DETERMINATION OF GROUND WATER QUALITY FOR AGRICULTURE AND DRINKING PURPOSE IN SINDH, PAKISTAN. (A CASE STUDY)

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ABSTRACT: *Present study has been done to evaluate the quality of ground water taken from different Talukas of district Tando Muhammad Khan for drinking and agriculture purpose. Water samples to check the quality were collected in one liter plastic bottles through standard sample collection method. Sample collection sites were kept at least 500 feet away from each other. Physical and chemical parameters of ground and surface water were observed as pH, Electrical Conductivity (EC), Turbidity, Colour, Taste, Odour, Alkalinity as $CaCO_3$, Bicarbonate (HCO_3), Carbonate (CO_3), Calcium (Ca), Magnesium (Mg), Hardness, Sodium (Na), Potassium (K), Chloride (Cl), Phosphate (PO_4), Total Dissolved Solids (TDS) and Arsenic (As). The results showed that pH and odour was within the permissible limits in the majority of samples whereas Arsenic (As), Hardness, Sodium (Na), Total Dissolved Solids (TDS), Taste, Chloride (Cl) and turbidity were beyond the permissible limit set by WHO. In the present study of groundwater status in Tando Muhammad Khan district, TDS in 50 %, Chloride in 54.16% , Sulphate in 44.8 %, Calcium in 38.5%, Sodium in 54.16%, hardness in 21.88% were beyond the WHO's permissible limits for human consumption.*

Key words: Ground water, physical composition, chemical composition

.INTRODUCTION

Groundwater is a vital source of clean drinking and irrigation water. This is increasingly the case due to the effects of population growth and climate change, which are causing severe stress to surface water supplies in these areas [1; 2]. Due to lack of proper operation and maintenance, the water supply systems are unable to run at their full capacity [3]. As fresh water will be a scarce in the future water quality monitoring program is necessary for the protection of fresh water resources [4]. Poor water quality is responsible for the death of an estimated 5 million children in the developing countries [5]. Groundwater is the major source of water for domestic, agricultural and industrial purposes in many countries. In Pakistan, most of the drinking water about 66% is supplied through metal pipes and hand pumps [6] of which quality is not maintained as long time passes rusts and various pathogens have been created that cause 30% of various diseases and 40% of deaths just due to poor water quality [6]. Among children and infants the most prevalent disease caused by polluted water is Diarrhea leading to the death, while every fifth citizen suffers from various diseases is due to the drinking of unhygienic water [7]. Unfortunately, little attention has been paid to drinking water quality issues and quantity remains the priority focus of water supply agencies. There is a lack of drinking water quality monitoring and surveillance programs in the country. Weak Government arrangements, lack of well-equipped laboratories, water purification systems and the absence of a legal framework for drinking-water quality issues have aggravated the situation. Above all, the public awareness of the issue of water quality is dismally low [8].

The quality of groundwater and surface water is detrimental and is further deteriorating because of the unchecked disposal of untreated municipal and industrial waste water and excessive use of fertilizers and insecticides. Water carrying pipes are at some distances ruptured and there by mixed with the waste water. Pakistan's per capita water availability has declined from 5,600 cubic meters at the time of independence to 1,200 cubic meters currently and expected to reach the threshold level of 1,000 cubic meters before 2010 or even in 2007 [9].

In Pakistan, water is a major source for sustaining wellbeing of its citizens. Water shortage and it's use for multiple uses has adversely affected the quality of water, consequently, water pollution has become a alarming problem in Pakistan. It has been reported that most of the health problems are directly or indirectly related to use of polluted water either in drinking or consuming agriculture produce. Pakistan is already one of the most water-stressed countries in the world, a situation which is going to degrade into outright water scarcity [10]. For improvement in the quality of water used for human consumption and agriculture use depend on reliable analytical measurements. Thus, analytical water quality parameters are utmost important and are playing a key role for water quality assessment. The analytical parameters for assessment of water quality included pH, EC, Turbidity, color, taste and odor. Among chemical parameters, the basic role in soil texture modification is played by Alkalinity, bithe carbonate, carbonate, calcium and magnesium. Mostly, the hardness of water is formed by the presence of sodium, potassium, chloride, sulphate, nitrate, methaemoglobinaemia, phosphorus and TDS, while among trace and ultra-trace elements; Lead, Arsenic, Iron, fluoride, chromium, manganese, molybdenum, nickel, Aluminum and selenium are determined [11]. In recent years, an increasing threat to poor ground water quality is due to human activities; building constructions, the use of chemicals in agriculture, taking baths, washing and throwing unhygienic materials in the rivers and canals has become of great importance (12; 13; 10; 14).

The objective of this study is to determine the groundwater quality is for drinking and agriculture use.

MATERIALS AND METHODS

The evaluation of water quality including Arsenic was carried out in each Union Council (UC) of District Tando Muhammad Khan, Sindh, Pakistan. Samples for determining the physico-chemical water quality parameters were collected in one liter plastic bottles through standard sample collection method. Sample collection sites were kept at least 500 feet away from each other. Before sample collection the bottles were washed and rinsed thoroughly with distilled water so as to remove any possible contamination. After purging, the bottles and their caps were washed with same water and then sample was collected in bottle for getting maximum accuracy in result.

The observations were mainly divided into following:

1. **Physical and Aesthetic Parameters**
   Electrical Conductivity (EC), pH, , Turbidity, Colour, Taste, Odour.
2. **Chemical Parameters**:

Alkalinity as $CaCO_3$, Carbonbate (CO_3), Bicarbonate (HCO_3), Calcium (Ca), Magnesium (Mg), Hardness, Sodium (Na), Potassium (K), Chloride (Cl), Phosphate (PO_4), Total Dissolved Solids (TDS), Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC).

Method used to investigate the water quality of samples

A detailed chemical analysis was carried out for each sample. In chemical analysis titration method was used for determining Anions (CO_3, HCO_3 and Cl), Cation (Ca and Mg), Alkalinity as $CaCO_3$ and Hardness. Water quality observations and methods employed for analysis are given in Table 1.

Table 1: Water Quality Parmeters and Methods used for Analysis

S. No.	Parameters	Test method
1	Colour (TCU)	15 units (WHO)
2	Odour	Odourless
3	Taste (bitter, salty, sour and sweet)	Unobjectionable
4	Alkalinity (m.mol/l as $CaCO_3$)	2320, Standard method (1992)
5	Arsenic (mg/l)	Merck Test Kit (0-0.5 mg/l) 1.17927.0001
6	Bicarbonates	2320,Standard method (1992)
7	Carbonates (mg/l)	Standard method
8	Calcium (mg/l)	3500-Ca-D, Standard method (1992)
9	Chlorides (mg/l)	Titration (Silver Nitrate), Standard Method (1992)
10	Electrical Conductivity (micro S/cm)	E.C meter, Hach-44600-00, USA
11	Hardness (mg/l)	EDTA Titration, Standard Method (1992)
12	Magnesium (mg/l)	2340-C, Standard Method (1992)
13	pH at 25oC	pH Meter, Hanna Instrument, Model 8519, Italy.
14	Phosphate (mg/l)	Method (Hach) 8190 & 8048
15	Potassium (mg/l)	Flame photometer PFP7, UK
16	Sodium (mg/l)	Flame photometer PEP7, UK
17	TDS (mg/l)	2540C, Standard method (1992)
18	Turbidity (NTU)	Turbidity Meter, Lamotte, Model 2008, USA

RESULTS

The groundwater quality in Pakistan and particularly in Sindh province is deteriorating fast due to varied causes. The study embodied in this paper aimed at determination of water quality for pH, Electrical Conductivity (EC), Turbidity, Colour, Taste, Odour, Alkalinity as $CaCO_3$, Bicarbonate (HCO_3), Carbonate (CO_3), Calcium (Ca), Magnesium (Mg), Hardness, Sodium (Na), Potassium (K), Chloride (Cl), Phosphate (PO_4), Total Dissolved Solids (TDS) and Arsenic (As).

In the present study of groundwater status in Tando Muhammad Khan district, TDS in 50 % groundwater samples, Chloride in 54.16 % samples, Sulphate in 44.8 % samples, Calcium in 38.5 % samples, Sodium in 54.16 % samples, hardness in 21.88 % samples were beyond the WHO's permissible limits for human consumption (Figure 1-3). Taluka-wise position of groundwater samples determined for various heavy metals and other chemical composition showed relatively different trend, where the Arsenic level in 23 samples was quite higher than the WHO's permissible limits. Moreover, taste, colour, TDS, chloride, sulphate, calcium, sodium, turbidity and hardness were also higher than the WHO's permissible limits for human consumption i.e. 31, 26, 26, 23, 27, 27, 23, 26 and 33% respectively (Figure 1).

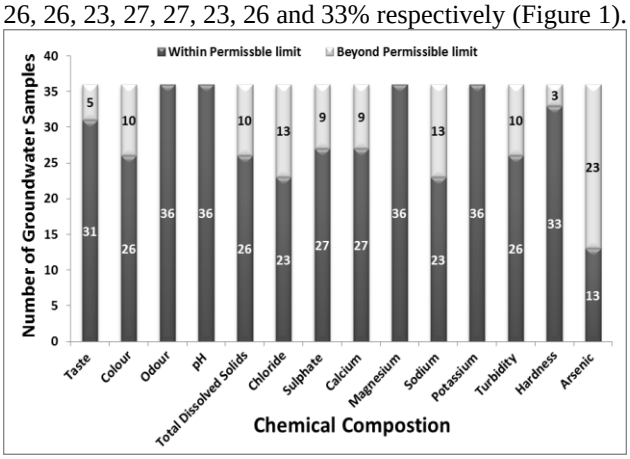

Figure 1. Chemical Composition of ground water in District Tando Muhammad Khan.

Similarly, in Taluka Bulri Shah Karim the groundwater quality was not suitable for human consumption and particularly, the limits for taste, colour, TDS, chloride, sulphate, calcium, sodium, turbidity, hardness and Arsenic were well beyond the permissible limits of WHO for drinking purpose (Figure-2). The arsenic level in 10% of samples was higher than the WHO's permissible limit of 10 ppb.

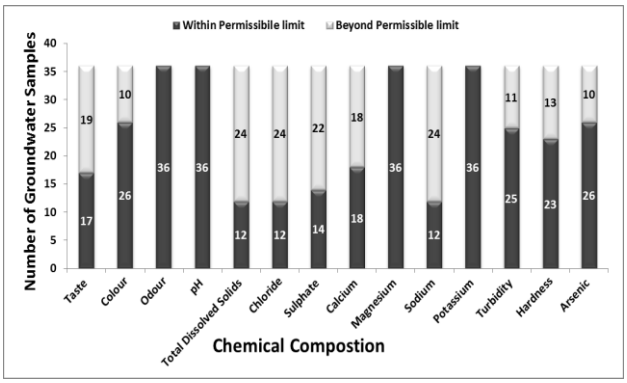

Figure 2. Chemical Composition of ground water in Taluka Bulri Shah Karim.

In Taluka Ghulam Hyder, the groundwater quality was relatively better than Tando Muhammad Khan and Bulri Shah Karim Talukas. However, limits for taste, TDS, chloride, sulphate, calcium, sodium and hardness and Arsenic were beyond the permissible limits of WHO for drinking purpose (Figure 3).

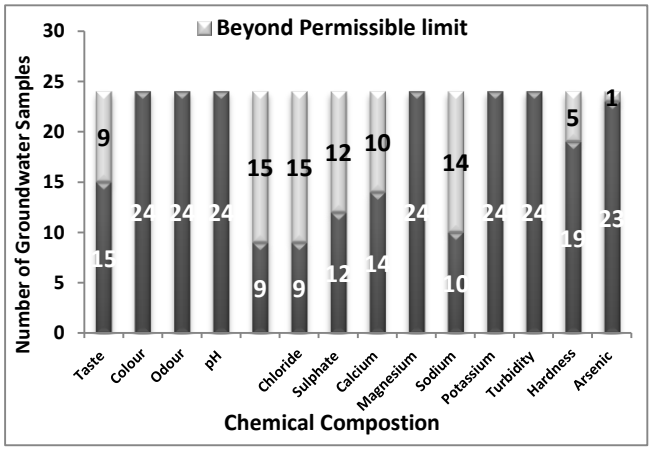

Figure 3. Chemical Composition of ground water in Taluka Ghulam Hyder.

DISCUSSION

The groundwater quality results of the present investigation are fully supported by [15], who from Peshawar (Pakistan) reported that pH and EC of drinking water were 7.8 and 0.62 dS/m, drinking water had low turbidity and crossed the limit of WHO in some areas, while Ca and Mg (16.2 and 48.4 mg/l) were within the WHO limits. Similarly, in the present study, the odor, pH, magnesium (Mg) and Potassium (K) in the groundwater samples was within unobjectionable limits for human consumption and for agricultural use. [16] found pH, EC, turbidity, TDS, alkalinity, total hardness, calcium, magnesium, sodium, potassium, chloride, nitrate, phosphate, sulfate and fluoride in excessive concentration and beyond the permissible limits of WHO [17].In another study, [18] from India analyzed groundwater quality and found total dissolved solids (86-1165 mg/l), iron (0.6-4.1 mg/l), nitrates (6.3-17.2 mg/l), sulfates (4.9-32.5 mg/l), chlorides (110-825 mg/l), calcium (60.0-185.3 mg/l), magnesium (33.2-140.0 mg/l), biochemical oxygen demand (6.2-22.0 mg/l) and chemical oxygen demand (18-38.5 mg/l) in all the selected water samples. The findings of the present study are in concurrence with those of [19] reported pH 7.2-7.8, salinity 224-674 mg/l, total dissolved solids (TDS) 1.0-1.96 mg/l, hardness 292-560 mg/l, chloride 124-373 mg/l, sodium 33-360 mg/l, potassium 30-165 mg/l, magnesium 31-97 mg/l and sulfate 20.5-40.3 mg and levels were highest in hand pump water.

In a recent study carried out by [20] in Lahore (Pakistan), it was found that about 10-20% samples of the study area crossed the maximum permissible limit for TDS, hardness, calcium, magnesium, sulphate and fluoride while 20-30% samples crosses the limit for nitrate. The groundwater of the study area has also been classified to study various hydro chemical processes. Similarly, from Egypt, [21] found that total dissolved solids (TDS) ranged from 390-8840 mg/l and the TDS, pH and water types with some minor differences between clusters.

CONCLUSION

It can be concluded that TDS about 50% in groundwater samples, Chloride 54.16%, Sulphate 44.8 %, Calcium 38.5 %, Sodium 54.16 % hardness 21.88 % and arsenic was about 35.42 % which were beyond the WHO [17] permissible limits for human consumption and agriculture use. Odor, pH, Magnesium (Mg) and Potassium (K) in the groundwater samples were within unobjectionable limits for human consumption and agriculture use water. The groundwater with TDS, Chloride, Sulphate, Calcium, Sodium and hardness were beyond WHO's permissible limits such type of water must not be used for drinking and irrigating crops. Without testing from recognized soil and water testing laboratory, the groundwater must not be used for drinking purpose.

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