

Civic Pollution and Its Effect on Water Quality of River Toi at District Kohat, NWFP

¹Zaigham Hasan, ²Zubair Anwar, ¹Khalid Usman Khattak, ³Mazhar Islam, ⁴Rizwan Ullah Khan and ²Jabar Zaman Khan Khattak

¹Department of Zoology University of Peshawar, KPK, Pakistan

²Department of Bioinformatics and Biotechnology, International Islamic University, Islamabad, Pakistan

³Department of Botany, Hazra University, Garden Campus, Mansehra, KPK, Pakistan

⁴Department of Chemistry, Gomal University, D.I. Khan, KPK, Pakistan

Abstract: The present study was conducted to evaluate the physico-chemical parameters as well as level of pollutants (Such as heavy metals and organic wastes) in River Toi originates from Hangu and flow through Kohat city. For this purpose a six months study was conducted from June to November 2008 on pre-selected three sampling sites i.e. upstream (Site-1), main point where city sewage enter the river (Site-2) and downstream (Site-3). The physico-chemical parameters such as alkalinity, hardness, electrical conductivity, dissolved oxygen, pH and temperature were monitored. While heavy metals analysis of lead, cadmium, zinc, arsenic, copper and nickel were conducted. The results revealed that the increased level of heavy metals and physico-chemical parameters was recorded at all the sites. The means of physico-chemical parameters recorded during the study at Site I, II and III are alkalinity (357.5, 344.1 and 363.3 mg/L), hardness (315.8, 307.5 and 312 mg/L), TDS (497.5, 445 and 470 mg/L) and electrical conductivity (1230.6, 1119 and 1172.8 $\mu\text{s}/\text{cm}$), DO (2.54, 2.75 and 2.64 mg/mL), temperature (18.2, 18.2 and 18.3°C) and pH (8.43, 8.31 and 8.35), respectively. The means of different heavy metals recorded during the study at Site I, II and III are lead (0.33, 0.40 and 0.55 mg/L), zinc (0.34, 0.60 and 0.53 mg/L), cadmium (0.03, 0.08 and 0.13 mg/L), arsenic (0.29, 0.63 and 0.51 mg/L), copper (0.04, 0.04 and 0.03 mg/L) and nickel (0.00, 0.01 and 0.01 mg/L), respectively. The results of the heavy metals and water quality analysis revealed that the condition of water is unsuitable for aquatic life and human consumption due to addition of civic and industrial pollution. This issue needed to be resolved immediately with both public and private partnership.

Key words: Anthropogenic, fauna, heavy metals, sediments

INTRODUCTION

Water covers 71% of the earth surface and makes up 65% of human body. Today 450 million people in 29 different countries suffer from water shortages (UNEP, 2002). If the water becomes polluted, it will lose its value and can become a threat to animals as well as human health and to the survival of the fish and other aquatic fauna living in it. The inadequate supplies of water due to drought and many other reasons increase the problem of maintaining water quality especially when there are multiple sources of water pollution such as sewage, industrial effluents and agricultural runoff (Afzal, 2007).

Heavy metals from manmade pollution sources are being continuously released into aquatic ecosystem and the contamination of heavy metals is a serious threat because of their toxicity particularly to life in water as well as to human health (Eisler, 1988). It is recognized that due to increasing consumption of water resources for

civic activities as well as natural processes such as change in precipitation inputs, erosion, weathering of crystal materials, surface water is degraded. This degradation in surface water impaired it to be used for drinking, industrials, agricultural, recreational or other purposes (Turner *et al.*, 1998).

There is inadequate knowledge and data on heavy metals concentrations in river waters. The scale of river pollution at the fresh water systems has high pollution potential. This could be measured through the use of fish heavy metal analysis (Badsha and Goldspink, 1982). In addition, the trace metals in such waters may undergo In Pakistan like other countries of the world, the level of heavy metals rapid changes affecting the rate of uptake or release by sediments (Boudou, 1981).

Pollution of fresh water bodies, especially the rivers is no longer within safe limits for human consumption as well as aquatic fauna. Earlier base line studies have identified elevated levels of certain trace metals in local

fresh water ecosystems especially rivers and lakes (Javed and Mehmood, 2000).

The water that fills our reservoirs, rivers and lakes is increasingly being viewed as a valuable and rare resource. They have been widely utilized by mankind over the centuries to the extent that very few are now in a "natural" condition. Freshwater is scarce, and resources are unevenly distributed throughout the world, with much of the water located far from human populations (UNEP, 2002). Pollution of fresh water bodies, especially the rivers is no longer within safe limits for human consumption as well as aquatic fauna. Earlier base line studies have identified elevated levels of certain trace metals in local fresh water ecosystems especially rivers and lakes (Javed and Mehmood, 2000).

Chemical contamination of aquatic ecosystems can influence the physiology of organisms and accumulate in the body tissues. Thus both the recruitment and marketability of fish products may be affected by contaminants (Richardson, 2003).

Fishes are often at the top of the aquatic food chain and may concentrate large amounts of some metals from the water (Mansour and Sidky, 2003). Increased loads of nutrients, heavy metals, and other compounds (e.g., pesticides, fertilizers) have resulted from changes in land use and anthropogenic development of the basins. Assessment of the environmental impacts and development of a framework for the continuous improvement of the water and soil quality are big issues (Turner *et al.*, 1988). In order to understand the environmental chemistry of a metal, it is necessary to include the physico-chemical forms of the metal, especially the amount of free metal ions and very labile complexes under the diverse range of conditions possible in natural systems (Davidson and Ure, 1995).

Such inputs to water can be derived from a variety of sources, some of them obvious, and others less so. They can be varied so that the concentrations of chemicals in water are rarely constant (Javed, 2001). Heavy metal inputs from industrial effluents and domestic sewage are likely to enter inland aquatic ecosystems that would accumulate in the fish and result in the physiological perturbations. From an ecological point of view, survival, growth, reproduction, spawning and hatching success, in fish under different levels of toxicity, provide end-points of undoubted significance (Groombridge, 1992).

Water pollution becomes most obvious when it involves poisoning of drinking water or causes the death of a large number of fish or other aquatic population. The heavy metals can clog the gills of fish and cause suffocation. The heavy metals pose health hazards when they are concentrated in fish, which are passed on to people, mammals and birds when they eat the fish. Drinking water from acidic lakes too may have high

concentrations of these toxic metals. This could be caused by sewage. Disposal of sewage wastes into a large volume of water could reduce the biological oxygen demand to such a great level that the entire oxygen may be removed. This would cause the death of all aerobic species including fish (Karadede and Unlo, 2000).

Contaminated sediments are another significant source of water pollution. These may be derived from inputs of suspended solids to which toxic substances are absorbed; such as soil particles in surface water run-off from fields treated with pesticides. Pesticides are useful tools in agriculture but their contribution to the gradual degradation of the aquatic ecosystem cannot be ignored (Rahman *et al.*, 2002).

The Kohat Nala locally called as Kohat Toi originates from Hungo. During its flow it gets contaminated with agricultural, industrial and domestic wastes. Thus making it unfavorable for aquatic fauna especially fish and also affecting the water quality and making it hazardous for human household as well as drinking purposes. For investigating these all, this study was done, to ultimate the industrialists, to ultimate the environmental protection agencies and to highlight the concerned authorities to took immediate precautionary steps for the betterment of environment, mankind and the aquatic life as well.

MATERIALS AND METHODS

Study area: The study was conducted from June to November 2008 on pre-selected three sampling sites on Nala called Kohat Toi. It originates from Hango and enters into Tanda dam. Tanda dam is approximately 10 Km away from Kohat. Several human activities in the area include washing of cloths, vehicles washing, refuge of dumps and wastes of different factories have been seen to be added in it.

Site selection and sampling: Survey was conducted from upstream and down stream of Kohat Toi to select the sampling sites. Three sites were selected on Kohat Toi for taking water samples for the study in order to do heavy metal as well as physico-chemical analysis these sites were about 40 m apart from each other. Water samples were collected on monthly basis from three different sites of river Toi. Water samples were collected in plastic bottles with screw caps and transported to Water Quality Lab of Aquaculture and Fisheries Program, NARC. These samples were then tested for different physico-chemical parameters. Samples were taken carefully to avoid any kind of debris in the water. Hydrochloric acid and boric acid were used as preservation in the sampling bottles for heavy metals before going to field.

Physico-chemical parameters: Physico-chemical parameters such as Dissolved Oxygen and Electrical

Conductivity were recorded on the spot at each sampling site using Limnological field meter (Cyberscan series 600, serial no: 452067, made in Singapore). Physical parameters include temperature and color of water while chemical parameters include pH, dissolved oxygen contents, alkalinity, hardness and electrical conductivity. Details of their examination are as follows:

For alkalinity 100 mL of water sample two drops of phenolphthalein indicator (Annexure I) were added. When pink color appeared, solution was titrated with 0.02 N sulphuric acids (Annexure II) to get a colorless solution. Volume of H₂SO₄ used was noted and phenolphthalein alkalinity was calculated as follows.

$$\text{Phenolphthalein alkalinity (mg/L)} = \text{mL of titrant} \times 10$$

To the same solution 4-8 drops of methyl orange indicator (Annexure III) were added and this solution was titrated with 0.02 N H₂SO₄ till faint orange color appeared. Reading was noted including the previously used volume total alkalinity was calculated as follows:

$$\text{Total alkalinity (mg/L)} = (\text{mL of titrant}) \times 10$$

For hardness 100 mL. of water sample, 2 mL of buffer solution (Annexure IV) and 8 drops of Eriochrome Black T indicator (Annexure V) was added. When purple color appeared solution was titrated with 0.01N EDTA solution (Annexure VI), till the solution turned deep blue. Volume of EDTA (Ethylene diamine tetra acetate) used was noted, and total hardness was calculated with the help of the following formula:

$$\text{Total Hardness (mg/L)} = (\text{mL of titrant}) \times 10$$

pH of water samples was measured by using PH meter (Model 3510, Bibby Scientific Ltd. UK). Electrical

conductivity was measured by EC meter (Model: LF 90, WTW, Germany).

Dissolved oxygen/temperature: The dissolved oxygen and temperature of water samples was measured by digital meter (Oxi 330i, WTW). The meter was calibrated by the manufacturers' calibration procedure before each measurement.

Heavy metal analysis: For heavy metal analysis water sample were subjected to Spectroquant NOVA 60 (Merck, Germany) using Kits provided by Merck and the readings were recorded on automatic computerized system.

Data analysis: At the end of trial all the data was entered in the MS Excel 2003 and means were calculated. The data for physico-chemical analysis was tabulated month wise and site wise while data for heavy metal analysis was only given month wise.

RESULTS

Physico-chemical analysis of water collected from different sites at river Toi, Kohat: The results of physico-chemical analysis of water samples collected from the Site-I are given in Table 1. The highest value of temperature was recorded in October (19.0°C). The highest value of pH was recorded in November (8.87) and lowest was in September (8.5). The highest value of TDS was recorded in September (620) and lowest was in June (450). The highest value of Dissolved Oxygen was recorded in July (3.10) and lowest was in October (2.16). The highest value of Hardness was recorded in November (380) and lowest was in October (250). The highest value of Alkalinity was in June (370) and lowest was in

Table 1: Physico-chemical properties of river Toi recorded at Site I

Months	Temp. (°C)	pH	TDS	DO	Hardness	Alkalinity	E.C
June	18.5	8.35	450.0	2.40	280.00	370.0	1165.00
July	18.3	8.25	475.0	3.10	330.00	360.0	1310.00
Aug	17.2	8.25	490.0	2.25	310.00	365.0	1210.00
Sept.	19.0	8.50	620.0	2.91	345.00	340.0	1486.00
Oct.	18.8	8.33	490.0	2.16	250.00	350.0	1177.00
Nov.	17.5	8.87	460.0	2.44	380.00	360.0	1036.00
Mean	18.22	8.43	497.5	2.54	315.83	357.5	1230.67

Alkalinity: ppm; Hardness: ppm; TDS (total dissolved solids): ppm; EC (electrical conductivity): us/cm; DO (dissolved oxygen): mg/L; Temperature: °C

Table 2: Physico-chemical properties of river Toi recorded at Site II

Months	Temp. (°C)	pH	TDS	DO	Hardness	Alkalinity	E.C
June	18.30	8.30	410	2.80	310.0	340.00	1210
July	17.90	8.40	465	2.80	310.0	345.00	1070
Aug	18.30	8.35	465	2.40	325.0	370.00	1235
Sept.	19.10	8.05	420	2.56	245.0	360.00	1034
Oct.	18.80	8.29	480	2.12	260.0	320.00	1174
Nov.	17.20	8.45	430	3.80	395.0	330.00	991
Mean	18.27	8.31	445	2.75	307.5	344.17	1119

Alkalinity: ppm; Hardness: ppm; TDS (total dissolved solids): ppm; EC (electrical conductivity): us/cm; DO (dissolved oxygen): mg/L; Temperature: °C

Table 3: Physico-chemical properties of river Toi recorded at Site III

Months	Temp.(°C)	pH	TDS	DO	Hardness	Alkalinity	E.C
June	18.8	8.15	425	2.15	290	355	1240
July	17.4	8.10	430	2.60	295	340	1190
Aug	18.9	8.40	475	2.60	340	375	1230
Sept.	18.9	8.44	480	2.35	334	330	1145
Oct.	18.9	8.22	480	2.20	238	385	1166
Nov.	17.1	8.77	530	3.93	375	395	1066
MeanI	8.33	8.35	470	2.64	312	363.33	1172.83

Alkalinity: ppm; Hardness: ppm; TDS (total dissolved solids): ppm; EC (electrical conductivity): us/cm; DO (dissolved oxygen): mg/L; Temperature: °C

Table 4: Heavy metals analysis of water samples collected from the Site -I

Months	Arsenic	Lead	Cadmium	Copper	Nickel	Zinc
June	0.20	0.17	0.01	0.013	0.001	0.50
July	0.10	0.07	0.02	0.090	0.003	0.30
Aug	0.20	0.11	0.04	0.011	0.004	0.40
Sept.	0.55	0.13	0.03	0.060	0.001	0.21
Oct.	0.51	0.35	0.04	0.030	0.004	0.30
Nov.	0.19	1.12	0.05	0.020	0.002	0.35
Average	0.29	0.33	0.03	0.04	0.000	0.34

As (arsenic): mg/L; Pb (Lead): mg/L; Cd (cadmium): mg/L; Cu (Copper): mg/L; Ni (Nickel): mg/L; Zn (Zinc): mg/L

Table 5: Heavy metals analysis of water samples collected from the Site -II

Months	Arsenic	Lead	Cadmium	Copper	Nickel	Zinc
June	0.40	0.17	0.07	0.025	0.006	0.70
July	0.58	0.13	0.06	0.030	0.009	0.45
Aug	0.68	0.19	0.07	0.020	0.008	0.70
Sept.	0.90	0.19	0.09	0.070	0.007	0.40
Oct.	0.70	0.50	0.08	0.045	0.009	0.80
Nov.	0.50	1.22	0.09	0.035	0.008	0.55
Average	0.63	0.40	0.08	0.040	0.010	0.60

As (arsenic): mg/L; Pb (Lead): mg/L; Cd (Cadmium): mg/L; Cu (Copper): mg/L; Ni (Nickel): mg/L; Zn (Zinc): mg/L

Table 6: Heavy metals analysis of water samples collected from the Site -III

Months	Arsenic	Lead	Cadmium	Copper	Nickel	Zinc
June	0.3	1.13	0.05	0.021	0.004	0.65
July	0.35	0.12	0.05	0.035	0.007	0.35
Aug	0.58	0.17	0.45	0.019	0.006	0.60
Sept.	0.71	0.21	0.07	0.065	0.006	0.35
Oct.	0.65	0.45	0.06	0.040	0.008	0.70
Nov.	0.45	1.19	0.07	0.025	0.006	0.55
Average	0.51	0.55	0.13	0.030	0.010	0.53

As (arsenic): mg/L; Pb (Lead): mg/L; Cd (Cadmium): mg/L; Cu (Copper): mg/L; Ni (Nickel): mg/L; Zn (Zinc): mg/L

September (340). The highest value of Electrical Conductivity was in September (1486) and lowest was in November (1036).

The results of physico-chemical analysis of water samples collected from Site-II are given in Table 2. The highest value of Temperature was recorded in September (19.1°C) and lowest was in November (17.2°C). The highest value of pH was recorded in November (8.45) and lowest was in September (8.05). The highest value of TDS was recorded in October (480) and lowest was in June (410). The highest value of Dissolved Oxygen was recorded in November (3.80) and lowest was in October (2.12). The highest value of Hardness was recorded in November (395) and lowest was in June and July (310). The highest value of Alkalinity was recorded in August (370) and lowest was in October (320). The highest value of Electrical Conductivity was recorded in August (1235) and lowest was in November (991).

The results of physico-chemical analysis of water samples collected from the Site-III are given in Table 3.

The highest value of temperature was recorded in months of August, September and October (18.9) and lowest was in November (17.1). The highest value of pH was recorded in November (8.77) and lowest was in July (8.10). The highest value of TDS was in September and October (480) and lowest was in June (425). The highest value of Dissolved Oxygen was in November (3.93) and lowest was in June (2.15). The highest value of Hardness was recorded in November (375) and lowest was in October (238). The highest value of Alkalinity was recorded in November (395) and lowest was in September (330). The highest value of Electrical conductivity was recorded in June (1240) and lowest was in November (1066).

Heavy metal analysis of water samples collected from different sites at river Toi, Kohat: The results of Heavy metals analysis of water samples collected from the Site-I are give in Table 4. The result showed that highest value of Arsenic was recorded in September (0.55) and lowest

was recorded in July (0.1). The highest value of Lead was recorded in October (0.35) and lowest was recorded in July (0.07). The highest value of Cadmium was recorded in November (0.05) and lowest was recorded in June (0.01). The highest value of Copper was recorded in September (0.060) and lowest was recorded in July (0.09). The highest value of Nickel was recorded in August and October (0.004) and lowest was recorded in June and September (0.001). The highest value of Zinc was recorded in June (0.50) and lowest was recorded in September (0.021).

The results of Heavy metals analysis of water samples collected from the Site-II are given in Table 5. The highest value of Arsenic was recorded in September (0.09) and lowest was recorded in June (0.4). The highest value of Lead was recorded in October (0.50) and lowest was recorded in July (0.13). The highest value of Cadmium was recorded in September and November (0.09) and lowest was recorded in July (0.06). The highest value of Copper was recorded in September (0.070) and lowest was recorded in August (0.02). The highest value of Nickel was recorded in July and October (0.009) and lowest was recorded in June (0.006). The highest value of Zinc was recorded in October (0.80) and lowest was recorded in September (0.40).

The results of Heavy metals analysis of water samples collected from the Site-III are given in Table 6. The highest value of Arsenic was recorded in September (0.71) and lowest was recorded in June (0.3). The highest value of Lead was recorded in October (0.45) and lowest was recorded in July (0.12). The highest value of Cadmium was recorded in August (0.45) and lowest was recorded in June and July (0.05). The highest value of Copper was recorded in September (0.035) and lowest was recorded in August (0.019). The highest value of Nickel was recorded in October (0.008) and lowest was recorded in June (0.004). The highest value of Zinc was recorded in October (0.70) and lowest was recorded in July and September (0.35).

DISCUSSION

Present study was conducted in order to assess the effect of civic pollution on water quality of River Toi, District Kohat NWFP. As the water pollution is dangerous for both aquatic life and human health (Hugh and Madoka, 2005), so it is need of the hour to assess the water quality of rivers passing through our cities as this is a very important issue related to human and environment (Turner *et al.*, 1998). For this purpose three different sites were selected at the river Toi i.e., upstream, main point and down stream in order to achieve the objectives of the study. The samples obtained were then subjected to physico-chemical analysis and heavy metal analysis and the results were presented in the form of tables.

When the data of water quality analyzed it was found that only temperature and pH recorded at all the three sites and fall under the normal range required for aquatic life in the water. While all the other physico-chemical parameters i.e, total dissolved solids, electrical conductivity, dissolved oxygen, hardness and alkalinity values recorded at all the three sites were beyond the normal ranges determined for fish and human health (Khan, 2008) particularly the values of electrical conductivity were quite higher. According to Khan (2008) and WHO normal ranges for pH are 6.5-8.5 and that of TDS, alkalinity and hardness are 50-250 mg/mL, respectively. Similarly the normal ranges for DO and electrical conductivity are 5-15 mg/mL and 400-600 $\mu\text{s/cm}$. all these parameters have their own importance as they are part of environment necessary for conductance of life processes. For example pH is a measure of acid-base equilibrium achieved by water dissolved compounds as well as extent of flocculation and coagulation process of chemicals is dependent on pH (Sawyer and McCarty, 1967). Similarly alkalinity and hardness are important for certain life processes. Similarly DO, EC and TDS are also limiting factors (Sweety, 2008). Thus their analysis and knowledge off their levels is also necessary for fish and human health.

The results revealed that water quality of the river is badly affected and this effect might be due to the anthropogenic activities and the civic wastes which are added time to time in the river (Afzal, 2007) and are changing the water qualities of the river. The reason for assessing these water quality parameters is that the fluctuation in these parameters due to the above mentioned activities make the water dangerous for both aquatic life as well as human health (Khan, 2008). Thus it is necessary to analyze the water which is in human use as well to do efforts to control the pollutants and their sources.

When samples collected from the three sites were analyzed for different heavy metals it was found that concentrations of heavy metals i.e. lead, copper, zinc, cadmium and arsenic recorded were beyond the normal ranges as elicited by WHO, PAK PSQA, EU and US EPA, respectively. According to these organizations the normal ranges (mg/L) for the heavy metals are as follows i.e. lead (0.01-0.015), Arsenic (0.006-0.01), Cadmium (0.003-0.005), Copper (1.0-2.0), Nickel (0.02) and Zinc (3-5), respectively. The study revealed that heavy metal contents in the River Toi River are beyond the normal ranges and extremely dangerous for human consumption. The reason for this extremity in values is might be due to the addition of civic wastes and industrial effluents as the sewage of the city is directly discharged into the river along with the industries which are also discharging their effluents directly into the river. This is in agreement with the studies (Javed and Hayat, 1995; Gulfranz *et al.*, 2001; Naseem *et al.*, 2005) who reported that the level of heavy

metals increasing in the rivers due to discharge of industrial effluents and civic pollution of various kinds. This in turn deteriorating the water quality and making it unsuitable for both aquatic and human life.

We concluded that the present study conducted indicates the unsuitable condition of water of River Toi both for aquatic fauna and human use. This is evident from the levels of heavy metals and physico-chemical parameters which are beyond the suitable range. So an immediate strategy is needed to be acquired in order to stop the further deterioration of water. For this purpose both public and private partnership is needed.

REFERENCES

- Afzal, M., 2007. Effect of civic pollution on fish and fisheries in the riverine system. Final report of ALP sponsored Project. AFP, NARC, Islamabad, pp: 165.
- Badsha and Goldspink, 1982. Preliminary observation on the heavy metals contents of 4 species of fresh water fish in NW England. J. Fish Biol., 21: 251-267.
- Boudou, A., 1981. Recherche en ecotoxicologie, experimental sur les processus de bioaccumulation et des transfer des derives due mercure, dans les systemes aquatiques continentaux. Thesis d, Etat, Universite de Bordeaux, pp: 300.
- Davidson, C.M. and A.M. Ure, 1995. Chemical Speciation in the Environment. 1st Edn., Chapman and Hall, UK.
- Eisler, R., 1988. Zinc Hazards to fish, wildlife and invertebrates a synoptic review US Fish Wildlife Serve. Biology of Reproduction, pp: 85.
- Groombridge, B., 1992. Global Biodiversity: Status of the Earth's Living Resources, World Conservation Monitoring Center, in collaboration with the World Conservation Union, UN Environment Programme, World Wide Fund for Nature, and the World Resources Institute.
- Gulfraz, M., M. Arhad and T. Ahmed, 2001. Determination of selected trace metals in the fish and relevant water of river Soan (Pakistan). Pak. J. Arid. Agr., 4(1-2): 105-109.
- Hugh, C. and C. Madauka, 2005. Water pollution and man's health. Int. J. Gastroenterol., 4(1): 151-159.
- Javed and Mehmood, 2000. Metal bioaccumulation in body organs and tissues of fish from the river Ravi. Pak. J. Fisheries., 1(1): 1-6.
- Javed, M., 2001. Studies on Metal Eco-toxicity of River Ravi. Pakistan Science Foundation Project No. P-AU/ENV(44).
- Javed, M. and S. Hayat, 1995. Heavy metal toxicity of Ravi River Aquatic Ecosystem. Pak. J. Agric. Sci., 36(3-4): 1-9.
- Karadede, H. and E. Unlo, 2000. Concentrations of some heavy metals in water, sediment and fish species from the Ataturk Dam Lake (Euphrates), Turkey. Chemosphere, 41: 1371-1376.
- Khan, M. F. 2008. Determination of the pollutants in the water and fish fauna of river Kabul. M.Phil Thesis, Department of Zoology, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi, pp: 88.
- Mansour, S.A. and M.M. Sidky, 2003. The fiest comparative study between lake Qarrus and wadi-EI-Rayah wet and (Egypt) with respect to contamination of their major components. Food Chem., 82(2): 181-189.
- Naseem, A., A. Tahira, M. Gulfraz and R. Khanum, 2005. Adverse effects of metal ions pollution on aquatic biota and seasonal variations. Pak. J. Bio. Sci., 8: 1086-1089.
- Rahman, M.Z., et al., 2002. Effect of Diazinon 60 EC on *Anabas testudineus*, *Channa puntatus* and *Barbodes gonionotus*. NAGA, 25(2): 8-12.
- Richardson, K., 2003. Anthropogenically Induced Changes in Environment and Effect on Fisheries. Responsible Fisheries in Marine Eco System, pp: 275-289.
- Sawyer, A. and M. McCarty, 1967. McGraw Hill Series in Sanitation Science and Water Resources Engineering. Toronto, Canada, pp: 341.
- Sweety, S., 2008. Effect of civic pollution on the quality of water and fish in River Soan. M.Phil Thesis, Department of Biochemistry. Quaid-e-Azam University, Pakistan, pp: 79.
- Turner, R.K., W.N. Adger and I. Lorenzoni, 1998. Towards integrated modeling and analysis in coastal zones: principles and practices. LOICZ report and studies. 11: 182-196.
- UNEP, 2002. Vital Water Graphics, Executive Summary. Link Accessed October 2004.