Evaluation of seasonal water quality and pollution status of Parashari river

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Abstract: The water quality of Parashari river of Ganj Basoda town of district Vidisha of Madhya Pradesh was evaluated during the period 2010-2011 to understand the degree of pollution due to inflow of sewage and agricultural residues from its catchment. River Parashari is a victim of water pollution which flows though the heart of Ganjbasoda town. The river starts from Parshora village, nearer to Ganj Basoda. It flows through Derkhi and Bhagharu, finally merges in Betwa River. It encounters several problems related to domestic waste disposal and wastewater discharge from neighboring restaurants and villages in addition to the upstream villages. Thus in order to determine the water quality of the River five stations were chosen for sample collection in the study area stretching a length of 20 km. Field visits were made during three different season’s viz. summer (March-June), rainy (July-October), winter (November-February) during the 2010–2011 session. Water samples were analyzed for physicochemical parameters including pH, turbidity, total dissolved solids, electrical conductivity, total alkalinity, total hardness, calcium, magnesium, nitrate, chloride, and phosphate. The values of these parameters are compared with standard values given by CPCB guideline. The Result showed that variations of the analyzed parameters for e.g. pH, conductivity, chloride and nitrate were found within the range but Biological oxygen demand (BOD), dissolved oxygen (DO) and total dissolved solids (TDS) were found crossing the range. Generally at station 1 and 2 values of these parameters are found very high and not in permissible limit. The Present study reveals that the seasonal changes are the major factors in fluctuation of most of the physicochemical characters of the water. Most of the parameters were higher in summer which may be due to high temperature, evaporation and low water level and minimum in winter due to increased water level and low metabolic activities. However while comparing the values with available standards it can be concluded that the water from Parashari river may be used for drinking purpose after due treatment as per “Class-C Category of CPCB, guidelines”. Based on the study, Station 1 and 2 which are situated on upstream of the river were found to be more polluted.

Key words: Pollution, Water Quality, Seasonal effect, Physico-chemical parameters, CPCB guideline

Introduction

The studies of physicochemical parameters are used to detect the effects of pollution on the water quality. The deterioration of quality, loss of biodiversity and fast depletion of water resources are the main challenges, which need urgent attention today. The limnological study gives the proper direction in decision making processes for problems like pollution control (Sujitha et al., 2011). The aquatic ecosystem consists of several components which are directly or indirectly affected by pollution (CPCB, 1995). Today, due to various anthropogenic activities, the river water usually receives untreated sewage, domestic waste, industrial and agricultural effluents that results in pollution of several rivers in India and abroad (Kosygin et al., 2007). Generally speaking, water pollution is a state of deviation from pure condition, whereby its normal functioning and properties are affected. Aggravated environmental problems often reflect the misuse or misunderstanding of technology (Petak, 1980). Maintaining the quality of water is the most important one for human being since it is directly linked with his daily life (Gosh, 2002). River pollution in India has now reached to a point of crisis due to unplanned urbanization and rapid growth of industrialization. The entire array of life in water is affected due to pollution in water (Saksena, 2008). The rapid growth of the human population, as well as the technological and industrial boom, has brought enormous problems and degradation of the environment. The process of urbanization in India since the beginning of last century reveals a steady increase in the size of its urban population. Pivotal to this urbanization phenomenon are the associated problems of providing municipal services and water resources (Sengupta, 2012). In addition to hydrologic and geomorphologic changes urbanization directly or indirectly affects the quality of the receiving water. Some of the indicators of the impact of urbanization on water quality include increased stream temperature and pollutants and radical changes in the subsurface infiltration rate (Misra, 2011).

Acute short fall of monsoon rains, poor water shed management, lavish use of water for domestic and agricultural purposes have led to the overexploitation of the surface water sources especially from the river bodies. Many perennial rivers become ephemeral and even dried up. On the other hand, surface water bodies become the dumping source for industrial effluent and domestic wastes. As a result, the naturally existing dynamic equilibrium among the environmental segments get affected leading to the state of polluted rivers. (Arasu, et al., 2007) Indian rivers are polluted due to the discharge of untreated sewage and industrial effluents.

The growing problem of degradation of our river ecosystem has necessitated the monitoring of water quality of various rivers all over the country to evaluate their production capacity, utility potential.
and to plan restorative measures (Datar, 1992 and Das, 1993). River water quality is the composite of several interrelated parameters which are subjected to local and temporal variations and also affected by volume of water flow and discharge rates. Considering the above fact in mind the River water quality of Parashari River of Ganj Basoda town of District Vidisha of Madhya Pradesh was evaluated during the period 2010 - 2012 to understand the degree of pollution due to inflow of sewage and agricultural residues from its catchment.

Description of the study area: Ganj Basoda is a well known town and a municipality in Vidisha district in the State of Madhya Pradesh, India. It is located at 23.85° N – 77.93° E. River Parashari in Ganj Basoda is a victim of water pollution which flows though its heart. The river starts from Parshora village, nearer to Ganj Basoda. It flows through Derkhi Lake and Bhagharhu, finally merges in Betwa River, a major name in Madhya Pradesh. It encounters several problems related to domestic waste disposal and wastewater discharge from neighboring restaurants and villages in addition to the upstream villages. At present, there are no wastewater treatment plants within the catchment area of the Parashari River. Moreover, there are no sewerage networks in many of the settlements.

Materials and Methods

Study area: In order to determine the water quality five stations were chosen for sample collection in the study area along the stretch of the river, as described below-


Station 1 and 2 are situated in the middle of the town, Station 1 receives large amount of raw sewage from its densely populated habitation. Station-2 is surrounded by vegetable market, marriage halls, residential areas and hospital. It receives residential wastes, untreated sewage, urban pollutants, animal waste and solid waste. Stations 3, 4 and 5 are situated at downstream of the river at a distance of 5 and 15 km, respectively, after the town of Ganj Basoda. It receives agricultural runoff from its catchment. The people of this area work mainly in agriculture in nearest places.

Water Sampling: Field visits were made during three different season’s viz. summer (March-June), rainy (July-October), winter (November-February) during the 2010-2011 session. For the study of water quality monthly samples were collected from all five established stations in the early hours (10.00 am-1.00 pm) of the day during first week of every month. utmost care was taken to avoid spilling of water and bubbling of air during sampling. The samples were collected in clean polyethylene bottles and prior to collection, the samples were rinsed thoroughly with sample water. Some of the physico-chemical characteristics of water were determined at the sampling sites while others were analysed in the laboratory within 4 to 8 hours according to the standard methods (APHA, AWWA and WPCF, 1985). The collection, preservation, transportation of sample from site to the laboratory and analysis were done as per standard methods for examination of water and waste water, APHA (1995), Khanna and Bhuitian (2004) and Trivedi and Goel (1986). The samples were analyzed for various parameters as DO, BOD, pH, Turbidity and Alkalinity etc.

Results and Discussion

Water Temperature: Temperature is one of the most important parameters that influence almost all the physical, chemical and biological properties of water and thus the water chemistry (Sharma, 2012). During present investigation Water Temperature values varied from 21.7 °C to 30.2 °C. The minimum value was observed in winter season while the maximum value was observed in summer season. Increasing temperature reduces the solubility of oxygen and increases odour. The variation in the water temperature may be due to different timing of collection and influence of the season as also reported by Jayaraman et al., 2003.

Hydrogen Ion concentration (pH): The pH of the samples analyzed during the period of investigation was slightly alkaline in nature with an average value of 7.6 - 8.2, 7.9-8.2 and 7.2 - 7.4 for the winter, summer and rainy season, respectively. It has been seen that pH values are higher in summer and winter than rainy season. The high pH values during summer may be due to high photosynthesis of micro and macro vegetation resulting in high production of free CO2, shifting the equilibrium towards alkaline side (Trivedi, 1989). Low pH is often caused by high concentration of carbon dioxide due to atmospheric dissolution (Neal et al., 1998), or by the decomposition of organic matter present in the municipal wastewater.

Turbidity: Turbidity of water is actually the expression of optical property in which the light is scattered by the particles present in the water. Clay, silt, organic matter, phytoplankton and other microscopic organisms cause turbidity in water (Das et al., 2003). High turbidity shows presence of large amount of suspended solids (Mariappam, 2002). Akuskar and Gaikwad (2006) observed higher turbidity during monsoon period and minimum turbidity during winter season at Manjara River. During present investigation maximum values of turbidity were recorded in monsoon months.

Transparency: Transparency is a characteristic of water that varies with the combined effect of colour and turbidity. It measures the depth to which light penetrates in the water body. In the present study the value of transparency varied from 46 cm to 98.3 cm, the maximum transparency was recorded at Station 5 which indicates productive nature of this water on the basis of clarity values as also reported by Sharma and Durve (1991). The transparency was less in monsoon season due to high current which erodes the bank of the river and due to turbid flood water, suspended matter and dissolved particles as has also been observed by Singh et al. (1999), Nath and Srivastava (2001) and Shaikh and Yeragi (2004).

Conductivity: The conductivity of water is a measure of capacity of a solution to conduct electrical current through it and depends on the concentration of ions and load of nutrients. As most of the salts in water are present in ionic forms, they make water capable for conducting current. During present study seasonal variations of conductivity showed higher values in summer and lower values in winter. In the dry season, the total volume of water decreases, as a result the conductivity also increases. Similar results were reported by Israili and Ahemad (1993) in river Yamuna and Khataekar and Trivedi (1992) in river Panchaganga.
Fig. 1: Seasonal variation in Temperature

Fig. 2: Seasonal variation in pH

Fig. 3: Seasonal variation in Turbidity

Fig. 4: Seasonal variation in Transparency

Fig. 5: Seasonal variation in Conductivity

Fig. 6: Seasonal variation in TDS

Fig. 7: Seasonal variation in Total Alkalinity

Fig. 8: Seasonal variation in Total Hardness

Fig. 9: Seasonal variation in Dissolved Oxygen

Fig. 10: Seasonal variation in BOD

Fig. 11: Seasonal variation in COD

Fig. 12: Seasonal variation in COD

Fig. 13: Seasonal variation in Nitrate

Fig. 14: Seasonal variation in Phosphate

Fig. 15: Seasonal variation in Free CO$_2$
Table 1: Comparison of different parameters with CPCB guidelines of surface water quality status

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>CPCB guidelines</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>pH</td>
<td>7.2-8.2</td>
<td>5.5-9</td>
<td>5.5-9</td>
</tr>
<tr>
<td>Turbidity JTU</td>
<td>28.5-63.7</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Transparency cm</td>
<td>46-84.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Conductivity mS/cm</td>
<td>0.63-1.4</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Total Dissolve Solids mg/l</td>
<td>298.8-824.1</td>
<td>500</td>
<td>1500</td>
</tr>
<tr>
<td>Total Alkalinity mg/l</td>
<td>157-276.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Hardness mg/l</td>
<td>224.2-324</td>
<td>224.2</td>
<td>224.2</td>
</tr>
<tr>
<td>Dissolved Oxygen mg/l</td>
<td>3.4-10.4</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>BOD mg/l</td>
<td>12-38</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>COD mg/l</td>
<td>36-76.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chloride mg/l</td>
<td>51.9-117.9</td>
<td>250</td>
<td>600</td>
</tr>
<tr>
<td>Nitrate mg/l</td>
<td>1.03-2.83</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>Phosphate mg/l</td>
<td>0.49-1.63</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Free CO₂ mg/l</td>
<td>0-11.6</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

A - Drinking water source without conventional treatment but after disinfection; B - Outdoor bathing (organised); C - Drinking water source with conventional treatment followed by disinfection; D - Irrigation, industrial, cooling, controlled waste disposal

**Total Dissolve Solids:** Total dissolved solids (TDS) indicate the general nature of the water quality or salinity. Locations near the city market area showed values higher than the desirable value of 500 mg/liter during the dry period and comparatively lesser values of TDS during post monsoon, which indicated dilution with salt free water. The maximum amount of total dissolve solid was recorded during summer season, high concentration of TDS enriches the nutrient status of water body which were resulted into eutrophication of aquatic ecosystem. Similar result was observed in the fresh water reservoir of Ajmer city (Singh and Mathur, 2005).

**Total Alkalinity:** Seasonally the minimum value of alkalinity during the period of investigation was recorded during winter season and the maximum value of alkalinity was recorded during summer season. Same results were also reported by Verma et al., 2012. The degradation of plants, living organism and organic waste might also be one of the reasons for increase in a carbonate and bicarbonate, resulting an increase in alkalinity value (Chaurasia and Pandey, 2007; Abbasi et al., 1999; Jain et al., 1997). Shiddamallayya and Pratima reported lowest alkalinity during winter.

**Total Hardness:** Total hardness is the parameter of water quality used to describe the effect of dissolved minerals (mostly Ca and Mg), determining suitability of water for domestic, industrial and drinking purposes and attributed to presence of bicarbonates, sulphates, chloride and nitrates of calcium and Magnesium (Taylor 1949). The maximum amount of total hardness in the water of Parashari River was recorded during summer season and the minimum amount of total hardness was recorded during winter season. The high value of hardness during summer may be due to evaporation of water and addition of calcium and magnesium salts by mean of plants and living organism. Similar result was also observed in J.N.U lake in Delhi and in various water bodies of Tamilnadu (Bagde 1985; Kumar, 2006). High values of hardness are probably due to regular addition of large quantities of sewage and detergent into lakes from the nearby residential localities (Kaur, 1996 and Mohanta, 2000).

**Dissolved Oxygen (DO):** The council on environmental quality defines the threshold for water pollution alert as dissolved oxygen content of less than 5 mg/l of water. Comparative low dissolved oxygen content during the period of study indicates the mild pollution of river water due to organic waste. The highest DO was found at minimum pouring of discharge of sewage effluent from town and lower values obtained where the higher sewage discharge and human activity were taking place. The average concentration of DO is higher in winter as compared to summer. Present results correlate with the findings of Bansal (1989), Mohanta and Patra (2000) and Khinchi et al., (2011). Maximum values of D.O. in winter might be due to the fact that the solubility of D.O. increases with the decrease in Water Temperature (Kumar and Singh, 2002).

**Biological Oxygen Demand (BOD):** High BOD values in summer and winter season, which could be due to lack of dilution; but BOD of most of the samples had been relatively lower and below the limit of Inland Surface Water quality standard (30mg/l). The average concentration of BOD is higher in spring and summer in contrast with fewer amounts in winter. The value of BOD in the present study was highest on site 1 and 2 as compared to site 3, 4 and 5. The reasons for high BOD level at Station 1 and 2 may be contribution of high BOD load by discharges of wastewater from urban agglomerations located upstream to these locations or due to human / animal activities in the river e.g. washing, defecation etc. Observed values clearly indicate that river water is moderately polluted by organic wastes. In the case of station 3, 4 and 5 land use covers partly agricultural lands and lake of residential area so BOD values are low. Almost similar results were observed by (Bhargava, 1982; Rao, 1992; Shukla, 1989) for the Ganga river water.

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**Chloride:** Chloride is one of the major inorganic anions in water and waste water. The greater source of chlorides in water bodies is due to raw sewage, municipal waste, industrial effluents and anthropogenic disturbances.

**Nitrate:** Nitrate is attributed mainly due to anthropogenic activities such as the run of water from agricultural lands, industrial wastes, discharge of house hold and municipal sewage from the market place and other effluents containing nitrogen. Such observations were also reported by Royer et al., (2004). In this study higher concentration of nitrate was recorded in summer and lower in rainy season. Similar observation was also reported by Thakor et al., 2011. Higher values of nitrate were observed during the pre-monsoon period than the other times of the year. Wolffhard and Reinhard (1998) concluded that nitrates are usually built up during dry season.

**Phosphate:** The increased application of fertilizers, use of detergents and domestic sewage greatly contribute to the heavy loading of phosphorus in the water (Golterman, 1975). Phosphate during the period of investigation was also found higher, ranging from 0.4 to 1.6 mg/l. This confirms the polluted status of Parashari River and more deposition of organic matter in it. Phosphorous is one of the most important nutrients limiting the growth of autotrophs and biological productivity of the system. High phosphorus content causes increased algal growth, often as blooms (Sharma, 2012). In the present investigation, maximum concentration of Phosphate was recorded in summer and minimum in winter season. Similarly, Ansari (1993) reported high values of Phosphate in summer in river Godavari at Nanded. Koshy and Nayar (2000) reported that the major sources of Phosphate in water are domestic sewage, agricultural runoff, industrial effluents and fertilizers.

**Free CO₂:** Most of the free carbon dioxide in water comes from the decomposition of organic matter and from respiration of organisms (Singh, 1999). In polluted water, the free carbon dioxide is generally high. In Parashari River, free carbon dioxide ranged from non traceable amount to the maximum value of 18 mg/l at Station-1 in summer. The carbon dioxide content of water depends upon the water temperature, depth, rate of respiration, decomposition of organic matter, chemical nature of the bottom and geographical features of the terrain surrounding the water body (Sakhré and Joshi, 2002). The value of CO₂ was high in summer. This could be related to the high rate of decomposition in the warmer months. Similar results were reported by Manjare et al. (2010).

**Conclusion:** The present study reveals that the seasonal changes are the major factors in fluctuation of most of the physicochemical characters of the water. Most of the parameters were maximum in summer which may be due to high temperature, high evaporation and low water level and minimum in winter due to increased water level and low metabolic activities. However while comparing the values with available standards it can be concluded that the water from Parashari river may be used for drinking purpose after due treatment as per “Class - C category of CPCB, guidelines”

**References**


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