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Hydrogeochemical Studies of Groundwater In Industrial And Agricultural Area Of Gokul Shirgaon MIDC Region, Kolhapur, Maharashtra, India

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Abstract: Groundwater is one of the earth's most widely distributed and most important natural resources. Groundwater exists, wherever water penetrates beneath the surface. The rocks beneath the surface are permeable enough to transmit water, and at places, the rate of infiltration is so sufficient that the rocks are saturated to an appreciable thickness. This water may be fresh or brackish in quality. As the fresh water constitutes very little quantity of the total water available, we must think as to how best we can exploit it, and utilize it. With the growth of population, today in many of the places water has become a critical source. In many places it is dwindling both in quality and quantity, creating problems for the communities involved. Water Quality Index indicates the quality of drinking water by assessing physical, chemical and biological parameters of water. India had the most studies, with 177 articles, followed by China, Brazil and the United States. This four countries together published 57% of studies on WQI. Groundwater quality implies the level of concentration of different constituents of water which is ultimately described if it is suitable or not for drinking or other purpose such as irrigation. There are mainly three types of constituents or parameters for describing quality of groundwater as physiological, chemical and biological parameters. These parameters are described below: EC ,TDS, K, Na, Ca ,Mg ,TH, Co3, HCO3, Cl, SO4 ,and also we determine some trace element such as Copper (Cu) ,Lead (Pb), Manganese (Mn) ,Nickel (Ni) ,Iron (Fe), Zinc (Zn).

Keywords: Gokul Shirgaon , Hydrogeochemical , GroundWater

I. INTRODUCTION

India has diversified geological, climatological and topographic set up giving rise to divergent groundwater situations in different parts of the country. Groundwater is one of the earth's most widely distributed and most important natural resources. Natural resources comprise groundwater that works dynamically in nature and can be used as an alternative to surface water for drinking, irrigation and industrial usage. Furthermore, much of the world's food is produced by irrigated agriculture, which relies on ground water. In addition to human uses, many plants and aquatic animals depend upon the ground water that discharges to streams, lakes, and wetlands Groundwater exists, wherever water penetrates beneath the surface.

Groundwater contamination occurs when manmade products such as gasoline, oil, road salts, and chemicals get into the water and cause it to become unsafe and unfit for human use. Groundwater pollution is a significant problem, intensified when storage is decreased. The most serious water quality degradation in agricultural regions is caused by fertilizer and pesticide use, which results in runoff of chemicals from agricultural fields into surface waters and percolation into groundwater. Three are several causes of groundwater pollution such as Natural sources, septic systems, Hazardous waste disposal, petroleum products, solid waste, agricultural chemicals. Pollution of groundwater due to industrial effluents and municipal waste in water bodies is another major concern in many cities and industrial clusters in India. A 1995 survey undertaken by Central Pollution Control Board identified 22 sites in 16 states of India as critical for groundwater pollution, the primary cause being industrial effluents. A recent survey undertaken by Centre for Science and Environment from eight places in Gujarat, Andhra Pradesh and Haryana reported traces of heavy metals such as lead, cadmium, zinc and mercury.

Analysis of groundwater indicates that water at most of the places is slightly hard comparing with WHO and ISI standards for drinking water. Most of the tube well water is contaminated hence unsuitable for drinking. Regular monitoring of all open wells and tube wells is essential. Now in the area of economic growth, groundwater is becoming contaminated due to the relocation of textile industrial waste through nallahs. The major problem with groundwater is that once contaminated, it is very difficult to restore it. Intensive use of natural resources and various human activities are posing a great threat to under water quality.

II. SCOPE OF PROJECT

A. The modeling study can be extended for other water quality parameter.
B. A study on groundwater quality movement can be carried out.
C. A detailed study on consumptive use of ground water can be carried
D. Discussion on results so obtained in the light of pollution contamination status of the area and literature on public health aspects keeping in view geochemical view point.
E. To make public and responsible agencies know about the facts so that pollution control measure can be taken on time at various level.
F. In future, the expansion in drinking water should takes place in surrounding of study area then our study are helpful for determination of the physico-chemical parameter of the surrounding area and then expansion should be easier to the public or developer who expand the sources of drinking water.
G. The agricultural point of view study of the trace element is important to understand the quality of the ground water are responsible for the agricultural activity then our project analysis of the groundwater are give the quite beneficial to the people who related to the agricultural firm and surrounding farmers.
H. By this analysis ground water pollution should be monitored frequently in the industrial belt to identify pollution sources and to initiate corrective and regulatory actions through pollution control measures.

III. STUDY AREA

The study area is about 15 sq kilometer and lies in Karveer Taluka of Kolhapur district (Maharashtra state) and between latitude 16° 38’04.3” and 16° 38’46.5” N and longitude 74°16’08.3” and 74° 18’02.0”E. The area is in Survey of India toposheet numbered 47 L/6 . We made 3 parts of the total area which is 5km in each part. The study of each part are done separate that’s why the analysis of the study area became easy. The area is accessible by all season motorable roads. Since, the study area is an industrial area, there are a number of good roads within it. The study area can be easily approached from National Highway (NH 4) from Pune to Bangalore. Two distinct trends in the hill range are seen in Kolhapur district. One runs roughly north-south, along the main range of the Western Ghats presenting hill and hill slopes and valleys. The other one comprises the narrow broken-crested ridges and flat topped masses stretching eastwards and merging gradually in to the plains in the east. The rivers Hiranyakeshi, Vedganga, Dudhganga, Bhogavati and Panchganga drain the area towards east.In the study area, major lithounits are laterite and Deccan volcanics. The main rock occurring in the study area is basalt in which compact basalt occurs widely and some vesicular and amygdaloidal basalt are also found.Study of soils are of equal importance in hydrogeology as a study of surface formation, because more than 95% of the meteoric water that falls on the ground come in contact with the soil and some part of it seeps through the soil and with passage of time, some of it joins the aquifers.Two major types of soils are recognized in the study area. They are; (1) Black cotton soil and (2) Red soil.

1) *Black Cotton Soil:* Black cotton soil covers a large portion of the area. This soil occurs in most part of the area where the underlying rock formation is deccan trap. The thickness of soils varies from 15cm to 100cm in general. At places it may reach up to 300-350cm. The soil is medium to deep black in colour. These soils don’t have capacity to store more water.
2) *Red Soil:* It is dark brown to red in colour and slightly lateritic at places. This soil is more suitable for agriculture.

IV. METHODS AND ANALYSIS

There are mainly three types of constituents or parameters for describing quality of groundwater as physiological, chemical and biological parameters. These parameters are described below EC ,TDS, K, Na, Ca ,Mg ,TH, Co3, HCO3, Cl, SO4 ,and also we determine some trace element such as Copper (Cu) ,Lead (Pb), Manganese (Mn) ,Nickel (Ni) ,Iron (Fe), Zinc (Zn). For the purpose of quality studies, 20 representatives bore well and open well water samples were collected from the study area. The locations of all samples are given in the present analytical study, procedures given by Trivedy and Goel (1984) have been employed. This study was carried out in three stages viz.

1) Determination of physical parameters
2) Determination of chemical parameters
3) Determination of trace elements

A. Analytical Methods Employed for Physico-chemical analysis of water Samples of the Study Area

Parameter	Methods and Equipments Used
pH	Elico portable kit
Electrical Conductivity (EC)	Elico portable kit
Total Hardness (TH)	Volumetric method, titrating against 0.01m EDTA solution with EBT indicator.
Calcium	Volumetric method, EDTA titration using muroxide as indicator.
Sodium and Potassium	Flame photometric method using Flame photo meter of Elico make
Bicarbonate and Carbonate	Bi-acidimetric titration method using phenolphthalein and methyl orange indicator.
Sulphate	Turbidimetric method using spectrophotometer at 420 nm.
Chloride	Volumetric estimation method, titration of 0.02N $AgNO_3$ solution in presence of potassium chromate.
Nitrate	Phenol disulfonic acid method
Trace element	GBC – 932 plus Atomic Absorption Spectrometer

The partial physico-chemical analysis of the natural waters of study area was carried out adopting standard analytical procedures (Trivedy and Goel, 1984). The physical properties viz. pH and EC were measured using the ELCO potable kit and total dissolved solids (TDS) by evaporating the samples on a water bath. Total hardness was determined by the volumetric method. Calcium, magnesium, chloride, carbonate and bicarbonates were analyzed by titrimetric methods. Sodium and potassium content was determined using flame photometer. Sulphate and nitrate content was determined by turbidimeteric (colorimetric) method. The various analytical methods employed for physico-chemical analyses of water samples of study area are given in Table 2.2. The values of cation (calcium, magnesium, sodium and potassium) and anions (carbonates, bicarbonates, chloride, sulphate and nitrate) are expressed in mg/l or parts per million (ppm). Electric conductivity (EC) of water is expressed in micromho/cm.

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V. RESULT AND DISCUSSION

A. Chemical Parameters

Result- Agricultural

Location	pH	EC	TDS	K	Na	Ca	Mg	TH	Co3	HCO3	Cl	SO4
Nerli-1	7.979	152	972.8	210.192	308.052	42	18.228	73.6	0	48.813	56.724	256.992
School area	6.872	1618	1035.52	202.372	293.799	80	81.418	152.4	0	244.067	120.54	251.904
Prabhadevi	7.72	237	1516.8	204.288	429.894	89	48.608	119.4	0	24.406	99.268	259.104
PatilNagar	7.312	1827	1169.28	211.209	282.075	52	37.671	120	0	73.22	120.54	244.32
Nerli-2	7.73	1904	1218.56	199.01	359.777	57	19.443	160.2	0	48.813	49.634	255.648
Kaneriwadi	7.132	1097	702.08	210.7	183.222	45	18.228	136.2	0	73.22	42.543	255.696
Malwadi	7.119	132	844.8	209.097	211.498	88	0.243	214.8	0	73.22	63.815	250.32
Kaneriwadi-2	7.464	2158	1381.12	202.177	450.124	78	110.583	187.6	0	24.406	85.087	261.072
Nerli-3	7.305	3721	2400.6	208.863	804.844	131	82.633	264.6	0	73.22	113.449	250.56

Result- Industrial

Location	pH	Ec	TDS	K	Na	Ca	Mg	TH	CO3	HCO3	Cl	SO4
Gokul shiragaon 1	7.551	1478	945.92	212.342	206.441	82	41.316	171.6	0	48.813	106.359	260.304
Sameer Casting	6.771	1076	688.64	209.566	196.785	76	38.886	140.96	0	24.406	120.54	255.696
Patil Indu.	7.291	246	157.44	198.73	72.185	33	96	371.8	0	244.067	70.906	243.84
Gokul shiragaon-3	7.659	244	1561.6	207.416	423.917	94	31.595	149.6	0	24.406	92.177	254.59
Gokul shiragaon- 4	7.339	2954	1890.56	213.163	68.139	119	81.418	223.8	0	24.406	120.54	261.456
Gokul shiragaon- 5	7.97	1861	1191.04	204.914	312.88	108	69.266	262.87	0	146.44	99.2648	255.36
Laxmi Pump	7.413	193	123.52	210.309	2.988	43	7.291	257.8	0	24.406	63.815	251.136
Krishna colony	7.97	839	536.96	207.651	146.899	135	82.633	459.4	0	73.22	85.087	253.536
Starch company	7.72	1016	650.24	208.002	196.785	51	30.358	117.8	0	73.22	42.543	255.936
Jainmandir	7.23	165	1056	214.688	278.166	80	12.152	153.44	0	97.626	49.634	258.72
Gokul Shirgaon-2	7.49	1298	830.72	202.802	201.843	112	4.86	266.8	0	122.033	35.453	25536

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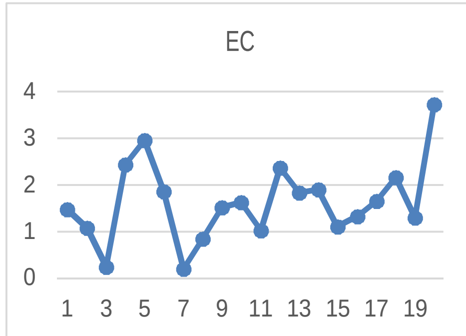
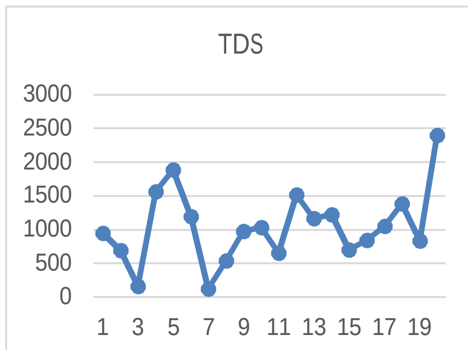
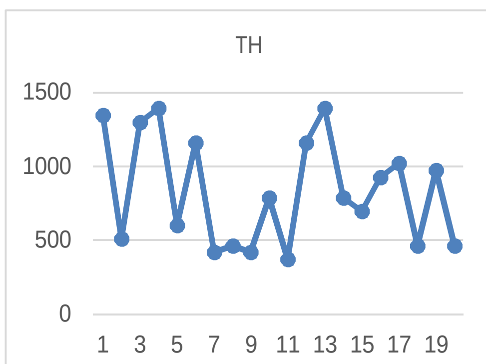
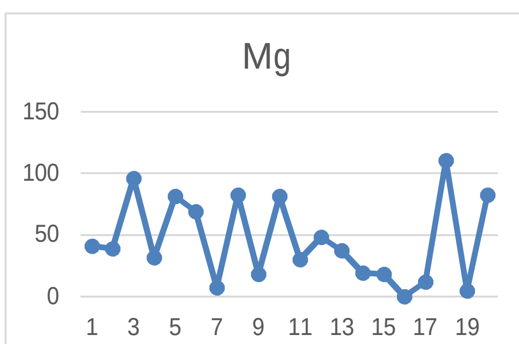
B. Chemical Parameters

(Graphs)









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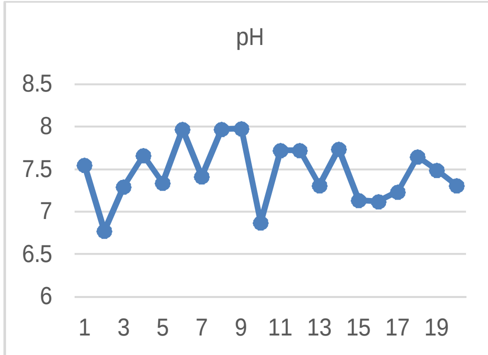

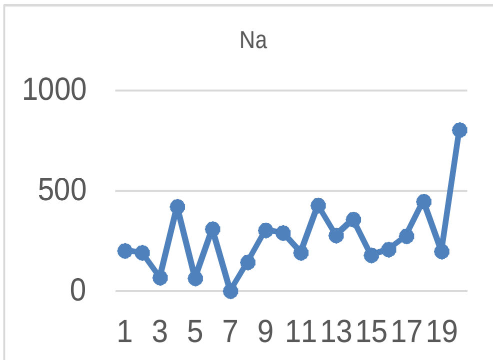

Sr. No	Location	Source	Mn	Pb	Cu	Zn	Ni	Fe	B
1	G Shirgaon-1	BW	<0.01	<0.01	ND	<0.01	ND	ND	0.542
2	Sameer casting	BW	ND	ND	ND	ND	ND	ND	0.529
3	Patil Ind.	BW	ND	ND	ND	0.001	ND	ND	0.508
4	G Shirgaon-2	OW	ND	ND	ND	ND	ND	ND	0.526
5	G Shirgaon-3	BW	0.130	ND	ND	0.054	ND	ND	0.529
6	G Shirgaon-4	BW	<0.01	ND	ND	<0.01	<0.01	ND	0.544
7	Krishna colony	BW	ND	ND	ND	0.111	ND	ND	0.531
8	Malwadi	OW	ND	ND	ND	0.006	ND	ND	0.529
9	G Shirgaon-5	BW	ND	ND	ND	0.010	ND	ND	0.529
10	School area	BW	ND	ND	ND	0.006	ND	ND	0.532
11	Jain mandir	OW	ND	ND	0.001	<0.01	0.017	ND	0.542
12	G Shirgaon-6	OW	ND	ND	0.042	0.009	<0.01	0.065	0.534
13	Laxmi pump	BW	ND	ND	ND	0.010	0.001	ND	0.523
14	Prabhadevi	BW	ND	ND	0.005	0.013	0.016	ND	0.534
15	Nerli-1	BW	ND	<0.01	0.000	0.015	0.020	ND	0.539
16	Patil nagar	BW	ND	ND	ND	0.013	<0.01	ND	0.508
17	Nerli-2	BW	ND	0.001	ND	<0.01	0.005	ND	0.531
18	Nerli-3	OW	ND	0.011	0.007	0.017	<0.01	ND	0.532
19	Statech company	BW	ND	0.014	ND	0.024	0.22	ND	0.535
20	Kanariwadi	BW	ND	<0.01	ND	0.013	0.019	ND	0.520

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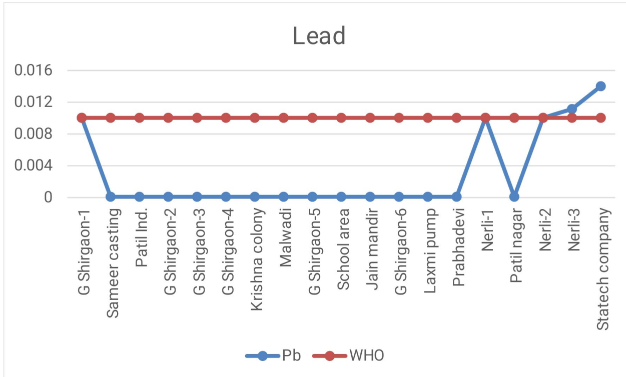
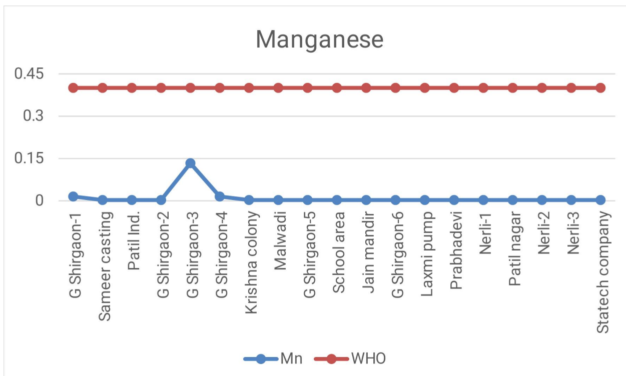
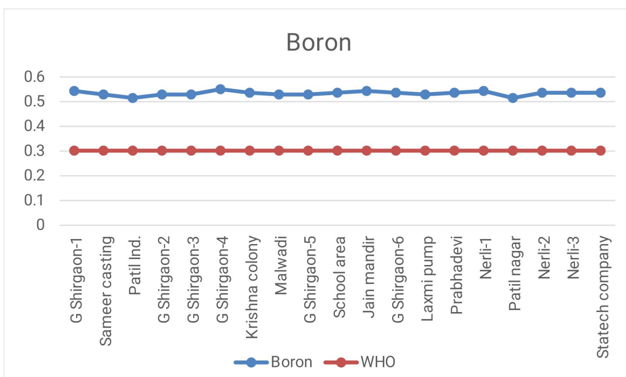
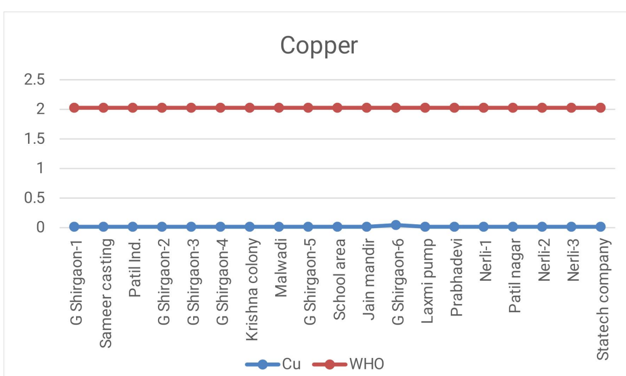
C. Trace Elements



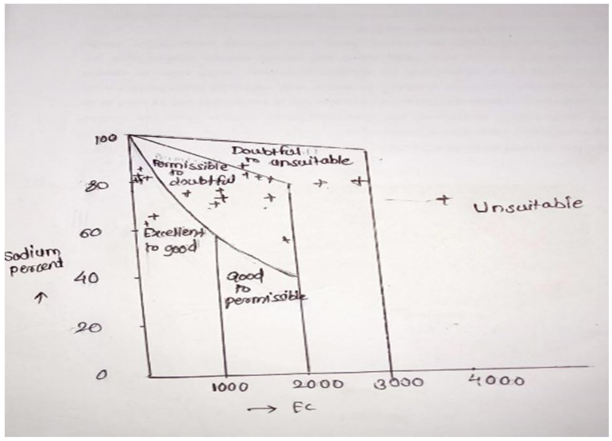






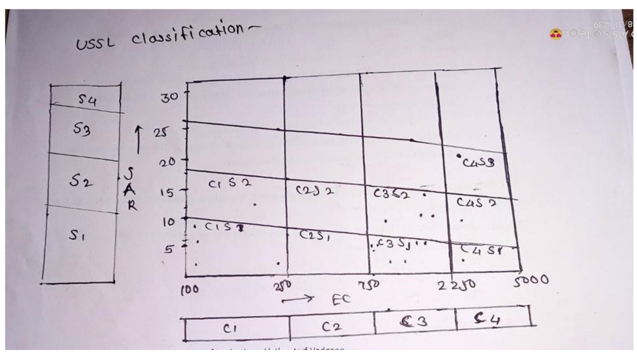
D. Classification Of Groundwater For Drinking And Irrigation Purpose

The groundwaters of the study area are classified on the basis of position of plots in the Wilcox diagram into five water divisions of irrigation suitability . 40% of the total samples fall in “Excellent to good” water class whereas only about 5% are unsuitable for irrigation . More than 5% of bore well samples fall in the category “Permissible to doubtful” while 10% of bore well samples fall in the category “Doubtful to unsuitable”. For open wells, 40% of the samples are categorized under “Excellent to good” category. This indicates that shallow aquifers are probably more suitable for irrigation than the deep aquifers. The unsuitable groundwater can be used for growing salt tolerant crops like, cotton, sunflower, coconut etc.



Wilcox Diagram

Accordingly water carrying more than 60% sodium is unsafe. 95% of the groundwater samples of study area shows Na% more than 60%. Hence, except only one sample from Prabhadevi Industry, 5% of the groundwater of study area are not in safe limits and therefore are unsuitable for irrigation.

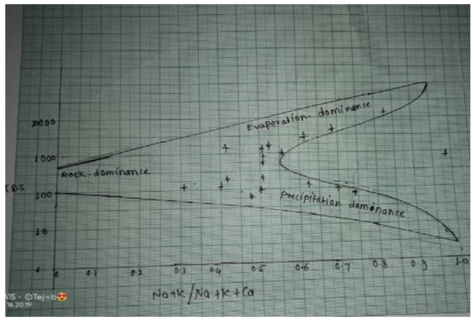


USSL Classification

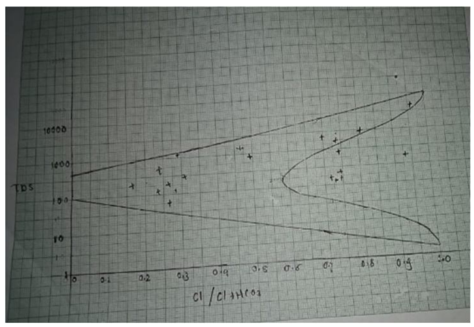
The United States Salinity Laboratory (USSL) proposed a diagram for the suitability of groundwater for irrigation purpose, which uses the sodium adsorption ratio (SAR) on vertical axis and conductivity on horizontal axis. The groundwaters are divided into 5 distinct classes both horizontally and vertically. On horizontal axis the salinity (hazard) is divided into low salinity (C1), medium salinity (C2), moderately high salinity (C3), high salinity(C4) and very high salinity(C1) similarly, on vertical axis sodium (alkali) hazard is divided into low sodium (S1), medium sodium (S2), high sodium (S3) and very high sodium hazard (S4).Out of total, 40% of the samples fall in C2S2 in USSL diagram i.e. medium salinity with low sodium hazard and groundwater of this class can be used with moderate treatment for the soil. Remaining samples fall in C1S3 and C2S1 with 5 % for each type and some samples fall in C2S2, C1S2 and C1S1 with 15 %, 20% and 10 % respectively.

Gibbs (1970) suggested that water chemistry is controlled by three factors namely, chemistry of rock types, chemistry of the precipitated water and rate of evaporation. According to Gibbs, causative factors are the ratio of Na+K to Na+K+Ca i.e., cations of dominant nature, and ratio of Cl to Cl+HCO3 i.e., anions of dominant nature. Based on the position of plots in the diagram, Gibbs has suggested two mechanism viz., if the plot falls in the upper portion it is the evaporation dominance and precipitation dominance if the plot falls at the lower part of diagram. However, a third mechanism was suggested by Vishwanathaiah et al., (1978) viz., the rock / lithology dominance for the plots falling in the middle part of the diagram.

The mechanisms controlling the chemistry of the study area were assessed by this method. The results indicate that, for deeper aquifers, evaporation dominance (for cation ratio) followed by rock dominance (for anion ratio) are the controlling mechanisms



Gibb's Diagram (Cations)



Gibb's Diagram (Anion)

VI. CONCLUSION

In the study area of Gokul Shirgaon, quantity of groundwater is not a problem. But, because of agricultural activities and presence of large number of various industries, especially the textile industries, groundwater pollution is widespread and is a major problem. Due to the pollution of both deeper- and shallow-aquifers, the waters of majority of these aquifers have been rendered non-potable. The groundwaters are unfit asthetically too as they smell bad and in many cases possess odd-colours. Thus, the present study is aimed at knowing the water quality problems in the industrial and agricultural environs of gokul shirgaon.

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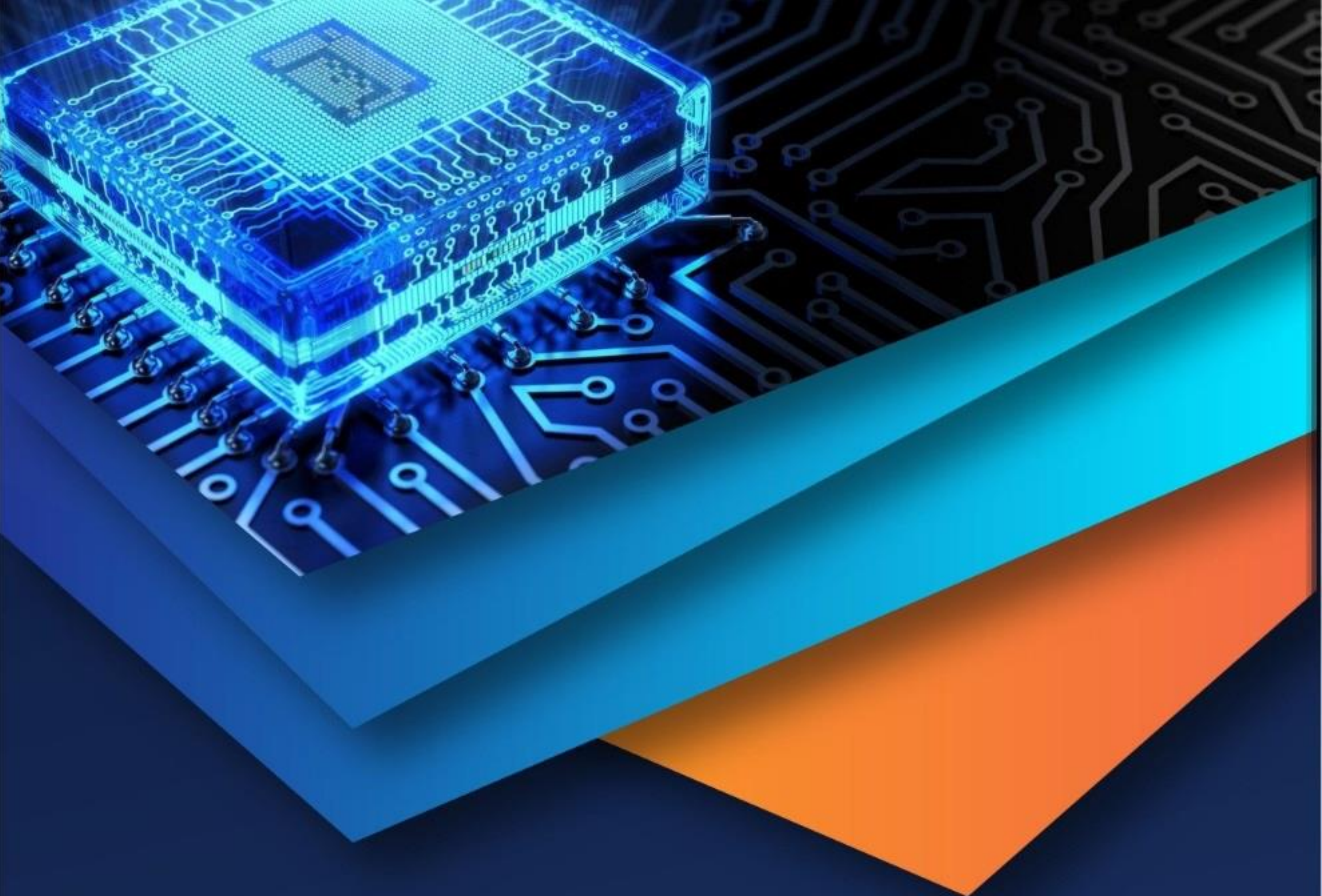

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