Groundwater Quality Evaluation of Taluka Kotdiji, Sindh, Pakistan

ISSN (e) 2520-7393
ISSN (p) 2521-5027
Received on 9th Mar, 2021
Revised on 23th Mar, 2021
www.estirj.com

J.A Keerio[1], G.S Solangi[2], Z.A Jumani[3], M.A Keerio[4]

[1]*Department of Civil Engineering Mehran University of Engineering & Technology Shaheed Zulfiqar Ali Bhutto Campus Khairpur Mirs*
[2]*Department of Civil Engineering Mehran University of Engineering & Technology Shaheed Zulfiqar Ali Bhutto Campus Khairpur Mirs*
[3]*Department of Civil Engineering Islamia University Bahawalpur*
[4]*Department of Civil Engineering Quaid-e-Awam University Campus Larkano*

Abstract: This study has been carried out to determine the groundwater quality of taluka Kotdiji district Khairpur Mirs, Sindh, Pakistan for drinking use. For this purpose, 39 groundwater samples were collected from various locations and were tested for physicochemical parameters like Odour, Colour, Taste Electrical Conductivity (EC), Total Hardness (TH), Power of Hydrogen (pH), Turbidity, and Total Dissolved Solids (TDS). The sensory test was adopted to determine the Odour, Colour and Taste of groundwater samples. The digital Turbidity meter, pH meter, EC meter and TDS meter were used respectively for the determination of Turbidity, pH, EC and TDS concentrations. The EDTA titration method was adopted to determine the Total Hardness of the groundwater.The results of these parameters were validated with WHO standards. The outcomes of physicochemical analysis showed that no any sample has pH and turbidity value beyond WHO limits, 54% samples of EC, 10% samples of TH and 54% samples of TDS have crossed the WHO suggested limits.

Keywords: *Groundwater Evaluation, Physicochemical, Taluka Kotdiji, Sindh*

1. Introduction

Water being the universal solvent is the essential life source on earth. Without water, no living organisms can survive. All the living forms use water for their survival. Freshwater is being used for a wide variety of activities such as drinking, agricultural, industrial as well as recreational purposes. But among these activities, the use of water for drinking is most important as it is necessary for the survival of life **[1]**

Groundwater is one of the chief source among natural water resources which is used largely for drinking and irrigation utilities, mainly in arid and semi-arid regions of the world [2-4]. At present, the literature reveals that about 65% of groundwater around the globe is utilized for drinking, 20% for agriculture and 15% is utilized by industries [5-7]. At present, water quality assessment has become a serious matter in developing countries around the globe [8]. On the basis of water quality, Pakistan ranks 80th, out of 122 nations worldwide [9-11]. The water discharged directly from industries and mixing of municipal sewage with water bodies has deteriorated the quality of water resources. Various toxic substance like heavy metals, pathogens and other hazardous elements have been reported in many parts of the country. Merely 20% people of the country have access to potable drinking water whereas it is stated that 80% population is affected by diarrheal disease [12-17]. Many researches have reported that four main pollutants were the reason for poor water quality in Sindh are 69% bacteria, 24% arsenic, 14% nitrate and 5% fluoride. On the basis of Inquiry Commission assigned by Supreme Court of Pakistan it was found that out of all water samples tested "78.1 % of water samples were unfit for drinking [18]. Currently, less than one half of the world population say 3.6 billion or 47% is living in regions that have water shortage issue at least one month each year [19]. Current demand of water for entire use around the world is nearly 4600 km^3 / year, by 2050 it will rise up to 5500 to 6000 km^3 / year a rise of 20 to 30% [20]. By 2025, globally the demand of water for agricultural use will rise by 60% [21].

Pakistan depend on Indus River system for its water requirements. Pakistan has turned into a water-stressed nation from the last decade [22-23]. An annual per capita available water content of Pakistan according to United Nations (UN) estimation is $1090m^3$. The stress on the national water assets is measured by the UN's Food and Agriculture Organization (FAO) by computing the total water extraction as a percentage of Total Renewable Water Resources (TRWR) [24]. If value of TRWR is more than 25%, the pressures will be reflected as to be high. Bordering country of Pakistan, India and Afghanistan has a stress of 34% and 31% respectively, but the Pakistan has a stress of 74%, which is considered to be very high [22].

The seriousness about water shortage issues in Pakistan can be decided from the studies that Pakistan will turn into a water-scare nation by 2025 [25-27], while the scarcity of water means deficiency in the accessibility of renewable freshwater compare to demand [28]. Due to population growth, the rate of demand versus supply is increasing which results in creating conflict between the states of country [29]. Among those countries around the world having severe water scarcity problem, Pakistan is listed at

Corresponding author Email address: engineer.jabir56@gmail.com

3rd reported by International Monetary Fund (IMF) [26]. It is reported by United Nations (UN), the water demand in Pakistan is growing at the speed of 10% per year [30]. It shows that annual per capita availability of water will be 809 m^3 by 2025 [31].

2. Experimental Work

2.1 Study Area

Administratively, Taluka Kotdiji is a sub-district of District Khairpur. District Khairpur is among the largest districts of Northern Sindh, Pakistan. The study area lies in between latitudes of 27°20′44″N to 68°42′24″E. About 3, 48, 899 people are living in the study area. The climate is very cold in winter and hot in summer. The area receives very less rainfall of 100 mm. The main cropping seasons in the study area are Rabi and Kharif. Wheat, barley, cotton, sugarcane, rice, vegetables are the main crops grown in the study region. The region is also famous around the country for the cultivation of Khajoor. The study area lies on the left bank of the river Indus. Due to the shortage of fresh water in the canals off-taking from Sukkur Barrage and less annual rainfall, groundwater is widely used by people for drinking and crop cultivation purpose in the area. This precious resource of the area is being contaminated due to climate change and less recharging rate, use of agrochemicals. The fig.1, 2, 3 and 4 show the Google maps of Pakistan, Sindh, Khairpur Mirs and the study area taluka Kotdiji respectively.

Fig. 1 Google Map of Pakistan

Fig. 2 Google Map of Sindh

Fig. 3 Google Map of Khairpur Mirs

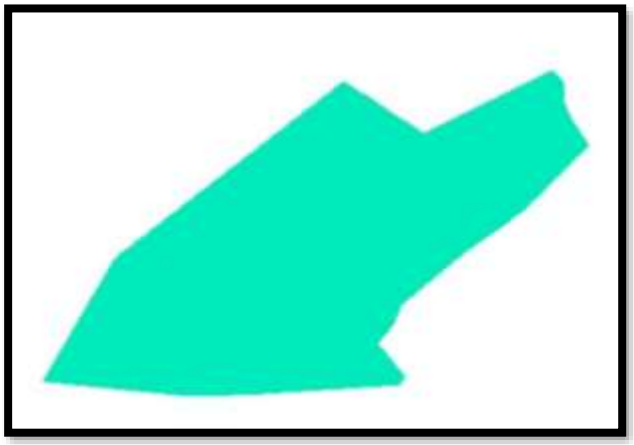

Fig. 4 The Study Area (Taluka Kotdiji)

2.2 Physicochemical Evaluation

Geo referenced groundwater samples were collected from hand pumps, electric motors, and boreholes, already installed in the study area shown in fig.5. The samples were collected from those pumps which are available at common public places such as schools, residential areas, hospitals, bus stops, and agricultural areas. One-liter plastic bottles were used for sample collection by using all the available standards. Whereas location and source of samples were also noted. Then all the samples were brought to laboratory for physicochemical analysis.

Fig. 5 Samples Collection

3. Methodology

The collected samples were analyzed for different physical and chemical properties viz., Turbidity, Power of Hydrogen (pH), Electrical conductivity (EC), Total Dissolved Solids (TDS) and Total Hardness (TH) etc. using standard available laboratory and field methods. The standard methods were adopted for determining the concentration of different parameters. The Colour (TCU), Odour and Taste were determined by sensory test. The digital Turbidity meter, pH meter, EC meter and TDS meter were used for the determination of Turbidity, pH, EC and TDS concentrations respectively. The EDTA titration method was adopted to determine the Total Hardness of the groundwater.

4. Results and Discussion

4.1 Color, Odor and Taste

On the basis of sensory test it was found that all the samples collected from 39 various locations of study area were colorless, odorless and tasteless.

4.2 Turbidity

The evaluation of groundwater of study area revealed the minimum turbidity value of 0 NTU and maximum turbidity value of 1 NTU. Whereas, the recommended value by WHO is 5 NTU [32].

Fig. 6 Turbidity Meter

4.3 pH

It shows the concentration of Hydrogen ions in any solution. It ranges from 0 to 14 and shows neutral solution at 7. The water with pH value below 7 is considered as acidic and water with pH value above 7 is considered as alkaline. Range of pH severely affects the health of people. pH values of 6.5 to 8.5 are recommended as suitable for drinking by U.S Environmental Protection Agency. The pH meter was applied to determine the pH range. The pH value in the study area ranged from 7.1 to 7.8. All samples have pH value within safe limit. The pH meter was used to examine the pH concentration shown in fig.7.

Fig. 7 pH Meter

4.4 Electrical Conductivity

The Electrical Conductivity was examined using digital conductivity meter as shown in fig.8.

Fig. 8 Conductivity Meter

The fig.9 shows the groundwater analysis for EC of the study area. The minimum and maximum value of EC were found 0.28 dS/m and 3.31 dS/m respectively. Out of 39 samples 21 samples had EC value beyond the WHO limit of 0.75 dS/m [32].

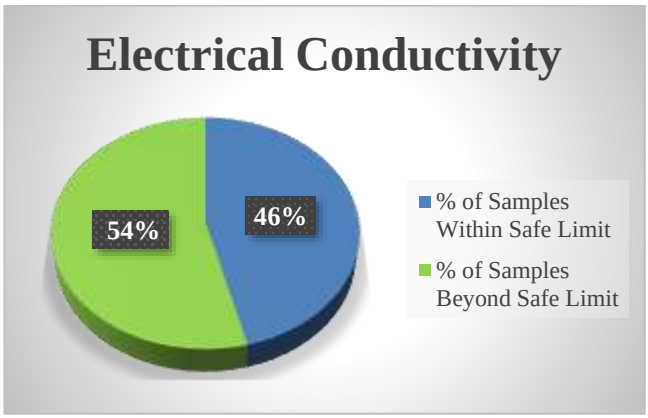

Figure.9 EC status of the Groundwater of the study area

4.5 Total Hardness

The TH status of taluka Kotdiji is shown in fig.10**.** Consumption of hard water does not affect the health of people. It is publicized by many researchers that people who consume hard water on regular basis throughout their lifespan have lower rate of heart disease. Particularly, hardness is not a fundamental of water but it is due to occurrence of calcium and magnesium ions in water.

The WHO has suggested the maximum value of TH as 500mg/l. The maximum and minimum values of TH in the study area were found as 1640 mg/l and 30 mg/l respectively.

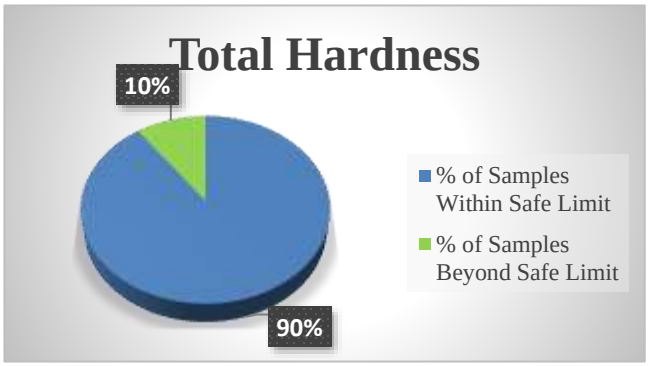

Figure.10 TH status of the Groundwater of the study area

4.6 Total Dissolved Solids

The digital TDS meter was used to determine the concentration of total dissolved solids in the study area shown in fig.11.

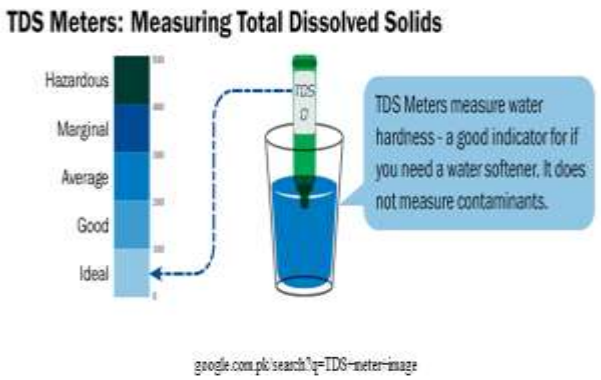

Fig. 11 TDS Meter

The concentrations of TDS in study area are shown in fig.12. The minimum value of TDS in study area was found as 240 mg/l and maximum value was 4160 mg/l. 21 out of 39 groundwater samples had TDS value beyond the specified limit of WHO.

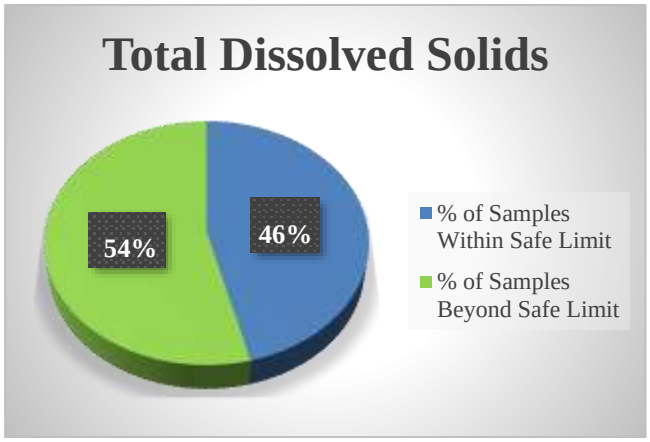

Figure.12 TDS status of the Groundwater of the study area

The groundwater evaluation of study area showed that no any sample has pH value beyond the permissible limit, EC, TH and TDS have 54%, 10% and 54% samples beyond the permissible limit.

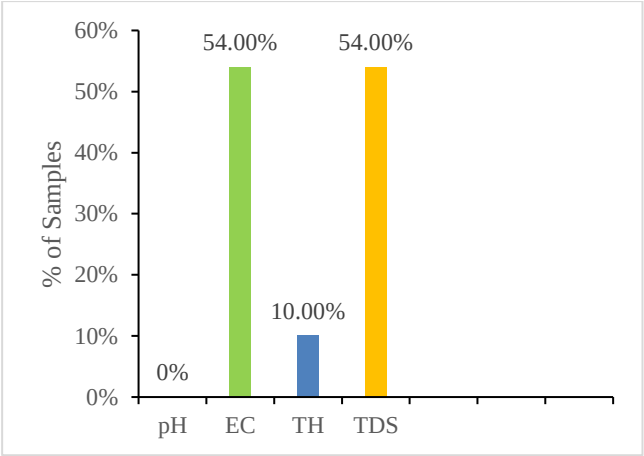

Fig.13 Physicochemical parameters beyond the allowable limit

5. Conclusion

The sensory analysis of physicochemical parameters revealed that all the samples were tasteless, odorless and colorless. In terms of pH it is concluded that no any sample has crossed the Who suggested limit. Furthermore, it is found that 54% samples of EC, 10% samples of TH and 54% samples of TDS have values beyond the WHO limits. Overall, it is observed that groundwater quality of rural areas of taluka kotdiji is not safe in terms of EC and TDS, water should be treated well prior to use for drinking.

References

[1] Şener, Ş., Şener, E., & Davraz, A. (2017). Evaluation of water quality using water quality index (WQI) method and GIS in Aksu River (SW-Turkey). *Science of the Total Environment, 584*, 131-144world

[2] Adimalla,N.,2018.Groundwater quality for drinking and irrigation purposes and potential health risks assessment: a case study from semi-arid region of South India. Expo. Health. https://doi.org/10.1007/s12403-018-0288-8.

[3] Adimalla,N.,Li,P.,Qian,H.,2018b.Evaluation of groundwater contamination for fluoride and nitrate in semi-arid region of Nirmal Province,South India:aspecial emphasis on human health risk assessment (HHRA). Human and Ecological Risk Assessment. Int.J. https://doi.org/10.1080/10807039.2018.1460579.

[4] Li,P.,He,X.,Li,Y.,Xiang,G.,2018a.Occurrenceandhealthi mplicationoffluoridein groundwater of loess aquifers in the Chinese Loess Plateau: a case study of Tongchuan, northwest China. Expo. Health. https://doi.org/10.1007/s12403-0180278-x.

[5] Adimalla,N.,Venkatayogi,S.,2018.Geochemical characterization and evaluation of groundwater suitability for domestic and agricultural utility in semi-arid region of Basara,Telangana State, South India. Appl.WaterSci.8,44.https://doi.org/10. 1007/s13201-018-0682-1.

[6] Adimalla N, Vasa SK, Li P (2018a) Evaluation of groundwater quality, Peddavagu in Central Telangana (PCT),South India: an insight of controlling factors of fluoride enrichment model. Earth Syst. Environ. https://doi.org/10.1007/s40808-018-0443-z

[7] Saeid S, Chizari M, Sadighi H, Bijani M (2018) Assessment of agricultural groundwater users in Iran: a cultural environmental bias. Hydrogeol J 26(1):285–295. https://doi.org/10.1007/s10040-017-1634-9

[8] Andrade, E. M., Lopes, F. B., Palacio, H. A. Q. , Aquino, D. N., Alexandre, D. M. B. (2010).

[9] Sanjrani MA, Talpur H, Talpur SA (2018) Physiochemical assessment of water sources for drinking purpose in Badin City, Sindh Province, Pakistan, (Water Supply Schemes and Hand Pumps). Advance Research Journal of Multidisciplinary Discov-eries 29(7): 38-44.

[10] Azizullah A, Khattak MNK, Richter P, Hader DP (2011) Water pollution in Pakistan and its impact on public health, a review. Environment Int 37(2): 479-497.

[11] UNESCO (2002) Water quality indicator values in selected countries.

[12] Sahu BK, Rao RJ, Behra (1995) Studies of some physicochemical characteristic of the Ganga River (Rishikesh-Kanpur) within twenty-four hours during winter. Ecology Environment Cons 1(1-4): 35-38.

[13] Science net (2018).

[14] Soomro ZA, Khokhar MIA, Hussain W, Hussain M (2011) Drinking water Quality challenges in Pakistan. World Water Day, p. 17-28

[15] Chilton PJ (2000) Pakistan water quality mapping and management project. Pakistan Integrated Household Survey (PIHS) Islamabad, Federal Bureau of Statistics, Government of Pakistan, Pakistan

[16] Aziz JA (2012) National water quality strategy, Report Submitted to The Asian Development Bank as Part of Water Resources Strategy Study, ADB, TA 3130 PAK, Islamabad. Ministry of Water and Power.

[17] Kosek M, Bern C, Guerrant RL (2003) The global burden of diarrheal disease as estimated fromstudies published between 1992 and 2000‖ Bulletin of the World Health Organization 81(3): 197-204

[18] Seerat Ul Ain Bhutto, Sanjrani MA and Mutaharat Ul Ain Bhutto (2019). Water Quality Assesment in Sindh, Pakistan: A Review. Journal of Environmental and Soil Sciences 2(3): 296-302

[19] Water Development Report 2018 (United Nations Educational, Scientific and Cultural Organization, New York, United States) www.unwater.org/publications/world-water development-report-2018/. (2018).

[20] Burek, P., Satoh, Y., Fischer, G., Kahil, M. T., Scherzer, A., Tramberend, S., & Wiberg, D. (2016). Water futures and solution-fast track initiative

[21] Alexandratos, N. & Bruinsma, J. World Agriculture Toswards 2030/2050: The 2012 Revision. ESA Working paper No. 12-03. Rome, Food and Agriculture Organization of the United Nations (FAO) www.fao.org/docrep/016/ap106e/ap106e.pdf. (2012).

[22] Mustafa, D.; Akhter, M.; Nasrallah, N. (2013). Understanding Pakistan's Water-Security Nexus; United States Institute of Peace: Washington, DC, USA

[23] Kirby, M.; Ahmad, M. (2014) Water Resources Management in Developing Countries: The Role of Hydrology—Economic Modelling; CSIRO: Canberra, Australia.

[24] Postel, S.L.; Daily, G.C.; Ehrlich, P.R. (1996). Human Appropriation of Renewable Fresh Water. Science, 271, 785–788.

[25] Briscoe, J.; Qamar, U.; Contijoch, M.; Amir, P.; Blackmore, D. (2006). Pakistan's Water Economy: Running Dry; Oxford University Press: Karachi, Pakistan.

[26] Baloch, S.M.Water Crisis: Why Is Pakistan Running Dry? Available online: https://www.dw.com/en/watercrisis-why-is-pakistan-running-dry/a-44110280 (accessed on 11 December 2018).

[27] Samuel, M. An Alarming Water Crisis: Will Pakistan Have No Water in 2025? Modern Diplomacy. 2018. Available online: https://moderndiplomacy.eu/2018/09/10/an-alarming-water-crisis-will-pakistan-have-nowater-in-2025/ (accessed on 5 July 2019).

[28] Damkjaer, S.; Taylor, R. (2017). The measurement of water scarcity: Defining a meaningful indicator. Ambio, 46, 513–531

[29] Ranjan, A. (2012). Inter-Provincial water sharing conflicts in Pakistan. *Pakistaniaat: A Journal of Pakistan Studies*, *4*(2), 102-122

[30] Connor, R. The United Nations World Water Development Report 2015: Water for a Sustainable World; UNESCO: Paris, France, 2015

[31] Bakhsh, A.; Hussain, Z.; Sultan, S.J.; Tariq, I. (2014). Integrated Water Resource Management in Pakistan; Zarai Taraqiati Bank Ltd.: Islamabad, Pakistan, pp. 73–92

[32] . WHO (World Health Organization), "Guidelines for Drinking Water Quality", 4th Edition,Geneva, Switzerland, 2011.