14) Project Report
15) Published Research Paper

"The chemistry of groundwater in Sanand (Ahmedabad) area with regard to suitability for drinking purpose"

ABSTRACT

With the advent of industrial complex in Sanand , Ahmedabad city of Gujarat state of India, the quality of groundwater in this region has been affected negatively due to discharge of industrial effluents into an open lands and ponds, tanks and streams. The improper disposal of the industrial effluents has caused widespread groundwater pollution. In the present study , water samples from surface water bodies and groundwater were collected and analyzed for their major and minor constituents. The high values of Electrical Conductivity (EC) and concentration of major and minor constituents indicate the negative effects The samples were carried out for a period of 12 months from Nov-14 to Octo-15 including winter , summer and rainy seasons. 15 samples of different villages of Sanand – villages were evaluated for selected physico –chemical parameters such as pH, Conducttivity, D.O., B.O.D. and C.O.D. It can be concluded that most of the parameters are found above the permissible limit. The study reveals that Sanand villages groundwater is unfit for drinking but it can be utilized for fish culture and irrigation.

Key Words: Assessment, Groundwater quality, Industrial effluents, Physico- chemical parameters, Water pollution

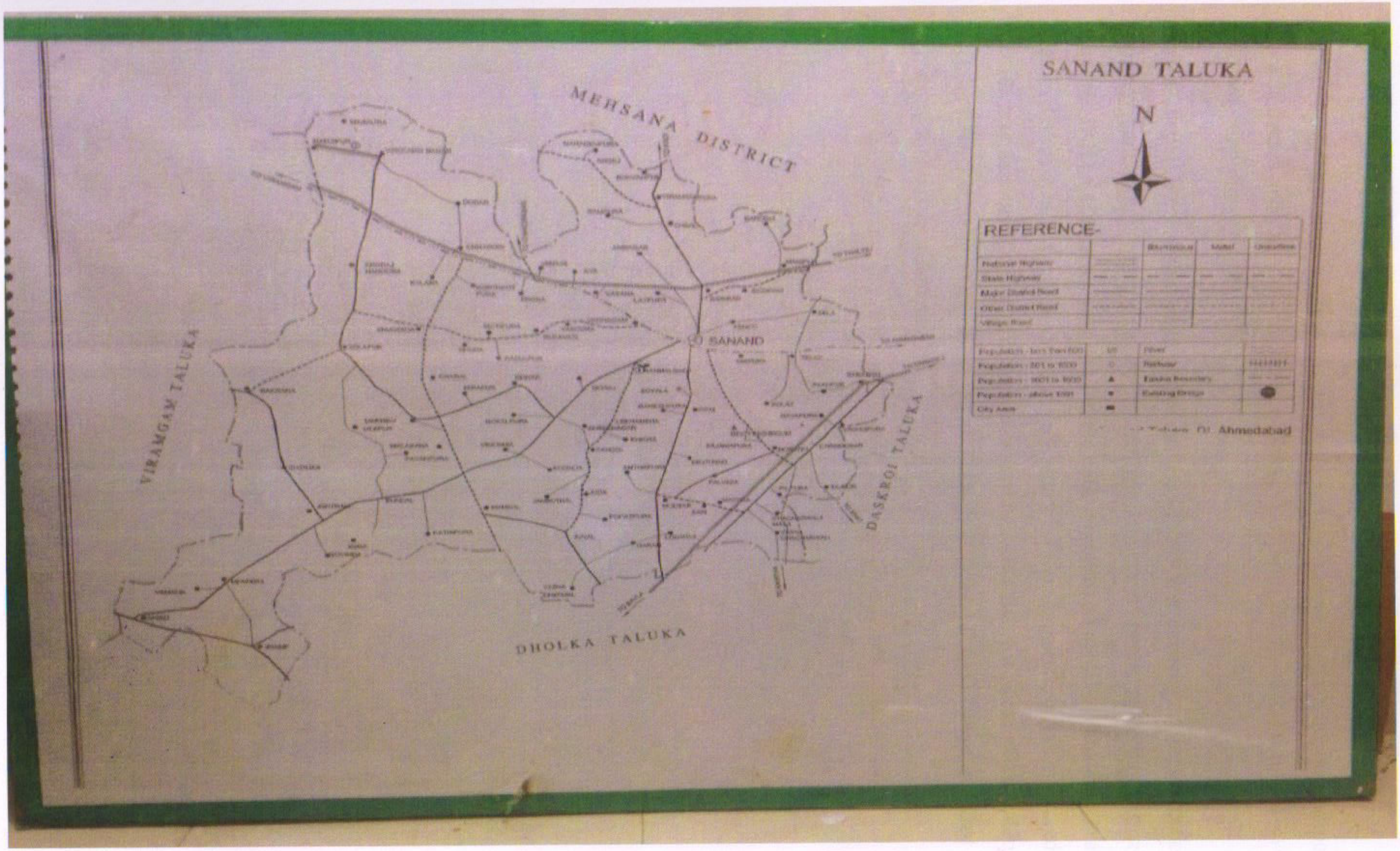
INTRODUCTION

Water is the essence of life. There is a basic need of safe drinking water for human beings. However, many are not able to get sufficient potable safe drinking water supply . Infant mortality is mostly due to drinking of polluted water. Globally, over one billion people are forced to rely on unsafe drinking water sources. The quality of groundwater in area is controlled by the rocks and soil through it moves and its location with respect to other surface water bodies like lakes, streams, tanks, canals and also nearby industrial establishment.[1] It is essential to identify the polluted zone with regard to their lateral and vertical extent and the composition of the water to evolve a scientific basis for development and management of groundwater resources in different situations in relation to groundwater quality. Without determining groundwater quality, quantity of available groundwater for any purpose lead to hazards for animals, plants and human being.

In India and in the countries of third world, groundwater resources are getting polluted due to unplanned disposal of untreated wastes of industries and excessive use of fertilizers in agriculture sector. Water quality is determinded by its chemistry. Surface water percolation is a major source of recharge of shallow aquifers . Therefore, the understanding of the interaction between surface water and groundwater. The major and minor water bodies in and around Sanand – villages are environmentally degraded/ polluted or undergoing rapid irreversible degradation/pollution due to discharged of waste effluents into open area . The industrial effluents are discharged from effluent storage ponds to minor irrigation lakes and the streams become perennial. Hence , there is an urgent need to improve the groundwater quality of area which in turn require standard chemical analysis of groundwater samples in and around Sanand area.

AIMS AND OBJECTIVES

To evaluate the effect on the groundwater quality due to disposal of industrial wastes into open area. to analysis of fifteen selected physic-chemical parameters of Sanand – villages.



MAP OF SANAND

Sampling and analysis

Fifteen sampling villages named as per table were selected for the sampling purpose. The samples were collected monthly till one year (Nov-14 to Octo-15) in each month of every season from selected sampling villages.

Water samples were collected in plastic bottles of two litre capacity. After collection, samples were properly packed and transported to my college laboratory in the same day to avoid any changes. Separate BOD bottles were used for sample collection for DO and BOD analysis. Water samples were kept in darkness at 4^0 C till analysis in laboratory. Water temperature was measured by thermometer and pH was measured by pen pH meter at sampling site. Other parameters like conductivity, turbidity, T.D.S., T.H., T.A., Cl^-, SO_4^{-2}, PO_4^{-3}, NO_3^-, D.O., B.O.D. and C.O.D., were analysed in the laboratory according to the standard methods.[2-4]

Table-1. Nov- Feb 2014-15 (winter)

Sr.	Village	Temp	PH	TDS mg/ml	D.O. mg/ml	Cl^{-1} mg/ml	Total Alkali mg/ml	Ca^{++} mg/ml	Mg^{++} mg/ml	SO_4^{-2} mg/ml	PO_4^{-3} mg/ml	NO_3^{-1} mg/ml	F^{-1} mg/ml	BOD mg/ml	COD mg/ml	EC
1	Fangani	30.2	7.3	255	7.6	27.22	328	35.13	66.45	345.4	8.4	150	1.5	5.0	27	1023
2	Bhavanpur	30.5	7.5	300	8.1	56.4	160	26.3	17.88	46.23	8.02	130	1.8	5.4	30	1133
3	Navapur	30.1	7.3	415	6.3	63.15	514	27.5	45.32	269.5	4.5	100	1.9	6.1	31	1043
4	Vuinchhiya	31	6.5	315	7.5	65.23	327	33.14	88.32	273.3	46.5	445	1.7	4.9	28	1082
5	Chharodi	29.9	6.9	361	8.1	305	256	45.2	20.2	85.31	33.4	206	1.5	5.7	31	1139
6	Hirapur	30.7	7.2	500	7.8	317	487	54.3	156.2	30.25	7.6	404	1.5	4.7	26	1439
7	Changodar	27	8	14.2	7.4	167.2	345	35.15	13.25	354.3	14.5	156	1.3	6.9	34	1250
8	Goraj	30.5	7.1	530	7.5	163.2	652	55.23	29.52	287.4	52.9	283	1.2	6.8	26	1378
9	Matoda	33	7.5	1413	7.9	286.3	584	63.14	23.85	283.3	22.8	172	1.2	6.7	27	1275
10	Vasodara	30.5	7.3	312	8.2	174.2	458	28.45	66.25	241.2	3.6	164	1.3	4.2	29	1433
11	Zamp	29.9	6.8	1355	6.8	555.3	549	36.16	232.2	256.3	49.3	334	1.5	4.7	28	1428
12	Sanand	31.2	7.4	462	6.9	45.66	748	55.21	61.36	346.4	38.2	450	1.8	4.9	26.6	1133
13	Khoda	31.2	6.6	1450	7.2	57.12	748	45.21	155.4	368.5	55	201	1.9	5.8	26.8	1049
14	Rampura	30.5	7.3	800	7.5	589.8	461	56.41	20.56	356.2	26.3	209	1.5	6.4	28	1128
15	Manipur	31.4	7.6	750	7.5	53.18	376	43.52	30.54	256.2	22.5	383	1.8	5.7		1420

Table-2. March – June 2015 (summer)

r.	Village	Temp	PH	TDS mg/ml	D.O. mg/ml	Cl^{-1} mg/ml	Total Alkali mg/ml	Ca^{++} mg/ml	Mg^{++} mg/ml	SO_4^{-2} mg/ml	PO_4^{-3} mg/ml	NO_3^{-1} mg/ml	F^{-1} mg/ml	BOD mg/ml	COD mg/ml	EC
	Fangani	31	6.5	355	8.5	47.22	348	36.14	70.51	350.3	6.8	180	1.6	4.5	25	1115
	Bhavanpur	30.2	6.9	385	8.9	56.4	220	36.15	17.55	50.5	8.5	150	1.5	6.9	30	1439
	Navapur	31.4	7.4	435	6.8	66.6	550	30.5	48.32	280.1	5.5	110	1.9	5.8	34	1140
	Vuinchhiya	32.5	7.9	375	8	65.2	334	34.14	88.4	288.2	45.5	450	1.5	4.7	42	1082
	Chharodi	34.5	6.5	365	8.2	4.5	268	45.5	24.2	90.5	35.5	250	1.2	5.6	39	1085
	Hirapur	33	7.1	555	7.9	417	490	54.35	159.2	310.5	9	450	1.3	4.9	38	1450
	Changodar	31.5	7.8	1500	7.6	167.2	355	34.2	23.4	368.4	25.8	256	1.6	4.9	37	1350
	Goraj	31.7	6.8	580	7.4	170.8	668	56.3	30.56	242.6	55.1	240	1.7	5.8	34	1379
	Matoda	31.8	7.1	1418	7.9	291	595	64.6	126.2	270.8	23.7	180	1.8	6.2	30	1280
0	Vasodara	33.2	7.9	470	8.4	178	468	25.45	76.25	368.1	3.9	184	1.5	5.4	31	1438
1	Zamp	33.8	6.5	1400	7.1	558	580	38.19	38.5	280.3	49.4	354	1.2	6.4	34	1450
2	Sanand	33.9	7.1	566	6.8	145.7	729	58.28	91.5	300.4	39.2	468	1.3	5.3	34	1139
3	Khoda	33.3	7.5	1585	7.5	58.8	728	47.21	158	418.5	56	220	1.4	6.3	38	1180
4	Rampura	33.8	7.1	1100	7.8	598	561	58.35	29	420.5	27.2	221	1.5	6.2	35	1120
5	Manipur	33.8	7.2	900	6.9	56.15	402	49.57	38.17	336.2	22.5	340	1.5	5.6	40	1428

Table-3. July- Oct 2015 (Rain)

r.	Village	Temp	PH	TDS mg/ml	D.O. mg/ml	Cl^{-1} mg/ml	Total Alkali mg/ml	Ca^{++} mg/ml	Mg^{++} mg/ml	SO_4^{-2} mg/ml	PO_4^{-3} mg/ml	NO_3^{-1} mg/ml	F^{-1} mg/ml	BOD mg/ml	COD mg/ml	EC
	Fangani	28.5	6.5	355	7.8	28.65	350	37.12	61.45	330.5	8.9	185	1.6	5.7	39	1213
2	Bhavanpur	28	6.8	310	7.5	57.4	480	35.75	56.12	58.45	8.5	175	1.5	5.7	40	1639
3	Navapur	27.5	6.9	425	7.3	40.13	258	27.18	44.15	290.1	8.3	165	2.2	2.2	41	1140
4	Vuinchhiya	27.5	7.5	435	8.1	40.48	322	26.15	37.08	190.2	8.7	180	1.3	5.4	42	1250
5	Chharodi	28.5	7.8	415	9.3	35.98	418	35.22	39.12	254.8	11.2	169	1.5	6.7	38	1370
6	Hirapur	28.5	7.8	385	9.4	305	312	37.18	40.15	240.9	12.7	158	1.3	7.0	39	1375
7	Changodar	30	7.5	361	7.5	317	483	24.1	39.18	276.9	13.8	170	1.2	6.5	40	1372
8	Goraj	24.5	6.8	400	8.2	168.2	320	31	32.8	280.2	15.3	130	1.1	6.4	41	1378
9	Matoda	27.5	7.3	369	6.8	226.1	520	63.12	50.55	217.8	7.7	188	1.7	5.8	40	1320
0	Vasodara	28.5	6.8	1520	6.9	178	418	47.12	58.25	315.2	8.3	169	1.4	5.6	43	1139
1	Zamp	24.5	6.8	462	9.2	45.66	312	25.11	35.25	228.3	8.5	158	1.5	6.4	44	1250
2	Sanand	28	6.9	800	7.5	47.58	434	32.66	56.12	225.5	8.8	163	1.4	6.8	42	1148
3	Khoda	29.5	6.5	750	6.8	52.44	348	43.11	47.88	334.4	8.8	154	1.3	6.3	40	1139
4	Rampura	28.5	7.3	800	6.9	137.2	461	37.12	57.32	258.7	8.4	173	1.2	5.9	41	1240
5	Manipur	24.5	6.8	900	7.5	158.6	378	35.18	65.12	285.4	8.9	152	1.3	6.3	42	1193

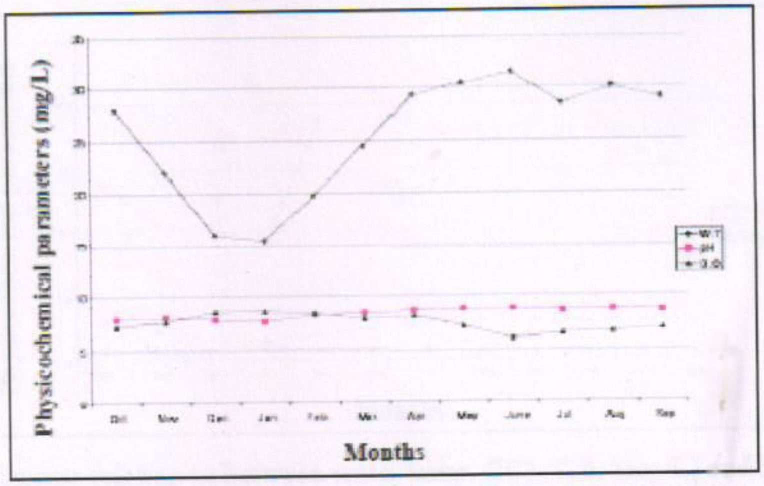


Fig. 2 : Express relation in between water temperature (°C), pH and Dissolved Oxygen (mg/L)

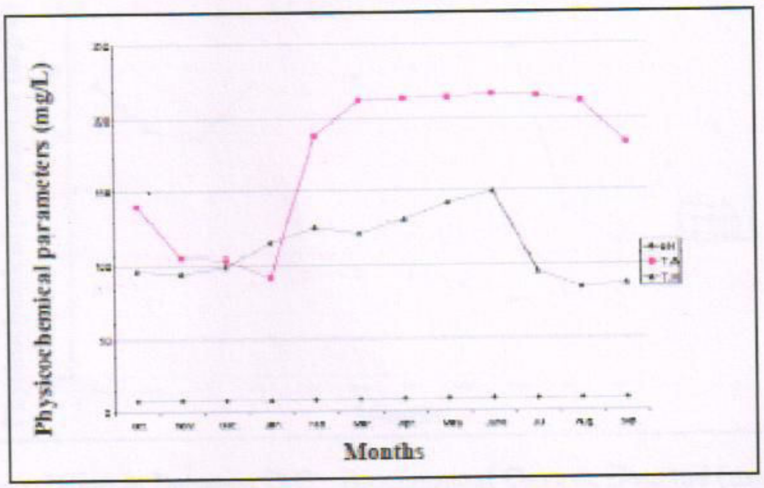


Fig. 3 : Express relation in between pH, Total Alkalinity (mg/L) and Total Hardness (mg/L)

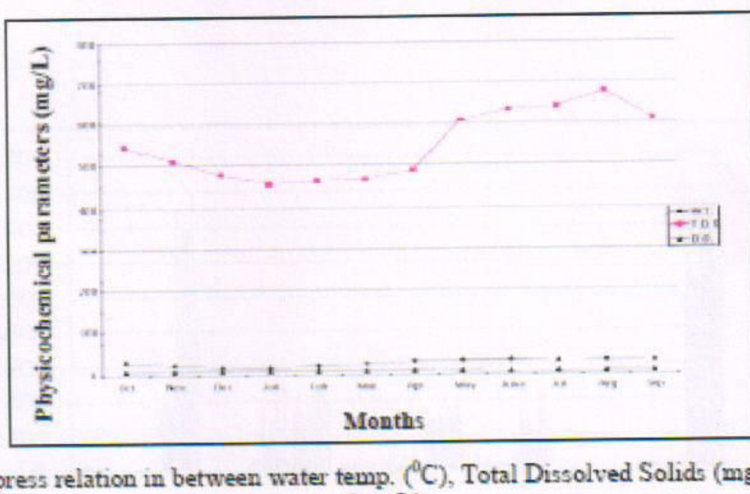


Fig. 4 : Express relation in between water temp. (^{0}C), Total Dissolved Solids (mg/L) and D.O. (mg/L)

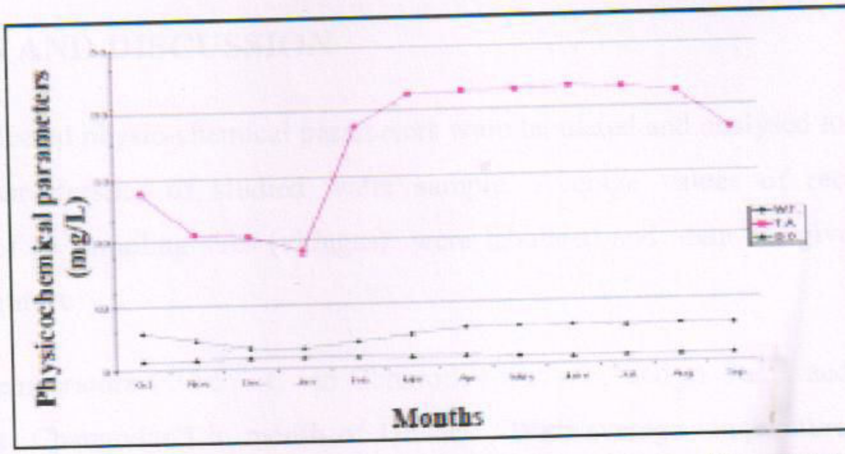


Fig. 5 : Express relation in between water temp. (°C), T.A. (mg/L) and D.O. (mg/L)

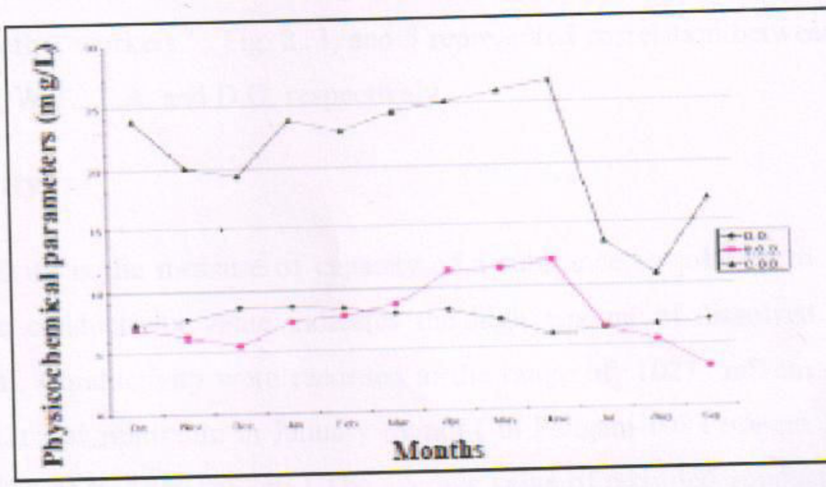


Fig. 6 : Express relation in between D.O., Biochemical Oxygen Demand (mg/L) and Chemical Oxygen Demand (mg/L)

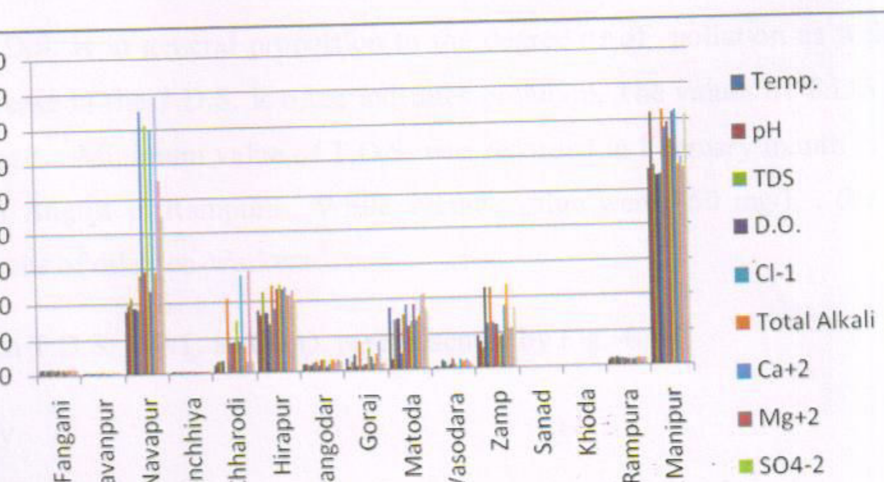


Figure: 7 Representation of different parameter in Chart form.

RESULTS AND DISCUSSION

Observed selected physic-chemical parameters were tabulated and analysed to understand the physic-chemical characterstics of studied water sample. Average values of recorded physic-chemical parameters of 15 sampling sites (villages) were tabulated and data has given in Table : 1, 2 , 3.

water temperature

Maximum temperature (34.5 ^{0} C –in Chharodi) was recorded in June and minimum temperature (27 ^{o} C – in Changodar) in month of January . With average temperature was 30.38 ^{o} C. Water temperature variation was due to changing in atmospheric temperature. The findings resemble with the result of other workers [6] . Fig. 2, 3, and 5 represented correlation between W.T., pH, D.O., W.T., T.D.S., D.O., W.T., T.A. and D.O. respectively.

Conductivity

The conductivity is the measure of capacity of a substance or solution to conduct electric current. High electric conductivity value indicates the high amount of dissolved inorganic substances in ionized form . Conductivity were recorded in the range of 1023 mS/cm to 1450 mS\cm during study period.It was minimum in January month (in Fangani-1023 mS\cm) and maximum in June month (in Chharodi -1450 mS\cm) The average value of recorded conductivity was 1255 mS\cm . Similar findings have also been reported by other workers [7].

Total Dissolved Solid (T.D.S.)

The quantity of T.D.S. is in general proportion to the degree of of pollution as well as industrial waste. Sudden increase in the T.D.S. is often indicates pollution. The values of T.D.S. was in range from 312 to 800 mg/L . Minimum value of T.D.S. was recorded in February month in Vasodara and maximum value in August in Rampura . While average value were 450 mg/L . the finding is co-related with the results of other co-workers [8].

Correlation between T.D.S. , W.T. and D.O. is represented by Fig. 4\

Total Alkalinity

Alkalinity is a measure of the quantity of compounds that shift the pH to the alkaline side of neutrality. Productivity of water depends upon the total alkalinity and has positive co-relation with the pH value of that water. Maximum value 580 mg/L of T.A. was recorded alkalinity in the month of June (in Zamp) and minimum value was 256 mg/L in the month of January (in Navapur) . while average value was 357 mg/L . The present findings are in conformity with the observation made by otherco-worker [9-10]. Correlation between T.A., pH ., T.H., W.T., and D.O., is represented by Fig 3 and Fig 5 [11-14].

Chloride (Cl^-)

Chloride concentration in water indicates presence of organic waste particularly of animal origin or industrial origin. Chloride was varied from 27.22 mg/L to 598 mg/L and mean value was 324 mg/L . Minimum Chloride value 27.22 mg/L was recorded in Nom-14 month (in Fangadi) , while maximum in May month 598 mg/L was recorded in Rampur. Result has been correlation with the work of other researcher.[15-16]. Tolerance range for chloride is 200-1000 mg/L.

Sulphate (SO_4^{-2})

Minimum sulphate 46.23 mg/L. was recorded in January in Bhavanpur ., while in month of June maximum 420.5 mg/L in Rampur, Average value of sulphate was recorded 286.67 mg/L. The tolerance range for sulphate is 200-400 mg/L. The Present Finding resembles with observation made by other workers [17].

Phosphate (PO_4^{-3})

Irregular increases of phosphate in water bodies indicates pollution by domestic sewage and industrial run-off specially phosphate waste. Phosphate was in the range of 3.6 mg/L , to 56 mg/L. Minimum 3.6 mg/L in February in Vasodara, while maximum recorded 56 mg/L in month of May in Khoda.

Average value of phosphate was 30.55 mg/L. The evaluated values of phosphate in the present study were higher than the prescribed values. If Phosphate is consumed in excess , phosphine gas is produced in gastro-intestinal tract on reactionwith bastric juice. Result of present investigation is in concurrence with the finding of previous researcher [18].

Nitrate (NO_3^-)

High amount of nitrates in water are indicative of pollution. Nitrate was recorded in the range of 100 mg/L ,in Navapur in the month of January, and maximum was recorded in 468 mg/L, in Sanand in month of April. The tolerance range for Nitrate is 20—45 mg/L, . Nitrate nitrogen is one of the major constituents of organic along with carbon and hydrojen as amino acids, proteins and organic compounds in the ground water . If the nitrate reduces to nitrite, then it causes methaemoglobinaemia in infants also diarrhea.The average value of recorded nitrate was 250 mg/L,. The findings were similar to those observed by previous researchers [12].

Fluorine (F^-)

The higher concentration of fluorine is due to leaching of solid wastes of industry and also leading of waste from surrounding urbanization . The average values of fluorine 1.1 to 2.0. mg/L. The minimum value was recorded 1.1 mg/L. in Goraj in September. , and maximum value of fluorine was recorded 2.2 mg/L., in Navapur in month of April. The tolerance range of Fluorine is 1.0-1.2 mg/L, higher concentration of fluorine causes Fluororisis and bone cancer . The findings were similar to those observed by previous researchers. [18-20].

Dissolved Oxygen (D.O.)

Dissolved oxygen is a measure of the amount of oxygen freely available in water. The effect of waste discharged in a water body is largely determined by the oxygen balance of the system . The value of D.O. were range from 4.4 to 9.4 mg/L., Minimum value of D.O. recorded 4.4 mg/L, in Goraj in December . and maximum value was recorded 9.4 mg/L in Hirapur in July. Average value of D.O was recorded 7.0 mg/L. The present work coincided with the finding of other researchers [12] . Correlation between D.O., W.T., pH. , T.D.S.,T.A., B.O.D., and C.O.D. is represented by Fig 2, Fig 4 , Fig 5 and Fig 6 respectively.

Biochemical Oxygen Demand (B.O.D.)

Biochemical Oxygen Demand is the amount of oxygen required by microbes to decompose the degradable organic matter under acrobic condition. B.O.D. determination is the best available single test for assessing organic pollution strength in a water body . Maximum value 12.00 mg/L in Matoda in June, and minimum value 3.56 mg/L in Sanand in September . , with the average value of B.O. D. is 7.70 mg/L. Finding of the present study made by other workers [17].Correlation between B.O.D. , D.O., and C.O.D. is represented by fig. 6.

Chemical Oxygen Demand (C.O. D.)

Chemical Oxygen Demand is the oxygen required for oxidation of organic matter by a strong chemical oxidant C.O.D. of the Sanand villages were varied between 10.85 mg/L (minimum) in Bhavanpur in August month and maximum 26.80 mg/L in Manipur in January . The average value of C.O.D. was recorded 21.2 mg/L. The present observation coincides with the result of other researchers [18].Correlation between C.O.D., D.O., and B.O.D. is represented by fig . 6

The concentration of Cu, Mn, Zn and Fe is slightly higher than the drinking water standard limits in the groundwater .

It is also observed that the concentration of water quality indication parameters such as B.O.D., D.O. and toxic elements are slightly higher than the permissible limits of drinking water standard. It indicates that the groundwater of the study area is polluted. If disposal of untreated industrial effluents continue, the groundwater may became hazardous for human health in future. therefore, it is suggested that the monitoring of water quality should be the study area.

CONCLUSION

The high concentration of ions and trace elements in groundwater of the study area indicates that the pollution of groundwater took place in the shallow water table condition inherent around Sanand . The results are important in understanding the influence of industrial effluents in groundwater. Therefore, the groundwater of the study area is not safe for drinking purpose.

The soils are becoming acidic and the surfacial encrustation of salts is evident in the area. The area situated mostly along the stream courses is affected by the significant reduction in the crop yields. The groundwater reservoir has now become degraded which was fresh a few decades ago. The improper disposal of the industrial effluents has caused widespread groundwater and soil pollution. The surface water of the stream is aiso polluted due to disposal to industrial effluents.

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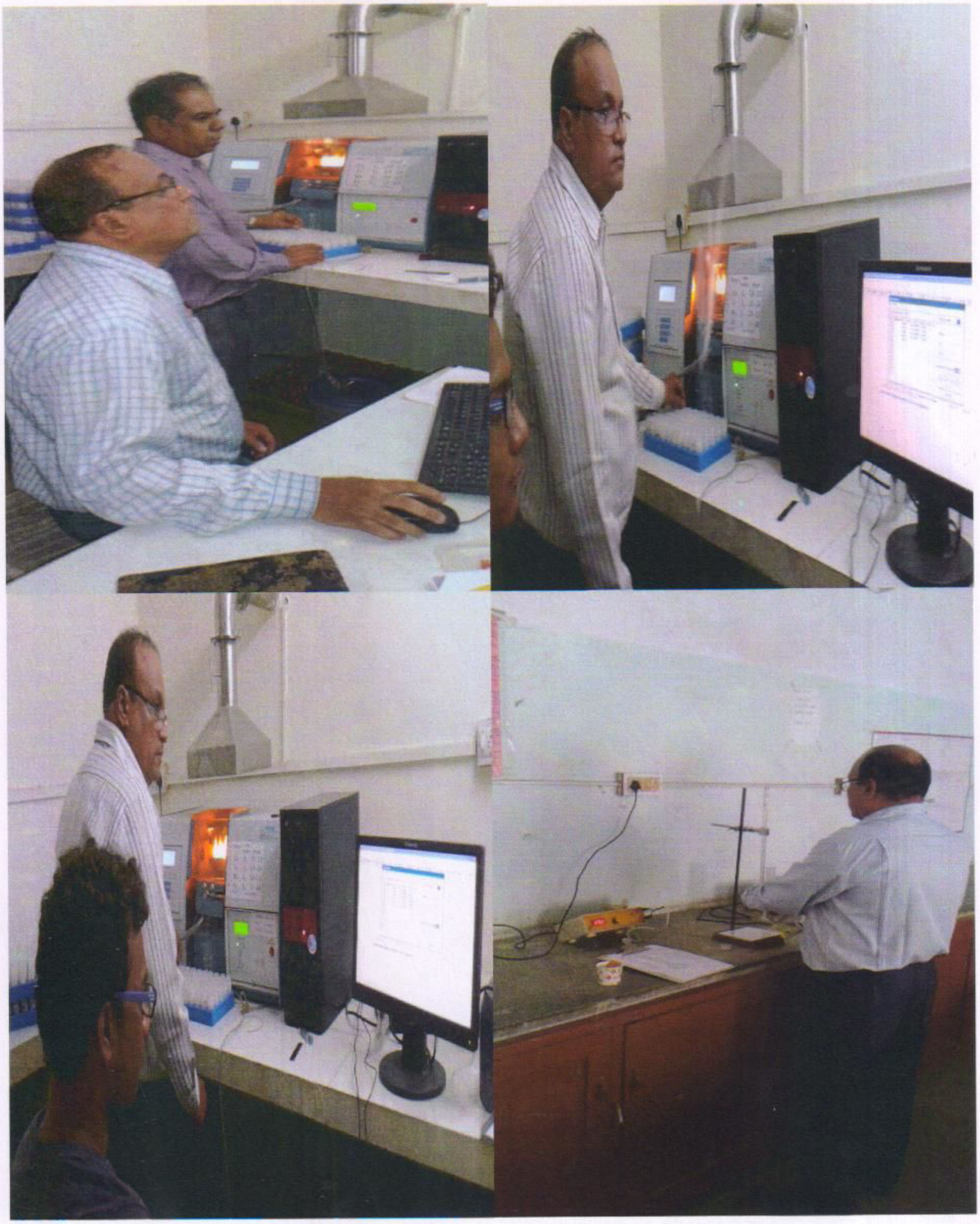

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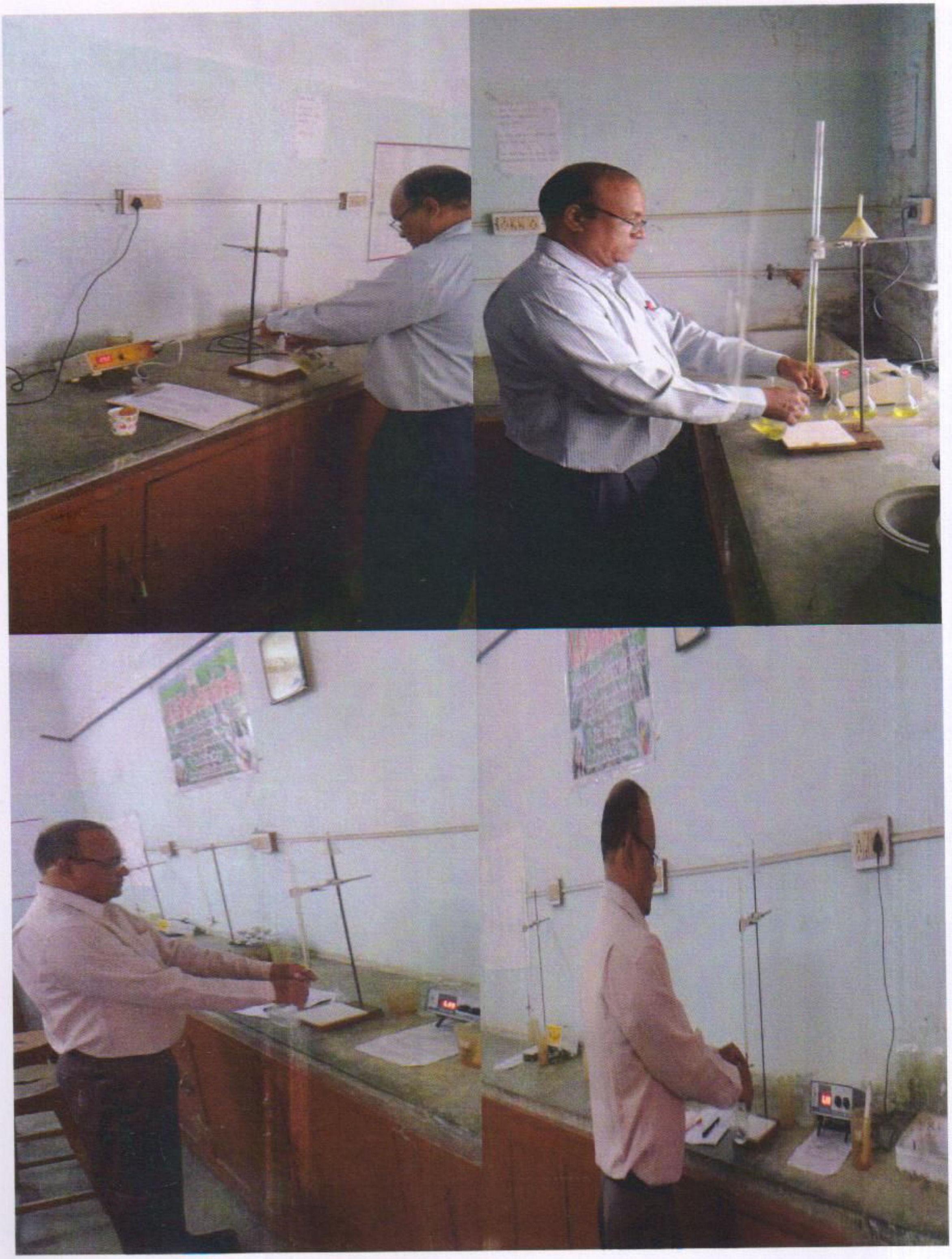

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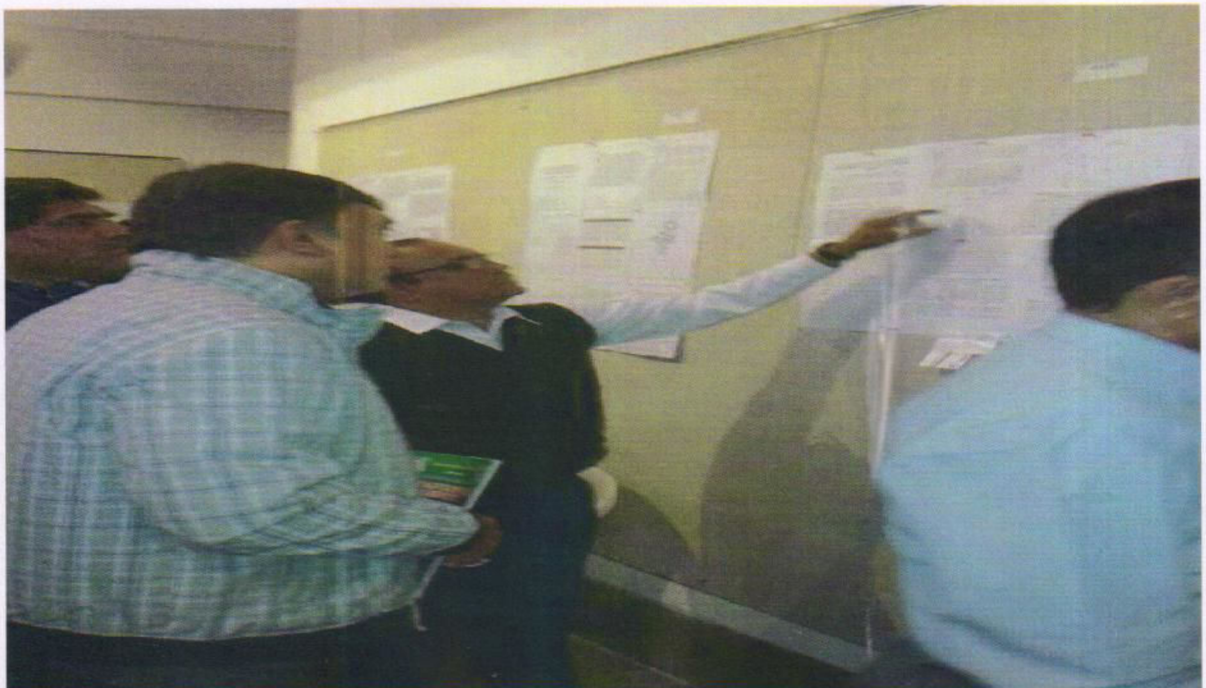

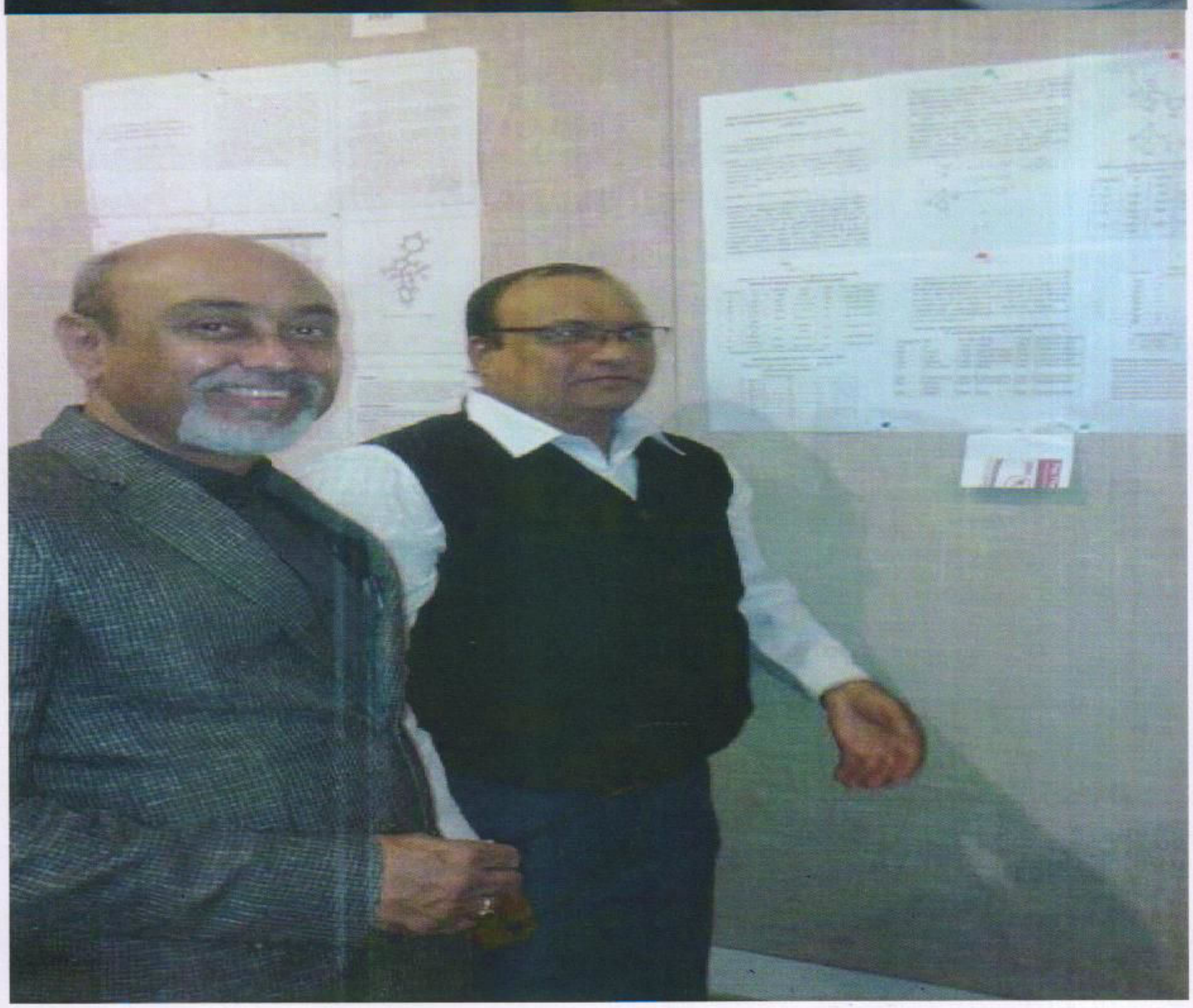

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Physico-Chemical Analysis of Drinking Water of Sanand District Villages

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ABSTRACT: Physico-chemical analysis such as temperature, pH, dissolved Oxygen, TDS, Chloride, Total Alkalinity, Calcium and Magnesium hardness, Sulphate, Phosphate, Nitrate and fluoride of borewells, wells and lacks drinking water has been carried of fifteen villages of Sanand District of Gujarat area during January 2015 in order to assess water quality index.

Keywords: Physico-Chemical analysis,Sanand, Complexometric, Chloride.

INTRODUCTION

Physico-chemical analysis of drinking water of Sanand district of Gujarat state has been investigated intensively[1-3]. Bore well water is generally used for drinking and other domestic purposes in this area. The use of fertilizers and pesticides, manure, lime, septic tank, refuse dump, etc. are the main sources of bore wells water pollution [4]. In the absence of fresh water supply people residing in this area use bore wells water for their domestic and drinking consumption. In order to assess water quality index, we have reported the physico-chemical analysis of bore wells drinking water. Fluoride is found in all natural water at some concentration. In ground water however low and high concentration of fluoride can occur depending upon the nature of the rocks and the occurrence of the fluoride – bearing minerals. Fluorosis has been described as an endemic of tropical climate[5].The main sources of fluoride intake is water[6].In low concentration of fluoride prevent dental caries. However it has been observed that when fluoride intake through water, food and air increases to a specific level (1.0-1.5 mg / l.) the beneficial effect is lost and in fact harmful effect being to show with increasing concentration (above 1.5 mg / l.). Excess intake of fluoride beyond permissible limit bring out dental and skeleton fluorosis along with some neurological disorder. Higher concentration of fluoride alsocauses respiratory failure, fall of blood pressure and genera paralysis. Continuous investigation nonfatal dose of fluoride causes permanent inhibition of growth. Fluoride ions inhibit a variety of enzymes often by forming complexes with magnesium ion and other metal ions[7].

According to Water and River Commission Western Australia ground water occupies the pores and crevices in sand, sand stone and other rocks[8]. The crucial role which ground water plays as decentralized sources of drinking water for millions of rural and urban families cannot be overstated[9]. Rao *et al.* reported that about 80 percentage of the diseases in the world are created because of poor quality of drinking water[10]. The quality of the ground water cannot be restored by stopping the pollution if it is contaminated once. Water quality index is very important tool for the information on water quality[7-10]. Some important ratings are given below:

Nonfatal dose of fluoride causes permanent inhibition of growth. Fluoride ions inhibit a variety of enzymes often by forming complexes with magnesium ion and other metal ions[7].

Table 1

Parameter	*Desirable Limit*	*Permissible Limit*	*Moderately safe*	*Unsafe*
Fluoride(ppm)	1.0	1.5	1.5-2.0	>2.0
RSC(Meq./L)	1.0	<1.25	-	>2.50
SAR	5.0	<10	10-18	>26
ECm moh/cm	0.0-0.5	0.0-0.75	0.25-0.75	>2.25

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Table 2
Result of analysis of samples collected in January- 2015

No	Village	Temp C^0	H P	TDS	D.O. mg/L	Chloride mg/L	Total Alkalinity	Ca^{+2} Hardness mg/L	Mg^{+2} Hardness mg/L	SO_4^{-2} mg/ml mg/L	Po_4^{-3} mg/L	NO_3^{-1} mg/L
1	Fangdi	30.2	7.3	255	7.6	27.22	328	35.13	68.45	345.36	8.4	150
2	Bhavanpur	30.5	7.5	300	8.1	56.40	160	26.3	7.88	46.23	8.2	130
3	Navapura	30.1	7.3	415	6.7	63.15	514	27.5	45.32	269.54	4.5	100
4	Vinchhiya	31.0	7.5	315	6.3	45.12	327	33.14	88.32	278.30	42.5	442
5	Chharodi	29.9	6.9	361	7.5	65.23	256	45.2	20.2	85.31	33.4	206
6	Hirapur	29.4	7.2	500	8.1	304.30	487	54.3	156.18	301.25	7.6	404
7	Changodar	30.7	8.0	1420	7.8	316.44	345	35.15	13.25	364.27	24.5	156
8	Goraj	31.1	7.1	530	4.4	167.15	652	55.23	29.36	287.65	52.9	283
9	Matoda	27.0	7.5	1413	7.5	163.15	584	63.14	123.65	263.29	22.8	172
10	Vasodra	30.5	7.3	362	7.9	286.25	458	8.45	66.25	341.23	3.6	164
11	Zamp	33.0	6.8	1355	8.2	174.14	549	36.16	132.23	256.32	55.0	334
12	Sanand	29.9	7.4	412	6.8	555.32	748	88.70	81.36	348.36	49.3	450
13	Khoda	31.2	8.0	1450	6.9	45.66	748	55.21	155.42	368.52	38.2	201
14	Rampura	30.5	7.3	800	7.2	57.82	461	43.21	20.56	356.21	55.0	209
15	Manipur	31.4	7.6	750	7.5	569.52	376	56.41	30.54	236.5	26.3	383

RESULT & DISCUSSION

Chlorides : In the present study chloride ranged from 27.22 to 569.52 mg/Lwhile thetolerance range for chloride is 200 – 1000 mg/L.

Total Alkalinity : The total alkalinity content in the samples is in between 160 to 748 mg/L.

Calcium Hardness : The calcium hardness ranged from 8.45 to 88.70 mg/L. The tolerancerange for Ca hardness is 75 – 200 mg/L.

Magnesium Hardness : The Magnesium hardness ranged from 7.88 to 155.42 mg/L. Thetolerance range for Mg hardness is 50 – 100 mg/L.

Sulphate: The Sulphate ranged from 46.23 to 368.52 mg/L. The tolerance range for SO_4^{-2}is200 – 400 mg/L.

Phosphate : Phosphate ranged from 3.6 to 52.9 mg/L. The evaluated values of phosphate in thepresent study are higher than the prescribed values. The higher values of the phosphate are mainly due to the use of fertilizers and pesticides by the people residing in this area. If phosphate is consumed in excess, phosphine gas is produced in gastro-intestinal tract on reaction with gastric juice.

Nitrate : The Nitrate ranged from 100 to 442 mg/L. The tolerance range for Nitrate is 20 – 45mg/L.

Nitrate nitrogen is one of the major constituents of organism along with carbon and hydrogen as amino acids proteins and organic compounds in the bore wells water. If the nitrate reduces to nitrite, then it causes methaemoglobinaemia in infants and also diarrhea.

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The Nebraska Children's Groundwater Festival

The Nebraska Children's Groundwater Festival was first organized in 1989 to educate Nebraska students about all aspects of groundwater, and therefore providing students the ability to choose good stewardship of groundwater in the future. About 32,000 children have attended the Festival since 1989 and learned about groundwater and related resources through hands-on activities, interactive displays and entertainment led by water experts, environmental educators and performing artists. Over 1,000 students are invited to attend each year and the remaining schools are placed on a waiting list to attend the following year.

The Festival increases awareness of groundwater protection, groundwater contamination and quantity of resources. Presenters are required to specifically tie activities to groundwater education and required to use only factual, science-based information. Presenters teach classroom-type activities for 25 minutes per session, giving them adequate time to promote critical thinking and relay solutions that students may partake in to maintain the quality and quantity of groundwater that is present in Nebraska.

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