Brief Report



# Assessment of Chemical Properties of Groundwater Quality of Larkana City

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# Assessment of Chemical Properties of Groundwater Quality of Larkana City

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**Abstract:** Groundwater is the most important source of drinking water in the Sindh Province of Pakistan. However, the quality of this crucial element of life is deteriorating day by day throughout Pakistan, particularly in its Sindh province. Thus the study was carried out to determine the chemical contamination in the groundwater of the Larkana city of Sindh province. A total of 40 samples were collected randomly from various locations in Larkana city. The chemical parameters like pH, Calcium, Magnesium, Total hardness (TH), Arsenic, Chloride, Sodium, Iron, Nitrites, and Nitrates were determined in the laboratory and were compared with WHO permissible limits. The results revealed that 26% of samples had chloride beyond the permissible limit, and 32% of samples had a concentration of Total Hardness (TH) above the desirable limits. Moreover, 6%, 23%, 29%, 92%, and 80%, of samples had a concentration of Nitrates, Nitrites, Sulfate, calcium, and magnesium respectively beyond the permissible limit. However, the concentration of pH, Iron, Sodium, and Arsenic in groundwater was found within the permissible limit.

**Keywords:** groundwater; chemical properties; drinking water; Larkana; Sindh

## 1. Introduction

Groundwater is the most common source of drinking water in the Sindh province of Pakistan. About 70-80% population in Sindh province relies on groundwater resources in order to meet their drinking and other domestic needs [1]. However, this important source of drinking water has been contaminated by various factors including natural and anthropogenic activities [2]. Water is contaminated by factors such as overpopulation, urbanization, climate change; percolation of solid waste leachate to groundwater, mixing of untreated domestic and industrial wastewater with natural streams, etc. [3].

Although groundwater contamination is a matter of grave concern for the whole of Pakistan, groundwater quality in Sindh province is declining due to the unavailability of waste water treatment units; failure of sewerage systems; frequent floods; and overuse of agricultural excessive use of fertilizers for crops, over abstraction of aquifers, and other anthropogenic activities. Studies have revealed that the mixing of sewage with streams and the percolation of sewage from standing ponds to groundwater is the main cause of poor water quality in the Sindh province of Pakistan [4]. It has also been found that the chemical characteristics of groundwater have drastically changed in the Sindh province of Pakistan in the last two decades. Water in Sindh is found to have higher concentrations of EC, TDS, TH, Cl, As, and other heavy metals. That's why the availability of safe drinking for residents of Sindh province is shrinking every year [6]. In this regard, this study was proposed to check the chemical characteristics of groundwater of Larkana city because in Larkana there is no other source of drinking than groundwater. Although many scholars already have done thorough research on the groundwater quality of Larkana, none have done detailed research on Larkana city. Previous research has been done on rural areas of Taluka Larkana, Ratodero, Dokri, and

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other parts, but an analysis of the water quality of the central part of Larkana including urban areas of district Larkana, was missing. Therefore, in this research fitness of drinking water in urban areas has been proposed to be studies.

## 2. Information about Larkana City

Larkana is located in the North-Western part of the Sindh province of Pakistan as shown in Figure 1. According to census 2023, the population of Larkana city is about 1,784,453. Moreover, Larkana is one of the largest districts of Sindh province and is located on the right bank of the Indus River. This city is also famous due to having historical archaeological site the "Meon Jo Daro" located in Larkana. People in Larkana completely count on groundwater and citizens are compelled to drink poor water in the most part of Larkana. The reason behind this compulsion is that there is no other economical source of drinking water in Larkana nor the government is providing water through any subsidized water supply schemes in any part of Larkana. Secondly, due to the unavailability of any source of treatment of water, people find groundwater more suitable for drinking than rain or river water. The depth of the Water table in Larkana City varies from 50 feet to 110 feet. The depth of the water table depends upon the intensity of aquifers being recharged, therefore, in the western, southern, and northern parts of Larkana, the average depth of the water table is 100 feet, while in the eastern part of Larkana, the average depth of water table is 50 feet due to being nearer to the river that keeps aquifer filled every time. Studies have found that western, southern, and northern parts of Taluka Larkana are completely contaminated and water is not suit for drinking [7]. Water at the eastern part of Larkana is suitable because it is nearer to the river and the river keeps aquifers recharged throughout the year and reduces the chances of wastewater percolating into the groundwater. However, the eastern part of Larkana needs an extensive analysis of Arsenic contamination, because Arsenic is usually found in the river water.

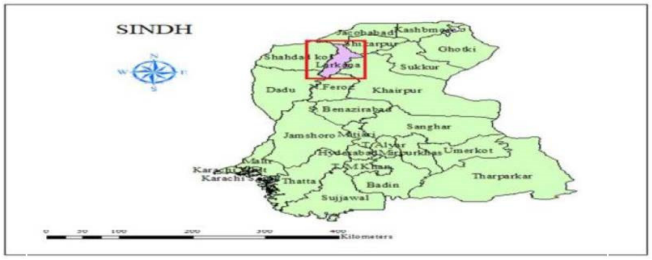


**Figure 1.** Location of Larkana in Sindh.

## 3. Methodology

In this study chemical parameters of drinking water such as pH, Calcium, Magnesium, Total hardness (TH), Chloride, Sodium, Iron, Nitrites, and Nitrates, were determined in each sample of groundwater to know the status of groundwater quality in Larkana city.

For analysis of groundwater samples total of forty (40) water samples were collected from different locations such as Ahsan Colony, Sachal Colony, QUEST student's hostel, etc. within Larkana city. Samples were collected in a half-litre water bottle purchased from the water treatment plant in Hyderabad and bottles were used that were never used before. Samples were taken from hand pumps, taps, and electric motors. It is important to note that the pump was allowed to discharge water for a minute and the hand pump for each sample was purged before collection of samples. This was done to remove water available in the suction pipe and to collect fresh groundwater samples. Bottles were washed with the same water, the sample of which was being collected. This was done in order to avoid any external source of contamination in water. Later on, Samples were gathered, labelled with a proper code, and sealed before taking to the laboratory. All 40 samples were tested for pH, Calcium, Magnesium, Total hardness (TH), Chloride, Sodium, Iron, Nitrites, Sulfate, and Nitrates, which were determined in the laboratory at the University of Larkano.

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For checking the pH value of water pH meter was used and for other parameters required methodology was used. The detailed process of testing is shown in Table1.

**Table 1.** Water testing methods.

| Parameters | Test method/Instrument |
|---|---|
| Calcium (mg/l) | 3500-Ca-D, Standard method (1992) |
| Chlorides (mg/l) | Titration, Standard Method (1992) |
| Hardness (mg/l) | EDTA Titration, Standard Method (1992) |
| Magnesium (mg/l) | 2340-C, Standard Method (1992) |
| pH at 25 °C | pH Meter, Hanna Instrument, Model 8519, Italy |
| Nitrate, Nitrite | NO2 Testing Kit |

Tests for each sample were done following all standard methods. The results of each parameter of each sample were noted and compared with the permissible values recommended by the WHO, NEQS, and water quality standard developed by SEPA.

## 4. Results and Discussion

Results of individual parameters such as pH, Calcium, Magnesium, Total hardness (TH), Chloride, Sodium, Iron, Nitrites, Sulfate, and Nitrates were determined and matched with the recommended values of the WHO, NEQS, and SEPA (Sindh Environmental Protection Agency). It should be noted that the recommended values of NEQS and SEPA are a reflection of the recommended values of the WHO. Therefore, the results of all samples were compared to the recommended values of the WHO and that was considered a benchmark for knowing the overall quality of groundwater in Larkana city. The results of each parameter are discussed below.

### *3.1. pH*

pH is the most important chemical parameter of drinking water. pH indicates an alkalinity and acidity in water. The higher the value of pH more acidic water. A higher pH value makes water bitter in taste and unsuitable for drinking. On the other lower the value of pH more will be alkalinity in water. The WHO has recommended that for water to be safe, water should be neither extremely acidic nor alkaline. That's why WHO has recommended that for safe drinking water value of pH in water should be between 6.5 and 8.5. When water samples in Larkana city were analyzed for pH, evaluation of pH concentration in drinking water disclosed that the pH value in samples was between 7.1 to 8.2. None of the samples collected from Larkana exhibited higher concentration pH. All samples were found to have pH concentrations within the allowable limit of the WHO, NEQS, and SEPA.

### *3.2. Calcium (Ca)*

Calcium is an important water quality. This water quality parameter indicates hardness in water. The higher the concentration of Calcium in water higher the hardness in water. Such as hardness in seawater is higher than in portable water that's why the concentration of Calcium in seawater is about 400 ppm while in portable water should be of lesser value. According to the WHO in portable water, the concentration of Calcium should not exceed 75 ppm. When the water samples collected from Larkana city were assessed, results represented that the concentration of Calcium in the water of Larkana city varies between 44 ppm and 167 ppm. It also disclosed that the value of calcium is higher in almost 36 groundwater samples. A higher concentration of calcium was found in samples collected from QUEST Boy's Hostel, Sachal Colony, and Ahsan Colony. It is important to note that people in these three areas have been borrowing water from nearby areas for a year because they have noticed a continuous change taste of water.

### *3.3. Magnesium (Mg)*

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Magnesium also contributes to hardness in water. However, calcium is responsible for temporary hardness and Magnesium is responsible for permanent hardness. The WHO has recommended that in order to have safe consumption of water, the concentration of Magnesium in drinking water should not exceed 50 ppm. Here, in this study when samples were tested for the concentration of Magnesium following standard methods, the results revealed that the value of magnesium in samples ranged between 30 ppm and 188 ppm. A higher value of magnesium was found in the water samples from Ahsan colony and the Police Training School (PTS) site of Larkana. Overall, the analysis revealed that thirty-two (32) samples fell in the poor category due to having a concentration of Magnesium beyond permissible limits suggested by the WHO.

### *3.4. Chloride (Cl)*

Chloride contributes to a change in the taste of water. Chloride value was found between 150-890 ppm. However, the WHO has suggested that in safe portable water, the value of Chloride should be below 250 ppm. Here in this case percolation of untreated domestic waste water can be the reason behind the higher value of chloride in groundwater samples. The highest value of Chloride was found in samples collected from Ahsan Colony, Sachal Colony, and Police Training School (PTS) of Larkana. Overall, ten (10) samples were found to be unfit for drinking due to Chloride.

### *3.5. Total Hardness (TH)*

Total Hardness (TH) in water is due to higher concentrations of Calcium, Magnesium, and chloride. Total Hardness in water causes nuisance, abdominal issues, and gastric pain. The WHO has fixed 500 ppm as a recommended value for Total Hardness for potable water. Although the most desirable value for hardness in water is between 75 ppm and 300 ppm, WHO recommended 500 ppm as the ultimate value because beyond this value water will be extremely unsuitable for drinking purposes. Here analysis of groundwater samples of Larkana city revealed that the value of Total hardness in groundwater samples ranged between 400 ppm and 2100 ppm. An extreme value of Total Hardness was found in a groundwater sample collected from Ahasan colony Larkana. Similar highest values were found in nearby Ahsan colony as well such as Sasti Basti and Sachal Colony. Overall, the results represented that thirteen samples (13) depicted a concentration of Total Hardness beyond the value recommended by the WHO.

### *3.6. Nitrate (NO3) and Nitrites (NO2)*

Nitrate and Nitrites are also important parameters for predicting the overall quality of groundwater. Nitrite and Nitrate both are contributed to water by waste oil and grease etc. Nitrite and Nitrate cause laziness, dizziness, cancer, and other health effects on human beings. The WHO has suggested that in portable water the concentration of Nitrate and Nitrite should not be above 10 ppm and 1 ppm respectively. Assessment of groundwater samples of Larkana City revealed that about three samples possessed a concentration of Nitrate beyond the WHO recommended value and nine samples had Nitrite beyond the WHO suggested value.

### *3.7. Sulphate (SO4)*

Sulphate in groundwater samples was assessed to know the safe concentration of sulphate in the drinking water of Larkana City. Results of the analysis of each sample for sulphate revealed that the concentration of sulphate in groundwater samples was between 80 ppm to 520 ppm. However, the WHO recommends that water is safe against sulphate concentration if the value of sulphate in water is below 250 ppm. Results of studies further exhibited that about eleven samples were extremely contaminated due to excessive concentration of sulphate. The sample that had a concentration of sulphate beyond permissible limits included samples collected from Ahasn Colony, PTS, QUEST boy's hostel, Sachal Colony, and others.

Overall analysis of groundwater samples based on chemical water quality parameters is shown in Figure 2

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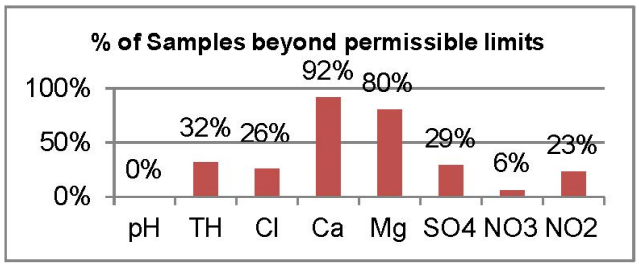


**Figure 2.** Overall analysis of groundwater samples.

## 5. Conclusion

Water is a crucial source of life. However, this precious element of life is contaminated by various factors such as over abstraction, urbanization etc. Therefore, research works are being to detect suitability of drinking water throughout the world. Sindh province of Pakistan is also grappling with the degrading quality of drinking water. Groundwater is the major source of drinking water in Sindh province, but this source is no more in its pure state. That's' why variety research are proposed for checking suitability of groundwater in Sindh province as well. This study was proposed to know true status of groundwater in Larkana city. Forty groundwater samples were randomly collected from random locations from taps, hand pumps, and motor pumps. Each sample was analysed for water quality parameter such as pH, Calcium, Magnesium, Total hardness (TH), Chloride, Sodium, Iron, Nitrites, Sulfate and Nitrates, were analysed. Overall, assessment water samples revealed that the concentration of pH was within the permissible limit. However, 26% of samples had chloride beyond the permissible limit, and 32% of samples had a concentration of Total Hardness (TH) above the desirable limits. Moreover, 6%, 23%, 29%, 92%, and 80%, of samples had a concentration of Nitrates, Nitrites, Sulfate, calcium, and magnesium respectively.

It is recommended that suitable treatment unit for water treatment should be introduced in larkana as soon as possible so that health of citizens should be protected on the priority basis.

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