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ASSESSING THE RISKS OF WASTEWATER CONTAMINATION IN URBAN ECOSYSTEMS: A STUDY OF GUJRAT CITY, PUNJAB, PAKISTAN

Muhammad Aleem Sarwar[1], Arooj Akbar[2], Arif Husain[3], Sajid Ali[4], Zahid Hassan Tarar[2], Sher Afzal[5]*, Muhammad Shoaib Aslam[5], Irfan Ahmad Saleem[6], Saiqah Toor[6], Muhammad Saleem[7], Saeed Ur Rehman[8], Abdul Ghaffar Khan[9], Allah Nawaz[10], Abid Ali[11], Hafiz Riaz Ahmad[9]

[1]**Soil & Water Testing Laboratory for Research,** Ayub Agricultural Research Institute, Faisalabad, Pakistan
[2]**Soil & Water Testing Laboratory,** Mandi Baha ud Din, Pakistan
[3]**Department of Soil and Environmental Sciences,** Ghazi University, Dera Ghazi Khan, Pakistan
[4]**Soil &Water Testing Laboratory,** Jhang, Pakistan
[5]**Soil & Water Testing Laboratory,** Jhelum, Pakistan
[6]**Soil & Water Testing Laboratory,** Gujrat, Pakistan
[7]**Soil & Water Testing Laboratory,** Okara, Pakistan
[8]**Soil & Water Testing Laboratory,** Bahawalpur, Pakistan
[9]**Soil Fertility Section,** Soil Fertility Research Institute, Punjab, Lahore, Pakistan
[10]**Soil Chemistry Section,** Ayub Agricultural Research Institute, Faisalabad, Pakistan
[11]**Regional Agricultural Research Institute**, Bahawalpur, Pakistan

***Corresponding Author:** Sher Afzal. E. mail: sherafzal78@yahoo.com

Abstract

Over the last decade, the rapid growth of population, urbanization, industrialization, increased demand for water and energy for a better quality of life, has been the talk of the town these days, which illustrates the future of wastewater in developing countries. The sudden increase in population and the mismanagement of water put stress on the supply of water which resulting in the reuse of untreated wastewater for agriculture. It will affect other life activities, such as those that pose a significant risk to global food security. The waste water itself doesn't only contain the nutrients which can be used by the plants for their growth but also contains the chemicals and heavy metals which pose a greater negative impact on environment and human health. The food irrigated by the wastewater is consumed by humans, then it becomes a part of the food chain and causes health issues. Present research is carried out for the characterization and risk assessment of wastewater at different locations of Gujarat city, Pakistan. Different parameters were analyzed which showed that majority of samples have a concentration of pH from (7.96-8.74), temperature (31-38 ºC), which is under acceptable limit by the national environment quality standard of pH (6.5-10) and temperature (40 ºC), Sodium (139.750-172.500 mg/L), and heavy metals such as iron (0.273-0.473 mg/L), manganese (0.048-1.35 mg/L) within standard limits. However, due to the contamination and leakage of the sewage system and mixing of different solvents in water, there is an increase in the concentration of residual sodium carbonate, heavy metals such as lead, and total dissolved solids, more than the accepted limits of the national environmental quality standard. Due to the contamination of water, the prevalence of waterborne diseases like cholera, typhoid, dysentery, and diarrhea increases. Regular monitoring of the quality of water using physicochemical parameters will provide a better quality of public health and the environment.

Keywords: *Heavy metals, Parameter, Public health, Quality of water, Risk assessment*

INTRODUCTION

Water plays a significant role in human life. According to Albert Szent-Gyorgyi "WATER IS LIFE'S MATER AND MATRIX, MOTHER AND MEDIUM. THERE IS NO LIFE WITHOUT WATER."Currently, about half of the global population faces severe water scarcity for at least part of the year. Furthermore, onequarter of the world's population is subjected to "extremely high" levels of water stress, utilizing over 80% of their annual renewable freshwater supply. Currently, over 75% of groundwater is used for irrigation, and the ongoing depletion of these water resources presents a major threat not only to economic stability but also to national food security. Freshwater use has been increasing at a rate of just less than 1% annually, driven by a combination of socio-economic development and changes in consumption patterns, including dietary shifts. While agriculture accounts for approximately 70% of global freshwater withdrawals, industrial (around 20%) and domestic (about 10%) uses are becoming key contributors to rising water demand. As economies industrialize, populations urbanize, and water supply and sanitation systems expand, the demand for water continues to grow. However, the effects of population growth are less pronounced in regions where per capita water use is the lowest, typically those experiencing the fastest population increases (1).

Ocean is the largest reservoir which contain 97% of water while only 3% of water is available on earth in the form of fresh water out of which only 0.01% used by human (2,3). Due to sudden increase in population and human activities like agriculture and industrialization, the demand of good quality of water also increases. To fulfill this demand, groundwater use as a source of fresh water becomes more important, which consist of 0.61% of total world water (4). Pakistan is one of the developing countries which depend on the financial aid from the developed countries for their development. One of the issues in Pakistan is that people are facing the scarcity of water and unfortunately there are many regions of Pakistan where the quality of drinking water is below the standard level. The research studies have shown that only 25.61% have access for clean water. Although ground water itself is radical free but due to some anthropogenic activities like dumping of waste on ground and some geological reasons like weathering and precipitation, pollutant leach out into the ground water and cause pollution which not only affect the quality of water but also public health (5). Several research studies have been conducted which show the toxic chemicals like chromium (Cr), copper (Cu), arsenic (Ar), iron (I), fluoride (F), lead (Pb), zinc (Zn) alter the quality of water but also pose health risks (4). Heavy metals are naturally occurring elements that, at elevated concentrations, can pose substantial health risks to humans, even with limited exposure. These metals are termed "heavy" because of their high atomic mass and density, which often correlate with their toxicological potential. The most concerning heavy metals in drinking water are Cadmium (Cd), lead (Pb), Arsenic (As), Mercury (Hg), and Chromium (Cr). These metals can cause harm to various physiological systems, including the nervous, renal, and cardiovascular systems. Prolonged exposure to certain heavy metals may lead to carcinogenic effects, as well as developmental, neurological, and immune system dysfunction (6). According to the world health organization (WHO) arsenic is one of the most harmful element in the environment which causes many health issues like cancer, leukemia, and fertility problems in male and female (7). Due to the rapid industrialization and urbanization a large amount of untreated water is being disposed into the surface water. Due to the shortage of water, many people are using this untreated wastewater for irrigation purposes which transfer these pollutants into the crops and when these crops are consumed by the humans in the form of food cause diseases (8). Water contamination, specifically through the presence of toxic heavy metals, represents a critical public health concern in Pakistan. Among 122 nations, Pakistan is ranked 80th in terms of access to safe drinking water. Both surface and groundwater resources across the country are progressively contaminated with hazardous metals, frequently exceeding the permissible limits set by the World Health Organization (WHO) and the Pakistan Environmental Protection Agency (Pak EPA). Key health risk parameters, including Chronic Daily Intake (CDI) and the Health Risk Index (HRI), are consistently elevated beyond established safety thresholds. The primary sources of water contamination include industrial effluents, inadequate disposal of municipal waste, and extensive use of agrochemicals. The accumulation of heavy metals in water bodies presents substantial risks to human health and the surrounding ecological systems (9).

Many countries like China, India, Pakistan, Egypt, and Morocco .farmers use wastewater for irrigation purposes as a source of nutrients (10). Due to sudden increase in human activities like industrialization urbanization agriculture and other commercial activities put a stress on the demand of the water supply. Industrial wastewater contamination represents a significant threat to both human and environmental health, particularly in developing countries. Access to safe drinking water is limited, with only an estimated 23.5% of the rural population and 30% of the urban population having reliable access to potable water (10). The wastewater discharge into water bodies without any processing also threat aquatic life and habitat and cause eutrophication the excess of nutrients in water bodies which produce algae which not let sunlight to reach under the water and use dissolve oxygen in water bodies and cause death of aquatic life. (12). The release of heavy metals into the environment poses a significant risk, as these contaminants can travel through the food chain and result in severe health effects. Untreated wastewater discharge and improper sewage disposal contribute substantially to the contamination of soils with heavy metals. In agricultural areas irrigated with industrial wastewater, the soils often accumulate high concentrations of heavy metals, which then bio accumulate in plants. These metals are transferred through the food chain, leading to considerable health risks for consumers. While the average concentrations of heavy metals such as chromium, copper, lead, and nickel in soils generally remain within permissible limits, the significant transfer of these metals from soil to plant, driven by biological magnification, raises serious concerns regarding their long-term health impacts (13). The objectives of this study were the characterization of drinking and wastewater, by physiochemical analysis and evaluation of associated risks in humans on the base of human perception of relevant areas of Gujrat.

MATERIALS AND METHODS

TARGET AREA AND SAMPLING SITES

The target area for this study was Gujrat, located almost 120 km distance from Lahore 150 Km from Islamabad at the bank of river Chenab. Its population is almost 3219375 and considered as the 20th largest city of Pakistan. Gujrat cover an area approximately 3192 square km (Pakistan Bureau of Statistics 2023). The waste water samples which have collected from the different sites of Gujrat are abbreviated as "B".

SAMPLE COLLECTION

Water samples have been collected from various points of Gujrat which have been described in Table I, in polystyrene bottles of 500 ml storage capacity labeled with a unique code. Two samples had been collected from each site, i.e. sample No.1 for basic parameters analysis, e.g. pH, EC, TDS etc. and Sample No.2 for Heavy metal analysis. The bottles used for the collection of sample for heavy metal analysis have been washed with distilled water to avoid any contaminations and the treated with 5 % for the preservation of trace element especially for those of heavy metal analysis (14). The preliminary preparation of water samples for basic parameter analysis was carried out at the Soil and Water Testing Laboratories in Gujrat and Jhelum. Subsequently, the samples were sent to the Soil and Water Testing Laboratory in Mandi Baha ud Din for the determination of heavy metal concentrations in the collected water samples. The samples were labeled with the specified code. After collection, the samples were refrigerated at 4 °C in an ice bag to prevent changes in chemical composition. The samples were transported to the laboratory. To ensure quality control during sample collection and handling, all necessary precautions were taken to minimize contamination. Equipment was regularly calibrated, and the accuracy of analytical results was verified by analyzing blank samples and replicate samples under identical conditions. All chemicals and reagents used were of analytical reagent grade quality. Glass and plastic ware were thoroughly cleaned by soaking in 14% HNO3 overnight, followed by multiple rinses with de ionized water. During transport, samples were kept in insulated containers, particularly to prevent contamination or evaporation, and were analyzed within 24 h of collection (15).

Table I. Sampling sites of Gujrat

Service Mor B1 Jail chowk B2	Shadola darwaza B8 Dhaki darwaza B9	Kurree B15, Sarai Alamgir B16,	Sehna B22, Rindheer B23,
GTS chowk B3	Sheeshian/wala darwaza B10	Tanda B17,	Bangial B24,
Muslim bazaar B4	Shah Faisal gate B11	Goch B18	Mangowal B25,
Nawazada B5 Medina Bazaar B6	Kunjah Dinga B12 Kharian B13	Bareela B19, Chopala B20,	Marala B26, Karnana B27
Urdu bazaar B7	Barnali B14	Deona B21,	

LABORATORY ANALYSIS

The collected waste water samples were analyzed in the laboratory for physiochemical parameters while observing the directions of Soil Fertility Research Institute, Punjab Lahore. The pH was measured by the standard method by pH meter (Thermo Scientific), TDS (total dissolve solids), electrical conductivity (EC) via EC meter (Orion Star A0151), while sodium, carbonate, calcium, magnesium, bicarbonate, chloride, by the water corrosion mineral scale residual sodium carbonate (RSC), and sodium adsorption ratio (SAR) according to SFRI Guide (16).The estimation of various metal ions such as copper (Cu), manganese (Mn), lead (Pb), iron (Fe), zinc (Zn), Aluminum (Al) with the help Atomic Absorption Spectrophotometer (Model AAS-iCE 3000 Series Thermo Scientific with VP 100 Vapour System. Hollow cathode lamps were utilized for each metal at specific wavelengths: Copper (Cu) at 324.8 nm, Cadmium (Cd) at 228.8 nm, Lead (Pb) at 217.0 nm, Zinc (Zn) at 213.9 nm, Mercury (Hg) at 253.6 nm, Chromium (Cr) at 257.9 nm, Iron (Fe) at 248.3 nm, and Nickel (Ni) at 232 nm (17). Due to budgetary issues, some randomly selected water samples were analyzed for the assessment of heavy metals.

STATISTICAL ANALYSIS

The obtained data of physiochemical properties and heavy metals as well of collected wastewater samples have been analyzed statistically with the help of Minitab statistical software MINITAB® Release 14.1 (Minitab Inc. State College, PA, USA). The main aim of this research was to evaluate the risk assessment of waste water on human health by the human perception. It usually includes the formation of questionnaire and the methods use for the analysis of data of questionnaire.

RESULTS AND DISCUSSION

The Table II shows the mean concentration of physiochemical parameters of sampling sites of targeted areas of Gujrat district. According to this table water samples of different site have color yellow to light yellow and the range of pH is from 7.97-8.74 which is acceptable under the standard value of water pH (6-9) according to the Pakistan National environmental quality standards and Punjab Environmental quality standards (18,19)The higher pH was reported at the site B16 (Sarai Alamgir) which was 8.74 may be the result of agriculture runoff, percolation of sewage water, originated from artificial fertilizer and alkaline detergents in wastewater, leaching of waste and higher nutrients level due to the use of chemical solvents like cleansing solvents. While the lowest pH at the site B25 (Mangowal)was observed as 7.97. The temperature value of the water sample which has been analyzed is up to 31°C- 38 °C which is under the acceptable limit within water standard range of (40°C) according to the Pakistan National environmental quality standards and world health organization. The highest temperature 38°C was reported at the site B4 (Muslim bazaar), B7, B12, B13, B19 & B23 as well. While the lowest temperature of 31°C at the site B1 (Service Mor) & some other sites e.g, B5, B6, B10, B18, B21, B24 and B25 was recorded. Electrical conductivity (Ec), the amount of salt and minerals dissolved which show the water proficiency to carry the electric current, was measured with great care after standardizing the EC meter. The range of EC value of the water samples is from 677.5 to 1234.5 µS/cm in Gujrat which has been shown in Table I. The Ec value of water exceeded from standard limits which is 1000 µS/cm according to the Pakistan national environmental quality standard at the site B16 (Sarai Alamgir) which was 1234.5 µS/cm. Such waste water could not be used for irrigation of crops due to its high EC values. According to SFRI Guide II, such water is unfit for irrigation purpose (16). This maybe the result of agriculture runoff, percolation of sewage water, municipal wastewater dispose off in open areas without any pre treatment or leaching of waste in groundwater (20). While the lowest Ec at the site of B19 (Bareela) 677.5µS/cm was noted. Majority of the sample have TDS (total dissolve solids) within standard range which is almost 3500 mg/L according to the Pakistan national environment quality standard and WHO standard for irrigation and other purposes. The higher TDS was reported at the site B14 (Barnali) which was 2882.25 mg/L, while the lowest TDS of 767.25mg/L was calculated at the site B10 (Shesian wala Darwaza). It has been described that the exceeded value of TDS of wastewater sample can be qualified by the cleansing of reactors and softeners and back washes of filters. In agriculture fields, TDS play vital role in the plant growth and yield of crops. The higher amount can pose a negative impact on crop production which result in a stress on our food production (21). India gives standards for this parameter as 500 mg/l, 1500mg/l and 2100 mg/l for class AA, B and D respectively. Alberta (Canada), FAO, Pakistan WAPDA, PCRWR Pakistan and NEQS (Pakistan)give its standards as 500-3500 mg/l, 450-2000 mg/l, 1000-1500 mg/l,800-2000 mg/l and3500 mg/l for irrigation water respectively. Florida gives standard for this parameter as <500 monthly avg., 1000 max. in mg/l only for class AA. The Soil Fertility Research Institute, Punjab, Lahore is dealing with the research in soil and water with special reference to agriculture, has formulated the following criteria for TDS related parameter of water (16).

Table II. Analysis of physico-chemical properties of sewage water samples of target areas of Gujrat

Sample Sites	Color	Odor	tem. (°C)	pH	EC (μs/cm)	TDS	HCO3	Na+	K+	Ca+	Mg+	SAR	RSC
						(mgL-1)							(meL-1)
B1	*L/Y	NO	31	8.39	999	846	504	131.5	7.65	200.5	143	3.6375	3.0125
B2	L/Y	NO	32	8.44	1144	918	576.50	142.50	10.575	255.75	180.75	3.4975	2.66
B3	L/Y	NO	34	8.44	979	867.5	494.25	126	6.5	205.25	147	3.59	2.745
B4	L/Y	NO	38	8.51	1208	1921	608.50	148.75	7.975	266.25	188.75	3.755	2.845
B5	BL	Pungent	31	8.46	981	824.25	495	124.75	6.775	220.25	156.25	4.255	-0.205
B6	BL	Pungent	31	8.61	1083	854	546	136.75	8.05	243.75	169.5	4.6025	-1.74
B7	BL	Pungent	38	8.24	722	1695	365.50	94	4.25	159.5	109.25	4	-1.82
B8	L/Y	NO	36	8.34	912	1765.75	460.50	119.25	6.475	198.5	134.75	3.8175	-1.135
B9	BL	Pungent	37	8.29	752	2715	380.50	102	4.925	164.25	109.75	3.67	-1.1025
B10	Y	NO	31	8.41	938	767.25	473.50	123.75	6.475	198.25	141	5.2975	1.4475
B11	L/Y	NO	32	8.29	739	1672.50	374	92.5	4.025	176.25	110.5	5.286	3.205
B12	Y	NO	38	8.54	1044	776.25	526.50	133	5.3	232.75	160.5	5.37	3.95
B13	Y	NO	38	8.54	997	815.75	503.25	124.25	2.825	215.5	151.75	5.9925	4.5075
B14	Y	NO	34	8.69	1192	2882.25	600.50	149.50	4.475	253	194.75	5.41	1.35
B15	BL	Pungent	36	8.59	1037	839.25	523.25	131	4.075	226.5	154.75	5.2975	1.55
B16	Y	NO	35	8.74	1234	889	621.75	157	5.475	252.75	200.25	4.5125	-2.1275
B17	Y	NO	35	8.69	1058	2791.25	533.50	134.50	3.575	230.25	160	4.635	-2.8925
B18	L/Y	NO	31	8.71	1179	1048.50	594.25	165	5.6	267.75	196.5	4.935	-1.41
B19	L/Y	NO	38	8.41	677	1573.5	343.25	130.25	3.8	219	149.5	4.0825	1.2375

*Y=Yellow, L/Y=Light yellow, BL=Blakish

Electrical conductivity is sometimes used as a measure of the total dissolved solids due to its ease in measurement. Electrical conductivity (EC) measurements can be converted into TDS by applying appropriate conversion factor (22). To better understand the environmental impacts of disposing high-salt concentration effluents, an analysis was conducted on the levels of various cations, including sodium (Na^+), potassium (K^+), magnesium (Mg^{++}), and calcium (Ca^{++}). The wastewater samples collected from different sites in Gujrat revealed that sodium concentrations ranged from 92.5 to 193.25 mg/L, which fall within the permissible limits for irrigation as per the WWF guidelines (2007). However, elevated sodium levels can potentially affect soil sodicity, altering soil structure and negatively impacting plant growth, crop yields, and even leading to plant mortality. The Sodium Adsorption Ratio (SAR) is used to assess the sodium content in water and its potential effects on soil structure and water retention capacity. Table 2 provides the SAR values for various sampling sites in Gujrat (B1-B28).

SAR = Na [(Ca + Mg)/2]$^{1/2}$ is the formula used to calculate SAR of water.

According to the analysis of wastewater samples, it has been shown that the SAR is greater than the 6 in case of B23 to B28 which make it marginally fit for the reuse of wastewater for irrigation purposes (23). The evaluation of sodium adsorption ratio SAR shows the concentration of sodium comparative to the Ca and Mg presents in wastewater. The higher amount of the sodium when come in contact with sludge can replace the concentration of salts like magnesium (Mg) and calcium ions (Ca) which result in the disfigurement of soil construction and it also affect the quality of soil to hold air and water. However, elevated Na+ concentrations can lead to soil sodicity, potentially altering soil structure and negatively impacting plant growth, crop yields, and even causing plant mortality. As a result of which the concentration of heavy metal decrease as alternate the pH range increase which effect soil fertility (24 & 25). According Qazi et al 2021(16) there are three limits for sodium adsorption range for irrigation purposes on the base of groundwater the range of SAR less than (<6), is considered as the acceptable limit while the range that from 6-10 is marginally acceptable while the ration which exceed from (>10) is unacceptable. The table 1 shows that the range of sodium adsorption range is 3.098 to 6.948 which indicates almost 81% waste water samples have SAR range which is fit for irrigation purpose. The amount of bicarbonates present in water is described as the residual sodium carbonates RSCs.

Due to a high level of bicarbonates in water increase in pH of water by suspension of organic matter and also increase the amount of sodium ion Na^+ (meq/L) present in soil could occur. The amount of acceptable limit of bicarbonates is (<1.25), marginal acceptable limit (1.25 – 2.5), and intolerable limit is (>2.5). In this research it has been shown that the range of RSC of wastewater sample lies from 0.068 to 4.508 meq/L which shows that 35% water samples are under un acceptable limit while 65% are under permissible & marginal acceptable limit which can be reuse for irrigation purposes. The wastewater which contains high level of RSC can be reused for irrigation purposes but with the help of special irrigation management technique which need continues monitoring of soil status by laboratory testing (23).

Table III. Irrigation water quality standards interpreted by SFRI, Punjab, Lahore

Water quality indicator	Status	Guide line value
EC(µS/cm)	Suitable	<1000
	Marginal	1000-1200
	Unsuitable	>1200
SAR	Suitable	<6
	Marginal	6-10
	Unsuitable	>10
RSC(me/L)	Suitable	<1.25
	Marginal	1.25-2.5
	Unsuitable	>2.5
Cl^{-1}(me/L)	Suitable	<4.5
	Unsuitable	>4.5
TDS(mgL^{-1})	Suitable	≤640
	Marginal	641-800
	Unsuitable	>800

DESCRIPTION OF HEAVY METALS PRESENT IN WATER OF GUJRAT

The concentrations of different metals of different wastewater sample which have been analyzed are shown in table 4. It is interesting to mention that cadmium & Chromium were not detected in wastewater sample. However the other toxic metals such as Fe, Cu, Zn, Mn, Pb & Al have been analyzed and found to be under acceptable limits as described by WHO and Pak-EPA (18).

The most polluting metal was Aluminum with maximum concentration of 13.165±0.159269 to 14.0875±0.098784 mg/L several magnitudes higher than WHO (0.01 mg/L) and PAK-EPA standards (0.05mg/L) in wastewater (26).The second most concentrated metal was lead 0.033333±0.005774 to 0.7875±0.027538 mg/ for Pb which is above WHO (0.5mg/L).Fortunately, only a single water samples is containing dangerous limits of Pb. Same results were quoted by (27).The Fe concentration in wastewater samples of different sites collectively is ranged from 0.07±0.29439 to 0.5025± 0.049917 mg/L which is under permissible limit of (28).Similarly, concentration of other heavy metals ranged from 0.075±0.00707 to 0.1875±0.009574 mg/L for Cu, 0.075±0.00707 to 0.256667±0.015275mg/L for Mn, and 0.066667±0.020817 to 0.18±0.014142 mg/L for Zn and. In general, wastewater samples were the most contaminated by lead (all sampling sites combined). the wastewater release from service industries and fan industries of city it also some old buildings in that area have lead based paints which also increase concentration of lead which produce toxic effect on human in the form cardiac dysfunction lead poising hypertension and high blood pressure. In a recent study conducted by Raza et al in 2021(22) , it was observed that In the case of Pb metal, the highest concentration of Pb (0.634± 0.048) was recorded in textile effluents which is higher than the WHO permissible limits (0.01mg/L) in wastewater. The trend of Pb was (0.634 ±0.048), (0.578 ± 0.032) and (0.286 ± 0.020) in textile, chemical and ghee industrial effluents, respectively but in ghee effluents, the Pb concentration was below the permissible limits. If the concentration of these metal increase from standard limit then they combine with food chain by the irrigation process by wastewater or when discharge into water bodies which later on uptake by human which as a result pose negative impact on human in the form of waterborne disease. It also affect ecology by putting a stress on the quality of food chain and aquatic life.

Table IV shows the physiochemical parameters and concentration of heavy metal which are analyzed by the wastewater sampling of different sites (n=28) were used in order to find the interaction level of heavy metals with physiochemical parameters with the help of Pearson correlation coefficient matrix (r). For this purpose some element were pair as Fe/Mn, Fe/Zn (the correlation of element which are near to 1 are positive related have same source and process while the element which are far away from 1 show negative correlation and alter process. Fe/Mn (r-0.19585) were negative related while the element pair (Fe/Zn (0.248332) are positively correlated. The Fe/Zn element show that these element have similar source and chemical process while the element which are Fe/Zn correlated show the reverse phenomena. Certain metals exhibited the positive and negative correlation with that of physicochemical parameters. For example, pairs Fe/pH (-0.42378) PH/Mn (-0.02113), TDS/Zn (-0.15057) EC /Pb (-0.21269) were negatively related while PH/Cu (0.020529) EC/Mn (0.339428) TDS/Al (0.070627) are positively correlated. Lead (Pb) has poor connection with crystalline oxides while some metals like chromium (Cr) absorb easily by soil under these condition. The co precipitation of metallic ions increases under acidic condition of water that range from (pH value <6) (28). It was further revealed by many scientists that that long term use of such effluents for irrigation may cause accumulation of toxic metals in soils, which may lead to their elevated levels in plants through bioaccumulation. Consumption of such plants may pose a potential threat to animal health. Moreover, accumulation of heavy metals in soil reduces the size of soil microbial biomass and results in development of metal tolerant bacterial species (29).

Table IV. Mean and standard deviation of concentration of metals in wastewater sample analyzed for different sites of Gujrat

	Fe	**Cu**	**Zn**	**Mn**	**Pb**	**AI**
Sampling sites	**(mgL^{-1})**					
Service Mor B1	0.1625+0.022174	0.17+0.26458	0.14+0.01	0.256667+0.01527	0.033333+0.005774	14.0875+0.098784
Shadola Darwaza B8	0.1375+0.079739	0.085+0.007071	0.18+0.014142	0.135+0.007071	0.045+0.00707	13.5175+0.153921
Shah Faisal Gate B11	0.17+0.029439	0.075+0.00707	0.14+0.01	0.075+0.00707	0.27+0.056569	13.375+0.322749
Goch B18	0.17+0.123018	0.165+0.007071	0.145+0.007071	0.085+0.0070071	0.22+0.014142	13.3475+0.288834
Bareela B19	0.07+0.29439	0.1875+0.009574	0.066667+0.020817	0.19+0.01	0.1175+0.057373	13.165+0.159269
Sehna B 22	0.4775+0.020616	0.08+0.014142	0.085+0.007071	0.0925+0.0095740.2875+0.055	0.787+0.027538	14.0375+0.29657
Karnana B27	0.5025+0.049917	0.105+0.021213	0.075+0.0007071	0.10.021602	0.2875+0.055	13.6325+0.13149

Table v. Pearson correlation matrix (r) of analyzed wastewater sample of Jhelum to describe the interaction among physiochemical parameters (n - 20)

Variables	Fe	Mn	Zn	Al	Cu	Pb	pH	EC	TDS
Fe	1								
Mn	-0.19585	1							
Zn	0.248332	0.189665	1						
Al	0.067874	0.62463	-0.02284	1					
Cu	-0.16139	0.0808464	-0.08079	0.690978	1				
Pb	0.573624	-0.50345	-0.06554	-0.29266	-0.41395	1			
pH	-0.42378	-0.02113	-0.51186	-0.07646	0.020529	-0.04982	1		
EC	-0.31197	0.339428	-0.20198	0.070627	0.103219	-0.21269	0.680106		
TDS	0.10686	-0.03847	-0.15057	0.070627	0.226878	0.120166	0.387337	-0.13717	1

CONCLUSION

Due to sudden growth of industrialization, urbanization and population, the demand of water increase which put a pressure on water supply and quality of water as a result reuse of water for irrigation and other purpose. The water sample which has been analyzed have a pH range (7.945- 8.5) and the temperature is (31-38°C) which is under the standard by NEQS and WHO pH (6.5- 10) and temperature (40°C). By the analysis of sodium, calcium, magnesium and residual sodium carbonate it has been suggested that 20% wastewater sample are under unacceptable limit while 70% under permissible limit while 23 % under marginal acceptable limit which can be reuse for irrigation purpose sodium adsorption range is 3.708 to 6.333 which indicate almost wastewater sample which have been analyzed have SAR range which is fit for irrigation purposes. Different metals of wastewater sample have been analyzed which include, Fe, Mn, Cu, Zn, and Pb, Al. The metals in toxic concentrations were Pb at Service Morr and Medina bazaar from (0.07-0.09) Pearson correlation coefficient matrix has been analyzed to suggest that the metals interaction with different physiochemical parameter and help in the characterization of wastewater. The discharge of wastewater directly in water bodies and without any pre treatment leakage of sewage and intermixing with ground as a result of poor management put the risk on human health in the form of waterborne disease like diarrhea dysentery cholera and typhoid fever which cause death of millions of peoples.

FUTURE RECOMENDATIONS

There is some recommendation for sustainable wastewater management

We should involve the public participation and provide awareness to the people about the health and environmental impacts of wastewater. The disposal of wastewater from industries and municipal discharge without any pre treatment in the water bodies should be treated before discharge NEQS should be opted in Pakistan for various water discharges from industries Need of time is to shift towards new technologies of wastewater treatment in order to sustainable development. Monitoring of wastewater should be done frequently to observe any sudden non permissible limit of contaminant in them and later adopting a strategy to remediate. Industries should follow the environment quality standards for the wastewater for a sustainable environment. As a nation we should be adhered to SDG 6 of WHO or Sustainable Development Goal 6, refers to "Clean Water and Sanitation," aiming to ensure universal and equitable access to safe and affordable drinking water and sanitation for all people, while also focusing on sustainable water resource management and improving water quality globally.

Conflict of interest:

There is no conflict of interest among authors regarding this article.

Authors` contribution:

MAS, SA,MSA conducted the research work & performed analytical work; AA, AH, SA composed the paper; ZHT performed proof reading and editing; MS, IAS, ST conceptualized and supervised the research work; SUR, AG critically reviewed the manuscript; AN, AA analyzed the data statistically, HRA Reviewed the literature .

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