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Studies on physicochemical parameters to assess the water quality in Obulavaripalli Mandal of YSR (Kadapa) District, Andhra Pradesh, India

M. Prasad[1]*, B. Muralidhara Reddy[2], M. Ramakrishna Reddy[1] and V. Sunitha[2]

[1]Department of Earth Sciences, Yogi Vemana University, Kadapa, Andhra Pradesh, India
[2]Department of Geology, Yogi Vemana University, Kadapa, Andhra Pradesh, India
Corresponding author

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A B S T R A C T

Groundwater constitutes an important source of water for drinking, agriculture and industrial production. The use of groundwater has increased significantly in the last decades due to its widespread occurrence and overall good quality. Physical and chemical constituents are useful in deciding water use strategies for various purposes. The present study deals with the ground water quality in Obulavaripalli Mandal of YSR (Kadapa) District, Andhra Pradesh, India. The study area lies in the Southeastern part of YSR (Kadapa) District, Andhra Pradesh and is located in the Survey of India Toposheet No's 57 N/4, N/8 O/1 and O/5 lying between e 79^0 06′ 09″ - $79^0$22′16″ longitudes and N13^0 48′ 50″ - 14^0 09′ 13″ latitudes. Geologically the study area consists of shales/phyllites, limestone and quartzite formations. A total of 27 samples was collected from bore wells and surface as well, in the month of September 2014. Deviations were observed by some groundwater samples in the study area. The correlation coefficients were calculated for water quality assessment. Assessment of water samples from various methods indicated that groundwater in the study area is not suitable for drinking purposes, and the TDS, EC TH and fluoride concentrations were exceeding the permissible limits for human consumption, as per the standards of WHO.

Introduction

Water plays vital role in human life. It is extremely essential for survival of all living organisms. Groundwater is ultimate, most suitable fresh water resource with nearly balanced concentration of the salts for human consumption (Krishna Kumar Yadav et al., 2012). The majorities of the populations in developing countries are inadequately supplied with potable water and are thus bound to use water from sources like shallow wells and bore holes that have high potential of contamination and provide the unsafe water for domestic and drinking purposes (WHO, 2011).

As water play an important role in the biological activities of universe. Without water no life on earth. Unfortunately, water resources are getting polluted and getting unfit for use (Hynes, 1971). Use of polluted water itself takes about 25000 peoples all over the world every day (Anil Kumar and Arnab Kumar De, 2001).

Ground water is believed to be comparatively much hygienic than the surface water. Over use of ground water drinking, irrigation and domestic purposes has resulted in rapid depletion of water. Pollution of ground water aquifers has made many of these wells unfit for consumption (Chutia and Sarma, 2009).

The quality of water is of vital concern for the mankind since it is directly linked with human welfare. There are several states in India where more than 90% populations are dependent on groundwater for drinking and other purpose (Ramachandraiah, 2004; Tank and Singh, 2010). Groundwater quality has become an important water resources issue due to rapid increase of population, rapid industrialization, unplanned urbanization and too much use of fertilizers and pesticides in agriculture (Joarder et al., 2008).

It is also important to note that groundwater quality is one of the most important aspects in water resource studies (Ackah et al., 2011; Sayyed and Wagh, 2011). It is largely controlled by discharge recharge pattern, nature of the host and associated rocks as well as contaminated activities (Raghunath, 1987; Sayyed and Sayadi, 2011; Zhang et al., 2011).

The availability of water through surface and groundwater resources has become a critical day today. Only 1% part is available on land for drinking, agriculture, domestic power generation, industrial consumption, transportation and waste disposal (Mishra and Pradip Tripathi, 2002; Tahir et al., 2008).

The present study was undertaken to investigate the impact of surface and groundwater quality of some open wells and bore well water samples in Obulavaripalli Mandal of YSR (Kadapa) district Andhra Pradesh. Thus, in this research work an attempt has been made to assess the physical and chemical parameters of groundwater like, Temperature (T), pH, electrical conductivity (EC), total dissolved solids (TDS), Total Hardness (TH), Total Alkalinity (TA), calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^{-}) and fluoride (F^{-}). The analyzed data were compared with standard values recommended by WHO and also correlation coefficient was calculated to assess the relationship between various parameters.

Materials and Methods

Water samples were collected in high dens polyethylene containers previously washed in a solution of 10% nitric acid in an ultrasonic bath for 15 minutes, followed by repeated rinsing with distilled water. A total of 27 samples was collected from bore wells and surface as well (tanks and mine), in the month of September 2014. Water samples were stabilized with ultrapure nitric acid (0.5% HNO3). Collected samples are analyzed for major physical and chemical parameters like pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Alkalinity (TA), Total Hardness (TH), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Flouride (F^{-}) Chloride (Cl^{-}) and were determined in the laboratory using the standard methods of APHA (1995), Water Analyser-371 (geochemical field kit). Arc GIS 9.2 mapping software used for

preparation of Location map as well as lithology map of the study area to get a better interpretation based on the rock types which are present in the study area.

Study area

Obulavaripalli Mandal is located in the Southern part of the of Cuddapah basin. Pullampet and Kodur are the adjacent Mandals of YSR (Kadapa) district. The area is located in the Survey of India toposheet No's 57 N/4, N/8, O/1 and O/5 lying between E 79^0 06′ 09″ - $79^0$22′16″ longitudes and N13^0 48′ 50″ - 14^0 09′ 13″ latitudes on 1: 50,000 scale. Obulavaripalli, Chinna Orampadu, Govindampalli, Korlakunta Mangampeta are the villages surrounded by the study area. Location map of the study area is shown in the Figure 1, and sample location latitude longitude and elevations of the study area were shown in the Table 1.

Lithologically, the Cuddapah formations are predominantly argillaceous sequence with subordinate calcareous sediments. Characteristically each group starts with quartzite and ends with dolomite or Shale/Phylite. The Nagari quartzite is exposed mainly in the southern part of the basin. This is dominantly an arenaceous consisting of conglomerate quartzite, quartzite with shale formations. The Pullampet formation rests over the Nagari quartzite conformably in the southern part of the basin with purple shale, carbonaceous shale and calcareous shale with prominent intercalations of dolomitic limestones. The basal part of the Pullampet is marked by the ferruginous chert and Jasper with lensoid dolomite patches. Large outcrops of quartzite are seen in the southern and western portion of the area as hills and ridges. The main factors that control the quality of water are associated with lithology and soil. Water quality may vary depending upon variations in geological formations. The ratio of different elements in the subsurface water is dependent on the associated rocks and sediments that form the aquifers and the time it has been in contact with this geological material (Arveti Nagaraju et al., 2006).

Result and Discussion

The results of analysis of physico-chemical parameters of the study area are shown in the Table 3

pH

pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. pH is considered as an important ecological factor and provides an important piece factor and piece of information on many types of geochemical equilibrium or solubility calculation (Shyamala et al., 2008). The maximum pH was recorded as 8.8 at sampling location Kadiyampalli and the minimum was 7.7 at G. Voddipalli village. When compared with the standard values of WHO and IS 10500-91, 6.5–8.5. The water samples are found to be in the permissible limit at all locations. The pH of the study area belongs to alkaline in origin.

Electrical conductivity (EC)

Electrical conductivity (EC) is a measure of water capacity to convey electric current. It signifies the amount of total dissolved salts (Dahiya and Kaur, 1999) and is a useful tool to evaluate the purity of water (Acharya et al., 2008). Conductivity shows significant correlation with ten parameters such as temperature, pH value, alkalinity, total hardness, calcium, total solids, total dissolved solids, chemical oxygen demand and chloride and iron concentration of

water. Navneet Kumar and Sinha (2010) suggested that the underground drinking water quality of the study area can be checked effectively by controlling conductivity of water and this may also be applied to water quality management of other study areas. EC values were in the range of 600–2450 µs.

High EC values were observed at 29% of the sampling points with reference to WHO standards, indicating the presence of high amount of dissolved inorganic substances in ionized form.

Total Dissolved Solids (TDS)

Total dissolved solids indicate the salinity behavior of groundwater. Water containing more than 500 mg/l of TDS is not considered desirable for drinking water supplies, but in unavoidable cases 1500 mg/l is also allowed (Shrinivasa Rao and Venkateswaralu, 2000), highly mineralized water may be used where better quality water is not available (Jain, 2002).

TDS values varied in the study area varies from 288 mg/l to 1170 mg/l which were found within the permissible limits of WHO 1000 mg/l, except at sample locations Chelampalem (1110 mg/l) and Mangampeta mine (1170 mg/l).

Total Hardness (TH)

Hardness is the property of water, which prevents the lather formation with soap and increases the boiling points of water (Patil and Patil, 2010). Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. According to some classifications, water with hardness up to 75 mg/l is classified as soft, 76–150 mg/l is moderately soft, 151–300 mg/l as hard and more than 300 mg/l as very hard (Saravanakumar and Ranjith Kumar, 2011). The hardness values of the present study area ranges from 100 mg/ to 600 mg/L. The Mangampeta mine location having the highest hardness 600 mg/l which exceeds the WHO limit of 100–500 mg/l

Total alkalinity (TA)

It is composed primarily of carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-), alkalinity acts as a stabilizer for pH. Alkalinity, pH and hardness affect the toxicity of many substances in the water. Alkalinity in boiler water essentially results from the presence of hydroxyl and carbonate ions.

Hydroxyl alkalinity (causticity) in the boiler water is necessary to protect the boiler against corrosion. Too high a causticity causes other operating problems, such as foaming. Excessively high causticity levels can result in a type of caustic attack of the boiler called "embrittlement" (Patil et al., 2012) in the present analysis values were found in the range of 12–146 mg/l.

Temperature (T)

Temperature is an important biologically significant factor, which plays an important role in the metabolic activities of the organism. The temperature ranged from 24.0°C to 27.00°C during the study period. The property of water is that with a change in temperature, its density varies and it becomes less with warming up and more with cooling.

Calcium (Ca^{2+})

Calcium is directly related to hardness and is the chief cation in the water. Calcium concentration ranged between 40 mg/l to 200 mg/l and found within permissible limits of WHO, 75–200 mg/l range.

Magnesium (Mg^{2+})

Magnesium is directly related to hardness. Magnesium showing very strong positive correlation against hardness content in the investigated water samples was ranging from 05 mg/l to 107 mg/l which was found within the WHO limit. In the study area majority of the sample locations fall in the 150–200 m water contour levels (CGWB, Kadapa, 2011) in which magnesium content is very less except location which belongs to Mangampeta mine water indicates that the rock type may be carbonate rock types and the study area lying on the shale.

Chloride (Cl^-)

The chloride concentration serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to laxative effects (Dahiya and Kaur, 1999). In the present analysis, chloride concentration was found in the range of 71 mg/l to 405 mg/l. 29% of the water samples collected from study area was above the prescribed limits 0–200 mg/l of WHO. 405 mg/l was recorded at Chelampalem location. This chloride may be supplied by the local leaching of sedimentary rocks. The average chloride content of sedimentary rocks is about the same as the evaporate rocks 150 ppm (Behne, 1953) and indicating sedimentary depositional environment in the study area.

Fluoride (F^-)

Probable source of high fluoride in Indian waters seems to be that during weathering and circulation of water in rocks and soils fluorine is leached out and dissolved in ground water (Murhekar Gopalkrishna, 2011). Excess intake of fluoride through drinking water causes fluorosis on human being. Fluoride at a lower concentration at an average of 1 mg/l is regarded as an important constituent of drinking water (WHO, 1972). In the present analysis, fluoride concentration was found to be in the range of 0.14 mg/l–2.54 mg/l at Yellapalli (2.54 mg/l). Chinna Orampadu (1.69), Mukkavaripalli (1.81), Mukkavaripalli harizanawada (1.65) and Appaguntapalli (1.75) locations are above the WHO permissible limit of 1–1.5 mg/l.

Statistical analysis

The high positive correlation was found between TDS and EC (0.998907), Magnesium and Total Hardness (0.904071), Chloride and EC (0.677821), Chloride and TDS (0.681212), Total Hardness and EC (0.626534). While the negatively correlated values were found between EC and pH (-0.36499) and TDS and pH (-0.3569) Chloride and pH (-0.3462) as shown in Fig.2

In conclusions, the physico-chemical analysis was carried out to assess the water quality in the Obulavaripalli Mandal of YSR (Kadapa) District. By observing the result, it can be concluded that the parameters which were taken for study the water quality are showing that, all the pH values above 7.6 and The maximum pH was recorded at 8.8 at Kadiyampalli location, indicating that the source rocks may be of alkaline origin. Fluoride concentration was found in the range of 0.14–2.54 mg/l. 18.5 % of the sample locations were found above the WHO permissible limits. High EC values were observed from 29 % of the sampling points. Chloride concentration was found in the range of 71 mg/l to 404.7 mg/l. positively correlated values were found between TDS and EC (0.998907), Magnesium and Total Hardness (0.904071), and low Magnesium and Calcium values indicating the non carbonaceous aquifers as

the source of the ground water. In this present investigation, it was found that the most of the parameters were exceeding the permissible limit of WHO, so that the water in the study area is not suitable for drinking purposes.

Table.1 Latitude, longitude and Elevation values of the water sample locations

S.No	Sample location	Latitude	longitude	elevation
1	Kapupalli	14^0 01' 10.2"	79^0 18' 40.2"	202
2	Chinnaorampadu	14^0 02' 24.9"	79^0 16' 00"	199
3	Mukkavaripalli	14^0 03' 41.4"	79^0 17' 9.6"	185
4	Mukkavaripalli harizanawada	14^0 04' 12"	79^0 17' 17.6"	183
5	Appaguntapalli	14^0 04' 10.2"	79^0 17' 35.5"	183
6	Papireddypalli - I	14^0 04' 35.4"	79^0 17' 10.9"	194
7	Papireddypalli – II	14^0 04' 40"	79^0 19' 6.9"	183
8	Bestavaripalli	14^0 05' 03.6"	79^0 16' 52.9"	186
9	Yellayapalli	14^0 03' 51.2"	79^0 18' 8.5"	192
10	Krishnampalli	14^0 04' 31.6"	79^0 17' 57.1"	196
11	Mangalampalli	14^0 03' 41.1"	79^0 18' 52"	187
12	Kadiyampalli	14^0 03' 31.9"	79^0 19' 5.0"	177
13	Shankarapuram	14^0 02' 50.2"	79^0 19' 13"	174
14	Govindampalli	14^0 02' 50.7"	79^0 19' 27.1"	168
15	**Govindampalli (Tank)**	14^0 02' 24.7"	79^0 18' 54.6"	177
16	Chelampalem	14^0 01' 13.4"	79^0 18' 14.5"	202
17	**Korlakunta (lake)**	14^0 02' 52.3"	79^0 17' 30.1"	193
18	Sanjeevapuram harizanawada	14^0 02' 34.2"	79^0 17' 19.1"	192
19	Korlkunta school	14^0 01' 54.4"	79^0 17' 22.9"	206
20	Chelampalem	14^0 00' 18.7"	79^0 18' 11.8"	207
21	Chennarajupodu	14^0 00' 04.6"	79^0 17' 19.5"	208
22	G. Voddipalli	14^0 00' 43.3"	79^0 17' 11.1"	207
23	Mudinepalli	14^0 01' 30.4"	79^0 16' 5.0"	206
24	O. Voddipalli	14^0 01' 57.6"	79^0 16' 2.9"	201
25	Obulavaripalli	14^0 02' 20.3"	79^0 16' 1.5"	199
26	Ayyalarajupalli	14^0 03' 05.5"	79^0 15' 57.9"	190
27	**Mangampeta (mine water)**	14^0 01' 10.2"	79^0 19' 40.2"	40

Table.2 Total hazardness

TH Range	Quality	No. of samples	%
>75	soft	-	-
76-150	Moderately soft	2	7.41
151-300	hard	16	59.26
>300	Very hard	9	33.3
Total		27	100

Table.3 Results of chemical analysis of physicochemical parameters of the Study area

Sample No	pH	EC (µs)	TDS (ppm)	TH (mg/l)	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)	CO_3^- (mg/l)	HCO_3^- (mg/l)	F^- (mg/l)	Cl^- (mg/l)
1	7.9	1090	470	320	60	63	48	-	0.51	121
2	8.1	1010	486	160	120	10	72	-	1.69	135
3	8.1	1840	890	240	60	44	36	-	1.81	284
4	8.3	1080	518	240	40	49	24	-	1.65	156
5	7.9	1950	940	240	180	15	48	-	1.75	334
6	7.9	1830	880	260	100	39	24	-	1.39	263
7	8	1980	950	280	100	44	48	-	0.96	327
8	8	1520	730	100	80	5	36	-	0.55	163
9	8.2	1330	640	280	40	58	36	-	2.54	142
10	8.3	1700	810	320	180	34	60	-	1.11	178
11	7.8	1090	522	200	160	10	36	-	1.03	135
12	8.8	740	355	180	140	10	36	-	0.52	78
13	8	1990	960	480	200	68	36	-	0.40	142
14	7.7	1110	529	320	100	53	72	-	0.64	78
15	7.9	1530	740	400	120	68	24	-	0.35	135
16	8.2	1110	529	280	100	44	24	-	0.45	142
17	8	1750	828	240	160	19	-	146	0.14	71
18	7.8	1390	660	340	140	47	48	-	0.75	178
19	7.7	1790	860	360	120	58	24	-	0.75	220
20	7.6	2320	1110	340	100	58	24	-	0.99	405
21	7.9	1080	518	240	60	44	12	-	0.71	142
22	7.9	1850	880	300	140	39	24	-	0.34	348
23	7.8	600	288	140	60	19	12	-	0.28	121
24	8.2	910	436	220	80	34	24	-	0.15	135
25	8.2	1010	485	180	80	24	24	-	0.89	178
26	7.7	1430	680	240	100	34	12	-	1.42	227
27	7.9	2450	1170	600	160	107	36	-	0.49	199
WHO 2005	***6.5 -8.5***	***500***	***1000***	***100 - 500***	***75-200***	***0 - 200***	***-***	-	***1-1.5***	***0-200***

Table.4 Correlation among physicochemical parameters of the water s

	Ec (µs)	TDS	TH	PH	Ca^{2+}	Mg^{2+}	CO_3^-	F^-	Cl^-
Ec	1								
TDS	0.998907	1							
TH	0.626534	0.617057	1						
PH	-0.36499	-0.3569	-0.2468	1					
Ca^{2+}	0.444346	0.44682	0.413536	-0.05782	1				
Mg^{2+}	0.479475	0.467906	0.904071	-0.24389	-0.01526	1			
CO_3^-	0.127112	0.115568	-0.01207	0.034772	0.373918	-0.18877	1		
F^-	0.088962	0.100586	-0.18866	0.091947	-0.25752	-0.0863	-0.08213	1	
Cl^-	0.677821	0.681212	0.140472	-0.3462	0.069734	0.121531	-0.29643	0.297432	1

Figure.1 Location map of the Study area

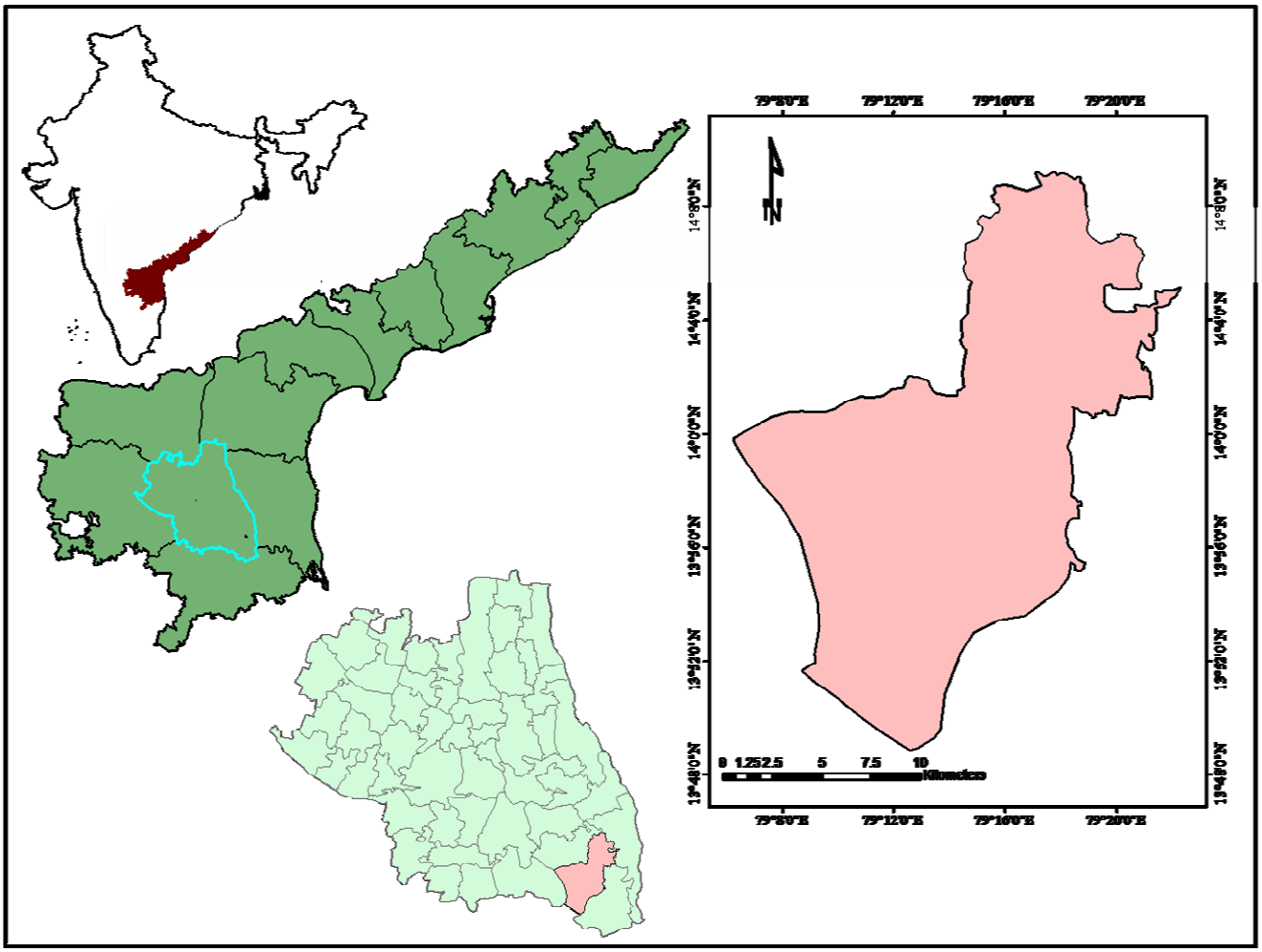
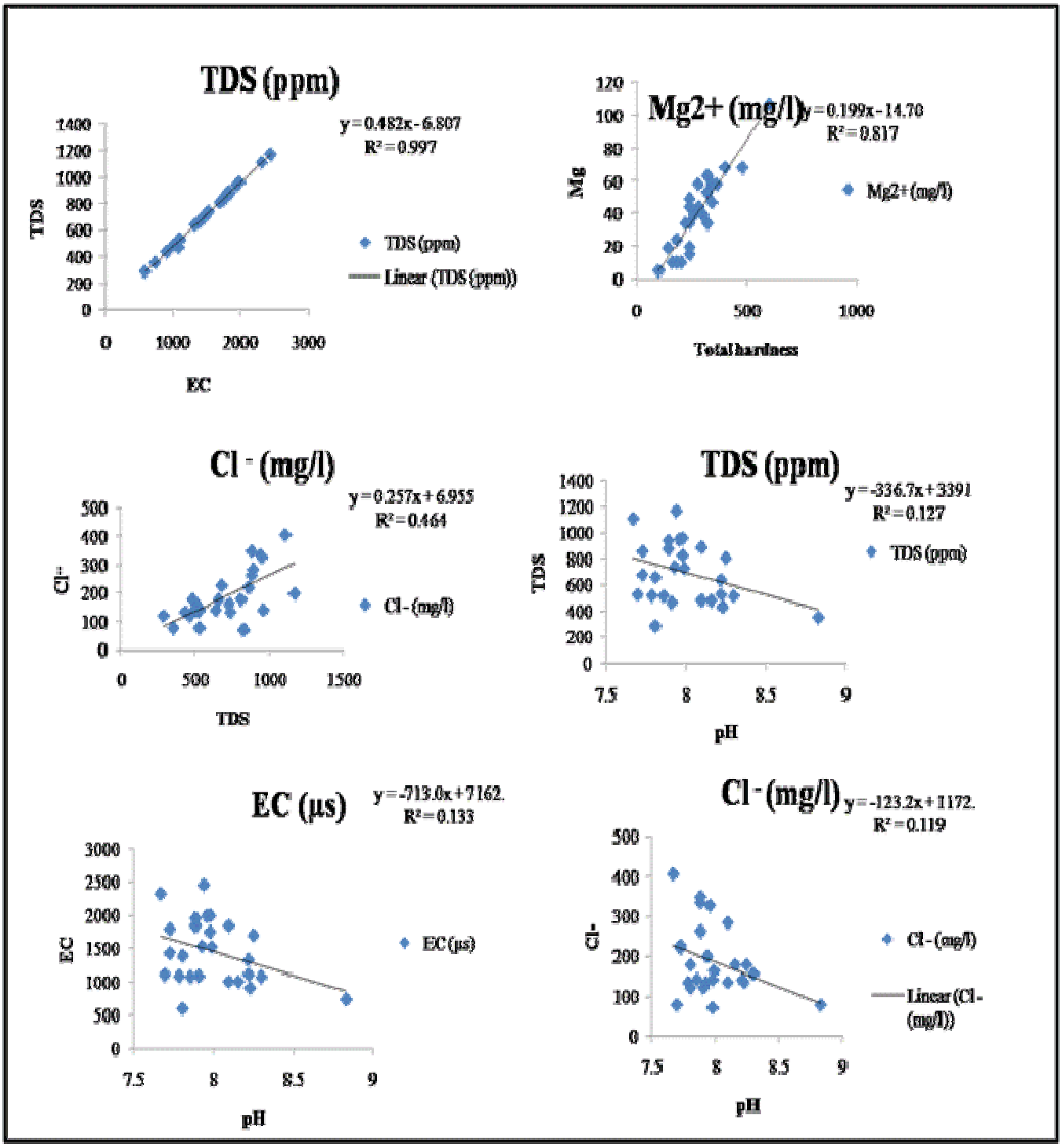


Figure.2 Correlation among physicochemical parameters of the water samples



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