ZIBELINE INTERNATIONAL PUBLISHING
ISSN: 2521-2893 (Print)
ISSN: 2521-2907 (Online)
CODEN: ESPADC

Earth Sciences Pakistan (ESP)

DOI: http://doi.org/10.26480/esp.01.2022.30.35

RESEARCH ARTICLE

IMPACT OF BIOLOGICALWASTEWATER TREATMENT PLANT AND PAHARRANG DRAIN ON GROUNDWATER CONTAMINATION AND ITS HEALTH RISK ASSESSMENT

Amina Manzoor[a]*, Haroon Rashid[a], Abdul Nasir[a], Hafiz Moeen Ud Din[b], Ahmad[a], Ahsan Saif ullah[a], Anam Maqsood[a]

[a]Department of Structures and Environmental Engineering, University of Agriculture, Faisalabad, Pakistan
[b]WASA Research Laboratories, Faisalabad, Pakistan
**Corresponding Author E-mail: aminamalik27590@gmail.com*

ARTICLE DETAILS

Article History:

Received 02 March 2022
Accepted 04 April 2022
Available online 13 April 2022

ABSTRACT

In developing nations like Pakistan, the dumping of untreated industrial effluents into drains is a major source of subsurface pollution. This research was carried out at the area of Chokera, Faisalabad and focused on the Paharrang drain to examine its impact on groundwater quality since companies in the area discharge untreated sewage into the drain at various points along its length. It was primarily concerned with determining the impact of the outflow on groundwater quality and observing discharge rate fluctuations. The goal of this study was to assess the toxicity of the drain's effluent and treatment plant on groundwater quality. Physio-chemical parameters such as pH, EC, TDS, TSS, DO, Carbonates, Bicarbonates, Cl, Arsenic, Lead, Chromium, Copper, Cadmium, and Zinc were measured in the collected samples. The findings of these samples were compared to WHO recommendations. The values of these data were represented using ArcView GIS v10.2 and a mapping of quality parameters. None of the values in the wastewater samples were determined to be within the WHO acceptable limit. Similarly, groundwater investigation revealed that all samples were unsuitable for human consumption. Drinking groundwater directly might be hazardous to one's health.

KEYWORDS

Groundwater Contamination, Health Risk Assessment, Water Quality Index, Chokera, Biological Wastewater Treatment Plant

1. INTRODUCTION

The usability of potable drinking purpose is determined by its quality. Water quality is determined by the composition of the water, which is impacted by environmental factors as well as anthropogenic activities. Water quality is affected by water parameters (physicochemical, biochemical, and biological), and if these values above permissible limits, public health is jeopardized (Ahmad et al., 1993). Pollutant in drinkable water is subject to environmental guidelines or acceptable limits defined by various authorities such as the World Health Organization (WHO) and the Centers for Disease Control. A widespread misconception regarding water is that clean water is of high quality, implying an information gap concerning the existence of all these contaminants from water. Several of the Development Goals (DG) is to increase the accessibility and ecological sustainability of sufficient water. This is a challenging issue for policymakers and Water, Sanitary, and Sanitary conditions (WASH) professionals, especially in the face of different climatic conditions, rising communities, economic hardship, and the significant impacts of human advancement. (Ahmad et al., 2005). The Quality of Groundwater (Water quality index) is widely regarded as the most accurate way of assessing water quality. A mathematical formula incorporates a few water quality characteristics to grade groundwater recharge and determine its acceptability for consumption. Hutton created the scale in 1965 to assess quality of the water utilizing ten of the most used water characteristics. Specialists updated the procedure in the following years. Those indexes employed a variety of physicochemical characterization that differed in terms of quantity as well as variety. (Ahmad and Joyia, 2003; Samjwal et al., 2006). All parameter's values are determined by it's own respective standards, and the allocated weight reflects the parameter's importance and influence on the index. A typical WQI approach includes three steps: (1) component assessment, (2) quality function determination for every parameter, and (3) aggregating utilizing mathematical calculation. Depending on several water factors, the indicator produces a single value that measures quality of the water at a specific place and time. That indicator makes it possible to compare data from various sampling locations. (Hinrichsen et al., 2002). Water quality index breaks down a complicated database become simply digestible and actionable facts. The WQI's water quality categorization indicates the acceptability of water for consumption. This index's only one output, generated from numerous characteristics, provides important water quality data is easily interpretable, even by laypersons. In a source of energy nation like Bangladesh, securing water supply and long-term maintenance is amongst the most difficult stages of development. For communicate water accurate information to WASH professionals, the current study used the arithmetic mean WQI approach. One of the advantages of this technique is that it requires fewer parameters to evaluate quality of the water voor different purposes. (Agelos et al., 2010). Faisalabad is separated into two zones (Western and Eastern). The Paharang Drain, which finally empties into the Chanab River, drains the northwestern region. The canal's east end descends south-east and empties into the Madhuana Drain, which empties into the Raiv River. WASA's wastewater treatment facility has a total capacity of roughly 20 MGD. As is normal, every venture should make

Quick Response Code	Access this article online	
	Website: www.earthsciencespakistan.com	**DOI:** 10.26480/esp.01.2022.30.35

Cite the Article: Amina Manzoor, Haroon Rashid, Abdul Nasir, Hafiz Moeen Ud Din, Ahmad, Ahsan Saif ullah, Anam Maqsood (2022). Impact of Biologicalwastewater Treatment Plant and Paharrang Drain on Groundwater Contamination and Its Health Risk Assessment. *Earth Sciences Pakistan, 6(1): 30-35.*

game plans to treat mechanical emanating and meet NEQS, which are indicated to deal with the wastewater characterization of modern profluent being unloaded into channels. Unfortunately, most industrial units lack separate industrial wastewater treatment, and even if they have, due to power shortages and high operational costs, they are rarely employed for treatment purposes. Due to untreated wastewater discharge, the wastewater treatment facility in Chokera, which was built to handle municipal wastewater, has a lot of industrial effluent mixed in with it .As is normal, every venture should make game plans to treat mechanical emanating and meet NEQS, which are indicated to deal with the unused water characterization of modern profluent being unloaded into channels. (Azizullah et al., 2011). The city of Faisalabad produced 280 MGD of sewage water, and there is no wastewater treatment facility to handle such a large volume of garbage. As a result, most sewers transport untreated wastewater all the way to the rivers' final destination. As the drains are not entirely lined to prevent seepage, this untreated wastewater, which includes high levels of pollutants, is likely to infiltrate keen on the topsoil then combination through surface water. Because sub aversive aquatic are primary foundations water popular suburban zones, consumption seawater and field water obtained by pushes could polluted as well as unfit used for intake or else irrigation purposes, advised through EPA rules. The current effort has been done to study wastewater effluents considering the importance of water pollution. pH, TDS, BOD, COD, EC, TSS, DO, Ca, Cd, As, Pb, Cu, Cr, and Zn are main pollution parameters concern in industrial eff (Zn) (Hashmi et al., 2009). Previously, we performed a review of relevant literature in program areas on water and hygienic practices problems, such as the use of tube well water and water safety procedures, women in water hygiene, and sanitary conditions and clean water knowledge gaps. Unemployment, unsanitary sanitation practices, low underground water, and the effects of natural disasters are all issues that obstruct access to safe drinking water (e.g., arsenic and salinity). This program used so many basic proxies indications to evaluate water quality, such as knowledge of the concrete block pipe bore foundation, overall hygiene, and the absence of flash flooding at the tubes well's bottom. The current study on freshwater quality assessment based on specific water quality parameters is, to our understanding, the very first study for the BRAC Washing program. The goal of this study was to determine how exposed households were to these water parameters based on their sociodemographic characteristics, which might have programmatic implications in the future. A study utilizes the arithmetic mean WQI approach to assess quality of drinking water based on a set of physiochemical properties. Chokera Biological Treatment Plant's WASH program required the selection of these measures for assessing groundwater resources. The current study is important because it has programmatic consequences by giving easy-to-understand evidence-based and helpful information about water quality. These results are expected to aid in the development of methods to be adopted to ensure potable water, whether by raising knowledge about toxic pollution of water or by improving water quality through the provision of technology (Farooq et al., 2008). The U.S. Ecological Insurance Office's (USEPA's) Hazard Evaluation Direction (USEPA, 1989) has been generally applied all throughout the planet to survey the human wellbeing dangers of metals. To evaluate groundwater quality by determining different physico – chemical parameters and finding out water quality index. To find out variation trend in groundwater quality by using GIS map contouring & interpolation technique. To conduct health risk assessment, by determining the impact of groundwater consumption for drinking purpose on human health.

2. Materials and Methods

2.1 Study Area

The examination region was chosen on the two sides of Chokera Treatment Plant in 2 km span around the treatment plant.

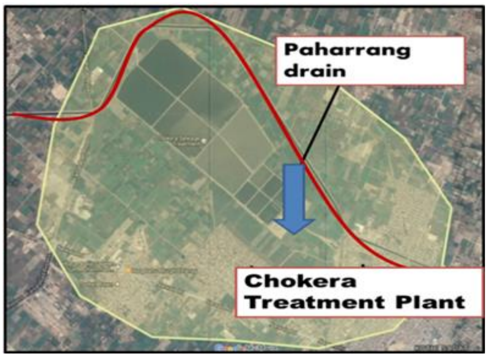


Figure 1: Chokera Biological wastewater Treatment Plant

2.2 Sampling of Underground Water

Groundwater samples were taken from residential areas on both sides of the Chokera Treatment Plant. At each sampling site, GPS coordinates were recorded. Each sample weighed 500 milliliters. PVC bottles and a GPS meter were utilized to collect groundwater samples.

2.3 Wastewater Sampling

Wastewater tests were gathered from channel (APHA, 1998). The examples were gathered from 10 unique focuses. Absolute 2 samples were gathered and the amount of each example was 500 mL.

2.4 Index of Quality of Water (WQI)

To determine the appropriateness of potable water, the arithmetic mean (Yisa and Jimoh, 2010) Water quality index approach had been used. (Tyagi et al., 2014). In this method, water quality rating scale, relative weight, and overall WQI were calculated by the following formulae:

$$q_i=(C_i/S_i)\times 100$$

Where q i, C i, and S i indicated quality rating scale, concentration of i parameter, and standard value of i parameter, respectively.

Relative weight was calculated by

$$w_i=1/S_i,$$

Where the standard value of the i parameter is inversely proportional to the relative weight.

Finally, overall WQI was calculated according to the following expression:

$$WQI=\sum q_i w_i/\sum w_i$$

2.5 Health Risk Assessment

To estimate risk to human health in persons exposed to As, a health risk assessment methodology taken from USEPA (2005) had been used. The following equation was used to calculate the daily average dosage (ADD) of as in drinkable water:

$$ADD=C*IR*ED*EF/BW*AT$$

Where C, IR, ED, EF, BW, and AT stand for As in water (mg/L), water intake rate (2L/day), exposure length (presumed eighty years), exposition frequencies (24/7/365), body mass (72 kg), and averaged lifestyle (24,455 days), respectively.

The mathematical methodology can be used to compute HQ in generally (USEPA 2005).

$$HQ=ADD*RfD$$

While HQ is indeed the hazards quality; if it is greater than 1, it is considered a public health concern, but an as standard dose (RfD) of 0.0003 mg/kg/day causes toxicity (USEPA 2005).

The following method was used to determine cancer risk (CR):

$$CR=ADD*CSF$$

where CSF is the cancer slope factor for as which is 1.5 mg/kg/day (USEPA, 2005).

3. Results and Discussion

The parameters were investigated according to standard procedures (NEQS 2000). These values were compared with standard values as per described in USEPA, WHO and NEQS. Based on these values WQI was determined furthermore the parameters were mapped on GIS using kriging method to determine the lowest of higher concentrations.

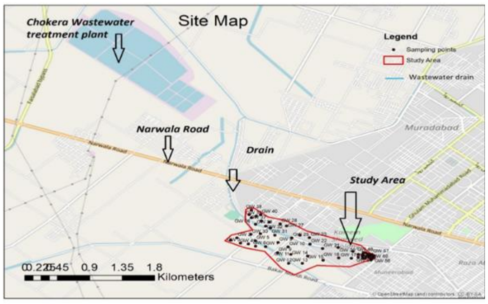


Figure 2: Site Map

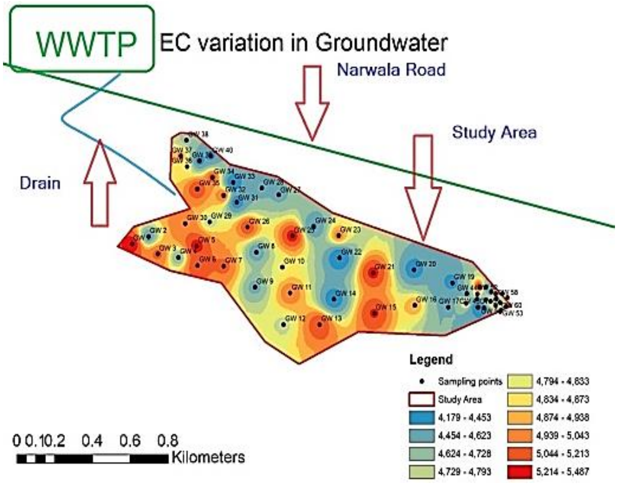
Cite the Article: Amina Manzoor, Haroon Rashid, Abdul Nasir, Hafiz Moeen Ud Din, Ahmad, Ahsan Saif ullah, Anam Maqsood (2022). Impact of Biologicalwastewater Treatment Plant and Paharrang Drain on Groundwater Contamination and Its Health Risk Assessment. *Earth Sciences Pakistan, 6(1): 30-35.*

3.1 pH Variation in Groundwater

It is very significant in the clarity and disinfection of drinking water. The pH of the water should be less than eight for successful chlorine disinfection; though, low pH water (pH 7) is more likely to be corrosive. The pH acceptable limit set by the World Health Organization (WHO) is 6.5–8.5 (WHO, 2004). The pH value of groundwater samples in this investigation was determined to be in the range of 6.6–8.8 showed in fig 3uncertainty or non-specific trend of pH.

3.2 EC Variation in Groundwater

The EC of the water should a a lesser amount of 750 though, lesser EC H2O (750) are extra likely to be corrosive. The EC acceptable limit set a World Health Organization is 750-2000. The EC value of groundwater samples in this investigation was determined to be in the range of 4000-5500 showed in fig 4 that indicated the groundwater is unsuitable for drinking or other purposes it is uncertainty or non-specific trend of EC.



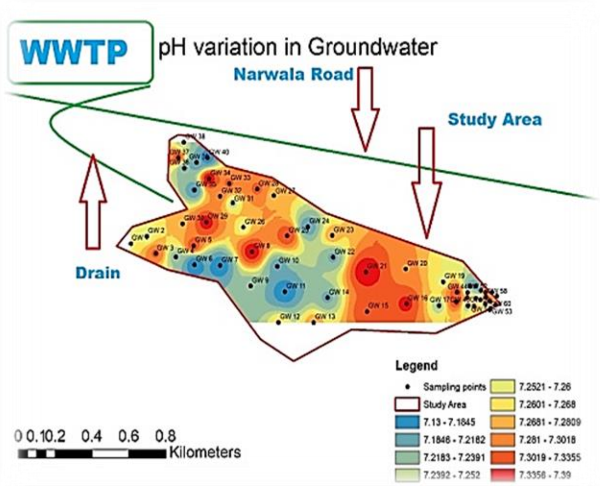


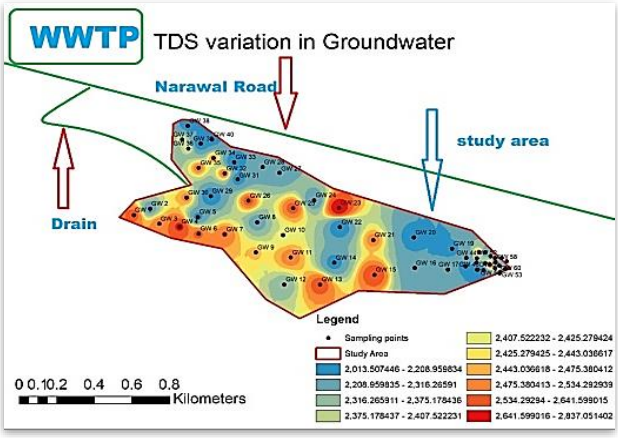
Figure 3 and Figure 4: Representing pH and EC variation observed in groundwater samples at research sites

3.3 TDS Variation in Groundwater

The flavour of water can be affected by the presence of dissolved particles. These palatability a consumption liquid has been Panels of tasters rated the product as outstanding (below 300 mg/l), acceptable (300–600 milligrams per litter), fair (600–900 mg/l), terrible (900–1,200 mg/l), and unpleasant (>1,200 mg/l). The permitted maximum for TDS in water used for drinking is 1000 mg/L, according to the WHO. The TDS content of the examined samples in this study ranges from 128 to 3010 mg/L showed in fig 5 uncertainty or non-specific trend of pH.

3.4 TSS Variation in Groundwater

Inorganic and organic particles can make up total suspended solids in water. Suspended solids are undesirable in water because they are unsightly and provide habitat for chemical and biological organisms. TSS levels in groundwater in the study region ranged from 61 mg/l to 1455 mg/l.



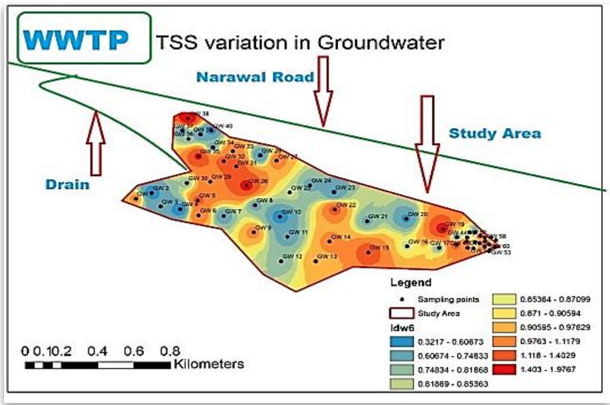
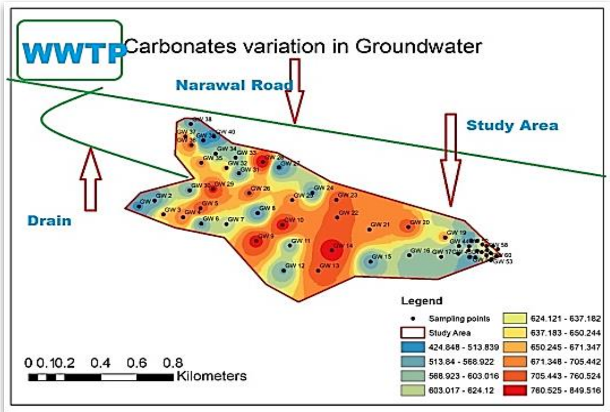


Figure 5 and Figure 6: Representing TDS and TSS variation observed in groundwater samples at research sites

3.5 Carbonates and Bicarbonates Variation in Groundwater

Carbonates and bicarbonates were determined to estimate the Residue Sodium Chloride for subsurface assessment. Furthermore, carbonates and bicarbonates are used to determine the quality of drinking water. Carbonates and Bicarbonates Variation in Groundwater ranged from 19 to 384 and 65 to 1285, respectively.



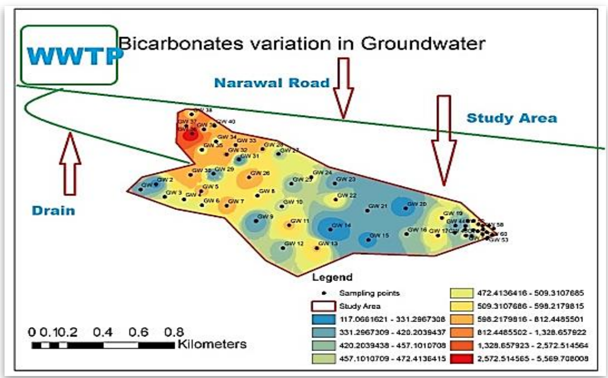


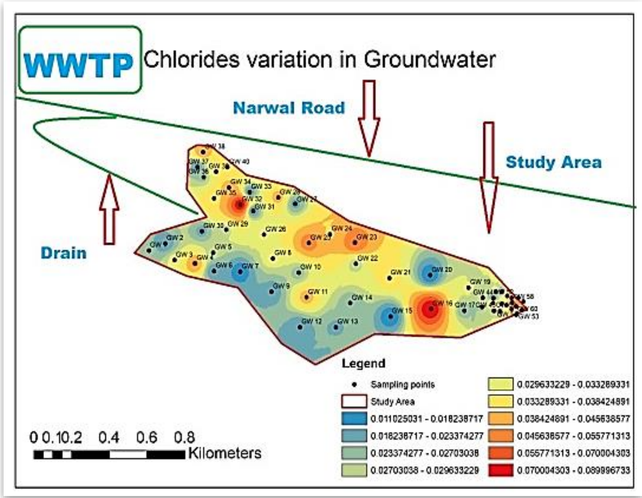
Figure 7 and Figure 8: Representing Carbonates and Bicarbonates variation observed in groundwater samples at research sites

3.6 Chlorides Variation in Groundwater

Some of the most common chloride compounds found in natural water are sodium carbonate (Sodium chloride), potassium nitrate (Potassium hydroxide), calcium hypochlorite and magnesium hydroxide. (MgCl2). Taste thresholds for the chloride anion are determined by the related cations, and sodium, potassium, and calcium chloride concentrations vary from 200 to 300 mg/L. The permissible limit for chloride has been set as 250 mg/l by the WHO, based on the taste threshold. The chloride concentrations in the obtained samples ranged from 32 to 960 mg/l.

3.7 Arsenic Variation in Groundwater

Arsenic levels in underground water tasters ranged beginning 0 towards 0.07 mg/l on average, with a value of 0.04. By law, 0.01 mg/l is the maximum permitted concentration. WHO. Fig. The number 10 depicts the entire scenario of arsenic variation in the research area.The arsenic level in most of the water samples is higher than the legal limit. The reddish-brown region depicted in Fig. The number 16 is the highest a high level of arsenic



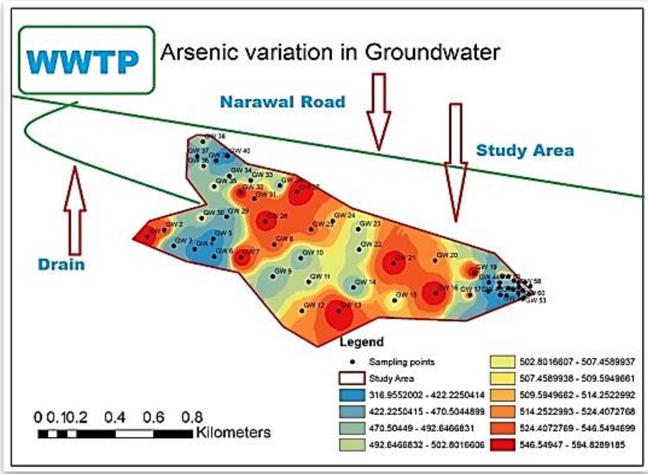


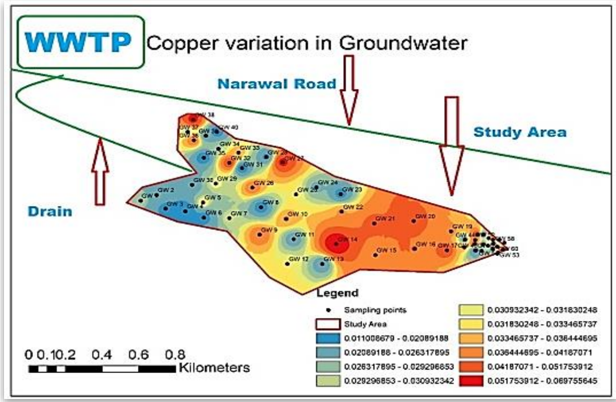
Figure 9 and Figure 10: Representing Chlorides and Arsenic variation observed in groundwater samples at research sites

3.8 Copper Variation in Groundwater

Copper concentrations in Chokera underground water tasters ranged starting 0 towards 0.08 mg/l. The average variance in cadmium was found to be 0.04. Copper has a permissible maximum of 0.05 mg/l. Figure 22 shows the spatiotemporal heterogeneity with brass in groundwater sources from the study area.

3.9 Zinc Variation in Groundwater

Zinc concentrations in groundwater ranged from 0.01 to 0.07 mg/l. As illustrated in Fig. 26, a GIS map depicts the concentration of Zinc (Zn) in groundwater. Zn levels were found to be high in groundwater samples on the western side, according to the GIS analysis.



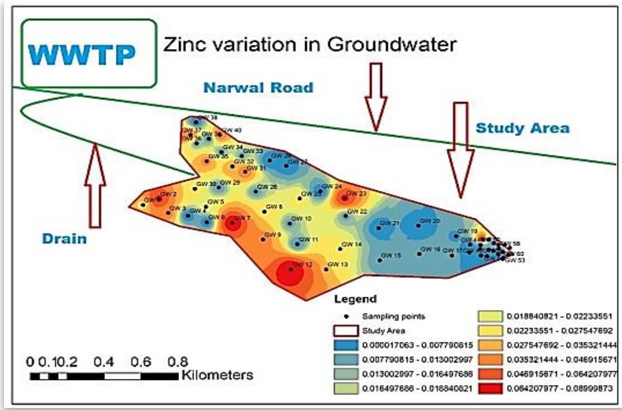
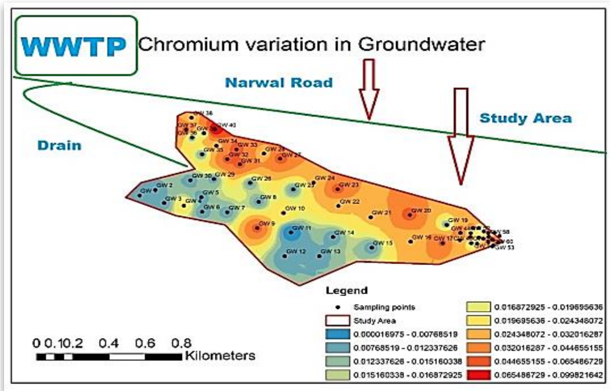


Figure 11 and Figure 12: Representing Copper and Zinc variation observed in groundwater samples at research sites

3.10 Chromium Variation in Groundwater

The chromium levels in Chokera UNDERgroundwater samples different since .01 toward .08 mg/l. All of the samples had an typical assessment of .04. The geographical variability of chromium in groundwater samples is seen in Figure 13. Chromium in water can be found in mining, garbage bins, detergent bottles, industrial discharges, including agriculture activities. Long-term chromium exposure can harm the kidneys, liver, circulatory system, and nerve tissue, posing a hazard to human life.



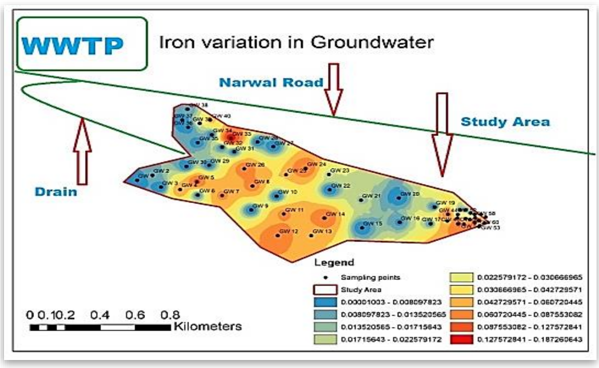


Figure 13 and Figure 14: Representing Chromium and Iron variation observed in groundwater samples at research sites

Cite the Article: Amina Manzoor, Haroon Rashid, Abdul Nasir, Hafiz Moeen Ud Din, Ahmad, Ahsan Saif ullah, Anam Maqsood (2022). Impact of Biologicalwastewater Treatment Plant and Paharrang Drain on Groundwater Contamination and Its Health Risk Assessment. *Earth Sciences Pakistan, 6(1): 30-35.*

3.11 BOD (Biochemical Oxygen Demand) Test

For wastewater, a 5-day BOD test was done. The BOD of sewerage varied between 159.87mg/L. Biochemical oxygen demand concentrations must be nearly 80 mg/L, as per Department of environment (doe regulations. The effluent in it sewer are highly filthy.

3.12 Chemical Oxygen Demand COD test

For wastewater, a COD test was done. The Chemical oxygen demand (COD) of sewerage varied between 260 - 333 mg/L. Biochemical oxygen demand concentrations must be nearly 150 mg/L, as per Department of environment (doe regulations. The effluent in it sewers are highly filthy.

3.13 Health Risk Assessment

Within study region, the maximum ADI readings 6.10E-03 milligrams was found for copper and the smallest 5.70E-06 mg/kg-day for Mercury, with the remainder of the metals falling somewhere between. Similarly, Cd has the highest HR 3.99, Zinc and Mercury get the lowest (0.01), and the rest of both the elements are somewhere in there. Because of its poisonous characteristics, higher proportion, as well as lower REfD rating, Cadmium does have a greater Health hazard list valuation. Metal including such Chromium, iron, copper, as well as Zinc, and as per the USEPA, provide little permanent danger to the indigenous residents when consumed through treated wastewater because the health hazed list ratios are less below 1. Therefore, in terms of arsenic and Cd contamination or poisoning, the populations could be at a low cost devices risk. This research region's oxidative stress and risk was evaluated exclusively with As and determined to also be 1.26E-09. A Crs appropriate protective than in a thousand, according the USEPA, were considered important. While a quantities of drinkable water may represent a really minimal disease risk to residents, according the findings. ADD = 0.0006746032 mg/kg.day and RFD for Chromium is 0.003 mg/kg.day so that Hazard Quotient is equal to the 0.225 this result showed that HQ for Chromium is less than 1 so population is safe. HQ for Arsenic is greater than 1 so population is at risk. HQ for Copper is less than 1 so population is safe. HQ for iron is less than 1 so population is safe.

4. Conclusion

The current study demonstrated that groundwater at the research site in the surrounding areas of Chokera wastewater treatment plant and the Paharrang drain are heavily contaminated due to higher concentrations of metallic cations and other heavy metals which include copper and chromium. Non - uniform trend of dispersion of areas with higher values of significant parameters have been observed. However thick clusters of these parameters can be observed in the regions nearer to the Paharrang drain and the treatment plant. It clearly depicted the impact of influx of different parameters leaching from the Chokera treatment plant and the Paharrang drain into the soil layers and gradually joining the groundwater aquifers. All-out attentiveness of As (594 mg/L) existed verified among all the samples in the study area. In addition, magnesium and calcium amounts in almost all of the tests exceeded the permitted levels. Water quality index also described the groundwater quality index not fit for drinking purpose as most of points the values observed were higher, not recommending the water quality for drinking purpose.

References

Ahmad, S. 1993. Viability of Agriculture Resource Base. A Critical Appraisal. In Agricultural Strategies in the 1990s: Issues and Options. Pakistan Association of Agricultural Social Scientists, Islamabad, 449-466.

Ahmad, S. 2005. Background Paper on Evapotranspiration and Water Balance. Water Country Assistance Strategy. Pakistan Economy Getting Dry. World Bank Resident Mission, Pakistan. 38, 449-466.

Ahmed, S.and M. F. Joyia .2003. Northern Areas Sustainable Development Strategy. NASDS Background Paper. Water IUCN Pakistan, Northern Areas Programme, Gilgit 66: 71-79.

Agelos. P., E. Dovriki, N. R. Panagiotis , I. Rigas, M.Kokkoraand P. Papastergiou. 2010. Assessment and Modelling of Groundwater Quality Data by Environmetric Methods in the Context of Public Health. Water Resour Manage. 24: 3257–3278.

APHA. 1998. Standard Method for Examination of Water Wastewater 20th ed. 1998. APHA AWWA WEF.

Azizullah, A., Muhammad, N.K., Khattak P,R., Donat-Peter, H. 2011. Water pollution in Pakistan and its impact on public health — A review. Environment International. 37, 2, 479-497.

Farooq, S., Hashmi. I, I.A.Qazi, S, Rasheed, S. 2008. Monitoring of coliforms and chlorine residual in water distribution network of Rawalpindi, Pakistan. Environ Monit Assess. 140: 339–347.

Hinrichsen, D., Tacio, H. The coming freshwater crisis is already here. 2002. The linkages between population and water. Washington, DC: Woodrow Wilson International Center for Scholars; 294: 115–21.

Hashmi I, Farooq S, Qaiser S. 2009. Chlorination and water quality monitoring within a public drinking water supply in Rawalpindi Cantt (Westridge and Tench) area, Pakistan. Environ Monit Assess . 158: 393–403.

Samjwal, R., P. Bajracharya, K. Mool andR. B. Shrestha. 2006. The impact of global warming on the glaciers of the Himalaya. African Journal of Ennvironmental Science and Technology. 46: 231 – 242.

The Gazette of Pakistan, Ministry of Environment, Local Government and Rural Development, Islamabad,SRO, 549(I)/2000, National Environmental Quality Standards for the Municipal and Liquid Industrial Effluents. 2000. 2-4.

Tyagi S, Singh P, Sharma B, Singh R. 2014. Assessment of water quality for drinking purpose in District Pauri of Uttarkhand India. Appl Ecol Environ Sci; 2(4): 94–9.

USEPA. 2005. Guidelines for carcinogen risk assessment. Risk Assessment Forum, United States Enviromental Protection Agency, Washington, DC. EPA-630: 03-001.

WHO (World Health Organization). 2004. Guidelines for Drinking Water Quality, 2nd ed, Recommendation. Geneva, Switzerland, 1.

Yisa J. and T. Jimoh. 2010. Analytical studies on water quality index of river Landzu. Am J Appl Sci; 7: 453–8.