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RESEARCH ARTICLE

ASSESSMENT OF GROUNDWATER QUALITY IN TEHSIL GOJRA BY USING GEOGRAPHICAL INFORMATION SYSTEM

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ABSTRACT

Groundwater is imperative for the continuance of life and sustainability of ecosystem. Contamination of the water is the well-recognized danger to the public health in Pakistan. Hence, this study was conducted to assess and map the spatial variation of groundwater quality in the surroundings of Dijkot Branch Drain by using the Geographical Information System(GIS). For this purpose, sixty samples of groundwater, ten samples of wastewater and five samples of sludge were collected along with their coordinates from the study area. The collected samples were analyzed for chemical parameters and heavy metals, such as pH, EC, TDS, Carbonates, Bicarbonates, Arsenic, Lead, Chromium, Cadmium, Zinc. The results obtained from the study were compared with WHO guidelines. Then, the values of these water quality parameters were mapped by using GIS software. Arc GIS V 10.2 was used for raster interpolation. To exhibit the spatial variation of groundwater quality scenario of the study area, Kriging method was adopted. on. It was generally observed that none of the parameters in the wastewater samples was found to be within the permissible limit. The research study resulted that the groundwater of the study area is deteriorated by Dijkot Branch Drain and is not fit for drinking purpose.

KEYWORDS

Groundwater Quality, Spatial Variation, GIS, Interpolation.

1. INTRODUCTION

The assessment of groundwater quality status is important for socio-economic development of any region of the world. The determination of groundwater quality for human consumption is important for the wellbeing of the ever increasing population. Good quality water will ensure the sustainability of socio-economic development, as the government priority is shifted to other sectors of the economy, rather than channeling the resources towards combating outbreaks of water borne diseases due to consumption of contaminated groundwater. Groundwater quality depends, to some extent, on its chemical composition which may be modified by natural and anthropogenic sources (Wadie and Abduljalil, 2010). Rapid urbanization has affected the availability and quality of groundwater due to waste disposal practices. Once groundwater is contaminated, its quality cannot be restored by stopping the pollutants from source (Ramakrishnaiah et al. 2009). As groundwater has a huge potential to ensure future demand for water, it is important that human activities on the surface do not negatively affect the precious resource (Sarukkalige, 2009). Groundwater quality is mainly controlled by the range and type of human influence as well as geochemical, physical and biological processes occurring in the ground. It therefore becomes imperative to regularly monitor the quality of the water and device ways to perfect it (Yisa and Jimoh, 2010).

In Pakistan, groundwater contamination is mainly due to the byproducts of different industries, such as sugar processing, textile, dying, cement, leather, fertilizers, pesticides, food processing, and others. These industrial effluents have leached down from the drain and pollute the groundwater (Rizwan and Riffat 2009). Water quality of main cities of Pakistan, such as Sialkot, Gujarat, Faisalabad, Karachi, Qasur, Peshawar, Lahore, Rawalpindi, and Sheikhupura, has deteriorated due to the uncontrolled disposal of urban wastewater and untreated industrial wastewater and excessive use of fertilizers and insecticides (Bhutta et al. 2002). These industrial effluents have leached down from the drain and pollute the groundwater. Groundwater is the major source of drinking and industrial water use. Faisalabad city has made rapid progress in the industry since independence. As a result of industries, a large amount of organic and inorganic solid wastes and heavy metals are being disposed of into the natural streams and drains. The groundwater is badly affected due to the haphazard construction of different industries which discharge their untreated polluted effluent into open ditches and fields around them (Qadir et al. 2008).

This study was conducted to estimate the water quality in the nearby zone of Dijkot Branch Drain and to prepare a quality map using geographic information system (GIS). It offers great opportunities for the simulation of groundwater mapping (Dixon 2005). GIS is a powerful tool for understanding the present and future scenario of groundwater quality and provides a data for contaminated zone (Al Hallaq and Elaish 2012).

2. MATERIALS AND METHODS

2.1 Study Area

The research was conducted in the vicinity of Dijkot Branch Drain at Chak No. 281. J.B. Dawakhary, Tehsil Gojra as shown in the Fig. 1. The stuy area

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was situated between latitude 31°24′ to 31°26′ N and longitude 72°74′ to 72°76′ E at an elevation of 465m from the sea level.

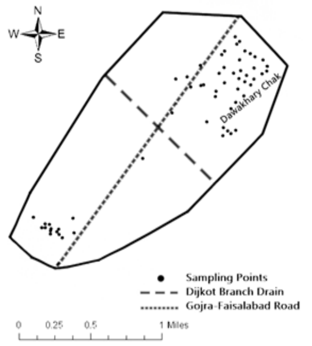

Figure 1: Study area at Chak No. 281 J.B. Dawakhary, Tehsil Gojra, with Groundwater Sampling Points

2.2 Sampling Plan

As part of the study, groundwater samples were collected from the both sides of the Dijkot Branch Drain. A total of 60 groundwater samples were randomly taken from whole area of newly installed pumps to investigate the different water quality parameters in the groundwater. The samples were taken in 500 ml bottles. The location of sample points was found with the help of co-ordinates of points. The co-ordinates of the sample points were taken with the help of Global Positioning System receiver (GPS Receiver). After the collection of the samples, the samples were preserved and analyzed in the laboratory.

2.3 Determination of Water Quality Parameters

Water samples were analyzed for various physio-chemical parameters. pH was determined by using pH meter while EC and TDS by Conductivity meter directly (Tahir et al. 2003).

The analysis of heavy metals, such as arsenic, lead, cadmium, chromium, and zinc, was performed in the study area Dawakhary Chak as shown in Fig. 1 with the help of atomic absorption spectrophotometer. Desired quantity of water sample was taken and 1–2 ml of conc. HNO_3 was added and kept aside for 10–15 min. Whatman filter paper was used to filter the contents. Clear solution was used to note the absorbance in AAS. We took the reading of the filtrate in the AAS. It may directly give the content of the metal depending on the model of AAS, or the concentration of each metal in the sample can be calculated by referring to the standard curve. Quantity of heavy metal in water is calculated in ppm (Niedzielski et al. 2002). The standards techniques were used for the analysis of all the metals and chemical parameters as described in the standard methods (APHA 1998).

2.4 Spatial Variability of Groundwater Quality

The spatial variability of water quality of study area was exhibited by using the ArcGIS software v10.2. A topographical sheet covering the study area was scanned and geo referenced with universal transverse (UTM) projection system and world geodetic system (WGS). The location of samples was digitized and database in association with parameters was generated. For the interpolation of data, inverse distance weighting method was used to create a smooth surface.

3. Results and Discussion

In this study a brief description of results is presented, discussed and necessary comparison is also performed in appropriate format such as table, maps and graphs.

Table 1: Statistical evaluation of quality parameters of groundwater samples obtained from Chak No. 281 J.B. Dawakhary, Tehsil Gojra.

Parameter	Range	Mean Value	WHO
pH	6.8-10.1	8.01	6.5-8.5
EC (dS/m)	0.3-4.63	1.82	2
TDS (mg/L)	153-2910	1212.03	1000
Carbonates (mg/L)	53-368	183.18	75
Bicarbonates	88-1234	590.27	250
Arsenic (mg/L)	0-0.07	0.04	0.01
Lead (mg/L)	0-0.08	0.04	0.01
Cadmium (mg/L)	0-0.08	0.04	0.01
Chromium (mg/L)	0.01-0.08	0.04	0.05
Zinc (mg/L)	0.01-0.07	0.03	0.05

3.1 pH analysis

The value of pH in the groundwater samples obtained from Chak No. 281 J.B. Dawakahry ranged between 6.5 to 8.8 with the mean value 7.65. The ranges are classified in spatial variation map shown in Fig. 2. The optimum values for pH are ranged between 6.5 to 8.5 set by the WHO for human consumption. Most of the groundwater samples of this area lie under the range for drinking water quality given by WHO.

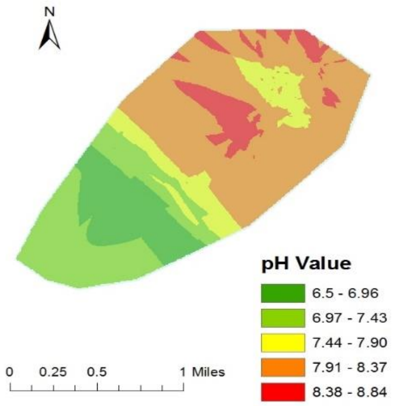

Figure 2: pH variation in study area

3.2 EC analysis

The value of EC in the groundwater samples varied from 0.3-4.63 dS/m with the mean value of 1.82 dS/m. The normal value for Electrical Conductivity (EC) is 2 dS/m for drinking purpose, according to WHO standards. The GIS map showing the EC concentration in groundwater is higher towards the north-eastern side samples. The white color in the map shows the area with the highest EC values.

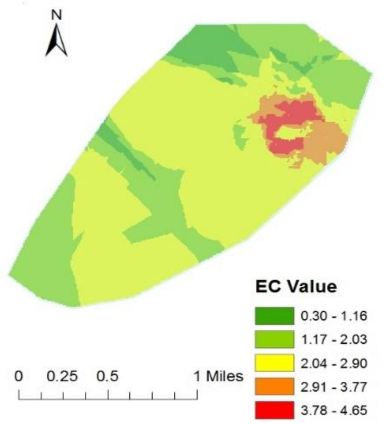

Figure 3: EC variation in study area

3.3 TDS analysis

The analysis of groundwater samples obtained from the Chak No. 281. J.B. Dawakhary indicates a wide variation in the concentration of TDS from 153 to 2910 mg/l. Fig.4 shows the variation in the concentration of TDS at study area. Almost 60% of groundwater samples were found above the permissible limit set by WHO. According to WHO, TDS level below 2000 mg/l is suitable for consumption and may not be detrimental to health but higher salinity can damage crops, affect plant growth and degrade drinking water (Al-Ahmadi, 2005).

3.4 Carbonates analysis

Carbonates are generated by the action of carbon dioxide in water on carbonate rocks such as limestone and dolomite. Carbonates produce an alkaline environment. In combination with calcium and magnesium, they cause carbonate hardness. Carbonates were ranging between 53 to 368 mg/l. The value of carbonates should not be more than 75mg/l for drinking purpose, according to the WHO standards.

3.5 Bicarbonates analysis

Bicarbonates are the principle anions in most surface as well as groundwater. The weathering of rocks raises the amount of bicarbonates in the water. Mostly, their concentration is related to pH. They manipulate the hardness and alkalinity in water. The values of bicarbonates were ranging between 88 to 1234 mg/l. The value of bicarbonates should not be more than 250 mg/l for drinking purpose, according to the WHO standards.

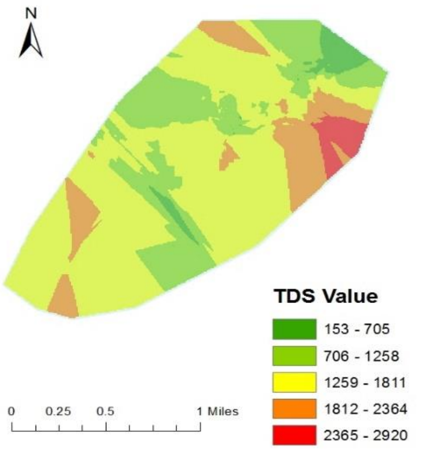

Figure 4: TDS variation in study area

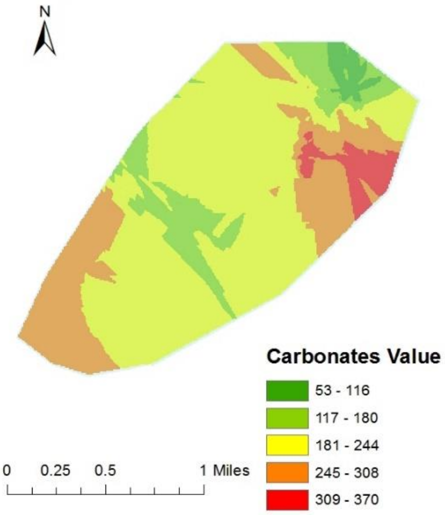

Figure 5: Carbonates variation in study area

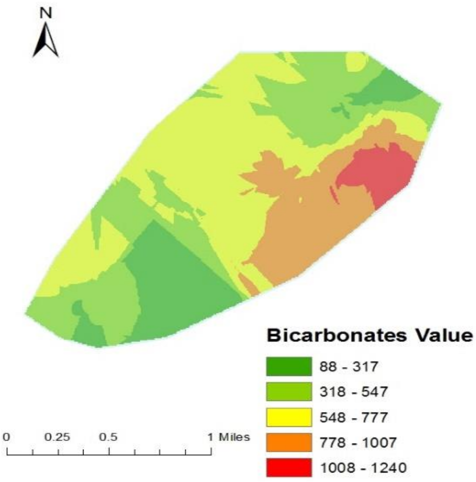

Figure 6: Bicarbonates variation in study area

3.6 Arsenic analysis

The value of arsenic in the groundwater samples varied from 0 to 0.07 mg/l with the average value of 0.04. The permissible limit is 0.01 mg/l by WHO. Fig. 7 tells the whole scenario of arsenic variation in the study area. Most of the water samples have the arsenic value above the permissible limit. The white colored area near to the drain as shown in the fig. 7 possesses the highest concentration of arsenic.

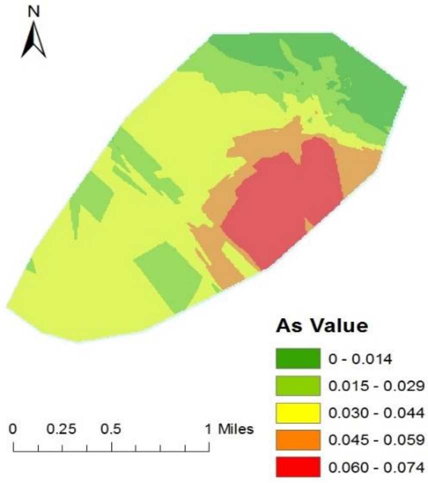

Figure 7: Arsenic variation in study area

3.7 Lead analysis

The main sources of lead in water are dyes, gasoline, batteries waste, manufacturing and pipe industries. It is a serious body poison. Guideline value for lead is 0.01 mg/l (WHO, 2011). Lead in groundwater samples in the study area is varied between 0.01 and 0.08 mg/l. Fig. 8 indicates the value of lead at study area. The area having a high concentration of lead is indicated by white color on a map.

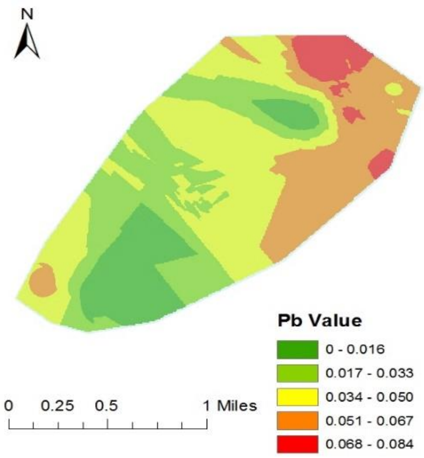

Figure 8: Lead variation in study area

3.8 Cadmium analysis

The value cadmium in groundwater samples of chak no. 281. J.B. is varied between 0 and 0.08 mg/l. The average value of cadmium was recorded as 0.04. Permissible limit for cadmium is 0.01 mg/l (WHO, 2011). Figure 9 shows the spatial variability in cadmium.

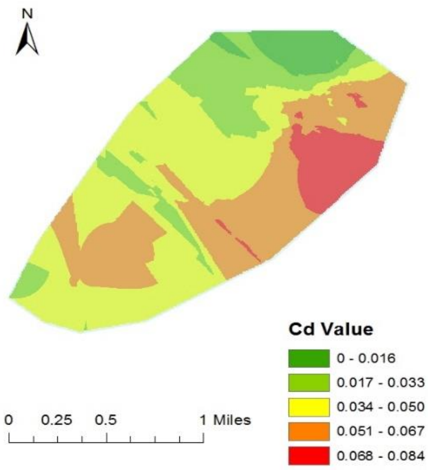

Figure 9: Cadmium variation in study area

3.9 Chromium analysis

The chromium concentration of groundwater samples obtained from Chak o. 281 J.B. ranged from 0.01 to 0.08 mg/l. The average value of all the samples was 0.04. Figure 10 shows the spatial variability of chromium in the groundwater samples. The sources of chromium in water includes; mining, garbage disposal, soaps and detergents, industrial effluents, agricultural activities (Musa et al, 2013). Long term exposure to chromium posed threat to human life and can cause kidney, liver circulatory and nerve tissue damages.

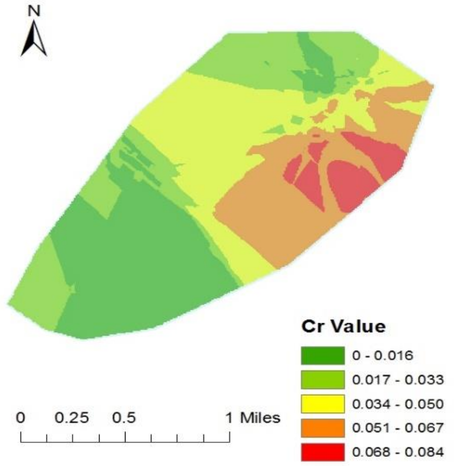

Figure 10: Chromium variation in study area

3.10 *Zinc analysis*

Zinc values for groundwater were ranging between 0.01 to 0.07 mg/l. GIS map shows the concentration of Zinc(Zn) in groundwater along the drain shown in Fig. 11 with different legends. The lowest Zinc (Zn) was found in the groundwater samples which were taken from the area away from the drain towards the north side. The GIS study explores that Zn level was found high in the groundwater samples at the north-eastern side of the drain. It shows that the trend of lateral movement of the zinc particles is towards the north-eastern side of the drain.

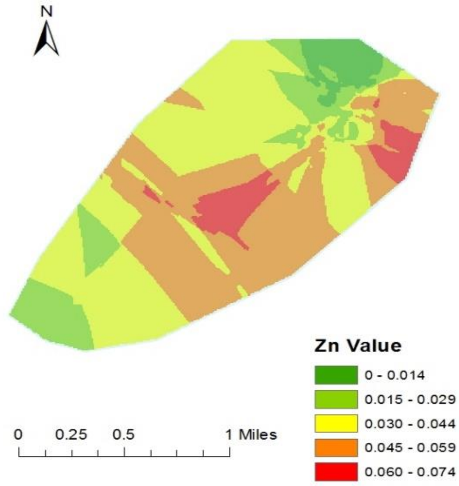

Figure 11: Zinc variation in study area

4. Conclusion

The groundwater analysis revealed that the level of pH, EC, TDS, Carbonates, Bicarbonates and heavy metal concentration in wastewater samples and in sludge samples were noticed considerably high. Wastewater contains heavy metals with extremely high concentration posing a direct threat to soil and groundwater. Contamination are ultimately affecting human health as this ground water is used for drinking purpose. Heavy metals were found in access in most of the groundwater samples up to large extent. Heavy metal analysis (As, Pb, Cd, Cr and Zn) showed the pollution level is high in drain. These contaminants are infiltrating downward, so the concentration of heavy metals in the groundwater samples gradually increasing up. This showed the dangerous situation for groundwater and that would definitely affect the health of inhabitants adversely. On conclusive note, Groundwater analysis showed that the water quality for drinking purpose is not safe for human being. The drain is deteriorating the groundwater water quality.

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