Suitability and water quality criteria of an open drainage municipal sewage water at Coimbatore, used for irrigation

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Abstract: Sanganur canal is the major open drainage system which has intricate linkage with storm water supply, domestic sewage and industrial effluent disposal. Water samples from various stations were collected and analysed for physicochemical parameters to assess the water quality of the Sanganur canal system. The study revealed that physicochemical parameters like pH, EC, TDS, DO, BOD, COD exceeded the permissible limit, clearly indicating the need of proper treatment of waste water before discharge into the Noyyal river.

Key words: Sanganur canal, Physicochemical analysis, Open drainage.

Introduction

The Sanganur canal originates from the Western ghats from Kuridimalai hills, flows from west to east, enters Coimbatore city limit at Coimbatore – Mettupalayam road and flows for about 10km within the city outfalling into Singanallur tank. Singanallur tank also has its own supply line from Noyyal river. The tank surpasses into Noyyal river. The sewage discharged from residences which are not provided with septic tanks and sewage disposal arrangements and from unsewered slums and residential colonies constitute a major source of pollution of Sanganur canal. The industrial effluents in parts of Coimbatore south and north were partly discharged into open drain, in unsewered areas which finally join Sanganur canal. As Sanganur canal water at Vellalore is utilized for irrigation, the present study was undertaken to determine the water quality of the Sanganur canal water to assess the suitability of this waste water for irrigation.

Materials and Methods

Water samples were collected from seven sampling locations as shown in Fig. 1. Station 1 is the Asoke Nagar which receives domestic sewage. Station 2 is Rathnapuri which receives domestic sewage and effluents from flour mill industries. Station 3 is Raju Gardens, which receives only domestic sewage. Station 4, Bharathipuram receives effluents from textile mills, electroplating industries, motor and engineering industries, dyeing industries, sugarcane crushers, sheet bending machine industries, monoblock, jet pump and pumps. Station 5 is Ramaswamy Naidu layout, where water receives higher amount of effluents from dye testing laboratory, soap company, motor pump engineering unit, transformer unit and electroplating works. Station 6 is Erimedu, here waste water from hospitals, rubber industry, foundry and pumpset industries are let out. Station 7 is Vellalore which receives mixedup domestic sewage from all over the city and effluent from hospitals and all types of industries.

Results and Discussion

The samples collected from these sampling stations were analysed by following the standard methods of APHA (1992) and Manivasakam (1987).

The results of the various physicochemical analyses are presented in Table 1. Temperature of the Sanganur canal water at different stations ranged between 29°C and 31°C. Higher temperature could be due to discharge of domestic sewage and industrial effluent into the open drainage. Domestic sewage (S1, S2 and S3) showed alkaline pH (8.17, 11.47 and 7.41), while industrial effluent at S6 was acidic (6.84), whereas, the places S6, S7 and S8 showed alkaline pH (7.39, 9.30 and 7.74). This may be due to high buffering capacity of the water. Electrical conductivity ranged between 1.39 mmhos/cm to 3.84 mmhos/cm at different sampling stations, while S2 recorded the maximum of 3.84 mmhos/cm followed by S6, S5, S1, S8, S7 and S4 recording (3.77, 3.39, 3.20, 3.08, 3.00, 3.00 and 1.39 respectively) which may be due to the high concentration of ionic constitutions and heavy sewage dumping (Bhuvaneswaran et al., 1999). At S2 station (Rathnapuri) domestic and flour mill effluents are discharged, they contain more of organic materials and high concentrations of ionic constituents. Such effluents contributed to the high level EC of 3.84 mmhos/cm. The lowest EC of 1.39 mmhos/cm was recorded at S8 (Bharathipuram) of industrial area receiving effluent from textile mill, auto carriage, electroplating and motor industry. It was found that those water which receives domestic sewage, sugar factory effluent and paper mill effluent showed a high degree of EC than water which receives industrial effluent as recorded by Sreenivasan and Sounderaraj (1967) and Trivedy (1988).

The maximum value of total solids was at S8 (14,000mg/l) followed by S6 (12,000mg/l), S3 (8000mg/l), S7 (8000 mg/l), S2 (7333.33mg/l), S1 (4666.67mg/l) and S8 (3333.33mg/l), which may be due to their flowing nature of the waste water. Similarly Total dissolved solids was maximum at S8.
Table 1: Physico-chemical characteristics of municipal sewage water of Sanganur canal at different sampling stations

<table>
<thead>
<tr>
<th>Parameters</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
<th>Tolerance limit ISI 1981</th>
<th>Permissible limit ISI 1982 - Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Temp. °C</td>
<td>29.40</td>
<td>29.45</td>
<td>29.48</td>
<td>30.00</td>
<td>30.18</td>
<td>30.00</td>
<td>31.00</td>
<td>Less than 40°C</td>
<td>-</td>
</tr>
<tr>
<td>2. pH</td>
<td>8.17</td>
<td>11.47</td>
<td>7.41</td>
<td>6.84</td>
<td>7.59</td>
<td>9.30</td>
<td>7.74</td>
<td>5.50-9.00</td>
<td>6.00-8.00</td>
</tr>
<tr>
<td>3. EC</td>
<td>3.20</td>
<td>3.84</td>
<td>3.08</td>
<td>1.39</td>
<td>3.77</td>
<td>3.00</td>
<td>3.39</td>
<td>-</td>
<td>2.30</td>
</tr>
<tr>
<td>4. TS</td>
<td>4666.67±642.81</td>
<td>7333.33±642.81</td>
<td>8000.00±1632.99</td>
<td>3333.33±642.81</td>
<td>12000.00±1632.99</td>
<td>14000.00±1632.99</td>
<td>8000.00±1632.99</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5. TDS</td>
<td>2866.67±642.81</td>
<td>1333.33±642.81</td>
<td>1333.33±642.81</td>
<td>2000.00±0</td>
<td>10666.66±1885.62</td>
<td>12000.00±1885.62</td>
<td>5333.33±941.81</td>
<td>2100.00</td>
<td>2100.00</td>
</tr>
<tr>
<td>6. Free CO₂</td>
<td>22.00±0</td>
<td>BDI</td>
<td>44.00±0</td>
<td>44.00±0</td>
<td>44.00±0</td>
<td>BDI</td>
<td>51.3±10.37</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. Total alkalinity</td>
<td>186.67±23.57</td>
<td>400.00±0</td>
<td>100.00±0</td>
<td>133.3±47.14</td>
<td>200.00±0</td>
<td>200.00±0</td>
<td>463.3±23.57</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8. Total hardness</td>
<td>533.3±9.43</td>
<td>46.6±9.43</td>
<td>85.6±9.43</td>
<td>80.0±0</td>
<td>93.3±9.43</td>
<td>80.0±16.33</td>
<td>380.0±14.14</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9. DO</td>
<td>44.1±0.13</td>
<td>4.2±0.23</td>
<td>3.2±0.23</td>
<td>7.81±0.37</td>
<td>6.09±0.35</td>
<td>3.57±0.26</td>
<td>4.31±0.13</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10. BOD</td>
<td>66.67±4.71</td>
<td>37.10±2.87</td>
<td>34.07±4.71</td>
<td>38.6±8.69</td>
<td>35.6±4.53</td>
<td>234.57±57.62</td>
<td>123.33±4.71</td>
<td>30.00</td>
<td>-</td>
</tr>
<tr>
<td>11. COD</td>
<td>328.00±6.53</td>
<td>272.00±13.06</td>
<td>186.67±16.96</td>
<td>746.67±16.96</td>
<td>265.67±19.96</td>
<td>1800.00±32.68</td>
<td>277.3±15.08</td>
<td>250.00</td>
<td>500.00</td>
</tr>
<tr>
<td>12. Ca²⁺</td>
<td>535.1±18.9</td>
<td>0.01±0.0</td>
<td>21.38±3.78</td>
<td>18.70±3.78</td>
<td>24.05±6.55</td>
<td>16.03±0</td>
<td>112.2±3.28</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>13. Chloride</td>
<td>428.37±12.07</td>
<td>260.3±26.78</td>
<td>291.10±5.80</td>
<td>324.2±24.14</td>
<td>76.10±0</td>
<td>468.6±17.39</td>
<td>227.17±6.69</td>
<td>1000.00</td>
<td>1000.00</td>
</tr>
<tr>
<td>14. Sulphate</td>
<td>80.00±0</td>
<td>500.00</td>
<td>500.00</td>
<td>500.00</td>
<td>500.00</td>
<td>10.00±0</td>
<td>40.0±0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15. Phosphate</td>
<td>420.0±0.08</td>
<td>4.87±0.87</td>
<td>52.00±0.70</td>
<td>32.67±0.66</td>
<td>6.40±2.08</td>
<td>6.09±1.18</td>
<td>9.47±0.17</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>16. Nitrate</td>
<td>59.5±0</td>
<td>7.94±0</td>
<td>7.94±0</td>
<td>9.25±0.93</td>
<td>7.94±0</td>
<td>9.95±0</td>
<td>19.84±0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>17. Ammon. nitro</td>
<td>98.0±0</td>
<td>61.6±0</td>
<td>22.4±0</td>
<td>28.01±0</td>
<td>33.62±0</td>
<td>22.4±0</td>
<td>33.62±0</td>
<td>50.00</td>
<td>-</td>
</tr>
</tbody>
</table>

*All values are in mg/L except pH and EC (mmhos/cm)*
Water quality criteria of municipal sewage water

Fig. 1: Course of Sanganur canal – The open drainage with different sampling stations.

at S6 (12,000.00 mg/l) followed by S5 (10,666.66 mg/l), S7 values (5333.33 mg/l) and S2 (2666.67 mg/l), while at S3, S1 and S4 were lower than the stipulated standard of 2100.00 mg/l. S6 (Erimedu) where hospital waste is the main source for contributing to high level of total solids. At S5 (Ramaswamy Naidu layout) soap company, dye testing unit contribute to total solids. S3 is Rajugardens and S7 is Vellalore, which receives mixed waste of domestic and industrial effluents which contribute to the total solids. S2 (Rathnapuri) receives domestic sewage and flour mill effluent which contribute to the total solids. S1 (Asoke Nagar) receives only domestic sewage and S4 (Bharathipuram) receives industrial effluent which contribute to the low total solids. So nature, type and time of retention of domestic sewage and industrial effluent in each station decide upon the total solids.

Wide fluctuations in the level of total hardness was noted among the sampling stations, maximum being at S1 (533.33 mg/l) followed by S7 (330.00 mg/l), S6 (93.33 mg/l), S2 (86.66 mg/l), S4 (80.00 mg/l) and S5 (60.00 mg/l). According to Murali and Stathyanarayana (2001) the hardness is mainly due to presence of calcium, magnesium and chlorides in the domestic wastes.

Dissolved oxygen was maximum at S4 (7.81 mg/l) followed by S3 (6.09 mg/l), S1 (4.41 mg/l), S7 (4.31 mg/l) and S2 (4.22 mg/l) while it was minimum at S6 (3.57 mg/l) and S1 (3.38 mg/l). Generally whenever DO increases BOD and COD will decrease. But in the present work the selected stations S3 and S4 with DO as 3.38 mg/l, 7.81 mg/l respectively are totally different in nature. S6 (Erimedu) is a domestic area receives domestic waste water with more organic materials. So it has less DO and more BOD and COD. This municipal sewage water flows for some distance during which time the atmospheric oxygen gets dissolved and reaches the S4 station (Bharathipuram). So municipal sewage water collected from this station has more DO but BOD and COD have not reduced, as Chemical oxygen demand and biological oxygen demand require time for their reactions. Maximum level was due to rheological phenomenon as well as the self purification capacity of flowing water (Singh and Trivedi, 1979). Minimum level was due to chemical impurities, stagnant condition and microbiological growth in water (Bhuvaneswaran et al., 1999).

BOD was maximum at S4 (384.67 mg/l) followed by S6 (365.87 mg/l), S3 (347.10 mg/l), S5 (328.00 mg/l) and S7 (123.33 mg/l) while a minimum of 66.66 mg/l at S1 were recorded. The values at all the stations were found to be beyond the permissible limit. Kandhasamy and Santhaguru (1994) have reported that the higher BOD may be due to higher organic load and higher growth of total micro organisms. COD level was maximum at S6 (1800.00 mg/l) followed by S4 (746.67 mg/l), S1 (328.00 mg/l), S7 (277.33 mg/l) S2 (272.00 mg/l) and S4.
(266.67mg/l) which may be due to the incessant flowing of se-wages in these stations and COD changes according to season (Mishra et al., 1990). The values at all the stations were found to be beyond the permissible limit.

Chloride was maximum at S6 (468.60mg/l) followed by S1 (428.37mg/l), S4 (324.23mg/l), S3 (291.10mg/l), S2 (260.33mg/l) and S7 (227.17mg/l) and minimum was found in S5 (78.10mg/l). The level of chloride at all the stations was found to be within the permissible limit. High level of chlorides may be due to heavy sewage dumping (Bhuvaneswaran et al., 1999).

Decreasing in the level of sulphate was noted in S1, S7 and S6, (80.00mg/l, 40.00mg/l and 10.00mg/l respectively). Same levels were recorded in S2, S3, S4, and S5 (5.00mg/l). Sulphate level at all the stations were found to be within the permissible limit. Sulphates are often present as calcium sulphates in natural waters and more in sewage.

Phosphate was maximum at S4 (32.67mg/l) followed by S7 (9.47mg/l), S6 (6.93mg/l), S5 (6.40mg/l) and S1 (5.20mg/l) and minimum was observed in S3 (4.87mg/l), S2 (4.27mg/l) and S1 (4.20mg/l). The high phosphate concentration was due to discharge of untreated industrial and domestic wastes (Chakrabarty et al., 1959 and Hannan and Young, 1974).

Nitrate level was found to be high at S1 (19.84 mg/l), S4 (9.26 mg/l) and same values were observed in S2, S3, S5, and S6 (7.94 mg/l) and S1 and S5 (9.55 mg/l). According to Grasshoff (1983) in water bodies, where toxic conditions change into anoxic, thin layer of nitrite content may occur together with low levels of oxygen.

Ammonical nitrogen was maximum at S6 (61.63mg/l) followed by S1 (56.03mg/l) and S4 (28.01mg/l) and the same results were obtained in S6 and S7 (33.62 mg/l) S1 and S4 (22.41mg/l). The level of ammonical nitrogen exceeded the permissible limit at S1 and S2. Das et al. (2003) reported that high organic pollutant load resulted in marked increase in ammoniacal nitrogen value in drains and may be due to decaying organic matter.

Results of this study recommends the treatments of domestic sewage and industrial effluent water before letting into the open drainage, so that the quality criteria of the Sanganur canal water will satisfy the ISI quality criteria set for inland surface water for irrigation and fish culture.

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