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INDUSTRIAL WASTE WATER MANAGEMENT IN DISTRICT GUJRANWALA OF PAKISTAN- CURRENT STATUS AND FUTURE SUGGESTIONS

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Generally industrial sector in Pakistan is impairing the surface as well as groundwater qualities by indiscriminately routing their effluents into streams, watercourses, agricultural fields, river, lakes and ocean that are invariably resulting in human ailments apart from threatening the health of water. In Pakistan, little wastewater treatment facilities are available for the municipal discharges. Consequently, the effluents are dumped into the water bodies causing surface and groundwater pollution which is endangering biodiversity, health of the people and other ecosystems. Gujranwala waste effluents are no exception either. The present study has, therefore, been planned to investigate quality status of the city effluents from Gujranwala; a hub of several industries in Pakistan. A field survey was conducted to locate where effluent samples may be collected from different industrial wastewater discharge outlets or locations. The study involved determination of water quality parameters at different points. The values of chemical oxygen demand (COD), biochemical oxygen demand (BOD), total suspended solids (TSS), total dissolved solids (TDS), dissolved oxygen (DO), pH, turbidity, electric conductivity (EC), Carbonates (CO_3^{-1}) and Bicarbonates (HCO_3^{-1}) varied for the different industries as 337-617mgl^{-1}, 115-301 mgl^{-1} , 385-820 mgl^{-1}, 195-6537 mgl^{-1}, 0.2-1.8 mgl^{-1}, 5.63-8.8 mgl^{-1}, 18-540FTU, 389-9950µs/cm, 0-390 mgl^{-1} and 60-750 mgl^{-1}, respectively. The measured values of different parameters were compared with those of National Environmental Quality Standards (NEQS) for precise assessment of their quality. The analysis of the parameters showed that almost all of the samples were unfit according to NEQS. This situation is indeed a serious threat for the environment and biodiversity and hence policy makers in the region have to start wastewater monitoring program with the help of local wastewater management authorities. Based upon the measured data, wastewater treatment plants should be installed to make the water clean which latter can be used for other purposes e.g., agriculture. It is added that the highest amount of the industrial effluent is coming from the leather and textile industries followed by ceramic and ghee industries, respectively. Excepting Ghee industries, all other releases are extremely toxic and therefore demand immediate remedial action.
Keywords: Effluents, biodiversity, chemical analysis, electrical conductivity, environment

INTRODUCTION

Municipal effluents are one of the major reasons for rapidly degrading environment in the metropolitans of developing countries lacking in wastewater treatment facilities. The industrial activities have already caused substantial air and water pollution leading to adverse effect on the vegetation as well as to the human beings and aquatic life (Mubin *et al.*, 2002). The quality of water can be assessed by chemical analyses using the parameters like conductivity, alkalinity, hardness, total dissolved solids, chlorides as well as dissolved oxygen (Makia *et al*., 1999).

Disposal of the untreated wastewater into drains and ultimately into the rivers, deteriorate the water quality and harms aquatic life. Khurshid *et al.* (1999) reported that due to discharge of the untreated effluents from industries, the dissolved oxygen (DO) level is decreasing whereas biological oxygen demand (BOD) and total dissolved solids (TDS) are increasing in the river Ravi.

The use of industrial and municipal wastewater in agriculture is a common practice in many parts of the world (Sharma *et al*., 2007; Ahmad *et al.*, 2010). Rough estimate indicates that at least 20 million hectares in 50 countries are irrigated with raw or partially treated wastewater (Scott *et al*., 2004). The major objectives of wastewater irrigation are that it provides a reliable source of water supply to farmers and has the beneficial aspects of adding valuable plant nutrients and organic matter to soil (Liu *et al.*, 2005; Cheunbarn and Peerapornpisal, 2010).

Wastewater effluent at least for irrigation use, could be a valuable source to augment this dwindling water supply, and should not continue to be wasted. Reuse of wastewater effluent could both decrease the disposal of water to the environment and reduce the demand on fresh water supplies (Jasem *et al*., 2003).

Textile industries consume large volume of water and chemical for wet operation of textile. The quantities and characteristics of effluent discharged vary from mill to mill depending on the water use and the average daily product (Saha, 2007). One of the burning problems of our industrial society is high consumption of water. Many approaches have been taken to reduce water consumption, but better was to recycle wastewater into high quality water (Schroder *et al*., 2007).

The present study aims to assess the quality of industrial effluents in district Gujranwala Pakistan where industrial wastewater is causing serious threat to environment. Ten parameters were chosen to assess the water quality of industrial wastewater namely chemical oxygen demand (COD), biochemical oxygen demand (BOD), total suspended solids (TSS), total dissolved solids (TDS), dissolved oxygen (DO), pH, turbidity, electric conductivity (EC), carbonates (CO_3^{-1}) and bicarbonates (HCO_3^{-1}). For example, BOD is measured to estimate the organic strength of the wastewater. Wastewater with high organic material and low DO may pose a risk to freshwater bodies by adversely impacting their oxygen content and endangering aquatic species (fish etc.) that depend on higher oxygen levels for their survival. Provide references that show these parameters to be effective in evaluation wastewater and fro making recommendation of its treatment for recycling or reuse.

Moreover, the use of wastewater for agriculture purpose without any treatment is affecting the health of the human beings as well as deteriorating the groundwater quality. The water is directly pumped out from the drains and being used in the fields for growing vegetables and field crops. The present study would help assessing the wastewater quality status in order to develop data base for of the competent authorities and its incorporation into developmental plans for treatment and / or safe disposal of Gujranwala wastewaters.

MATERIALS AND METHODS

***Study area*:** Study was conducted in district Gujranwala of Pakistan which is situated in the Punjab province of Pakistan (Fig. 1). The population of the region is 3,401,000 (http://www.pportal.punjab.gov.pk/portal/portal/media-type/html). Due to its extensive road and rail links, the region has flourished with manufacturing and agricultural

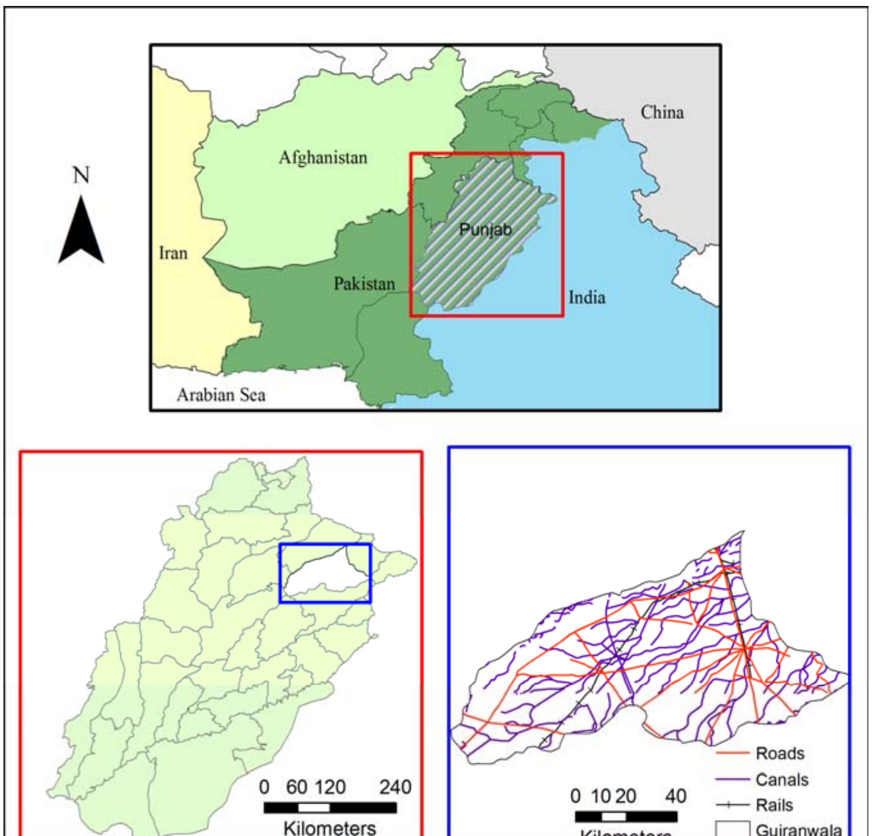

Figure 1. Location of study area in district Gujranwala of Pakistan

markets. The city of Gujranwala also has set up several commercial and industrial centers allowing the manufacturing of ceramics, iron safes, metal utensils, textiles, steel, sanitary and tannery production. Main crops in the region are sugarcane, melons, rice and grains for international export. People grow vegetables by using effluent drained in to ditches near fields and because the drain water is easily accessible to the farmers.

Sampling strategy**:** A sampling plan was prepared to evaluate the results of water quality parameters of industries in the study region. Random samples were taken from twenty industries in the city situated at different places. The randomly selected industries were ghee industries, ceramic industries, flour mills, leather industries and textile industries. The designation samples numbers for these industries presented in Table 1. Wastewater samples were collected 500 ml size microbiological examination bottles. Then each of the samples was tested against 10 parameters including chemical oxygen demand (COD), biochemical oxygen demand (BOD), total suspended solids (TSS), total dissolved solids (TDS), dissolved oxygen (DO), pH, turbidity, electric conductivity (EC), carbonates (CO_3^{-1}) and bicarbonates (HCO_3^{-1}).

Table 1. Type of selected industries and their designation sample number

Nature of industry	No. of industries	Designations
Ghee Industries	4	S1, S2, S3, S4,
Ceramic industries	4	S5, S6, S7, S8,
Textile Mills	4	S9, S10, S11, S12,
Tanneries	4	S13, S14, S15, S16
Flour Mills	4	S17, S18, S19, S20

These Industrial wastewater samples were collected from the outlets that represented effluent from all sources of wastewater in each industrial operation. After taking samples, the bottles were tightened properly to protect from any type of leakage. Storage of the samples was done by cooling to near freezing temperature during storages, even then holding time was kept to minimum. The samples were chilled to 20^{o}C before analysis.

For the samples, the industries were selected randomly to get accurate results. There is no systematic system for the disposal of industrial effluent in drain water which is later on used for agricultural purposes. For wastewater quality parameters, different equipment can be used to find different parameters. We used a Fenway Meter for finding the dissolved oxygen and pH. To find the Electric Conductivity and Total Dissolved Solids, the equipment used was Hanna Meter. A Lovi Bond Meter was used to find the Chemical Oxygen Demand. Carbonates and Bicarbonates were found by titration method (Koca *et al*., 2011). The values of Total Suspended Solids were detected using Filtration Method. Turbidity was found by using Turbidity Meter and Biochemical Oxygen Demand was found by using the 5-Day BOD test.

RESULTS AND DISCUSSION

After a laboratory analyses of various samples and careful examination of the data, results are being reported for retrieving useful information. Results are outlined to quantify and evaluate the impact of untreated industrial effluents for different levels of wastewater quality.

Total suspended solids (TSS) and total dissolved solids (TDS)**:** In National Environmental Quality Standard (NEQS) Pakistan, the permissible value of total suspended solids (TSS) for industrial water is 150mg/l as against the observed mean value of TSS of 577 mg/l from the industries and the it ranges from 385 to 820 mg/l (Fig. 2). The higher TSS values are for leather industries i.e., S13, S14, S15 and S16. In fact, all of the observed values of TSS much higher than standards values suggesting a poor quality of the wastewaters from the industries.

In case of the TDS, the NEQS standards of industrial effluent are 3500 mg/l. However, the TDS value of the leather industry in study region is much higher than the set standards (Fig. 3). The mean value for leather industry is 6303 mg/l. The value for all the industries ranges from 195 to 6537mg/l. The least effected TDS among these samples were S1, S2, S3 and S4 all of these samples were of industries. The moderate results for the values of TDS were from the Flour Mills i.e., S17, S18, S19 and S20.

Chemical oxygen demand (COD), biochemical oxygen demand (BOD) and dissolved oxygen (DO)**:** The standard values of dissolved oxygen (DO) is 2 mg/l. Results show that DO value for all the industries falls between 0.2 mg/l to 2.5 mg/l (Fig. 4). The maximum value for DO among all of the 20 samples was 1.8 mg/l for S13. The minimum value of DO was 0.2 mg/l for S1.

While in case of biochemical oxygen demand (BOD), the NEQS value should not exceed 80 mg/l for industrial wastewater. The mean value of BOD is 202 mg/l (Fig. 5). The maximum value for BOD among all of the 20 samples is 301 mg/l for S7. The minimum value of BOD is shown in the sample S3 which is 115 mg/l.

The value of chemical oxygen demand (COD) for NEQS is 150 mg/l whereas the mean value for COD in the study region is 430 mg/l (Fig. 6). The value for all the sampling points ranges from 251 to 658 mg/l. The maximum value of COD among all of the 20 samples was 658 mg/l for sample S7. The minimum value of COD is for S3 is 132.

Turbidity, pH and electric conductivity (EC)**:** The mean value for twenty samples of industries for Turbidity is 180 FTU which ranges from 19 to 540 FTU (Fig. 7). The maximum value of Turbidity among all of the 20 samples was 540 present in S7. The minimum value of Turbidity is shown in the sample S3 which is 19.

The NEQS for pH ranges from 6 to 9. From the Figure 8, it can be concluded that some of the samples are slightly acidic. The sampling values vary from 5.63 to 8.8 mg/l. We found the maximum value of pH among all of the 20 samples which is 8.8 mg/l in S13. The most effected sample of pH was of S13, S12 and S8.

The mean value of EC was 2819 micro-s/cm (Fig. 9). The value of EC ranges from 285 micro-s/cm to 9950 micro-s/cm. The minimum value of conductivity is shown in the sample S2 which is 285 micro-s/cm. The highest values of EC were in leather industries.

***Bicarbonates and Carbonates*:** The mean value for twenty samples of industries for Bicarbonates is 435 mg/l. The value for all the sampling points ranges from 60 to 750 mg/l (Fig. 10). The maximum value of Bicarbonates among all of the 20 samples was 750 mg/l in S13. The minimum value of Bicarbonates is for sample S4 which is 60 mg/l. The mean value for twenty samples of industries for Carbonates is 49 mg/l (Fig. 11). Most of the sampling points were observed carbonate nil. The maximum values were observed 370 and 210mg/l in textile and highest 390mg/l in S13, leather industry.

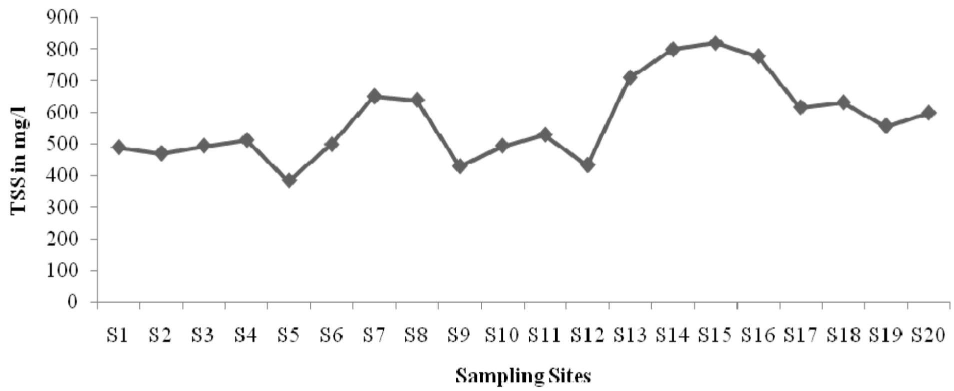

Figure 2. Total suspended solids at different sampled industries

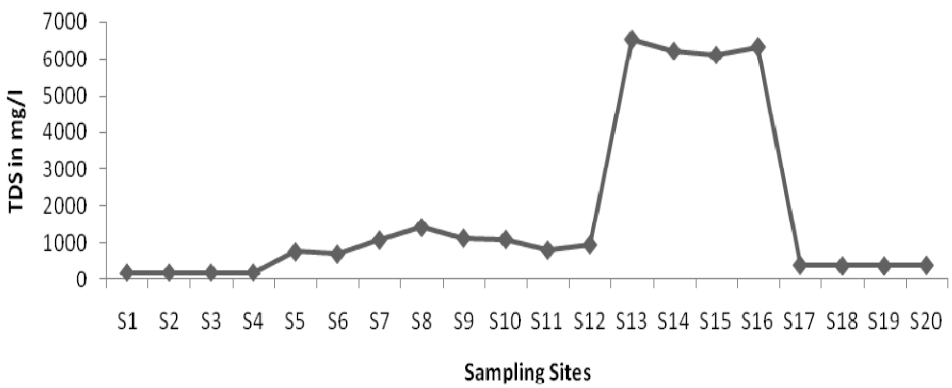

Figure 3. Total dissolved solids at different sampled industries

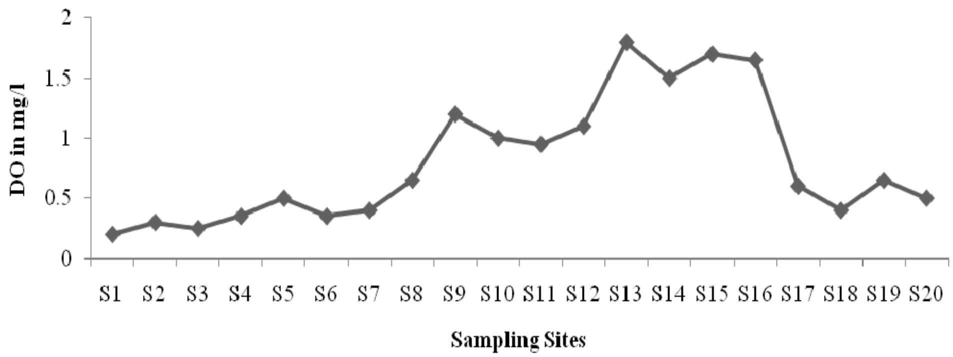

Figure 4. Dissolved oxygen at different sampling industries

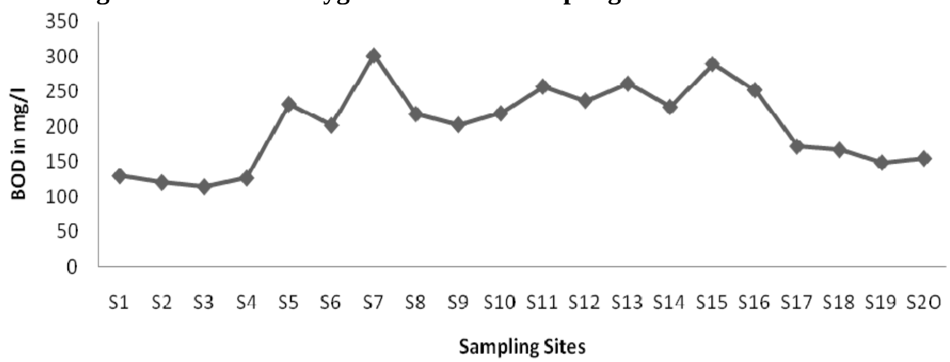

Figure 5. Biochemical oxygen demand at different sampling industries

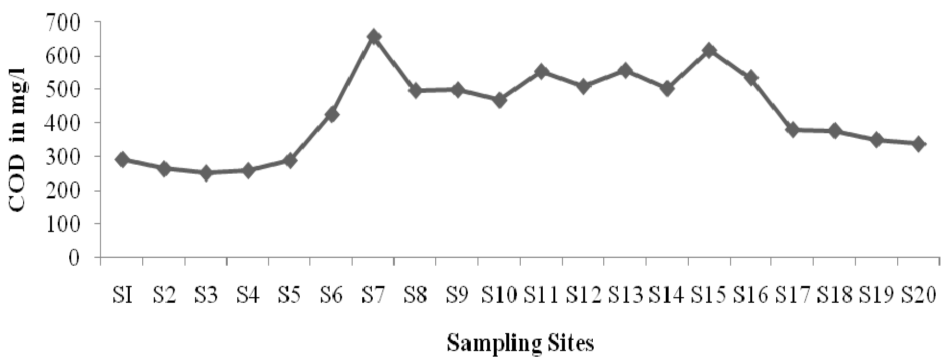

Figure 6. Chemical oxygen demand at different sampling industries

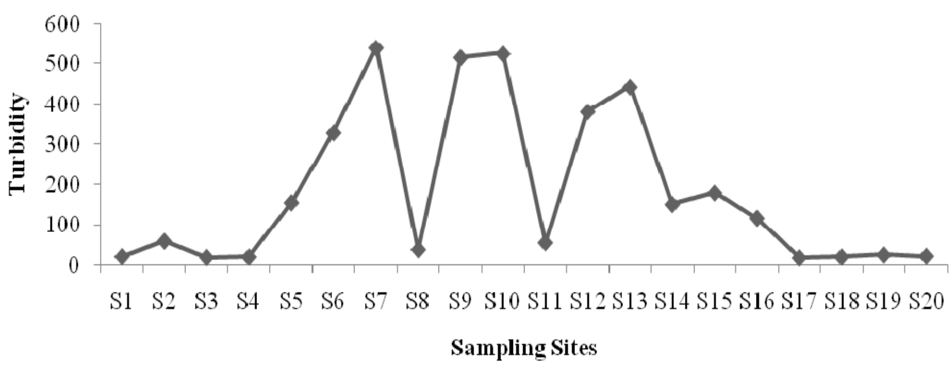

Figure 7. Turbidity at different sampling industries

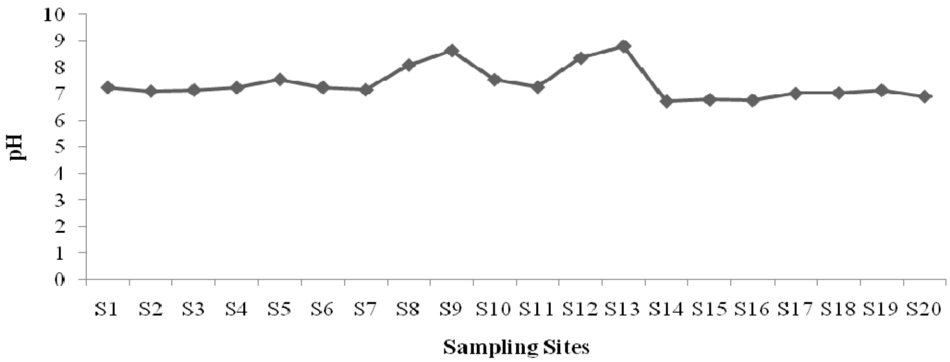

Figure 8. Level of pH at different sampling industries

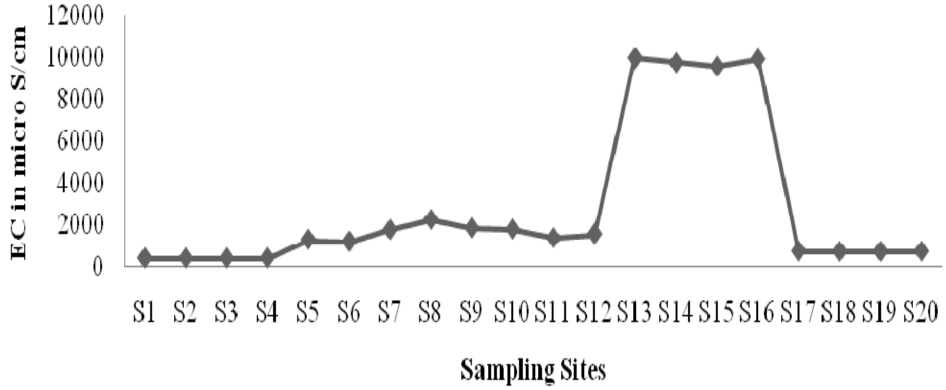

Figure 9. Electrical conductivity at different sampling industries

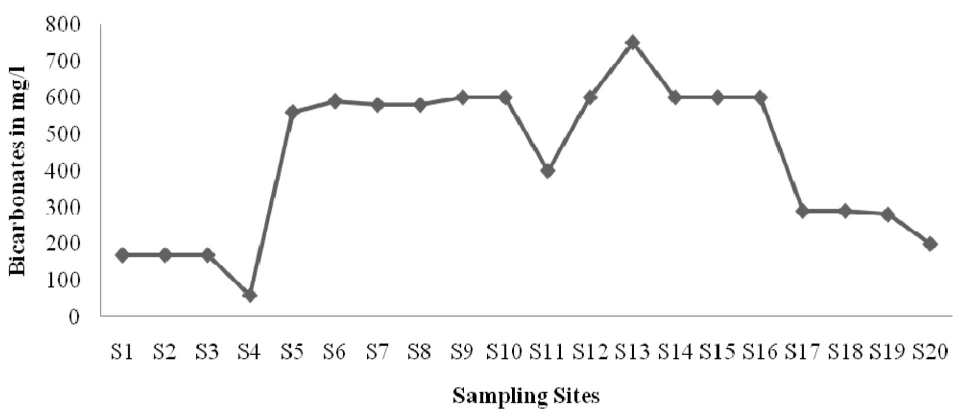

Figure 10. Bicarbonates at different sampling industries

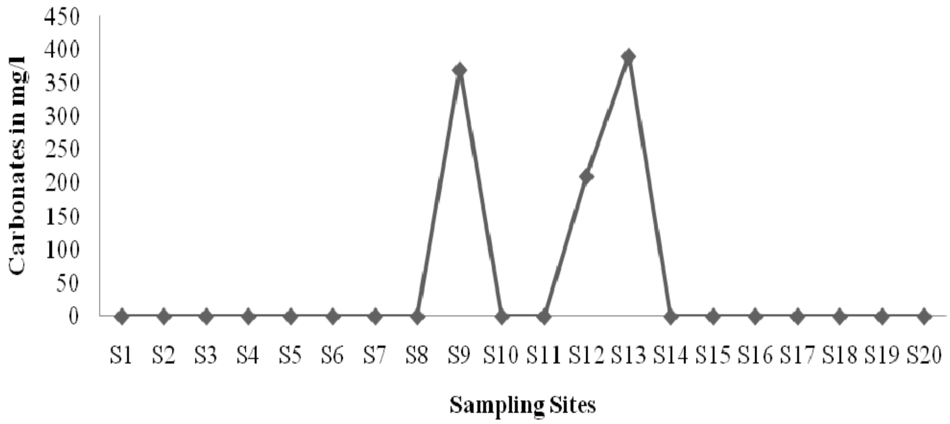

Figure 11. Carbonates at different sampling industries

CONCLUSIONS

Flour industry had minimal adverse impacts of wastewater releases whereas the *Ghee* mills showed moderate effects that can be rectified and/or treated within the factory premises through minor arrangements by the owners. Tanneries were the worst of all other industrial units; they demand serious attention of the planners before it is too late. Special treatments processes are required to be installed at industrial units in order avoid polluting all the drains, waterways, surface and groundwater.

REFERENCES

Ahmad, M., A.S. Bajahlan and K.A. Al-Hajery. 2010. Potential impacts of industrial reclaimed water on landscape irrigation. Int. J. Agric. Biol. 12:707-712.

Cheunbarn, S. and Y. Peerapornpisal. 2010. Cultivation of Spirulina platensis using anaerobically swine wastewater treatment effluent. Int. J. Agric. Biol. 12:586-590.

Jasem, M.A., H.S. Behbehani and T.H. Abdullah. 2003. Wastewater reuse practices in Kuwait. The Environmentalist 23:117-126.

Khurshid, A.W. 1999. Evaluation of water quality of rivers in Pakistan. National workshop on water resources achievement. June 28-30, 1999. Proceedings of the Pakistan Council of Research in Water Resources. pp. 406-416.

Koca, S.B., N.O. Yigit, A. Dulluc, G. Erol, N. Cılbız and R. Kucukkara. 2011. Appropriate usage level of shrimp waste meal as chitin source for feeding young crayfish (*Astacus leptodactylus* esch. 1823). Pak. Vet. J. 31:207-210.

Liu, W.H., J.Z. Zhao, Z.Y. Ouyang, L. Solderland and G.H. Liu. 2005. Impacts of sewage irrigation on heavy metal distribution and contamination in Beijing, China. Environmental International 32:805-812.

Makia, D.H., E. Fadaly and M.E. Zawawy. 1999. Microbiological and chemical aspects on some fresh water samples. Pak. J. Biol. Sci. 17:10-23.

Manahan, S.E. 1994. Environmental Chemistry. 6th Ed. Lewis Publisher, CRC Press Inc., USA.

Mubin, S., S. Gul, M.I.A. Khokhar and M. Ashraf. 2002. Statistical solution for the industrial waste problem. J. Drainage and Waste Manage. 6:55-68.

Saha, R. 2007. Impact of the effluents of textile dying industries on the water quality of Dhaka-Narayanganj-Demra (D.N.D). J. Biol. Sci. 11:11-14.

Schroder, P., J. Navarro-avino, H. Azaizeh, A.G. Goldhirsh, S. Digregorio, T. Komives, G. Langergraber, A. Lenz, E. Maestri, A.R. Memon, A. Ranalli, L. Sebastiani, S. Smrcek, T. Vanek, S. Vuilleumier and F. Wissing. 2007. Using phytoremediation technologies to upgrade waste water treatment in Europe. Env. Sci. Pollut. Res. 14:490- 497.

Scott, C.A., N.I. Faruqui and L. Raschid-Sally. 2004. Wastewater use in irrigated agriculture: Management challenges in developing countries. In: (U.K. Scott (ed.) Wastewater use in irrigated agriculture: confronting the livelihood and environmental realities. CABI International, UK.

Sharma, D.C. 2007. By order of the court: environmental cleanup in India. Environmental Health Perspectives 113:395-39.