Assessment of quality of water in Kabul River, Nowshera city, Pakistan

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Abstract

This study reports results of a three-year project carried out to investigate the impacts of wastewater on the quality of water in Kabul River. The characteristics of wastewater from Nowshera city and groundwater quality from areas adjacent to Kabul River were also studied using standard laboratory techniques. The results indicate that there is gradual increase of about 16%, 10% and 24% in biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solids (TSS) values, respectively, over the three years of the study. There is also an abrupt increase in the levels of TSS, TDS, electric-conductivity (EC), BOD and COD downstream of a discharge point of wastewater effluent into Kabul River. Groundwater levels show a continuous decrease of 20-25% over the three-year period of the study. In addition, the wells have poor groundwater quality, falling below the drinking water quality guidelines.. Therefore, it is suggested that proper wastewater treatment units should be installed to treat all kind of wastewater prior to its disposal in the River Kabul.

Keywords: River Kabul, Water Quality, Water Table, Impacts

1. Introduction

In Pakistan, lack of proper organisation and supervision for industrialization and urbanization has led to environmental pollution on an alarming scale. Similarly, the accessible water assets are also getting contaminated owing to the release of unprocessed domestic and industrial waste and agricultural run-off [1]. Wide-ranging analysis of surface water is important to form a basis for establishing levels of a variety of contaminants. They are thus essential sustainable water resource management [2]. Unfortunately, owing to the lack of funding and technical expertise, inadequate studies have been conducted to evaluate the surface water quality of natural rivers in Pakistan. Information from such studies is essential in identifying the required extent of wastewater treatment prior to their release into the rivers. This is because this information can be used to determine the assimilation capability of rivers which are widely used for the removal of domestic and industrial wastewater. The ability of natural waters to incorporate wastes is termed stream assimilative or self distillation ability. Self cleansing capability of a river using de-oxygenation and re-aeration methods taking place in the water resource act as a guide as to how much wastewater a stream can sustainably receive [3,4] in order to retain water of useable quality. Hence the estimation of the assimilative ability of the stream is requisite to any complete water assets development plan [5]. Hence this study was performed i to determine the pollution weight of domestic wastewater and its impact on the water quality of River Kabul.

2. Materials and Methods

Several samples of domestic wastewater from various places in Nowshera city as well as water samples from Kabul River were collected by regularly for a period of more than thirty months. The samples were collected early morning, peak hourly flow period, in order to a certain their proper characteristics, in a properly sterilized sampling bottles. These samples were examined in the laboratory for various water quality parameters of concern. pH, temperature, EC and total dissolved solids (TDS) were determined in the field. BOD, COD were determined in the laboratory by means of "Dilution Method" and "Open Reflux Method", respectively. Chlorides and Sulfates were measured by using "Titration Method" and Spectrophotometric analysis. The other

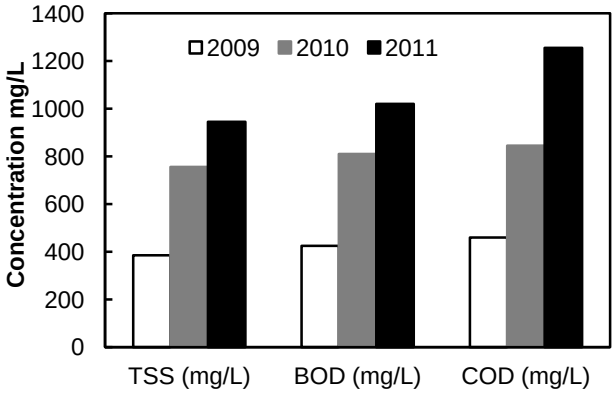
examinations were carried out as per Standard Methods [6].

3. Results and Discussions

3.1. Wastewater Characteristics of Nowshera City

The results obtained through the course of study (Fig. 1) show that the domestic wastewater from Nowshera city has high pollution weight in terms of its BOD, COD and total solids levels. The limits put by Pak-EPA (Pakistan Environmental Protection Agency), the NEQS (National Environmental Quality Standards of Pakistan) do not allow the discharge of domestic and industrial effluent into any receiving bodies which has BOD, COD higher than 80 mg/L and 150 mg/L, respectively. Similarly, the NEQS does not allow the wastewater having TSS content more than 150 mg/L to be release in any receiving body. The wastewater quality examination results showed that there is small rise in the concentration of different parameters throughout the course of study. The values of BOD ranged from 385 mg/L to 460 mg/L, COD from 756 mg/L to 845 mg/L, TSS from 945 mg/L to 1255 mg/L. This is attributable to a fast increase of urbanization in Nowshera city. Since, the growth rate of the city is more than 3.6%, therefore, the municipal facilities are failing to cope with the situation. Field analysis and information collected from the concerned areas indicate that most of the wastewater from the city is being disposed into Kabul River without any proper treatment.

Figure 1. Wastewater characteristics of Nowshera city, 2009-2011



3.2. Water Quality Assessment of Kabul River

Various sampling locations along the course of Kabul River were chosen to examine the quality of water in the river. Locality, distance along river and identity of all these sampling stations are stated in Table 1. These locations were chosen in view of the city's wastewater discharge point, tributaries and gauging station on the river. Laboratory results of the elected sites along Kabul River are showed in Figs. 2-7. Samples from these sample locations were collected in low flow season because of ease of accessibility. Considering January and February as low flow months, complete field testing was carried out for three successive years (2009, 2010, and 2011). Upon examination of the results, it can be concluded that Total Dissolved Solids (TDS) and Electric Conductivity (EC) values were highest downstream of point of discharge of the city's wastewater effluent outfall, which means that Nowshera city sewerage is affecting the surface water characteristics of River Kabul.

Table 1. Sampling location/distance with respect to Nowshera Bridge

Site	Distance
Site "A"	12 km ahead
Site "B"	08 km ahead
Site "C"	04 km ahead
Nowshera Bridge "D"	at bridge point
Site "E"	05 km downstream
Site "F"	08 km downstream

Both TDS and EC values increase slightly with time. A large volume of unprocessed domestic and industrial wastewaters enter Kabul River at points "B" and "C" respectively. Temperature is one of the evaluating parameters of the sewage characteristics. Broad changes in temperature can seriously impact biological activities, the solubility of gases in it and sediment transport through change in viscosity [7,8]. The average temperature of polluted water is slightly higher than that of unpolluted water. The temperature of polluted water varies with the degree and source of pollution. Because the increase or decrease in river discharge can also change the degree of temperature, temperature was thoroughly monitored at several points. During the investigation temperature of different collected samples was measured and it was found that the temperature of Kabul River is increasing with time due to high concentration of untreated wastewater.

Figure 2. pH concentration of River Kabul, 2009-2011

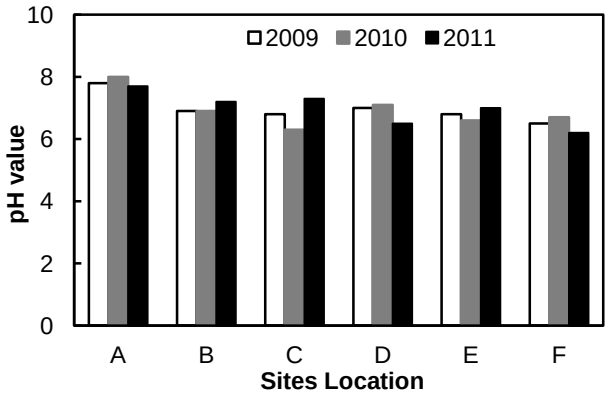


Figure 3. TDS concentration of River Kabul, 2009-2011

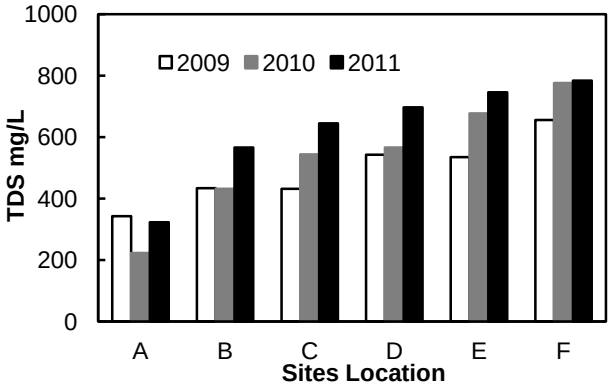


Figure 4. EC concentration of River Kabul, 2009-2011

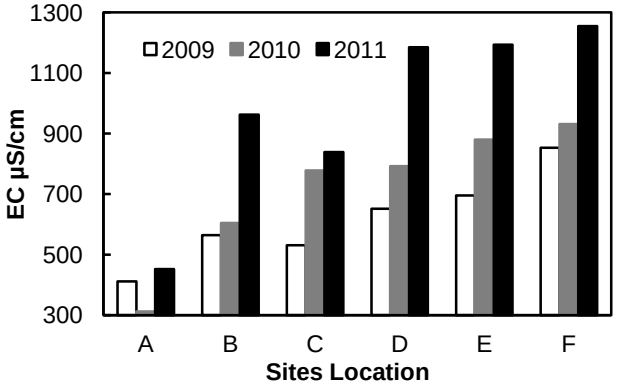


Figure 5. Temperature of River Kabul, 2009-2011

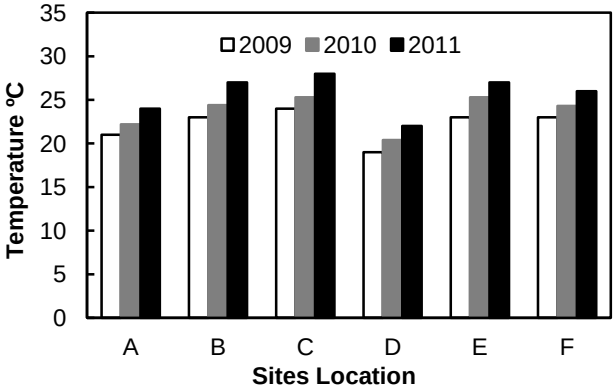


Figure 6. Sulfates concentration of River Kabul, 2009-2011

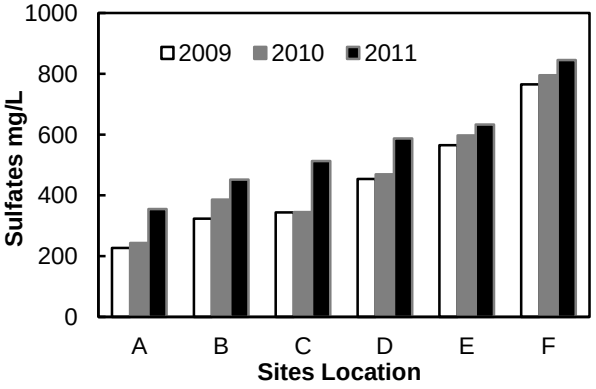
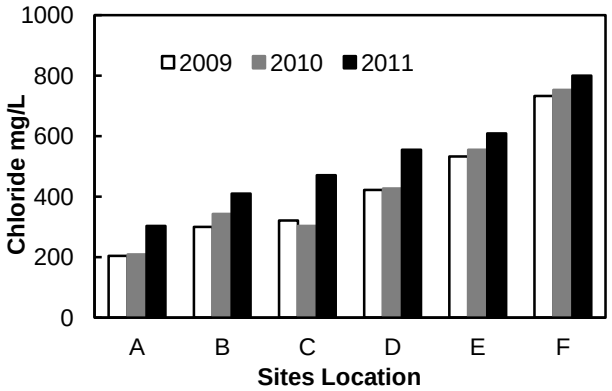


Figure 7. Chloride concentration of River Kabul, 2009-2011



Generally grey or dark color of the sewage may indicate polluted water, particularly if accompanied by septic order [9]. Other colours may be formed due to the presence of some types of industrial wastes containing excessive dissolved solids [10]. The field observations showed that in the River Kabul there is a variation in colour in different months of the years due to change in flow quantity. During the low flow conditions, collected samples from Kabul River are dark-gray in color which represents the high concentration of untreated domestic and industrial wastewater. Normal water is almost odourless, whereas rotten or putrid odour, such as those of hydrogen sulphide and other products of decomposition, indicate a stale of septic sewage during biological degradation [11]. Certain industrial wastes will also impart typical odours. Due to mixing of large quantity of industrial wastewater especially at sampling location B and C, collected samples are presenting odour problem, where the untreated wastewater from some industrial estates joins the river. The

sulphate concentration is continuously increasing along the river due to increase in wastewater quantity through different drain outlets. It also represents the annual rising trend of sulphate concentration at all five selected sampling stations. Agricultural, industrial and domestic wastewater discharged to surface water is a major source of chlorides. In municipal sewage, chlorides are derived from the kitchen waste and human wastes. Large amounts of chlorides may also come from the industrial sources also [12,13]. When the chloride contents of given sewage is found too high, it may indicate the presence of industrial waste [14]. The samples collected from Kabul River show high concentrations of chloride contents due high ratio of untreated industrial wastewater. The rising trend in concentration along the river is representing that huge amount of untreated domestic and industrial sewage is mixing into river water.

3.3. Groundwater Quality and Levels Along River Kabul

The groundwater depth and quality were also investigated along the River Kabul. Table 2 represents ground water table depths for last three years along the along the periphery of River Kabul, which is affected by low flow in the river. After analyzing the data it can be concluded that water table depth in Nowshera city is lowering down more rapidly as compared to tube wells, which are located near River Kabul. On the other hand, quality of underground water is degrading so quickly along River Kabul due to high rate of contaminants in the river during low flow. In the city, excessive pumping is responsible for the decline in ground water table. Before Indus water treaty the amount of water flowing in River Kabul was much higher as compared to now and there were no problems of water quality and scarcity in the study area.

Table 2. Groundwater table depth (ft)

Tube well location	2009	2010	2011
Barabanda	27	29	37
Jehangir town	30	33	39
Seesmandi	38	43	46
Ghandari	36	37	41
Amangarh	43	48	53
Shagulraat	29	34	36

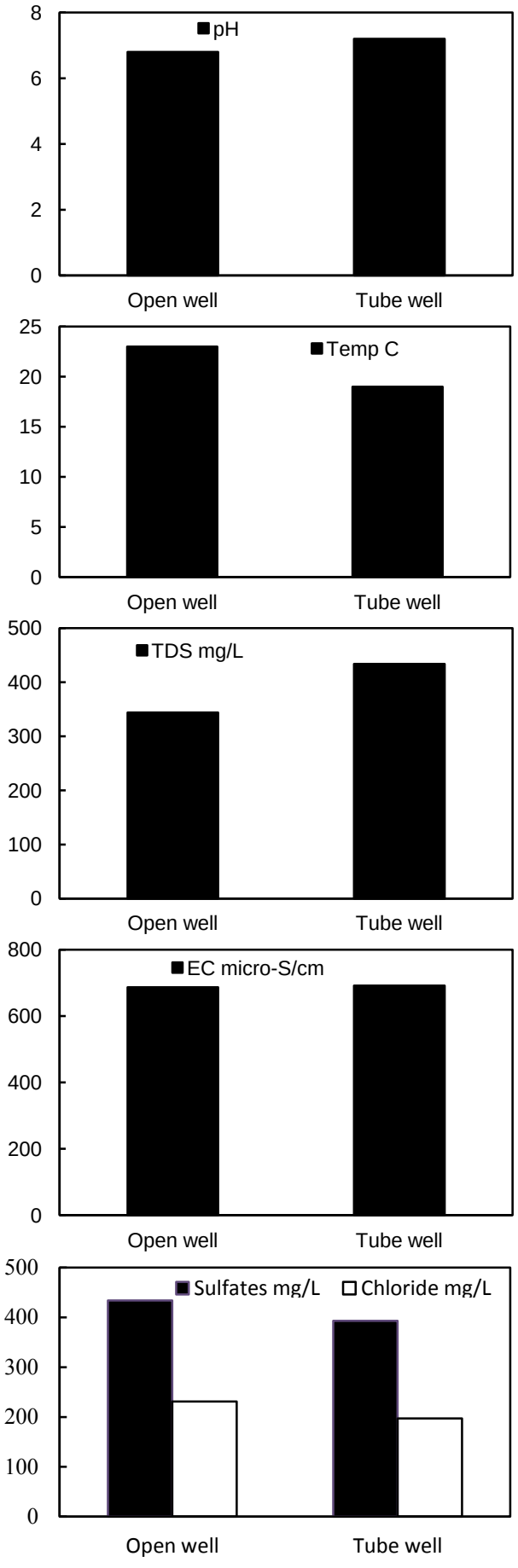
Ground water quality analyses of different tube wells along River Kabul were carried out to analyze the groundwater quality along river. For this purpose, groundwater quality in one of the village (Khyeshgi Payyan) near Nowshera city was examined. The village is situated on the bank of River Kabul and low flow conditions in the river after "Indus Water Treaty" are seriously affecting the quality of the aquifers in this area. The quality of groundwater from hand pumps in the periphery of River Kabul was also investigated. Samples from the two hand pumps near River Kabul were analyzed to investigate the environmental issues in study area. The Figs. 8a-e clearly represents the water quality of the subject area. These results are clearly showing that groundwater quality in these tube wells is not satisfactory, which may be attributable to low flow and very high rate of contaminants in Kabul River.

3.4. Environmental Impacts of Kabul River Pollution

The increased load of pollutants to Kabul River has adverse effects on flora and fauna [15, 16]. Recreation activities are also seriously affected by the low flow, due to poor aesthetics. Previously, River Kabul played a vital role as a recreation/picnic point for the people of Nowshera [17]. Low flow in River Kabul has adverse effects on socio-economic parameters such as boating, fishing and agriculture, which are seriously reduced.

It is now a well established fact that the range of adverse human health effects are due to toxicants intruding into the river is very broad. These contaminants can cause lung diseases, cancers, bone abnormalities, sterility and other problems. The bacterial pollutants in the water spread diseases such as plague, tuberculosis, phenomena, typhoid fever, cholera [1,4]. The increased environmental pollution in the River Kabul has resulted in an increased number of infectious diseases among the general public. This is apparent from the high incidence of infectious and parasitic diseases in the population as approximately 70% of illness and 30% of deaths in the surroundings of River Kabul are attributable to water borne diseases [10, 18]. The contamination of food crops because of the use of River Kabul water for irrigation is a source of enteric diseases.

Figure 8a-e. Water quality of groundwater and tube well along River Kabul



4. Conclusions and Recommendations

During dry season the major portion of discharge in the River Kabul is wastewater, reaching it through various point and non point sources. The present river water quality is not reasonable for any kind of use. Highly concentrated industrial and domestic wastewaters, which are being disposed off directly into River Kabul are converting its condition from aerobic to anaerobic. Concentrations of different contaminants in river water are very high. River Kabul is the major source of the recharging of groundwater for Nowshera city. Due to extensive pumping of groundwater as well as low flow in river, water table is lowering very rapidly within the Nowshera city. So, there are more chances of recharging groundwater with the polluted river water in future. It is also concluded that ground water quality along the River Kabul is not satisfactory. Low flow conditions in River Kabul along with high rate of contaminants are increasing the negative environmental impacts in study area. However, the impacts of Indus Water Treaty on the low peak flow, as well as on its quality need to be evaluated thoroughly. A proper wastewater treatment facility for domestic and industrial wastewater is required and continuous monitoring program must be planned for River Kabul to improve its water quality. Ground water should be disinfected in the periphery of River Kabul before use.

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