A study of spatial and temporal Ground Water Quality of Jalandhar District, Punjab, India

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Abstract— ***Leaching of pollutants from solid waste and industrial sites to the ground may lead to ground water pollution. A trial study has been conducted to decide the degree of pollution in the groundwater of Jalandhar region, Punjab. Inverse Distance weighted (IDW) technique has been utilized to study spatial variation of 9 water quality parameters of 14 inspecting destinations in the Jalandhar area. Temporal variation of all these water quality parameters was likewise done by looking at the information of past four-years (2015-2018). Through research center experimentation it was discovered that pH, Total broke up solids (TDS), Electrical Conductivity (EC), Sulfate, Chloride, Nitrate and Iron all were found inside the desirable limits of drinking water quality parameters. In ground points G1, G5 and G8 the concentration of Bicarbonate ion was above the permissible limit of 250 mg/l and in G5 the Alkalinity of water was more than the desirable limit of drinking water quality i.e. 600 mg/l. The spatial variation maps show that in the South East part of the Jalandhar region, water was Alkaline in nature, with high estimation of Total Hardness (TH), Sulfate particle, Chloride particle and TDS. This abridges the water nature of this locale isn't acceptable when contrasted with the remainder of the area. As the examining was done in two seasons and tests were performed on 9 parameters of water quality, it was discovered that concentration of all parameters was high in the summers in contrast with the winters.***

INTRODUCTION

Groundwater is well thought-out to be the most vital natural and fresh resource on earth which is used for drinking and irrigation purposes [1]. Groundwater quality studies become unavoidable since its poor quality may badly affect its users. Groundwater pollution occurs when pollutants make their way down into groundwater and exploit the quality [2]. Groundwater may be contaminated through various sources which may be point or non-point sources. It may be caused by natural or man-made activities [3]. This water pollution is referred to as contamination rather than pollution. Movement of water and dispersion within the aquifer spreads the pollutant over a wider area thus causing more contamination [4]. Groundwater contamination due to anthropogenic sources include sewage disposal, solid waste disposal on land, municipal wastewater, brine disposal from petroleum industries, mine wastes, and agricultural activities [5]. It occurs naturally due to the presence of minor and unwanted constituents such as rainwater flowing through sedimentary rocks and soils may get mix with wide range of compounds like magnesium, chlorides and calcium and finally reach groundwater table [6,7]. It is difficult to restore its original quality once it gets contaminated. The study will help in determining the level of contamination in the groundwater distributed over a wide area and over a period [8]. Also, it will help in recognising the use of the groundwater for various domestic and recreational purposes.
Geographic Information System is a software or a high-performance based tool which plays a great role in water resource management and pollution study [9]. A geographic information system (GIS) is a system designed to capture, store, manipulate, analyse, manage, and present all types of geographical data [10,11]. It is that suggested spatial variability map of different groundwater quality parameters can be generated using interpolation techniques in the software Interpolation is a technique that predicts values for cells in a raster from a finite or limited number data points and be used to predict unknown values for any geographic point data, such as elevation, rainfall, chemical concentrations, noise level, and so on [12,13]. For pollution

concentrations in water, inverse distance weighted, and ordinary kriging were found to be best interpolation techniques to get better overview of spatial distribution by most of the researchers.

STUDY AREA & METHODOLOGY

Jalandhar is located on the intensively irrigated plain between Beas and Sutlej rivers. The district is mainly drained by the River Sutlej and its tributaries. Jalandhar is situated at 71^0 31’ East and 30^0 33’ North (Fig. 1) at 146 kms from state capital Chandigarh.

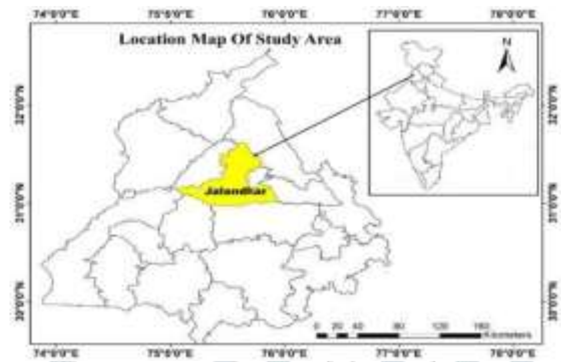


Fig. 1: Study Area (Jalandhar District)

Jalandhar is surrounded by Ludhiana district in East, Kapurthala in West, Hoshiarpur in North and Firozpur in South. the district occupies an area of 2632 km^2. The study area receives average annual precipitation 701 mm. The groundwater flow in the district is towards South-West direction [14].

A. Sampling Points

The study was carried out by taking the samples from the Jalandhar region of Punjab. It comprises 9 towns and total 14 samples were collected. Adampur, Alwalpur, Goraya, Jalandhar City, Jalandhar Cantonment, Kartarpur, Lohian Khas, Nakodhar, Phillaur and Shahkot were the points from where the samples were collected.

Table I: Sampling Points with Depths

S.No.	Location	Sample No.	Latitude	Longitude	Depth (ft)
1	Municipal Corporation, Adampur	G1	31.4303	75.7177	350
2	Printing Press, Moga Road, Alwalpur	G2	31.561595	75.650049	300
3	Mosque, Alwalpur Road	G3	31.434973	75.651914	250
4	Bharat Petrol Pump, Goraya	G4	31.139326	75.775097	450
5	Jandiala Guru	G5	31.163	75.6176	600
6	Old Court, Jalandhar	G6	31.337468	75.579414	400
7	Lalian	G7	31.32606	75.57562	550
8	Puspa Gujral Science City, Jalandhar	G8	31.327652	75.522997	350
9	Defence Colony, Jalandhar Cant.	G9	31.310093	75.605159	450
10	Nathan Ki Bagichi, Kartarpur	G10	31.445372	75.505296	500
11	Shahkot Road, Lohian Khas	G11	31.144772	75.212374	500
12	Guru Tejahadur Nagar, Nakodhar	G12	31.128022	75.478515	550
13	Municipal Park, Phillaur	G13	31.020885	75.789362	250

14	Old Tehsil Road, Shahkot	G14	31.07098	75.33393 4	400

B. Methodology

For the analysis of groundwater quality in the area, primary data was collected. For collecting the data, total 14 sites were selected in the district (Table I) and groundwater samples were taken from all these sites. The samples were collected for two seasons, one in the month of November i.e. winter season and another in the month of April i.e. summer season. Further the physico-chemical tests were performed in the laboratory for determining the pH, Electrical Conductivity, Alkalinity, Hardness, sulphate, Nitrate, Iron and Chloride. After laboratory experimentation, spatial distribution maps were prepared by using ArcGIS 10.5. In ArcGIS, Inverse distance weighted (IDW) tool was used for spatial distribution of maps.

RESULTS AND DISCUSSIONS

The present study conducted to analyse the groundwater quality in Jalandhar district and sample were collected in two seasons i.e. winter and summer. In Summer season concentration of water quality parameter were lying for pH 7.1 – 8.58, Electrical Conductivity 477µmho/cm to 1243 µmho/cm, Hardness 145 mg/l to 430 mg/l, Alkalinity 112 mg/l to 616 mg/l, Total dissolved solids 320 mg/l to 833 mg/l, Chloride 45 mg/l to 264 mg/l, Sulphate 54 mg/l to 271 mg/l, Iron 0.061 mg/l to 0.26 mg/l and for Nitrate 7mg/l to 42 mg/l. Values are shown below in Table II.

In winter season concentration of water quality parameter were lying for pH 7.1 – 8.78, Electrical Conductivity 478µmho/cm to 1228 µmho/cm, Hardness 143 mg/l to 388 mg/l, Alkalinity 123 mg/l to 388 mg/l, Total dissolved solids 311 mg/l to 798 mg/l, Chloride 29 mg/l to 216 mg/l, Sulphate 45 mg/l to 240 mg/l, Iron 0.056 mg/l to 0.3 mg/l and for Nitrate 1mg/l to 33 mg/l. Values are shown below in Table III.

The results of the spatial distribution maps show that the water quality of the groundwater in the South East part of the study area was not good as concentration of Chloride, Sulphate, Alkalinity, Hardness, Nitrate and Iron were not in the Bureau of Indian Standards (BIS) Guidelines of drinking water. Study reveals that groundwater of sample points G5 and

G8 were highly Alkaline and Hard in nature and the Alkalinity of sample point G6 was 616 mg/l i.e. more desirable limit of drinking water i.e. 600 mg/l [15].

Table II: Results of ground water testing in Summer season

Location	EC	pH	Alkalinity	TH	chloride	TDS	Iron	Nitrate	sulphate
G1	685	7.28	112	145	45	459	0.061	10	54
G2	1100	8.26	308	365	115	737	0.24	40	132
G3	818	7.42	148	174	152	548	0.15	25	185
G4	477	7.26	168	230	131	320	0.2	18	110
G5	918	7.45	616	153	81	606	0.22	7	81
G6	1088	7.2	147	165	69	729	0.18	20	75
G7	750	7.59	503	224	172	345	0.26	24	122
G8	1243	8.58	412	430	264	833	0.3	42	271
G9	692	7.36	187	198	58	464	0.09	10	70
G10	518	7.1	225	128	115	347	0.25	30	105

G11	872	7.46	305	369	228	584	0.1	40	216
G12	835	7.48	133	150	74	559	0.2	22	65
G13	437	7.17	176	178	88	293	0.25	8	160
G14	576	7.72	195	163	125	386	0.2	12	154

Table III: Results of ground water testing in Winter season

Location	EC	pH	Alkalinity	TH	Chloride	TDS	Iron	Nitrate	Sulphate
G1	785	7.1	192	195	29	510	0.056	15	45
G2	1228	8.4	378	388	140	798	0.3	30	112
G3	888	7.62	148	184	171	577	0.26	18	150
G4	597	7.56	241	250	95	388	0.25	8	123
G5	1150	7.85	426	143	103	771	0.18	1	92
G6	988	7.12	187	215	53	642	0.3	10	68
G7	719	7.79	324	204	146	482	0.1	3	103
G8	1053	8.78	388	356	216	685	0.35	25	240
G9	802	7.64	177	148	25	521	0.2	6	75
G10	478	7.3	285	168	68	311	0.088	24	120
G11	932	8	248	250	89	606	0.15	28	190
G12	769	7.68	123	190	36	500	0.05	33	85
G13	547	7.2	176	198	49	356	0.1	12	145
G14	657	7.82	195	193	80	427	0.15	8	170

A. Spatial Variation

Spatial distribution maps were plotted for two season and spatial variation of water quality parameters were shown for pH Fig. 2, EC fig. 3, Alkalinity Fig. 4, Hardness Fig. 5, Chloride Fig. 6, Sulphate Fig. 7, Iron Fig. 8, TDS Fig. 9 and for Nitrate Fig. 10.

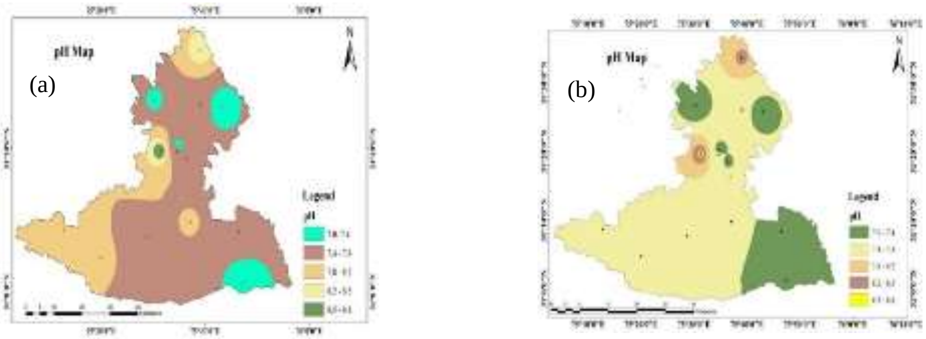


Fig. 2: Spatial distribution of pH in (a) winter (b) summer

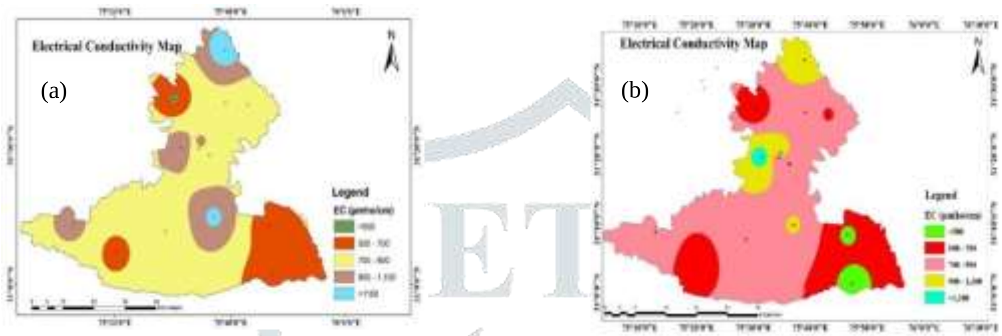


Fig. 3: Spatial distribution of EC in (a) winter (b) summer

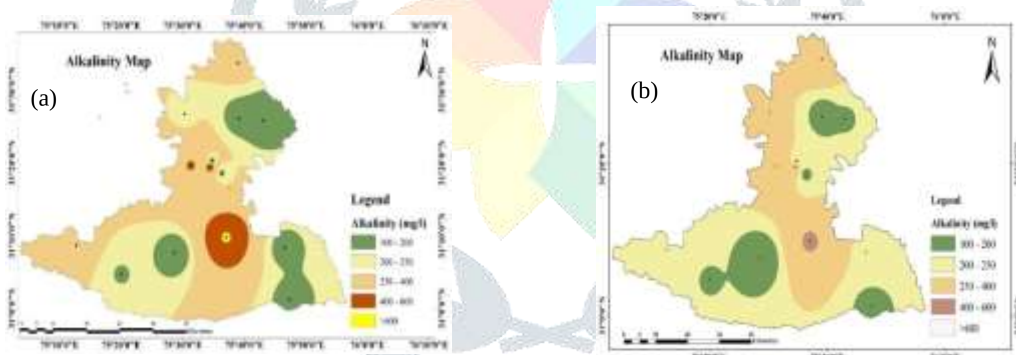


Fig. 4: Spatial distribution of Alkalinity in (a) winter (b) summer

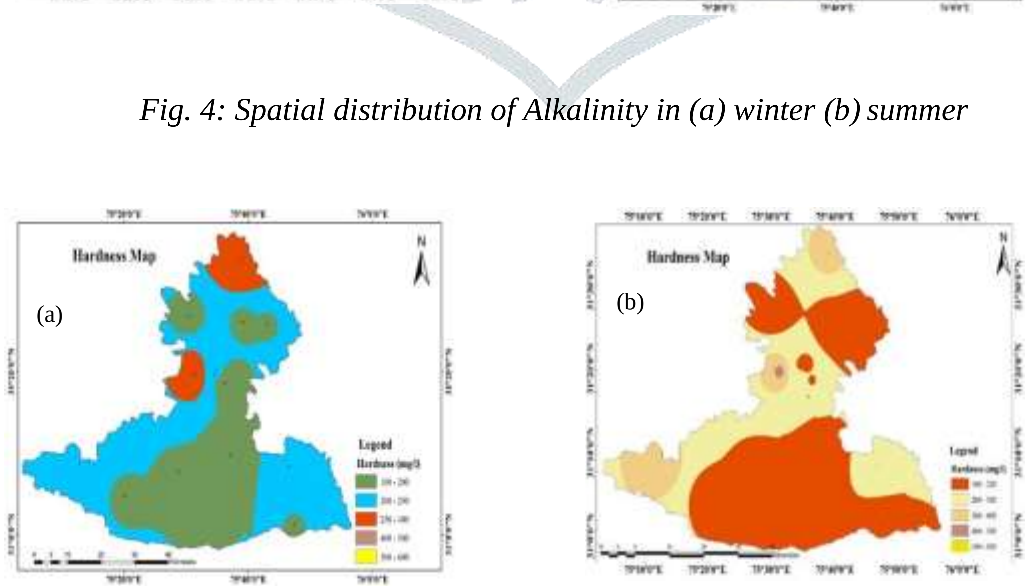


Fig. 5: Spatial distribution of Hardness in (a) winter (b) summer

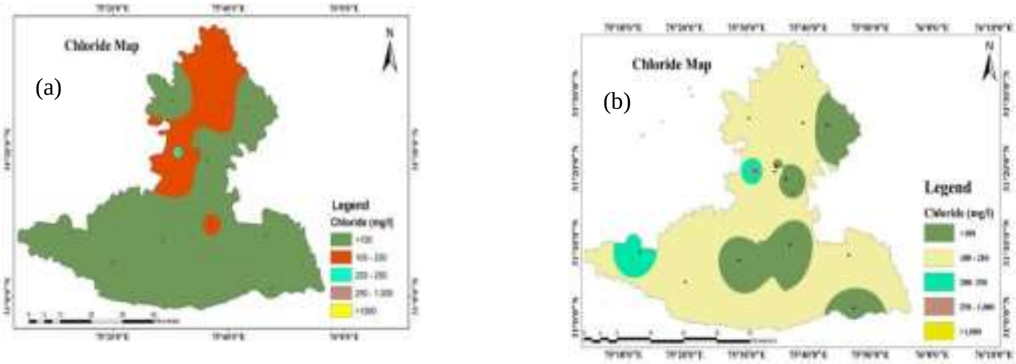


Fig. 6: Spatial distribution of Chloride in (a) winter (b) summer

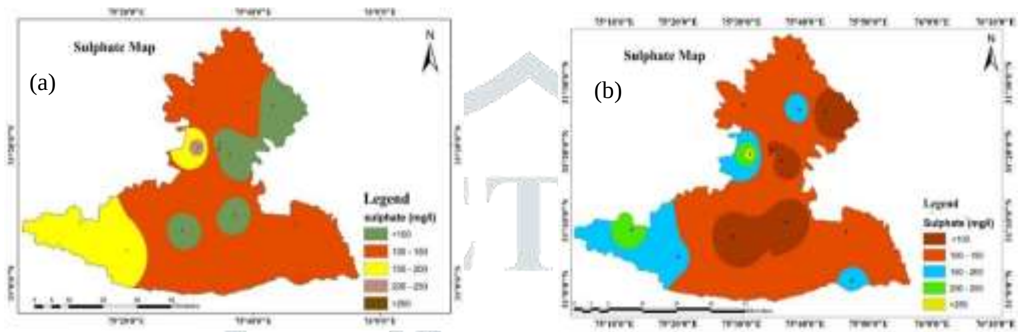


Fig. 7: Spatial distribution of Sulphate in (a) winter (b) summer

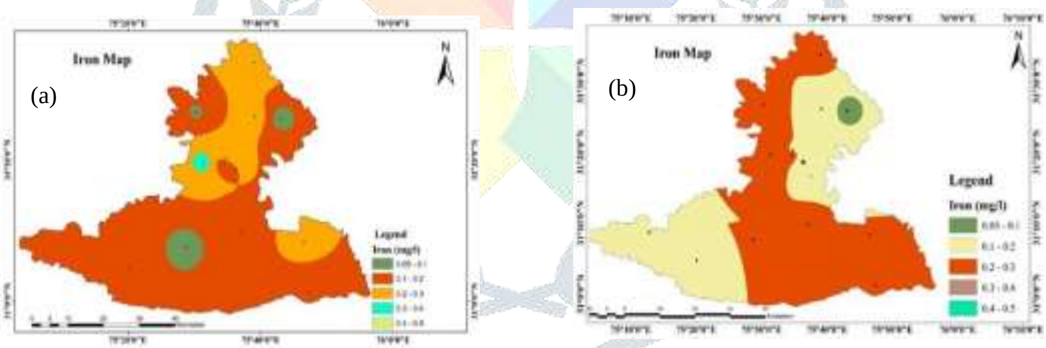


Fig. 8: Spatial distribution of Iron in (a) winter (b) summer

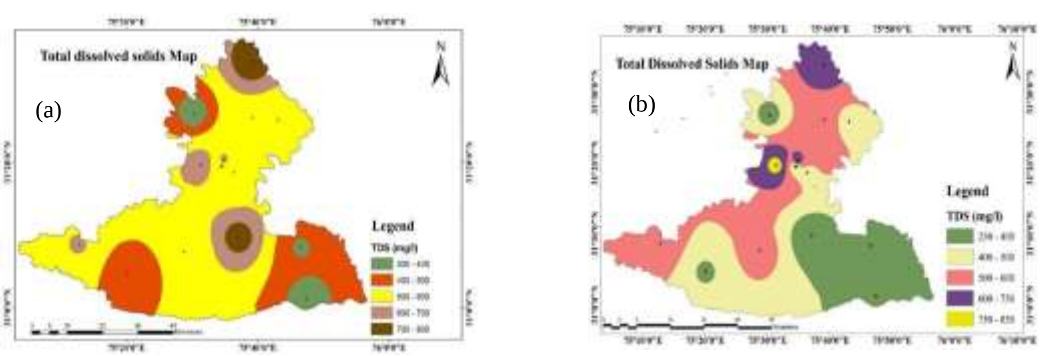


Fig. 9: Spatial distribution of TDS in (a) winter (b) summer

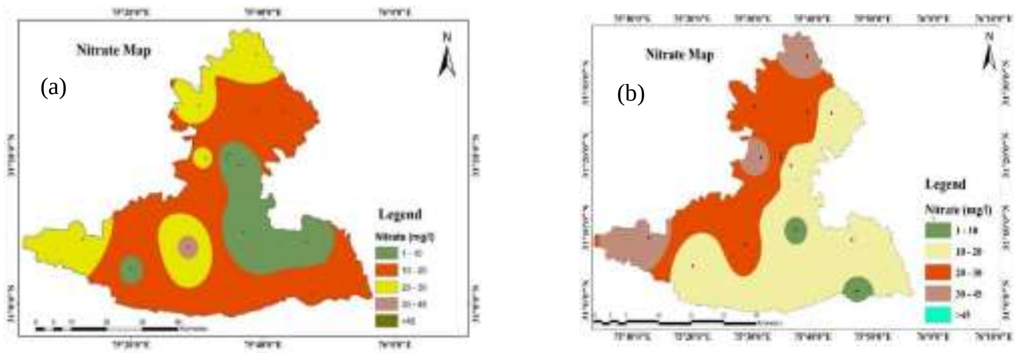


Fig. 10: Spatial distribution of Nitrates in (a) winter (b) summer

B. Temporal Variation

Temporal variation of 9 water quality parameters was done by comparing the data of previous four-years (2015-2018). Temporal variation of pH shown in Fig. 11, EC fig. 12, Alkalinity Fig. 13, Hardness Fig. 14, Chloride Fig. 15, Sulphate Fig. 16, Iron Fig. 17, TDS Fig. 18 and for Nitrate Fig. 19.

Fig. 11: Temporal variation of pH

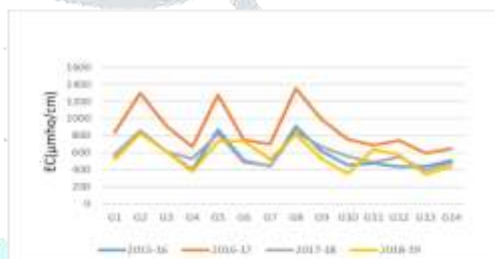


Fig. 12: Temporal variation of EC

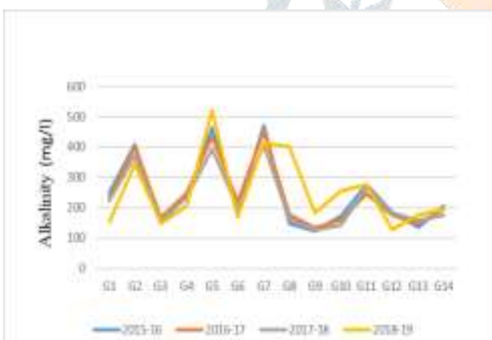


Fig. 13: Temporal variation of Alkalinity

Fig. 14: Temporal variation of Hardness

Fig. 15: Temporal variation of Chloride

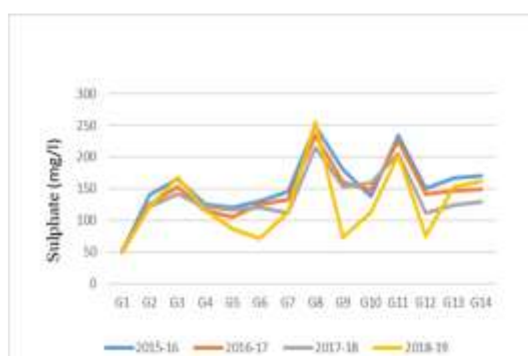
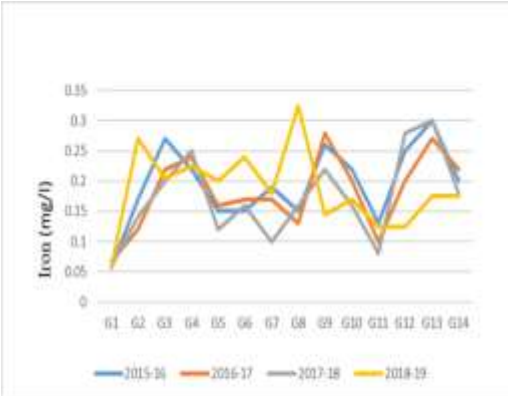


Fig. 16: Temporal variation of Sulphate



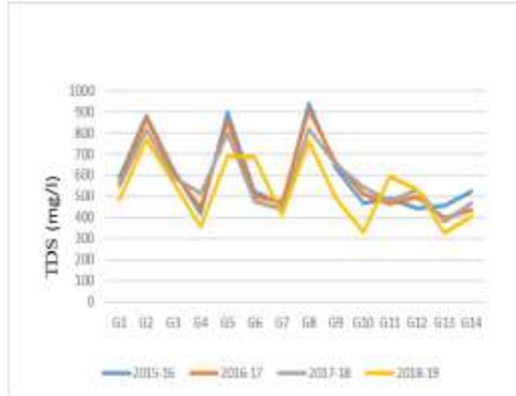


Fig. 17: Temporal variation of Iron

Fig. 18: Temporal variation of TDS

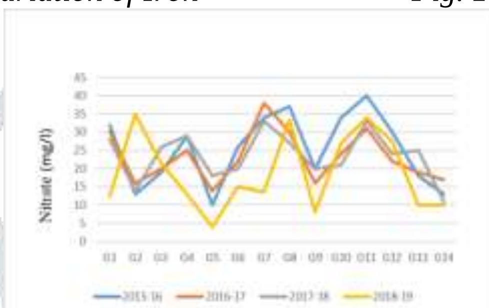


Fig. 18: Temporal variation of Nitrates

CONCLUSIONS

The present study has been conducted to analyze the groundwater quality using Inverse Distance Weighted (IDW) as an interpolation technique. Using the IDW interpolation technique spatial distribution maps were plotted for the two seasons
i.e. winters and summers. Winter samples were taken in the month of November and summer samples were taken in the month of April. Physico-chemical tests were performed over 9 water quality parameters. The results obtain from study were:

- In winter season concentration of water quality parameter were lying for pH 7.1 – 8.78, Electrical Conductivity 478µmho/cm to 1228 µmho/cm, Hardness 143 mg/l to 388 mg/l, Alkalinity 123 mg/l to 388 mg/l, Total dissolved solids 311 mg/l to 798 mg/l, Chloride 29 mg/l to 216 mg/l, Sulphate 45 mg/l to 240 mg/l, Iron 0.056 mg/l to 0.3 mg/l and for Nitrate 1mg/l to 33 mg/l.
- In Summer season concentration of water quality parameter were lying for pH 7.1 – 8.58, Electrical Conductivity 477µmho/cm to 1243 µmho/cm, Hardness 145 mg/l to 430 mg/l, Alkalinity 112 mg/l to 616 mg/l, Total dissolved solids 320 mg/l to 833 mg/l, Chloride 45 mg/l to 264 mg/l, Sulphate 54 mg/l to 271 mg/l, Iron 0.061 mg/l to 0.26 mg/l and for Nitrate 7mg/l to 42 mg/l.
- For spatial distribution thematic map of groundwater quality, ArcGIS was used to plot the places in order to interpret the results more easily. GIS maps showed that in the South East part of district, water quality was little bit poorer as compared to the rest of the district. Temporal variation of groundwater was shown by Bar chart and comparison was done between the previous four-years data. Results shows that the groundwater pollution level increase in past four year. It also shows that not much variation was found in pH, EC, Iron and Nitrate concentration.

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