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Study of Pre and Post Rainfall Impacts on Ground Water Quality in Taluka Mirpur Sakro, District Thatta

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Abstract: In rural areas of Pakistan, mostly ground water is used for domestic use. Previous study of underground water in Indus plain indicates that availability of noticeable levels of TDS, Magnesium, zinc, arsenic and other metals. Also the water table falls in pre-rainfall season due to low input of fresh water and increases relevantly during monsoon/rainfall season. This study has been carried out in area of Taluka Mirpur Sakro, District Thatta to analyze the pre and post storm water scenario on ground water condition. The samples were collected from different location and analysed for physico-chemical and heavy metals parameters such as pH, TDS, EC, Calcium, Magnesium, Phosphate, Nitrate, Fluoride, Arsenic, Alkalinity, Zinc, and Sodium. The obtained results indicated that the ground water quality in the area of Ghulamullah, Sukhpur, Sakro and Buhara was found significantly above WHO standards in post rain-storm season. And areas of Smoki, Karampur, and Khangan were found in suitable for drinking purpose in particularly after rainy season. The result of the study revealed that the ground water quality was not suitable in some of the areas of Taluka Mirpur Sakro. In order to make water portable it is advisable treat water using electrodialysis or reverse osmosis treatment.

Keywords: Domestic, rainfall, ground water, physico-chemical, heavy metals

1. INTRODUCTION

Water available on the variable depth of earth in pore spaces of soil and dividend joints of rocks is known as ground water. Ground water is considered as primary source to meet household and industrial needs in the study area. In rural areas of Pakistan, ground water is mostly used to meet domestic needs such as cooking, sanitation and drinking. Groundwater is recharged from different means and eventually uplifted to the surface using mechanical or dug wells (Dohare *et al.* 2014). Anthropogenic activities related to industrial and agriculture and seawater intrusion are major sources of ground water contamination (Sundar and Jyoti). The contaminated water may cause different diseases in study area like diarrhoea and cancer. Several studies have been conducted to mitigate and overcome problems causing waterborne diseases (Rao, 2012). Contamination of ground water is a major problem in Pakistan and it caused by disposal of untreated effluent disposal from industries, municipality, and agriculture into canals are major reason to this (Azizullah, 2011). In Pakistan most of the people do not have access to fresh water for drinking; due to this people suffer from teeth and bone diseases. The advanced study conducted in samples collected from well in Indus plains indicated noticeable concentration of fluoride, arsenic and other metals in groundwater. Due to easy access, use of ground water is increasing thereby increase in human population and expanding demands of agriculture, domestic and industrial purposes. It is estimated that yearly ground water extraction increased from 10 BCM (billion cubic meters) in 1965 to 68 BCM in 2002. Improper groundwater extraction has caused bringing down of the water table in specific regions. Groundwater development is a major factor in improving shortage of water in rural areas of Pakistan, especially to secure the agriculture. In Pakistan, if the cost of one tube well is taken as 50,000 PKR, the total increase in investment in groundwater will be 30 billion PKR. The usage of groundwater contributes approximately US$ 1.3 Billion to the national economy per year. It was noticed that groundwater utilization yields of harvests have expanded from 150 to 200 percent. The quantity of existing private tube wells is more than 600,000 in Pakistan and increasing at the rate of 20,000 tube wells per year (Shahid, 2011). The lower Indus plain, which is known as Sindh, is hot, desert and arid. The most extreme temperature runs here from 95ºF in the south to 121ºF in the north. The average yearly precipitation, which all comes in summer, is less than 10 inches and diminishes from annually eight creeps in the south to 3 creeps in the north (Panwhar and Mehrunissa, 2009). The water table in the Indus basin was falling down before rainfall season due to low flow of fresh water and water table reduced during rainfall season (April/June) due to recharge of ground water (Qureshi *et al.* 2008). It estimated that 75% area of Sindh and 17% of Punjab provinces underlain by saline groundwater. Most of the coastal areas of Sindh, such as Sijawal, Thatta, and Tharparkar are mainly contaminated by salinity due to excessive withdrawal and reduced freshwater flow in the lower basin of Indus delta which caused ea water intrusion (Sarala and Babu 2012). In order to pre and post rain-storm groundwater

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condition, Taluka Mirpur Sakro, District Thatta was selected as a study area. Mirpur Sakro is a large Taluka in a district Thatta, which is situated 70 km east of Karachi and 70 km away from Thatta district and encircled on the way south to the Arabian Sea and the northwest way by Hyderabad district **(Fig.1).** Majority of the locals are farmers and 20% of the local population are fisherman.

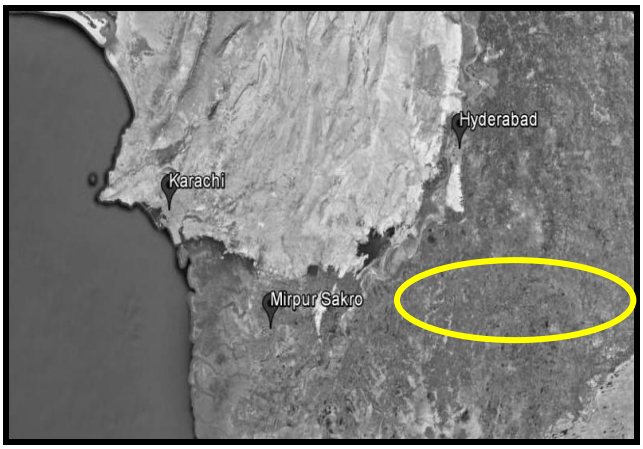

Fig. 1. Site Location Map

The southwestern part of Thatta is saline, and sea water has intruded due to shortage of discharge of river Indus water into sea. According to Official census report of 1998, the demographic population of district Thatta was 1.113. This has increased exponentially in last decade about 46.27%. The minimum and maximum temperature in District Thatta is about 25°C and 40°C respectively **(Fig. 2a).** During the month of March to October, the sea gust blows for eight months of the year, making the hot climate fairly fresh. However, January is the coldest month as shown in **(Fig. 2b).** Overall district yearly regular rainfall is about 200 mm.

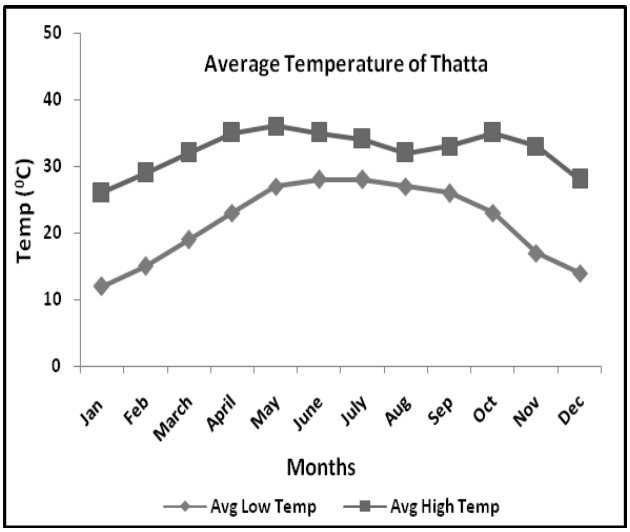

Fig. 2a Annual Average Temperature

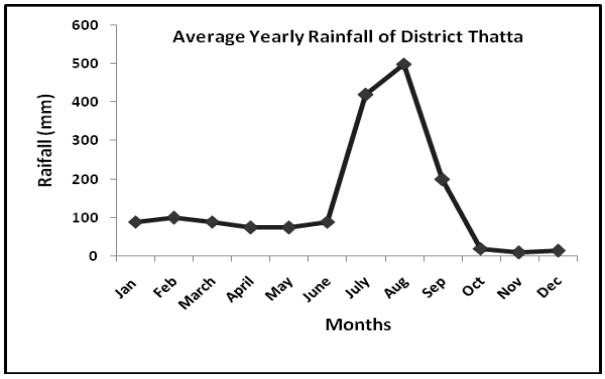

Fig. 2b Annual average Rainfall

It has been observed that, ground water quality in most of the study area is significantly affected by salinity and other pollutants due to deltaic and flood plains of Sindh and reduced flow of Indus River. The aim of this study is to find out the causes of ground water quality deterioration and to recommend remedial measures to improve ground water quality. Waterborne diseases such as diarrhea, dysentery, Hepatitis C and Cholera were also noticed and according to a local Doctor, at least 200 patients with hepatitis C and 100 cases of diarrhea and cholera are being observed.

2. MATERIAL AND METHODS

2.1 Samples Collection

Total 48 (forty-eight) ground water samples of pre and post rain-storm condition were collected in 2016 from villages of Khangan, Mirpur sakro, Haji Gharano, Karampur, Ghulmullah, Smoki and Sukhpur respectively. The samples were collected in sterlized bottle and were stored at 4°C before analysed in the laboratory for physico-chemical analysis.

2.2 Experimental Work

Fluoride, Zinc, Sodium, Alkalinity following APHA (2002), the Fluoride was analsyed using Red zirconium dye method on UV- Visible spectrophotometer. Zinc and Sodium was analyzed using Atomic Absorption spectrophotometer. Alkalinity was analysed using titration method. pH and Total Dissolved Solids (TDS) were analysed using Electrode method. Levels of Calcium, Magnesium, Nitrate and Phosphate present in water sample were analyzed following USEPA. Calcium and Magnesium were analysed using titration method however; Nitrate and Phosphate were analyzed following colorimetric method.

3. RESULTS AND DISCUSSION

(Fig. 3) demonstrates the pH variation in samples of ground water collected from various villages during pre and post rain-storm season. It is depicted from the results that pH of samples collected from Taluka Mirpur sakro, District, Thatta fulfils the drinking water guide of WHO guidelines. The pH ranges from 7.5 to 8.1 in pre rain-storm season and 7.2 to 8 in post rain-storm season.

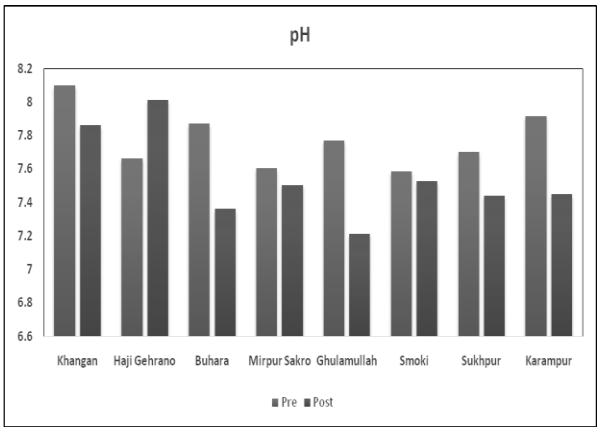

Fig. 3 Pre & Post Rainstorm pH levels in different villages of Taluka Mirpur Sakro

The TDS levels in samples collected from Haji Gehrano, Mirpur Sakro, Sukhpur exhibited higher levels during in pre rain-storm season in comparison to WHO standards **(Fig.4).** The increased levels of TDS are found due to agricultural activities. However, increased levels of TDS in post Rain-storm season are reported due to influence of anthropogenic sources such as domestic sewage, solid waste dumping, agricultural activities and influence of rock-water interaction (Sarala, and Babu, 2012). Overall pre and post rain-storm ground water condition in study area was not found in WHO standards.

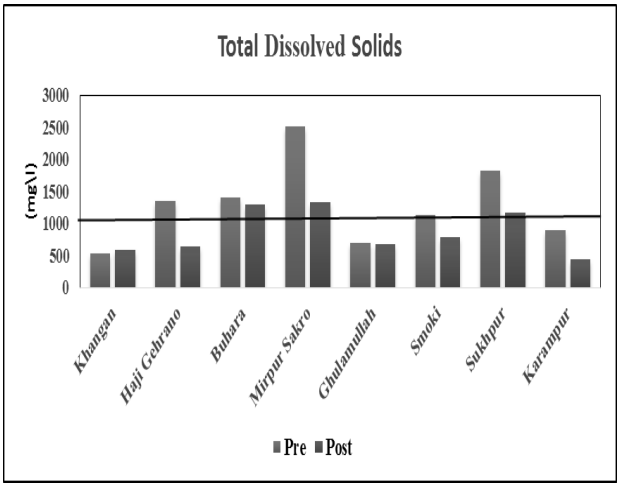

Fig. 4 Pre and post rainstorm TDS levels in different villages of Taluka Mirpur Sakro

The value of Magnesium in pre and post rain-storm condition of ground water in areas of Ghulamullah and Sukhpur were found more than WHO drinking water quality standard **(Fig.5).** The increased levels are caused due to the dissolution of magnesium calcite and dolomite from rock source and sea water interaction (Vasanthavigar ,*et al.* 2010).

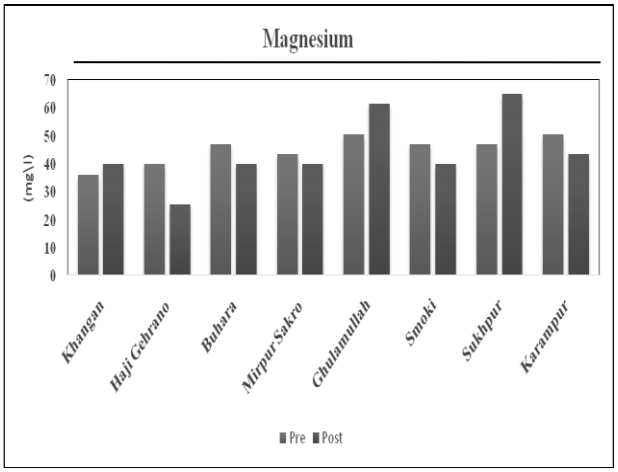

Fig. 5 Pre and post rainstorm Magnesium in different villages of Taluka Mirpur Sakro

The concentration of Calcium in the study area was found in range 100 to 140 mg/l in pre rain-storm season and 70 to 180 mg/l in post rain-storm season. The pre and post rain-storm condition of ground water Calcium value in all of the samples were satisfactory with WHO standards **(Fig.6).**

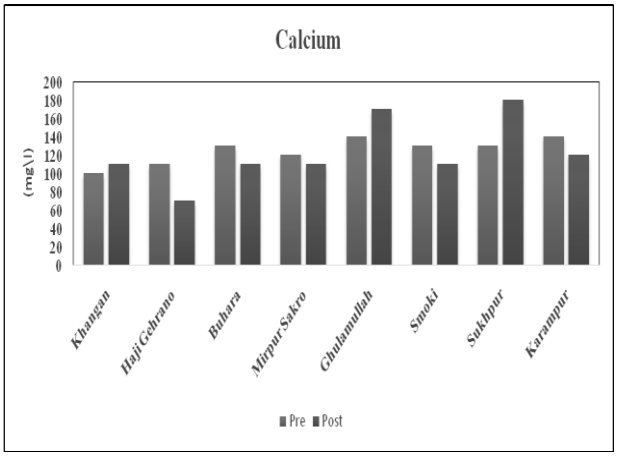

Fig. 6 Pre and post Rain-storm Calcium levels in different villages of Taluka Mirpur Sakro

Nitrate and phosphate are present in fertiliser as chief minerals. As study areas comprised of agricultural land. Due to unplanned agricultural runoff and disposal of municipal wastewater cause increase in phosphate levels (Kumar *et al.* 2006; Kupwade, and Langade, 2006). Concentration of phosphate in the study area was found in range of 3.3 to 7.8 mg/l in pre rain-storm season and 7.7 to 14.6 mg/l in post rain-storm season **(Fig.7).** Compare to pre rain-storm condition of ground water, the post rain storm cause increase in levels of phosphate levels in the study area of Taluka Mirpur Sakro.

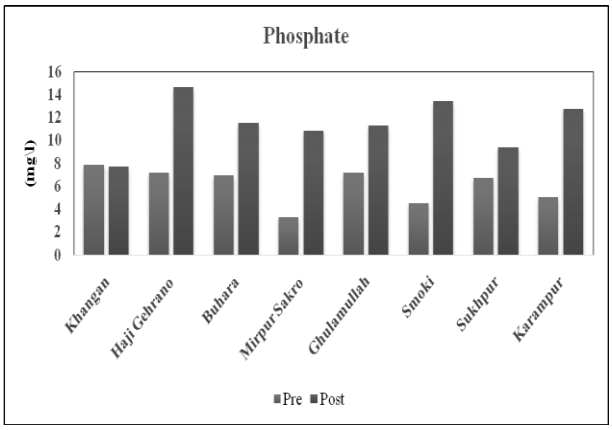

Fig. 7. Pre and post Rain-storm Phosphate levels in different villages of Taluka Mirpur Sakro

Likewise Phosphate levels, the concentration of Nitrate were also observed higher compare to WHO standard. The Nitrate levels in the study area were found in range of 1.9 to 10.0 mg/l in pre rain-storm season and 9.0 to 29.9 mg/l in post Rain-storm season (Fig. 8). The reasons of increase in Nitrate levels are retrospective from increase levels of Phopshate in ground water samples (Jinwal, and Dixit, 2008). The increase levels of nitrate and phosphate contents in a post rain-storm season were due to the significant use of fertilizer (Ramakrishnaiah *et al.* 2009) and higher inflow of water in to the ground aquifer (Khalid *et al.* 2014).

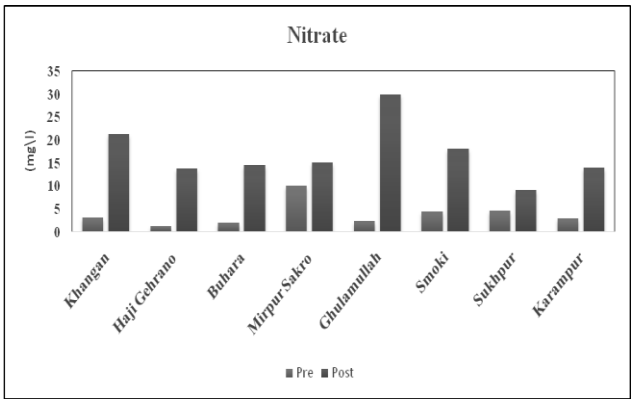

Fig. 8 Pre and post Rain-storm Nitrate levels in different villages of Taluka Mirpur Sakro

The concentration of Fluoride in study area was found in range of 0.1 to 0.5 mg/l in pre rain-storm season and 0.4 to 0.7 mg/l in post rain-storm season. An excess amount of Fluoride present in drinking water may cause mottling of teeth and weakness of bones called dental as fluorosis and Itai Itai. The high Fluoride content was observed in post Rain-storm season compare to the pre Rain-storm season, due to percolation of leachate produced from un-planned solid waste dumping, long-term irrigation process, and semiarid climate (Vasanthavigar *et al.* 2010). The overall pre and post rain-storm condition of ground water was good and found in the range of WHO standard values **(Fig. 9).**

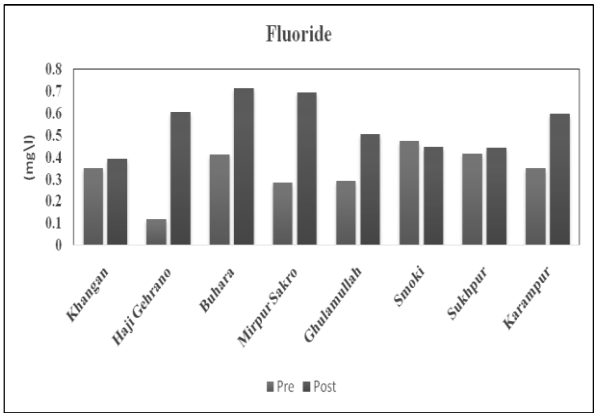

Fig. 9. Pre and post rainstorm Fluoride levels in different villages of Taluka Mirpur Sakro

The Alkalinity levels were observed in range of 75 to 180 mg/l and 70 to 200 mg/l in pre and post rain-storm season respectively (Fig. 10). Alkaline water may reduce the solubility of metals. Increased levels of Alkalinity during post rain-storm season are due to presence of bicarbonate and carbonate. The overall pre and post rain-storm condition of ground water was good and found well in range of WHO standard.

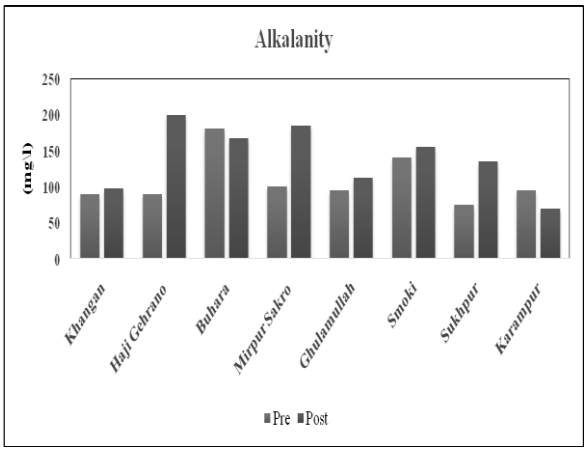

Fig. 10 Pre and post Rainstorm Alkalinity levels in different villages of Taluka Mirpur Sakro

The concentration of Zinc was observed in range of 0.03 to 0.05 mg/l before rainfall and 0.12 to 0.52 mg/l after rainy season **(Fig. 11).** Zinc is important for human health, but an excess amount of zinc present in drinking water may cause adverse health impact on human. The main source of zinc in water could be use of fertilizer and pesticides in the agriculture land (Khalid *et al.* 2014).

Zinc primarily forms complexes with organics (Kokkat *et. al*. 2016). The organic compounds formed a higher affinity for the soil matrix. The overall concentration of zinc in pre and post rain-storm season was found in the range of WHO standard values.

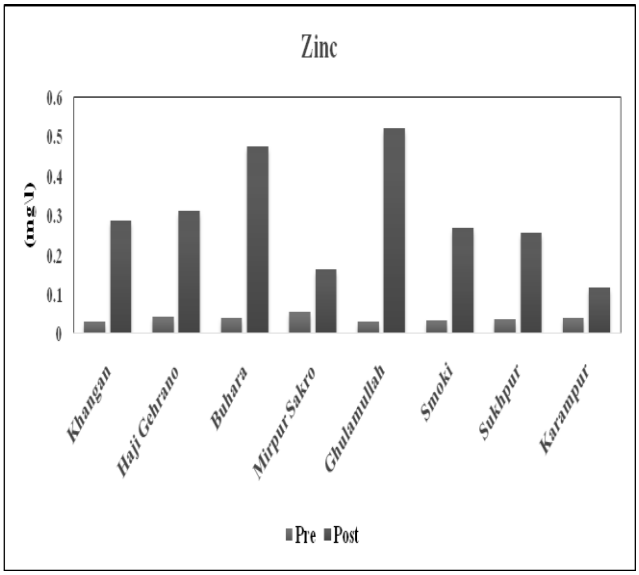

Fig: 11 Pre and post Rainstorm Zinc levels in different villages of Taluka Mirpur Sakro

Sodium was observed in range of 42 to 50 mg/l before rainfall and 43 to 45.65 mg/l after rainfall season (Fig. 12). The higher concentration of sodium present in ground water may cause arteriosclerosis and blood pressure. The increase level of sodium levels produces saline taste to ground water (Umaran and Ramu, 2015). The high sodium percentage can reduce the soil permeability and soil structure (Rao 2012). The higher concentration of sodium present in ground water before and after rainfall season indicated intrusion of seawater in to ground water. Seawater contains high levels of sodium which results in causing Pseudo hardness. The overall concentration of zinc in pre and post rain-storm season was found in the range of WHO standard values.

3. CONCLUSION

The study was conducted to analyze the pre and post rain-storm conditions of ground water quality in Taluka Mirpur Sakro district Thatta. Analysed results of ground water samples revealed that the ground water quality was not suitable for drinking in some areas of Taluka Mirpur Sakro It was observed that ground water samples areas of Buhara, Ghulamullah, and Sukhpur during pre and post rain-storm, the levels of TDS and Magnesium were found unsatisfactory against WHO drinking water quality guidelines. In order to make groundwater portable it is suggested to use electro dialysis or reverse osmosis method which can make water viable and portable for locals of Taluka Mirpur Sakro.

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