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DRINKING-WATER QUALITY ASSESSMENT: A CASE STUDY OF SADIQABAD CITY

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Abstract- Water used by humans should be fresh and non-toxic as it is one the most important need among all and used for various purposes from human consumption to industrial use. Drinking water is causing many deaths in Pakistan. Pakistan falls on number 80, in the list of 122 those states which consume contaminated potable water. The water quality in several municipalities of Pakistan is getting worse day by day. It is required to examine and analyze the quality of water in Sadiqabad, as there are no primary reports or in-depth research available related to ground and municipal water quality assessment of Sadiqabad city. This analysis was particularly concerned about the collection of water samples, to test physicochemical and biological contamination present in potable water of Sadiqabad, for exactness of their influence on water quality. For this purpose, the tube wells (bore) samples were collected from fifty-eight different localities of the city and were analyzed for 17 parameters including, Taste, Color, and Odor detected by senses, pH value by using pH meter, Total Dissolved Solids (TDS) with the help of TDS meter, Turbidity by using Nephelometer, Total Hardness, alkalinity, etc. This qualitative analysis strategy adopted to undertake this research has provided valuable data and information. For all the samples, the measure of color, taste, and odor was unobjectionable. The amount of turbidity and hardness was satisfactory. The amount of pH also lies within the permissible ranges set by WHO standards. The amount of TDS was also in between excellent to the fair ranges. It was, concluded that overall, the water quality of the city, was satisfactory and there was no need for water treatment. The results of this research can boost up the knowledge of the quality of safe drinking water in Sadiqabad. The methodology adopted can be replicated in other cities of Pakistan, where significant issues of the potable water pollution, are being risen.

Keywords- Water Quality, Potable Water, Total Dissolved Solids.

1 INTRODUCTION

Water is one of the necessities among all and used for the various purpose of human consumption to industrial use. Over 70% above, of the Earth's surface, comprises of water, only less than 1% of which is available as freshwater –not equally distributed throughout the world. Water used by humans should be fresh and non-toxic. Other than the shortage of water, there are many other incitements in providing harmless and sufficient water supply in many regions of the world. Approximately more than one billion people lack safe drinking water worldwide. A person requires to consume 2–4.5 liters of water per day for proper body functioning. Water is obtained, through underground, surface, and rain. In developing countries, approximately 50% of the water used, is obtained from boreholes and wells, and more than 1000 million people in Asia depend upon these resources. Many analytical methods are used to check the presence and concentration of harmful material in water. Most of the health issues related to water are the result of biochemical contamination present in it in addition to the dangerous problems of water pollution in developing countries, the water caused deaths and diseases are also an important issue worldwide. Approximately 500 million people are forced to use polluted water worldwide. More than 14,000 people per day, 2.2 million every year all over the developing countries die because of the unavailability of safe drinking water (Global Water Supply Sanitation Assessment, 2000; Report WHO).

Drinking water is the cause of many deaths in Pakistan too. As per the conducted survey, polluted water is one of the main threats to people's fitness in Pakistan that kills about 100,000 people a year, and over 250,000 children every year. In 2015, in Pakistan, 311189 people were died because of polluted water consumption, and in 2018, 40% of deaths were caused by it. Pakistan falls on number 80 in the list of 122 those states which consume contaminated potable water. So, large-scale water assessment is the need of the hour to evaluate and treat drinking water in Pakistan that will help to produce water that is safe and palatable. The water quality in several cities of Pakistan is deteriorating day by day due to uncontrolled municipal and industrial wastewater control and excessive use of fertilizers and pesticides.

This research is mainly based, on qualitative analysis of potable water in Sadiqabad, the city of Punjab, Pakistan. This city is also one of the main cities in Punjab, Pakistan. Although the Sadiqabad Division mainly comprises villages. Its literacy rate is relatively high compared to many other regions of Punjab, because of the importance of this city, it is essential to access and monitors the quality of its potable water, as there are no primary reports or in-depth research available related to ground and municipal water quality assessment of this city. The innovation of this research was particularly concerned about the collection of water samples, to test physicochemical and biological contamination present in the freshwater of Sadiqabad city, for exactness of their impact on the quality of water. This qualitative analysis strategy adopted to undertake this research has provided valuable data and information.

2 LITERATURE REVIEW

Many studies have been, presented at the research level on the qualitative assessment of water, which will make public the consequence of this purposed research. The study about trace metals and some physicochemical properties including pH, EC, turbidity, fluoride, iron, zinc, manganese and aluminum in drinking water samples using the procedure outlined in the plainest photometer method showed that the concentrations of most of the parameters in samples were within the limits of WHO and there was no correspondence of trace metals [1]. The physicochemical study such as the temperature of air and water, pH, humidity, EC, free carbon monoxide, TS, DO, total alkalinity, TH, calcium, and magnesium, for the period of one year i.e. of water of Triveni Lake was conducted for the one year December 2010 to November 2011 and results revealed, that water was fit for drinking during winter and summer [2].In India, the various bacteriological and physicochemical parameters of water quality index (WQI) for different surface water resources were calculated especially, lakes in Nagpur city, Maharashtra (India). EC, total dissolved solids, chloride, T-H, biochemical oxygen demand, dissolved oxygen, and pH were determined by standard methods, and FC and TC were determined by Membrane Filtration (MF) technique. The results for many lakes showed, fairwater in monsoon, medium in winter, and poor quality for the summer season while, Gore Wada Lake showed moderate results for every season, other than that of monsoon season [3]. The studies reported the physicochemical properties of water such as pH, EC, turbidity, total dissolved solids, dissolved oxygen,F^-,Cl^-, $Na^+$and SO_4^{-2} in AhmedPur, District Latur and significant changes in water quality were observed, after treatment [4]. In India, the drinking water quality of many lakes was evaluated, for physicochemical and biological parameters i.e. Total Hardness, TDS, DO, Specific Conductance, COD, pH, DO, temperature, and Total Alkalinity. The result revealed that most of the parameters were significantly dominant, in the summer as compared to the winter [5]. The nearshore of Cleveland sediments of Erie Lake and Cuyahoga River, Basin were assayed with Photobacterium phosphorus during the summer, and nearly all (93%) of the "navigation channel" and the samples were toxic nearshore [6]. In Gorgan city, (Iran) the physical, microbial, and chemical properties of drinking water samples of urban areas were assessed for one year (2009-2010) and compared with national and international standards. It was, concluded that for all the 598 water samples, the chemical and physical parameters were within the standard ranges, other than that of the hardness of drinking water, which was higher than the required amount [7]. Farzaneh, Manijeh et.al. , in 2019, checked the microbial and physical quality of potable water of Maku city (Iran) and, also determined the spatial distribution of chemical quality parameters of potable water through GIS during summer and winter. The research conducted for two years showed, all the parameters under consideration for 136 samples from 36 distribution networks during summer and winter were, within the standard ranges of W.H.O and Iranian National Standard, and overall, water was good and safe for drinking [8].In Pakistan district, Mardan Khyber Pakhtunkhwa, various physicochemical parameters including magnesium (Mg), electrical conductivity (EC), odor, taste, temperature, color, alkalinity, total hardness pH, total dissolved solids (TDS), turbidity, calcium (Ca) and bicarbonate were investigated for 39 potable water samples gathered from groundwater source of 13 union councils, and the results showed that the taste of 23%, TDS of 15% samples, EC of 38% samples, and the hardness of 20% of samples, were out of the ranges set by the Pakistani Standards water and W.H.O [9]. In 2018, Mahmood et.al. analyzed the groundwater quality trend changes, in Abhar city (Iran), for 15 years and observed that first and end year of the study period, the amount of total hardness, electrical conductivity (EC), and total dissolved solids (TDS) were 606.217194.69, 192.69756.83 and 235.25784.73 464.717183.52, 744.557288.52 and 348.797106.81, respectively [10].

Devendra et.al. measured the various biological and physicochemical parameters, to assess the bore water quality of various wards of Indore city India and the parameters analyzed from November to February and March to May include (1)Calcium,(2)Sulphate,(3)Nitrate,(4)Total alkalinity, (5)Fluoride, (6)Magnesium, (7)M.P.N., (8)Electrical Conductivity, (9)Temperature,(10)pH,(11)Totalhardness,(12)TDS,(13)Chloride,(14)Turbidity,(15)Chromium,(16)Nickel,(17)Iron,(18) Cadmium, (19)Boron, (20)Phosphate,(21)C.O.D,(22)Zinc,(23)Manganese and (24) Sodium. After comparing the obtained result with the Indian Standard of Drinking Water Standards, (IS 10500-2012) it was observed, that during the wet season, the majority of the parameters of water quality were higher up to some extent than in the dry time of year [11]. Various biochemical and physical parameters were analyzed for one year, before and after the monsoon season, for different potable water samples of city Bhopal, India. From the results, it was observed that most of the parameters, including pH, electrical conductivity,Cl^-, alkalinity, total hardness, calcium hardness, magnesium hardness, dissolved oxygen, chemical oxygen demand were, within the prescribed range, of IS: 10500 while others such as free carbon dioxide, biochemical oxygen demand, NO^{-3}, F^-, and Most Probable Number tests were out of the range of ISI and WHO [12]. The physiochemical study conducted in different commercial and residential areas of Perak state Malaysia revealed that the overall water was safe for potable water supply with the values of all the parameters within the required limits of NDWQS and W.H.O [13]. The study was, conducted in Nekemte Oromia (Ethiopia) to check the bacteriological, chemical, and physical quality of untreated, main distribution sources and residential tape water in the dry season for the one year. The outcomes revealed that for most of the samples, all the parameters were as per within the World Health Organization and Ethiopian Drinking Water Standards, but some of them were more than the range. Bacteriological contamination (TC and FC), were seen in all the samples. On the other hand, in many residential water samples, they were not found FC contaminated. It was concluded that bacteriological contamination was present in both sources of drinking water [14].

3 EXPERIMENTAL PROCEDURES

In Pakistan, Sadiqabad (28.3N, 70.116667 E) is the executive tehsil of Rahim Yar Khan district in Punjab, with a population of 1.265million people shown in figure 1.

Figure 1: Study Area Map

For the water quality assessment tube, wells samples were collected from fifty-eight different station points from the whole tehsil. A total of 17 parameters was considered such as temperature, taste, odor, color, turbidity, pH, TDS, total hardness for analysis of water samples. The apparatus used were a thermometer, nephelometer, burette, flak, measuring cylinder, stirrer, pipette, pH, and TDS meter. The procedure adopted was as follows, the temperature of the water samples was recorded by the ordinary thermometer. The odor, color, and taste were tested by smelling, visualizing, and drinking the water samples, respectively. The pH value was noted by placing the pH meter into the specimens. The turbidity of the samples was checked by Nephelometer with a nephelometric tube inside, filled with the water sample. The amount of scattering of light gives the measure of turbidity present in a sample. The difference between the initial and the final reading of the burette filled with the standard solutions gives the amount of that parameter present in water samples. In the case of

Total Hardness, the titrant used was sodium salt of EDTA with the blue color representing the endpoint of the titration. The number of TDS present in water was counted simply by dipping the TDS meter into the water sample. The beneficial and reliable methods for the elimination of water contaminations (if present, in any season), were also suggested that can be adapted efficiently by the people at the domestic level. The purposed methods for the treatment of the water samples include boiling, UV radiations, solar radiations, and by using potash alum. The required to permissible ranges set by, WHO are shown in Table 1 given below.

Table 1. Permissible Limits/Ranges/Standard set by WHO

Parameter	**Permissible limit**	**Parameter**	**Permissible limit**
pH	6.8-8.5	Total Alkalinity	Not Set
Colour	Un-obj	SO_4^{2-}	400 mg/l
Odor	Un-obj	Cl_2	250 mg/l
Taste	Un-obj	Iron	1.0 mg/l
Turbidity	5 NTU	Arsenic	50 ppb
Total dissolved solids	1000 mg/l	Flouride	1.5 mg/l
Ca.	200 mg/l	Total Coliform	0 cfu/100 ml
Mg.	150 mg/l	Nitrate	50mg/l
Total Hardness	500 mg/l		

4 RESEARCH METHODOLOGY

Water pollution is a serious worldwide issue that demands unending analysis and modification of water resource policy at all levels. The methodology adopted during the research work for collecting and analyzing the water samples is summarized in the form of a flowchart shown below in figure 3.

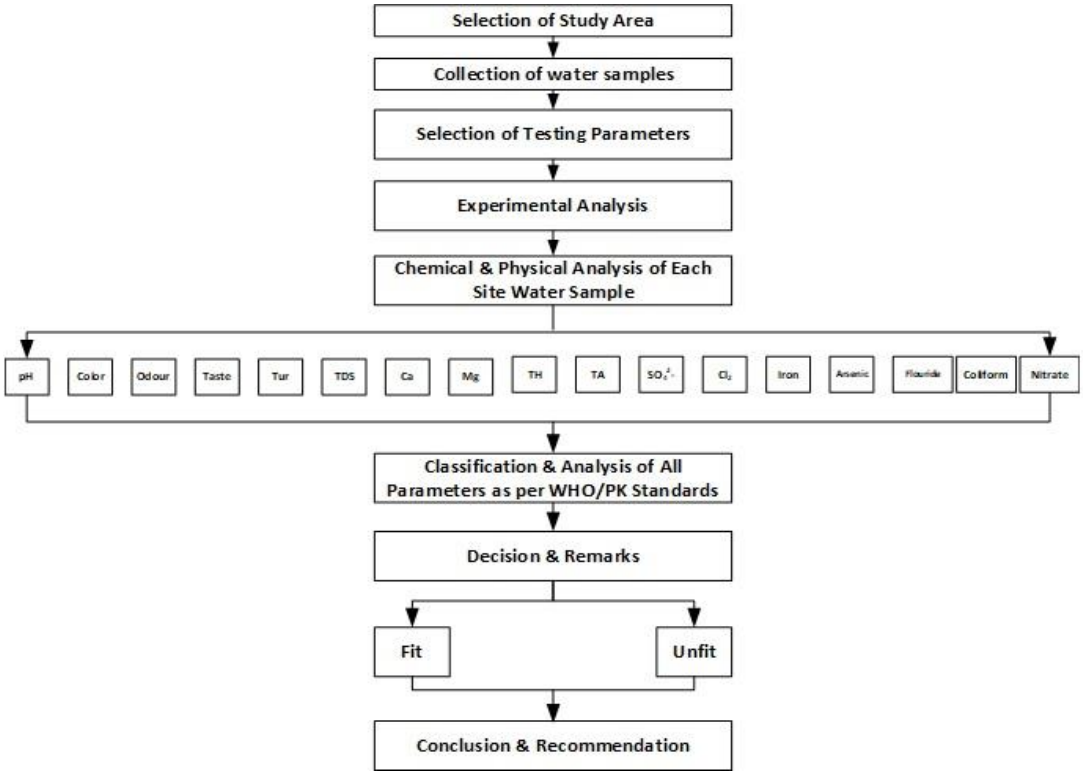

Figure 3: Research Work Methodology

5 RESULTS

The integral role of water depends on the quality of the water. According to the research, carried out with the analysis of the Sadiqabad areas the results were monitored for water quality assessment. A brief overview of the state of water quality in these areas is discussed below. The required and permissible limits of different water quality parameters set by WHO, standards are discussed in the table1 given above. After all the tests performed, the results were evaluated and summarized in table 2. A total of fifty-eight samples were collected from distinct areas.

Table 2-Water Quality Analysis of Sadiqabad City, Pakistan

Sr.No	Location/Facility	pH	Colour	Odor	Taste	Tur.	TDS	Ca.	Mg.	TH	TA	SO_4^{2-}	Cl_2	Iron	Arsenic	Flouride	Total Coliform	Nitrate	Remarks
1	Shahbaz pur tube well # 04	7.4	✓	✓	✓	1.47	647	50	41	213	141	140	89	3	10	1.6	0	0	Unfit
2	Shabaz pur tube well # 05	7.2	✓	✓	✓	1.68	702	77	41	241	229	190	91	3	30	1.1	0	0	Unfit
3	Shahbaz pur tube well # 06	7.4	✓	✓	✓	2.6	657	70	45	249	200	170	79	3	40	1.7	0	0	Unfit
4	Shahbaz pur tube well # 07	7.2	✓	✓	✓	1.89	637	80	37	227	237	215	77	2	40	0.74	0	0	Unfit
5	Shahbaz pur tube well # 10	7.5	✓	✓	✓	2.17	731	93	44	269	229	210	93	2	40	0.89	0	0	Unfit
6	Shahbaz pur tube well # 12	7.4	✓	✓	✓	1.71	719	101	34	237	222	200	88	2	40	0.97	0	0	Unfit
7	Shahbaz pur tube well # 14	7.2	✓	✓	✓	1.93	689	87	35	227	192	160	73	4	40	1.8	0	0	Unfit
8	Shahbaz pur tube well # 01	7.4	✓	✓	✓	1.43	670	83	37	233	207	205	82	4	40	1.7	0	0	Unfit
9	Shahbaz pur tube well # 02	7.3	✓	✓	✓	1.74	665	91	40	251	155	155	79	3	10	1.2	0	0	Unfit
10	164/p	7.3	✓	✓	✓	1.82	696	77	42	247	259	140	81	0	25	0.72	0	0	Fit
11	Ahmad pur Lamma tube well # 01	7.2	✓	✓	✓	1.39	590	77	35	217	244	150	73	0.3	30	0.68	0	0	Fit
12	Ahmad pur lamma tube well # 03	7.3	✓	✓	✓	1.82	621	73	41	239	117	121	84	0.4	10	0.76	0	0	Fit
13	Ahmad pur lamma tube well # 05	7.2	✓	✓	✓	1.69	607	59	36	205	104	105	79	0	0	0.49	0	0	Fit
14	Ahmad pur lamma tube well # 06	7.4	✓	✓	✓	2.13	623	77	39	234	259	180	84	0.6	20	0.67	0	0	Fit
15	Ahmad pur Lamma tube well # 08	7.3	✓	✓	✓	1.18	652	73	45	253	237	170	79	0	20	0.81	0	0	Fit
16	148/p	7.2	X	X	X	7.48	269	53	7	82	118	115	35	0	20	0.29	17	0	Unfit
17	146/p	7.4	X	X	X	6.89	272	47	16	110	111	95	58	0	20	0.27	20	0	Unfit
18	Basti Baiggar Garri Pumping Station	7.4	✓	✓	✓	1.33	663	133	39	289	159	166	97	0	0	0.85	0	0	Fit
19	150/p	7.1	X	X	X	5.72	311	57	15	116	133	105	39	0	20	0.21	14	0	Unfit
20	151/p	7.3	X	X	X	6.31	289	50	6	75	126	110	31	0	25	0.34	12	0	Unfit
21	RWSS 173/P	7.2	✓	✓	✓	1.62	845	101	41	267	96	80	139	0	5	0.81	0	0	Fit
22	RWSS 195 (Barra)	7.3	✓	✓	✓	2.18	306	79	9	116	97	91	46	0	0	0.63	0	0	Fit
23	RWSS 191/P	7.4	✓	✓	✓	1.89	332	73	11	116	111	50	46	0.3	5	0.64	0	0	Fit
24	RWSS 156/P	7.2	✓	✓	✓	2.13	559	33	31	158	81	55	58	0.2	0	0.51	0	0	Fit
25	RWSS 201/P	7.1	✓	✓	✓	1.89	647	53	38	205	155	95	116	0	5	0.79	0	13.29	Fit
26	RWSS 197/P	7.2	✓	✓	✓	1.79	706	67	40	226	170	100	136	0	0	0.57	0	0	Fit
27	RWSS 213/P	7.4	X	X	X	5.57	259	50	16	116	111	75	46	0	0	0.79	16	0	Unfit

28	216P	7.3	✓	✓	✓	1.37	505	109	18	181	117	125	81	0	0	0.56	11	0	Unfit
29	RWSS 211/P	7.2	✓	✓	✓	1.69	672	147	42	315	241	170	81	0	0	0.68	0	0	Fit
30	RWSS 199/P	7.3	✓	✓	✓	2.17	706	154	21	240	259	201	155	0	0	0.87	0	0	Fit
31	Pumping station 11/NP	7.2	✓	✓	✓	2.4	689	129	44	307	215	110	89	0.5	25	0.62	0	0	Fit
32	RWSS 182/P	7.3	✓	✓	✓	1.26	633	135	35	277	171	197	66	0	0	0.73	0	0	Fit
33	RWSS 86/P	7.8	✓	✓	✓	3.17	1510	207	39	363	371	509	318	0	0	0.91	0	0	Unfit
34	RWSS Walhar	7.3	✓	✓	x	1.39	1870	251	72	541	447	580	515	0	0	1.3	0	0	Unfit
35	RWSS 177/P	7.4	✓	✓	✓	1.54	805	113	45	295	222	130	120	0.4	25	0.79	0	0	Fit
36	Basti Masoorian	7.5	✓	✓	✓	3.19	882	137	74	432	133	120	97	0.8	30	0.87	0	0	Fit
37	Pumping Station Mazher Fareed colony	7.6	✓	✓	✓	1.97	669	117	50	319	207	115	75	0	0	0.75	0	0	Fit
38	Pumping Station Satellite town	7.4	✓	✓	✓	1.52	693	157	42	327	259	155	87	0	25	0.61	0	0	Fit
39	Pumping station Municipal Town	7.2	✓	✓	✓	1.31	703	161	47	349	229	145	101	0	25	0.82	7	0	Unfit
40	Pumping station near Madina cotton factory	7.3	✓	✓	✓	1.56	653	139	41	303	274	160	86	0	25	0.69	0	0	Fit
41	Pumping station Model Town	7.4	✓	✓	✓	1.43	661	129	41	294	229	135	79	0	25	0.76	0	0	Fit
42	New overhead Bridge Pumping Station	7.2	✓	✓	✓	1.61	679	153	37	301	200	105	87	0	25	0.43	0	0	Fit
43	Overhead bridge Old Pumping station	7	✓	✓	✓	1.23	688	157	38	311	192	100	98	0	55	0.86	0	0	Unfit
44	basti Moran	7.2	X	X	x	7.41	277	33	16	96	96	60	39	0	0	0.23	19	0	Unfit
45	Pumping Station Tibbi Baghawar	7.2	✓	✓	✓	1.39	663	109	45	289	252	180	76	0	10	0.58	0	0	Fit
46	RWSS 184/P	7.4	✓	✓	✓	1.93	516	87	31	212	148	70	58	0.3	0	0.53	0	0	Fit
47	RWSS 267/P	7.5	✓	✓	✓	1.41	665	92	47	281	170	115	74	2	5	0.88	0	0	Unfit
48	RWSS 161-162/P	7.3	✓	✓	✓	1.37	583	57	32	185	126	60	79	0	0	0.71	0	22	Fit
49	RWSS 185-195/P	7.1	X	X	x	4.89	256	33	14	89	74	50	43	0.3	5	0.28	9	0	Unfit
50	RWSS 189/P	7.1	✓	✓	✓	1.63	574	63	46	247	185	105	54	0	5	0.76	0	0	Fit
51	RWSS 157/P	7.8	✓	✓	✓	1.63	946	67	43	240	163	80	217	0	0	0.67	0	0	Fit
52	RWSS 194/P	7.6	✓	✓	✓	2.41	636	81	43	253	96	45	100	0	5	0.73	0	0	Fit
53	RWSS 195/P	7.2	✓	✓	✓	5.57	311	53	14	110	170	80	46	0	0	0.68	0	0	Fit
54	RWSS 160/P	7.5	✓	✓	✓	2.58	788	102	50	301	163	100	81	1.6	10	0.87	0	17.72	Unfit
55	121/p	7.2	✓	✓	✓	1.52	325	79	11	123	101	79	54	0	0	0.49	0	0	Fit
56	RWSS 175/P	7.3	✓	✓	✓	1.93	768	128	64	384	244	160	74	0	25	0.67	0	0	Fit
57	147/p	7.3	✓	✓	✓	2.85	419	77	28	191	107	111	81	0	0	0.55	0	0	Fit
58	165/P	7.6	✓	✓	✓	3.47	868	123	68	397	178	160	136	0	10	0.94	0	0	Fit

Note: ✓= Un-objectionable, x = Objectionable, Tur= Turbidity, TDS= Total dissolve solids, TH= Total hardness, TA= Total alkalinity, EC= Electrical Conductivity

Based on the results mentioned in table 2, it was, noticed that the overall water quality of the city was satisfactory and, as such, there was no need for treatment. For all the samples, the measure of temperature, color, taste, and odor was unobjectionable. The amount of turbidity, alkalinity, acidity, and hardness was also satisfactory. The amount of pH also remained within the permissible ranges set by WHO, standards. The amount of TDS was in between excellent to the fair ranges.

6 PRACTICAL IMPLEMENTATION OF WORK IN INDUSTRY

The study will be implemented to identify risky areas in the region where there is more need to install water filtration plants.

7 CONCLUSION

Over a billion people above worldwide, especially in developing countries, do not have safe drinking water. Apart from the shortage of water, there are many other challenges in providing safe, adequate, and reliable water supply in many regions of the world. The research was conducted to access different contamination found in the drinkable water of Sadiqabad for outlining their impact on water quality. This qualitative analysis strategy adopted to undertake this research has provided valuable data and information. The overall water quality of the city was satisfactory and, as such, there was no need for treatment. For all the samples, the temperature, color, taste, and odor were unobjectionable. The turbidity and total hardness in the water were also within an acceptable value. The amount of pH also remained within the permissible ranges set by different standards WHO, standards. The number of TDS present in water was also lying within the excellent to the fair ranges. From, the results of the whole testing, it was concluded that there were no significant issues of any type of contamination i.e. physical, biological, and chemical present in the water of Sadiqabad city and was considered safe for drinking. The methodology may also be, replicated in different cities of the country.

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