Punjab Univ. J. Zool., Vol.19, pp.89-95, 2004

POLLUTION SOURCE ASSESSMENT OF RIVER WATER

JAVED I. QAZI, SHAGUFTA SHAHJAHAN AND SHAHJAHAN BAIG

Department of Zoology, University of the Punjab, Quaid-e-Azam Campus, Lahore (JIQ), Environment Protection Department, 4-Lytton Road, Lahore-5400 (SS), Biotechnology and food Research Center, Pakistan Council of Scientific and Industrial Research, Lahore-54600 (SB) Pakistan

Abstract: The present paper deals with quantitative assessment of certain pollutants in wastewater originated from various industries. It draws heavily on data collected at different sampling sites of water channel receiving raw industrial effluents, which is linked with river for ultimate disposal. The characteristics of river water before mixing of industrial effluents are within the range of NEQS of Pakistan. The quality of river water, however, was deteriorated after receiving enormous amount of organic pollutants, in terms of BOD_5, from vegetable oil ghee mills and pulp and paper industrial units, in particular. Need of establishing admissible limits for different industrial effluents having specific dilution rates that might be accommodated by the river water without harming its natural biota is indicated.

Key words: River BOD, River COD, River pollution, Industrial effluents.

INTRODUCTION

Water, may be of ground or surface origin, is a basic natural resource and the use of streams or rivers as the recipient of unlimited amounts of industrial waste is definitely unacceptable. In general, the sources of river pollution are land-based and may reach the river through drains and out falls. Major chronic river pollution problems can often be attributed to the local discharge of large volume of wastes. They include materials which are potentially biodegradable such as raw sewage, food and beverage processing waste, pulp and paper mills effluents incorporated with wastes from textile, vegetable oil and dairy industries (Council of European Communities, 1976). The characterization of wastewater from various industries, however, revealed the highest concentrations of metals, halogenated hydrocarbons and a variety of settle able and suspended solids, which are found after mixing industrial effluents to the river water. These pollutants adversely affect the river ecosystem. Eventually, the effects of river pollution on human health, quality of life and fisheries in the fishing zones must fully be considered (Beavis and Rowley, 1980).

Pakistan, today is progressing towards higher stages of development and industrialization, which have brought radical changes in economic field. Consequently, various industrial units operative in the province Punjab of Pakistan are categorized as

0079-8045/04/0001-0089 $ 03.00/0

follows: Tanneries, Textile, Pulp and Paper, Vegetable Oil and Ghee, Chemicals, Food, Fertilizers, Sugar, Steel, Cement and Pharmaceuticals. Like most of Asian and African countries, Pakistan is an agricultural country and its economy is primarily based on the export of agricultural commodities. The water pollution is of special significance in an agriculture-oriented economy of the province Punjab, where rivers, irrigation canals network and streams are used for irrigation of cultivated land. Unexpectedly, most of the industries in Pakistan discharge their effluents directly or indirectly in the existing water bodies without proper treatments, while, polluted water significantly imbalances the ecosystem associated with agriculture productivity (Department of Environment and Welsh Office, 1971; Murrey and Norton, 1979; Shea, 1988).

This article surveys the intensity and frequency of industrial pollution and draws heavily on data collected at various disposal sites where raw effluents are mixed with drain water for ultimate discharge into river Ravi.

MATERIALS AND METHODS

Study area

The study area is situated near Sheikhupura, a historical City after the name of great Mughal Empire "Sheikhu" (Jahangir). For this work a drain namely "Barrianwala drain" was selected which was excavated in 1961under local land reclamation scheme to prevent the area from water logging and salinity.

The Barrianwala drain is the fifth important drain on the Lahore-Sheikhupura road. The existing conditions of Barrianwala drain in the study area indicate that a number of industrial units located along side the Lahore-Sheikhupura road, have been discharging their effluents into it without appropriate treatments. The drain assumes the function of a channel carrying dark brown liquid covered with a thick brown layer of scum varying from 20-30 cm, containing most of the fibrous material.The drain after receiving industrial effluents runs further 12.8 km. And then it discharges to Chichokimalia drain, which is named as Deg-nullah (II), near Mundi, where it crosses Qadirabad-Baloki link canal through siphon. It receives also the wastewater from Jaranwala sewage drain and ultimately discharges it into the river Ravi near Mouza Mubarik (Fig.1).

The Ravi is generally a clean river, maintaining a healthy aquatic environment suitable for propagation of warm water fish from its entry into Pakistan from India, up to the point near Shadbagh where it receives the first major pollution load from the city of Lahore. More than 90% of wastewater eventually finds its way into the river from the city of Lahore. The river Ravi has a wide variation in its flow with peak periods during July and August and periods between November and February, when augmentation of water is essential to meet the requirements of down stream utilization for agriculture practice. Since there was no sufficient data available indicating qualitative discharge of industrial effluents in the study area, therefore, a survey was conducted to probe the evaluation of major polluting industrial establishment.

Sampling of wastewater

Figure 1 shows the sampling sites in study area. The samples were taken from the grab wing by a plastic beaker and placed in pre-acid washed polyethylene screw bottles of 1 L capacity. The samples were stored in a refrigerator at 5°C for latter analysis.

Analytical methodology

The analysis of Chemical oxygen Demand (COD), Biochemical Oxygen Demand (BOD_5), Solids, Oils and Fats were determined according to the methods described by American Public Health Association in Standard Methods of Water and Wastewater Analysis (1985). The pH of the samples was determined by glass electrode.

RESULTS AND DISCUSSION

In the Sheikhupura-Lahore industrial estate, there are approximately 280 industrial units including paper and pulp, textile, chemicals, vegetable ghee and oil, light engineering and dairy industries. These are collectively producing more than 44000 m^3d^{-1} of wastewater that is being discharged into Barianwala drain for ultimate disposal into the river Ravi. Test results from pulp and paper industrial units indicated alkaline pH (8.6-8.7) with highest BOD_5 value of 4000-6000 mgl^{-1}, while vegetable oil and ghee mills discharged effluents contained least concentration of TSS i.e., 55-65 mgl^{-1}. The data presented in Table I also reveal that wastewaters from textile and polyester industries were of slightly acidic pH, that is, 5.4-5.5 and 6.5-6.7, respectively.

Table I: Wastewater quality

Industry	Parameters (Typical Values)			
	pH	BOD mgl^{-1}	TSS mgl^{-1}	TDS mgl^{-1}
Pulp and Paper	8.6-8.7	4000-6000	537-400	1100-1200
Vegetable oil and Ghee	8.0-8.3	350-300	55-68	300-400
Textile	5.4-5.5	200-300	200-250	700-1000
Polyester	6.5-6.7	120-130	700-900	200-300
Dairy	7.2-7.5	1300-1600	8000-10000	7200-8000

In subsequent studies, the results of sixteen sampling sites are indicated in Table II. They were located for qualitative assessment of wastewater discharged in Barianwala drain and Degh-nulla-II for ultimate disposal in river Ravi. At all sampling points the concentrations of BOD_5, TSS, pH and TDS were larger and varied probably

corresponding to the environmental conditions into which the wastewater is disposed-off in addition to their different natures from industries. From the data on characteristics of effluents mixed with water channel, it was observed that the location below Shariqpur Road Bridge gave highest BOD_5 value. The least value for these parameters were observed in the drain water before entering the industrial estate near Lahore-Sheikhupura road bridge, that is BOD_5, 90 mgl^{-1}, TSS, 170 mgl^{-1}, TDS, 200 $mgl^{-1}$and pH 7.1. A close look at the frequency of pollution at various sampling sites, however, reveals a general trend of gradual decrease in BOD. It should be noted that wastewater from pulp and paper industries contributed immensely to increase organic fraction in terms of BOD_5 in the drain water. The results of analysis at sampling point-10, near Tiba Niaz village, indicated that TSS, 2076 $mgl^{-1}$and TDS, 1502 $mgl^{-1}$are all very high near rural sites before final disposal into river Ravi. These elevated levels of the parameters may be a consequence of agriculture runoff. Further, the quality of wastewater before and after mixing with river Ravi water is also shown in Table II. Infact, the characteristics of river water prior to be contaminated with industrial pollutants are within or near to maximum limits of National Environment Quality Standard (NEQS) of Pakistan (Table III). From the data shown in this table it can be clearly seen that the river water contains higher level of BOD_5, 300 $mgl^{-1}$with slightly acidic pH (6.5) at the junction of Degh nullah and river Ravi. At this sampling site, the industrial wastewater is mixed with river water; thus, we can conclude that the estimated impact of the discharge of pollutants from industrial estate on river water quality seems to be strong. The concentration of these contents remained more or less consistent except TSS that showed tremendous increase at the distance of 9-km downstream of river Ravi. This behaviour of the parameters suggests that although the microbial picture has not been changed over a range of about 10-km downstream as evidenced by the BOD value but slight decrease in TDS is indicating the importance of establishing admissible dilution levels of different industrial effluents.

In general, during the periods of high water velocity, the wastewater could be diluted in the river water more than that during times of little water flow (Notel, 1988). Eventually, the maximum concentration of pollutants in the river water is attributed to constant wastewater discharge. However, assuming a constant discharge of pollutants, their concentration of river water should change due to varying velocity of flow, either tidal or laminar. Seasonal studies on the similar lines are needed to generate the data on a year wise pattern.

Conclusively a large quantity of untreated waste water originating from Barianwala drain and Degh nullah (Chichokimalian and Barianwala drain) are the most polluted drains with maximum BOD_5 and TDS values in the range of 500 $mgl^{-1}$to 800 $mgl^{-1}$and 200 $mgl^{-1}$to 3000 mgl^{-1}, respectively. The industrial wastewater also transports a variety of organic and inorganic pollutants, which adversely affect the ground water quality and agriculture commodities, especially when it is allowed to be spreaded on open land. Moreover, untreated industrial effluents discharged into irrigation water channels and river cause a considerable damage to phytoplankton. Therefore, issues demanding a comprehensive, integrated approach to tackle the problems of water and raw materials along with the waste minimization should have the highest priority. Obviously, cleaner

production covering both products and manufacturing process are necessary for proper waste management in the developing countries, in particular.

Table II: Quality of river Ravi receiving wastewater from Lahore-Sheikhupura Industrial Estate

Sampling Points	Sampling Location	Parameters (Typical values)			
		BOD mgl^{-1}	TSS mgl^{-1}	TDS mgl^{-1}	pH
1	Lahore-Sheikhupura road bridge	90	170	200	7.1
2	After mixing of paper mills wastewater	250	530	620	7.3
3	After mixing of Ghee mills wastewater	300	760	618	7.3
4	After mixing of paper mills wastewater	640	880	920	7.4
5	Below Shariqpur road bridge	700	900	1500	7.5
6	Near Barianwala distributary	650	800	1436	7.3
7	Chichokimalian distributary site	460	200	900	7.0
8	Lahore- Nankana road bridge	600	700	1300	7.1
9	Siphon Qadirabad-Baloki link canal	160	348	322	7.1
10	Sued wala/Tiba Niaz village	380	2076	1502	6.7
11	Moza Mubariq	312	1200	700	6.7
12	Degh nullah-Ravi junction	309	1213	813	7.3
13	Upstream of river Ravi before joining Degh nullah near bridge	15	102	186	6.8
14	Upstream, 4km from Degh nullah-Ravi junction	20	110	182	7.0
15	Upstream, 4km from Degh nullah junction	230	113	430	6.4
16	Downstream-9km from Degh nullah-Ravi junction	225	470	400	6.4

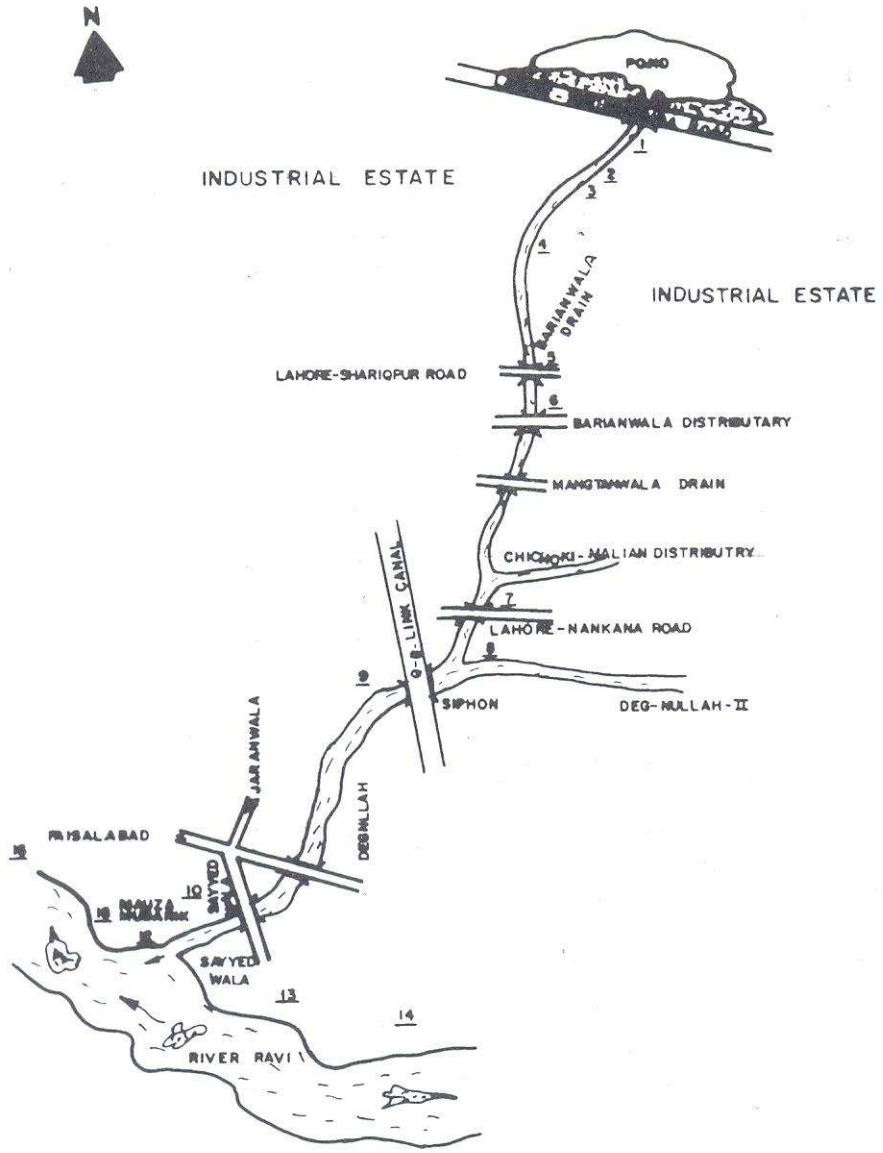

Fig. 1: Location of industrial estate as pollution source of river Ravi. Numbers indicate the sampling sites.

Table III: Proposed industry specific NEQS in Pakistan

Industry	PH	BOD_5 mgl^{-1}	COD mgl^{-1}	TSS mgl^{-1}	TDS mgl^{-1}
Pulp and paper	6.9	50	250	-	-
Dairy industry	6.9	50	250	50	-
Beverages	6.9	50	250	100	-
Fruits and Vegetable Processing	6.9	50	250	50	-
Nitrogen Fertilizers	6.9	-	-	100	-
Sugar	6.9	50	250	500	-
Dye and Dye Intermediate	6.9	100	250	100	3500
Cotton Textile Composite and processing	5.5-9.0	100	250	100	-
Tanning and Leather Finishing	6.9	80	250	200	3500
Paints	6.9	50	250	80	3500
Pesticide Formulations	6.9	30	150	80	3500

REFERENCES

AMERICAN PUBLIC HEALTH ASSOCIATION, 1981. American Water Works Association. Water Pollution Control Federation. *Standard Methods for the examination of Water and Wastewater*. 15th ed. pp.141. American Public Health Association. Washington, D.C.

BEAVIS, B. AND ROWLEY, C.K., 1980. Economic instruments for effluent discharges to the River Tees Estuary. *Marine Pollution Bulletin*. **11**: 120-124.

COUNCIL OF EUROPEAN COMMUNITIES, 1976. Council directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the community (76/464/EEC). *Official Journal of the European Communities* 23. L129.

DEPARTMENT OF THE ENVIRONMENT AND WELSH OFFICE, 1971. *Report of a River Pollution Survey of England and Wales* 1970. Vol.1 HMSO.

MURREY, L.A. AND NORTAN, M.E., 1979. *The composition of degraded spoils dumped at sea from England and Wales*. Fisheries Research Technical Report. Lowes Roft, UK. Number 52. Ministry of Agriculture, Food and Fisheries.

NOTLE, J., 1988. Pollution source analysis of river water and sewage sludge. *Environ. Technol.*, **9**: 857-868.

SHEA, P., 1988. Developing national sediment quality criteria. *Environ. Sci. Technol.*, **22**: 1256-1261.

(Received: September, 2004)