*Biological Forum – An International Journal* **5**(1): 50-61 (2013)

**ISSN No. (Print) : 0975-1130**
**ISSN No. (Online) : 2249-3239**

# Pollution Status of Freshwater Bodies From Gadhinglaj Tahsil, District Kolhapur

***N.A. Kamble and S.S. Sakhare***
*Department of Zoology,*
*Shivaji University, Kolhapur, (MS) India*

*(Received 15 December, 2012, Accepted 20 February, 2013)*

**ABSTRACT: Limnology is an interdisciplinary science, which involves a great deal of fieldwork along with laboratory studies to understand the structural and functional aspect of freshwater bodies. Six freshwater bodies were assessed for seasonal variations of physico-chemical parameters pH, Temperature, Dissolved Oxygen, Free Carbon dioxide, Hardness, Chemical Oxygen Demand, Total Solids, Total Dissolved Solids, Suspended Solids, Chloride, Alkalinity and base level contamination of heavy metals like $Fe^+$, $Na^+$ and $K^+$ was evaluated. Physico-chemical parameters with heavy metal contamination found direct impact over the animal diversity of polluted water. The data was statistically analyzed and interpreted by using ANOVA. Attempt was made to compare the water quality of aquatic habitats for pollution status.**

**Key words:** Freshwater bodies, Physico-chemical parameters, Pollution status.

## INTRODUCTION

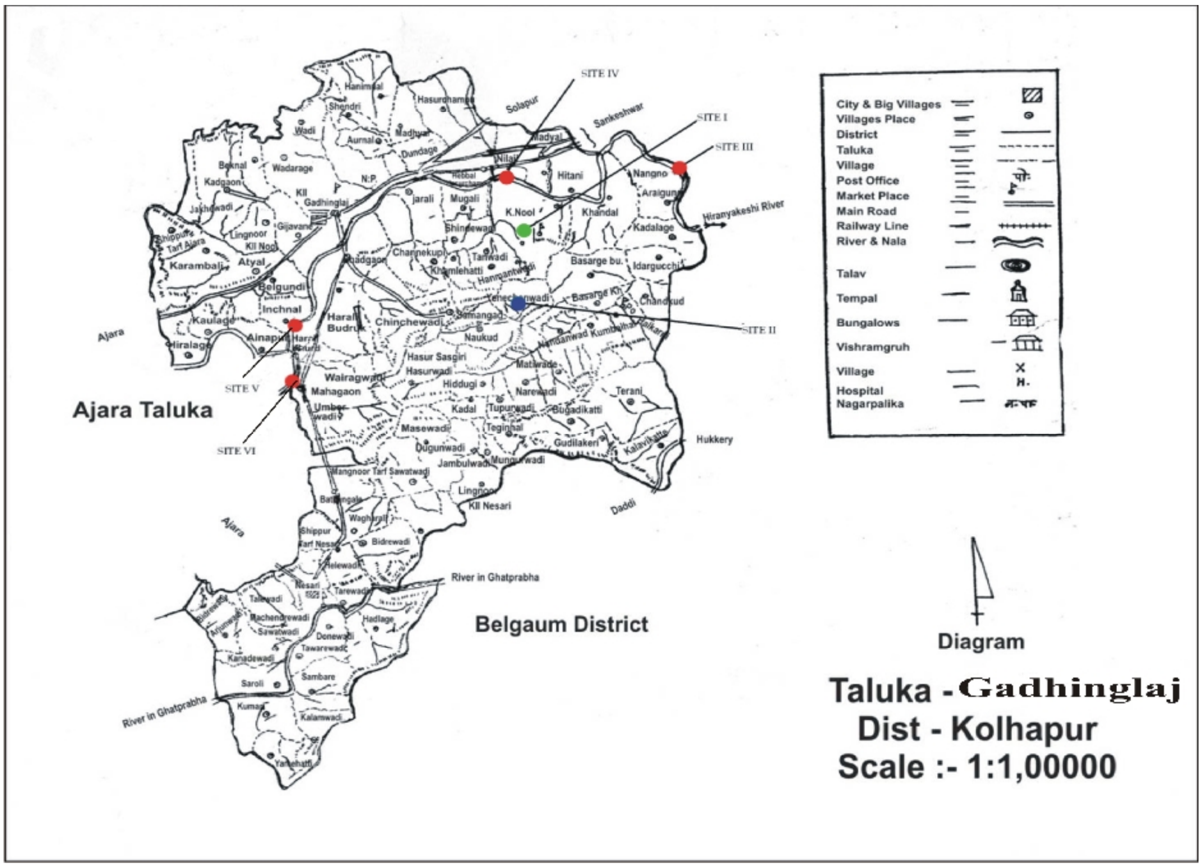
Biodiversity encompasses different communities and ecosystems along with their relative abundance. Rich diversity of an organism reflects good water quality, where as contamination affects diversity and abundance of organisms. Supply of potable water has also been affected by contamination of water resources in most developing countries (Ahmed and Begum, 2002). Water pollution is now posing a serious problem in India. Deterioration of inland water sources due to contamination by pathogens, parasites and other pollutants have many health problems. Oluduro and Aderiye, (2007) documented that, the availability of good quality of water is an indispensable feature for preventing diseases and improving quality of life. Regina and Nabi, (2003) reported that, increased demand of water because of population growth, agriculture and industrial development has tremendously deteriorated the chemical, biological and physical characteristics of the natural water resources. The worldwide distribution of water has variety of temporary pond due to geological differences (Solanki *et al.*, 2007). The quality of drinking water plays an important role in maintaining health. Safe water is one, which should be free from fecal contamination and be conventional to the limits of chemical contamination (Murugesan *et al.*, 2004). The wide array of pollutants discharged into aquatic environment may have physicochemical, biological, toxic and pathogenic effects (Goel, 2000).

The quality of water is getting vastly deteriorated due to unscientific waste disposal, improper water management and carelessness towards the environment, leading human health hazards (Agarkar and Thombre, 2005). Sediment analysis is increasingly important in evaluating qualities of the total ecosystem of water body the suspended precipitated (non-floating) substances and organic substances in water found capable of adhering pollutant particles (adsorption). Pollutants are conserved in sediments over long periods of time according to their chemical persistence and the physico-chemical and biochemical characteristics. This can also allow conclusions to be drawn regarding sources of contamination. The increasing industrialization and consequent pollution of water bodies have brought variable water crises. Discharge of sewage generates toxic materials leading to biodiversity problem (Dara, 2006). Number of factors, viz., pollution of soil, water, air, population, energy crises etc., has adverse effect over the floral and faunal diversity in the region. Direct discharge of industrial wastewater to soil surface or aquatic bodies severely contaminates the environment. Therefore, it is necessary to give treatment to disposed water before letting it off as effluent, to avoid contamination of natural system. According to Murugan *et al*., (1998), the zooplankton plays an integral role and served as bioindicators with tool for understanding water pollution status.

Ahmad, (1996) and Contreras *et al*., (2009) documented that, the life of aquatic ecosystem is directly or indirectly depends on the water quality. The alteration of physico-chemical parameters of water affects the biota, its number and diversity. Physico-chemical parameters of aquatic bodies in relation to health have been studied by number of workers,(Vijaykumar,1996; Reddy, 2001; Nagaraja,2005), but less attention has been paid to compare data with river, reservoirs, lake and pond systems. In the present investigation, physico-chemical parameters from six freshwater sites of Gadhinglaj tahsil (District Kolhapur, Maharashtra) were assessed.

## MATERIAL AND METHODS

**Study area:** Gadhinglaj is important tahsil of Kolhapur district, state Maharashtra, geographically latitude has 16°13´26"N and longitude 74°26´9" E. Hiranyakeshi river is the major river which arises at Amboli in Sindhudurg district. River Hirenkeshi and 40 to 45 small or larger water reservoirs distributed in the tahsil. Local inhabitants use water for their daily needs with agriculture and industrial processes. For present study six water sites were selected including, site I (Nool pond), site II (Yenechwandi lake), and four riverine sites viz., site III (Nangnur spot), site IV ( Nilgi spot), site V (Harali spot) and site VI (Mahagoan spot).




**Map-1:** Sampling sites: I-Nool pond, II-Yenechiwandi lake, III-Nangnur spot, IV-Nilgi spot,V-Harali spot and VI-Mahagoan spot from Gadhinglaj tahsil.

**Table No. I to VI:** Analytical results of physico-chemical parameters from respective sites during December 2011 to November 2012. BDL: Below Detectible Level. Nil: Absent.

**Table No. I.**

| **Site No. I** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter (unit) | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | July | Aug. | Sept. | Oct. | Nov. |
| Temperature($^0$C) | 26 | 26 | 22 | 26 | 24 | 26 | 22 | 22 | 23 | 22 | 22 | 22 |
| pH | 8.37 | 8.76 | 8.32 | 9.25 | 7.75 | 8.23 | 8.1 | 6.2 | 8.9 | 8.7 | 7.4 | 6.4 |
| DO(mg/l) | 36 | 90 | 30 | 2.4 | 3 | 50 | 10 | 5 | 4 | 5 | 6 | 2 |
| Free $CO_2$(mg/l) | 8.8 | 8.8 | 22 | 95.48 | 94.6 | 11 | 22 | 28.6 | 8.8 | 17.6 | 19.8 | 13.2 |
| TH(mg/l) | 160 | 204 | 184 | 250 | 184 | 164 | 90 | 75 | 84 | 90 | 100 | 80 |
| Alkalinity(mg/l) | 12 | 14 | 30 | 90 | 162 | 145 | 130 | 130 | 105 | 150 | 144 | 140 |
| Chlorides(mg/l) | 36.92 | 34.0 | 105 | 42.6 | 119.2 | 184.6 | 411.8 | 195.9 | 127.8 | 232.8 | 107.9 | 99.4 |
| TS(mg/l) | 464 | 504 | 556 | 678 | 812 | 796 | 660 | 664 | 634 | 698 | 596 | 548 |
| TDS(mg/l) | 440 | 488 | 540 | 664 | 740 | 748 | 612 | 640 | 620 | 672 | 588 | 512 |
| SS(mg/l) | 24 | 16 | 16 | 14 | 72 | 48 | 48 | 24 | 14 | 26 | 8 | 26 |
| COD (mg/l) | 128 | 48 | 98 | 125 | 120 | 105 | 105 | 114 | 124 | 118 | 76 | 108 |
| Sodium(mg/l) | 52 | 72 | 68 | 68 | 110 | 120 | 0.570 | 80 | 72 | 78 | 70 | 80 |
| Potassium(mg/l) | 70 | 4 | 1 | 80 | 68 | 66 | 91 | 83 | 58 | 58 | 78 | 58 |
| Iron(mg/l) | 0.270 | 0.354 | 1.203 | 0.140 | 0.748 | 1.041 | 0.570 | 0.774 | 0.270 | 0.587 | 0.786 | 1.071 |

**Table No. II**

| **Site No. II** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter unit | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | July | Aug. | Sept. | Oct. | Nov. |
| Temperature-$^0$C | 23 | 28 | 23 | 25 | 25 | 26 | 25 | 23 | 22 | 22 | 23 | 24 |
| pH | 8.12 | 8.86 | 8.64 | 9.3 | 7.84 | 7.17 | 8.2 | 8.61 | 7.9 | 8.4 | 6.7 | 6.5 |
| DO(mg/l) | 38 | 70 | 90 | 50 | 70 | 24.6 | 2 | 7 | 7 | 4 | 15 | 10 |
| Free $CO_2$(mg/l) | 13.2 | 13.2 | 30.8 | 11 | 15.4 | 11 | 15.4 | 8.8 | 11 | 13.2 | 13.4 | 4.4 |
| TH(mg/l) | 184 | 164 | 156 | 64 | 58 | 94 | 124 | 64 | 90 | 100 | 90 | 40 |
| Alkalinity(mg/l | 12 | 10 | 18 | 162 | 74 | 65 | 72 | 75 | 75 | 75 | 80 | 80 |
| Chlorides(mg/l) | 73.8 | 85.2 | 71 | 127. | 39.7 | 136. | 51.1 | 113. | 76.6 | 90.8 | 62.48 | 48.28 |
| TS(mg/l) | 256 | 170 | 240 | 312 | 272 | 388 | 248 | 256 | 320 | 340 | 292 | 260 |
| TDS(mg/l) | 240 | 164 | 232 | 300 | 264 | 372 | 228 | 248 | 316 | 324 | 280 | 252 |
| SS(mg/l) | 16 | 6 | 8 | 12 | 8 | 16 | 20 | 8 | 4 | 16 | 12 | 8 |
| COD (mg/l) | 4 | 8 | 86 | 33 | 7 | 8 | 26 | 23 | 23 | 58 | 186 | 46 |
| Sodium(mg/l) | 38 | 39 | 32 | 32 | 50 | 42 | 42 | 42 | 42 | 42 | 33 | 42 |
| Potassium(mg/l | 4 | 7 | Nil | 2 | 2 | 5 | 3 | 4 | 2 | 1 | Nil | Nil |
| Iron(mg/l) | 0.321 | 1.163 | 0.864 | 0.143 | 0.924 | 0.924 | 0.188 | 0.084 | BDL | BDL | BDL | 0.071 |

**Table No. III**

| Site No. III | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter (unit) | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | July | Aug. | Sept. | Oct. | Nov. |
| Temperature- $^0$C | 27 | 27 | 25 | 25 | 25 | 29 | 29 | 24 | 22 | 23 | 24 | 24 |
| pH | 8.03 | 8.33 | 8.02 | 8.07 | 8.27 | 7.2 | 7.8 | 7.9 | 7.7 | 8.6 | 7.3 | 6.4 |
| DO (mg/l) | 12 | 58 | 50 | 50 | 4 | 45 | 1 | 10 | 5 | 5 | 4 | 4 |
| Free CO2(mg/l) | 8.8 | 26.4 | 22 | 39.6 | 6.6 | 6.6 | 11 | 15.4 | 13.2 | 15.4 | 19.8 | 30 |
| TH (mg/l) | 48 | 144 | 90 | 162 | 48 | 82 | 90 | 66 | 85 | 94 | 65 | 24 |
| Alkalinity(mg/l) | 5 | 10 | 26 | 82 | 44 | 70 | 90 | 36 | 18 | 35 | 35 | 50 |
| Chlorides(mg/l) | 22.72 | 45.44 | 99.4 | 56.8 | 36.92 | 62.48 | 120.7 | 163.3 | 35.5 | 63.5 | 49.7 | 22.72 |
| TS(mg/l) | 234 | 368 | 372 | 352 | 200 | 336 | 394 | 34 | 92 | 66 | 120 | 144 |
| TDS(mg/l) | 224 | 348 | 264 | 344 | 192 | 308 | 350 | 30 | 80 | 56 | 112 | 124 |
| SS(mg/l) | 10 | 20 | 8 | 8 | 8 | 28 | 44 | 4 | 12 | 10 | 8 | 20 |
| COD (mg/l) | 16 | 110 | 19 | 33 | 8 | 4 | 22 | 4 | 23 | 392 | 4 | 25 |
| Sodium(mg/l) | 42 | 62 | 58 | 50 | 26 | 18 | 68 | 6 | 10 | 9 | 15 | 24 |
| Potassium(mg/l) | 4 | 6 | Nil | 1 | 2 | 2 | 8 | 1 | 2 | 0 | Nil | Nil |
| Iron(mg/l) | 0.321 | 0.365 | 0.525 | BDL | 0.402 | 0.364 | 2.1 | 0.774 | 1.55 | 0.27 | BDL | BDL |

**Table No. IV**

| Site No. IV | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter (unit) | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | July | Aug. | Sept. | Oct. | Nov. |
| Temperature $^0$C | 26 | 25 | 25 | 26 | 26 | 27 | 24 | 19 | 24 | 24 | 22 | 22 |
| pH | 8.04 | 8.12 | 8.67 | 8.60 | 6.97 | 7.06 | 7.6 | 8.2 | 7.2 | 8.3 | 6.7 | 6.3 |
| DO(mg/l) | 16 | 70 | 16 | 58 | 3.6 | 80 | 7 | 26 | 24 | 4 | 3.4 | 2 |
| Free CO2(mg/l) | 26.4 | 8.8 | 66 | 35.2 | 7.48 | 2.2 | 44 | 22 | 13.2 | 13.2 | 22 | 28.6 |
| TH(mg/l) | 50 | 80 | 84 | 110 | 52 | 114 | 80 | 55 | 90 | 90 | 45 | 54 |
| Alkalinity(mg/l) | 14 | 2 | 16 | 42 | 26 | 34 | 15 | 14 | 47 | 50 | 35 | 51.12 |
| Chlorides(mg/l) | 51.22 | 51.12 | 85.2 | 65.32 | 25.56 | 42.6 | 28.4 | 14.2 | 119.28 | 63.5 | 92.3 | 36 |
| TS(mg/l) | 102 | 228 | 130 | 194 | 80 | 164 | 56 | 42 | 66 | 68 | 100 | 596 |
| TDS(mg/l) | 88 | 220 | 124 | 188 | 72 | 156 | 44 | 36 | 60 | 56 | 92 | 588 |
| SS(mg/l) | 14 | 8 | 6 | 6 | 8 | 8 | 12 | 6 | 6 | 12 | 8 | 8 |
| COD (mg/l) | 12 | 39 | 19 | 8 | 26 | 12 | 7 | 4 | 4 | 4 | 8 | 4 |
| Sodium(mg/l) | 25 | 76 | 22 | 44 | 10 | 50 | 4 | 6 | 8 | 8 | 15 | 14 |
| Potassium(mg/l) | 2 | 2 | Nil | 1 | 2 | 2 | 8 | 1 | 2 | 0 | Nil | Nil |
| Iron(mg/l) | 0.280 | 0.394 | 0.949 | 0.207 | 0.340 | 0.298 | 1.144 | 0.774 | 2.175 | 1.222 | BDL | BDL |

**Table No. V**

| Site No. V | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter (unit) | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | July | Aug. | Sept. | Oct. | Nov. |
| Temperature $^0$C | 25 | 26 | 26 | 29 | 28 | 28 | 30 | 23 | 23 | 23 | 24 | 24 |
| pH | 7.67 | 8.40 | 7.78 | 7.80 | 6.89 | 6.84 | 8.5 | 7.9 | 8.7 | 8.4 | 7.2 | 4.1 |
| DO(mg/l) | 8 | 34 | 32 | 142 | 5 | 80 | 5 | 4 | 5 | 5 | 4 | 3 |
| Free CO2(mg/l) | 8.8 | 26.4 | 39.6 | 18.48 | 11 | 13.2 | 6.6 | 8.8 | 11 | 17.6 | 46.2 | 37.4 |
| TH(mg/l) | 180 | 140 | 98 | 50 | 46 | 54 | 123 | 90 | 124 | 96 | 80 | 44 |
| Alkalinity(mg/l) | 24 | 4 | 18 | 24 | 16 | 34 | 63 | 34 | 55 | 75 | 50 | 50 |
| Chlorides(mg/l) | 34.08 | 45.44 | 71 | 35.56 | 17.04 | 35.5 | 99.4 | 105.8 | 127.8 | 76.88 | 42.6 | 21.3 |
| TS(mg/l) | 104 | 78 | 68 | 98 | 60 | 100 | 254 | 32 | 668 | 272 | 408 | 68 |
| TDS(mg/l) | 90 | 72 | 64 | 92 | 56 | 92 | 192 | 28 | 520 | 264 | 400 | 56 |
| SS(mg/l) | 14 | 6 | 4 | 6 | 4 | 8 | 62 | 4 | 148 | 8 | 8 | 12 |
| COD (mg/l) | 138 | 8 | 19 | 16 | 30 | 28 | 30 | 4 | 272 | 27 | 21 | 312 |
| Sodium(mg/l) | 20 | 12 | 8 | 16 | 8 | 8 | 4 | 5 | 30 | 27 | 28 | 8 |
| Potassium(mg/l) | 1 | 2 | Nil | 1 | 1 | 3 | 4 | 1 | 27 | 3 | 7 | Nil |
| Iron(mg/l) | o.220 | 0.304 | 0.610 | 0.207 | 0.294 | 0.304 | 0.762 | 0.47 | 4.079 | 0.27 | 1.214 | 1.785 |

**Table No. VI**

| Site No. VI | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter (unit) | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | July | Aug. | Sept. | Oct. | Nov. |
| Temperature $^0$C | 26 | 28 | 25 | 28 | 28 | 30 | 28 | 23 | 24 | 23 | 24 | 24 |
| pH | 7.5 | 8.34 | 7.70 | 8.03 | 7.04 | 6.93 | 7.9 | 7.7 | 7.2 | 8.5 | 9.4 | 6.0 |
| DO(mg/l) | 18 | 30 | 38 | 140 | 7 | 73 | 3 | 3 | 4 | 3 | 5 | 1 |
| Free $CO_2$(mg/l) | 22 | 8.8 | 11 | 11 | 7.48 | 6.6 | 6.6 | 6.6 | 13.2 | 15.4 | 15.4 | 41.8 |
| TH(mg/l) | 164 | 144 | 84 | 52 | 44 | 45 | 90 | 54 | 75 | 90 | 50 | 30 |
| Alkalinity(mg/l) | 28 | 6 | 14 | 24 | 10 | 24 | 55 | 12 | 20 | 15 | 58 | 20 |
| Chlorides(mg/l) | 28.4 | 11.36 | 42.6 | 34.88 | 14.2 | 31.24 | 53.96 | 34.08 | 14.2 | 42.6 | 22.75 | 14.2 |
| TS(mg/l) | 92 | 58 | 66 | 68 | 52 | 78 | 220 | 40 | 64 | 48 | 64 | 64 |
| TDS(mg/l) | 80 | 56 | 56 | 64 | 48 | 72 | 188 | 36 | 50 | 44 | 48 | 56 |
| SS(mg/l) | 12 | 2 | 10 | 4 | 4 | 6 | 32 | 4 | 14 | 4 | 16 | 8 |
| COD (mg/l) | 16 | 4 | 85 | 27 | 4 | 20 | 11 | 4 | 4 | 4 | 8 | 8 |
| Sodium(mg/l) | 20 | 6 | 6 | 12 | 6 | 5 | 1 | 10 | 8 | 6 | 7 | 8 |
| Potassium(mg/l) | 2 | 1 | Nil | 2 | 1 | 1 | 1 | 1 | 2 | 0 | Nil | Nil |
| Iron(mg/l) | 0.225 | 0.293 | 0.525 | 0.143 | 0.187 | 0.174 | 0.570 | BDL | 1.54 | 1.857 | 3.5 | BDL |

**Water Sampling:** The water samples were collected from all sites in the period of December (2011) to November (2012). The samples were collected at the morning in between 8:00 am to 10:00 am. Samples were brought to the laboratory by plastic containers for analysis of physico-chemical parameters along with detection of metal concentration in it.

**Laboratory analysis:** Different physico-chemical parameters were analyzed by following standard physico-chemical methods. (APHA, 1985, Trivedi *et al* 1987). Heavy metal analysis was carried out by using Atomic Absorption Spectrophotometer (AAS) (Kemito company- 201).

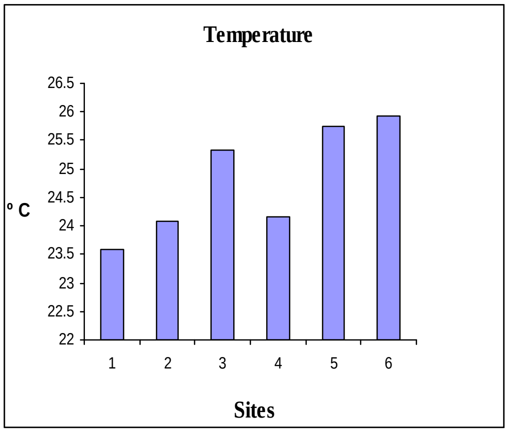
**Table No. VII. Standard deviation of physico-chemical parameter in six freshwater bodies.**

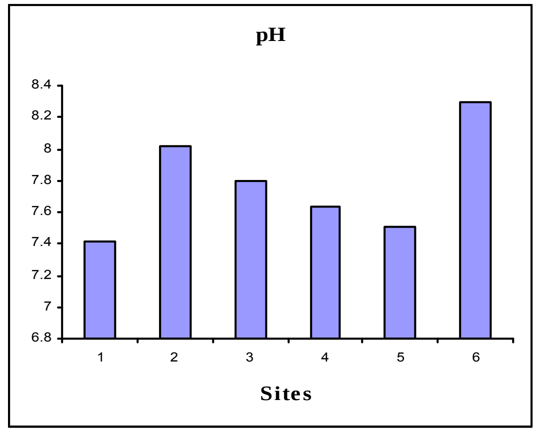
| | Site I | Site II | Site III | Site IV | Site V | Site VI |
|---|---|---|---|---|---|---|
| Temperature $^0$C | 23.58±1.880 | 24.08±1.781 | 25.33±2.22 | 24.16±2.24 | 25.75±2.49 | 25.91±2.39 |
| pH | 7.42±0.78 | 8.02±0.8573 | 7.8±0.5958 | 7.64±0.78 | 7.51±1.29 | 8.29±0.832 |
| DO (mg/l) | 20.28±27.102 | 32.3±30.707 | 20.6±22.576 | 25.8±27.813 | 27.25±42.68 | 27.08±41.46 |
| Free $CO_2$ (mg/l) | 29.22±31.381 | 13.4±6.254 | 17.9±10.13 | 24.09±17.93 | 20.42±13.68 | 13.82±9.96 |
| TH(mg/l) | 138.75±59.227 | 102.33±45.77 | 83.16±38.99 | 75.33±23.78 | 93.75±42.45 | 76.83±41.17 |
| Alkalinity(mg/l) | 104.33±55.304 | 66.5±40.79 | 41.75±27.15 | 28.84±16.61 | 37.25±21.38 | 23.83±16.54 |
| Chlorides(mg/l) | 141.49±105.91 | 81.41±31.04 | 64.93±42.5068 | 56.22±30.71 | 59.3±36.06 | 28.7±13.70 |
| TS(mg/l) | 634.16±107.13 | 279.5±55.896 | 226±133.75 | 152.16±151.19 | 184.16±189.39 | 76.16±47.26 |
| TDS(mg/l) | 605.33±96.39 | 268.33±54.43 | 202.66±120.23 | 143.66±151.62 | 160.5±156.43 | 66.5±40.11 |
| SS (mg/l) | 28±18.72 | 11.16±4.932 | 15±11.42 | 8.5±2.71 | 23.66±42.29 | 9.66±8.34 |
| COD (mg/l) | 105.75±23.171 | 42.33±51.330 | 55±109.92 | 12.25±10.81 | 75.41±107.26 | 16.25±22.90 |
| Sodium(mg/l) | 72.54±29.305 | 39.66±5.262 | 32.33±22.49 | 23.5±22.14 | 14.5±9.47 | 7.91±4.66 |
| Potassium(mg/l) | 59.583±28.668 | 3.33±1.870 | 2.88±2.6193 | 2.22±2.27 | 5±7.95 | 1.22±0.66 |
| Iron(mg/l) | 0.65116±0.3472 | 0.520±0.439 | 0.741±0.646 | 0.77±0.61 | 0.93±1.14 | 0.90±1.09 |

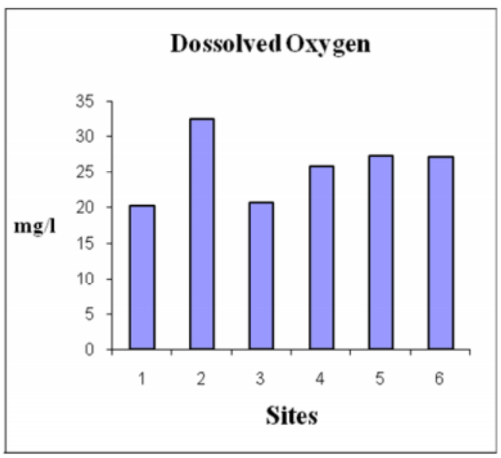
## RESULTS AND DISCUSSIONS

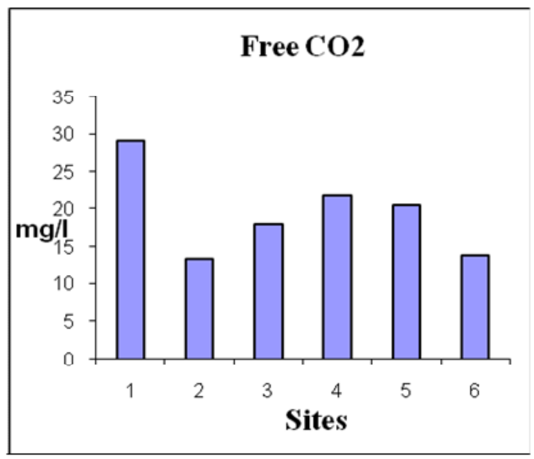
Over 17 million peoples put considerable pressure on the natural resources and have minimized the rate of development. Number of factors directly or indirectly responsible for ecological damage leading to extinction of species. The sewage, when influxes the aquatic systems, cause serious effects on physico-chemical and biological features of the water. The oxygen present in the lotic or lentic systems would destroy the organic part of sewage under natural processes. The biodegradable substances of sewage are rapidly decomposed by the process of oxidation. Aquatic ecosystems are affected by several health stressors, which significantly deplete biodiversity. Sediments in our rivers is an important habitat as well as a main nutrient source for aquatic organisms. Furthermore, sediments have an impact on ecological quality, because of their quality or quantity or both (Stronkhorst *et al.,* 2004).

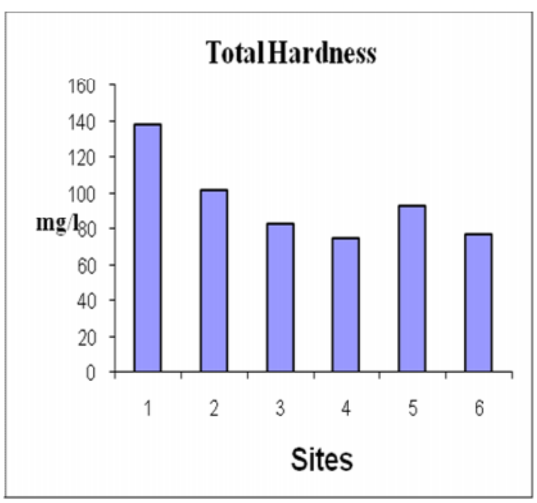
**Temperature:** Temperature is one of the essential and changeable environmental factors, since it influence the growth and distribution of flora and fauna. Temperature is an important parameter, with vital role in chemical and biological activities. The excessive amount of nutrients in water bodies along with higher temperature favors the growth of algae and aquatic weeds (Wetch, 1952). In study we found that, surface water temperature ranged between 19°C to 31°C. It was recorded minimum during winter and maximum in summer. The monthly variations showed that, the water temperature followed the seasonal pattern and found fluctuated according to the prevailing atmospheric temperature. Thus on an average the maximum range of temperature was seen at site VI (25.91ºC) while minimum at site I (23.58 ºC) throughout the year (Table No.VII and fig. 1).

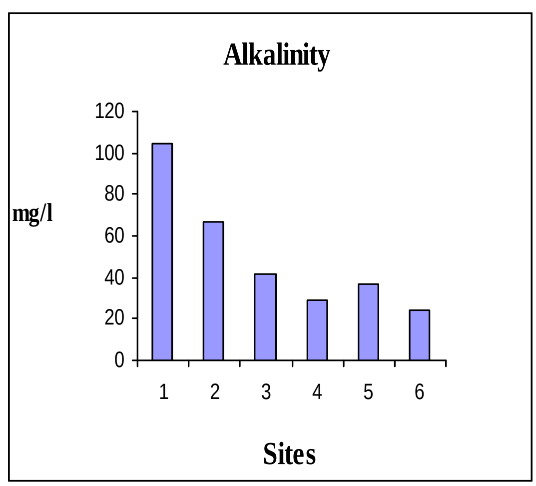


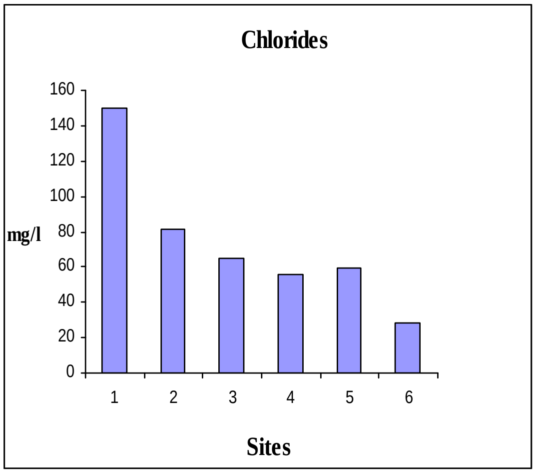



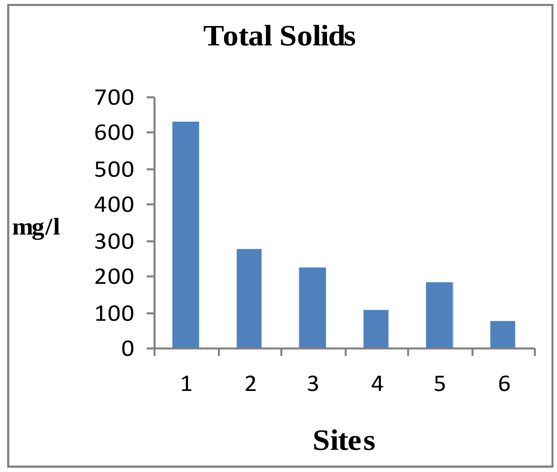



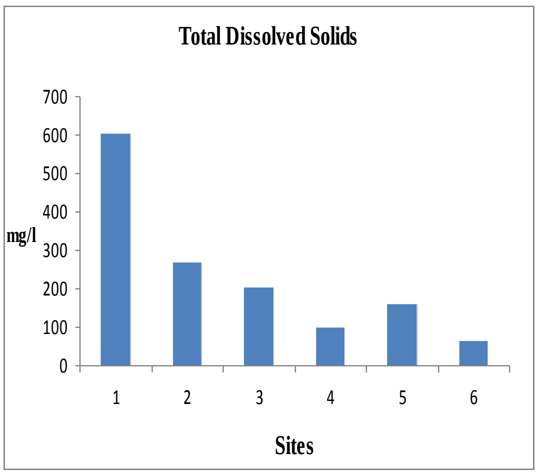



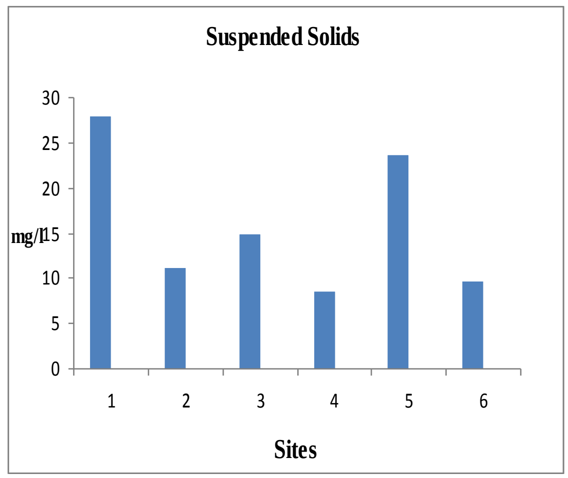



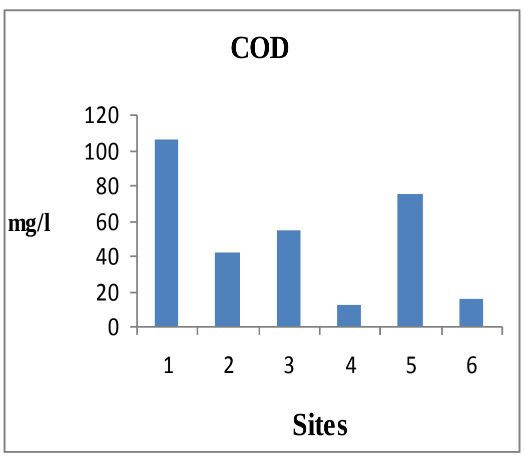



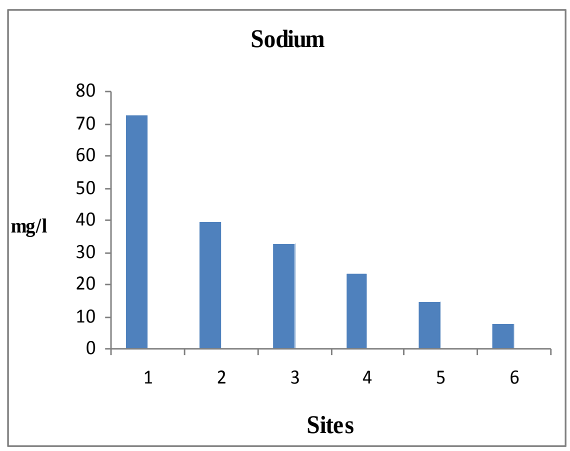

Chlorides
160
140
120
100
mg/l
80
60
40
20
0
1
2
3
4
5
6
Sites

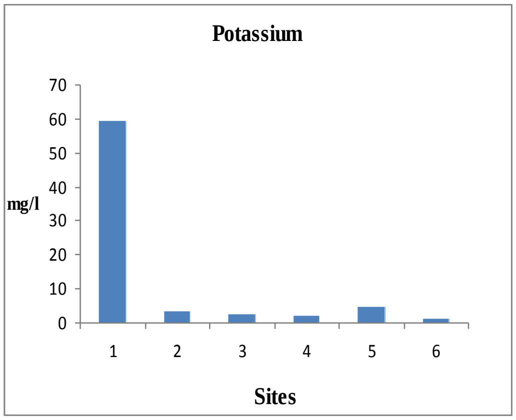

Total Solids
700
600
500
400
mg/l
300
200
100
0
1
2
3
4
5
6
Sites


Total Dissolved Solids
700
600
500
400
mg/l
300
200
100
0
1
2
3
4
5
6
Sites


Suspended Solids
30
25
20
mg/l
15
10
5
0
1
2
3
4
5
6
Sites


COD
120
100
80
mg/l
60
40
20
0
1
2
3
4
5
6
Sites


Sodium
80
70
60
50
mg/l
40
30
20
10
0
1
2
3
4
5
6
Sites



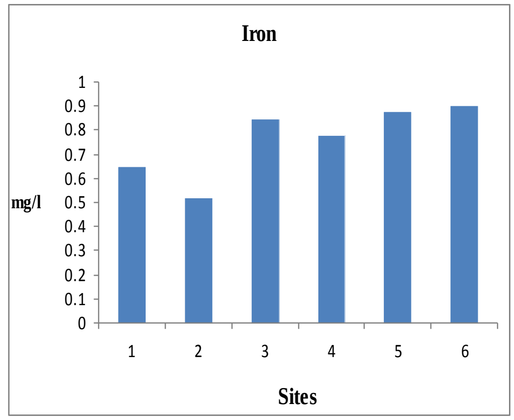




**Fig. 1:** Graphical representation of physico-chemical parameter.

**pH**: Higher pH value is normally associated with high photosynthetic activity in water (Hujare, 2008). pH of water is an important indication of its quality and provides information in many types of geochemical equilibrium or solubility calculations (Hem, 1985). The large variation in pH of water found indicator of a highly productivity of natural water. (Sreenivasn 1976). (Krishna Ram *et al.*, 2007), documented that, the pH range of 6.7 to 8.4 is considered to be safe for aquatic life to maintain productivity. However, pH below 4.0 and above 9.6 found hazardous to life. (Dash *et al.*, 2008), reported that, the pH intensity of pollution, which influences aquatic productivity in rural areas. During the assessment we recorded acidic pH 6.2 at site I where as alkaline pH 9.4 at site VI. (Table No. VII and fig.1).

**Dissolved oxygen:** Oxygen is an index of the physical, chemical and biological processes. It also acts as an indicator of trophic status and magnitude of eutrophication in freshwater ecosystem. The exchange of oxygen across the air, water interface depends upon temperature, partial pressure of gases in atmosphere, dissolved salt concentration, wave action, relative solubility, photosynthetic activity of plants and respiration by bacteria, plants and animals in the water (Krishna *et al.*, 2007). The rate of oxidation of organic matter increases, where oxygen get consumed and at higher temperature oxygen holding capacity of water decreases (Welch, 1952). The maximum range of dissolved oxygen was found 142 mg/l at site V in month of March while minimum 1 mg/l at site III. The occurance of high oxygen values during the summer season at site V indicated that, the photosynthesis by phytoplankton has major influence to the oxygen distribution. Gouda and Panigraphy, (1993) documented that, high values of dissolved oxygen during summer might be due to increased photosynthetic activity while lower values may be because of its utilization during decomposition of organic matter and respiration by micro and macro organisms. Maximum range of dissolved oxygen calculated by standard deviation method was (32.3 mg/l) at site II, while minimum at site I (20.28 mg/l) throughout the year (Table No. VII and fig. 1). Results indicated that, the population rate of phytoplankton and zooplankton was high at site II as compared to other sites, pond and all river spots.

**Free $CO_2$:** Free $CO_2$ concentration in water indicates the presence of decomposable organic matter, bacterial action on organic matter and physiological activities of biotic components. $CO_2$ content of water is essential sources of carbon that, can be assimilated and incorporated into the skeleton of living matter specifically in aquatic autotrophs. The amount of free $CO_2$ present in stagnant water is generally maintained by diffusion from atmosphere, respiration of animals along with plants and bacterial decomposition of organic matter (Misra *et al.*, 1991). The maximum free $CO_2$ Value was 95.48 mg/l at site I whereas, minimum 2.2 mg/l at site IV. Thus on an average calculated by standard deviation method maximum range of free $CO_2$ was noticed at site I (29.22 mg/l), while minimum at site II (13.4 mg/l) throughout the year (Table No.VII and fig. 1).

**Hardness:** Hardness results from the presence of divalent cations of which $Ca^{++}$ and $Mg^{++}$ which are most abundant in groundwater. The higher hardness value in summer season was mainly attributed to rising temperature, thereby increasing the solubility of $Ca^{++}$ and $Mg^{++}$ salts (Garg, 2003). Hardness in water is also derived from $CO_2$ released in bacterial action from soil through in percolating water. The water hardness is primarily due to the result of interaction between water and geological fragmentation. Jeyaval, (2010) reported that, total hardness is varying from 40 mg/l to 1818mg/l and the total hardness for drinking water was specified as 300 mg/l.

Hardness in water also caused by metallic ions dissolved in water. (Krishna Ram *et al.,* 2008b) noted that, calcium as a main cation or factor causes water hardness in natural water. In general hardness favors to zooplankton production, alkalinity and phosphate contact of water body. (Meshram, 2005) has noticed that, hardness is essential for normal growth of aquatic ecosystem. Total hardness value was maximum 250 mg/l at site I while minimum 44 mg/l at site VI. The average range of total hardness was maximum at site I (138.75 mg/l) by standard deviation method due to higher concentration of metallic ion while minimum recorded at site IV (76.80 mg/l) (Table No.VII and fig. 1). Recorded reading indicated that, in river water metallic ions are less dissolved.

**Alkalinity:** Alkalinity of natural water is generally the result of content of bicarbonates and is usually expressed in terms of presence of calcium carbonate. Alkalinity favors to zooplankton population (Singh *et al*., 2002; Kiran *et al*., 2007). The higher value of alkalinity indicated the presence of bicarbonate, carbonate and hydroxide in the water bodies (Jain *et al.*, 2000). The pH has direct relationship with total alkalinity, reported by (Bharadwaj and Sharma, 1999). The total alkalinity of water is mainly caused by the cations of Ca, Mg, Na, $NH_4$ and Fe combined either as carbonates or bicarbonates or occasionally as hydroxides. The maximum value of alkalinity was (162 mg/l) at site I, while minimum (2 mg/l) at site VI. The average range of alkalinity was maximum at site I (104.33 mg/l) due to higher concentration of carbonates and bicarbonates while minimum at site VI (23.83 mg/l), (Table no.VII and fig. 1). Results indicated that, in river water carbonate and bicarbonate ions are less dissolved.

**Chloride:** Sreenivasan, (1965) documented that, Chloride concentration between 4-10 ppm indicates purity of water. The limit of chloride concentration for drinking water is specified as 600 mg/l (WHO, 1993). Chlorides are usually present in low concentrations in natural waters and play vital role in photophosphorylation reactions in autotrophs. The most important source of chloride in natural water is discharge of sewage. The excess sodium and chloride in drinking water may induce heart failure and hypertension (Husain and Ekbal, 2003). The minimum value of chloride is 14.2 mg/l at site VI in month of March, whereas maximum 411.8 mg/l in June month at site I. Water analysis from site I indicated that it was contaminated due to organic content of sewage, agricultural wastes inducing fertilizers etc. with discharge by surrounding areas.

**Total solids:** Water as a universal solvent, dissolved different type of materials as compare to other solvents (Welch, 1952). More contact with its own basin, erosion at shore line, windblown materials, surface water inflow and decay of aquatic organisms these and other sources provide reservoir with quantities of solid materials. The average range of total solid content was maximum at site I (634.16 mg/l), while minimum at site VI (76.16 mg/l) (Table No.VII and fig. 1).

**Total dissolved solids:** High TDS concentration of water may cause laxative or constipation effects (Kumarasamy, 1989) beside the taste. The total concentration of dissolved solids in a water body found useful parameter in describing the chemical density as a fitness factor and as a general measure of edaphic relationship and productivity of the water (Jhingran, 1982). High content of dissolved solids elevated density of water, influencing osmoregulation and reducing gas solubility utility of water for drinking, irrigation and industries (Edmondson, 1959, Manivasakam, 2003). In freshwater ecosystem dissolved solids originate from natural sources and found depend upon location, geological basin of the water body, drainage, rainfall, and inflowing water. The animal pollution and human interference also contribute to enrichment of dissolved solids (Krishna Ram *et al.,* 2007). In the present investigation the concentration of total dissolved solid found high at site I (605.33 mg/l) which has decreased potability and reduced utility of water for drinking, irrigation and industrial purposes. Minimum range of TDS was seen at site VI (66.5 mg/l) (Table No.VII and fig. 1).

**Suspended solids:** The higher concentration of total suspended solids was found due to insoluble organic matter in sewage. According to Jain *et al.,* (2003) the disposal of sewage and industrial effluent contribute suspended matter to the rivers. WHO, (1984) recorded that, 30-80 % human diseases were occurred due to impurities of water. The average range of suspended solids was maximum at site I (28 mg/l) while minimum at site VI (9.66 mg/l) (Table No.VII and fig. 1). Results Indicated enrichment of suspended solids at site I found unfit for drinking, irrigation and also for industrial purpose.

**COD:** COD found reliable parameter for analysis of water pollution. The maximum COD was found at site III 392 mg/l in month of September while at site VI 4 mg/l (Table No.VII and Fig.1).

**Sodium:** The industrial discharge and sewage disposal found increased the content of sodium, sodium salts impart water with softness (Adoni *et al.,* 1985).

Sodium when present in high concentration limits the biological diversity due to osmotic stress (Adoni *et al.*, 1985). The maximum range of sodium seen at site I (72.54 mg/l) while minimum at site VI (7.91 mg/l) (Table No.VII and Fig.1). Maximum sewage discharge was found at site I leading to its pollution as compared to others.

**Potassium:** Potassium found vital role in the metabolism of freshwater organisms (Krishna Ram *et al.*, 2007). Cell membrane continually pumps the potassium and sodium, which requires the expenditure of large amount of energy (Goldman and Horne, 1983). The high concentration of potassium content was noted at site I (59.58 mg/l) while minimum at site VI (1.22 mg/l) (Table No.VII and Fig. 1).

**Iron:** Iron is the vital element of life. It is a natural component of soil and its concentration can be influenced by industrialization. Iron concentration in surface water varies greatly, from 61ppm to 2680 ppm (Abal *et al.*, 2001). The direct and indirect effect of iron contamination decreases the species diversity and abundance of plankton and benthic invertebrates (Fritz *et al.*, 1975). Fe found to induce free radicals that, causes breaks in nucleic acid and oncogene activation (Reizen and Wang, 2001). Iron content of water was high at site V (0.93 mg/l) while minimum at site II (0.52 mg/l) (Table No.VII and Fig. 1).

Present limnological study revealed that, the site I (Nool pond) found highly polluted due to continuous discharge of municipal waste, runoff from agricultural waste and industrial content. High content of alkalinity, chlorides, total solids, total dissolved solids, suspended solids, sodium and potassium was found more at site I. Thus the water found unfit for drinking and other domestic uses. Seasonwise content of COD was high 392 mg/l in month of September at site III and at site V 312 mg/l in month of November. On the basis of these analysis of physico-chemical characteristics, it was concluded that the site III and site V which is near sugar mill found contaminated due to higher concentration of total dissolved solids, chloride, COD, and alkalinity which were recorded greater than permissible limits of WHO. Site VI was found least polluted as that of other sites. All the sites found more or less contaminated. It was found above contents has direct impact over the animal diversity. The study is in progress for the assessment.

## ACKNOLEDGEMENTS

Authors are thankful to the Head, Department of Zoology, Shivaji University Kolhapur for providing facilities in the progress of work.

## REFERENCES

Abal, E., Dennisan, E. and Greenfield, P. (2001). Managing the Brisban river and Moreton Bay: An integrated research/management program to reduce impact on an Australian Estuary. *Water Sci. Tech.* **43**(9): 57-70.

Adoni, A. (1985). Water Book of Limnology. Prathibha publishers, Sagar. India.P. 216.

Agarkar, V. and Thombre, B. (2005). Status of drinking water quality in schools in Buldhana District of Maharrashtra. *Nature Env. and poll. Tech.* **4**(1): 495- 499.

Ahmad, K. and Begum, J. (2002). Bacteriological quality of water in hill stream of khanapara during different seasons. *Nat. Env. and Poll. Tech*., **1**(2):171-173.

APHA, (1985). Standard method for the examination of water and waste water. American Public Health Association, 19th Edn. Washington, USA.

Bharadwaj, K. and Sharma, L. (1999). Study of some physico-chemical characteristics of a sewage fertilized seasonal pond of Udaipur (Rajasthan). *J. Env. Poll.* **6**(4): 255-260.

Contreras, J., Sarma, S., Merino-Ibarra, M. and Nandini, S. (2009). Seasonal changes in the rotifer (Rotifera) diversity from a tropical high altitude reservoir (Valle de Bravo, Mexico). *J. Environ. Biol.*, **30**: 191-195.

Dara, S. (2006). A text Book of Environmental Chemistry and Pollution Control. S. Chand and Co. publication, New Delhi.

Edmonson, W. (1959). Freshwater Biology. Second Edn. John Wiley Sons, Inc., London. in the Rushikulya estury,east coast of India. Mahasagar-Bull. *Natl. Oceanogr.*, **26**(2): 73-85.

Fritz, J., Pla, G., Harrison, B. and Clark, G. (1975). Estimation of the bioavailability of iron. *J. Assooc. of Anal.Chem.*, **58**(ISS): 902-905.

Garg, S.(2003). Water quality of wells and bore wells of 10 selected locations of chitrakoot region. *Indian J. Env. protec.* **23**(9): 966-974.

Goel, P. (2000). Water pollution: Causes, effect, and control. New Age International Publishers, Ltd. New Delhi.

Goldman and Horne, (1983). Limnology.Mc.Graw Hill Company.pp 464.

Gouda, R. and Panigarhy, R. (1993). Monthly variations of some hydrogaphic paramet Hem, J. (1985). Study and interpretation of the chemical characteristics of natural water, U.S. Geol. Surv.Water supply paper, 2254, 264p.

Hujare, M. (2008). Limnological studies of the perennial waterbody, Attigre tank, Kolhapur Dist.Mahareshtra. *Nature Environment and Poll. Tech.*,**7**(1):43-48.

Hussain, J. and Ikbal, H. (2003). Evaluation of drinking water quality of the village situated near Banas, Rajasthan, and India.*Jr.Env. Protec.*, **23**(6): 640-645.

Jain, C. (2000). Groundwater quality in sugar districts, Madhya Pradesh. India. Jr.Env.Health, **42**(4):151-158.

Jhingran, V. (1982). “Fish and fisheries of India”.Hindusthan publishing corp. (India) Delhi.

Kiran, B., Puttiaiah, E. and Kamath, D. (2007). *Zoos. Print J.*, **22**, 2935.

Krishnaram, H., Mohan,M. and Ramchandra (2008b). Limnological studies on Thalli lake Krishnagiri District Tamil *Nadu. Env. Ecol.*,**26**(4): 1518-1522.

Krishnaram, H. Mohan, M., Ramchandra, and Vishalkashi, Y. (2007). Limnological studies on Kolaramma lake Kolar, Karnataka. *Env.Ecol.*, **52**(2): 364-367.

Kumaraswamy, N. (1989). Ascending pollution potential potential from basic panactic ratio-A case study. Indian journal env.protec.**9**: 178-181.

Manivasakam, N. (2003). Physico-chemical Examination of Water, Sewage and Industrial Effluents. Pragati prakashan.

Meshram, C. (2005). Macro invertebrate fauna of lake Wadali, Amarvati, Maharashtra, *J. Aqu.Bio.***18** (2): 47-50.

Murugan, N., Murugavel, P. and Koderkar, M. (1998). Freshwater cladocera; Indian Associ. Of Aqua. Biologists (IAAB), Hyderabad. pp. 1-47.

Murugesan,S., Kumar,D., Rajan,S. and Chandrica, D. (2004). Comparative study of groundwater resources of east and waste region of Chenni, Tamilnadu. *Nature Environment and pollution Technology*, **3**(4): 495-499.

Olduro, and Aderiye, (2007). Efficiency of moringa Oleifera seed extract on the microflora of surface and groundwater. *J. plant Sci.*, **6**: 453-438.

Reddy, M., Murth, D. and Prakash, T. (2001). Quality of groundwater in Karnataka with special reference to nitrate, International workshop on Integrated Water Management, Banglore University, pp.29.

Regina, B. and Nabi, B. (2003). Physico-chemical spectrum of Bhavani river water collected from the Kalinggaryan dam,Tamilnadu.Indian *J. environ. and Ecoplan.*, **7**(3): 633-636.

Singh, S., Pathak, D. and Singh, R. (2002). *Eco. Environ. Cons.* **8**, 289.

Solanki, V., Murthy, S., Samba, Kaur, A. and Sabita, R. (2007). Variations in dissolved oxygen and biochemical oxygen demand in two freshwater lakes of Bodhan, Andhrapradesh, India. Nature, Env. and Pollution Technology, **6**(4): 623- 628.

Sreenivasan, A. (1965). “Limnology of tropical impoundments III limnology and productivity of Amaravathy reservoir. (Madras state) India”, *Hydrobiologia*, **26**: 501-516.

Sreenivasan, A. (1976). Limnolgy of tropical impoundments III, Limnology and productivity of Amrawathy reservoir, Madras, India, Hydrobiologia, 1965, **26**, 501.

Stronkhorst J., Brils J., Batty J., Coquery M., Gardner M., Mannio J., O'Donnell C., Steenwijk J. and Frintrop P. (2004). Discussion document on Sediment Monitoring Guidance for the EU.

Trivedi, R., Goal, P. and Trisel, C. (1987). Practical methods in ecology and environment science. Published by Envoronmental Publications, Post Box 60 Karad,15110, India. 340.

Vyas, N. and Nama, H. (1991). ‘Pollution ecology of freshwater reservoir at Jodhpur with special reference to microorganisms’. *Gebobios*, **18**(1): 33-37.

Welch, P. (1952). “Limnology”, $2^{nd}$ ed.Mc Graw Hill Book co.N.Y.1952.

WHO (1983). Guidelines for drinking waterquality.World Health Organisation, Geneva.

WHO (1984). Guideline for water quality.Vol.1 World Health Organisation, Geneva.