Assessment of Drinking Water Quality Status and its Impact on Health in Tandojam City

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Abstract: Unsafe drinking water is one of the major concerns in developing countries. The southern Sindh is province of Pakistan that adjoins the Arabian Sea coast where the drinking water quality is deteriorating due to unrefined urban waste and excessive use of agro-chemicals. Present study aimed to assess the quality of ground water source and to compare it with WHO standards. Water borne diseases associated with drinking it in the vicinity Tandojam city were identified. Water from ground water source was sampled at selected locations in the study area. The samples were collected mostly from pumped waters. The samples were analyzed for physico-chemical properties in order to identify the quality problems and suggest safe source for drinking purpose. Findings revealed that the ground water quality in Muzaffrabad colony is deteriorating. The situation was much worse in Muzaffrabad colony, Jam Ghar and Mir colony with high TDS and salty taste, respectively at few sampling locations. In addition, laboratory analysis of the water quality parameters revealed the detail of variation in the groundwater. TDS, hardness, sodium (Na), chloride (Cl) and magnesium (Mg) etc. were considerably beyond the WHO permissible limits. The poor quality of the water has created different waterborne diseases like cholera, diarrhea etc. Moreover, the samples of SAU Colony and Amar Town showed that the water quality of these areas was within acceptable limits according to WHO standards and was suitable for the purpose of drinking.

Keywords: Drinking water quality, physico-chemical parameters, Tandojam city, waterborne diseases, WHO standards.

INTRODUCTION

Safe drinking water is essential for all humankind. In excess of one billion people around the world do not have access to safe water for drinking purpose [1]. Only 2.5 % of earth water is fresh and thus is suitable for consumption. More than two-third of available fresh water is locked aside in glaciers and is not easily available to fulfil the growing demands of society [2].

In Pakistan, the availability of groundwater is limited. In most cases is it unsafe for drinking purpose. The problem of ground water pollution is many parts of the country have become so acute that extensive ground water resources are rapidly deteriorating [3].

Groundwater quality is the result of all those reactions and processes that affect water. It quality varies with space and time. It differs from one place to other and with depth of water table. Reid [4] it is estimated that about 75% of the population of developed countries lacks access to safe drinking water and so many other problems. The other problems include: adequate sanitary facilities and landfills that are located near the water bodies [5].

Water pollution directly affects drinking water lakes, rivers and oceans in different parts of the world, which consequently harms human health and natural environment. Poor water quality includes wastewater and sewage, marine dumping, oil pollution, atmospheric deposition, underground storage & leakages, radioactive waste, global warming, industrial waste etc.

The contaminated water may cause waterborne diseases. Mostly children are widely affected due to consumption of poor quality of groundwater and open channels [6]. It has been reported that between 100 and 150 children die every day due to diarrhea infection caused by unsafe drinking water and unhygienic conditions in Pakistan [7]. Moreover, diarrheal diseases represent a major health problem in developing countries and some estimates suggest that global death toll from diarrheal diseases is about two million per year (between 1.7 and 2.5 million deaths). Worldwide, the death toll due diarrheal diseases ranks third among all infectious diseases [8].

The improvement of drinking water quality for human consumption and agriculture depends on reliable analytical measurements. Thus, the analytical testes color, odor, EC, pH, flavor, turbidity, bicarbonate, alkalinity, carbonate, magnesium, calcium, water hardness, potassium, sodium, chloride, sulfate,

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phosphorus, TDS and nitrate are very important water quality parameters and play a significant role [9].

The ground and surface water resources are deteriorating every year due to increasing population growth, urbanization and un-planned water usages. In most of the area of Pakistan, the groundwater is main source of drinking water. The most common tools for the extraction of groundwater in rural areas are hand pumps and electric motor pumps. The quality of water in many areas of Sindh province is poor. In the areas with no filtration plants, peoples are compelled to drink poor quality water. The depletion of water resources and deteriorating quality of ground water leads to increased water borne diseases, which are transmitted to human beings through this water [10].

Keeping the above aspects of drinking water, the present study was undertaken to investigate the quality of groundwater and its impact on health of local residence in different locations of Tandojam Hyderabad.

MATERIALS AND METHOD

Description of the Study Area

Tandojam city is situated in district Hyderabad, which lies at latitude of 25°25'60 N and longitude 68°31'60 E at an elevation of approximately 23 m above the sea level. The weather of this zone is moderate. However, from April to June the weather is very hot during day time. The monsoon dominates from July to September. December and January are the coldest months.

Sampling Methodology

In order to assess the groundwater quality and its related diseases, samples were collected in monsoon season at seven different locations viz.: SAU Colony, Mir Colony, Amar Town, Muzaffarabad Colony, Jam Bungalows, Jam Ghar and Liaquat Town. The details on each location with source of drinking water are shown in Table **1**. Five water samples at each selected location were collected from motor pumps in 500 ml polyethylene bottles and got tested in DRIP lab. The averages of five sampling locations are shown through graph. The samples were collected, systematically labeled and analyzed for different physical (i.e. color, odor etc.) and chemical properties (i.e. pH, EC, TDS, Ca, Mg, HCO_3, Hardness, Na, NO_3, Cl, K, SO_4).

Data Comparison

The results of groundwater physical and chemical parameters were compared with WHO drinking water standards. In addition, to assess the overall physico-chemical quality of water and main waterborne diseases in study areas, a field survey was conducted and data was gathered through questionnaire.

Water Quality Status in Study Area

Water quality is the physical and chemical characteristics of water in relation to some set standards. These characteristics are directly related to the safety of the drinking water to human use. Water quality characteristics provide important information about the fitness of a water body. These characteristics are used to find out the quality of water fit for drinking purpose. During health survey, waterborne diseases were also investigated using a questionnaire.

Analysis of Physico-Chemical Parameters of Water

Both physical and chemical water quality parameters of collected water samples were analysed in the laboratory of Drainage Reclamation Institute Pakistan (DRIP) in Tandojam and the results are given in Table **2**. The physical parameters that were tested included colour and odour and the chemical characteristics included: pH, electrical conductivity (EC) and Total dissolved solids (TDS), magnesium (Mg), calcium (Ca), bicarbonates (HCO_3), chloride (Cl), sulfate (SO_4), hardness, sodium (Na), potassium (K) and nitrate (NO_3). The WHO standards set for these parameters are also shown in Table **2**.

Table 1: Sampling Locations, Water Source and Sampling Code

Sr. No.	Samples Location	Sample Source	Samples Code
1	SAU Colony	Electric pump	D_1
2	Mir Colony	Electric pump	D_2
3	Amar town	Electric pump	D_3
4	Muzaffarbad Colony	Electric pump	D_4
5	Jam Bungalows	Electric pump	D_5
6	Jam Ghar	Electric pump	D_6
7	Liaquat Town	Electric pump	D_7

RESULTS AND DISCUSSION

The present study has provided information of health survey and analysis of drinking water quality status of groundwater from seven selected locations of Tandojam city and safety level for drinking water compared with WHO standards. Ground water samples

Table 2: Physico-Chemical Water Quality Parameters of Study Areas and Values of WHO Standards

Sr. No.	Parameters	SAU Colony	Mir Colony	Amar Town	Muzaffrabad Colony	Jam Bungalows	Jam Ghar	Liaquat Town	Permissible limit set by WHO
1	pH	7.3	7.0	7.4	7.1	7.1	7.3	7.1	6.5-8.5
2	EC	1.1	2.2	1.5	2.7	1.9	1.4	2.0	1.4 (dS/m)
3	TDS	756	1457	960	1760	1245	1400	1324	1000 (mg/l)
4	Ca	92	70	52	68	70	65	60	100 (mg/l)
5	Mg	50	68	41	60	60	60	55	50 (mg/l)
6	HCO_3	240	280	250	320	260	250	240	500 (mg/l)
7	SO_4	90	160	102	130	110	190	210	250 (mg/l)
8	Hardness	360	300	200	520	380	290	280	500 (mg/l)
9	Na	130	280	140	340	150	280	220	200 (mg/l)
10	NO_3	2.4	3.6	3.4	3.2	2.7	2.3	3.4	45 (mg/l)
11	Cl	145	280	160	300	200	240	230	250 (mg/l)
12	K	4.6	7.4	4.0	8.8	5.0	8.4	7.0	12 (mg/l)

were collected from each proposed location from the source pump to investigate the water quality of drinking water. The pump was main source of water for drinking purposes in study area. As the quality of water in some locations was not appropriate for drinking purpose, so the local community was mainly dependent on market filtered water.

Colour and Odour in Water

The results on colour and odour reveal that the sampled water is colour-less and odourless. Any decomposition arising from organic material and leakage from sewage may not have reached the groundwater hence its colour was not affected. In the study area, the water samples collected at all locations were odorless and all samples were apparently safe for drinking purpose. However, their quality was further determined from chemical analysis.

Total Dissolved Solids (TDS)

The results on total dissolved solids TDS are shown in Table **2** and illustrated in Figure **1**. Figure shows that the values of TDS at sampling locations i.e. D_2, D_4, D_5, D_6 and D_7 were unfit for drinking. The highest TDS value (1760 mg/l) was observed at D_4 location, while the lowest TDS value (756 mg/l) was observed at D_1 location.

Electrical Conductivity (EC)

The results on EC are shown in Table **2** and presented in Figure **2**. Figure shows that the EC values at D_2, D_3, D_4, D_5, and D_7 sampling locations crossed the acceptable limits set by WHO and were unfit for drinking. The values of electrical conductivity (EC) were higher than those set by WHO standards. The highest EC value (2.7 dS/m) was found at D_4 location, while the lowest EC value (1.1 dS/m) was observed at D_1 location.

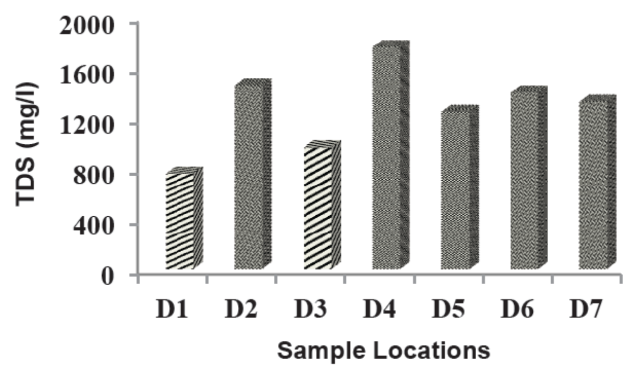

Figure 1: Values of Total Dissolved Solids (TDS) in Study Areas.

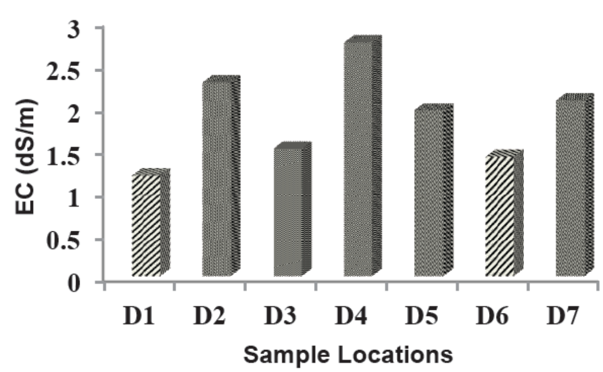

Figure 2: Values of Electrical Conductivity (EC) in Study Areas.

pH

The results on pH for different locations are plotted in Figure **3**. It shows that the pH values at all sampling locations i.e. D_1 D_2, D_3, D_4, D_5, D_6 and D_7 were within acceptable limits set by WHO, hence were fit for drinking. The highest pH was found at D_3 location while, the lowest values observed at D_2 location.

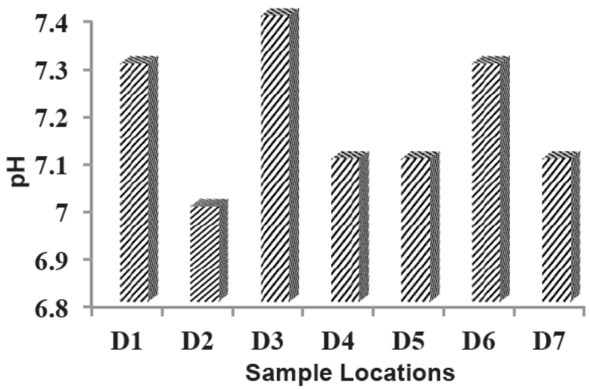

Figure 3: Values of pH in Study Areas.

Potassium

The results on potassium (K) present in the water samples are illustrated in Figure **4**. Figure shows that the values of potassium at all sampling locations D_1, D_2, D_3, D_4, D_5, D_6 and D_7 were within the acceptable limits set by WHO hence, water was fit for drinking purpose. The highest value of potassium (8.8 mg/l) was found at D_4 location while, the lowest value of potassium (4.0 mg/l) was observed at D_3 location.

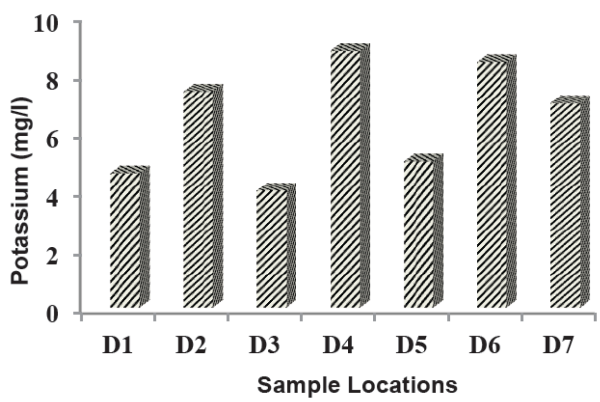

Figure 4: Values of Potassium (K) in Study Areas.

Sodium

The results on sodium in water samples collected at various locations are shown in Figure **5**. Figure reveals that the values of sodium at different sampling locations i.e. D_2, D_4, D_6 and D_7 crossed the acceptable limits set by WHO hence use of this water could be avoided as it was unfit for drinking. The highest value of sodium (340 mg/l) was found at D_4 location while the lowest value of sodium (130 mg/l) was observed at D_1 location.

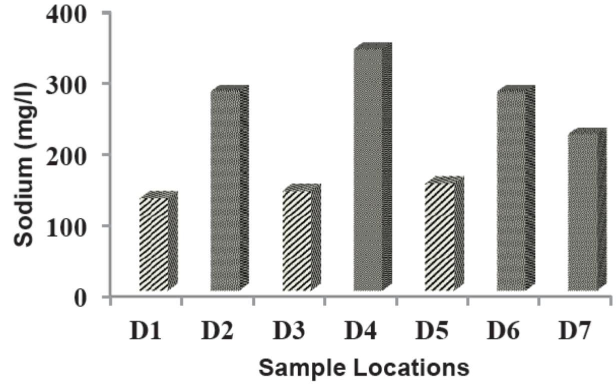

Figure 5: Values of Sodium (Na) in Study Areas.

Calcium

The results on calcium in water samples collected at various locations are described in Figure **6**. Figure shows that all values of calcium in sampled water were within the acceptable limits set by WHO hence, water was fit for drinking purpose. The highest values of calcium (90 mg/l) was found at D_1 location while, the lowest values of calcium (52 mg/l) were observed in D_3 location.

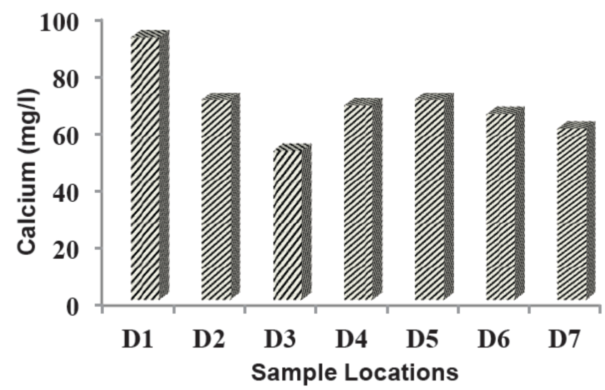

Figure 6: Values of Calcium (Ca) in Study Areas.

Magnesium

The results on magnesium concentrations are shown in Figure **7**. It shows that the values of magnesium in sampling locations i.e. D_2, D_4, D_5, D_6 and D_7 crossed the acceptable limits of WHO hence the caution should be taken before drinking such water. It might result in health problems. The highest values of magnesium (68 mg/l) was found at D_2 location while, the lowest values of magnesium (41 mg/l) was observed at D_3 location.

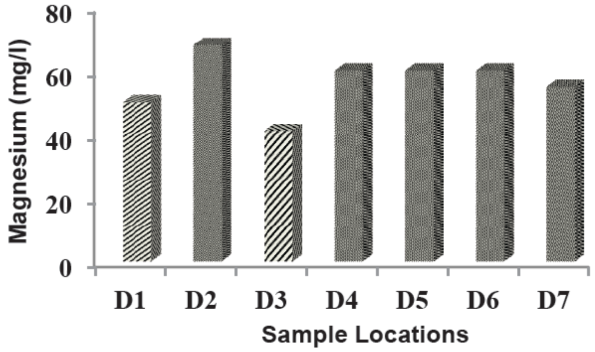

Figure 7: Values of Magnesium (Mg) in Study Areas.

Hardness

The results on hardness are illustrated in Figure **8**. Figure shows that the values of hardness at D_4 location crossed the acceptable limits set by WHO hence this water can be treated as hard water. It should be used after proper treatment otherwise it is unfit for drinking. The highest value of hardness (520 mg/l) was found at D_4 location while, the lowest value of hardness (200 mg/l) was observed at D_3 location.

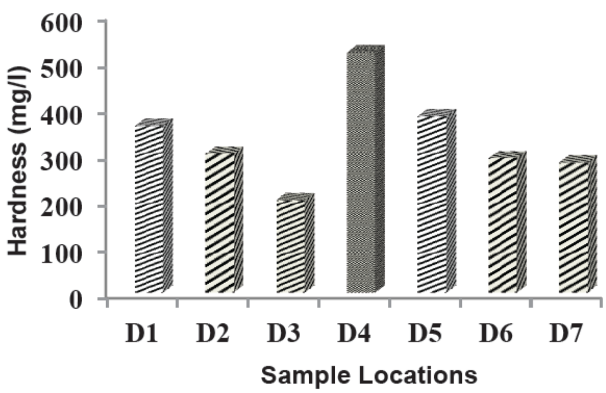

Figure 8: Values of Hardness in Study Areas.

Chloride

The results on chloride concentration in water sampled at different locations are illustrated in Figure **9**. Figure shows that the values of chloride at two sampling locations i.e. D_2 and D_4 crossed the acceptable limits set by WHO and were unfit for drinking. The highest values of chloride (300 mg/l) were found at D_4 location while, the lowest value of chloride (145 mg/l) was observed at D_1 location.

Nitrate

The results on nitrate are shown in Figure **10**. Figure shows that the values of nitrate in all sampling locations i.e. D_1, D_2, D_3 D_4, D_5, D_6 and D_7 were within the acceptable limits set by WHO and water was fit for drinking from nitrate point of view. The highest value of nitrate (3.6 mg/l) was found at D_2 location while, the lowest value of nitrate (2.3 mg/l) was observed at D_6 location.

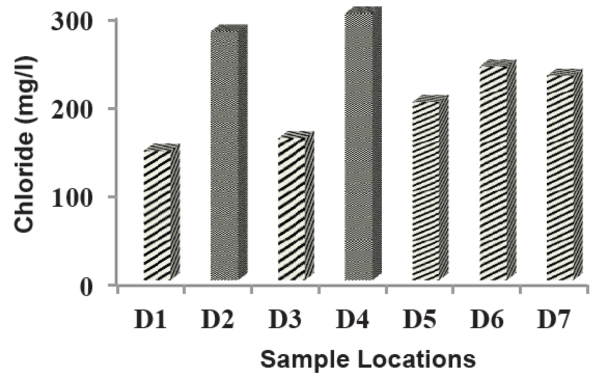

Figure 9: Values of Chloride (Cl) in Study Areas.

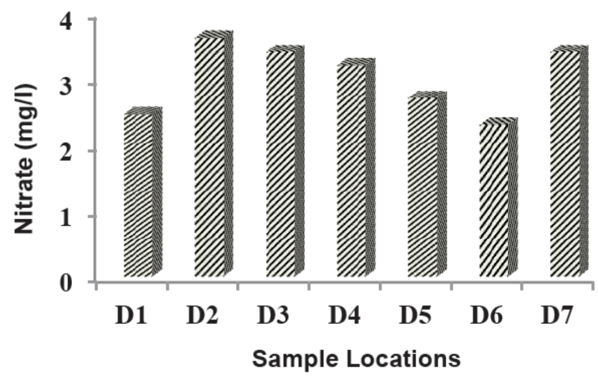

Figure 10: Values of Nitrate (NO_3) in Study Areas.

Bicarbonate

The results on bicarbonate concentrations are shown in Figure **11**. It shows that the values of bicarbonate in all sampling locations i.e. D1, D_2, D_3 D_4, D_5, D_6 and D_7 were within the acceptable limits set by WHO and water is fit for drinking. The highest value of bicarbonate (320 mg/l) was found in D_4 location while,

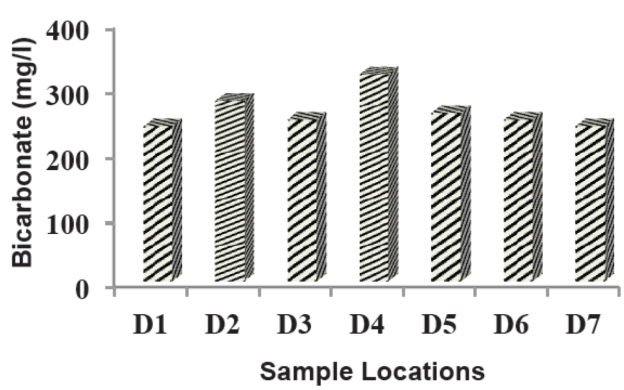

Figure 11: Values of Bicarbonate (HCO_3) in Study Areas.

the lowest value of bicarbonate (240 mg/l) was observed at D_1 location.

Sulfate

The results on sulfate concentrations present in water are shown in Figure **12**. Figure shows that the values of sulfate in water sampled at all locations were within the acceptable limits set by WHO and water was suitable for drinking. The highest value of sulfate (210 mg/l) was found at D_7 location while, the lowest value of sulfate (90 mg/l) was observed at D_1 location.

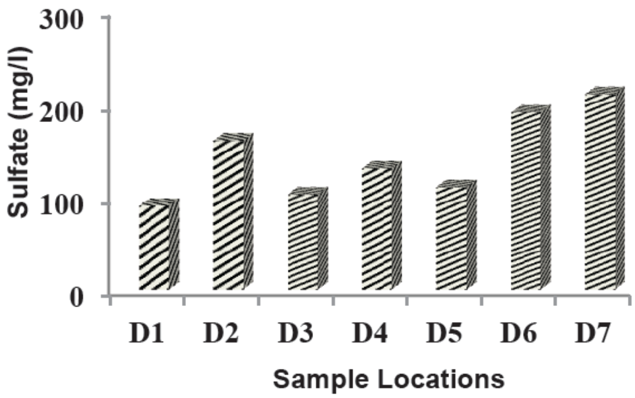

Figure 12: Values of Sulfate (SO_4) in Study Areas.

Diseases by Poor Drinking Water Quality

The results on waterborne diseases during monsoon season in the study areas are shown in Figure **13**. Results reveal that at some places residents were under the threat of many water related diseases such as cholera, abdominal pain, diarrhoea and typhoid etc. It was observed that about 12.3% people in the study area were suffering from diarrhoea and about 4.8% were suffering from typhoid, about 5.3% were suffering from cholera and about 15.5% had abdominal pain due to the continuous use of poor quality water. The poor quality of water caused water borne diseases and it is harmful for human health. While, on overall basis, about 62.2% of local community was free from water related diseases.

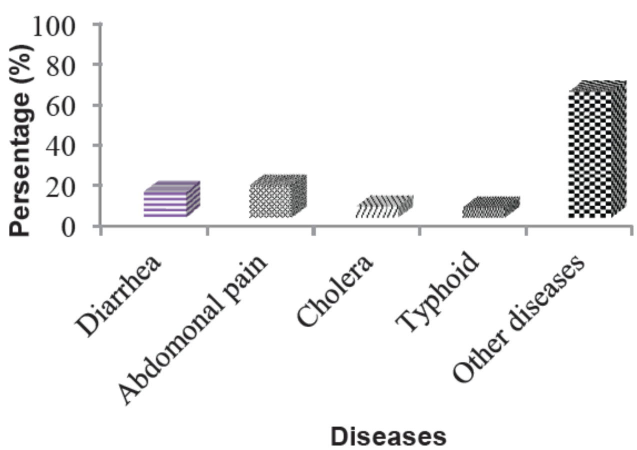

Figure 13: Water borne diseases in study area.

The results of present study suggest that the colour, odour, pH, potassium (K), bicarbonates (HCO_3), calcium (Ca), sulfate (SO_4) and nitrate (NO_3) were within allowable limits for human consumption, while, TDS, Mg, EC and Na were slightly higher in several samples Cl^- and Hardness were found beyond the permissible limits set by WHO standards at few locations. The similar findings were reported by Tay [11] who concluded that physico-chemical constituents of ground water were within limits for drinking. However, the TDS concentrations were found high and above the permissibility limits, while Cl- ion concentrations in some boreholes crossed the limits. The continuous intake of water having higher TDS, and Cl- ion can cause serious health effects. These results are further supported by Kempster and Kuhu [12] who reported that the maximum acceptable concentration of TDS especially in drinking water is above 2450 mg/l, which is considered critical value. The long-term use of this water can cause health problems due to excessive concentration of the dissolved particles. These results are further supported by Purohit and Saxena [13] who reported that the Mg also occurs in all kinds of ground waters along with concentrations of calcium (Ca). However, high concentration of calcium and magnesium in the drinking water can cause the kidney disease. According to Guru [14] high concentration of sulphate in water can cause diarrhea and laxative effects. However, Mohsin [15] conducted that the ground water quality has been deteriorated due to significant variation in physico-chemical parameters. Similarly, poor water quality has created different waterborne diseases such as diarrhoea, typhoid, jaundice, cholera and kidney stone etc.

CONCLUSIONS AND RECOMMENDATIONS

Groundwater quality in Tandojam city is deteriorating like other major cities of Pakistan. In the study area, the quality of groundwater samples was poor at some locations and was unsafe for human consumption.

The drinking water quality at SAU Colony and Amar Town was better than other locations. Similarly, according to interviews on health issues created by drinking poor quality water in the study area suggest that, in some places, residents were under the threat of many water related diseases such as cholera, abdominal pain, diarrhoea, typhoid and skin diseases etc. The many residences were not applying any water purification treatment technique hence; they were more prone to waterborne diseases due use of such unsafe drinking water.

The groundwater quality has deteriorated due to natural underground pollution activities and quality of drinking water has become inferior that has often resulted in high incidence of contaminants and ultimately contagious diseases. District government and other water supply entities must take responsibility to provide safe drinking water to all citizens. The waste disposal sites should be kept away from the residential areas. Based on the results of waterborne diseases, there is a need to rescue human life which is precious. Therefore, regular monitoring of drinking water quality should be practiced.

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