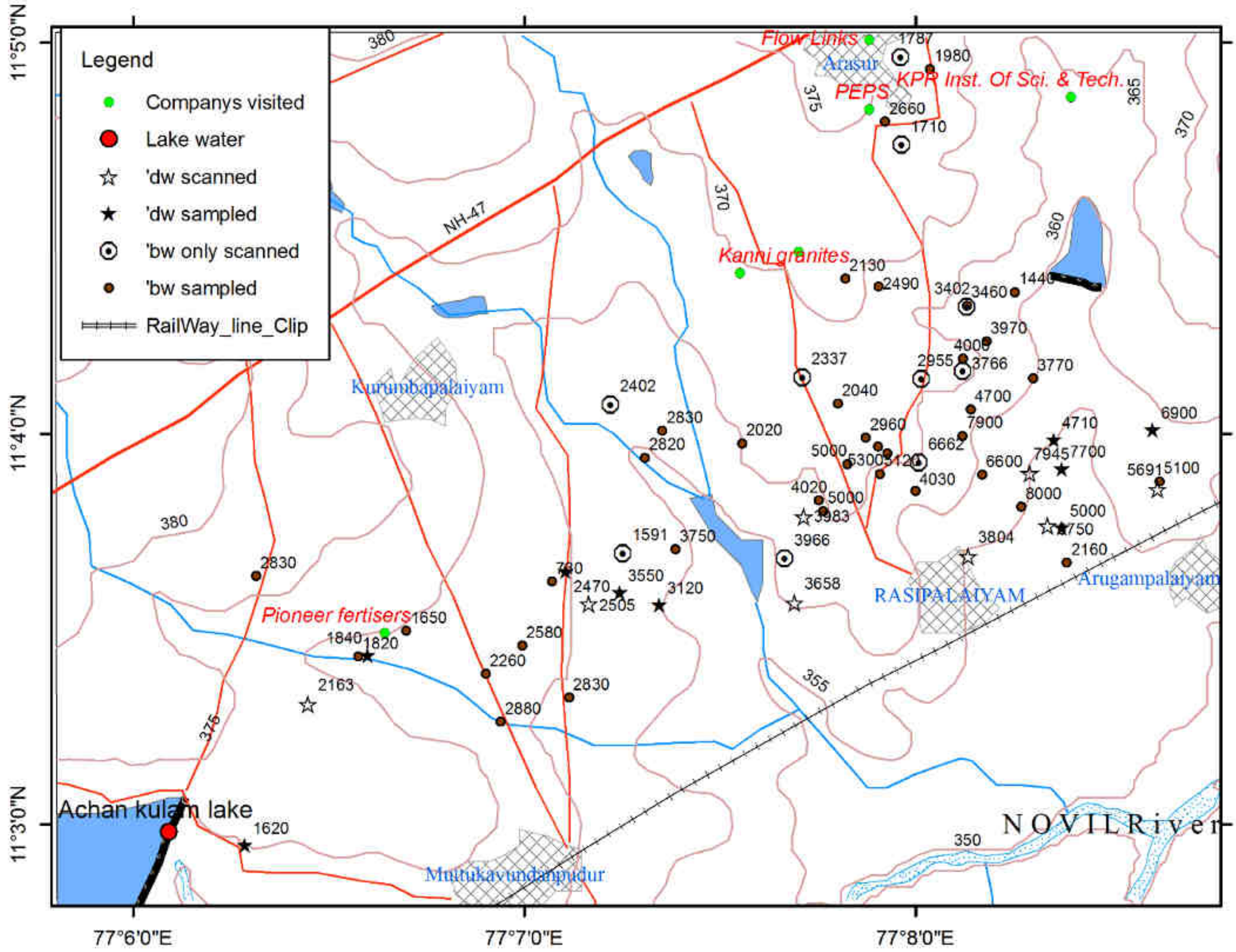

Fig. 5: Spatial distribution of TDS values (mg/l) and few medium size industries located in the area also shown.

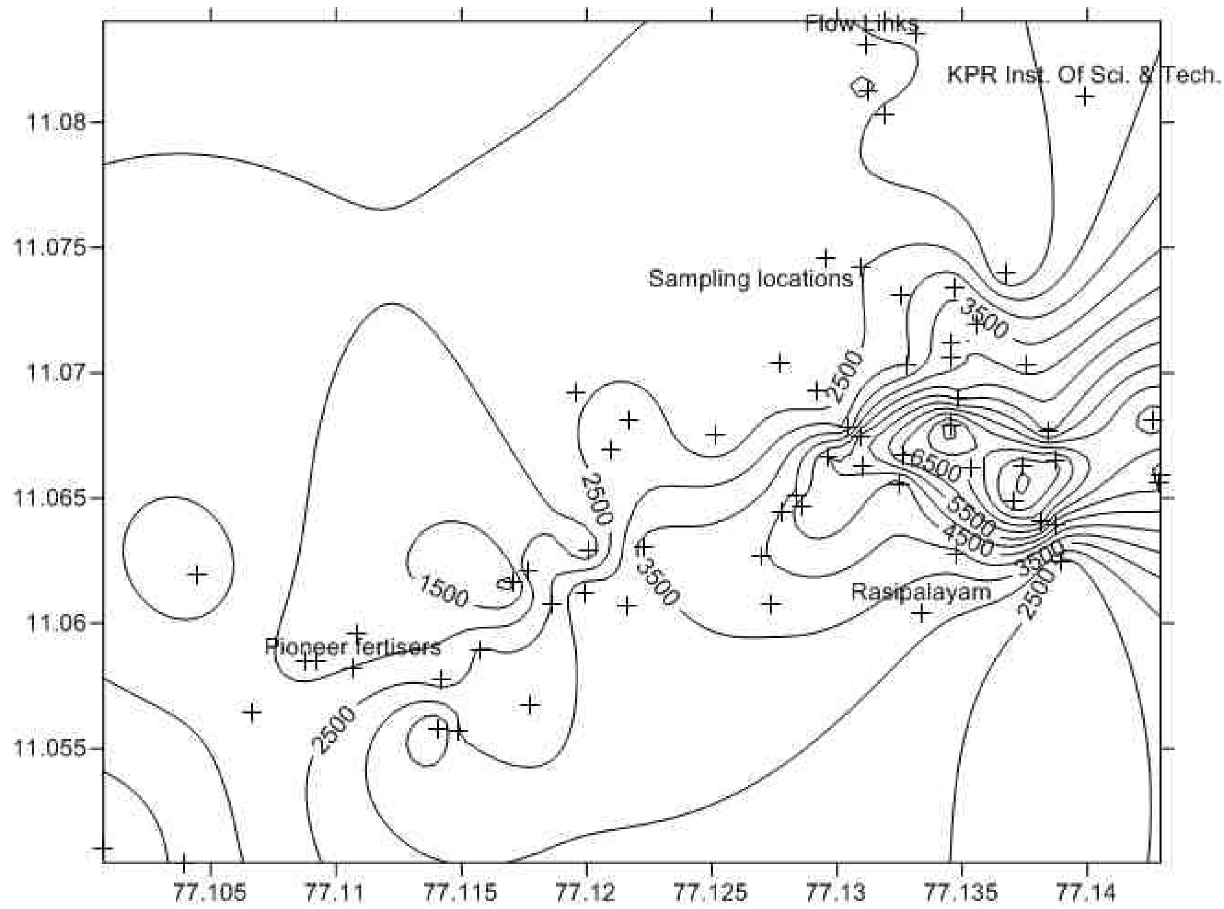

Fig. 6: Spatial distribution total dissolved solids (TDS, mg/l) in the groundwater in the study area.

Different ion concentrations in groundwater

Statistical distribution of different hydrochemical parameters are shown in Table 1 and Figure 7. Hydrogen ion concentration (pH) of groundwater ranges from 6.68 to 7.74, indicating slightly acidic to slightly alkaline character. Overall, most of the samples are neutral in nature. Na, the predominant cation varies between 234 mg/l to 1447 mg/l with an average of 700 mg/l. Ca, the second most dominant cation, is almost close to Na concentrations, even though its maximum and minimum values (89 and 1824 mg/l, respectively) deviated from Na values. Mg concentration ranges between 10 and 840 mg/l with a standard deviation of 223. K concentration varies from 8 mg/l to 45 mg/l. Cl is predominant anion with a large variation (standard deviation 1349) between minimum (258 mg/l) and maximum (5447 mg/l). Sulphate concentration is the second highest in anion, ranging from 206 mg/l to 2387 mg/l, which is almost half of the Cl concentration. HCO_3 is much lower in comparison to the other two anions ranging from 120 to 460 mg/l. No fluoride found in any of the samples but NO_3 concentration varies between 1 mg/l to 83 mg/l with an average of 29 mg/l.

Table 1: Statistical distribution of different ions in groundwater

	pH	EH	Cond	TDS	Na	K	Mg	Ca	Cl	SO_4	HCO_3	NO_3
		mV	µS/cm	←--------------------------------------mg/l-----------------------------------→								
Maximum	7.74	-22	14300	8000	1447	45	840	1824	5447	2387	460	83
Minimum	6.68	-102	1360	730	234	8	10	89	258	206	120	1
Average	7.04	-58	6772	3696	700	26	394	677	2316	1101	335	29
Stdev	0.22	13	3296	1835	303	8	223	397	1349	634	62	21

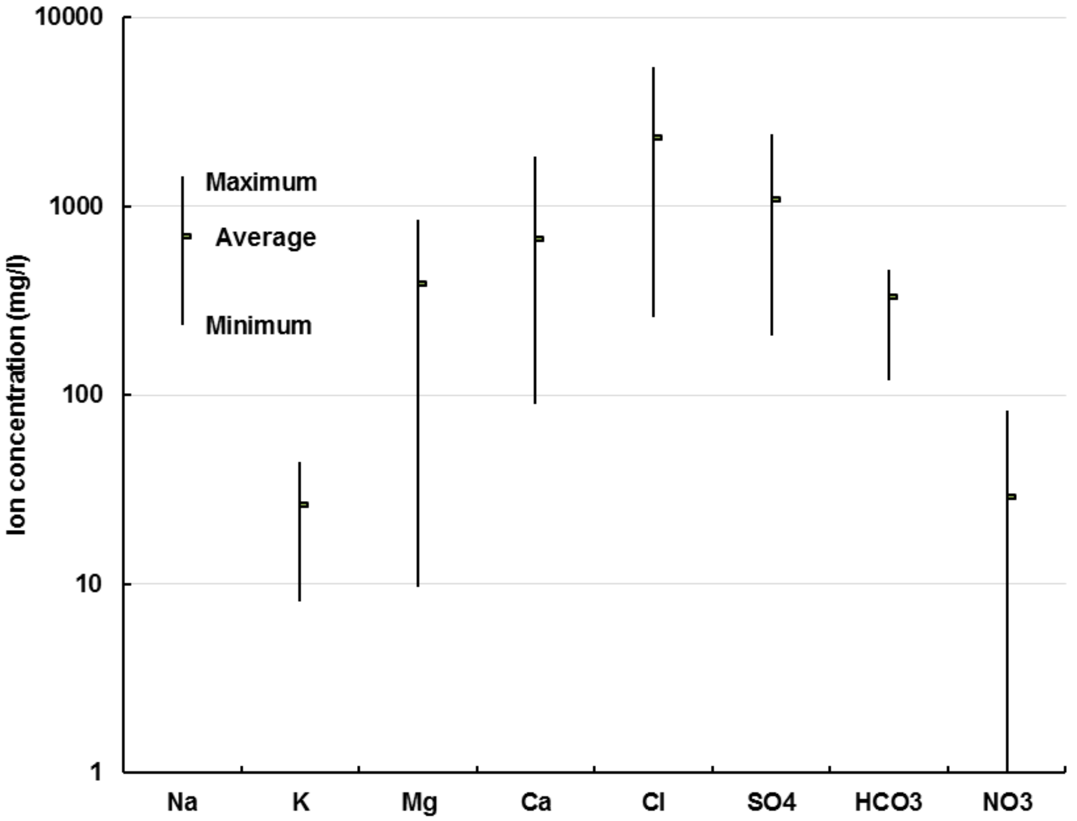

Fig. 7: Minimum, maximum and average ion concentrations in studied groundwaters.

Correlation of TDS with other chemical paramaters

Dissolved species and their relationship with each other, can reveal the origin of solutes and the processes that generated the measured composition of the groundwater. The plots of TDS versus major ions (Fig. 8) show that the mineralization is mainly controlled by calcium (R^2 = 0.9194) and magnesium (R^2 = 0:9236) for cations while chloride (R^2 = 0:9855) and sulphate (R^2 = 0.8798) for anions. Though the sodium concentration is in second position and closer to calcium concentrations, TDS and Na correlation coefficient is 0.7107. Bicarbonate concentration in groundwater is much less and has poor correlation with TDS.

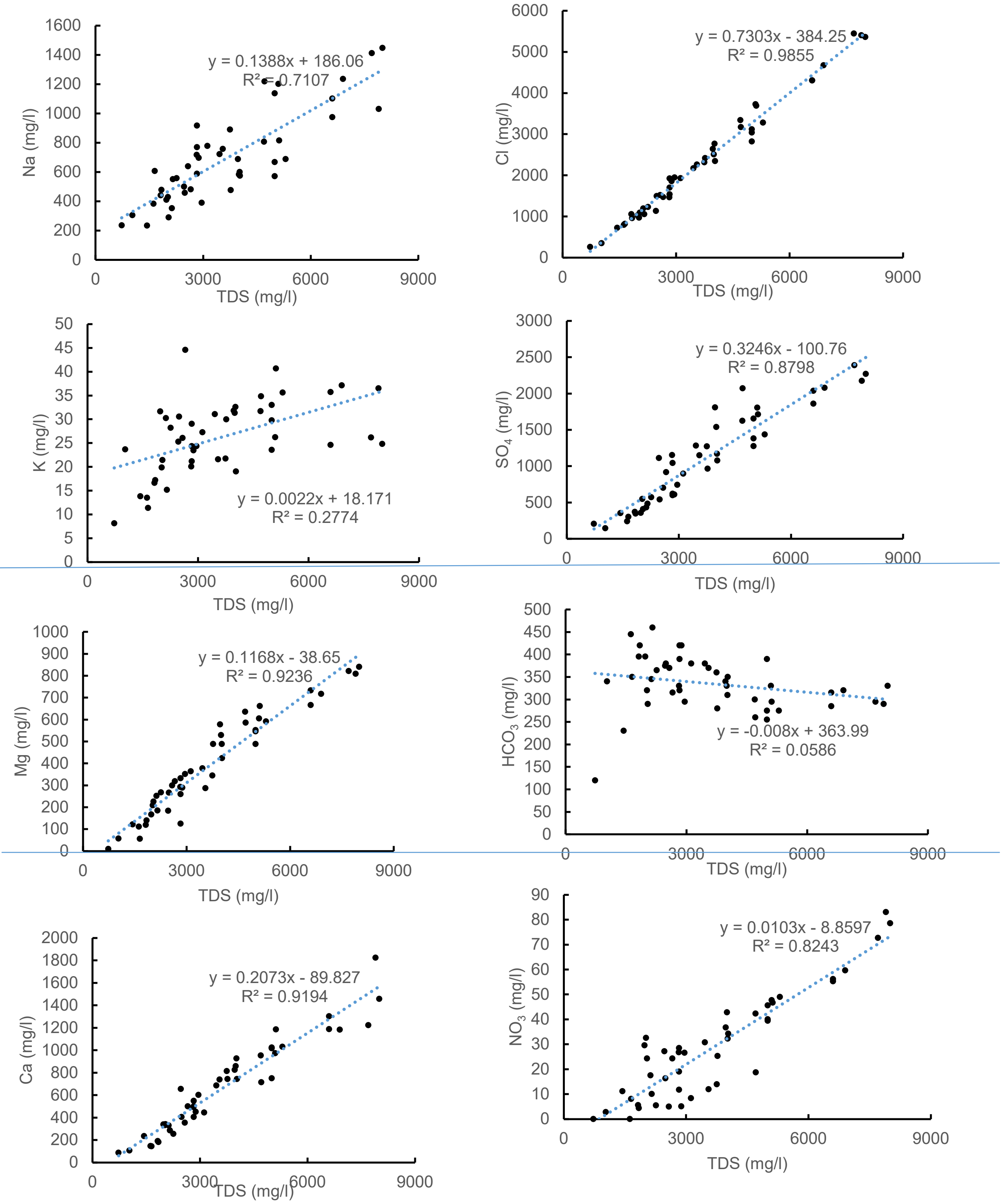

Fig. 8: Plots showing total dissolved solids (TDS) vs different ion concentrations in groundwater

Correlation coefficient of different ions in groundwater is presented in Table 2. Apart from the above correlation, Na, Ca and Mg also have good correlation with Cl and SO_4. HCO_3 does not have any correlation with any of the ions. Often the Na+ vs. Cl− relationship has been used to identify the mechanism for acquiring salinity. Being the granitic terrain, such relation may not exist for the study area, as the sources of these may be different. Main source of Na in granitic region is weathering of plagioclase feldspars. However, mineral of which Cl is an essential component, are not very common and Cl is likely to present as an impurity (Hem, 1991). Cl enters in groundwater mainly through precipitation, but later due to evaporation, enrichment and recirculation processes, its concentration increases. If the Cl concentration of higher-salinity water is approximately 1/10 of that in seawater (1950 mg/L) and half of the Cl ions are derived from biotite dissolution (Kamineni, 1987). Hence, in the present study area, combination of both the processes resulted high Cl content in the groundwater. Sulphur is widely distributed in igneous rock as metallic sulphides. Due to weathering process in the presence of aerated water, sulphur oxidizes and forms the sulphate in the groundwater. Due to this reaction, hydrogen ions are produced in considerable quantities. Hence the groundwater in the study are has slightly acidic conditions. Strong relationships Cl^{-}-Mg^{2+} and Cl^{-}-Ca^{2+} suggest that cation exchange can also significantly affect groundwater composition.

Table 2: Cross- correlation coefficients of different ions in groundwater

		pH	TDS	Na	K	Mg	Ca	Cl	SO_4	HCO_3	NO_3
pH		1	-0.181	0.314	-0.137	-0.322	-0.217	-0.105	2.90E-02	-0.42	-0.183
TDS	mg/L		1	0.7107	0.2774	0.9236	0.9194	0.9855	0.8798	0.0586	0.8243
Na	mg/L			1	0.47	0.529	0.585	0.791	0.709	-0.259	0.331
K	mg/L				1	0.552	0.446	0.578	0.347	7.30E-03	0.17
Mg	mg/L					1	0.906	0.911	0.827	-0.177	0.811
Ca	mg/L						1	0.909	0.888	-0.305	0.861
Cl	mg/L							1	0.844	-0.265	0.732
SO_4	mg/L								1	-0.367	0.755
HCO_3	mg/L									1	-0.363
NO_3	mg/L										1

Hydrochemical facies

Majority of groundwater samples with high TDS show Ca-Mg-Na-Cl-SO_4 water quality type and few of them Mg-Ca-Na-SO_4 and Na-Ca-Mg-Cl-SO_4 type. In order to find out the overall groundwater quality and the relation between different samples, hydrochemical data plotted in the Piper (1944) diagram (Fig. 9) which shows that the groundwater evolves toward the Cl+ SO_4 and Ca+Mg pole. Low HCO_3 indicates low present day recharge conditions. Out of 47 samples, only three samples (having lowest TDS and much higher Na in comparison to Mg+Ca) formed a group considered as Group I. Out of three samples, one is surface water from Achankulam lake, and other two are, a bore well sample and one dug well sample. Five wells forming Group II are two dug wells and three bore wells. Except one bore well located at southern boundary of high TDS wells, other four wells are located at western side. These samples also have higher Na and Cl concentrations. The rest 39 samples form as one group with higher Ca+Mg and Cl+SO_4 irrespective of their location. As almost all the samples concentrated at one corner, it shows similar type of chemical processes undergone all the samples.

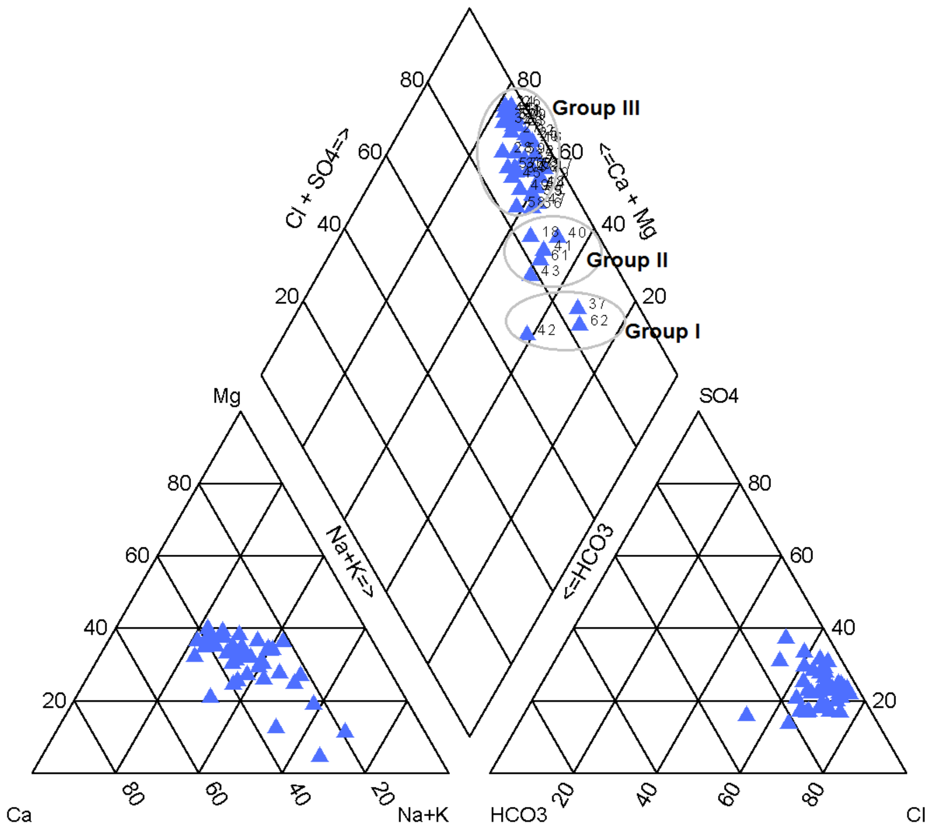

Fig. 9: Piper plot of groundwater samples.

Real time monitoring of electrical conductivity in Mr. A. K. Jaganathan's dug well

The dug well, which is having high TDS, encountered very good east-west fracture system at the level of water table. The well owner believes that, major groundwater source to the well is existing fracture system and groundwater flows into the well from the existing fractures. To understand the groundwater flow from the preferred path ways and its relation with high TDS, CTD divers were installed in the well to record the electrical conductivity (EC) and groundwater level in real time with 30-minute interval. We expected some changes in the EC during pumping of groundwater and non-pumping hours. Measurements were continued for about 20 days. Unfortunately, the water level sensor did not work, but EC measurements are shown in Figure 10.

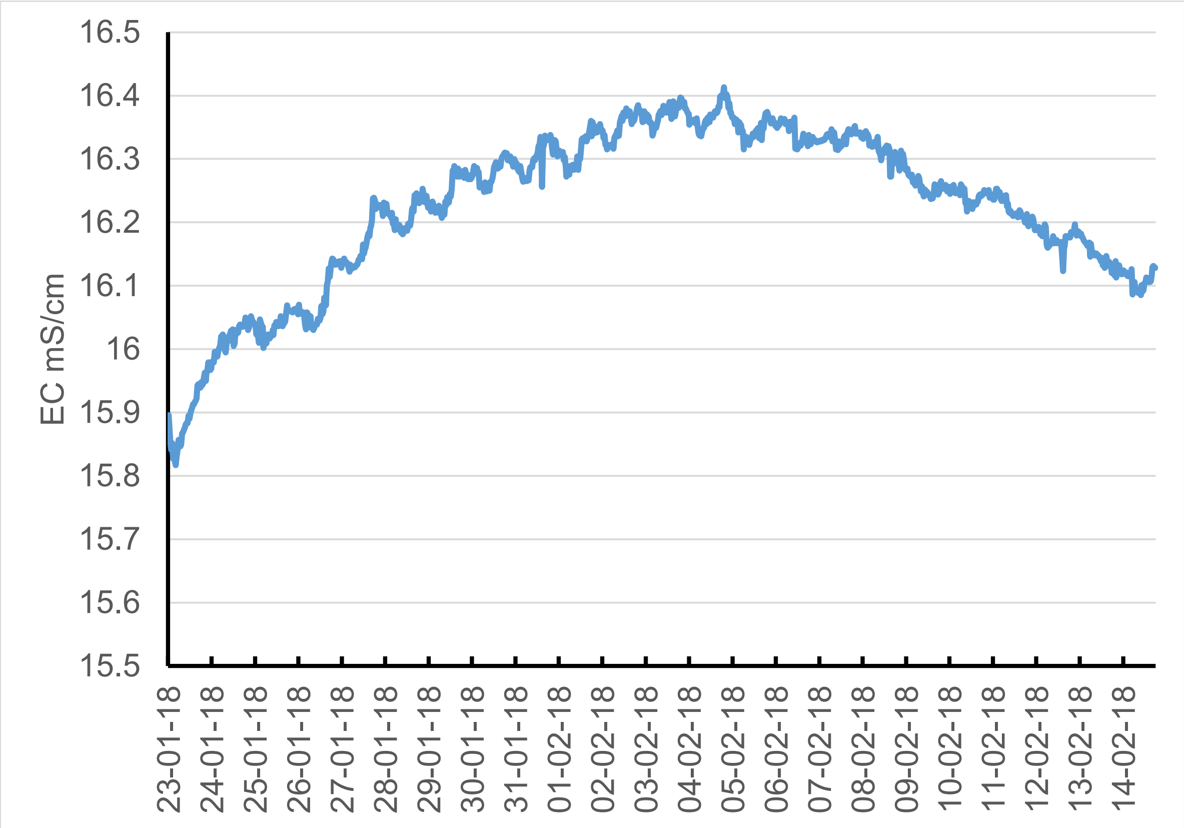

Fig. 10: Electrical conductivity of groundwater monitored in real time at 30-minute interval in the dug well of Mr. A. K. Jaganathan.

The farmer is pumping the groundwater for few hours every day. Due to that pumping we expect some drop in water level. Due to the drop in water level, we expect some change in chemistry, if certain portion water contributing from preferred pathways (fractures). In the figure 10, we could not see such systematic change in the EC in 24 hours' time. The change observed over a period of 20 days' time may be the natural change seasonal change. It shows that, fractures are not yielding any different quality type of water into the well.

10. **Summary and Concluding remarks**

Hydrochemical data compiled from all over India, Central Ground Water Board (CGWB, 2010) reported that along with many districts in India, Coimbatore in Tamil Nadu, is one of the district where, average TDS values exceed 3000 mg/l. However, they did not give any explanation for this high salinity. Present study results (based on salinity classification) show that, there is only one fresh water sample from the entire study area and rest of the samples can be classified as either slightly saline or moderately saline. Most of the moderately saline samples are concentrated in a small zone, north of Rasipalayam village. Even though, there is some variation in TDS and other hydrochemical values within the study area, high correlation coefficients between TDS and other ions; and between different major ions, indicate that the ions dissolved in the groundwater are from a single source. Hence, the source for high TDS/high ionic concentration could be the water rock interaction or geogenic. This argument is strengthened by the distribution of hydrochemical facies in the Piper Diagram (Fig. 9). Low bicarbonate content indicates low present-day groundwater recharge associated with low rainfall conditions in the area. Long residence time of groundwater can lead to long interaction between host rock and groundwater resulting in high TDS. Lack of variation in the EC during pumping and non-pumping hours, indicates lack of high TDS groundwater from preferred path ways existing in the study area. Though there are few medium size industries around the study area, they are not producing either solid or liquid waste and groundwater in their premises has relatively better quality. Many samples in and around the Coimbatore Pioneer Fertilizers Ltd. Industrial unit, have relatively better quality groundwater. Concertation of moderately saline groundwater in a limited area, may be due the specific geological formation and structures (dense network of fracture system) in the area, which may require further geophysical investigations.

Table 3: Hydrochemical data of collected samples

s. no	Location	well type	Sampling Date	well depth	pH	EH	Cond	TDS	Na	K	Mg	Ca	Cl	SO4	HCO3	NO3	Total hardn	Ca hds	Mg hds
				feet		mV	µS/cm	<---mg/l-->											
1	CMB-16	Dw	09-01-18		6.92	-53	13900	7700	1411	26	822	1223	5447	2387	295	73	5320	674	4646
2	CMB-17	DW	09-01-18		7.74	-102	8630	4710	1219	35	586	716	3169	2071	260	19	3060	329	2731
3	CMB-18	BW	09-01-18		7.26	-69	4010	2160	551	15	186	286	1056	482	460	10	900	900	0
4	CMB-19	DW	09-01-18		7.13	-64	9100	5000	1138	24	489	751	2821	1653	390	39	2940	978	1962
5	CMB-20	DW	09-01-18		7.14	-65	12700	6900	1236	37	717	1185	4672	2078	320	60	5320	1075	4245
6	CMB-21	BW	09-01-18	450	7.08	-60	9300	5100	1202	26	605	975	3724	1803	330	48	3900	1123	2777
7	CMB-22	BW	09-01-18		6.98	-55	12000	6600	1102	25	666	1189	4304	2038	315	56	3800	834	2966
8	CMB-23	BW	09-01-18	740	7.19	-67	8610	4700	806	32	636	955	3343	1622	300	42	3540	818	2722
9	CMB-24	BW	09-01-18		7.01	-57	9200	5000	572	30	552	1019	3041	1382	275	46	3460	1163	2297
10	CMB-25	BW	09-01-18	150	7.02	-57	14300	8000	1447	25	840	1457	5361	2269	330	79	4820	1532	3288
11	CMB-26	BW	09-01-18	700	6.83	-46	14200	7900	1030	36	809	1824	5406	2174	290	83	6060	786	5274
12	CMB-27	BW	09-01-18		6.95	-52	7400	4030	574	19	424	745	2343	1077	350	34	3060	329	2731
13	CMB-28	BW	09-01-18	700	7.14	-64	3780	2040	290	21	226	343	1088	408	290	24	1520	938	582
14	CMB-29	BW	09-01-18	600	6.87	-49	12100	6600	974	36	733	1304	4308	1858	285	55	4260	850	3410
15	CMB-30	BW	09-01-18		6.9	-48	7340	4000	582	31	529	860	2508	1539	330	43	3620	850	2770
16	CMB-31	BW	09-01-18	350	6.77	-45	9700	5300	689	36	592	1032	3280	1435	275	49	3720	529	3191
17	CMB-32	BW	09-01-18	500	6.81	-46	5480	2960	389	24	351	602	1945	741	295	27	2040	1091	949
18	CMB-33	BW	09-01-18	550	6.82	-46	9280	5120	816	41	661	1187	3692	1711	295	47	4360	321	4039
19	CMB-34	BW	09-01-18	900	6.94	-52	4590	2490	457	31	267	407	1496	540	380	16	1480	513	967
20	CMB-35	BW	09-01-18	750	6.93	-52	6380	3460	722	31	378	688	2170	1281	380	31	2560	513	2047
21	CMB-36	DW	09-01-18		7.29	-73	4580	2470	500	25	184	656	1134	1112	375	27	1380	513	867
22	CMB-37	BW	09-01-18	700	7.65	-95	1360	730	236	8	10	89	258	206	120	0	220	80	140
23	CMB-38	BW	09-01-18	300	6.88	-51	5170	2830	587	29	333	406	1921	597	320	12	1580	321	1259
24	CMB-39	BW	09-01-18	500	7.01	-57	5270	2880	696	23	290	452	1857	609	420	5	1320	345	975
25	CMB-40	BW	09-01-18	620	6.86	-49	5240	2830	917	24	125	549	1699	618	390	19	1080	401	679

26	CMB-41	BW	09-01-18		7.2	-68	3380	1820	440	17	120	191	1051	370	395	6	700	209	491
27	CMB-42	tw	09-01-18		7.82	-103	1930	1030	305	24	57	109	348	146	340	3	480	88	392
28	CMB-43	DW	09-01-18		7.36	-77	3000	1620	382	13	112	147	791	240	445	0	360	144	216
29	CMB-44	BW	09-01-18	850	6.68	-39	6930	3770	475	30	488	746	2419	963	280	25	2880	626	2254
30	CMB-45	BW	09-01-18	800	7.16	-65	2690	1440	234	14	122	237	720	353	230	11	600	160	440
31	CMB-46	BW	09-01-18	900	6.75	-43	7290	3970	688	32	578	826	2639	1808	340	37	3320	730	2590
32	CMB-47	BW	09-01-18	560	7.29	-56	5220	2830	769	21	260	501	1537	1043	420	28	1780	321	1459
33	CMB-48	BW	09-01-18	880	6.94	-53	5210	2820	717	20	293	495	1462	1153	330	27	1900	449	1451
34	CMB-49	BW	09-01-18	550	6.95	-54	3760	2020	428	20	209	333	966	546	320	33	1060	345	715
35	CMB-50	BW	09-01-18	700	6.77	-44	7290	4020	599	33	489	928	2767	1168	310	32	3060	642	2418
36	CMB-51	BW	09-01-18	630	7.24	-70	9100	5000	668	33	546	1025	3117	1276	255	40	3800	794	3006
37	CMB-52	BW	09-01-18	750	6.88	-50	6900	3750	889	22	345	816	2312	1270	360	14	2000	730	1270
38	CMB-53	DW	09-01-18		7.03	-57	6540	3550	757	22	287	740	2263	1148	370	12	2400	537	1863
39	CMB-54	DW	09-01-18		7.02	-57	5750	3120	777	27	364	446	1931	896	380	8	1940	553	1387
40	CMB-55	BW	09-01-18		7.01	-57	4790	2580	639	26	299	355	1515	702	370	5	1500	273	1227
41	CMB-56	BW	09-01-18		7.03	-58	4200	2260	557	28	267	256	1226	572	365	5	1420	241	1179
42	CMB-57	BW	09-01-18		6.97	-56	3950	2130	352	30	252	331	1194	431	345	17	1460	361	1099
43	CMB-58	BW	09-01-18		7.07	-60	3680	1980	410	32	167	341	1021	355	395	30	1180	313	867
44	CMB-59	BW	09-01-18	350	7.26	-71	4940	2660	481	45	318	502	1468	916	315	24	1960	385	1575
46	CMB-61	DW	09-01-18		7.01	-22	3420	1840	478	17	140	183	954	344	420	4	880	241	639
47	CMB-62	BW	09-01-18		7.2	-67	3060	1650	606	11	56	146	819	301	350	8	500	201	300
	CMB-63				7.95	-114	9700	5300	2145	26	274	913	4234	1852	120	17			
	CMB-64				8.21	-125	7300	3970	1715	24	318	951	3045	2522	125	44			
	CMB-65				7.37	-77	9000	5000	1349	46	558	710	4272	621	310	40			
	CMB-66				7.15	-65	8980	4900	2065	75	568	812	5114	1304	410	1			

References:

CGWB 2010.Groundwater quality in shallow aquifers of India. A report from Central Ground Water Board, Faridabab, GoI.

Hem JD (1991) Study and interpretation of the chemical characteristics of natural waters, Book 2254, 3rd edn. Scientific Publishers, Jodhpur

Kamineni, D.C., 1987. Halogen-bearing minerals in plutonic rocks: a possible source of chlorine in saline groundwater in the Canadian Shield. In: Fritz, P., Frape, S.K. (Eds.), Saline

Piper, A.M. (1944) A Graphic Procedure in the Geochemical Interpretation of Water Analyses. Transactions—American Geophysical Union, 25, 914-923. http://dx.doi.org/10.1029/TR025i006p00914

Ramesh, R and Subramanian, V. 1988. Nature of the dissolved load of the Krishna River Basin, India. Journal of Hydrology, 103(1-2), 139-155.

Subburaj, A. 2008. District groundwater brochure Coimbatore district, Tamilnadu. Technical Report series, Central Ground Water Board, Chennai.

Few Field Photographs: