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Original Article

Preliminary appraisal of physio-chemical and bacteriological water contaminations in Rawalpindi/Islamabad catchment of Soan river, Potwar plateau (Punjab), Pakistan

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Abstract
This preliminary study was conducted to evaluate physio-chemical and bacteriological status in the Rawalpindi/Islamabad catchment of Soan River. Physio-chemical parameters of given zones and there means were; pH (7.74, 8.62, 8.4 and 8.13), E.C (1125, 580, 395 and 427), TDS (674, 348, 237 and 256), Potassium (3.4, 2.7, 5.7 and 2.4), Phosphates (1.7, BDL, BDL and 0.11), Sulfates (48, 24, 15 and 13), and Nitrates (8, 1.7, 0.3 and 1). Color, turbidity and odor were objectionable in zone 1 only. Similarly, mean of bacteriological parameters were, total coliform (350, >1600, 500 and 280) and feacal coliform (280, 220, 220 and 130). Results of these physio-chemical and bacteriological parameters revealed that current situation of the Soan river (specifically Zone 1) water is unsuitable for human and aquatic lives of the river. It needs immediate attention from government as well as public participation for the conservation of this natural resource.
Key words: Physio-chemical, contamination, bacteriological, aquatic, conservation

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INTRODUCTION

Rivers are important pathways for the flow of energy, matter (surface as well as ground matters) and organisms through the landscape. A wide range of human activities at the catchments areas may lead to environmental deterioration of river waters (Kagalou *et al*., 2002). Water quality provides current information on concentration of various parameters at a given place at certain time. Water quality principles provide a strong base for measuring the suitability of water for its imposed uses and for improving the existing conditions at a certain time in the area (Iqbal, *et al*., 2004, 2006). For optimum development and management of water for the beneficial uses, current information needed, are to be provided by water quality programmes (Lloyd, 1992). Water quality deals with the physical, chemical and biological characteristics in relation to all other hydrological properties. Water quality provides current information about the concentration of various solutes at a given place and time. Water quality parameters provide the basis for judging the suitability of water for its designated uses/to improve existing conditions. A continuous monitoring of water quality is very essential to determine the state of pollution in our rivers. This information is important to communicate to the public and the government in order to develop policies for the conservation of the precious fresh water resources (Ali *et al*., 2000).

Soan is a seasonal river of Punjab in Potwar region. Soan river is one of the left bank tributary of Indus river. Soan River has five major streams Ling river, Korang river, Dharab Nala, Sil (lacally named as siyal) river and Lai nullah. These streams have the major contribution of water into Soan river. Total length of the main river is 274 km. The catchment area of Soan river upto Dhok Pathan gauging station is 6475 sq km (Jehanzeb, 2004). Solid-waste disposal practices threaten the quality of ground-water reserves. The Soan river right bank suburb area lies in the southern part of Rawalpindi, covering about a 900 ha irrigable area. Water is provided from the Rawal, Khanpur and Simly dams for irrigation purposes. This paper presents a detailed review of drinking-water quality in the Soan river with

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reference to civic pollution of Rawalpindi/Islamabad. It presents the total contamination ratio (water quality) of Soan river with respect to WHO (World Health Organization) and PSQCA (Pakistan Standards and Quality Control Authority) standards.

MATERIALS AND METHODS

The basic reason to conduct research was to get the estimation of contamination in the Soan river. Selection of sampling sites was based on previous studies, indicating these sites as potential sites for estimation of contamination. There were four zones for sampling to get true estimation of each priority area. Brief description of the zones is divided as under…

1. Kurang river zone (6 samples), Date: 05 July 2012, Time: 01:20pm – 02:30pm
2. Ling nallah zone (6 samples), Date: 05 July 2012, Time: 04:50 pm – 06:50pm
3. Main Soan river near Sihala (6 sample), Date: 06 July 2012, Time: 01:20 pm– 02:45pm
4. Main Soan River, Soan camp (6 samples), Date: 06 July 2012, Time: 04:30 pm– 05:25pm

From each site two samples were collected, 1st for physical and chemical analysis and 2nd for bacteriological analysis according to the methods referred in Table 1. It is difficult to obtain a truly representative sample while collecting surface water samples. Sampling points were selected carefully (near to bank) to avoid any kind of debris in the water. Considerable variations like seasonal stratification, runoff, rainfall and wind were also documented while collecting water sample. All the samples were collected in clean plastic bottles and were stored at 4^{o}C (carefully placed in the cooler with ice) in order to reduce the possibility of bacterial reduction and also to make possible that true representative samples could be analyzed.

Statistical Analysis

Data were expressed as Mean±SD and compared with control group using student t-test. P< 0.05 was considered statistically significant. WHO standards used as control parameters and each sampling zone was compared with control parameter to get the significance of the data provided. For the graphs, WHO guidelines were used as control parameter for all the zones.

RESULTS AND DISCUSSION

Study area was selected due to its potential importance with reference to water quality variations in the river. These sites add most of the contaminants in the river through out its journey. This preliminary study was conducted to assess the effect of civic pollution on the quality of water in Soan river, Islamabad. Soan river catchment study area was divided into 4 zones i.e. main Soan river upstream, Ling stream (left bank tributary), Kurang river (Right bank tributary) and main Soan middle zone. water samples processed for physio-chemical and bacteriological examinations and the results are presented in table 2. The collected samples were analyzed at National Water Quality Laboratory (NWQL).

Determination of electrical conductivity provides a rapid and convenient means of estimating the concentration of electrolytes in water containing mineral salts. Zone 1 expressed the level of E.C greater than the permissible limit of the water defined by both WHO and PSQCA. All of the other zones had E.C within the permissible level (figure. 1). The purpose of showing the significance from the permissible limit was to show variations above or below limit. From the results obtained by using t-test, it can be concluded that there is greater significance difference between all the values of given zones with reference to WHO standards. pH was within the permissible level, except in zone 1(Kurang River zone) which is showed level little more than WHO and PSQCA standards. We can conclude from the results that except zone 1(Kurang River zone), all the other zones had turbidity levels lesser than the permissible limit of WHO & PSQCA. Kurang river had maximum contribution of water in the Soan river which could cause the severe impact on the aquatic life and hence the quality of river water. Color of the water in Zone 1 (Kurang River zone) was dark green towards blackish. The water colour could be attributed to the industrial and household wastes of Islamabad areas and intrusion of humus etc. Ling stream had also light green color but to a lesser extent than the above level (15TCU) of contamination of water.

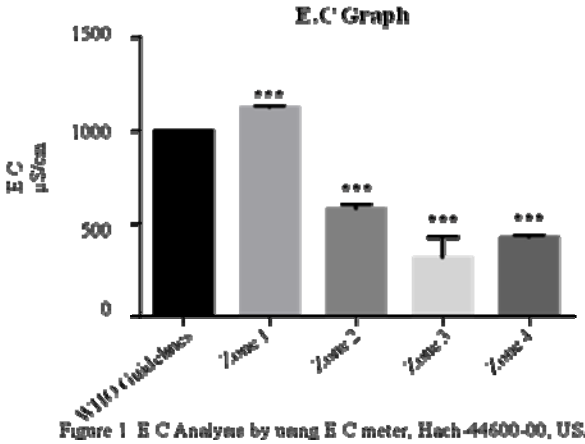

Figure 1 E C Analysis by using E C meter, Hach-44600-00, USA

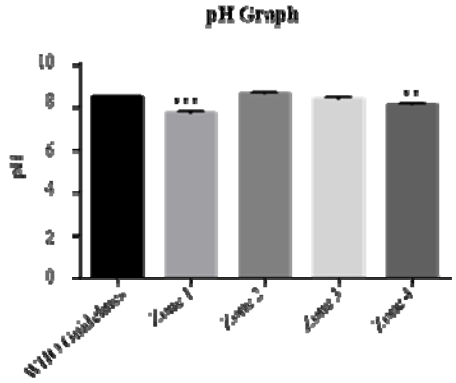

Figure 2 pH Analysis by using pH Meter, Hanna Instrument, Model 8519, Italy

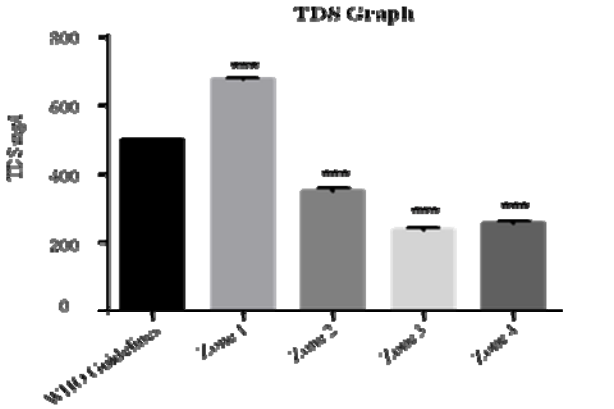

Figure 3 TDS Analysis by using TDS meter 25402, Standard method

Drinking waters should have no observable odor to any consumer (WHO, 1984). Zone 1 had the objectionable odor due to significant amount of biological contamination and presence of algae etc. Its ratio is high in summer and during rainfall season, its value decreased specially in Kurang river because Islamabad has very high rainfall ratio, which causes decrease of odor in the water bodies by transferring the contaminants to downstream.

The TDS levels also appeared hazardous in Zone 1 showing a significant difference of values. It indicates that this zone has water showing the properties of hard water, which can affect the soils as well as the infrastructural problems. TDS has secondary health impacts related to human. Values showing that all the zones had levels of TDS within the capacity to use it. Nevertheless, as TDS is one of the major indicators of high concentration of harmful contaminants like manganese, bromide, sulfates and arsenic etc, it could cause the severe impact on human health due to availability of these contaminants. As Kurang river contains the wastewaters of some industries, household, road salts etc, it is more disastrous for health due to probability of presence of above discussed harmful matters.

Major sources of nitrates in water are fertilizers from cultivated land, drainage from livestock feed lots and domestic and some industrial wastewaters. Unpolluted natural water usually contains only small fraction of nitrate. In infants, intestinal tract nitrates are reduced to nitrites, which may cause methaemoglobinaemia. The basic sources of NO_3 in the Soan and its tributaries were of non-point origin (e.g. by use of fertilizers and geology of the area) while the point sources were represented by industries in Islamabad and sewerage water of all the watershed tributaries. The dead waste organic materials are also one of the sources of NO_3. Chemical industries in I10 and its related areas are participating partially NO_3 in the river. Zone 2, 3 and 4 are showed the significantly low levels of nitrates as compared to zone 1 (Kurang river zone). Potassium at present is used as a tracer element and an indicator of geological origin of water, however still it is one of the major cations (Faust *et al*., 1981). Although potassium has no defined permissible levels by WHO or PSQCA but different studies assumed to 4.5 mg/l as upper limit related to its hazardness for drinking water. From the results obtained, it can be easily revealed that zone 3 has potassium at hazardous level.

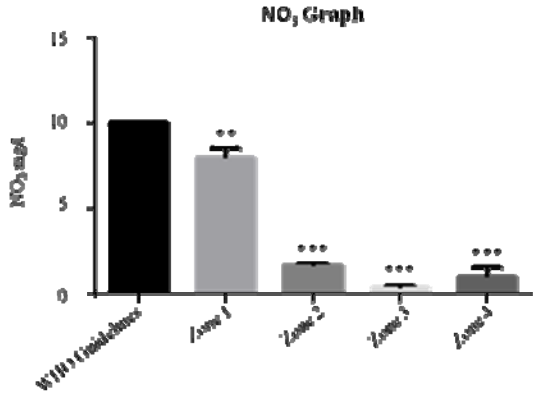

Figure 4 NO_3 Analysis by Cd Reduction (Hach-8171) by Spectrophotometer

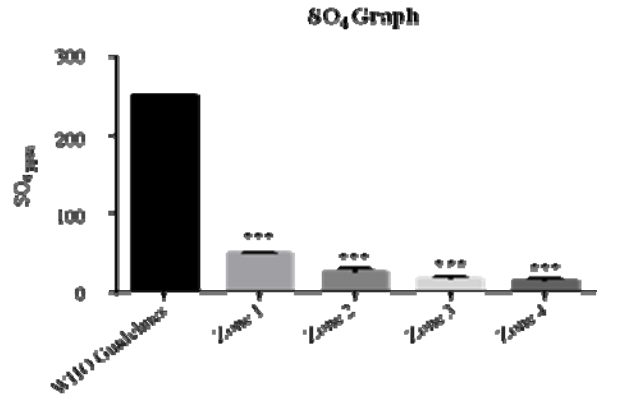

Figure 5 SO_4 Analysis by SulfaVer4 (Hach-8051) by Spectrophotometer

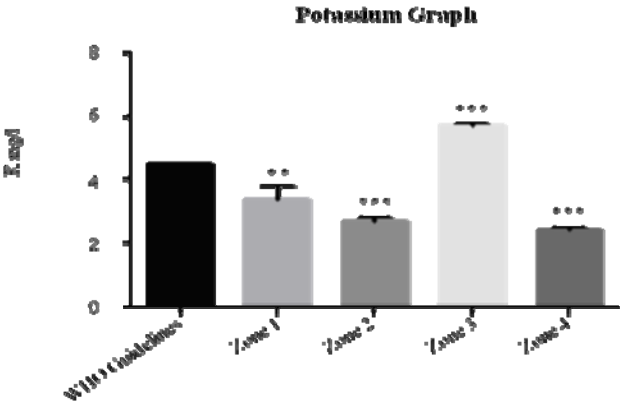

Figure 6 Potassium Analysis by 8190 and 8048 (Hach)

However, statistically all the values have significant difference with the given assumption of 4.5 mg/l. Sulfate concentrations in natural water range from a few mg to several hundred mg per liter. Samples were collected in clean plastic bottles and stored at 4°C in order to reduce the possibility of bacterial reduction of sulfate to sulfide in polluted or contaminated samples. Wastewater containing the detergents is the major cause of sulfates in the river especially through tributary of Islamabad (Kurang) and small nallahs of the villages along the river. Geology of the upstream areas also has the contribution containing the carbonate rocks. The major cause of sulfates in the river is the gypsum industry in Islamabad. Irrigation and sewerage system are also participating into the concentration of sulfates in the river. Phosphorus is important for microbial regrowth of in water (Sathisvan, 1999). WHO and PSQCA have not defined the permissible limits of phosphorus in water but different studies identified that the permissible level for phosphorus lies between 0.02 to 2.2 mg/l. Zone 1 has a significant amount of phosphorus but other zones data' showed deficiency of phosphates in the river waters. This indicated the loss of microbial limitations as well as the degraded conditions of water quality due to lack of phosphates.

Coliform are found in polluted and non-polluted soils, human feces and other warm-blooded animals (Thomann and Mueller, 1987). The feacal coliforms' presence indicates the organisms from the humans and animals intestinal tracts. Feacal coliforms are preferred on total coliform as their origin could not be the soil organisms (Chapra, 1997). Results of all the samples indicated that these they were highly contaminated sites and usage of this water for drinking purpose is hazardous for health. Especially zone 2 had the highest value *i.e.,* greater than 1600 which indicated highly polluted nature of water by anthropogenic source. We have concluded from the present study that Soan river water quality is unsuitable for both aquatic as well as human health. This is evident from the high availability of coliforms as well as from the physio-chemical parameters. Therefore, an immediate strategy is need of the hour to control the deterioration of this natural resource. For this purpose, both public as well as private partnership along with government initiatives is the basic need to conserve the natural condition of Soan river.

It is recommended to develop a recycling unit near Soan camp, to recycle this overall contaminated water for its better usage. The development of small retaining ponds with artificial liter traps below the Rawal dam outlet of

Kurang River will also be beneficial to minimize the contaminants ratio in downstream waters.

Table I: Basic Water Quality Parameters selected for Analysis and method of analysis adopted.

Sr. No	Parameter	Method adopted
01	EC µS/cm	By E.C meter, Hach-44600-00, USA
02	pH	By pH Meter, Hanna Instrument, Model 8519, Italy
03	Turbidity	By Turbidity Meter, Lamotte, Model 2008, USA
04	Color (TCU)	By Sensory Test
05	Odor	By Sensory Test
06	TDS (mg/l)	By 2540C, Standard method (1992)
07	NO_3 (mg/l)	By Cd. Reduction (Hach-8171) by Spectrophotometer
08	K (mg/l)	By Flame photometer PFP7, UK
09	SO_4 (mg/l)	By SulfaVer4 (Hach-8051) by Spectrophotometer
10	PO_4 (mg/l)	By 8190 and 8048 (Hach)
11	Total Coliform MPN/100ml	By 9221-B,Multiple tube fermentation Technique, Standard (Nat10) (Nat10; bottled water report july- september 2012 with Annex.pdf) Methods for the Examination of Water and Waste Water
12	Feacal Coliform MPN/100ml	By 9221-E,Multiple tube fermentation Technique, Standard Methods for the Examination of Water and Waste Water

Table II: Physio-chemical and bacteriological analyses of the water samples.

Sr. No.	Physico-chemical parameters									Bacteriological parameters (MPN/100ml)	
	E.C. (µS/cm)	pH	Turbidity (NTU)	Colour (TCU)	TDS (mg/l)	NO_3 (mg/l)	K (mg/l)	SO_4 (mg/l)	PO_4 (mg/l)	Total coliform	Fecal coliform
Mean Data 1	1125	7.74	> 5	>15	674	8	3.4	48	1.7	350	280
Mean Data 2	580	8.62	<5	<15	348	1.7	2.7	24	BDL	>1600	220
Mean Data 3	395	8.4	<5	<15	237	0.3	5.7	15	BDL	500	220
Mean Data 4	427	8.13	<5	<15	256	1	2.4	13	0.11	280	130
WHO standards	<1000	6.5-8.5	<5	<15	500	10	-	250	-	0	0
(PSQCA)	<1000	6.5-8.5	<5	<15	1000	10	-		-	0	0

Pakistan standards and Quality control Authority (PSQCA), World Health Organization (WHO), Nephlometric Turbidity Unit (NTU), True Color Units (TCU), Below Demanding level (BDL).

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