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Physico-Chemical Studies of Ground Water in Ghogha Taluka Of Bhavnagar District (Gujarat) India

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ABSTRACT

Water plays non replaceable role in human life most required for healthy population. In the present study of ground water samples from 12 different wells have been carried out for investigation. The sample ware analysed for pH, EC, turbidity, carbonate, bicarbonate, total alkalinity, calcium, magnesium, total hardness(TH), chloride, fluoride, nitrate, nitrite, sulphate, Sodium, SAR (sodium adsorption ratio), RSC (residual sodium carbonate), potassium and TDS (total dissolved solids). All the data result of the present study has been compared with water quality parameters of Indian standards (IS), WHO and standard laboratory method of APHA. Thus an attempt has been made in some selected villages of Ghogha taluka in Bhavnagar district of Gujarat in the month of April-May-2017 to find the quality of groundwater is appropriate for drinking and irrigation purpose.

Keywords : Groundwater, physico-chemical analysis, Ghogha taluka of Bhavnagar district, drinking and irrigation purpose.

I. INTRODUCTION

Water is the most vital renewable resources and prime important for human consumption which must be prevented from falling in quality [1]. For healthy living safe portable water is absolutely required [2]. Chemical water quality of any region, the ground and surface water is as important as the quantity of water. Geographical data of the individual region gives the quality picture of the groundwater which depends on different chemical components and their concentrations [3]. Ground water quality has become a beneficial water resources issue due to manmade activities like urbanization, rapid industrialization, population, excessively use of pesticides, fertilizers in agriculture and especially rapid growth of population [4]. Groundwater quality is an expected factor for the ecological agriculture as a source of water in irrigation. Out of 70% of overall global fresh water withdrawals, irrigation is the most abundant use of fresh water supply. For a beneficial irrigation the quality of surface and groundwater becomes an essential factor in agriculture. In the agricultural purpose ground water is traveled in sub urban areas particularly in those areas, where other water resources like river and dam or canal is not available [5]. Ghogha taluka of Bhavnagar district having a large coastal area of bay of Khambhat, and have semiarid region and temperature above 45 ºC in the month of May. In the seasons of summer the people have facing problem related portable drinking and irrigation water. Aim of the present study to investigate physico-chemical anlysis of ground water because these regions have difficulties for getting drinking water, consequently the people were used high saline and contaminated water for drinking purpose. In the present study some report of ground water quality suggested that in these area have higher salinity value, high level of nitrate concentration and higher concentration fluoride (CGWB reports)[6].

II. MATERIAL AND METHODOLOGY

Study area

The Gujarat state has longest Costal area covered around 1600 k.m. length which major length of Indian sub-continents. The Bhavnagar is one of the district of Gujarat state which is located near Gulf of Khambhat. The Ghogha is a tehsil of Bhavnagar district which is situated on the mid-western bank of the Gulf and about 15 k.m. south of the present port town of Bhavnagar. The Ghogha tehsil located in latitude of 21.6848795 and longitude of 72.2748686. The Ghogha tehsil consist of 48 villages and have populace of 85624 according to census 2011. The climate status of this area moderately humid. The minimum temperature recorded 10 ºC mostly in December month, while maximum recorded around 40 ºC in May month. In these are concerning scarcity of potable water is a long-time problem. This area is categorised by hot summer and also unpredictable rain during the year. These area are located near a costal so the salinity ingress into the groundwater. The ground water source like well and bore well either dry or highly saline due to depleting water tables every year. The drinking water supply by tanker but in some cases higher saline water use in purpose of drinking water which serious threat health of public.

Sample collection and methodology

In this present study ground water samples were collected from 12 different sampling stations at Gogha tehsil in Bhavnagar. The samples were collected from wells of different villages. The study was carried out in month of April 2017 in summer season. The ground water triplicate samples were collected in pre-clean plastic bottle and preserved to till the laboratory analysis. The plastic bottle previously washed by distilled water and during the collection time its rinse with three time from the collecting samples [7]. The Physico-chemical parameter like temperature, pH and conductivity were analysed in-situ using the multi parameter instrument Cyber Scan PCD 650 (Eutech). The turbidity also performed at during of sample collecting using portable turbidity meter TN-100 (Eutech). The analysis of chloride, sulphate, carbonate, bicarbonate, magnesium and calcium were done by standard methods of APHA. The sodium and potassium analysed by using flame photometer using standard method (systronic). The nitrate and nitrite analysed by colorimetric method using spectrophotometer (Shimazdu UV-1800) [8], [9].

III. RESULT AND DISCUSSION

Groundwater analysis of Ghogha taluka shows a significant variations from sample to sample. **pH**

The average pH values were fluctuating in between 7.04 to 8.39 during the month of April (Fig. 1-A). The lowest pH value was observed in Morchand (7.04) and the highest in Kareda (8.39). It is observed that all the samples have high acceptable level of pH, the permissible limit (6.5 to 8.5) given by BIS [10]. Neutral water pH deviates may be due to dilution of alkaline substances [11].

Electrical conductivity (EC)

One of the important parameter for water quality assessment is EC. It becomes an essential to recognise the relationships between mineral salt composition and Electrical conductivity because the composition of mineral salts disturbs the EC of the groundwater [12]. This parameter shows purity of water. Higher EC value of water creates competition in plants with ions in the soil solution for water means higher the conductivity less water is available to the plant [13]. Highest EC was observed at Avaniya (9.27 mS/cm) and lowest at Valukad (0.719 mS/cm) and which shown in (Fig.1-B). The importance of conductivity shows its measure of salinity, which remarkably disturbs the taste and thus there is a significant impact for acceptance of water as potable for the user's (WHO 1984) [14].

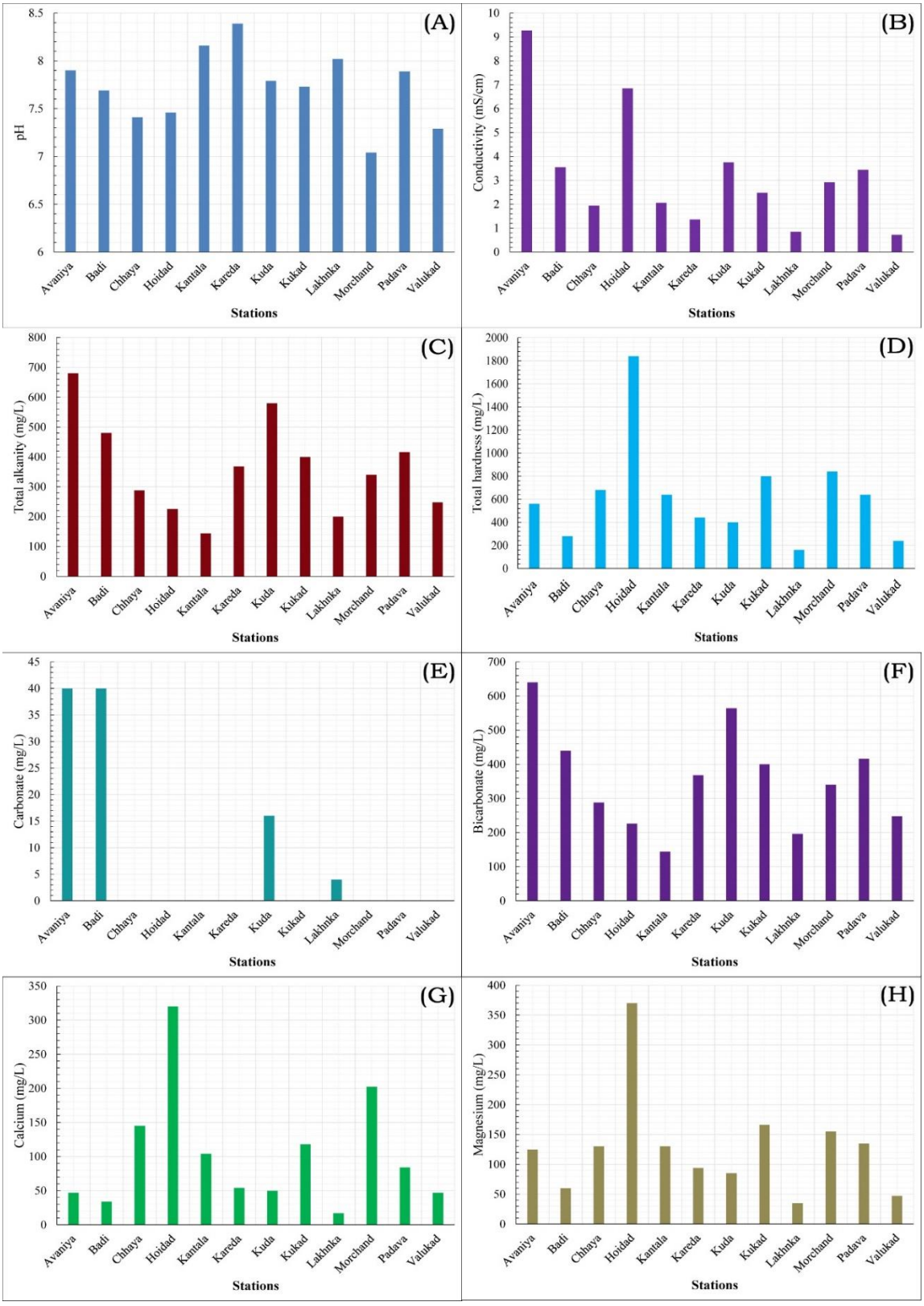


Figure 1. Spatial temporal variation of physico-chemical parameters (A) pH, (B) conductivity, (C) Total Alkalinity, (D) Total Hardness, (E) Carbonate, (F) Bicarbonate, (G) Calcium and (H) Magnesium at Ghogha Taluka

Total Alkalinity

Generally alkalinity is not produced by any human activities but In fact 98% of all world groundwater are dominated by magnesium and calcium salt of carbonate, bicarbonate and hydroxide ions present in groundwater body. Total alkalinity ranges from 144 mg/L to 680 mg/L which depicted in (Fig. 1-C). During this present study we have find out that the total alkalinity of ground water samples were upper than the desirable limits by BIS.

Total Hardness

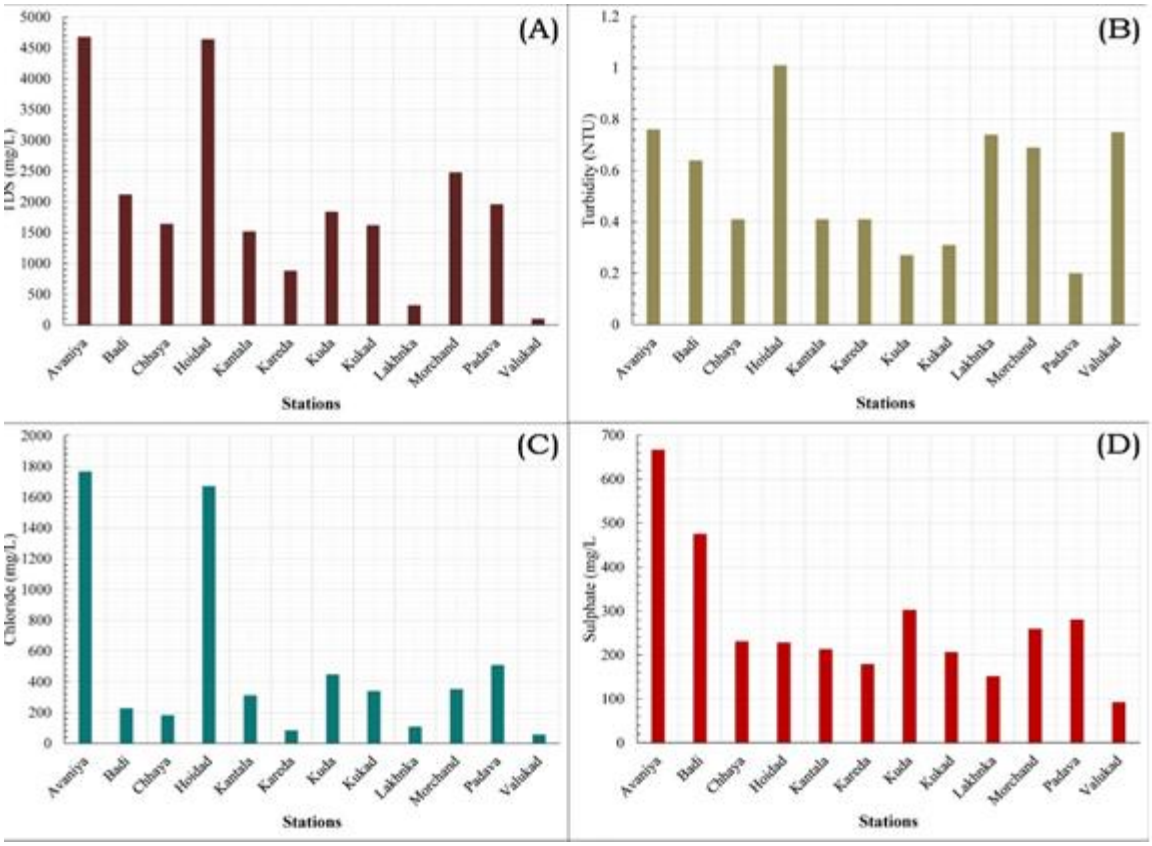
Total hardness (TH) of water depends on the most common minerals like magnesium (Mg^{+2}) and calcium (Ca^{+2}) which makes increase the hardness of water. The value of total hardness fluctuates from 160 mg/l to 1840 mg/l which depicted in (Fig.1-D). The maximum value (1840 mg/l) was recorded at Hoidad village and corresponding calcium is 320 mg/l and magnesium is 370 mg/l. During the summer seasons, evaporation rate of water is higher consequently the hardness of water increase and these reason may be consider as higher hardness in these regions.

Total dissolved solids (TDS)

Mineral ions dissolve in water naturally from sediments, soil particles and rocks when the water travels through the aquifer and factures or pores of the unsaturated zone. These mineral ions are referred as dissolved solids. Some dissolved solids may have made in the precipitation water or river water that refreshes the aquifer. The total dissolved solids fluctuate from 100 mg/l to 4680 mg/l. the maximum value (4680mg/l) was recorded at Avaniya which is shown in (Fig.2-A). Except to lakhanka and Valukad all other station have higher TDS value than the permissible limits.

Turbidity

Turbidity is the parameter used commonly as an indicator for determination of general condition of drinking water and is one of the easiest field water quality parameter to measure. The cause of turbidity is suspended matter such as microscopic organisms, clay, slit, plankton and organic matters which interferes with light passage through water [15]. The turbidity parameter is one of the key test of water quality. The turbidity fluctuate between 0.2 to 1.01 NTU. Which is shown in (Fig.2-B). The lowest turbidity found in Padava (0.2 NTU) and highest found in Hoidad (1.01 NTU). The results of turbidity suggested that it is beyond the standard water quality guidline [7], [10].



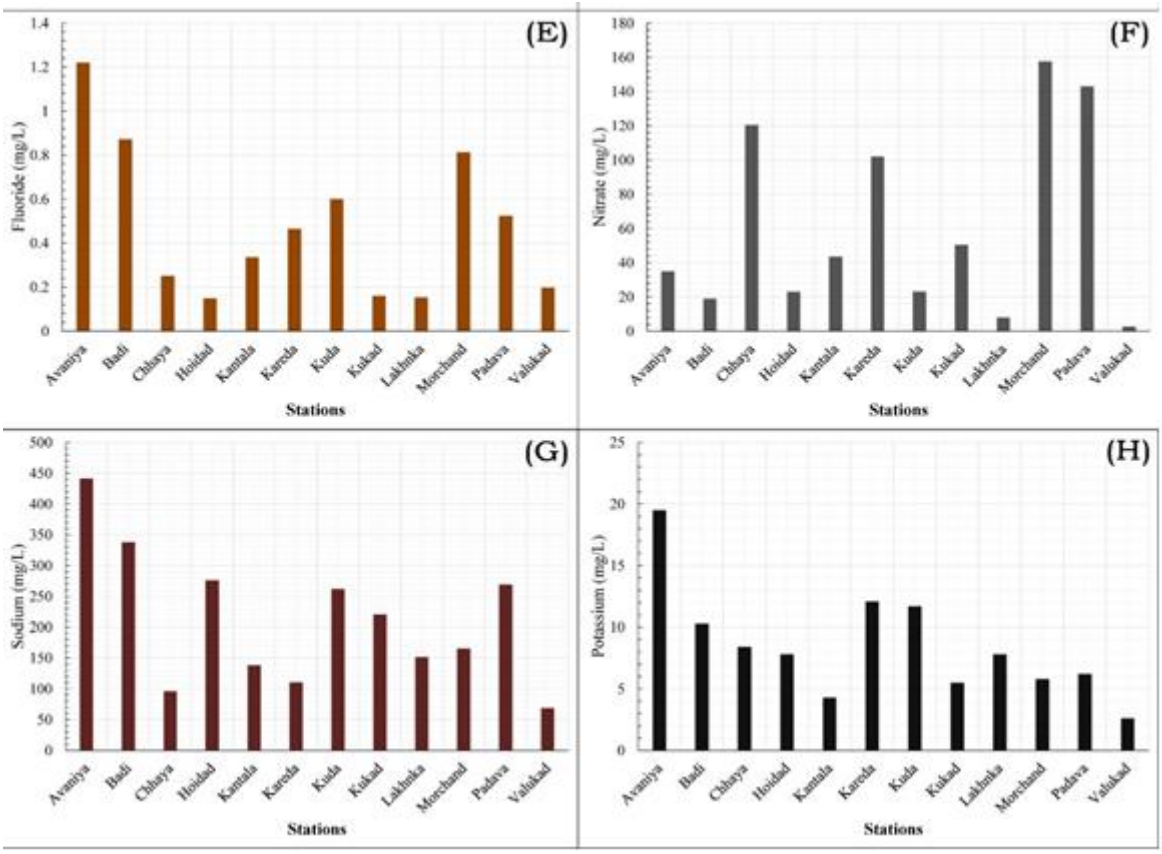


Figure 2. Spatial temporal variation of physico-chemical parameters ; (A) TDS, (B) Turbidity, (C) Chloride, (D) Sulphate, (E) Fluoride, (F) Nitrate, (G) Sodium and (H) Potassium at Ghogha Taluka

Chlorides

Chloride usually occurs as NaCl, $CaCl_2$, $MgCl_2$, and in broadly fluctuating concentrations, in all natural waters. The presence of chloride in drinking water sources can be attributed to the irrigation drainage, dissolution of salt deposits, sewage, sea spray and seawater interruption in coastal areas. Each of these causes may result in local source of pollution in ground and surface water.

The concentration of chloride found to be higher as per permissible limits in following station Avaniya, Hoidad, Kantala, Kuda, Kukad, Morchand and Padava which is shown in (Fig.2-C). Highest value of chloride was found 1767 mg/l at Avaniya and lowest was 57 mg/l at Valukad. Chloride creates unacceptable taste above the concentration of 250 mg/l although there is no adverse effect have been found on human for regularly consuming high concentrated chlorine water [16].

Sulphate

Sulphate occurs comprehensively in both natural and anthropogenic water systems. Primary natural sources of sulphate include atmospheric deposition, sulphate mineral dissolution, and sulphide mineral oxidation [17]. Sulphate is not much harmful but it leads to diarrheia and other unknown disease. The concentration of sulphate found higher 666 mg/L at Avaniya and lowest in Valukad 98.2 mg/l which shown in (Fig.2-D). Higher sulphate concentration in the study groundwater area may be due to spoiling of organic wastes and attribution of the discharge of domestic sewage in the region.

Fluoride

The concentration of fluoride in ground water samples in study areas ranges from 0.149 mg/l (Hoidad) to 1.22 mg/L (Avaniya). The permissible limits allowed is 1.5 ppm for drinking purpous [14]. In our investigation the content of fluoride found to less than the permissible limits which is depicted in (Fig.2-E). It is noticed that small fluoride concentration in potable water has

positive result on human body. The low fluoride amount below than the 0.5 ppm causes dental caries and higher beyond 1.5 ppm causes dental and crippling skeletal fluorosis.

Nitrate and Nitrite

Nitrate is not too much unsafe but it causes mathemoglobenemeia or "blue baby syndrome". This should not be allowed particularly in children under six months of age. Presence of nitrate in human body reduced into nitrite that oxidise haemoglobin to methemoglobin which is not able to transfer oxygen in tissues of the body and becomes an indirectly cause of mathemoglobenemeia. Nitrate (NO_3^-) contamination of the groundwater is mainly due to the intensive use of fertilizers. Leaching of nitrate into groundwater is due to extreme application of nitrogen-fertilizer, improper soil, septic tanks, absence of water management practices and disposal of domestic wastes.

The concentration of nitrate ion ranges from 2.61 mg/l to 157.63 mg/l which depicted in (Fig.2-F). The maximum concentration of nitrate was 157.63 mg/l observed at Morchand and minimum 2.61 mg/l at Valukad. During the our inivestigation we have find out that the concentration of nitrate is higher than the permissible limits upto 50 ppm in Chayya, Kantala, Kareda, Morchand and Padava stations. The concentration of nitrite values fluctuating between 0.65 µg/l to 221 µg/l. The lowest concentration of nitrite found at Kuda and Avaniya(0.02 µg/l) and highest at Chhaya(1.7 µg/l) .

Sodium (Na)

The sodium concentration in ground water is varied between 69 mg/l to 441.6 mg/l which show in Fig.2-G. The maximum value of sodium ion concentration is detected at Avaniya. The high concentration of sodium (Na) in drinking and irrigation water causes heart problems and salinity problems respectively [18].

Potassium (K)

The concentration of potassium ranges from 2.6 to 19.5 mg/l. It were maximum observed in Avaniya and minimum was observed in Valukad which is depicted in (Fig.2-H). The higher concentration of Potassium in groundwater is due to the presence of silicate minerals from igneous and metamorphic rocks [19].

Sodium adsorption ratio (SAR)

SAR is the very important parameter used for determination of groundwater suitability for irrigation, because it measures alkali hazard for crops [20]. SAR determination formulae is expressed as shown below:

$$\text{SAR} = \frac{\text{Na}^+}{\sqrt{\frac{1}{2}(\text{Ca}^{+2}+\text{Mg}^{+2})}}$$

The sodium effect on soil and plants, due to its effects it is considered one of the major factors governing irrigation water. SAR values should be < 10 as excellent, good in 10-18, doubtful in 18-26 and unsuitable > 26 given by Richards in 1954 [21]. In this present study highest SAR value was observed at Badi (49.35 mg/L) and lowest at Chhaya (8.24mg/L).

Table: 1 SAR and RSC analysis data of Ghogha taluka

Station Name	Avaniya	Badi	Chhaya	Hoidad	Kantala	Kareda	Kuda	Kukad	Lakhnka	Morchand	Padava	Valukad
SAR	47.6	49.4	8.2	14.9	12.8	12.8	31.9	18.5	29.8	12.4	25.7	10.1
RSC (meq/L)	-0.9	1.9	-13.4	-43.1	-13.7	-4.5	0.2	-13.2	-0.4	-17.4	-8.6	-2.2

Residual Sodium Carbonate (RSC)

The expressions of RSC is carried out in terms of meq/L units generally. The preferable value for water irrigation, the residual sodium carbonate should be less than +0.5 meq/L and not be higher than 1.25 meq/L [21]. RSC value can be concluded by the addition of carbonate and bicarbonate values with subtraction of calcium & magnesium values in terms of meq/L of the sample. Negative value of RSC represents that Magnesium and Calcium precipitates of carbonates are excessively

sufficient than Sodium build up. RSC value of present study varies between -43.1(Hoidad) to 1.8 meq/L (Badi).

IV. CONCLUSION

Water samples from Ghogha Taluka of Bhavnagar were analysed for physico-chemical study for its suitability for human consumption and agriculture. pH of all the samples was shown alkaline. The concentration of Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}, Cl^{-}, sulphate and nitrate are fall in permissible limits except in few samples. Our study on fluoride shows that all the stations are in permissible limits given by BIS and there is no risk by fluoride concentration. All over study represents that some of samples have poor quality for consumption and required regular monitoring for avoid further contamination. Almost all the samples have suitability for irrigation according their SAR and RSC values, only one station Badi has less among them.

V. ACKNOWLEDGEMENT

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