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AN ASSESSMENT, IMPACTING OF 2022 HEAVY RAINFALL ON GROUND WATER QUALITY IN TALUKA KHAIRPUR, PAKISTAN

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Abstract : *Groundwater is the primary source of Fresh water, plays a central role in sustaining life and livelihoods in Taluka Khairpur, where the quality of groundwater may significantly impacted due to increased surface runoff, infiltration of contaminants, and water table fluctuations. As groundwater is a source for drinking and irrigation in the region, potential changes in its quality pose risks to public health and agriculture. However, no detailed assessment has been conducted to evaluate the extent and nature of these impacts, creating a critical gap in local water resource management. of drinking water, agricultural irrigation, and household usage. However, with recent shifts in climatic conditions particularly the increased intensity and unpredictability of heavy rainfall events the safety and quality of this vital resource are under growing threat. This research aims to assess the impact of heavy rainfall on groundwater quality by conducting a comparative analysis of pre- and post-rainfall water samples collected from various boreholes and hand pumps across Taluka Khairpur, with a focus on identifying potential contaminants, evaluating the risks, and informing sustainable water resource management practices. Through a comprehensive analysis of groundwater samples and hydrochemical data, this research will provide critical insights into the effects of heavy rainfall on groundwater quality and contribute to the development of effective strategies for mitigating these impacts and ensuring the long-term sustainability of water resources in the region.*

Keywords Groundwater , Rainfall , Preciptation , Water Quality.

Introduction: Earth has a very limited supply of fresh water; only about 3 percent of the planet's water is believed to be fresh, with the other 97% believed to be brackish. (Goldscheider et al., 2020). Glaciers and permanent snow cover hold 68.7% of the world's fresh water supplies, groundwater for 30.1%, freshwater lakes for 0.26%, rivers for 0.006%, atmosphere for 0.004%, and biosphere for 0.003%(Shang et al. 2021 ; Wu et al., 2018)

Groundwater is a naturally replenishable resource that receives yearly replenishment from precipitation (H.Zaisheng et al., 2018)Groundwater is replenished via rainfall infiltration, which accounts for around 60% of the total recharge. Despite the fact that the world is covered in a lot of water, just 1% of it is fresh and readily usable by humans (WHO 2020) Groundwater quality is crucial to protecting and conserving groundwater quality. (Young et al. 2019). According to the characteristics of groundwater supplies fluctuate naturally and greatly depending on the climate, season, bedrock geology, and human activity Given that over 30% of the global population directly depends on these groundwater aquifers, its contribution is essential. The primary component of the global water cycle is precipitation. (Ricolfi et al., 2020 ; Vadiati et al., 2016). However, excessive precipitation can also impair water quality for human use and harm ecosystems and human health. (Xiao et al., 2019). The quality of groundwater is always changing because of daily, yearly, and climatic factors. Changes in water quality have big effects on both people and the environment, so it is very important to keep an eye on water quality data all the time(Daud

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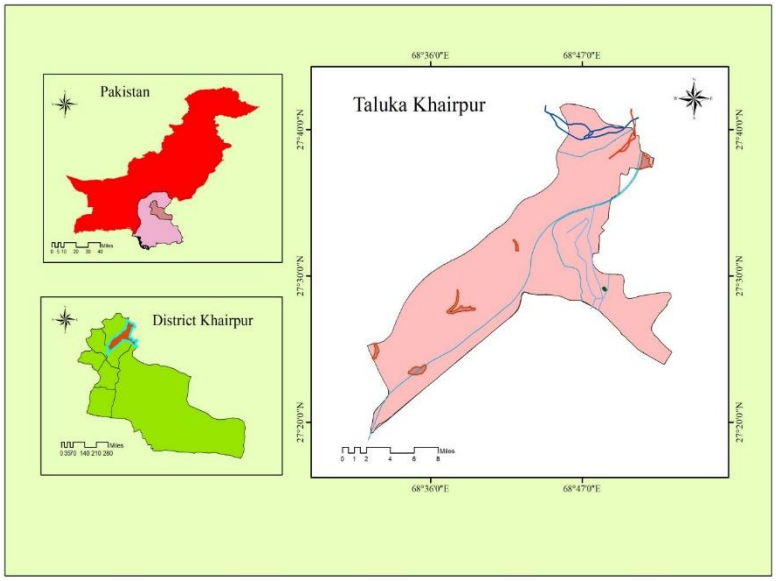
et al.2017) There are more biological and physicochemical factors (like temperature, turbidity, pH, etc.) that should be used to judge the quality of open water than hydrochemical factors. Rainfall is anticipated to have an expected impact on the quality of groundwater . Studies have indicated that variations in precipitation patterns and intensity can have a substantial impact on groundwater recharge, which in turn can cause variations in groundwater levels and quality (He et al., 2021 ; Fiorillo et al., 2015 ; Tatli et al.2015). Groundwater resources may be impacted by climate change, which is a serious issue that must be taken into account while managing groundwater. (Connor, 2015). Changes in precipitation patterns and rising temperatures can impact the quality and recharging of groundwater (Zhang et al., 2021) The variations in groundwater level are caused by the aquifer's recharge and discharge of groundwater. Increased water consumption, modified rainfall patterns, and a changing climate all contribute to an annual change in groundwater levels (Ramesh and Soorya, 2012). |In order to include high-resolution rainfall data and sophisticated subsurface techniques into modeling tools, more study is required. It is crucial to look into how different aquifer types react to intense rainfall and the consequences for strategies for managing water resources. (Hasan et al. 2018). Assessment of groundwater quality is essential for preserving freshwater supplies in arid and semi-arid regions, which is necessary for long-term growth. Depending on the condition of the groundwater, water quality control authorities can limit the amount of water. (Guo et al., 2021).



Study Area:

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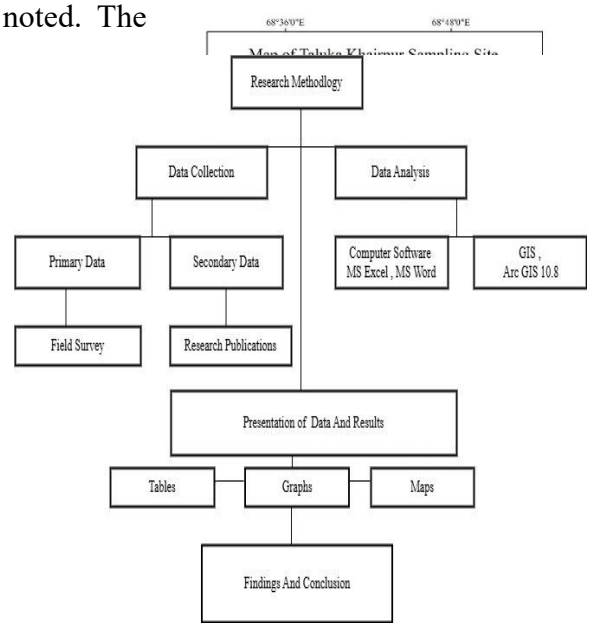
Khairpur District is divided by 8 Talukas, Khairpur is one of the eighth talukas and the biggest city in the district. Khairpur is one of the and economic Hub of the district. Located on the left bank of the Indus River, between 27° 3′ 12″ to 27° 33′ 34″ North latitude and 68° 42′ 36″ to 68° 47′ East longitude. Its precise geographical area is approximately 585 square kilometers. The Khairpur is located on the agricultural belt of Indus Plain. Rohri canal and Mir Wah canal divide the city into two parts. The dry climate of the area has temperatures between 41.51 and 44.3 degrees Celsius in the summer season and between 29.8 and 6.4 degrees Celsius in the winter season. The rainy season, which starts in July and goes through September, brings heavy rain to the area, Over the course of the year, the temperature typically varies from 41.5°c and 44.3°c in the summer and between 6.4°c and 29.8°c in the winter. which doesn't happen very often otherwise.The area has little precipitation, and the heaviest rain falls from July to September during the monsoon season. The climate is hot and arid, and the average annual rainfall vary between 125 to 255 mm.

Material and Method

Random sampling technique were used to collect the water sample from different areas , bottles of 50mm was firstly sanitized. The water sample were stored , to collect water sample handpumps were used through standard techniques Water samples were collected in bottles using hand pumps, from several locations and the time was noted. The chemical properties of Groundwater was observed (TDS , pH , EC , Temp.) with the help of Tds meter , Ec meter and pH meter and each sample was collected individually. To know about the position and status of the surface and groundwater. Global Positioning System (GPS). Ultimately, all of the collected data was shown using Arc GIS 10. The descriptive figures for the water quality parameters (minimum, maximum, and mean). pre-condition sample data collected from research article data used to determine comparative analysis.



Results

The assessment of the groundwater quality in Taluka Khairpur both before and after periods of heavy rainfall. The findings center on important indicators of water quality, such as electrical conductivity EC, pH, and total dissolved solids (TDS).

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Post-Rainfall Analysis of pH level :

A field investigation in Taluka Khairpur was used to analyze the post-rainfall groundwater quality, and the results showed that the infiltration of surface runoff and heavy rainfall had significantly altered the water composition. The pH values decreased, falling to 6.902.

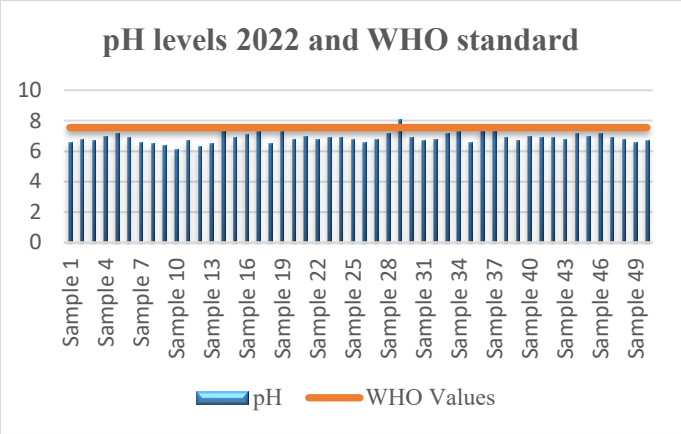


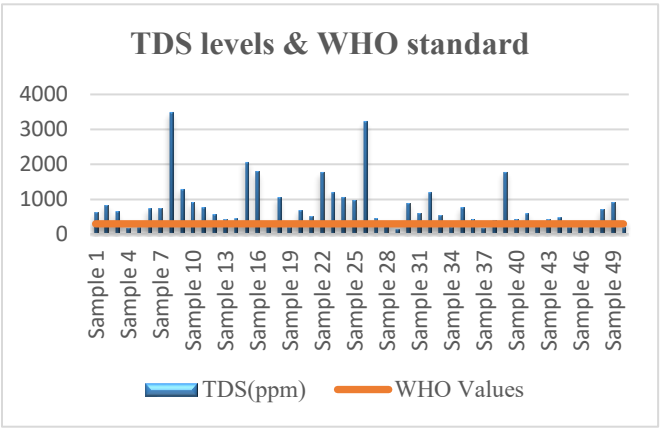
Figure 4.1.1 An analysis of pH level along with WHO standards field survey samples collection

pH: According to National Environmental Quality Standards (NEQS) and WHO guidelines, water should have a pH between 6.5 and 8.5. The pH values found in the study area's groundwater samples ranged from 6.9.

Post-Rainfall Analysis of TDS level :

Total dissolved solids (TDS) concentrations in the groundwater quality assessment after rainfall increased to 793.38, indicating the dissolving and minerals carried by rainfall.

Figure 4.1.2 An analysis of TDS level along with WHO standards field survey samples collection



TDS: The TDS establishes the purity of the water. In relation to charged ions that comprise minerals and salts dissolved in a particular volume of water, TDS levels are excellent (less than 300 mg L−1), good (between 300 and 600 mg L−1), reasonable (between 600 and 900 mg L−1), poor (between 900 and 1200 mg L−1), and unacceptable (−1200 mg L−1).Analysis of the groundwater samples in the study area revealed values ranging from 793.38 . According WHO guidelines, water should have a TDS between 300. The TDS values found in the study area's groundwater samples ranged from 793.38.

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Post-Rainfall Analysis of EC level

Electrical conductivity (EC) rose, ranging from 0.786868, according to an assessment carried out through a field survey in Taluka Khairpur, further showing the presence.

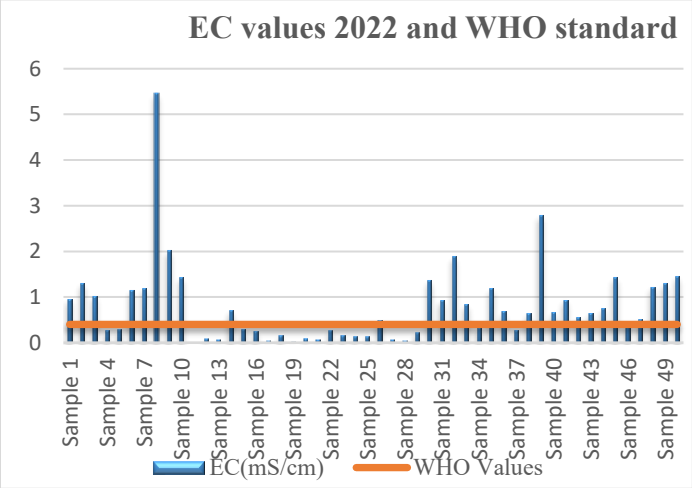
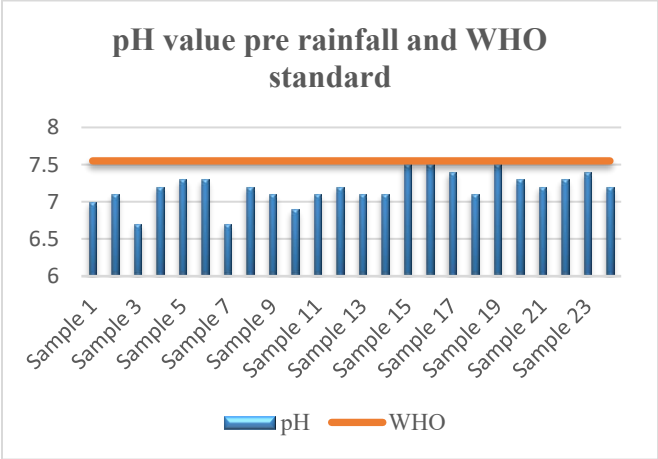


Figure 4.1.3 An analysis of EC level along with WHO standards field survey samples collectionThe EC can indicate whether dissolved ions, including salts or minerals, are present, which may have an impact on the water's flavor and quality. In general, water with an EC below 500 µS cm−1 is thought to have low dissolved salt content, whereas water with an EC exceeding 1000 µS cm−1 may have high dissolved salt content (Siddique et al., 2021). The EC and TDS have a direct relationship. Groundwater sample analysis in the study area showed values between 0.4 and 400 µS cm. According WHO guidelines, water should have a EC between 0.4. The TDS values found in the study area's groundwater samples ranged from 0.78668.

2 Pre-Rainfall Groundwater Quality

The pre-rainfall groundwater quality assessment, based on Groundwater samples taken from a published research study, provides a crucial reference for understanding the baseline water conditions in Taluka Khairpur before the onset of heavy rainfall. (Chandio el at. 2019)The result of samples include 2018 groundwater data



1 Pre rainfall analysis of pH level: The evaluation of groundwater quality prior to rainfall, According to the results, the pH values of the groundwater ranged from 7.183 and WHO guidelines, water should have a pH between 6.5 and 8.5.

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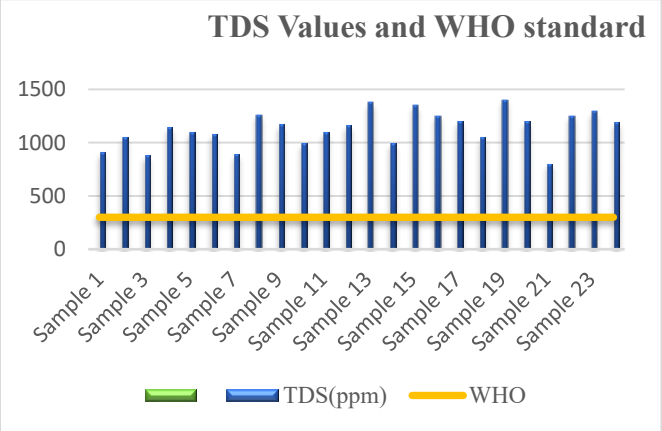
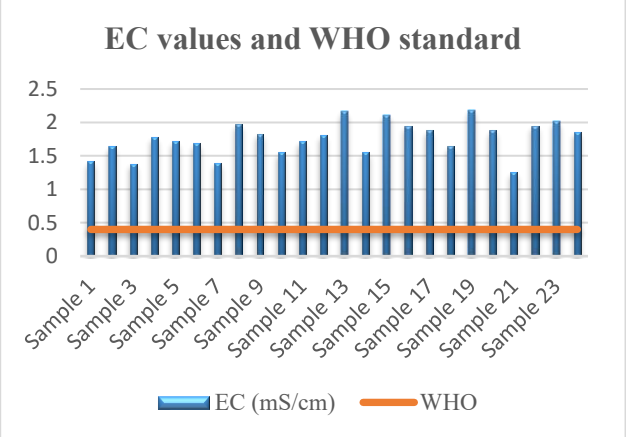
Pre rainfall analysis of TDS level:

The concentrations of total dissolved solids (TDS) varied from 1128.16 to 300 which is the WHO's recommended limit.





Pre rainfall analysis of EC level:

The results show that there was a moderate amount of dissolved minerals in the groundwater, as evidenced by electrical conductivity (EC) values ranging from 1.764.

Comparative analysis of Pre & post groundwater quality :

A comparison of Taluka Khairpur's groundwater quality before and after heavy rainfall reveals notable changes in important water parameters, including pH, turbidity, total dissolved solids (TDS), electrical conductivity (EC). These findings show how rainfall affects groundwater quality. The result of samples include pre & post analysis groundwater data have been examined and compiled.

Table 4.3. A Comparative analysis of ground water (Pre & post rainfall)

Parameter	Pre-Rainfall	Post-Rainfall	WHO Guideline
pH	7.183	6.902	6.5 - 8.5
TDS(ppm)	1128.16	793.38	300
EC(mS/cm)	1.764	0.78668	0.4

Source: WHO 2020

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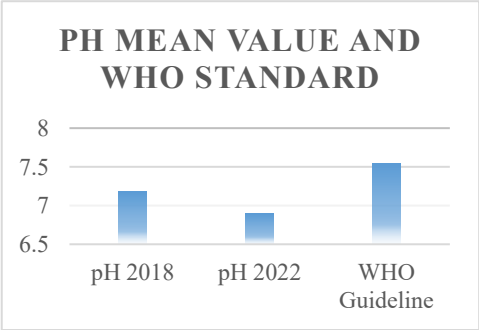
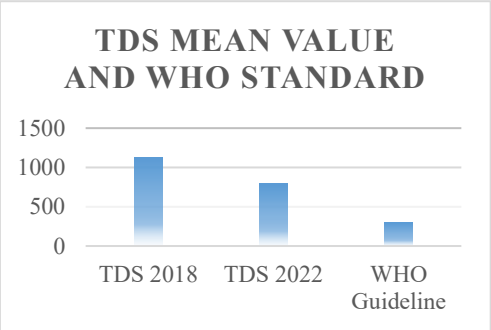
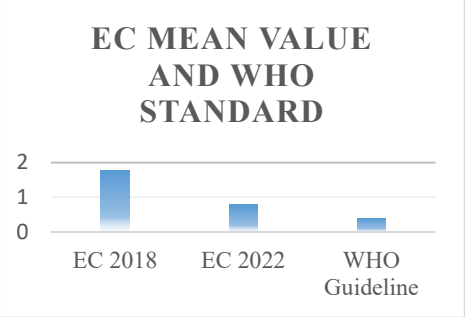
The pH was 7.183 before the rain, but it dropped to 6.902 after the heavy rainfall, indicating a higher level of acidity. Rainwater infiltration, which can convey acidic elements from surface runoff and dissolved organic matter, is probably the cause of this decline. Although the post-rainfall pH stays the WHO's permitted range. TDS levels were substantially beyond the WHO-permissible guideline of less than 300 before rainfall, ranging from 1128.16. TDS, on the other hand, decreased to 793.38 after the rain, suggesting that minerals were seeping into it. The EC values from 1.764 before the rainfall to 0.78668 after the rainfall. The decrease in dissolved ions shown by EC values after rainfall suggests that rainfall and dissolved salts seep into groundwater.

Conclusion

The comparative investigation of pre- and post-rainfall water quality measures indicated considerable changes, emphasizing possible concerns related with rainfall-induced infiltration and







runoff. This study evaluated three important physicochemical parameters pH, total dissolved solids (TDS), and electrical conductivity (EC) in order to compare the groundwater quality in Taluka Khairpur, Sindh, before and after the 2022 high rainfall events

- pH : (Power of Hydrogen)The study's conclusions show that after the intense rainfall in 2022, there were notable changes in the composition of groundwater, indicating that precipitation had a significant impact on aquifer despite this alteration, the pH readings stayed within the 7.5 range that the WHO recommends, indicating that the water is still fit for the majority of applications.

- Total dissolved solids (TDS) showed a notable decrease, going from an average of 1128.16 ppm before the rain to 793.38 ppm after it. This decline indicates that rainfall increased recharge and flushed out dissolved ions, which contributed to dilution. The persistence of salinity problems, however, is indicated by some areas where post-rainfall TDS values remained above the WHO's desirable limit of 300 ppm. This could be because of naturally saline aquifers in some areas of the region

- **EC (Electrical Conductivity)** After the rain, the average EC dropped significantly from 1.764 mS/cm before to 0.78668 mS/cm after. EC is directly related to TDS and represents the total ion content in water. This modification confirms the finding that rainfall diluted the salinity of groundwater, improving the water quality in several areas of the study region.

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Suggestions and Recommendation

- The results affirm that rainfall has a mixed but generally certain impact on groundwater quality in Taluka Khairpur, primarily through dilution and recharge. However, the potential for contaminants to be introduced via runoff must not be overlooked.
- There is an urgent need for integrated groundwater management strategies that consider both natural influences (rainfall, lithology, aquifer properties) authorities should focus on strengthening groundwater .
- Monitoring frameworks, especially before and after monsoon events. Policies that regulate land use, promote efficient irrigation, and protect aquifer recharge zones should be prioritized. to understand the long-term impacts of climate change and extreme weather events on groundwater systems.

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