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 water borne diseases associated with drinking it. The contaminated water may cause waterborne diseases and may pose serious health problems. 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, etc.
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, HCO₃, Hardness, Na, NO₃, Cl, K, SO₄).

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 (HCO₃), chloride (Cl), sulfate (SO₄), hardness, sodium (Na), potassium (K) and nitrate (NO₃). The WHO standards set for these parameters are also shown in Table 2.

Table 1: Sampling Locations, Water Source and Sampling Code

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Samples Location</th>
<th>Sample Source</th>
<th>Samples Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SAU Colony</td>
<td>Electric pump</td>
<td>D₁</td>
</tr>
<tr>
<td>2</td>
<td>Mir Colony</td>
<td>Electric pump</td>
<td>D₂</td>
</tr>
<tr>
<td>3</td>
<td>Amar town</td>
<td>Electric pump</td>
<td>D₃</td>
</tr>
<tr>
<td>4</td>
<td>Muzaffarabad Colony</td>
<td>Electric pump</td>
<td>D₄</td>
</tr>
<tr>
<td>5</td>
<td>Jam Bungalows</td>
<td>Electric pump</td>
<td>D₅</td>
</tr>
<tr>
<td>6</td>
<td>Jam Ghar</td>
<td>Electric pump</td>
<td>D₆</td>
</tr>
<tr>
<td>7</td>
<td>Liaquat Town</td>
<td>Electric pump</td>
<td>D₇</td>
</tr>
</tbody>
</table>

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
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. D₂, D₄, D₅, D₆ and D₇ were unfit for drinking. The highest TDS value (1760 mg/l) was observed at D₄ location, while the lowest TDS value (756 mg/l) was observed at D₁ 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 D₂, D₃, D₄, D₅, and D₇ 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 D₄ location, while the lowest EC value (1.1 dS/m) was observed at D₁ location.

![Figure 1: Values of Total Dissolved Solids (TDS) in Study Areas.](image1)

![Figure 2: Values of Electrical Conductivity (EC) in Study Areas.](image2)
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. D1, D2, D3, D4, D5, D6 and D7 were within acceptable limits set by WHO, hence were fit for drinking. The highest pH was found at D3 location while, the lowest values observed at D2 location.

![Figure 3: Values of pH in Study Areas.](image)

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 D1, D2, D3, D4, D5, D6 and D7 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 D4 location while, the lowest value of potassium (4.0 mg/l) was observed at D3 location.

![Figure 4: Values of Potassium (K) in Study Areas.](image)

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. D2, D4, D6 and D7 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 D4 location while the lowest value of sodium (130 mg/l) was observed at D1 location.

![Figure 5: Values of Sodium (Na) in Study Areas.](image)

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 D1 location while, the lowest values of calcium (52 mg/l) were observed in D3 location.

![Figure 6: Values of Calcium (Ca) in Study Areas.](image)

Magnesium

The results on magnesium concentrations are shown in Figure 7. It shows that the values of magnesium in sampling locations i.e. D2, D4, D5, D6 and D7 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 D2 location while, the lowest values of magnesium (41 mg/l) was observed at D3 location.

![Figure 7: Values of Magnesium (Mg) in Study Areas.](image)
Assessment of Drinking Water Quality Status

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 D₄ 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 D₄ location while, the lowest value of hardness (200 mg/l) was observed at D₃ location.

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. D₂ and D₄ crossed the acceptable limits set by WHO and were unfit for drinking. The highest values of chloride (300 mg/l) were found at D₄ location while, the lowest value of chloride (145 mg/l) was observed at D₁ location.

Nitrate

The results on nitrate are shown in Figure 10. Figure shows that the values of nitrate in all sampling locations i.e. D₁, D₂, D₃, D₄, D₅, D₆ and D₇ 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 D₂ location while, the lowest value of nitrate (2.3 mg/l) was observed at D₆ location.

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, D₂, D₃, D₄, D₅, D₆ and D₇ 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 D₄ location while,
the lowest value of bicarbonate (240 mg/l) was observed at D₁ 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 D₇ location while, the lowest value of sulfate (90 mg/l) was observed at D₁ location.

![Figure 12: Values of Sulfate (SO₄) in Study Areas.](image)

**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.

The results of present study suggest that the colour, odour, pH, potassium (K), bicarbonates (HCO₃), calcium (Ca), sulfate (SO₄) and nitrate (NO₃) 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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REFERENCES


