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# QUALITY CHARACTERIZATION OF PHULALI CANAL WATER FOR IRRIGATION PURPOSES

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Impact of sewage and industrial effluents on the quality of Phulali canal water for agricultural purpose was monitored while passing through Hyderabad city. Present study is made to monitor pollution parameters like pH, EC, COD, DO, BOD, Fecal coliforms, SAR and some essential elements. The results were then compared with irrigation water standards and national environmental quality standards (NEQs). The values of pH, EC, TDS, and fecal coliforms were found higher with marginal to unsafe hazardous status. Calcium, magnesium and sodium were found higher than potassium and water is found to be poorly suitable for irrigation purposes in the long run.

**Keywords:** Fresh water, Water pollution, Irrigation water, Phulali canal.

## 1. Introduction

Indus River is an important source of livelihood of millions of people. It mainly supplies water for drinking purposes in towns and agricultural activity of countryside along its entire route. Presently, 90 % of the wastewater containing pollutants in high concentrations falls into 'Indus River' and its tributaries. Studies show that river water pollution has consistently increased with industrialization and urbanization [1].

Nonperennial Phulali canal was constructed in 1955 to meet the irrigation requirements of the locality. The canal originates from left bank of river Indus from Ghulam Muhammad Barrage and has the discharge capacity of 14350 cusecs with total culture able commanded area (CCA) of 929,358 acres. The canal passes through Hyderabad city with a population of about 2 million. The water of the canal is used mainly for agricultural purposes and also for drinking of human beings and domestic animals. This effected irrigation water of the canal thus deteriorating the quality of irrigated crops [2 – 4].

Hyderabad is the second most populated city in Sindh province. The city is expanding and developing with the addition of population, industrial activities, agricultural practices and other infrastructures, as a result a large amount of industrial effluents, municipal wastes, oil and greases are discharged into the Phulali canal about 20 km without any treatment through different drainage systems. The average quantity of wastewater and the percentage contribution of wastewater from different sewage stations discharged into Phulali canal are given in Table 1. These large volumes of organic and inorganic substances change the chemical characteristics of the water body by producing toxic substances and ultimately pollute the canal's water. The use of polluted waters has been reported to have adverse effects on livestock and vegetation [2 – 4].

The quality of irrigation waters depends

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! Dedicated to the memories of **Prof. Dr. Abdulwahab Khan Khanzada**

Table 1. Average quantity of wastewater and the percentage contribution of wastewater from different sewage stations discharged into Phulali canal.

| Waste water station | *Average quantity discharged ($m^3$/day) | % Contribution of the total discharged |
|---|---|---|
| Jacob tank Cantonment board waste | 13944 ± 1397 | 6.18 |
| Kali Mori open drain | 56376 ± 2232 | 25 |
| Open drain near old power house | 42323.44 ± 3229.82 | 18.76 |
| Darya Khan Panhwer Pumping Station | 96441 ± 4151 | 42.75 |
| Site area pumping station near Nara Jail | 13500 ± 1963.4 | 5.98 |
| Other sources | 3000 ± 855 | 1.33 |
| Total | 225584.44 | 100 |

*Mean of 12 determinations, ± Confidence interval at 95% [Reproduced from ref. 2 page 360].

principally upon the total amount of salts present and on the proportion of sodium to other cations. The salt content of irrigation water adversely affects the crop production via osmotic pressure of soil solution whereas higher proportion of sodium to other cations deteriorates the soil structure. The most satisfactory method for rating the salt content of irrigation waters involves measuring of their electrical conductivity and sodium adsorption ratio (SAR). In order to improve the production of crops, it is necessary to improve the irrigation water quality [5 – 8].

The present work describes pollution parameters like pH, Electrical Conductivity (EC), COD, DO, BOD, Ca, Mg, K, fecal coliforms and SAR to investigate the effect of municipal discharge on the quality of irrigation water.

## 2. Materials and Methods

### *2.1 Description of the investigated area*

Six sampling points were selected at different distances starting from Ghulam Muhammad Barrage to Bihari Colony Bridge i.e. 20 km away from the initial point (Fig. 1). Mostly samples were collected near sewage water pumping stations being discharged into Phulali canal.

### *2.2 Collection of water samples*

Subsurface canal water samples were collected by using a fiberglass Rutner sampler. Mobile van with essential laboratory equipments of the 'NCE in Analytical Chemistry - Jamshoro' was used and all samples were collected from 11 hrs to 1430 hrs of the same day.

### *2.3 Preservation of samples*

The samples were collected in pre-washed polythene containers and acid washed glass bottles. For metal determination, acidified immediately after collection, with the addition of 2 ml ultra pure $HNO_3$ per liter of canal water and then carefully preserved in a refrigerator at $4^{\circ}C$ for laboratory analysis. All the tests were conducted according to standard methods [2, 9].

### *2.4 Chemical oxygen demand and biochemical oxygen demand*

Chemical Oxygen Demand (COD) was determined using the standard procedure. Biochemical Oxygen Demand (BOD) is a measure of the amount of oxygen used by micro-organisms in the sample as they decompose the readily degradable organic matter. The test involves measuring the dissolved oxygen in the sample initially and then after incubation for 5 days at 20 $^{\circ}C$, the difference between the two values being the BOD [4, 5].

### *2.5 Digestion of samples*

250 ml of well-mixed acidified water sample was kept in Pyrex beaker and evaporated the samples on water bath (temperature ± 100 $^{\circ}C$) placing watch glass on each beaker to about dryness. Five ml of 2 M $HNO_3$ was added in each beaker and digested on water bath and filtered by

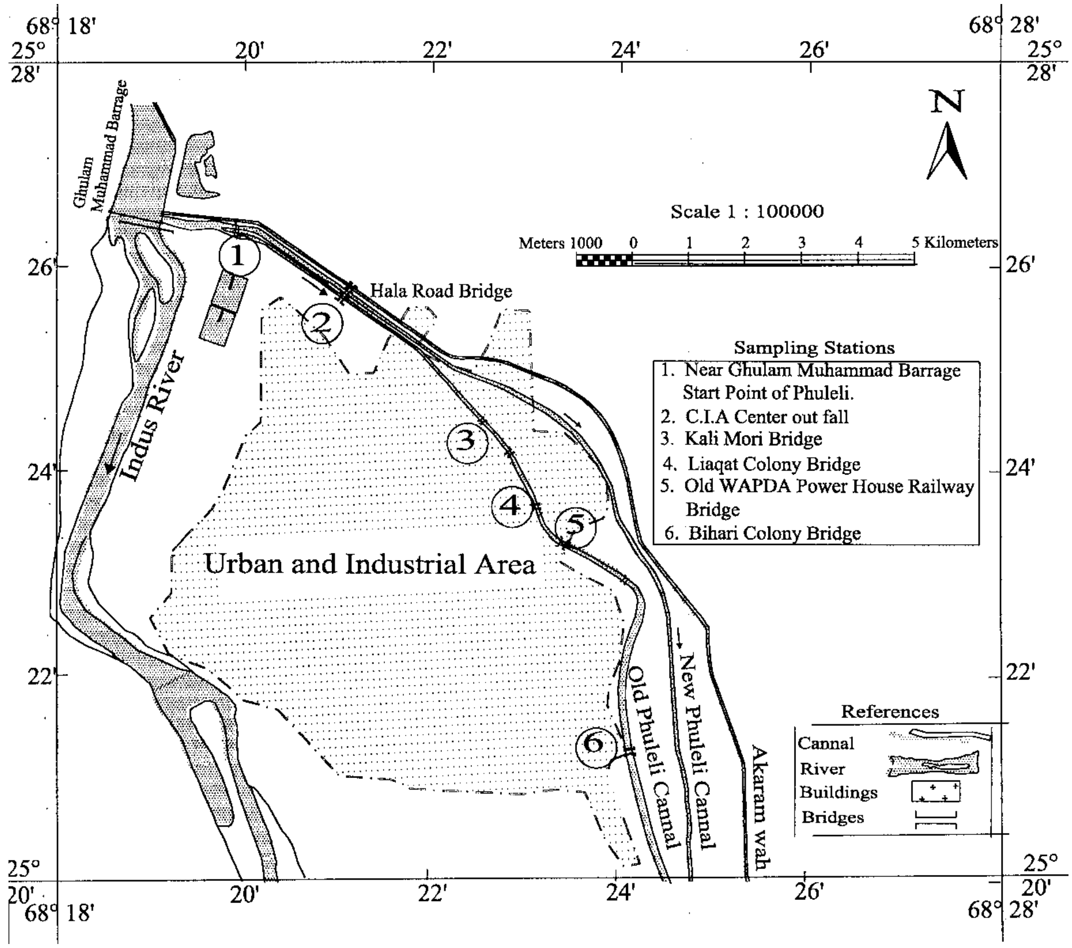


Figure 1. Map showing the sampling locations of Phulali canal passing through Hyderabad city.

a Whatman 42 filter paper and the filterate was made to 25 ml with deionised water in a 25 ml volumetric flask. Blank digestion was carried out for each sample [2,9,10] .

### *2.6 Atomic absorption spectrophotometer measurements*

The digested samples were analysed by using air-acetylene flame in combination with single element hollow cathode lamps into an Atomic Absorption Spectrophotometer Hitachi model 180–50. The blanks were used for zeroing the instrument before each analysis to avoid matrix interference [11–13].

### *2.7 Analytical precision*

The reproducibility of the analytical procedures was checked by carrying out a duplicate analysis. Duplicate results did not differ by more than 5 % of the mean [9].

## 3. Results and Discussion

The water bodies like streams, rivers and oceans have their own system of keeping themselves clean but the untreated wastewater from our cities is reaching above the threshold of these water sources to clean automatically. After contamination of water, aquatic life like fish and plants etc. become extinct. In the winter season the importance of wastewater becomes more acute as the quantity of canal water is reduced. This leads to the reduction of oxygen in the water and fish cannot survive. If this contaminated water is used for drinking purposes, it causes many diseases especially those related to digestive system [14,15]. Table 2 shows various parameters,

Table 2. Quality characterization of phulali canal water for irrigation purposes.

| S. No. | Time (Hrs.) | Temp. (°C) | TDS (mg/l) | pH | EC ($dSm^{-1}$) | Hazard status | SAR | Hazard status | Class | COD (mg/l) | DO (mg/l) | BODs (mg/l) | Fecal coliforms (MPN/100ml) | $Na^+$ | $K^+$ | $Ca^{++}$ | $Mg^{++}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stds. Values* | -- | 40 | 450 | 6.5–8.5 | >3.0 | -- | 3 | -- | -- | 150** | -- | 80** | -- | SAR=3 | SAR=3 | SAR=3 | SAR=3 |
| 1 | 11.00 | 27 | 497.02 | 8.51 | 3.01 | Marginal | 3.71 | Safe | $C_4S_1$ | 0.32 | 10.15 | 141 | 170 | 22.23 | 7.32 | 51.35 | 20.56 |
| 2 | 11.45 | 30 | 497.95 | 7.55 | 6.13 | Unsafe | 6.62 | Safe | $C_4S_1$ | 0.61 | 12.65 | 152 | 192 | 45.78 | 10.35 | 83.46 | 12.25 |
| 3 | 12.30 | 30 | 535.52 | 7.48 | 4.15 | Unsafe | 4.66 | Safe | $C_4S_1$ | 2.15 | 4.84 | 132 | 178 | 29.07 | 6.29 | 59.98 | 17.98 |
| 4 | 13.05 | 28 | 92.98 | 7.65 | 3.49 | Marginal | 2.74 | Safe | $C_4S_1$ | 1.00 | 9.31 | 143 | 195 | 21.15 | 7.64 | 56.49 | 63.13 |
| 5 | 13.35 | $28^0$ | 895.54 | 7.53 | 4.72 | Unsafe | 4.43 | Safe | $C_4S_1$ | 0.80 | 5.34 | 139 | 205 | 30.81 | 11.72 | 61.48 | 35.52 |
| 6 | 14.30 | 27 | 530.54 | 8.20 | 3.07 | Marginal | 1.83 | Safe | $C_4S_1$ | 0.55 | 12.03 | 140 | 200 | 23.02 | 7.98 | 68.23 | 249.53 |

(Average of the results of the four samples collected at the same day from each sampling site, n = 4, Confidence interval at 95%).

*Water quality standards for irrigation i.e. Minimum restriction values [19].

**National Environmental Quality Standards for municipal and liquid industrial effluents [19].

which were studied for quality characterization of Phulali canal water.

Temperature of the canal varies with climate and the season and its measurement is useful to indicate the trend of various chemicals, biochemical and biological activities. The rise in temperature leads to faster chemical and biochemical reactions. Biological activity is also enhanced by higher temperature upto 60 $^{\circ}$C. The growth and death of microorganisms, kinetics of biochemical oxygen demand is also regulated to some extent by water temperature. Temperature may also affect some other characteristics of water like dissolution of gases, pH and conductivity. Temperature of canal varies to some extent as we move from point 1 to point 6 i.e. down stream (Table 2), which is probably due to the addition of municipal and industrial effluents [6–8,11].

Neutral to alkaline pH is the general characteristics of flowing water. Generally pH is higher during winter and lower during monsoon and summer. pH is elevated with increase of phytoplanktonic population. Here an imbalance in pH (Table 2) from up stream to down stream is observed is due to an increase of phytoplankton population by addition of sewage and industrial effluent [8, 16, 17].

Conductivity of canal water is mainly associated with the dissolved material. Investigation shows that conductivity increases (Table 2) from up stream to down stream due to addition of more solute concentrations [8, 12, 15].

Water is the major contributing factor for life as well as salinity development and management. The use of poor quality water causes problems of salinity, permeability and phytotoxicity to common agricultural crops. Sodium adsorptive ratio (SAR) is used as one of the criteria for classifying irrigation water. Water having SAR ranged from 0 - 10 are classified as $S_{1,}$ from 10 - 18 as $S_{2,}$ from 18 - 26 as $S_3$ and above 26 as $S_4$ water. Likewise, water with EC from 0 - 0.25 $dSm^{-1}$ are classified as $C_1$, water from 0.25 - 0.75 $dSm^{-1}$ as $C_2$, 0.75 - 2.25 $dSm^{-1}$ as $C_3$ and above 2.25 $dSm^{-1}$ as $C_4$ [20–27]. There were few samples with medium to high sodicity which could present appreciable sodium hazard in fine textured soil having high exchange capacity. This water should be used on coarse textured soil with good permeability and management conditions [20].

Total dissolved salts (TDS) increases with temperature but is independent of pressure [1,6]. The TDS value at initial point is comparatively lower than the down stream points. The highest observed value is 895.54 mg/l.

Biochemical oxygen demand (BOD) test is used to determine the strength and amount of organic matter present and provide a quantitative index of the organic matter, which is easily degradable in a short span of time [5]. The maximum BOD observed is at point 4 i.e.143 mg / l.

Chemical oxygen demand (COD) measure the amount of organic compounds present in that water sample [4]. The maximum COD observed is 2.15 mg / l at point 3. The mixing of industrial and municipal wastewater causes not only an increase in bacterias, algae, faecal coliforms (Table 2) but also toxic elements. The presence of these elements in heavy ratio and above than those which are recommended, seriously affects the quality of irrigation water [7, 15 – 19]. One or two organisms in water might be sufficient to cause infection. Most probable number (MPN) of fecal analysis was found in the last sample.

Calcium is an essential plant nutrient and waters high in calcium or magnesium are considered hard and are not desirable for domestic water supplies, but hard water is considered good for irrigation. Calcium helps keep soils in good physical condition, which favors good water penetration and easy tilling. Table 2 shows that the extra amount of calcium i.e. 83.46 mg/l may be because of regular mixing of municipal sewage [2,11, 22–30].

Magnesium is another essential plant nutrient and normally occurs at about half the concentration of calcium. Higher amount of magnesium 249.53 mg/l (Table 2) may cause serious effect on soil, which is irrigated with this water [22–30].

Waters high in sodium are considered ‘soft’ and are generally undesirable for irrigation. Unfavorable conditions are likely to develop when the concentration of sodium exceeds that of calcium plus magnesium. When clay particles adsorb the sodium, they tend to disperse and create ‘slick spots’. Sodium affected soils take water slowly and form dry, hard clods that melt when wetted and tend to seal the soil surface, leaving a slick appearance. Sodium not only affects the soil structure, but also may have a toxic effect on plants. Maximum load of sodium was observed at point 2. Increase of sodium i.e. 45.78 mg/l, may increase the percentage of salinity, which has serious effect on both human life and crop yield. [22 – 30]

Potassium is an essential plant nutrient commonly found in good supply irrigation water. Potassium is a minor element in irrigation waters and consequently its determination is no longer a routine part of irrigation water analysis [22 – 30]. The maximum load of potassium was found at point 5 to be 11.72 mg/l.

Observation shows that all the samples, collected from different points, have the values for metals within the recommendations for irrigation water. Water from point 1 has the minimum observed values than all other points.

## 4. Conclusions

It can be concluded that owing to continuous addition of untreated wastewater to the Phulali canal, the water is no more fit either for the irrigation or for the drinking purpose. The only remedy lies in the wastewater treatment plant before the effluents are added to the canal. There is a need that all such industries where more water use is involved should immediately arrange for treatment of their wastewater before discharging. This will have a long term positive effect.

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