

## ASSESSMENT OF GROUND WATER QUALITY: A CASE STUDY IN SARGODHA CITY, PAKISTAN

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**ABSTRACT:** *The paper presents a case study on the ground water quality analysis carried out at Sargodha city, Pakistan. Twelve ground water samples were collected randomly from different locations during June 2013 to July 2013. The quality analysis has completed in the course of chemical and physical parameters which were obtained by using Atomic Absorption Spectrometer. pH and EC values were determined through pH and EC meters while TDS concentration measured by using indirect method. The results reveal that the concentration of all parameters were high as compare to World Health Organization (WHO) permissible limit. Geographic Information System (GIS) was used to produce spatial circulation map of ground water quality. Spatial division maps provided significant information to illustrate the concentration of parameters. The study concluded that ground water of study area is not fit for drinking purpose.*

**Keywords:** Groundwater quality, Geographic Information system (GIS), Sargodha

### INTRODUCTION

Enormous part of the world is occupied by water which is the most indispensable and imperative constituent on the planet [1]. Science reveals that life is ongoing from water, living things began to occupy the earth as water receded, even then water continued to be a primary necessity of life not only as an article of food but also for cleanliness, clothing and other uses [2]. Ground water is major source of drinking water in whole world. Ground water has percolated from the surface of the earth above it and carries all sorts of impurities with it. Water pollution has been constantly a serious global threat as it affects environment and human being, at present; water quality is more critical than the magnitude [3]. Ground water contamination in built-up areas is a most important concern and it is more complex by a large number of probable sources of contamination [4]. There are two core reasons for deplorable water quality, i.e. natural and anthropogenic activities. The depraved water eminence is not only the impact on human health [5], but also influence the agricultural production and environmental purity [6]. Ground water chemistry is an imperative aspect to determine its utilization for irrigation, domestic and industrial purpose. It is suggested that infected water is the leading wide-ranging cause of deaths and diseases in whole world. Clark et al., (2004) identified that only 33% of the total world population has access to use able water and annually five million children are dying due to the poor water quality in the World [7]. Globally, 60% of children death is allied with water related diseases. The problem is more significant in the urban and manufacturing areas, where rapid water quality decline has caused widespread diseases. A study in Rawalpindi proved that 81996 cases of water-linked diseases were registered in community health unit in 1994 [8]. In the last two decades, the number of patients with water born diseases has increased about 200 percent in hospitals of Pakistan [9]. The demand of safe drinking is increasing day-by-day especially in urban areas of Pakistan. Sargodha is the 11<sup>th</sup> largest city of Pakistan. Owing to the importance of this city, it is necessary to assess and monitor the water quality. The present study is planned to investigate and assess the groundwater quality in term of its contaminations.

### STUDY AREA

Sargodha lies on the 32°5'1"North latitude and 72°40' 16" East longitude (fig.1.1). Its population was 458,440 according to the census report of March 1998 [10] which has increased to one million in 2013. District Jhelum lies in the north and Mandi Baha-ud Din, Hafizabad, and Chenab River in the east. Chiniot and Jhang districts bound Sargodha from the south while Khushab district is separated by Jhelum River, which is situated in the west. Whole of the study area is part of chaj doab and represents plain area having the altitude of 150-200 Meters. The two rivers namely Chenab and Jhelum flow in this basin. Sargodha is an agricultural district and has a loamy soil. The climate of area is hot in summer and mild in winter. Maximum temperature is experienced in June and July when temperature reaches above 39°C whereas winter is mild and temperature remains around 10°C. Study area receives most of its rainfall from summer monsoon especially in July, August and September.

### MATERIAL AND METHODS

Ground water samples were collected from 12 different locations in the study area namely (New Muhammdi colony, Meer Colony, New Satellite town A Block, 18 Block, 34 Block, Maryam Town, Rehmat Pura Town, M. C. Society, Mujahid Colony, PAF, New Satellite town X Block, Istaqlala-Abad colony) during the months of June to July 2013. Water samples were collected through random sampling method and Global Position System (GPS) was used to mark the sample co-ordinates which are shown in table 1.1. One-litter volume polyethylene bottles were used for sampling; bottles were washed with distilled water and once or twice with the water to be sampled before used for sampling. . The samples were collected from hand pump after being pumped for 3-5 minutes for real results otherwise the collected sample will not show the original water quality of that location. The greatest care which must be taken is that the stopper showed never be laid down on anything and bottle held by the bottom. After this procedure, the bottles were sealed and stored in a cool place and were transferred to the laboratory. Necessary information about samples like altitude, coordinates, location, bore depth; sample collection date, bore timing, and condition of the hand pump were recorded precisely.

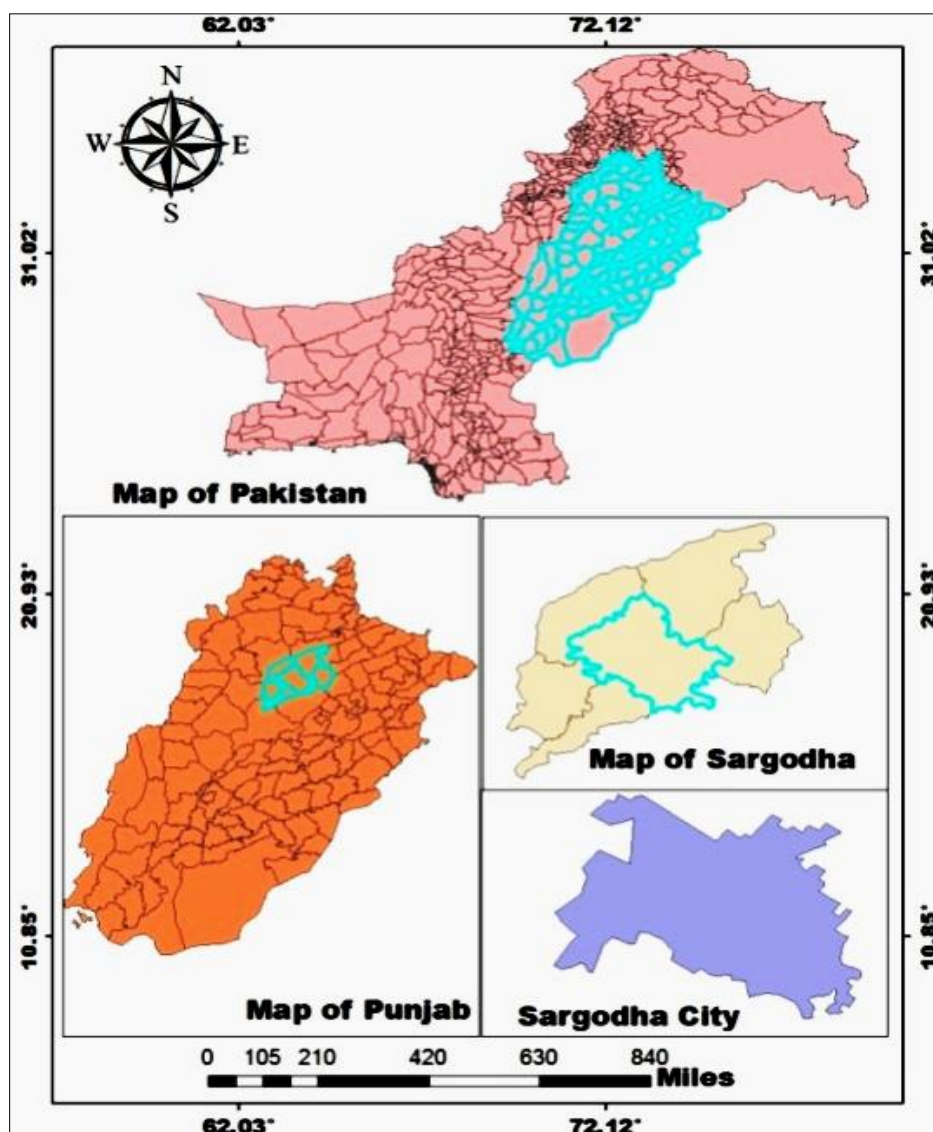


Fig.1 Study Area Map

Water samples were tested in Hi-Tech Instrument Lab, University of Sargodha in a suitable environment. The concentration of pH (Presence of Hydrogen ions) and EC (Electric Conductivity) were determined by using

pH/conductivity meters (Jenway model, 3510), TDS (Total Dissolved Solid) through Electric Conductivity while all the concentrations were determined by using (AAS) Atomic Absorption Spectrometry (AA 630, Shimadzo, Japan).

Table 1.1: Detail of sampling locations of the study Area

Sample Code	Locations	Latitude (dms)	Longitude (dms)	Altitude (M)
G.W.1	New Muhammadi colony	32 <sup>0</sup> 06' 21"	72 <sup>0</sup> 39' 30"	188
G.W.2	Meer Colony	32 <sup>0</sup> 05' 28"	72 <sup>0</sup> 39' 42"	187
G.W.3	N.S.A Block	32 <sup>0</sup> 05' 07"	72 <sup>0</sup> 41' 36"	185
G.W.4	18 Block	32 <sup>0</sup> 05' 21"	72 <sup>0</sup> 39' 58"	187
G.W.5	14 Block	32 <sup>0</sup> 04' 22"	72 <sup>0</sup> 39' 39"	190
G.W.6	Maryyam Town	32 <sup>0</sup> 01' 44"	72 <sup>0</sup> 42' 13"	186
G.W.7	Rehmat Pura Town	32 <sup>0</sup> 05' 38"	72 <sup>0</sup> 40' 49"	187
G.W.8	M. C. Society	32 <sup>0</sup> 04' 59"	72 <sup>0</sup> 39' 53"	186
G.W.9	Mujahid Colony	32 <sup>0</sup> 05' 49"	73 <sup>0</sup> 41' 25"	188
G.W.10	PAF	32 <sup>0</sup> 03' 22"	72 <sup>0</sup> 40' 47"	187
G.W.11	N.S. X Block	32 <sup>0</sup> 04' 21"	72 <sup>0</sup> 42' 05"	191
G.W.12	Istaqlalabad colony	32 <sup>0</sup> 04' 07"	72 <sup>0</sup> 38' 28"	186

**RESULTS AND DISCUSSIONS**

A total of 12 samples from different locations in the study area were analyzed for evaluation of selective parameters. The detailed results were shown in table 2 and discussed in the next section.

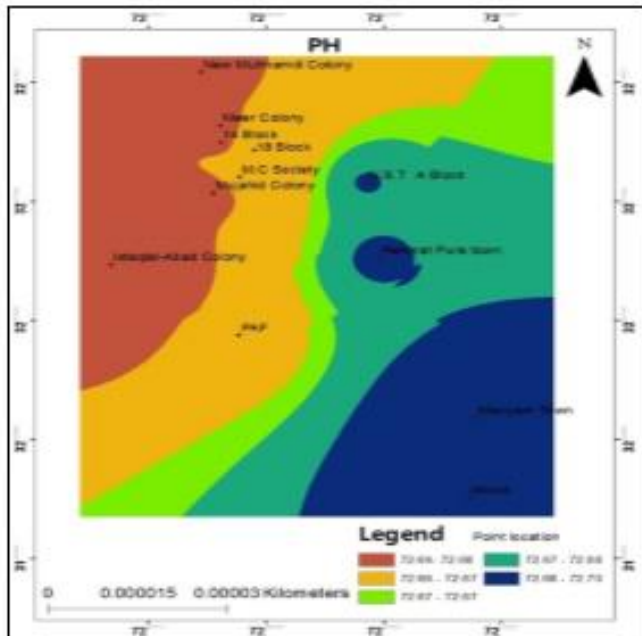
**Table 2: Detail result of Sample of the Study Area**

Parameter	N. Muhamm di Colony	Meer Colony	N.S. A Block	18 Block	14 Block	Maryyam Town	Rehmet Pura Town	M.C. Society	Mujahid Colony	PAF	N.S. X Block	Istaqlala-Abad colony
pH	7.9	7.9	8.4	7.8	8	7.7	7.9	7.9	8.2	8.1	7.8	8.0
EC	1992	4690	1168	4020	2310	4400	1909	3140	1040	3870	3680	2050
TDS	1354	3189	794	2733	1571	2992	1298	2135	707	2632	2502	1394
T. Alkalinity	473	538	482.3	468.8	484.8	292	278	480	388	603.2	320	603.2
Chloride	42.6	168.6	763.2	213	106.6	532.5	512	106.5	106.5	284	156.2	154.43
Sulphates	170	405	190	340	180	171	213	185	251.3	230	190	207
Nitrates	23.7	25.4	23.5	28.5	21.3	31.52	26.8	18	27	20.5	27	30
Iron	0.11	0.15	0.12	0.33	0.23	0.10	0.25	0.28	0.525	0.33	0.40	0.125
Sodium	150	60	508	322	123.8	324.5	408	---	88.5	170	741.2	930
Potassium	182.3	18	16.23	23	20	18.54	19	13	7	9.55	15	19
Calcium	24.72	29	25	42	25	30	37	28	21	78	21	17
Magnesium	62	63	75.5	60	78.5	58.32	71	48	98.3	48	147	113.9
Copper	0.44	0.65	0.68	0.47	0.58	0.62	0.50	0.55	0.54	0.49	0.59.5	0.68

**GROUND WATER QUALITY VARIATION**

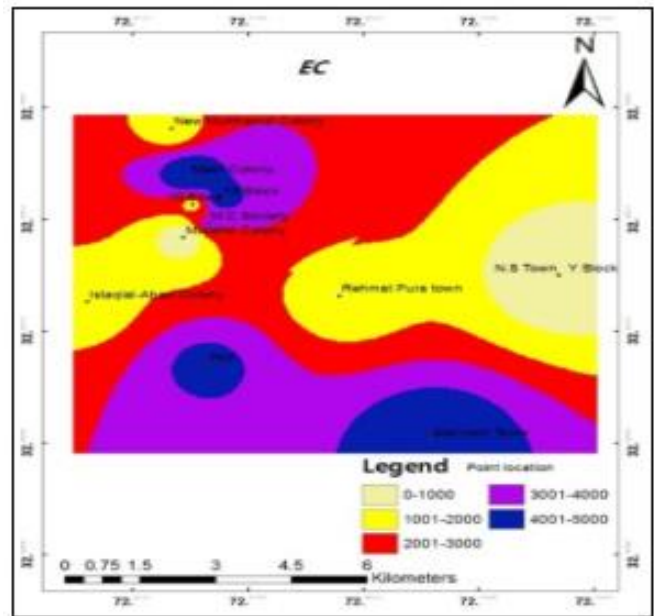
The overall pH values at all 12 locations are shown in table 2 and fig 2. World Health Organization (WHO) proposed standard of pH concentration in drinking is 6.5 to 8.5. The concentration of pH varies from 7.7 at Maryyam town to 8.4 at New Satellite town (A) block and ground water was a little acidic in the study area. Acidic water enhances the termination of manganese and iron and causes the repulsive taste of drinking water. It shows that all 12 points result were in limit as compared to WHO desirable standard.

of 4690  $\mu\text{S}/\text{cm}$  at Meer colony. In the study area, all 12 selective places were out of limit as compared to WHO purposed standard. Similar results were described by [11] in Islamabad, Rawalpindi Lahore and Sargodha. EC provides quick information about Total Dissolved Solid in the water. Surface water always present less quantity of TDS as compared to ground water which affects the taste of ground water [12].



**Fig. 2: Concentration of pH**

Electric Conductivity indicates the concentration of substances in water in the form of ions. The detailed results of EC are revealed in table 2 and fig 3. WHO desirable limit of EC is 1000  $\mu\text{S}/\text{cm}$  for drinking water. EC concentration varies from place to place in the study area with minimum value of 1040  $\mu\text{S}/\text{cm}$  at Mujahid colony and maximum value



**Fig. 3: Concentration of EC**

All the mean values of TDS in samples are presented in table 2 and fig. 4. Concentration of TDS obviously diverse from place to place in the study area and the value of TDS varies from 707 mg/l to 3189 mg/l. Minimum TDS Values found at Mujahid colony while minimum at Meer colonies ground water in study area. WHO proposed standard of TDS in ground water is 1000 mg/l. The results reveal that only two localities namely New Satellite town (A) block and Mujahid

colony were in limits as per WHO drinking water standard. The TDS in remaining 10 sample locations were out of limit and contained the high concentration. The number of studies conducted on other cities Kasur, Gujranwala, Lahore Rawalpindi by PCRWR, (2005); Tahir and Bhatti (1994) results also show the high concentration of TDS. High concentration of TDS in ground water is due to the seepage of wastewater of industries and salt [9].

while minimum in Mujahid colony ground water. WHO purposed guideline and permission able limit of K is 10 mg/l. The results of selective ground water samples show that except one location (Mujahid colony), all localities have high concentration of K. In order to evaluate the Calcium (Ca) concentration in ground water all mean values of selective sample localities, are calculated and shown in table 2 and fig.6. The concentration range of Ca in ground water varies from the minimum limit.

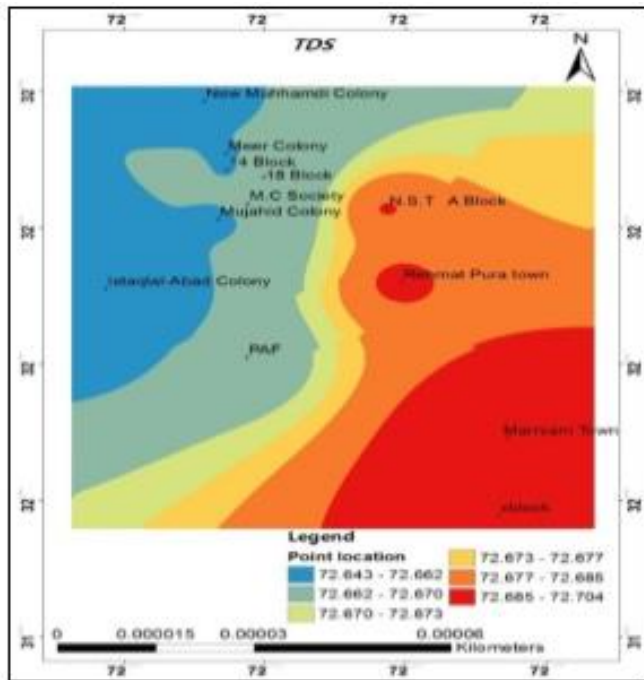


Fig. 4: Concentration of TDS

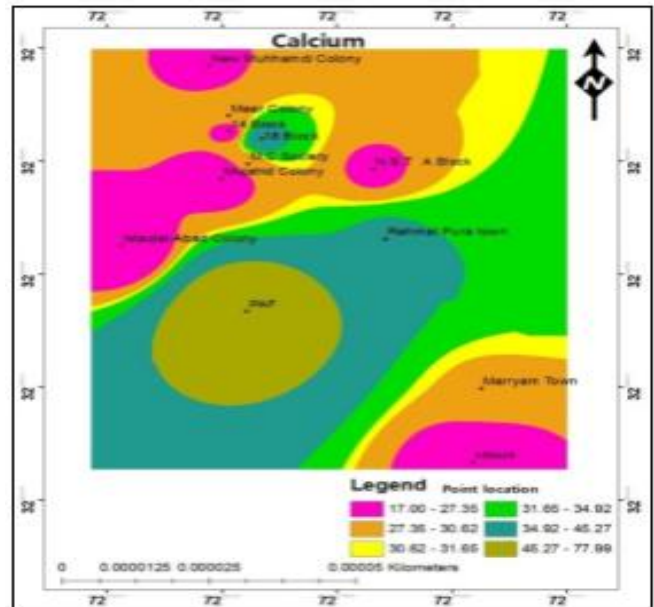


Fig. 6: Concentration of Calcium

Chloride (Cl) is another element which is present in the water and high concentration of chloride has some serious effects on humans [13]. The concentrations from 17 mg/l to 42 mg/l in the study area.

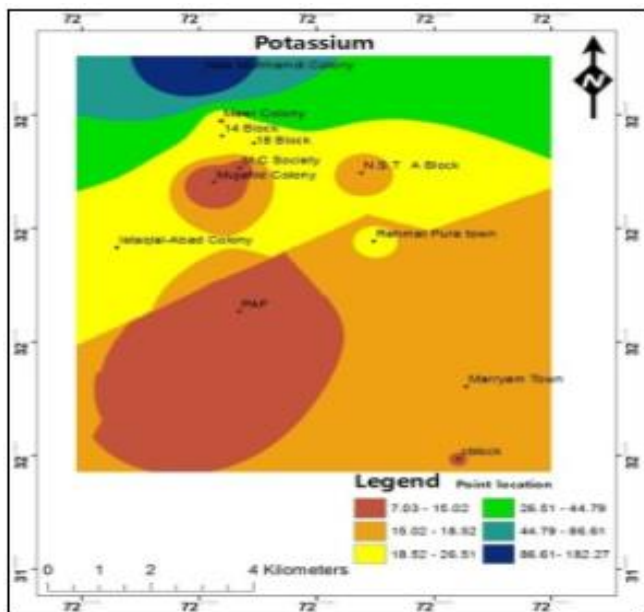


Fig. 5: Concentration of Potassium

The overall Potassium (K) values are shown in table 2 and fig. 5. The values of K vary from 7 mg/l to 23 mg/l. Maximum concentration of K is present in 18 block sample

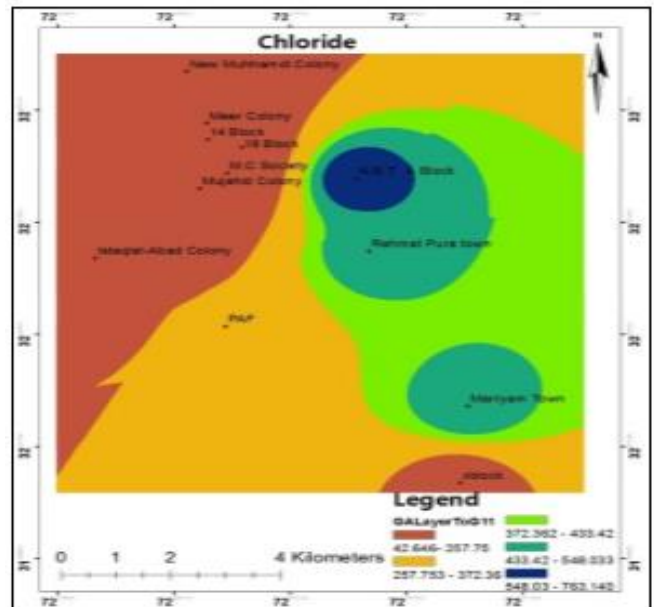


Fig. 7: Concentration of Chloride

The highest value of Ca is present at 18 Block location while lower value at New Satellite town (X) Block. WHO desirable

limit of Ca in drinking water is 75 mg/l. The present study reveals that all localities results are lower of chloride are shown in table 2 and figure 7. Chloride range varies from 106.5 mg/l to 1560 mg/l. WHO standard of chloride in drinking water is 250 mg/l. The maximum concentration of chloride noted at N.S. town while minimum at X block. Our study results show that Meer colony, 18 block, 14 block, M.C. Society and Mujahid colony samples were in limits while remaining are out of limit as compared to WHO guidelines

Copper (Cu) entered into water bodies from diverse sources like industrial waste, mining and domestic waste. The overall evaluated values of Cu are shown in table 2 and fig. 8. The concentration of Cu in our selective localities varies from 44 mg/l to 68 mg/l. Maximum value of Cu noted at Istaqlala Abad colony and New Satellite town (A) block while minimum Concentration at New Muhammadi colony. WHO desirable quantity of Cu in drinking water varies between 0.5-1.5 mg/l. Current studies reveals that three locations of the study area (New Muhammadi colony, 18 Block, New Satellite town X block) have copper concentration less than the proposed limit by WHO, while all other locations have normal range.

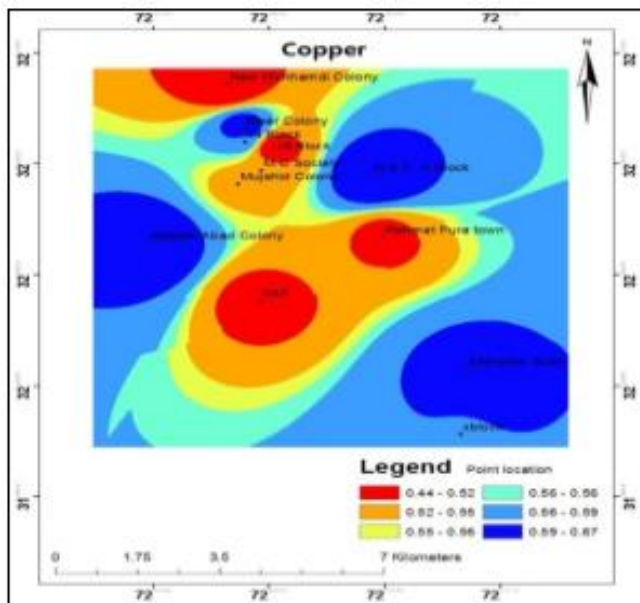


Fig. 8: Concentration of Copper

Sodium (Na) is a naturally occurring element in the water. The concentrations of sodium in drinking water are shown in table 2 and figure 9. The maximum concentration of Na is present in Istaqlal abad colony while minimum in Meer colony. The Na range varies from 60mg/l to 930 mg/l. WHO recommended drinking water standard is 200 mg/l. The results show that five locations (N. Muhammdi colony, Meer colony, 14 Block, PAF and Mujahid colony) are in limit and all others are out of limits as per WHO guidelines.

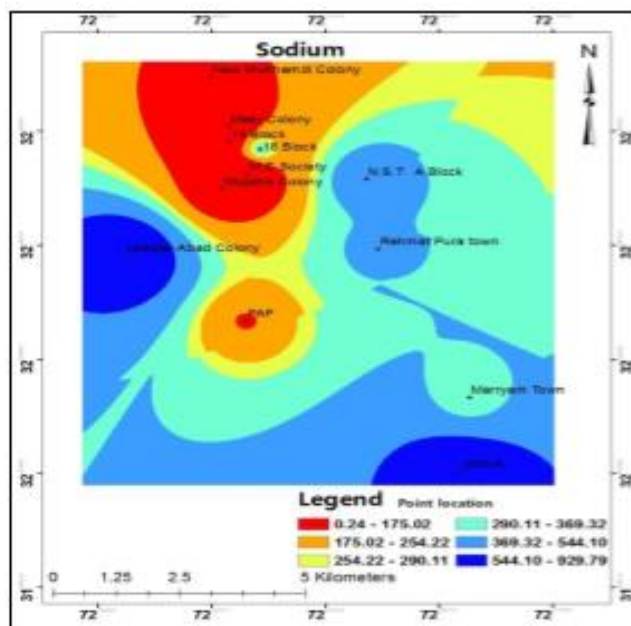


Fig. 9: Concentration of Sodium

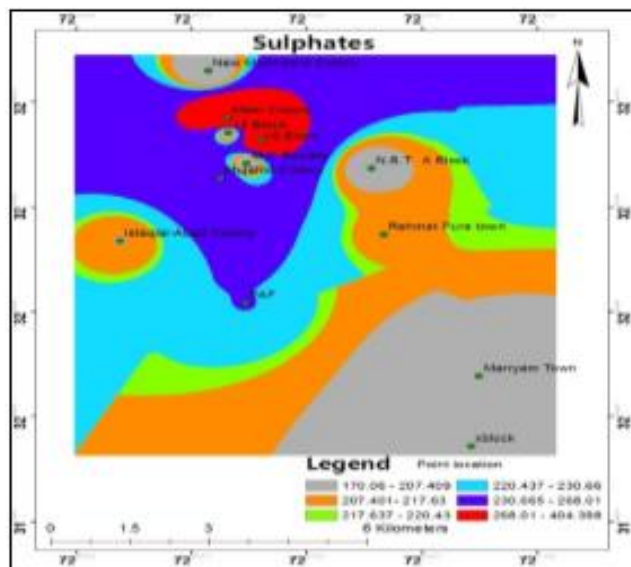
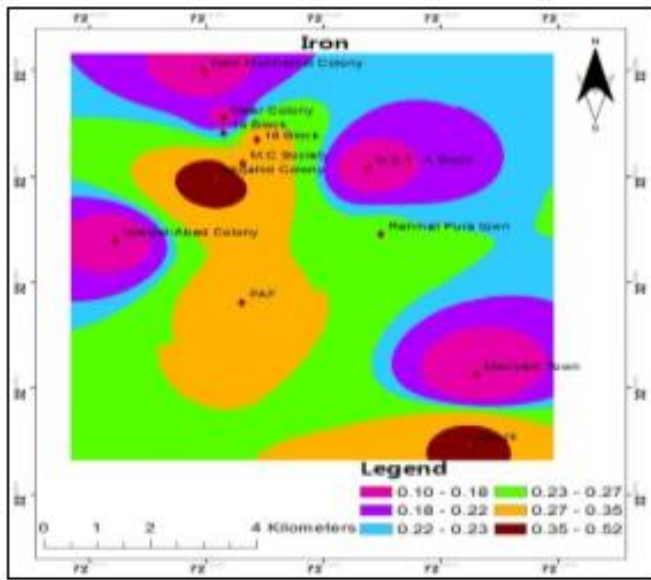


Fig.10: Concentration of Sulphates

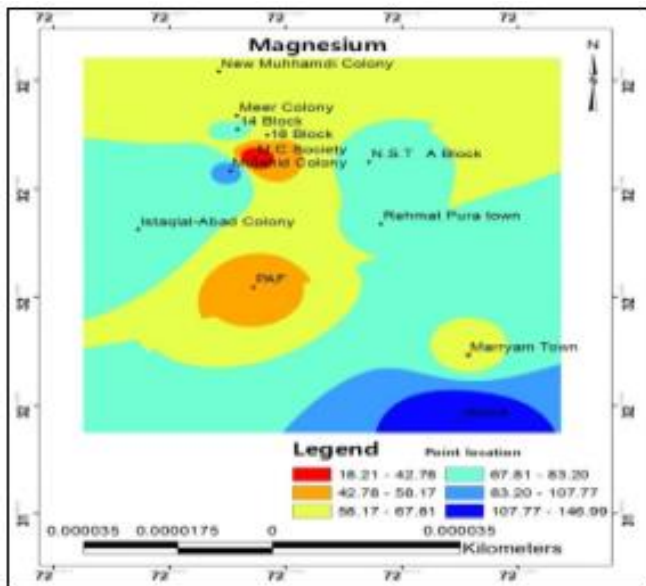
All mean values of Sulphat are shown in table 2 and figure 10. The maximum concentration of Sulphat found at Meer colony while minimum at New Muhammdi colony. The study results show that all the sample values were in limit except Meer colony and X block as compared to WHO recommended values.

In order to evaluate the Iron (Fe) concentration in ground water all mean values of selective sample localities are calculated and shown in table 2 and fig.11. The concentration range of Fe in ground water varies from 0.10 mg/l to 40 mg/l in the study area. The highest value of Fe is present at New Satellite town (X) Block location while lower value at Maryam Town. WHO desirable limit of Fe in drinking water is 0.3 mg/l. The present study reveals that three locations of the study area (18 Block, PAF area and New Satellite town (X) block) are Fe concentration high then the proposed limit by WHO, while all other locations have normal range.



**Fig. 11: Concentration of Iron**

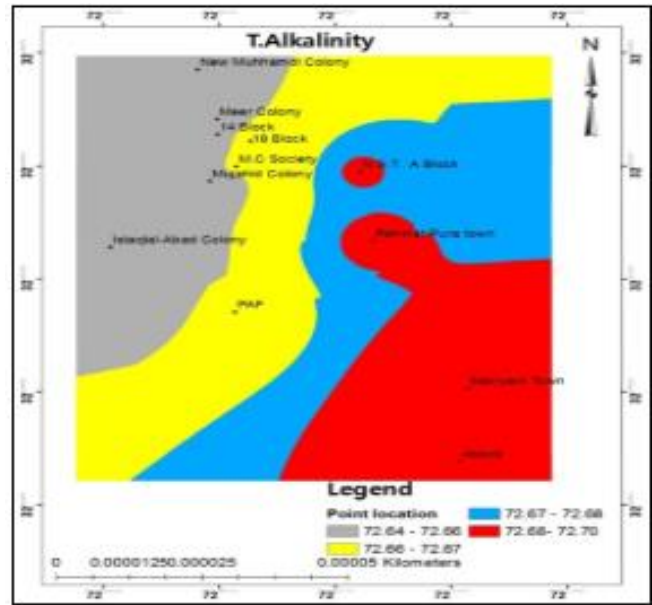
Magnesium is important metal in water but high concentration of this metal contributes hardness in drinking water. All mean values of Mg are shown in table 2 and figure 12. The Mg value varies between 48-113.9 mg/l in the study area. WHO recommended value of Mg is 150 mg/l. The present study revealed that all localities results were in limit.



**Fig. 12: Concentration of Magnesium**

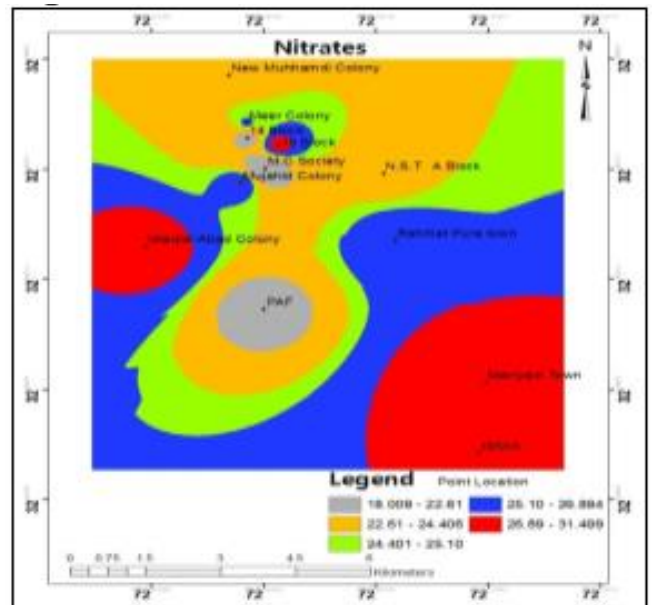
Total alkalinity in drinking water typically is due to potassium, calcium, carbonates and bicarbonates. All mean values of Total alkalinity are shown in table 2 and figure 13. The Total alkalinity values varies between 278-603 mg/l. Minimum concentration of Total alkalinity is present in Rehman pora town while maximum in Istiqlal-abad colony groundwater. WHO desirable quantity of total alkalinity in drinking water is 500 mg/l. The study shows that sample collected from Meer colony, PAF Area and Istiqlal-abad

were out of limit while remaining rest of areas are in defined limit.



**Fig. 13: Concentration of Alkalinity**

Nitrate ( $\text{NO}_3$ ) is one of the important parameter to identify water quality. The major sources of nitrates are industrial waste, nitrogen source and pesticides [14].  $\text{NO}_3$  concentration in water samples are shown in table 2 and figure 14.  $\text{NO}_3$  values fluctuate from 18mg/l to 30mg/l which are above the recommended limit of WHO standard of 10 mg/l in drinking water. These results show that nitrates values in all study area were very high.



**Fig. 14: Concentration of Nitrates**

**CONCLUSION**

The present study focused on the assessment of ground water quality in Sargodha city. The result revealed that ground water had high concentration of all parameters while pH and

Ca values were below the permissionable limit of WHO. Therefore, it is concluded that groundwater of the study area is not fit for drinking purpose.

#### ACKNOWLEDGEMENT

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