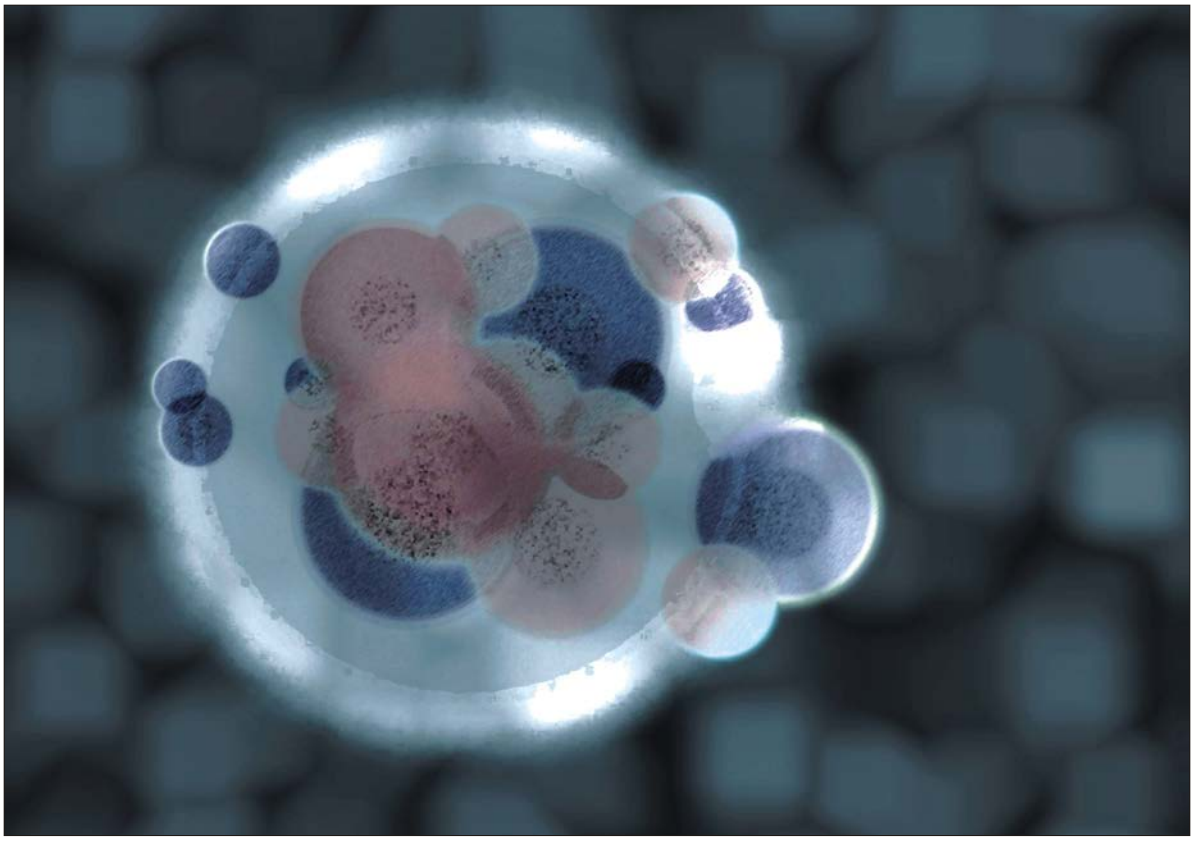

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Effect of Wastewater on the Quality of Ground Water from Southern Parts of Hyderabad City

[1]Abdullah Laghari, [2]Shah Nawaz Chandio, [3]M.Y. Khuhawar, [3]T.M. Jahangir and [4]S.M. Laghari
[1]Institute of Environmental Engineering and Management,
Mehran University of Engineering and Technology Jamshoro, 76080, Sindh, Pakistan
[2]Institute of Irrigation and Drainage Engineering,
Mehran University of Engineering and Technology Jamshoro, 76080, Sindh, Pakistan
[3]Dr. M. A. Kazi Institute of Chemistry, University of Sindh, Jamshoro, 76080, Sindh, Pakistan
[4]Department of Fresh Water Biology and Fisheries, University of Sindh Jamshoro, 76080, Sindh, Pakistan

Abstract: The wastewater from southern part of the Hyderabad city is pumped towards Southern Sewage Treatment Plant (SSTP), but most of the wastewater is used for agricultural purpose and a little wastewater reaches up to SSTP. Three samples, each from Latifabad unit No. 9, 10 and 11 sewage disposal stations and seven ground water samples from the areas where the wastewater is applied for irrigation were collected and analyzed for ground water quality. The sampling scheme was repeated 6 times during November 1999 to May 2000. The obtained results were analyzed on the average basis and some contamination was recorded in ground water quality with alkalinity, chloride, Chemical Oxygen Demand (COD), Kjeldahl nitrogen, nitrite nitrogen and residues as compared with EEC standards.

Key words: Study of wastewater, ground water

INTRODUCTION

Hyderabad, the second largest city of Sindh consists of Hyderabad city, Latifabad and Qasimabad talukas. Total population of Hyderabad including its talukas is 1.6 million[1] and is situated on the left bank of river Indus at 160 km East of Karachi.

The total capacity of water supply to the city by Water and Sanitation Agency (WASA) of Hyderabad Development Authority (HDA) is 46 million gallon per day (MGD^{-1}). WASA is also responsible for the safe disposal of the wastewater. The wastewater from Hyderabad is disposed off into irrigation canals[2]. The wastewater from the southern areas of the Hyderabad (Latifabad) is disposed off towards treatment plant known as Southern Treatment Plant (SSTP), which is situated 2 km south side of Latifabad unit No. 11. The wastewater from Qasimabad is disposed off into open fields, which makes huge stagnant pools along with loop protection Bund of river Indus. The wastewater from southern parts is diverted, before reaching to SSTP by the local growers to irrigate, mostly vegetables. Different villages in the areas are using ground water as a source of drinking water. Khurshid[3] reported that ground water quality near Lahore city had undergone deterioration as a result of long-term sewage irrigation. Similarly Naeem[4] observed contamination of ground water of Korangi – Landhi Karachi due to seepage of domestic and industrial wastewater. The present work examines the effects of the wastewater on the quality of ground water around SSTP because of its use for human consumption.

MATERIALS AND METHODS

Wastewater samples were collected from the disposal stations, discharging their wastewater towards the agriculture field, from Latifabad unit Nos. 9, 10 and 11. The ground water samples were also collected from the same area where the wastewater was used for irrigation. The wastewater samples were collected in clean pre washed 1.5 L plastic bottles after rinsing several times with sewage samples. The samples were collected from the pipeline at convenient points, when disposal stations were actually in operation. Seven groundwater samples were collected from the hand pumps having different depths (15–60 ft). The water of these hand pumps is mostly used for drinking as well as washing purposes. Before the collection of samples the water was allowed to run for five minutes and then the bottles were rinsed several times with sampling water. The time, temperature of water, wastewater and air were noted at each sampling station with mercury thermometer in °C. The information

Corresponding Author: Abdullah Laghari, Institute of Environmental Engineering and Management, Mehran University of Engineering and Technology Jamshoro, 7680, Sindh, Pakistan

about the depth of the hand pumps was noted by the help of the users of water.

Conductivity was determined by WTW 320 conductivity meter, pH was determined by Orion 420 A pH meter, chloride was determined by titration method by standard silver nitrate solution (0.01 N), total Kjeldahl nitrogen was determined by using standard procedure[5]. Chemical Oxygen Demand (COD) was determined by acid dichromate oxidation method using silver sulphate as catalyst. Orthophosphate was estimated by the reduction of phosphomolybdate to molybdenum blue with ascorbic acid. Acid hydrolysable phosphate-phosphorous was determined by persulphate digestion method, followed by estimation as the orthophosphate. Sodium, calcium, magnesium and potassium were determined by air–acetylene flame atomic absorption using Varian AA–20 atomic absorption spectrometer at the conditions recommended by the manufacturer. Sodium, potassium, calcium and magnesium were determined at 589, 766.5, 422.7 and 285.2 nm (nanometer), respectively in the triplicate; with delay time 3 sec. and integration time 3 sec.

Sodium Absorption Ratio (SAR) values for wastewater were calculated by using following equation, where concentrations were in milli equivalent.

$$SAR = \frac{Na}{\sqrt{\frac{Ca+Mg}{2}}}$$

RESULTS AND DISCUSSION

Ground water samples were collected during the year 2000. The results of chemical analysis are summarized in Table 1. The conductivity and total dissolved solids (TDS) were observed between 2.18 – 9.87 mS cm^{-1} and 1269–6317 mg L^{-1}, respectively. The higher values of conductivity and TDS at sampling station 1, 2 and 7 may be due to nature of ground water. The pH was observed within acceptable limits of 6.69–7.19. COD, Kjeldahl nitrogen and nitrite nitrogen were observed in the range of 15.4–205.6, 0.0–5.3 and 0.021–0.2 mg L^{-1}, respectively. The permissible limits by EEC standards for drinking water for COD and nitrite nitrogen are 20–35 and 0.1 mg L^{-1}. The observed values crossed the permissible limits and it is concluded that ground water is contaminated due to application of wastewater, with high COD values except station 4 and 6 (Table 1).

The SAR values calculated from the results of analysis of Na, Ca and Mg were in the range of 3.3 – 20.1 and also crossed the safe limits for the application for agriculture.

Sewage samples were collected during the years 1999–2000 at an interval of 4–6 week and the sampling was repeated six times (n=6). The average values with standard deviation (±) are summarized in Table 2. Conductivity and TDS were observed in the range of

Table 1: Groundwater analysis. Samples collected from hand pumps at agriculture fields of wastewater applied areas. Date of collection of samples, 04–06–2000

	Sampling stations						
Parameters with units	1	2	3	4	5	6	7
Time of collection	13:45	13:50	13:55	14:15	14:30	14:45	15:30
Air temperature (°C)	41.00	41.00	41.00	41.00	41.00	42.00	42.00
Ground water temperature (°C)	30.00	28.00	28.00	28.00	28.00	26.00	26.00
Conductivity (mS cm^{-1})	3.53	9.87	2.18	2.38	2.91	1.98	4.83
pH	7.02	7.19	7.11	6.81	7.08	6.84	6.69
Salinity (mg L^{-1})	1900.00	5500.00	1100.00	1200.00	1500.00	1000.00	2600.00
Total dissolved solids (mg L^{-1})	2259.20	6317.00	1395.00	1523.00	1863.00	1269.00	3091.00
Alkalinity as $CaCO_3$ (mg L^{-1})	585.00	555.00	785.00	910.00	525.00	500.00	510.00
Chloride (mg L^{-1})	546.00	1454.00	305.00	333.00	461.00	312.00	830.00
Hardness as $CaCO_3$ (mg L^{-1})	840.00	1700.00	500.00	730.00	640.00	690.00	1500.00
COD (mg L^{-1})	106.00	184.00	170.00	15.36	205.60	30.72	183.00
Total residues (mg L^{-1})	3745.00	6331.00	2217.00	2457.00	2459.00	1937.00	3583.00
Total Kjeldahl nitrogen (mg L^{-1})	0.00	0.00	1.12	5.32	0.00	1.40	0.00
Nitrite nitrogen (mg L^{-1})	0.05	0.02	0.04	0.02	0.07	0.06	0.20
Na (mg L^{-1})	510.20	1795.50	306.60	264.10	417.50	174.10	473.00
Ca (mg L^{-1})	63.75	128.80	38.85	58.10	80.90	106.60	205.30
Mg (mg L^{-1})	122.95	292.10	82.20	103.70	83.75	64.80	223.20
K (mg L^{-1})	11.70	20.90	13.85	21.05	23.65	11.80	31.55
SAR	8.61	20.00	6.40	4.81	7.77	3.28	5.44

Sampling stations

1. Major Jee Mian, southern side about 1 km away from SSTP. The depth of the hand pump is about 60 ft.
2. Village Kiko Panhwar, southern side about 100 m away from SSTP. The depth of the hand pump is about 35 ft.
3. Panjabi village, west side about 100 m away from SSTP. The depth of the hand pump is about 35 ft.
4. Village Major Bakir, west side about 100 m away from SSTP. The depth of the hand pump is about 37 ft.
5. Village Bathy Waro, north side about 750 m away from SSTP. The depth of hand pump is about 45 ft.
6. Village Bachal Khan Laghari, north side about 1 km away from SSTP. The depth of the hand pump is about 55 ft.
7. Village Bachal Khan Laghari, north side about 1 km away from SSTP. The depth of the hand pump is about 40 ft.

Table 2: Average value with±standard deviation in parenthesis of physico–chemical analysis of wastewater collected from different sampling stations of Latifabad, (n=6)

	Sampling stations		
Parameters with units	1	2	3
Air temperature (°C)	28.00±3	28.50±3.2	28.30±3.1
Wastewater temperature (°C)	25.50±3.6	25.70±3.4	25.50±3.3
Conductivity (mS cm^{-1})	1.88±0.52	2.42±0.78	2.03±0.15
pH	7.08±0.09	7.06±0.20	7.04±0.14
Salinity (g L^{-1})	0.71±0.34	1.08±0.46	0.76±0.07
Total dissolved solids (mg L^{-1})	1216.00±451	1618.00±597	1307.00±178
Alkalinity as $CaCO_3$ (mg L^{-1})	281.00±90.8	290.00±142	315.00±110
Chloride (mg L^{-1})	282.00±138	392.00±151	272.00±58
Hardness as $CaCO_3$ (mg L^{-1})	351.00±171	449.00±205	352.00±126
Dissolved oxygen (mg L^{-1})	ND	ND	ND
BOD_5 mg L^{-1}	195.00±40	168.00±42	200.00±82.6
COD (mg L^{-1})	348.00±81	296.00±87	354.00±150
Total residues (mg L^{-1})	1610.00±724	2013.00±683	1669.00±218
Total filterable residues (mg L^{-1})	1137.00±345	1568.00±571	1265.00±198
Total non filterable residues (mg L^{-1})	481.00±196	412.00±110	362.00±70
Total hydrolysable phosphate (mg L^{-1})	3.64±1.6	3.10±0.98	4.61±0.82
Total Kjeldahl nitrogen (mg L^{-1})	20.78±10.3	21.65±9.12	23.20±7.3
Nitrite nitrogen (mg L^{-1})	0.09±0.03	0.10±0.04	0.11±0.07
Na (mg L^{-1})	170.80±98.3	268.12±110	167.00±40
Ca (mg L^{-1})	68.50±21.5	87.00±25	77.10±7.52
Mg mg L^{-1}	65.60±47	66.00±13	83.10±55
K mg L^{-1}	35.10±22.5	28.60±15	33.50±12.2
SAR	3.20±0.5	4.45±1.4	3.65±0.7
BOD:COD ratio	0.56	0.56	0.56

Sampling stations
1. Latifabad unit No. 9, 2. Latifabad unit No. 10 and 3. Latifabad unit No. 11 disposal stations.

1.88–2.42 mS cm^{-1} and 1216–1618 mg L^{-1}, respectively. pH was observed within acceptable limits of 7.04–7.08, it may be because the sewage mostly belonged to domestic origin. The dissolved oxygen was noted below the detection limits and Biological Oxidation Demand (BOD) and COD crossed the safe limits of 150 mg L^{-1} for wastewater and were recorded in the range of 168–200 and 296–354 mg L^{-1}, respectively. BOD:COD ratio indicates biodegradability of waste organic compound[6] and was observed in the range of 0.565–0.568. Total acid hydrolysable phosphate– phosphorus, Kjeldahl nitrogen and nitrite nitrogen were observed with an average value of 3.1–4.61, 20.78–23.2 and 0.9–0.11 mg L^{-1}, respectively. SAR values were calculated from the concentration of Na, Ca and Mg in milli equivalent and were in the range of 3.2–4.45 on average basis (Table 2).

The contamination of ground water due to wastewater is indicated with higher values for COD, Kjeldahl nitrogen and nitrite content. In the light of above discussion, the groundwater from wastewater-irrigated areas is not fit for drinking purposes; it can be used for bathing, washing and for livestock.

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