*Acta Ciencia Indica, Vol. XLIII C, No. 3, 373 (2017)*

# WATER QUALITY OF SOME COMMUNITY POINDS OF PURI TOWN

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RECEIVED : 28 May, 2017

Water quality and pollution load of three community ponds of Puri town were monitored for 2 years. The ponds exhibited a COD/BOD ratio of > 3 every month and water quality index calculated from thirteen physico-chemical and one biological parameter taken together varied from 168-870 indicating level of nutrient load and pollution in the ponds. The water is unsafe for human use. Appropriate recommendations have been made.

## INTRODUCTION

Community ponds like temple and other ponds have immense importance in Indian villages and towns as these are used for collection of drinking water, religious works, fish culture, bathing, washing of clothes, utensils and cattle and irrigation. Although analysis of water quality and pollution load in Indian rivers and lakes have been made extensively (Tivedy 1989) much attention has not been given to the analysis of water quality and pollution load of community ponds in Indian rural ecosystems. This work, forms a part of a comprehensive research work carried out for two years on some temple and other ponds of Puri town to assess water quality, pollution load and safety of its use by the people.

## MATERIALS AND METHODS

Puri is a small commercial town having about 30 sq.km area inhabited by about 50 thousand people, 2 mtrs above sea level. The town has about 10 ponds having range of sizes varying from 2000 to 20000 sqm which are used for fish culture, religious purposes, for bathing, washing, cattle bathing, etc. and the banks of all ponds except the *Sweta Ganga* are used as open air latrine. Three important ponds from the point of view of human use (One *Sweta Ganga*, one small community pond (SC Pond) locally named as *Markanda* and other large community pond (LC Pond) named as *Indradumna* were studied. The large community pond receives municipal drain in rainy and winter season.

Table 1 gives the salient features of the ponds. This region experiences three distinct seasons, summer extending from mid March to mid June. Rainy extends from mid June to October and Winter from November to February. Monthly surface sampling for physico-

chemical parameters and seasonal sampling for bacteriological parameters were done. Samples were collected in triplicate in plastic container during morning hours and analysed in the laboratory. Analysis was done after methods outlined by Golterman (1978), APHA (1981) and Trivedy and Goel (1984).

**Water quality Index**

Seasonal values for each parameter were calculated from monthly sample data. Out of 19 parameters studied, 14 parameters were taken for calculating water quality index. (Deininger and Maciunas, 1971; Harkins, 1974 and Tiwari and Ali 1988). A water quality index (W.O.I) is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water. We calculated the WQI from the point of view of the suitability of pond water for human consumption. The weights for various water quality parameters are assumed to be inversely proportional to the recommended standards (Table 4) for the corresponding parameters *i.e.*,

$$W_i = \frac{K}{S_i} \quad \ldots (1)$$

where $W_i$ = Unit weight for the *i*th parameter

$S_i$ ($i$ = 1, 2 … 14) refers to water quality parameters and

$K$ = Constant of proportionality.

For the sake of simplicity we assume $K$ = 1.

The unit weights $W_i$ obtained from Eq. (1) with $K$ = 1 are shown in the third column of Table 4. Calculation of W.Q.I. involves two fundamental steps (1) Calculation of the quality rating for each of the water quality parameters used in the index (2) Aggregation of these subindices into the overall index.

## CALCULATIONS

Let there by N water quality parameter and $P_i$ ($I$ = 1, 2 … N) is to be taken into account for calculating the W.Q.I. Then the quality rating (or Subindex) qi corresponding to the ith parameter of Pi is a number reflecting the relative value of this parameter in the polluted water with respect to its standard or permissible value ($S_i$). One of the simplest relations to calculated $q_i$ is

$$q_i = \frac{100(V_i - V_{10})}{(S_i - V_{10})} \quad \ldots (II)$$

**Table 1.** Salient features of the Study Ponds of Puri Town

| Name of the Pond | Area of the Pond | | Features | Vegetation species | |
|---|---|---|---|---|---|
| | Length in mts. | Breadth in mts. | | Shore line vegetation | Macrophyte |
| Swetaganga | 200 | 220 | Used for utencil cleaning, Feet washing | Oryza sp. | Salvania sp.<br>Hydrocharis sp.<br>Limnathemum sp. |
| Markanda | 150 | 180 | In one side of the Bank, municipal | Ipomoea carnea | |

| | | | | | |
|---|---|---|---|---|---|
| | | | solid garbage was dumped. Banks are extensively used for open air latrine. Extensive human use (bathing and washing) | | |
| Indradumna | 280 | 160 | Banks are used for open air latrine. Pond receives municipal drain discharge (except during summer) | Ipomoea carnea | Ipomoea acquatica |

where $V_i$ = The measured value of the *i*th parameter in the polluted water.

$V_{10}$ = The ideal value of this parameter in pure water.

$S_i$ = The Standard or permissible value for the *i*th parameter.

Since in general, the ideal value $V_{10} = 0$ for the drinking water for most parameters. Eq. II assumes the simple form for these parameters

$$q_i - 100\left(\frac{V}{S}\right) \quad \ldots \text{(III)}$$

Equation II and III ensure that $q_i = 0$ if the *i*th parameter is totally absent in the polluted water and $q_i = 100$, if the amount of this parameter is just equal to its permissible value *S*, for the drinking water. But there are the following three exceptions.

(a) For DO, the ideal value may be taken as 14.6 mg/l (The solubility of $O_2$ in pure water at $0^oC$. Since the standard for drinking water is 5.0 mg/l, Eq. II reduces to

$$qDo = 100\frac{14.6}{(14.6-5.0)}.\frac{VDO}{(14.6-5.0)} \quad \ldots \text{(IV)}$$

where *VDO* = observed value of dissolved oxygen.

(b) For pH, the ideal value of 7.0 (for neutral water) and the permissible value is 8.5; So Eq. II for this case may be written as

$$q\,pH = 100\ (VpH - 7.0)/*8.5 - 7.0) - (V)$$

where *VPH* is the observed value of pH.

(c) In the case of *MPN* of coliform, the permissible value for drinking water is 1 per 100 ml, while their actual number in Ponds may be much more per 100 ml. To get a convenient number for the quality rating *q MPN* in this case can be as follows :

$$qMPN = \frac{\log_{10} VMPN + 1}{\log_{10} SMPN = 1} \times 100 \quad \ldots \text{(VI)}$$

Here *VMPN* = *MPN* of coliform/100 ml of water.

*SMPN* = Standard for coliforms for the drinking water.

= 1 per 100 ml and 1 is added to the numerator and denominator of the term inside basket in order to avoid division by zero, since $\log_{10}{}^1 = 0$.

The overall water quality indeed (WQI) may be calculated by aggregating the quality ratings (or subindices) qi line only. Thus we may write

$$WQI = \left( \sum_{i=1}^{N} q_i w_i \Big/ \sum_{i=1}^{N} w_i \right) \quad \ldots(VII)$$

# Results and discussion

Physico-chemical and Biological parameters, BOD/COD values and water quality indices are respectively given in Table 2, 3 and 4.

**Temperature**

In all the ponds the minimum and maximum temperature were respectively observed during winter and summer. There was no significant difference in surface temperature between the ponds. It varied from 25.5 to 31.5$^{o}$C.

**pH**

It varied from 7.6 to 8.71, 8.8 to 9.6 and 8.8 to 9.3 in Swetaganga, Markanda and Indradumna Pond respectively. The minimum range of pH was observed during rainy season in all ponds except the small community pound where the lower value occurred in winter. The higher pH was found in Summer in all the Ponds. Klein (1973) have pointed out that the pH values between 6.7 and 8.4 are suitable while the pH below 5.0 and above 8.3 are detrimental. The pH of community pond were always above 8.5 indicating their unsuitability.

**Turbidity**

In the terms Nephelometric turbidity expand units (NTU), Swetaganga was less turbid (3 to 8.1) than the Markand, (15.5 to 32 NTU) and Indradumna Pond (61.1 to 308 NTU). Minimum turbidity was observed in Summer in the Swetaganga and in Winter in the Markand Ponds. Maximum turbidity was observed in the rainy season in Swetaganga and in Summer season in Markanda ponds. The higher turbidity values in the community ponds coincide with higher density count of phytoplanktons and concentration of total solids.

**Dissolved Oxygen**

The dissolved oxygen ranged from 5.71 to 7.58, 2.8 to 10.12 and 3.7 to 7.9 mg $l^{-1}$ in Swetaganga, Markunda and Indradumna respectively. Minimum $DO_2$ was observed during winter in Swetaganga and summer in Indradumna ponds. Maximum value was observed in Summer in Swetaganga and Rainy in Markanda Ponds. This differential growth of Macrophytes in the ponds. The T. Pond has a high growth of macrophytes. The critical requirement level for all fishes in 3-6 mg $l^{-1}$ of $DO_2$. The seasonal low level of $DO_2$ in the ponds is indicative of stress problem for aquatic organisms and pollution.

**Total Alkalinity**

Total Alkalinity ranged from 128 to 159, 300 to 428 and 131.5 to 187 mg $l^{-1}$ in Swetaganga, Markanda and Indradumna respectively. The greater alkalinity for the community pond was due to large scale use of its banks as open air latrine and consequent washing of the excreta into the ponds.

**Total Solids and Dissolved Solids**

Total solids ranged from 290 to 326.6 mg $l^{-1}$, 1.11 $g^{-1}$ to 1.35 $g^{-1}$ and 360 mg $l^{-1}$ to 585 mg $l^{-1}$ in Swetaganga, Markanda and Indradumna respectively. Total dissolved solids ranged

from 238.7 to 293.3 mg $l^{-1}$, 1.045 to 1.34 $g^{-1}$ and 368.3 to 473.3 mg $l^{-1}$ in the Swetaganga, Markanda and Indradumna respectively. There is a significant difference between the ponds with regards to total solid load. The Markanda Pond was loaded with greater amounts of solids because of large scale use of its banks as open air latrine. Water with high dissolved solids generally are of inferior palatability and may induce an unfavourable physiological reaction in the transient consumer. For these reasons a limit of 500 mg $l^{-1}$ (ICMR Standard) is desirable for drinking water. Higher suspended solids in the water of Markanda could be very harmful to fish.

**Table 2.** Physico-Chemical & Biological Parameters of Community Ponds
(Values X ± SEM)

| | | **Swetaganga** | **Markanda** | **Indradumna** |
|---|---|---|---|---|
| pH | S | 8.71 ± 0.24 | 9.532 ± 0.116 | 0.392 ± 0.296 |
| | R | 7.68 ± 0.238 | 9.535 ± 0.110 | 8.817 ± 0.207 |
| | AW | 8.0 ± 0.341 | 8.835 ± 0.190 | 8.937 ± 0.303 |
| Total Alkalinity | S | 128 ± 3.265 | 401.5 ± 12.974 | 187 ± 14.62 |
| | R | 130.50 ± 6.42 | 300 ± 21.684 | 131.5 ± 12.801 |
| | AW | 159 ± 7.449 | 428 ± 89.799 | 140.666 ± 9.625 |
| Total Hardness | S | 76.50 ± 2.559 | 152 ± 12.892 | 59.5 ± 11.52 |
| | R | 102.50 ± 10.213 | 163 ± 29.188 | 79.25 ± 5.644 |
| | AW | 110.50 ± 5.527 | 203.5 ± 4.041 | 73.0 ± 2.748 |
| $DO_2$ | S | 7.58 ± 1.037 | 2.898 ± 1.052 | 3.710 ± 0.708 |
| | R | 5.84 ± 0.721 | 10.120 ± 3.148 | 7.964 ± 2.824 |
| | AW | 5.71 ± 0.594 | 4.251 ± 1.687 | 6.937 ± 0.661 |
| Chloride | S | 90.42 ± 5.151 | 526.536 ± 56.372 | 166.647 ± 22.548 |
| | R | 72.69 ± 6.141 | 421.937 ± 31.801 | 106.37 ± 22.174 |
| | AW | 72.26 ± 3.903 | 382.935 ± 12.947 | 104.598 ± 3.919 |
| Na | S | 74.33 ± 6.569 | 342.5 ± 60.104 | 150.0 ± 19.901 |
| | R | 62.50 ± 3.535 | 299.0 ± 55.154 | 112 ± 53.74 |
| | AW | 64.0 ± 1.414 | 290.5 ± 41.719 | 94.333 ± 9.907 |
| K | S | 19.0 ± 0.707 | 127 ± 8.03 | 31.333 ± 1.079 |
| | R | 14.0 ± 1.414 | 190 ± 98.994 | 21.0 ± 5.656 |
| | AW | 21.0 ± 2.828 | 94 ± 15.936 | 24.666 ± 6.975 |
| CA | S | 10.93 ± 1.372 | 18.502 ± 2.059 | 10.933 ± 1.048 |
| | R | 18.29 ± 2.70 | 29.852 ± 5.83 | 19.341 ± 3.245 |
| | AW | 23.55 ± 2.412 | 37.636 ± 2.976 | 13.246 ± 2.035 |
| Mg | S | 12.00 ± 0.448 | 25.814 ± 3.286 | 7.856 ± 2.267 |
| | R | 13.87 ± 2.227 | 21.852 ± 4.425 | 7.555 ± 1.311 |
| | AW | 12.61 ± 0.296 | 26.723 ± 1.352 | 9.744 ± 1.419 |

All values except pH, Turbidity, Coliform & Temp in mg $l^{-1}$ Turbidity in NTU, Coliform – Most probable Number in 100/ml. Temperature $0^{o}$C.

**WATER QUALITY OF COMMUNITY PONDS**

| | | Swetaganga | Markanda | Indradumna |
|---|---|---|---|---|
| Turbidity | S | 3.0 ± 2.828 | 32.0 ± 1.414 | 30888 ± 16.97 |
| | R | 8.133 ± 1.839 | 22.533 ± 12.9 | 166.533 ± 150.119 |
| | AW | 4.0 ± 2.828 | 15.5 ± 0.707 | 61.15 ± 5.161 |
| Total Solids | S | 290 ± 19.436 | 1350 ± 0.104 | 585 ± 95.065 |
| | R | 326.666± 123.557 | 1113 ± 0.177 | 431.666± 134.365 |
| | AW | 303.333± 111.933 | 1121 ± 0.12 | 360 ± 67.453 |
| Total dissolved Solids | S | 238.75 ± 12.99 | 1340 ± 0.105 | 473.333 ± 48.676 |
| | R | 293.333± 106.379 | 1045 ± 0.107 | 383.333 ± 160.83 |
| | AW | 266.666± 86.914 | 1096 ± 0.107 | 368.333 ± 83.541 |
| Temp | S | 31.5 ± 2.012 | 30.525 ± 0.83 | 31.025 ± 1.558 |
| | R | 30.45 ± 1.124 | 30.112 ± 1.178 | 30.187 ± 0.967 |
| | AW | 25.525 ± 1.198 | 26.062 ± 1.176 | 25.737 ± 1.065 |
| Total Coliform | S | 23 | 150 | 93 |
| | R | 2400 | 4600 | 1100 |
| | AW | 2400 | 1100 | 390 |
| Nitrate | S | 0.029 ± 0.001 | 0.052 ± 0.004 | 0.068 ± 0.007 |
| | R | 0.002 ± 0.0007 | 0.004 ± 0.002 | 0.002 ± 0.0007 |
| | AW | 0.024 ± 0.005 | 0.058 ± 0.005 | 0.071 ± 0.011 |
| Phosphate | S | 0.008 ± 0.001 | 0.009 ± 0.004 | 0.018 ± 0.009 |
| | R | 0.004 ± 0.002 | 0.006 ± 0.002 | 0.006 ± 0.005 |
| | AW | 0.031 ± 0.008 | 0.018 ± 0.007 | 0.016 ± 0004 |
| Surfate | S | 0.038 ± 0.006 | 0.041 ± 0.00 | 0.053 ± 0.004 |
| | R | 0.038 ± 0.016 | 0.043 ± 0.019 | 0.071 ± 0.002 |
| | AW | 0.021 ± 0.005 | 0.025 ± 0.006 | 0.052 ± 0.009 |

**Total Hardness and Calcium**

Total Hardness ranged from 76.5 to 110.5, 152 to 203.5 and 59.5 to 79.2 mg $l^{-1}$ in Swetaganga, Markanda and Indradumna respectively. Calcium ranged from 10.9 to 23.5, 18.5 to 37.6 and 10.9 to 19.3 mg $l^{-1}$ in Swetaganga, Markanda and Indradumna respectively. Minimum values of hardness and calcium were observed in Summer in all Ponds and maximum values occurred in Winer in Swetaganga and Markanda in the Rainy season in Indradumna. Greater hardness and calcium values in the Markanda was due to large scale human use.

**Magnesium**

Magnesium ranged from 12 to 13.8, 21.8 to 26.7 and 7.5 to 9.7 mg $l^{-1}$ in Swetaganga, Markanda and Indradumna respectively. Lower amount of magnesium was observed in Summer in the Swetaganga and in rainy season in the Markanda where higher values were found in Winter for Markanda and in rainy season for Swetaganga.

**Sodium and Potassium**

Sodium concentration varied from 62.5 to 74.3, 290 to 342.5 and 943 to 150 mg $l^{-1}$ in Swetaganga, Markanda and Indradumna respectively. Potassium ranged from 14 to 21, 94 to 190, 21 to 31.3 mg $l^{-1}$. Minimum amount of sodium was found respectively in rainy season in Swetaganga and in Winter in the Markanda where maximum amount was found during

Summer in all the ponds. Minimum Potassium occurred in rainy season in Swetaganga and Indradumna but in Winter in the Markanda. Maxaimum value of sodium and potassium was found in winter, rainy and summer in Swetaganga, Markanda and Indradumna respectively.

**Chloride**

Chloride content ranged from 72.2 to 90.4, 382.9 to 526.5 and 104.5a to 166.6 mg $l^{-1}$ in Swetaganga, Markanda and Indradumna respectively. Minimum amount of chloride occurred in Winter and maximum amount occurred in summer in all the ponds.

**Table 3.** Seasonal BOD and COD data of three study ponds

(Values ± SEM)

| Season | Swetaganga | | | Markanda | | | Indradumna | | |
|---|---|---|---|---|---|---|---|---|---|
| | COD | BOD | COD/BOD | COD | BOD | COD/BOD | COD | BOD | COD/BOD |
| Summer | 17.397 ±4.206 | 3.035 ±1.463 | 5.732 | 146.218 ±21.665 | 15.218 ±1.24 | 9.649 | 118.60 ±33.786 | 20.084 ±1.249 | 5.905 |
| Rainy | 15.603 ±6.317 | 8.345 ±1.621 | 1.869 | 119.401 ±29.247 | 18.498 ±1.147 | 6.454 | 55.53 ±12.65 | 15.665 ± 3.65 | 3.544 |
| Winter | 22.765 ±5.104 | 2.538 ±2.463 | 8.969 | 118.766 ±5.315 | 14.547 ±5.315 | 8.164 | 73.10 ±8.089 | 12.625 ±7.289 | 5.79 |

**Table 4. Water Quality Index (WQI) of Study Ponds of Puri Town**

| Parameter (Pi) | ICMR Standard (quoted By TIWARI & ALI 1988) (Si) | Unit Weight (Wi) | Swetaganga Parameter Sub Inded | | | Markanda Parameter Sub Index | | | Indaradumna Parameter Sub Inded | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Summer qiwi | Rainy qiwi | Winter qiwi | Summer qiwi | Rainy qiwi | Winter qiwi | Summer qiwi | Rainy qiwi | Winter qiwi |
| pH | 7-8.5 | 0.07164 | 8.16696 | 3.2238 | 4.7759 | 12.5703 | 12.1071 | 8.7639 | 11.4241 | 8.6769 | 9.2510 |
| ALK | 120[2] | 0.00417 | 0.44479 | 0.4534 | 0.5525 | 1.3952 | 1.0425 | 1.4872 | 0.6498 | 0.4569 | 0.4888 |
| Total Hardness | 200 | 0.00167 | 0.04258 | 0.0570 | 0.0615 | 0.0846 | 0.0907 | 0.1132 | 0.0331 | 0.441 | 0.0406 |
| DO | 5[1] | 0.10030 | 7.32190 | 9.1481 | 9.2881 | 12.2260 | 4.6805 | 10.8125 | 1.1471 | 6.9332 | 8.0061 |
| BOD | 5[2] | 0.10030 | 6.08821 | 16.7400 | 5.0912 | 30.5273 | 37.1069 | 29.1821 | 40.2885 | 31.4239 | 25.3257 |
| Cl | 250 | 0.00200 | 0.07233 | 0.0581 | 0.5610 | 0.4212 | 0.3375 | 0.3063 | 0.1333 | 0.0850 | 0.0836 |
| Na | 20[1] | 0.02507 | 9.31764 | 7.8343 | 8.0224 | 49.9323 | 37.1069 | 29.1821 | 40.2885 | 31.4239 | 25.3257 |
| K | 10[1] | 0.05015 | 9.52850 | 7.0210 | 10.5315 | 63.6905 | 95.2850 | 47.141 | 15.7134 | 10.5315 | 12.3699 |
| Ca | 75 | 0.00668 | 0.09737 | 0.1628 | 0.2097 | 0.1647 | 0.2658 | 0.3352 | 0.0973 | 0.1722 | 0.1179 |
| Mg | 50 | 0.01003 | 0.24080 | 0.2781 | 0.2530 | 0.5178 | 0.4383 | 0.5360 | 0.1575 | 0.1515 | 0.1954 |
| MPN Coliform | 1/100 ml | 0.50156 | 118.40415 | 219.6570 | 219.6570 | 159.2764 | 233.7993 | 202.6561 | 148.8452 | 202.6561 | 180.088 |
| Turbidity | 5 | 0.10030 | 6.01800 | 16.3147 | 8.0240 | 64.1920 | 45.2011 | 31.0930 | 617.8480 | 334.0651 | 122.6669 |
| Total solids | 500[3] | 0.00100 | 0.05800 | 0.0653 | 0.0606 | 0.2700 | 0.2226 | 0.2242 | 0.1170 | 0.0863 | 0.0720 |
| COD | 20 | 0.02507 | 2.18071 | 1.9558 | 2.8535 | 18.4062 | 14.9669 | 14.8873 | 14.8665 | 6.9606 | 9.1630 |
| Σwi | 0.99988 | Σqiwi | 167.98194 | 282.9694 | 269.4419 | 413.6745 | 483.0238 | 383.9512 | 870.1233 | 616.2835 | 379.6935 |
| WQI Σqiwi/ Σwi | | | 168.003 | 283.003 | 269.474 | 413.724 | 483.724 | 383.9972 | 870.198 | 616.357 | 379.739 |

All values except pH, Turbidity & MPN Coliform are in mg $l^{-1}$

(1) European Economic Community Standard (EEC)

(2) United States Public Health Service (USPHS) Standard

(3) World Health Organisation (WHO) Standard.

**Nitrate, Phosphate and Sulphate**

In the Swetaganga, $NO_3$, total $PO_4$-P and $SO_4$ remained in the range of 0.002 – 0.029, 0.004 – 0.031 and 0.021 – 0.038 mg $l^{-1}$ respectively. In Markanda Pond $NO_3$, $PO_4$-P and $SO_4$ remained in the range of 0.004 – 0.058, 0.006 – 0.018 and 0.025 – 0.043, 0.006 – 0.018 and 0.025 – 0.043 mg $l^{-1}$ respectively. In Markanda $NO_3$, $PO_4$-P and $SO_4$ remained in the range of 0.002 – 0.071, 0.006 – 0.018 and 0.052 – 0.071 mg $l^{-1}$ respectively. Minimum amount of $NO_3$ and $PO_4$ occurred in the rainy season and minimum amount of $SO_4$ occurred in winter in all the ponds. Maximum amount of $NO_3$ was found in Summer in Swetaganga and in winter in the Markanda Ponds. Maximum amount of $PO_4$ was found in winter in Swetaganga and Markanda and in Summer in Indradumna. Maximum $SO_4$ was found in Rainy in all the Ponds. Concentration of nitrate in excess of 0.3 mg $1^{-1}$ is considered sufficient to stimulate algal bloom (Raina *et al*, 1984). The study ponds are below this limit. Ketchun (1967) observed that 2.53 $mg^{-1}$ of $PO_4$ is the maximum limit of its concentration which could be accepted as the danger signal of evaluation of eutrophication of estuary. All the study ponds showed ranged above the danger signal limit.

**BOD, COD and its ratio**

The five day biological oxygen demand indicated low value in Swetaganga. This is expected as it is less polluted. BOD ranged from 2.5 – 8.3, 14.5 – 18.4 and 12.6 – 20 mg $l^{-1}$ in Swetaganga, Markanda and Indradumna respectively. Low BOD value was found in winter in all the Ponds. High BOD value was found in the Rainy season in the Swetaganga and Markanda but in summer in the Indradumna. Martin (1970) considered water body with BOD more than 8 mg $l^{-1}$ to be moderate polluted. COD values ranged from 15.6 – 22.7, 118.7 – 146.8 and 55.5 – 118.6 mg $l^{-1}$ in Swetaganga, Markanda and Indradumna respectively. High COD value was seen in Summer in the Markanda and in winter in the Swetaganga. For untreated domestic sewage the approximate COD/BOD ration was = 2.0 (Mara 1978). On the other hand presence of industrial or agriculture waste may alter this ratio. Biological treatment of the material is needed if R > 1.7 and acclimatization of the material is needed before biological treatment if R is in between 1.7 – 3.3 and treatment other than biological is needed if it is more than 3.3 (Rao and Datta 1979). COD/BOD ration was maximum (Table 3) in winter in Temple Pond and in Summer in the Markanda. Minimum ratio was seen during rainy season in all Ponds. As the COD/ BOD ratio is more than 3 in all the ponds except rainy season in the Swetaganga, the water is unsafe and treatment is needed for human use. The higher COD/BOD observed in different months does not show corresponding lower BOD value indicating presence of negligible amount of obscene of toxic chemicals.

**Total Coliform**

The MPN of Coliform count in 100 ml water ranged from 23-2400, 150-4600, and 93-1100 in Swetaganga, Markanda and Indradumna respectively. Highest count was found in rainy season and lowest in Summer in all Ponds. The results is similar with the finding of Sinha (1991). The drinking water standard recommended by ICMR for coliform group is 1 per 100 ml. Hence all the ponds were found to be heavily contaminated with coliform group and unfit for drinking purposes.

**WQI**

For the purpose of present study the use of water for drinking and personal hygiene has been treated as the primary consideration. The reason for this preference is that nearly 80% of our population live in more than half a million villages and all of these villages have negligible facility of any kind whatsoever, either for potable water or for excreta disposal. The

typical water source for these villages is often a Pond or a well. The report prepared by the WHO and the World Bank "The importance of safe community water supply and sanitation in the control of diseases such as diarrhea, typhoid, paratyphoid, shigelloses, salmonelloses, cholera, infectious hepatitis, amoebiasis and giardiasis is well established.

The value of WQI was always more than 100 in all the three ponds indicating that the water is unsuitable for human use. In the Swetaganga the value of WQI varied from 168-282 which was comparatively lesser than the other two Ponds (Markanda 384-483, Indradumna 380-870). The quality of water in summer in the Swetaganga was better than the other two ponds and the reason may be the presence of a large macrophyte population and lesser human activity. High density *Microcystis* population was present in Indradumna and high density population of chlorophyceae was found in Markanda during Summer. Hence we recommend that the appropriate authority in Odisha should take immediate steps to provide alternate source of water (Tube well etc.) to the people and advise people not to use this unsafe water. The ponds can be profitably used for fish culture by the fishery department. Puri municipality should make provisions of public latrine facilities and excreta disposal.

# REFERENCES


1. APHA. Standard methods for the examination of waster and waste water, APHA, Washington, USA (1985).
2. Deininger, R.A. and Maciunas, J.J., A water quality index for Public Water supplies. Department of Environmental and Industrial Health, School of Public Health, University of Michigan. Ann Arbor, Michigan, (USA) (1971).
3. Golterman, H.L., Clymo, R.S. and Ohnstad, M.A.M., Method for chemical analysis for fresh water, I.B.P. Hand book No.8, Blackwell Scientific Publication, Oxford (1978).
4. Harkins, R.D., "An objective water quality index", *J. Water Poll. Cont. Fed*., 3: 589-591 (1974a).
5. Ketchun, B.H., In : Estuaries, Ed. G.H. Lauff, Pub. No. **83**. Am. Assoc. Adv. Sci. Washington (1967).
6. Klein, L., *River Pollution*. II Causes and effects (5th imp), Butterworth and Co. Ltd. (1973).
7. Mara, D., *Sewage treatment in Hot Climates*, John Wiley and Sons, Chichester (U.K.) (1978).
8. Martin, D.M., *Marine Chemistry*, Vol. **I**, Marcel Dekker. Inc. N.Y. (1979).
9. Prati, L., Paranello, R. & Pesarin, P., Assessment of surface water quality by a single indeed of Pollution. Wat. Res. 5: 741-751 (1971).
10. Raina, V., Shah, A.R. and Ahmed, S.R., Pollution Studies on river Jhelum-I : An assessment of Water quality, *Ind. J. Environ. Hlth*., **26**, 187-201 (1984).
11. Rao, M.N. and Datta, A.K., *Waste water treatment*, Oxford and IBH Publishing Co. Calcutta, p. 202 (1979).
12. Sinha, S.K., Bacterial Contamination in some rural ponds water of Muzaffarpur, *Poll. Res*., **10(3)**, 179-182 (1991).
13. Tiwari, T.N. and Ali, Manzoor, "Water quality index for Indian rivers, R.K.Trivedi (edited) *Ecology and Pollution of Indian Rivers,* pp. 271-286 Ashish Publishing House, New Delhi – 110026 (1988).
14. Tiwari, T.N., Bose, P.K. and Das, S.C., Conceptual studies on the role of oxygen in Environmental Pollution effects, *J. Env. Sci.,* Vol. **2 (1)**, 1-7 (1986).
15. Trivedy, R.K. and Goel, P.K., Chemical and Biological methods for water pollution studies. Env. Pub. Karad (1984).
16. Trivedy, R.K., *Ecology and Pollution of Indian Rivers*. Ashish Publishing House, New Delhi (1989).


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