Impact of Encroachment and Hyderabad City Effluents on Pinyari Canal

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Abstract—Pinyari canal off-takes from the left bank of Kotri barrage with a design discharge of 13,636 cusecs which passes through the ridge of Hyderabad city along with New Fuleli Canal and Akram Wah on its left side. Its water is used for irrigation, agriculture, industrial, domestic, and drinking purposes in Hyderabad and Sajawal districts in Sindh. This canal is non-perennial. Water is being released with low discharge only for drinking purposes during the dry season and with full supply in the wet season. The global water quality issue reflects the major impact of socioeconomic development and population growth changes on freshwater resources including canals and rivers. This paper presents the impact of untreated wastewater disposal to the canal. The practice of disposing of untreated effluents has created serious health and environmental problems for the locals. The statistical and geospatial tool GIS has been used for the assessment of water quality with visualization of wastewater behavior in the canal. The results of the statistical analysis showed that pH was within the permissible limits but Electric Conductivity (EC), Total Dissolved Solids (TDS), Sodium (Na), and Hardness exceed them. The Water Quality Index of the samples rated from very poor to unsuitable for drinking, hence, canal water is unfit for domestic use or drinking purposes.

Keywords—waterborne diseases; Hyderabad city; solid waste; wastewater; GIS; statistics

I. INTRODUCTION

Globally, freshwater resources are depleting and their quality is deteriorating due to over exploitation. Effluents from various sources are discharged into freshwater bodies and rivers creating potential risks for public health [1, 2]. Furthermore, the growing population with economic development poses a pressure on the available limited freshwater resources. Waste disposal has created critical problems to the environment [3, 4]. The water quality of the rivers in Pakistan has been degraded due to wastewater discharge [5, 6]. The rivers and canals have directly been contaminated from industrial and urban waste of major cities [7]. The discharge of wastewater from the industries is most alarming in rivers, canals, and drains irrespective of wastewater treatment. Karachi, Sialkot, Faisalabad and Lahore cities are major contributors of pollution into fresh water bodies [8]. Polluted water from urban and industrial sources has been disposed to urban peripheral canals. Hence, municipal, domestic, industrial, and agricultural waste, animal manure, etc. are dumped directly to canals [9]. Sewage water is added to canals by different sources of drains which affects directly their water quality [10, 11].

The consumption of contaminated fresh canal water poses negative impacts on public health and agro-environment [12]. The reuse of wastewaters has a potential in industrializing countries as being cost-effective for industries where secondary effluents are readily available for reuse [13]. Annually, about 1.8 million people die from waterborne diseases from the consumption of contaminated water [14, 16] and frequent attacks of diarrhea caused by bad water quality can leave a child more vulnerable to illness [6]. Recent studies indicate that the various water quality parameters of Pakistan drinking water do not meet the Standards of Pakistan and WHO [15]. Various researchers have indicated that fresh water quality in several countries is not in accordance with WHO standards [17]. However, the introduction of remote sensing technology and of the Geographical Information System (GIS) has made easy to integrate various metadata for assessment of water quality and gave a powerful tool for mapping and assessing water quantity and quality, flood management, and precipitation assessment

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such as households, farms or factories), major disposal locations from the city, and industrial units. Figure 2 shows the encroached left and right banks of the canal with houses, huts, ranches, and farms with high density. The solid waste and wastewater is directly dumped to the canal. There are many major and small inlets for wastewater disposal to the canal at locations such as the Deplai Colony wastewater pumping station, the Jacob wastewater pumping station, the wastewater of Khawaja colony, the outfall structure at Kari Mori bridge, the outfall structure just upstream the railway line, and the Darya Khan pumping station (Figure 2). Samples were collected and preserved in an icebox in 4°C. Nitric acid (HNO₃) was added to the sampling bottles in quantities sufficient to lower the pH of the sample to just about 2, to stabilize the concentration of total and dissolved metals for a maximum of 28 days. Standard sample transfer procedures were followed to avoid confusion in sample identification, including labeling and safe transportation to laboratory. The collected samples were sent to the Hi Tech Laboratory of the Sindh University, for further analysis.

### Table I. Sample Collection Locations

| Sample # | Latitude  | Longitude  | Location                                      |
|----------|-----------|------------|-----------------------------------------------|
| 1        | 25°44.339 | 68°37.372  | Hur Camp pumping station wastewater dumping into the canal |
| 2        | 25°43.706 | 68°38.622  | Wastewater of Khawaja colony                  |
| 3        | 25°40.994 | 68°38.899  | Wastewater dumping from the central jail area into the canal |
| 4        | 25°42.556 | 68°37.939  | Hala Road bridge                              |
| 5        | 25°43.178 | 68°38.385  | Wastewater into the canal, just d/s of Kari Mori |
| 6        | 25°41.5   | 68°39.122  | Wastewater into the canal just d/s of Preetabad bridge |
| 7        | 25°41.822 | 68°39.539  | Wastewater into the canal near the Preetabad bridge |
| 8        | 25°40.456 | 68°41.522  | Wastewater coming from urban areas            |
| 9        | 25°41.4   | 68°41.389  | Wastewater to the canal, near Kachihi Paro    |
| 10       | 25°40.517 | 68°41.078  | Wastewater u/s of the Railway bridge          |
| 11       | 25°39.333 | 68°41.267  | Darya Khan pumping station                     |
| 12       | 25°39.372 | 68°41.256  | Darya Khan pumping station                     |
| 13       | 25°40.517 | 68°41.078  | Waste effluents at Railway bridge              |
| 14       | 25°42.261 | 68°38.033  | Slaughterhouse, Liaquatabad                    |
| 15       | 25°41.922 | 68°40.0    | Kari Mori bridge                              |

### Table II. WQI Ratings

| WQI value | Rating     |
|-----------|------------|
| 0 - 25    | Excellent  |
| 25 - 50   | Good       |
| 50 - 75   | Poor       |
| 75 - 100  | Very poor  |
| > 100     | Unsuitable for drinking |

### B. Water Quality Index (WQI)

WQI is an indicator of water suitability for drinking and surmises many parameters [21]. The equation of WQI is:

\[
WQI = \sum_{i=1}^{n} W_i Q_i
\]

where \( Q_i \) is the \( i \)th WQ parameter, \( W_i \) is the weight associated with this parameter, and \( n \) is the total number of WQ parameters. The classification of water samples according to the WQI is shown in Table II.
IV. RESULTS AND DISCUSSION

A. Solidwaste Dumping

Besides the problem of wastewater discharging, a huge volume of solid waste is dumped to the canal. Solid waste dumping locations along the canal were observed during the survey at Hala road bridge, Kari Mori bridge, downstream of the Pretabad bridge, adjacent to the slaughterhouse, and at the railway bridge. The estimated quantity of solid waste on the canal embankments is about 15-20 tons per day (Figure 2).

B. Buffaloe Farms (BFs) on the Banks of Pinyari Canal

Many BFs were spotted during sampling, i.e. 4 on the left side of the canal just upstream of the bypass bridge, each farm with 15 to 40 buffaloes and 6 BFs on the right side of the canal just upstream of the Bypass bridge, with 10-35 buffaloes, 8 BFs on the left side of the canal between the bypass road bridge and Hala road bridge, with 10-25 buffaloes, and 10 BFs between the bypass road bridge and the Hala Road bridge with 10-30 buffaloes on the right side of the canal (Figure 2). The manure and the other waste of the farms are directly disposed to the canal.

C. City Wastewater

- Deeplai Colony wastewater pumping station is discharging its wastewater into the canal at RD 14+00 and has a capacity of about 7.8 million gallons per day.
- Pumping Station at Jacob Ponds is pumping wastewater at RD 16+00 through a delivery pipe with 18” diameter.
- Wastewater of Khawja/Mubark Colony discharges wastewater into the canal at RD 17+00 and 18+00 by pipes and the estimated disposal water is about 0.6 million gallons per day.
- Outfall Structures at Kari Mori Bridge. The effluent of vast area of Market and Hirabad area is being discharged through these inlets at RD 24+00. An open channel of 6’ x 6’ just downstream of Kari Mori Bridge is discharging 10 to 15 cusecs of untreated wastewater.
- Slaughterhouse: the wastewater of the Liaquat colony and the slaughterhouse is being disposed of at RD 25+00. The main slaughterhouse is situated downstream of Pretabad bridge on the right bank which is a covered large area in which an estimated number of 1500 animals are being slaughtered every day. The remains and the blood are directly dumped to the canal.
- Outfall structure upstream of railway bridge: The main outfall structure and pumping station on the right side of the canal and near the railway bridge has been constructed by Hyderabad Development Authority (HDA) for discharging wastewater at RD 28+00.
- Darya Khan pumping station: Darya Khan wastewater outfall and pumping station is situated at RD 40+00 on the right side of the canal has been constructed by HDA and receives untreated wastewater of Hyderabad SITE area. During the dry season when there is not water available in the canal, the wastewater is being discharged through gravitational flow, whereas during the full supply flow in canal the wastewater is discharged through pumping.

There are 17 main and about 20 small locations inlets on the left side of the canal from where the untreated wastewater generated from small industries and municipal areas is being discharged. There are 20 main and many small inlets at the right side of the canal from where the untreated wastewater is being discharged. The total estimated discharge of untreated wastewater (industrial & municipal) into the canal is about 90 million gallons per day.

D. Canal Wastewater Sample Analysis

The collected samples were analyzed at the Hi Tech Laboratory of Sindh University. The results are shown in Table II and are discussed below.
1) pH

It is a measure of the acidic or basic (alkaline) nature of a solution. A pH ranging from 6.5 to 8.5 is suitable for aquatic life. It was observed after analyzing of the samples that the values of all samples ranged from 6.5 to 7.3, hence pH is within the permissible limits of NEQS (Table III). Figure 3 exhibits the geospatial distribution of pH using GIS.

![Fig. 3. Spatial distribution of pH with GIS](image)

2) Electrical Conductivity (EC)

The EC of the collected samples exceeds the permissible limit of NEQS (680μS/cm). The EC ranged from 760μS/cm to 13700μS/cm. The highest value (13700μS/cm) was found at location SW-1 because of wastewater that mostly comes from the domestic and saline pond area.

3) Total Dissolved Solids (TDS)

The TDS values of the collected samples are higher than the permissible limits of NEQS. The sample S-1 had the higher TDS value. Figure 5 exhibits the geospatial distribution of TDS and its red color indicates high concentration of wastewater.

![Fig. 5. Spatial distribution of TDS with GIS](image)

4) Hardness

The hardness of all samples was higher than the limits of NEQS. The highest value was found in water Sample 1 as shown in Table III. The hardness of the collected samples varied from 120 to 760mg/L.

![Fig. 4. Spatial distribution of TDS with GIS](image)

5) Nitrate

The values of the collected samples shows that nitrate varied from 0.14 to 16mg/L. Nitrate level below 0.5mg/l seems to have no effect on warm water fish. Water with nitrate levels exceeding 1.0mg/l should not be used.

6) Sodium (Na)

The values of analyzed samples are within the permissible limit of NEQS except sample No. 14 due to the industrial unit waste. These units mostly comprise of textile, soap, paper, etc. industries, which require large quantities of sodium.

7) Potassium (K)

The analyzed result shows that the values of potassium varied from 24 to 120mg/L. The value of Sample 13 was higher than the permissible limit.

![Table III. WATER SAMPLE PARAMETER VALUES](image)
The values of the analyzed samples vary from 23.2 to 49.2 mg/L. The maximum value found at Sample 1. Magnesium is a nutritionally essential metal that can be responsible for adverse health effects due to deficiency or excess.

**E. WQI Analysis**

The water quality of the study area calculated by WQI indicates that the water of most of the samples is unsuitable for drinking. The computed WQI values range from 81 to 410 as shown in Table IV. Thus, the quality of the canal water varies from very poor to unsuitable for consumption. The overall view of the WQI of the study area signifies its deteriorated water quality. Hence, the canal water is unfit for drinking during low discharge. The physicochemical parameter values of the collected samples reveal that 100% of the EC and TDS values and 70% of the K values were found higher than the permissible limits, while pH Na, hardness, nitrate, and Mg are close to the permissible limits. However, WQI indicates the water from very poor to unsuitable for drinking. The result indicates that the canal is receiving different category of effluents, e.g. domestic, industrial, farming, etc. which undermine its own and ground water quality, having repercussions in agriculture, livestock, and soil while degrading the environment. There is a need to follow the ISO-14000 standard for the protection of environment from degradation. This can be achieved by adopting state-of-the-art primary and secondary wastewater treatments at tertiary level and along with the encroachment removal from the canal banks [23]. Furthermore, the use of GIS tools for monitoring of wastewater dumping sites and canal water quality is proven useful.

**8) Magnesium (Mg)**

The statistical analysis of physicochemical parameters showed that pH was within permissible limits, EC and TDS exceeded the permissible limits and hardness, K, Na, and Mg were almost within the permissible limits. Nevertheless the Water Quality Index showed that the water quality of the collected samples ranged from very poor to unsuitable for drinking.

![Table IV. WQI Rating](#)

| Sample | Latitude     | Longitude    | WQI |
|--------|--------------|--------------|-----|
| 1      | 25°.44339    | 68°.37372    | 403 |
| 2      | 25°.43706    | 68°.38622    | 372 |
| 3      | 25°.40994    | 68°.38969    | 209 |
| 4      | 25°.42556    | 68°.37939    | 430 |
| 5      | 25°.43178    | 68°.38383    | 316 |
| 6      | 25°.415      | 68°.39122    | 228 |
| 7      | 25°.41822    | 68°.39539    | 352 |
| 8      | 25°.40456    | 68°.41522    | 389 |
| 9      | 25°.414      | 68°.41389    | 344 |
| 10     | 25°.40517    | 68°.41078    | 71  |
| 11     | 25°.39333    | 68°.41267    | 355 |
| 12     | 25°.39372    | 68°.41256    | 81  |
| 13     | 25°.40517    | 68°.41078    | 86  |
| 14     | 25°.42261    | 68°.38033    | 294 |
| 15     | 25°.41922    | 68°.400      | 101 |

**V. CONCLUSIONS**

The statistical analysis of physicochemical parameters showed that pH was within permissible limits, EC and TDS exceeded the permissible limits and hardness, K, Na, and Mg were almost within the permissible limits. Nevertheless the Water Quality Index showed that the water quality of the collected samples ranged from very poor to unsuitable for drinking.

The effluents discharged into the fresh canal water pose serious threats to public health, aquatic life, livestock, agriculture, soil, and ground water. Their negative impact on water may be addressed by installing primary and secondary tertiary treatment with trickling effect and oxidation ponds before it is too late [9]. It is further suggested that research studies on surface and ground water quality should continue in the area to assess canal water quality as a result of multiple categories of wastewater from different sources [1, 9, 22].

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