Assessment of Wastewater Characteristics for Irrigation in Faisalabad

Muhammad Asif Hanif Bhatti, Abdul Aleem, Ali Akbar

Abstract– Rapidly growing population and industry has increased the wastewater generation and fresh water demand. The lack of management in sewerage system and deficiency of treatment plants resulted in wastewater discharge into drains and also used for irrigation at various points which affect agriculture, environment and freshwater resources. Both the industrial and domestic wastewater of Faisalabad city is collected through the network of 34 disposal stations and disposed into two main rivers i.e. Ravi and Chenab. Firstly, field was surveyed and samples were taken from fourteen disposal stations in industrial, domestic and commercial areas. These samples were analyzed for various physico-chemical parameters such as pH, EC, TDS, BOD, COD, Ca, Mg, Cl, turbidity, bicarbonates and heavy metals and the results were compared with National Environmental Quality Standards (NEQS) and FAO guidelines for irrigation. From results it was concluded that the wastewater effluents were not fit for irrigation purpose and use of this water for irrigation may cause harmful impacts on crops and groundwater resources.

Keywords– Wastewater, Disposal Stations, Irrigation, FAO, Groundwater

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1 INTRODUCTION

Faisalabad is the hub of industries and a large number of textile industries are working in the city with 280 full scale textile units in function. The safe disposal of wastewater is a big challenge for authorities as topography of the city is flat and does not allow water to flow under gravity. All the industrial and domestic wastewater of the city is managed through 34 disposal stations installed at different locations by WASA Faisalabad. For this purpose, the city is divided into eastern and western zones. The Madhuana Drain collects the wastewater of eastern region and dispose into river Ravi while Paharang Drain collects the water from western region and discharge into river Chenab. Estimated discharge of the city is about 580 MGD while only a wastewater treatment plant of capacity 20 MGD is operating under WASA which is not enough for safe disposal of wastewater [1].

The industrial and municipal wastewater is commonly used in all over the world [2]. It is estimated that more than 20 million hectares of land is irrigated with partially or untreated wastewater in more than 50 countries [3]. Farmers prefer wastewater irrigation because of the fact that it contains nutrients and increase output [4]. Fresh water availability is a major problem and about 60% of population has no access to drinking water in developing countries. It is reported that more than 3.5 million people die each year in the world due to water related diseases [5].

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Textile industry has biggest contribution in degrading the quality of water. Direct disposal of wastewater by these industries into rivers and lakes is not only spoiling environment but also causing harmful impacts on organisms. The industrial effluent should never be directly discharged into drinking water source because it contains sulfate contents in large quantity and presence of sulfate in drinking water may cause cathartic action [6]. Chloride content in wastewater with other parameters indicates the pollution level in wastewater and high content of chloride may be harmful for crops and damage metallic pipes [7]. Assessment of different chemical parameters like pH, total dissolved solids, dissolved oxygen, alkalinity, conductivity, chloride. Sulfate, hardness could be used to determine the quality of water [8].

Water shortage is one of the serious issues of world due to socio economic development and population growth. To compensate this problem, the wastewater can be used as an alternative source of irrigation water. The use of wastewater without treatment could be harmful for human health and environment. Strong practices like suitable treatment and irrigation technologies could minimize the risks [9].

Severe shortage of irrigation water in Pakistan has adverse effect on agriculture in past few years. Municipal sewage water is used as a source of irrigation to overcome these issues but it contains many harmful elements like heavy metals, pathogens, soluble salts and suspended particles [10]. Agricultural crops especially vegetables are grown with untreated domestic effluents due to shortage of fresh water supplies. Both the domestic and industrial wastewater is disposed into same drain which at some points used as a source of irrigation and nutrients [11]. About one-tenth population of world is consuming food

which is produced by wastewater [12]. The use of untreated wastewater for irrigation is increasing due to increasing food insecurity and fertilizer costs, inadequate wastewater disposal and global water scarcity [13].

2 Materials and Methods

2.1 Description of Study Area

The city Faisalabad is situated in central part of Rechna Doab between latitude 30°42' to 31°47' North and longitude 72°40' to 73°40' East.

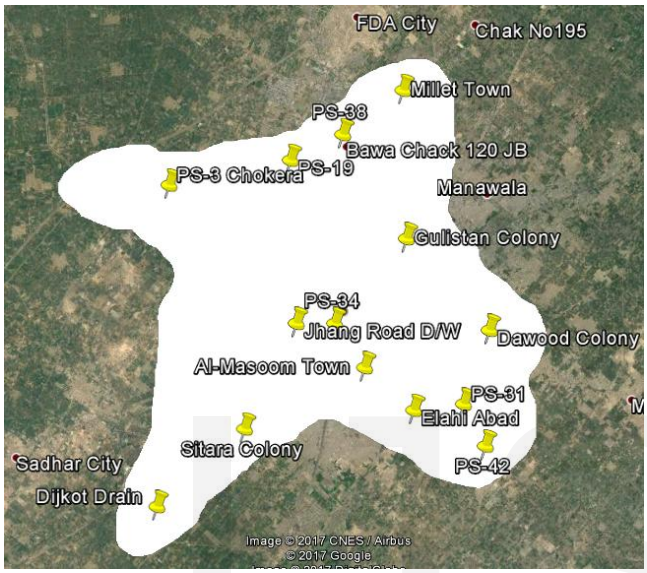

Fig. 1. Sampling points in study area

The geographical location of study area is shown in Fig. 1. Most of the major industries are located along various intercity roads like Faisalabad- Jarawala, Faisalabad-Sargodha, Faisalabad-Samundri, Faisalabad-Shahkot and Faisalabad-Jhang roads.

2.2 Sampling Plan

The samples were taken randomly from 14 wastewater disposal stations working under WASA. The quantity of each sample was taken 1000 mL and their co-ordinates were taken with the help of GPS receiver which gives us the location of points. After collection of samples, the samples were preserved and analyzed in laboratory of WASA Faisalabad. Physico-chemical characteristics of samples were determined and compared with standard values recommended by FAO and NEQS. Table 1 shows the methods and equipment used for analysis of wastewater characteristics.

TABLE 1
METHOD/EQUIPMENT USED FOR ANALYSIS OF WASTEWATER EFFLUENTS

Sr. No.	Parameter	Units	Method / Equipment Used
1	Temperature	°C	HANNA digital meter
2	pH	µc/cm	HANNA digital meter
3	EC	mg/l	HANNA digital meter
4	TDS	mg/l	HANNA digital meter
5	Calcium	mg/l	Titration / USEPA
6	Magnesium	mg/l	Titration / USEPA
7	Chloride	mg/l	Titration / USEPA
8	Sodium	mg/l	Titration / USEPA
9	Bicarbonates	mg/l	Titration / USEPA
10	COD	mg/l	Standard method by APHA
11	BOD_5	mg/l	DO meter
12	Heavy Metals	mg/l	Spectrometer

3 Results and Discussion

The present study was done to assess the quality of wastewater collected at different disposal stations in the city as it is directly disposed into drains and being used for irrigation purpose. Results of physic-chemical parameters and heavy metals are shown in table 2 and 3.

The results of pH value of wastewater was varied between 6.6 and 7.8 with mean value of 7.2. The maximum value was found in disposal station PS-31 and minimum value was found in Gulistan Colony-1 however, all the results for pH were within permissible when compared with NEQS and FAO guidelines

TABLE 2
RESULTS OF PHYSIC-CHEMICAL PARAMETERS OF WASTEWATER AT VARIOUS DISPOSAL STATIONS IN THE CITY

Sr. No	Location	Temp	EC	pH	TDS	Ca	Mg	Cl	Na	SAR	HCO3-	COD	BOD_5
		°C	µs/cm		mg/l	mg/l	mg/l	mg/l	me/l	me/l	mg/l	mg/l	mg/l
1	PS-19	18	4050	7.3	2020	144	15	1118	38.5	19.1	1048	234	517
2	Millet Town	18	3850	6.8	1920	96	44	1076	52	25.8	1680	162	536
3	PS-38	18	4370	7.1	2200	116	67	736	49.5	20.7	1024	184	220
4	Gulistan Colony	18	4160	6.6	2120	179	30	1121	51.6	21.6	796	266	353
5	PS-31	21	7530	7.8	3760	216	33	948	44	16.9	1680	220	688
6	PS-42	19	4325	7.4	2860	186	32	1204	50.5	20.8	1302	202	548
7	Dawood Colony	19	3650	7.1	1940	79	69	932	38.2	17.4	1018	196	478
8	Elahi Abad	19	5200	7.3	2590	196	65	1042	39.5	14.3	900	200	454
9	Masoom Town	19	4750	7.2	2360	258	16	1194	53.4	20.0	1152	210	393
10	Dijkot Drain	20	6580	7.4	3280	67	82	1208	46	20.3	1080	192	504
11	Sitara Colony	20	4590	6.7	2280	91	48	956	47.4	22.9	992	208	407
12	PS-34	20	5090	7.3	2530	82	73	1038	45.5	20.1	836	188	432
13	PS-3	21	5570	7.3	2770	71	55	1128	40	19.9	1140	172	353
14	Jhang Road	18	4680	7.2	2230	16	50	1042	39.7	19.8	976	166	402

The organic and inorganic components present in wastewater are degraded at specific oxygen demand which is indicated by chemical and biochemical oxygen demand. The measurement of oxygen demand in wastewater is an important parameter to determine pollution in wastewater. Fig. 2 shows the value of COD, BOD against various disposal stations situated in the city. The maximum value of Chemical Oxygen Demand among all of the samples found at disposal station PS-31 was 688 mg/l while minimum COD value was 220 mg/l which was found at disposal station PS-38. Similarly, the maximum value of Biochemical Oxygen Demand was 266 mg/l present in station Gulistan Colony-1 and the minimum value shown in the Millat Town B-Block which is 162 mg/l. While the average values of COD and BOD were 448 mg/l and 200 mg/l respectively. Results show that almost all the samples for COD and BOD exceeded the permissible limits according to National Environmental Quality Standards.

One of the most important parameters for irrigation water quality is total dissolved solids. TDS affect the plant growth, quality of product and crop yield in irrigation water. It also directly affect the rate of salts accumulation in soil. Fig. 3 shows EC, TDS and chlorides contents against various disposal stations situated in the city. Relationship shows that the value of EC varies between 3620 ms/m and 7530 ms/m with mean value of 4883 ms/m, the value of

TDS varies between 1920 mg/l and 3760 mg/l with mean value of 2490 mg/l and the value of chloride varies between 736 mg/l and 1208 mg/l with mean value of 1053 mg/l. The maximum values of electrical conductivity and total dissolved solids were found at disposal station PS-31 while chloride content were maximum at Dijkot Drain.

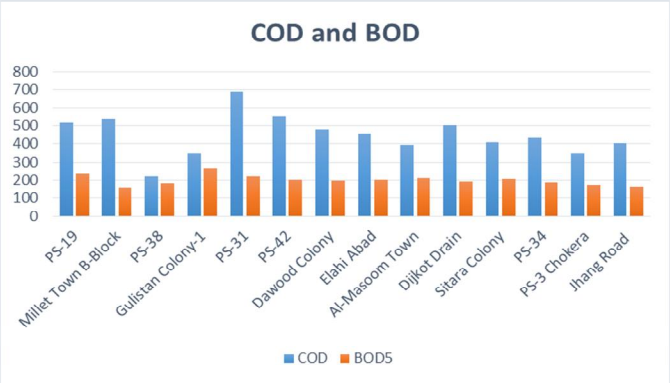

Fig. 2. Level of COD and BOD

From results, it was concluded that only few samples for chloride analysis were within the permissible limits while the values of electrical conductivity and total dissolved solids for all the samples were beyond the permissible limits according to NEQS and FAO.

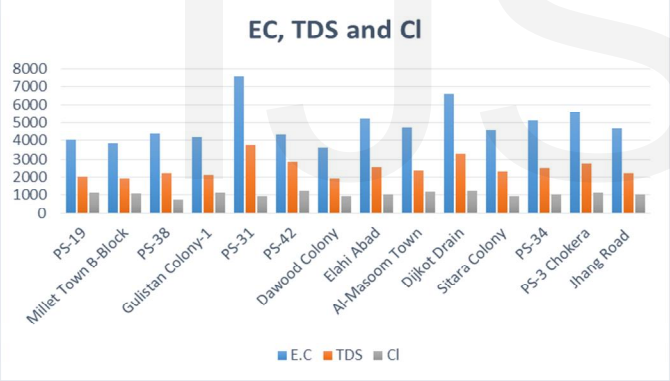

Fig. 3. Level of EC, TDS and Chlorides

Sodium absorption ratio (SAR) is used to find that how much pressure on soil properties due to sodium relative to calcium and magnesium. When sodium exceeds than permissible limits in irrigation water, it disperses the soil causing less penetration of water and air into the soil. It is also difficult to harvest in the soil with the higher SAR. So, it is important to measure SAR in irrigation water. Fig. 4 shows the SAR value against various disposal stations situated in the city. Relationship shows that the value of SAR varies between 14.3 me/l and 25.8 me/l. The results showed that the value of SAR for all samples was beyond permissible limits according to FAO guidelines and is not suitable for irrigation.

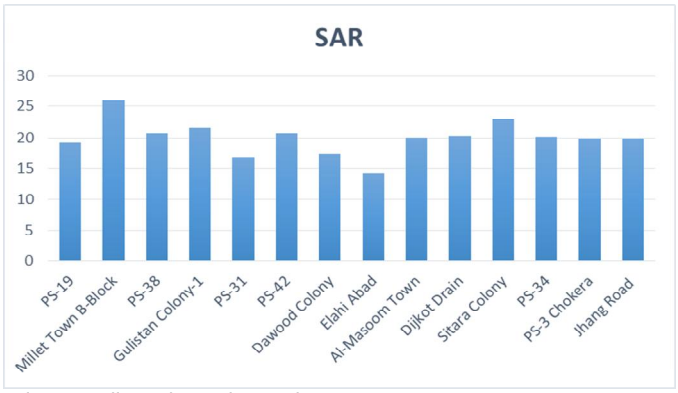

Fig. 4. Sodium Absorption Ratio

Another important environmental aspect of irrigation water is the heavy metal contamination as their use for longer period of time might be injurious to soil and crop health. Three disposal stations were selected for heavy metals analysis because wastewater is frequently used for irrigation from these stations i.e. PS-3 Chokera, PS-19 and Dijkot Drain. The collected irrigation water samples were analyzed for 4 elements i.e. Lead (Pb), Nickle (Ni), Chromium (Cr) and Copper (Cu).

TABLE 3 HEAVY METALS CONCENTRATION

Sr. No.	Location	Pb	Ni	Cr	Cu
		mg/l	mg/l	mg/l	mg/l
1	PS-19	2.94	1.78	3.36	1.33
2	Dijkot Drain	2.4	1.12	1.44	0.98
3	PS-3	2.23	1.33	4.98	2.26

Fig. 5 shows the heavy metals concentration at three disposal stations. The concentration of lead and chromium was very high as compare to their guidelines values at all three stations. Results show that heavy metals concentration in all the samples of wastewater were above the standard values given by NEQS.

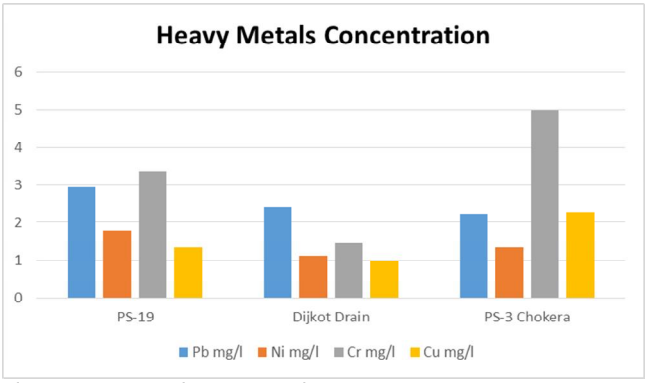

Fig. 5. Heavy Metals concentration

4 CONCLUSION

The study resulted in following conclusion

Wastewater effluent were not feasible for irrigation purpose and almost all of the samples were above the permissible limits.

The concentration of heavy metals in wastewater was extremely high which would ultimately affect the human health through grown crops and leach down to groundwater

Most of the industries are directly disposing their wastes into drains without any treatment which is a serious threat for environment and fresh water resources.

Almost all the samples of wastewater exceeded the permissible limits for BOD_5 and COD. The calculated pollution load for BOD_5 and COD was up to 688 mg/l and 266 mg/l respectively.

5 RECOMMENDATIONS

It is a big challenge for government and other related water management authorities to manage the wastewater in this industrial hub and populated city. Following measures should be taken in this regards

Wastewater treatment plants should be constructed to reuse the wastewater for irrigation and safely dispose into rivers.

A media campaign is required throughout the country to make aware the farmers about health risks of using untreated wastewater in irrigation.

Drains should be lined to avoid groundwater contamination through seepage and pumping of groundwater for drinking purpose near drains should be avoided.

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