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Research Article

# Spatio-Temporal Study on Groundwater Quality of Khairpur City, Sindh, Pakistan

**Noor Hussain Chandio[1*], Gohar Ali Mahar[2], Muhammad Jawed Iqbal[2], and Naveed Noor Chandio[1]**

[1]Shah Abdul Latif University, Khairpur, Sindh
[2]Federal Urdu University, Karachi, Sindh

**Abstract:** The Mir Wah canal divides the Khairpur city into Luqman main and city area. Groundwater quality of the Khairpur city fully depends upon this canal. In 2011, district government initiated a project of lining of Mirwah canal. It adversely affected the quality of groundwater due to reduction in seepage losses of water which otherwise recharged groundwater resources and maintained its quality with sweet water addition. Groundwater quality of the Khairpur district is unable to drink. Before 2011, the groundwater quality of the Khairpur city was good. Main objective of the project was to save losses and seepage of canal water. This study was conducted to evaluate the groundwater quality and to compare the results of 2007 with the current situation. Three parameters pH, Total Dissolved Solid (TDS) and Electric Conductivity (EC) were analyzed in the laboratory. Twelve samples of ground water were collected from different sampling locations. The results of the current study were compared with the results of previous study to perform temporal analysis.

**Keywords:** Groundwater, Water quality, Seepage, Canal Lining, pH, TDS, EC

## 1. INTRODUCTION

Water is a vital source of life. Pakistan is among those countries which are facing scarcity of drinking water. Saline water is used for drinking. It causes many of diseases and reduces average life span. Increasing population of the country needs more water consumption. Standard of drinking water level set by WHO are not observed in the third world countries [1]. About 2.5% of total water of the earth is fresh water. This is very interesting that only 31% of total is available for human consumption and remaining 69% of that fresh water is frozen in the earth's two ice sheets. Research reveals that entirely 31% of the water is not under consumption of human and merely 0.00775% (31% of 2.5%) is available for 7.5 billion population of the world, which is less than 1% of total available water on the Earth surface [2]. Only 1% fresh water is available for 7.5 billion population of the world. In 2007, a study was conducted and found that more than 137 million people of the world, comprising 70 countries are affected by arsenic poison mixed in groundwater. This problem is concerned with serious health issues in third world countries like Bangladesh and India. The developed world like USA is also facing groundwater quality issues [3]. The shortage of freshwater is the main issue of Asian countries especially countries of the Middle East. Saudi Arabia, Yemen, Israel, Philistine and South Asia are also under threats of availability of the fresh water. Increasing population and changing climatic conditions in Pakistan has created water issues in the country that could be converted into critical situation.

Under the present world condition of water crisis, it is realized that 3rd World War may be started due to water. Statistics of 2017-2018 was provided to the Supreme Court (SC) of Pakistan that 83% water supplies to Sindh is contaminated and is mixed with sewage disposal and industrial effluent [4]. It is also mentioned that more than 60 million population of Pakistan is using groundwater

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* Corresponding Author: Noor Hussain Chandio <hussain.chandio@salu.edu.pk>

with arsenic contamination of more then 10 µg/L (exceeding WHO standards). In 2009, a National Dirking Water Policy (NDWP) was introduced; the aim of the policy was to provide safe drinking water to 93% of the total population of the country by 2015. It was planned to establish the Water Treatment Plants (WTP) in rural areas till 2015 and made ensure that the drinking water quality at WHO standard will be attained [5].

Khairpur is a fast growing city of the Sindh province. The Geographical location of very unique. It is located on the east of the River Indus. Arore hill is on the east of the city, beyond the hill Nara Thar deserted is located (Fig. 1). Soil and water salinity is the main problem of the district. Salinity Control and Reclamation Project (SCARP) of WAPDA is undertaken to of salinity in the district. The Khairpur is located on the agricultural belt of Indus Plain. Rohri canal and Mir Wah canal are crossing the city. Ground water quality of the entire district is saline and unable to drink, but earlier groundwater quality of the city was at ISO standard level [6, 7]. In 2010, the provincial Government launched a project of lining of the Mirwah canal. The main purpose of the project was to save canal water from seepage to groundwater. This study has found out the groundwater quality issue of the Khairpur city because the canal lining project has interrupted groundwater seepage from canal. A joint research was conducted by Shah Abdul Latif University, Khairpur, Mehran Engineering University, Jamshoro and University of Sindh, Jamshoro in 2007. The purpose of the present study is not only to determine pH, TDS and EC but to compare the results with the study of 2007 to check the temporal changes and its causes.

## 2. MATERIALS AND METHODS

On May 2018, twelve groundwater samples were collected from different locations of the study area using Global Positioning System (GPS) (Fig. 2). The samples were collected in purified plastic bottles from already installed hand pumps, especially near the Mir Wah canal and its surroundings. Before getting samples, hand pumps were used to extract water for four minutes to maintain accuracy of the results and permanent ink was marked on bottles for identification of each sample [8, 9].

Samples were collected from the depth of 30 to 40 feet and analyzed for pH, TDS and EC values in the laboratory of Geography department, SALU. The pH value was estimated by using WTW microprocessor. Electric Conductivity was estimated and TDS was calculated. The laboratory results of groundwater were transferred in statistical


**Fig. 1.** Geographical location of study area and Khairpur in map of Pakistan

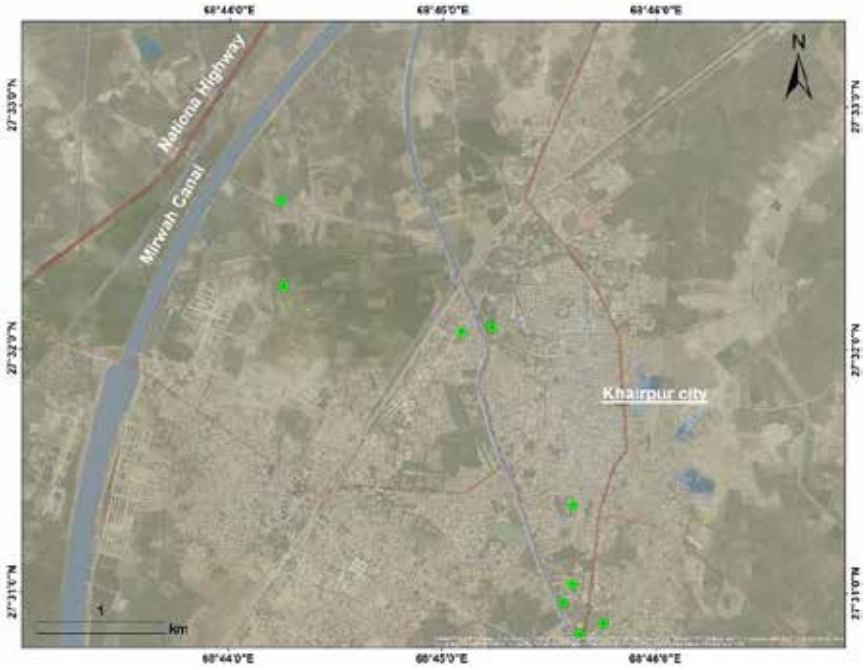


**Fig. 2.** Map showing the location of samples

form in the computer program Microsoft Excel 2013 [10].

## 3. RESULTS

The results of all three parameters (pH, EC and TDS) of groundwater data dated 2007 and 2018 has been investigated and compiled (Table 1).

In 2007, the pH level of all samples of groundwater of the study area was not more than 7.3 and minimum pH value was 6.7, which is suitable for human drinking purpose [5]. In 2018, difference in pH level from the results of the 2007 was detected (Fig. 3). The minimum calculated pH value was 7.1 and maximum 7.5. Difference, observed in last 10 years, is between (Figure 6). The normal range pH limit of safe drinking water is 6.5 to 7.5 [11].

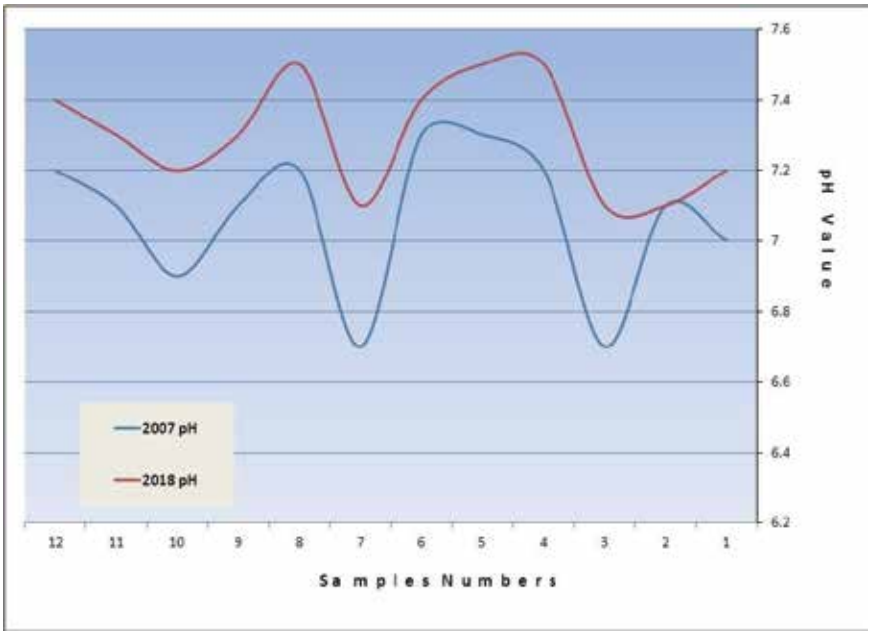


**Fig. 3.** Comparison of pH of 2007 and 2018

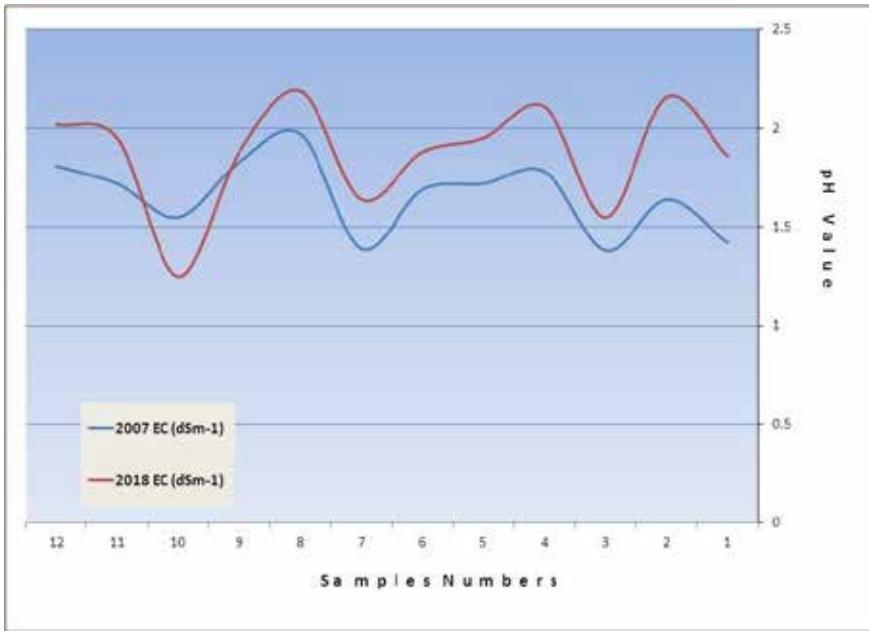


**Fig. 4.** Comparison of EC of 2007 and 2018

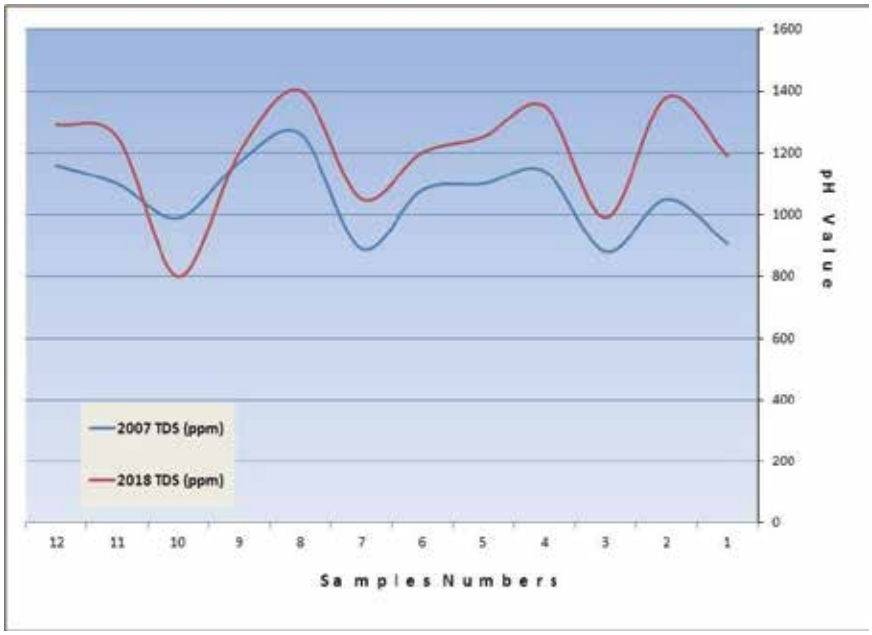


**Fig. 5.** Comparison of TDS of 2007 and 2018

The normal range of of groundwater for drinking purpose is between 0.625 and 0.935 dSm-1 [12]. In the minimum 1.38 and maximum 1.97 dSm-1 were calculated. The limit of the EC in 2007 was just above the WHO standard. On the contrary, in 2018 the minimum range of EC was 1.25 and maximum was 2.19 dSm-1 (fig. 4). It was observed in the results that groundwater quality could not be maintained with WHO standards [12].

The amount of TDS in groundwater regulates the value and quality of water. The quantity of different types of soluble salts reflects TDS [13]. Standard limit of TDS in drinking water is less than 300 mg/L is excellent, 300-600 mg/L is good and more than 1200 mg/L is not appropriate for drinking

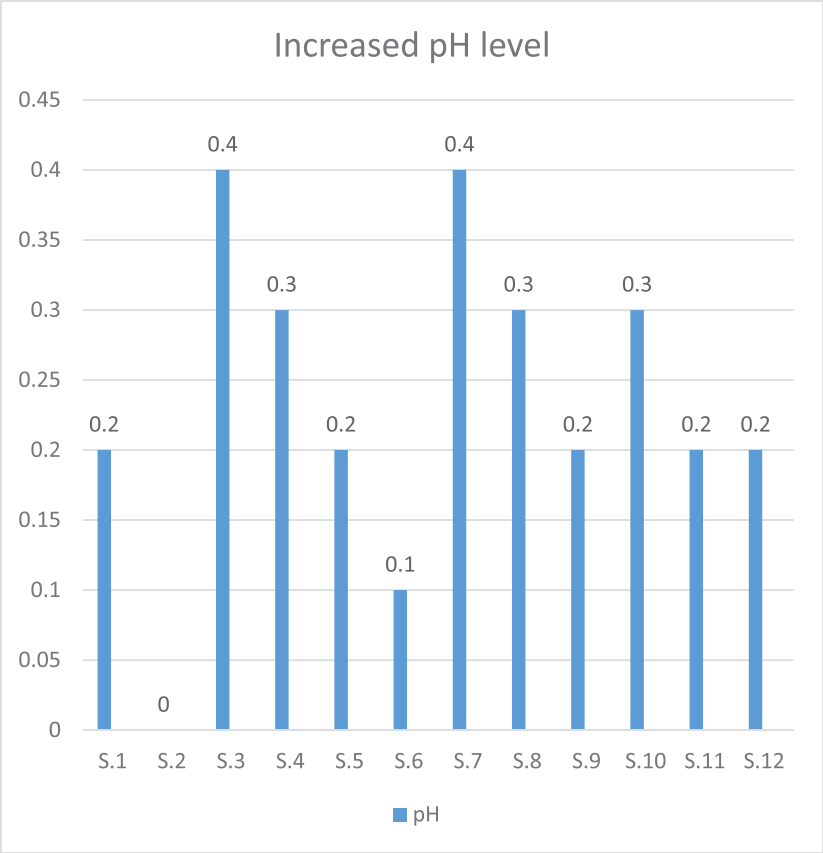


**Fig. 6.** Increased value of pH from 2007 to 2018

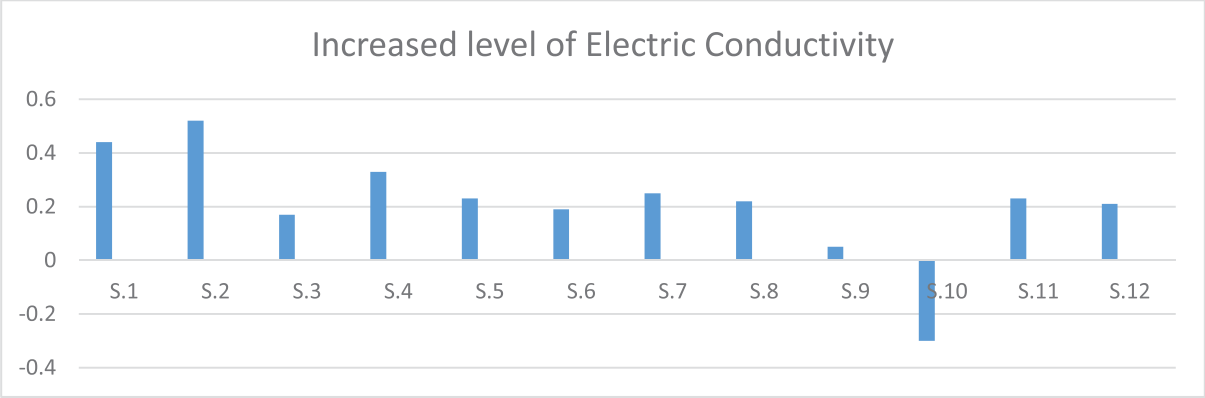


**Fig. 7.** Increased value of EC from 2007 to 2018

purpose. The difference of results was also found in 2018 (Fig. 5). It is realized from the overall results of groundwater that water quality is crossing the limits of WHO standards and water is not suitable for the people of Khairpur and could create health issues for the community.

## 4. DISCUSSION

Water logging and salinity has been a critical issue in Pakistan. Stagnant water prolongs and Soaked fields gradually turns millions of acres of farmland into saline [14, 15]. Network of canal commands on Indus River System has produced many issues in Pakistan like loss of cultivated land, water logging and salinity [16]. This issue has not only affected the sustainability of irrigated land but it has also affected the quality of life of the people living in the urban areas or towns.

Problem of salinity in Sindh is more acute. About 50% of the cultivated land in Sindh is

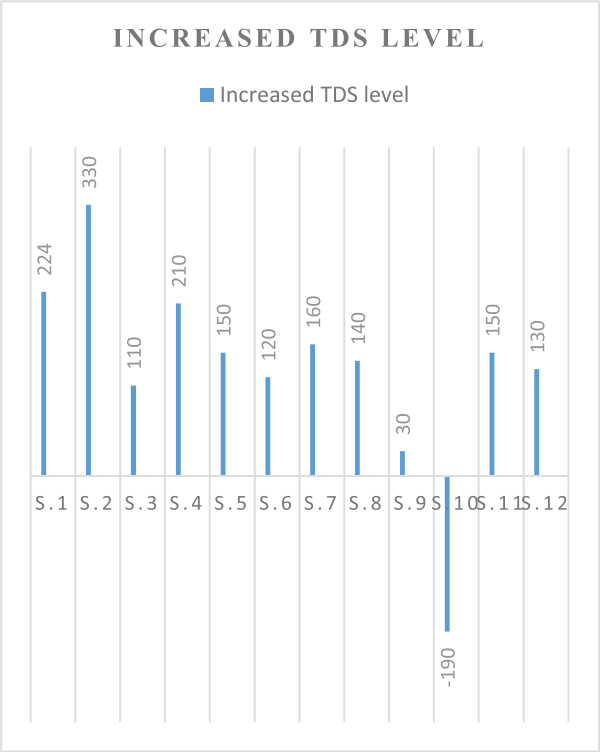


**Fig. 8.** Increased level of TDS from 2007 to 2018

affected by salinity [17]. Main reason of water issue in Sindh is insufficient water supplies and use of poor quality of groundwater for irrigation [18]. A research study conducted in 2015, evaluated that villages of Khairpur district located near Indus River are facing the issue of arsenic in groundwater [19]. Present study has identified a specific issue of salinity in groundwater because it is limited to the city area of Khairpur. Mirwah canal is passing from west of Khairpur, parallel to N5 National Highway, while Indus river is flowing beyond the canal that is located more western side of the city. Lining on the canal has stopped the groundwater recharge and flow. Khairpur city is encountering hazardous groundwater which ultimately causes health issues.

## 5. CONCLUSION AND SUGGESTIONS

The groundwater quality in Khairpur has been degraded since last ten years. The pH of the water is still within but near the upper limit of the WHO standards have been found not suitable for drinking purpose. This increasing limit of TDS and EC is very dangerous for human health. It has been analyzed from the results of varying temporal calculated data and condition of the Mir Wah that the quality of groundwater of Khairpur city depends upon the Mir Wah canal. In 2010, lining were constructed on the canal. The lining on the canal has reduced the seepage of freshwater and recharge process of groundwater. The availability of the freshwater through this channel has been reduced. Saline and brackish water of surrounding areas has been mixed with the groundwater of the city. It is suggested that lining of canals passing through city area should be avoided in order to encourage the recharge process of groundwater to maintain the water quality. Apart

**Table 1.** Potential of Hydrogen (PH), Total Dissolved Solids (TDS) and Electric Conductivity (EC) of 2007 and 2018

| | 2007 | | | 2018 | | |
|---|---|---|---|---|---|---|
| **Sample No** | **pH** | **TDS (ppm)** | **EC ($dSm^{-1}$)** | **pH** | **TDS (ppm)** | **EC ($dSm^{-1}$ )** |
| S.1 | 7.0 | 906 | 1.42 | 7.2 | 1190 | 1.86 |
| S.2 | 7.1 | 1050 | 1.64 | 7.1 | 1380 | 2.16 |
| S.3 | 6.7 | 880 | 1.38 | 7.1 | 990 | 1.55 |
| S.4 | 7.2 | 1140 | 1.78 | 7.5 | 1350 | 2.11 |
| S.5 | 7.3 | 1100 | 1.72 | 7.5 | 1250 | 1.95 |
| S.6 | 7.3 | 1080 | 1.69 | 7.4 | 1200 | 1.88 |
| S.7 | 6.7 | 890 | 1.39 | 7.1 | 1050 | 1.64 |
| S.8 | 7.2 | 1260 | 1.97 | 7.5 | 1400 | 2.19 |
| S.9 | 7.1 | 1170 | 1.83 | 7.3 | 1200 | 1.88 |
| S.10 | 6.9 | 990 | 1.55 | 7.2 | 800 | 1.25 |
| S.11 | 7.1 | 1100 | 1.72 | 7.3 | 1250 | 1.95 |
| S.12 | 7.2 | 1160 | 1.81 | 7.4 | 1290 | 2.02 |

Source: Data of 2007 adapted [9] and data of 2018 by Author, 2018.

from this, sewerage water of the city should not be directed into city canals without proper treatment, the local and provisional governments are suggested to devise a comprehensive mechanism to treat sewage water and protect the natural environment.

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