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Appraisal of Heavy Metals in Drinking Water Sources Along the River Indus District Dera Ghazi Khan

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Abstract

Safe drinking water is very important for the existence of life on earth. Access to safe drinking water is basic human right. Water quality is declining day by day due to anthropogenic activities, which are causing various health related issues all over the world. Certain health problems are associated with the occurrence of heavy metals and other contaminations in water. The main purpose of this research work to evaluate and investigate the underground drinking water Sources of various pollutants like physico-chemical parameters (pH, Turbidity, Electric Conductivity and Total Dissolved Solid) and Heavy metals (Iron, Zinc, Manganese, Arsenic and Copper) along the western bank of River Indus in Dera Ghazi Khan District (30.2748° N, 70.2408° E), Punjab, Pakistan. Water samples were collected from rural areas most common sources of drinking water of three regions Kot Chutta (K), Dera Ghazi Khan (D) and Taunsa (T) and analyzed physico-Chemical (pH, Turbidity, Electric Conductivity and Total Dissolved Solids), heavy metals (Iron, Zinc, Manganese, Arsenic and Copper) using standard methods. Results of water analysis of certain physicochemical parameters (pH, Turbidity, Electric Conductivity and Total Dissolved Solids). Turbidity values are exceeding at points Ranjha ala, Chah sobar wala, Chah inayat wala, Khoo mooli wala and Basti Bohar in three regions were higher than the world health organization (WHO) Standard value and Pakistan environmental quality standards for drinking water (PEQSDW). Total Dissolved solids (TDS) and Electrical conductivity (E.C) exceeded the standards value at Jakkar Imam Shah, Dauo Wala, Dawood kot, Chah kalar wala, Chah kabeer wala, and Mari gharbi than the WHO and PEQSDW. Furthermore, heavy metals analysis results shown higher concentration of arsenic (As) 37.1 % samples exceeded than WHO standard value and only 3.22 % samples exceeded from PEQSDW standards value, while 1.61% samples exceeded the WHO and PEQSDW standard value but Iron (Fe), Zinc (Zn) and Manganese (Mn) were within the standards limits. The heavy metals concentration in study area follows the order As>Cu>Fe>Zn>Mn. The groundwater drinking sources quality in these areas is poor and is not fit for drinking purposes, which is harsh condition for the human being of this area.

Keywords: Ground Water, Heavy Metals, Dera Ghazi Khan, Kot Chutta, River Indus

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1. Introduction

Water is key to long-lasting wellbeing, and fullness (suitable, healthy and affordable) should be open to all. Improving access to clean drinking water will offer substantial health benefits. We will make every effort to achieve healthy drinking water with access [1]. The flow of water to the earth's atmosphere is very irregular. Water distribution on earth is as 97.5% of the oceans and other saline water and 2.5 % is freshwater. Out of 2.5 % 68.7% glaciers and icecaps, 30.1% Groundwater and 1.2% Surface and other fresh water. In 1.2 % Surface and freshwater 69% ground ice and permafrost, 20.9% Lakes, 3.8%Soil Moisture, 2.6% swamps and Marshes, 0.49% Rivers, 0.26% Living things and 3% in atmosphere as seen in Figure 1. Alternatively, we consume one fifth of the earth's surface water, while 99 percent of the remaining capacity remains deep. Displayed in Figure 1 [2].

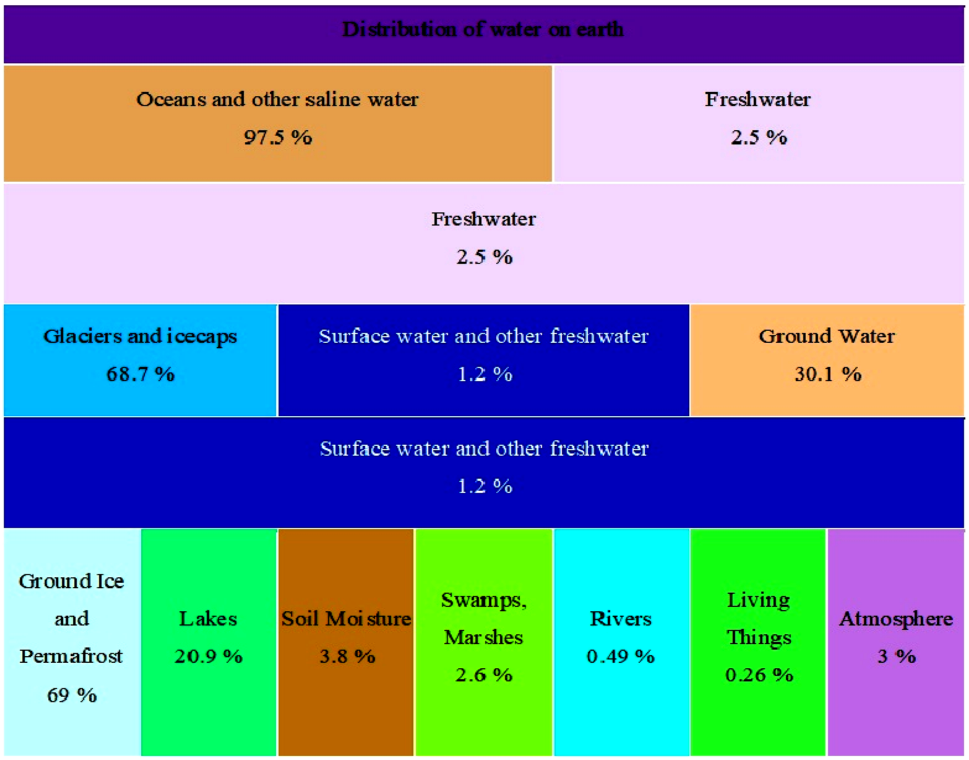

Figure 1: Global distribution of world water.

Freshwater replenishment relies on evaporation from ocean waters. Annually evaporates from the oceans around 505000 km^3, or a sheet 1.4 meters thick. Another 72,000-km^3 of ground evaporates. Around 80% or around 458000 km^3 / year of all precipitation occurs on the oceans and the remaining 119000 km^3 / year on shore. The disparity between precipitation on land surfaces and evaporation from these surfaces (119,000 km^3 minus 72,000 km^3 per year) is run-off and groundwater depletion around 47,000 km^3 per year. [1]. Estimated total maximum water balance in large continental areas, including precipitation, evaporation, and runoff. Across Asia and South America, there are more than half of all runoffs and a substantial proportion are contained in a channel, in the Amazon that carries more than 6000 km^3 of water annually [2].

Approximately, 2 billion citizens (about one third of the world 's population) are reliant on sources of groundwater, which draws around 20% annually from shallow water source (600-700 km3) [3]. Most agricultural residents are subterranean. Until recently, questions of groundwater usage and safety have attracted even less consideration (in some emerging regions in particular) than surface water and far less trust with respect to groundwater inventories and flows. However, in Europe, significant attention paid to the safety of groundwater since many communities rely on water supplies. Groundwater supplies, including overuse and pollution, are typically susceptible to a number of risks. Whether the use is longer than that of normal regeneration, soil waters sink. There are falling water levels in part of India, China, West Asia, former Soviet Union, Western USA, and the Arab Peninsula, which reduce the amount of waste and raise farmers' cost of pump [4]. Groundwater may force into marine waters through seawater infiltration. Saltwater infiltration, for example, has spread 10 km inland from Madras, India, and has polluted wells [5].

Arsenic is a toxic metal that has extensively researched that has an influence on greater areas of Asia. Heavy metals used for construction in multiple production processes such as burning, and refining. Wastes from these factories shall contain heavy metals, which if proper care not taken in disposal, pollute soil, surface water and ground water. Groundwater metals exist in regions, which have mineral reserves, associated mining operations. Many others have identified the possible danger of heavy metal industrial waste related to fertilizer use. Causes of surface water emissions listed in Table 1 [6].

Table 1. Groundwater quality problems.

Problem	Causes	Concerns
Anthropogenic pollution	Inadequate protection of vulnerable aquifers against human-made discharges and leachates from: • urban and industrial activities.	Pathogens, nitrates, ammonium salts, chlorine, sulphates, boron, heavy metals, DOC, aromatic and halogenated hydrocarbons
	• intensification of agricultural cultivation	nitrates, chlorine, pesticides
Naturally occurring contamination	Naturally occurring contamination and dissolution of minerals (aggravated by anthropogenic pollution and/or uncontrolled exploitation)	Mainly iron, fluorine and sometimes arsenic, iodine, manganese, aluminium, magnesium, sulphates, selenium and nitrates (from paleo recharge)
Well-head contamination	Inadequate well design and construction allowing direct intrusion of polluted surface water or shallow groundwater	Mainly pathogens

Source: Foster, Lawrence and Morris 1998

1.1 Research Validation

Clean and safe drinking water is a basic human requirement for the healthy survival and common resources. Public safety is subject to sufficient supply of healthy and accessible potable water [7]. Adequate sources of safe drinking water in developed countries lead in large measure to not only lower mortality risk but also rising people's economic conditions. [7]. This is why most studies worldwide strive to test drinking water [7]. Pakistan still faces other problems with supplying healthy and reliable drinking water to its rural areas, as do many developed countries. Just a few reports on potable water contamination have published in northern Pakistan in the past. [8][9][10]. Many studies indicate that the leading cause of all recorded diseases and deaths in Pakistan is polluted waters (30 to 40 percent) [11]. In the last 10 years, the consistency of surface water has improved owing to the toxins human, environmental and biological [12][13] [14]. To control the need for and the extent of pollution, water quality is important [14].

1.2 Objective of Research

The objective of this study / research is as given below.

- To assess the concentration of drinking water from various sampling sites in the three regions (K, D, T), utilizing the GPS organizing method, of heavy metals (iron, zinc manga, arsenic, copper) and physico-chemical components (pH, turbidity, TDS, E.C).
- Scientific study of Standard Variance, Mean, Meiden, Maximum and Minimum significance of their tests.
- Comparing all the findings with WHO and PEQSDW standard values and having a divergence from standard values attributable to pollution sources.

2. Materials and Methods

2.1. Study Area

On the western side of the River Indus, the Dera Ghazi Khan is situated. The Koh-e-Suleman Mountains are in the west of Dera Ghazi Khan from the province of Baluchistan. Ismail Khan in Khyber Pakhtunkha Region in North Dera, in southern Khyber Pakhtunkha Division, in eastern Rajanpur Region, in the Muzafargarh districts and in western Balouchistan Rural region, Loralai and Dera Bugti regions. The territory is 11,922 km2. The whole city. This comprises of the Tehsils D. G. Khan, Taunsa Sharif, Tribal district and Kot Chutta. As defined in the 2017 District Census Report (DCR), its population is 2,872,201. The Dera ghazi khan district subdivided into 115 union councils in which 98 are in rural sector, while 17 union councils are located in urban part of the tehsil Dera Ghazi Khan, also that District having 33 wards in which 20 lies in Taunsa city and remaining are in Kot Chutta. The region's environment in summer and winter is especially dry in the hills and on the plains. End of April in the summer season. The hottest months in the season include April, June and July. The maximum daily temperature is 40.6 ^{0}C and the lowest average temperature in the season is 27.2 ^{0}C. In November the winter starts. The hardest months of winter are November, January and February. The mean average temperature in the winter season is 22.3 ^{0}C and the minimum winter temperature is 5.9 ^{0}C,[15]. Regeneration is sporadic and happens in both the monsoon and the snow. The province's climate ranges from cold temperate to tropical which allows for a fantastic variety of communities to develop economically because of the large variation in weather regime. The breeding of crops and livestock is a significant source of revenue for rural citizens. Soil content is thickness and densities of spores. Porosity, which governs the soil's water storage ability, is the key physical parameter for soil. A number of reports [16] We also advertised, if the consistency is correctly measured, that measurements of several physical and chemical characteristics of soils may be produced. The soils in hill flood areas coated with a thin foundation and fair to fine textures.

2.2 Sample Collection and Storage

Water samples taken from the main settlements in Dera Ghazi Khan District along the eastern side of the River Indus. Study specimens from various sites obtained as hand pumps and tube wells at specific depths in three regions: Kot Chutta (K), D G Khan (D), and Taunsa (T). Maximum 62 samples from those regions collected; 14 were from K, 33 from D and 15 from the T. Water samples obtained and taken to the test in acid-washed polystyrene sample bottle. On-site investigation the physico-chemical parameters i.e. pH, turbidity, E.C and TDS. The sampling sites of three regions i.e., K, D and T shown in Table 2, 3 and 4, respectively.

Table 2. Sampling point K region.

Sr. No.	sampling points Name	Coordinates		Sample ID
		Latitude	Longitude	
1	Jakkar Imam Shah	29°45'43"	70°49'30"	K1
2	Jakkar Imam Shah City	29°47'33"	70°43'33"	K2
3	Haji Kammand	29°48'52"	70°43'51"	K3
4	Nabli More, Haji Kammand	29°49'36"	70°44'15"	K4
5	Kho Ary Wala, Jokhe Uttra	29°50'21"	70°43'38"	K5
6	Jokhe Uttra	29°51'66"	70°43'58"	K6
7	Kanoon Wala	29°51'28"	70°44'01"	K7
8	Dauo Wala	30°03'47"	70°48'29"	K8
9	Butta Colony	29°53'30"	70°42'23"	K9
10	Ranjha Wala	29°53'16"	70°44'20"	K10
11	Ghousa Abad	29°54'15"	70°44'28"	K11
12	Basti Merani	29°55'03"	70°44'47"	K12
13	Basti Saidani	29°56'01"	70°45'10"	K13
14	Bahadur Shah Wala	29°57'15"	70°42'47"	K14

Table 3. Sampling point D region.

Sr. No.	sampling points Name	Coordinates		Sample ID
		Latitude	Longitude	
1	Chah Bhuki Wala	29°57'27"	70°44'51"	D1
2	Mula Wala	29°59'22"	70°45'35"	D2
3	Basti Baqir Shah	29°59'49"	70°45'51"	D3
4	Malkana	30°02'50"	70°45'09"	D4
5	Chah Ghurmani Wala	30°01'48"	70°45'23"	D5
6	Darhama	30°04'05"	70°44'05"	D6
7	Chah Sohbar Wala	30°05'37"	70°45'10"	D7
8	Chah hoot Wala	30°06'08"	70°45'00"	D8

9	Basti Noon	30°07'06"	70°44'55"	D9
10	Ladan	30°08'06"	70°44'19"	D10
11	Rawan	30°09'43"	70°42'16"	D11
12	Basti Khakh	30°11'16"	70°43'20"	D12
13	Dari Pir Adil	30°12'12"	70°43'26"	D13
14	Dawood Kot	30°12'56"	70°43'49"	D14
15	Chah Inayat Wala	30°13'48"	70°44'15"	D15
16	Sikhani	30°14'05"	70°44'40"	D16
17	Sikhani	30°14'06"	70°44'40"	D17
18	Chah Pir Wala	30°14'27"	70°44'40"	D18
19	Phaphary	30°14'38"	70°44'36"	D19
20	Khoo Mooli Wala	30°15'18"	70°44'23"	D20
21	Khoo Hashim Wala	30°15'36"	70°43'54"	D21
22	Hussain Shah More	30°18'04"	70°43'19"	D22
23	Thadi	30°17'29"	70°43'37"	D23
24	Qabool Wala	30°18'29"	70°43'37"	D24
25	Chah Jalal Wala	30°18'53"	70°43'34"	D25
26	Chah Kalar Wala	30°19'25"	70°43'40"	D26
27	Chah Kabeer Wala	30°20'20"	70°43'31"	D27
28	Jhari Wala	30°21'6"	70°43'28"	D28
29	Band Kastori	30°04'14"	70°44'46"	D29
30	Noria Koria Sharqi	30°05'57"	70°45'27"	D30
31	Basti Kanera	30°05'55"	70°45'51"	D31
32	Basti Daha	30°07'01"	70°45'17"	D32
33	Basti Rind	30°08'24"	70°45'05"	D33

Table 4. Sampling point T region.

Sr. No.	sampling points Name	Coordinates		Sample ID
		Latitude	Longitude	
1	Basti Johk Dur Wali	30°53'19"	70°43'16"	T1
2	Basti Bohar	30°38'47"	70°39'32"	T2
3	Basti Ali Shah	30°54'55"	70°43'15"	T3
4	Kabir Shah	30°57'49"	70°44'14"	T4
5	Jan Pur	30° 55' 13"	70° 43' 48"	T5
6	Mari Gharbi	30° 58' 11"	70° 45' 22"	T6

7	Mari Gharbi	30° 57' 55"	70° 44' 58"	T7
8	Mari Darmiyani	30° 57' 58"	70° 44' 32"	T8
9	More Jhangi	30° 56' 42"	70° 44' 08"	T9
10	Basti Malana	30° 55' 42"	70° 42' 58"	T10
11	Basti Pati Khar	30° 58' 06"	70° 43' 42"	T11
12	Basti Rahlee	30° 57' 55"	70° 44' 39"	T12
13	Hoot Model Village	30° 57' 35"	70° 44' 25"	T13
14	Zoor Ma Hazara	30° 56' 52"	70° 44' 08"	T14
15	Zoor Ma Hazara	30° 55' 54"	70° 43' 53"	T15

2.3 Physico Chemical Parameters and Analytical Procedure

2.3.1 pH

HANNA Combo meter of HI98129 models manufactured in Romania used to calculate pH. The buffer was used for the pH meter calculated (pH = 7.0). Through dipping the meter sensor into the sample, the pH of each specimen recorded.

2.3.2 Turbidity

Water turbidity induced by, e.g., sand, fine-separated natural and inorganic compounds, natural aggregate shaded by solvents and microorganisms and certain infinitesimal species, which are suspended pieces in water. Water turbidity is reflective of these ions in the water sample ranges of about 10 nm. Shades of drinking water are the primary source of fluid turbidity. The drinking water is cloudy or misty because of turbidity. This known to be the proportion of the environment of water samples. There will be better clarity of the water with low turbidity and the suspended contaminants. Drinking water turbidity prompted bacteria and other smaller living species, for example viruses, parasites and microorganisms that affect drinking water quality. During turbidity, the microorganisms found during colour and chlorine must dosed for removing the microbes. When the turbidity value of water reaches 5 NTU, it may not be considered as drinkable, the water is purified by filter and water samples are less turbid and fewer particles suspended.

While turbidity values represented in many forms, the Nephelometric Turbidity Unit (NTU) is among the most popular. A 15 ml test cell with labelled circle. The test cell filled up to a visible 10 ml mark. Set and put on the meter the cap on the test container, pressing the meter button. Then mark down the read of the sample on the meter pad. After 10 measurements, turbidity meter should be calibrated by means of specific standard solution for turbidity i.e. 0.02 NTU, 10 NTU, 100 NTU and 800 NTU.

2.3.3 Electric Conductivity (E.C) & Total Dissolved Solid (TDS)

The JENCO conductivity meter, model 3010M used to calculate it. The range for this meter is 0 μS/cm to 400 mS/cm. By taking 50 ml sample in the glass beaker switch on the meter after 30 sec by dipping the glass electrode without touching the beaker walls select the required mode and recorded the reading of Conductivity in μS/cm. The meter was calibrated after 20 readings using 1413 μs/cm standard solution. The T.D.S value calculated by using the formula given below.

$$\mathrm{T.D.S}\left(\frac{\mathrm{mg}}{\mathrm{L}}\right) = \mathrm{E.C\ X\ 0.65}$$

2.4 Detection of Heavy Metals

For the detection of Heavy metals i.e., Copper, Iron, Manganese, Zinc with the help of PALINTEST photometer 7100. Arsenic determined by the PALINTEST Digital Arsenator. Measurement methods for each metal described as under

2.4.1 Arsenic

Arsenic measured through PALINTEST digital Arsenator by gutzeit method. Place the hydrogen Sulphide removal filter at the bottom of the plug. Take Arsenic Collector filter in the black filter slide. Take Arsenic scrubber filter in the red filter slide. Place the black and red filter slides in their proper places of the plug. Take 50 ml sample into the reaction flask. Add sulphamic Acid Sachet (A1) in flask. Add Sodium borohydride (10%) tablet (A2) in flask. Place the plug immediately on the flask within 2 second. Run the blank by inserting the black filter slid into the Arsenator detection terminal. Allow the Sample to stand for 20 minutes to complete the reaction. After completion of reaction remove the black filter slide and place into the Arsenator detection terminal. Press read button; the result displayed in µg / L As

2.4.2 Copper

For the examination of copper set the photometer program at Phot 10. Fill the two test tubes with 10 ml sample and deionized water each. Add one tablet of Coppercol No. 1 reagent containing 2,2 Biqunioline-4-4-dicarboxylic, crushed and mixed to dissolve. Gently invert the sample test tube to remove any bubbles from the inner walls of the tube. By adding Coppercol No. 1 reagent tablet sample colour turn to purple if the copper concentration present. Higher the colour concentration means higher concentration of copper. Run the blank after standardization run the sample and press the read button. The result displayed as mg / L free Cu. To determine the total copper concentration in the sample, add Cppercol No. 2 tablet reagent which contain decomplexing reagent which further induced the reaction, crush and mixed to complete dissolved. Run the sample again by photometer setting the follow-on option. The result displayed in mg / L of Total copper.

2.4.3 Iron

For the examination of Iron set the photometer program at Phot 19. Fill the two test tubes with 10 ml sample and deionized water each. Add one tablet of iron reagent containing alkaline thioglycollate, crushed and mixed to dissolve. Stand for one minute to develop the colour. If iron present in the sample colour turn to pink. Higher the pink colour concentration means higher concentration of iron. Run the blank after standardization run the sample and press the read button. The result displayed as mg / L Fe.

2.4.4 Manganese

For the examination of Manganese set the photometer program at Phot 20. Fill the two test tubes with 10 ml sample and deionized water each. Add one tablet of Manganese No. 1 reagent, Crush and mixed to dissolve. Add Manganese No. 2 reagent, crushed and mixed to dissolve. Place the cap of the test tube. Stand the sample for 20 minutes for completing the reaction. If the manganese present in the sample Colour turn to turquoise colour complex. Higher the colour concentration means higher concentration of Manganese. Run the blank after standardization run the sample and press the read button. The result displayed as mg / L Mn.

2.4.5 Zinc

For the examination of Zn set the photometer program at Phot 35. Fill the two test tubes with 10 ml sample and deionized water each. In zinc examination two interferences occurs. In case free chlorine is present in the sample then Add one tablet of zinc-dechlor crushed and mixed to dissolve or vice versa. Add one table of zinc reagent containing 5-(o-carboxyphynyle)-1-(2-hydroxy-5-sulphophynyle)-3-phynyle-formazan, crush and gently mixed to dissolve. The colour of the sample turns to orange. Allow the sample for five minutes for completing the reaction. If zinc concentration present colour of the sample turns orange through purple to blue. Higher the colour concentration means higher concentration of Zinc. Run the blank after standardization run the sample and press the read button. The result displayed as mg / L Zn. In case copper traces presented into the sample which interface the actual reading of zinc. Then add E.D.T.A tablet to the sample, which eliminate the copper interference. Run the sample again on photometer setting the follow-on option. The result displayed in mg / L of corrected Zn concentration.

3. Results and Discussion

The environmental, biological, and radiological elements of drinking water based on consistency. For this review, 62 samples from various sources of drinking water tested for physico-chemical and heavy metals.

The World Health Organization (WHO) and Pakistan Environmental Quality Standards for Drinking Water (PEQSDW), the details of the above-mentioned parameters in Table 5.

Table 5. Drinking water Standard values.

Sr. No.	Metals	Symbols	Unit	WHO Standard Value	PEQSDW Standard Value
1	pH	-	-	6.5-8.5	6.5-8.5
2	Turbidity	-	NTU	<5	<5
3	Electric Conductivity	-	µs/cm	-	-
4	Total Dissolved Solid	T.D.S	mg/l	1000	1000
5	Arsenic	As	mg/l	0.01	0.05
6	Copper	Cu	mg/l	2	2
7	Iron	Fe	mg/l	0.3	0.3
8	Manganese	Mn	mg/l	0.5	0.5
9	Zinc	Zn	mg/l	3	3

Data obtained, after analyzing of water samples from different Region are described in Tables 6, 8 and 10 i.e., Kot Chutta, D G Khan and Taunsa, respectively. Statically data obtained from the above-mentioned regions described in Tables 7, 9 and 11, respectively.

Table 6. Analyzed Data Obtained from K-Region.

Sample ID	PHYSIO CHEMICAL PERAMETERS				HEAVY METAL PERAMETERS				
	pH	Turbidity	E.C	TDS	Fe	Zn	Mn	As	Cu
K1	8.32	0.7	1971	1330	0	0	0	0	0.58
K2	8.3	0.06	1542	1030	0.01	0	0	0.005	0.36
K3	7.9	0.1	1182	790	0.14	0.01	0.017	0	0
K4	8.35	0.1	1448	980	0	0	0	0.013	0.68
K5	8.08	0.28	512	340	0	0	0	0	0.5
K6	8.03	0.13	1202	810	0	0	0	0.03	0.5
K7	7.97	1.02	1446	970	0.01	0	0	0.027	0.48
K8	8.02	1.9	1610	1070	0	0	0	0.039	0.5
K9	8.1	0.03	1315	880	0	0.05	0	0.03	0.46
K10	8.09	16.63	1013	680	0	0	0	0.016	0.66
K11	7.98	1.25	1058	710	0	0	0	0	0.6
K12	7.83	1.01	1142	770	0	0	0	0	0.36
K13	7.88	2.93	545	360	0	0.05	0	0	0.5
K14	7.85	0.36	571	380	0	0	0	0.015	0.42

Table 7. Statically Data Obtained from K-Region.

Parameter	Mean	Median	Min	Max	S.D (±)	W.H.O Safe Limit	% Number of samples >WHO limit	PEQSDW Safe limit	% Number of samples >PEQSDW limit
pH	8.05	8.03	7.83	8.35	0.17	6.5-8.5	0	6.5-8.5	0
Turbidity (N.T.U)	1.89	0.53	0.03	16.63	4.32	5.00	7	5.00	7
E.C (µs cm^{-1})	1183	1192	512	1971	427	1492	21	1492	21
TDS (mg L^{-1})	793	800	340	1330	288	1000	21	1000	21
Fe (mg L^{-1})	0.011	0	0	0.140	0.037	0.3	0	0.3	0

Zn ($mg L^{-1}$)	0.008	0	0	0.050	0.018	3	0	3	0
Mn ($mg L^{-1}$)	0.001	0	0	0.017	0.005	0.5	0	0.5	0
As ($mg L^{-1}$)	0.013	0.009	0	0.039	0.014	0.01	50	0.05	0
Cu ($mg L^{-1}$)	0.471	0.500	0	0.680	0.167	2	0	2	0

Table 8. Analyzed Data Obtained from D-Region.

Sample ID	PHYSIO CHEMICAL PERAMETERS				HEAVY METAL PERAMETERS				
	PH	Turbidity	E.C	TDS	Fe	Zn	Mn	As	Cu
D1	7.97	0.08	437	290	0	0	0	0	0.82
D2	8	0.21	1167	790	0	0	0	0	0.7
D3	8.07	1.32	460	310	0.02	0	0	0	0.64
D4	8.11	0.03	385	260	0	0	0	0	0.8
D5	8.04	0.18	479	320	0	0	0	0	0.66
D6	7.95	0.07	872	580	0.01	0	0	0	0.6
D7	7.88	5.6	695	460	0	0	0	0.003	0.46
D8	7.85	1.08	832	560	0	0	0	0.013	0.74
D9	7.65	0.64	666	450	0.02	0	0	0	0.44
D10	8.01	0.77	363	240	0	0	0	0.023	0.64
D11	8.1	0.54	282	190	0	0	0	0.013	0.96
D12	8.1	1.17	298	200	0	0	0	0.043	0.62
D13	8.19	0.18	290	200	0	0	0	0.004	0.5
D14	7.88	3.71	1723	1160	0	0	0	0.076	0.76
D15	7.95	8.32	863	580	0.01	0	0.001	0.01	0.88
D16	7.94	2.61	897	600	0	0	0	0.005	0.78
D17	7.9	0.58	682	460	0.01	0	0	0.014	0.6
D18	7.91	0.12	540	360	0	0	0	0	0.76
D19	7.92	0.02	638	430	0	0	0	0.015	0.66
D20	7.79	39.6	668	450	0	0	0	0.087	0.92
D21	7.6	2.27	917	620	0.01	0	0	0	0.5
D22	7.8	0.24	772	520	0	0	0	0	0.68
D23	7.94	1.04	570	380	0	0	0	0	0.56
D24	7.77	0.44	961	640	0	0	0	0.034	0.46

D25	7.82	0.21	586	390	0.03	0	0	0	0.68
D26	7.77	0.16	1968	1320	0	0	0	0	0.84
D27	7.74	1.12	2450	1640	0	0	0	0	1.15
D28	7.94	0.48	1160	780	0	0	0	0	0.84
D29	8.22	1.61	1066	710	0	0	0	0	0.94
D30	8.19	1.63	578	390	0	0	0	0	1.2
D31	8.19	1.25	478	320	0.07	0	0.004	0	0.8
D32	8.05	1.68	709	470	0.01	0	0	0	0.92
D33	8.02	1.75	868	580	0	0	0	0.001	0.78

Table 9. Statically Data Obtained from K-Region.

Parameter	Mean	Median	Min	Max	S.D (±)	W.H.O Safe Limit	% Number of samples >WHO limit	PEQSDW Safe limit	% Number of samples >PEQSDW limit
pH	7.95	7.94	7.60	8.22	0.16	6.5-8.5	0	6.5-8.5	0
Turbidity (N.T.U)	2.45	0.77	0.02	39.60	6.89	5.00	9	5.00	9
E.C (µs cm^{-1})	798	682	282	2450	476	1492	9	1492	9
TDS (mg L^{-1})	535	460	190	1640	319	1000	9	1000	9
Fe (mg L^{-1})	0.006	0	0	0.070	0.014	0.3	0	0.3	0
Zn (mg L^{-1})	0	0	0	0.000	0.000	3	0	3	0
Mn (mg L^{-1})	0	0	0	0.004	0.001	0.5	0	0.5	0
As (mg L^{-1})	0.010	0.000	0	0.087	0.021	0.01	27	0.05	6
Cu (mg L^{-1})	0.736	0.740	0.44	1.200	0.184	2	0	2	0

Table 10. Analyzed Data Obtained from T-Region.

Sample ID	PHYSIO CHEMICAL PERAMETERS				HEAVY METAL PERAMETERS				
	pH	Turbidity	E.C	TDS	Fe	Zn	Mn	As	Cu
T1	7.42	0.31	447	300	0	0.15	0.013	0.005	0.44
T2	6.94	20.1	2280	1530	0.2	0.27	0.021	0.03	8.8
T3	6.6	0.85	956	640	0.02	0.017	0.035	0.05	0.76
T4	7.26	0.44	359	240	0.04	0	0	0.01	0.16
T5	7.3	1.01	498	330	0	0.034	0.18	0.05	0.34
T6	7.72	3.02	445	300	0.03	0	0.07	0.05	0.04
T7	7.37	0.81	400	270	0.02	0	0	0.025	0
T8	7.18	1.26	380	250	0	0.061	0.012	0.005	0
T9	7.27	0.69	376	250	0.08	0.053	0.019	0.025	0
T10	7.31	0.52	381	250	0.02	0	0	0.0025	0
T11	7.18	0.91	162	110	0.06	0	0	0.01	0.02
T12	6.98	2.99	202	140	0.17	0.008	0.008	0.005	0
T13	6.11	4.62	661	440	0.06	0.062	0.054	0.03	1.05
T14	6.14	0.55	490	330	0.07	0	0.023	0.005	0.38
T15	7.7	4.22	748	500	0.16	0	0.041	0.01	1.25

Table 11. Statically Data Obtained from T-Region.

Parameter	Mean	Median	Min	Max	S.D (±)	W.H.O Safe Limit	% Number of samples >WHO limit	PEQSDW Safe limit	% Number of samples >PEQSDW limit
pH	7.10	7.26	6.11	7.72	0.48	6.5-8.5	13	6.5-8.5	13
Turbidity (N.T.U)	2.82	0.91	0.31	20.10	4.99	5.00	7	5.00	7
E.C (μs cm^{-1})	586	445	162	2280	510	1492	7	1492	7
TDS (mg L^{-1})	392	300	110	1530	342	1000	7	1000	7
Fe	0.062	0.040	0	0.200	0.065	0.3	0	0.3	0

(mg L^{-1})									
Zn (mg L^{-1})	0.044	0.008	0	0.270	0.075	3	0	3	0
Mn (mg L^{-1})	0.032	0.019	0	0.180	0.046	0.5	0	0.5	0
As (mg L^{-1})	0.021	0.010	0	0.050	0.018	0.01	47	0.05	0
Cu (mg L^{-1})	0.883	0.160	0.00	8.800	2.228	2	7	2	7

4.5. Discussion

4.5.1 Physico-Chemical Parameters

Majority of the water sources were within the safe limit in different regions only two points have less pH value in three regions at points T13 and T14. The pH is the negative logarithm of hydrogen ion concentration and pH has no direct effect on drinking water quality but change in pH value cause wide change in other water quality parameters like TDS, EC, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-, trace elements and provide medium for microbial growth [17]. While Turbidity values are exceeding at points K10, D7, D15, D20 and T2 in three regions. Turbidity describes the cloudiness of water caused by suspended particles such as clay and silts, chemical precipitates such as manganese and iron, and organic particles such as plant debris and organisms [18]. The sources of turbidity are diverse, and many of the constituent particles (e.g. clays, soils and natural organic matter) are harmless. However, turbidity can also indicate the presence of hazardous chemical and microbial contaminants, and have significant implications for water quality, [19]. TDS and Electrical conductivity exceeded seven points at K1, K2, K8, D14, D26, D27 and T2 in three regions. Greater the electrical Conductivity greater will be the T.D.S. The Electric Conductivity is flow of electric current in the water. Pure water is not a good conductor of electric current rather a good insulator. Increase in ions concentration enhances the electrical conductivity of water. By the definition of electrical conductivity when the electric current passes through the water. Then the number of ions presents in water sample, to pass an electric current through it. Temperature related to the conductivity and the total number of dissolved ions and substances indicated the conductivity .in water the conductivity influenced by the ions like calcium, sulphates, magnesium, sodium, nitrate, phosphate and many other ions. Organic and inorganic compounds are presents in water when current passes through water then ions produced to indicate the conductivity. It has no standard value by the W.H.O and PWQSDW. Cations and anions are presents in drinking water. Conductivity indicate the total number of ions present in it [20]. The value of TDS was measured after measuring the conductivity through meter then multiplying the reading by the average factor value 0.65 of the range (0.55-0.70) [21].

4.5.2 Heavy Metals

Heavy metals concentration in three regions of district Dera Ghazi Khan was found in the order of As>Cu>Fe>Zn>Mn shown in Tables 6, 8 and 10. Only 37.1% Samples from the three regions found unsafe from WHO standard limit and only 3.22% samples exceed the

PEQSDW. In Figure 2, Trends Shows the Arsenic Contamination in the district Dera Ghazi Khan.

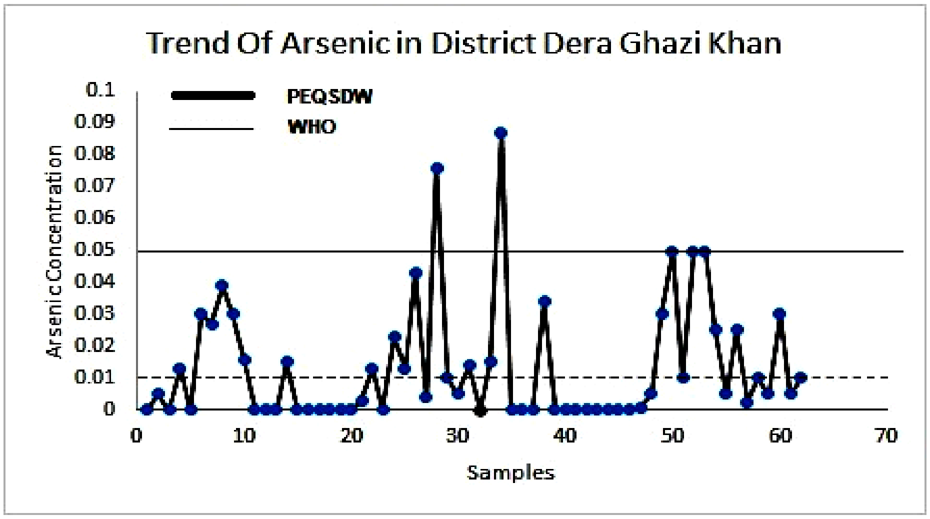

Figure 2. Arsenic Trend in District D G Khan.

While 1.61% samples exceeded the WHO and PEQSDW standard value but Iron (Fe), Zinc (Zn) and Manganese (Mn) were below the limits.

4. Conclusions

The following key are points outcome that are associated and considered in the aspect of the conclusion from study results of three regions district Dera Ghazi Khan.

- 7%, 9% and 7% of the samples have high value of turbidity than WHO and PEQSDW in K, D and T regions respectively.
- 21%, 9% and 7% samples have high value of Electric Conductivity and Total Dissolved Solids than WHO and PEQSDW of in K, D and T Regions respectively.
- 50%, 27% and 47% samples have high value of Arsenic than WHO in K, D and T regions respectively.
- 6% samples have high value of Arsenic than PEQSDW D region.
- 7% samples have high value of copper 8.8 mg/L at point T2 than WHO and PEQSDW T region of district Dera Ghazi Khan
- Highest values of Arsenic found 0.076 mg/L and 0.087 mg/L at Points D14 and D20 in District Dera Ghazi Khan.
- According to the WHO 37.1 % samples found unsafe for drinking due to high value of Arsenic Contamination all regions.

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