



## Seasonal Variation in Physicochemical Characteristics of Bor and Vidarbha (Idarba) Rivers of Amravati (M.S.), India

### KEYWORDS

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**ABSTRACT** *The present study focussed on seasonal variation in physicochemical analysis of Vidarbha (Idarba) and Bor Rivers of Amravati district from Maharashtra studied during different seasons for one year from Oct.2010 to Sept.2011. The analyzed data were compared with standard values recommended by BIS (1998). The physicochemical parameters which were analysed include pH, Calcium hardness, Magnesium hardness, Total hardness, Total dissolved solids, Alkalinity, Sulphate, Nitrate, Dissolved oxygen, BOD and COD.*

*The study on analysis of the water quality parameters of Vidarbha (Idarba) and Bor Rivers of Amravati district from Maharashtra shows that the calcium, TDS, Sulphate, nitrate, dissolved oxygen, Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) values are well within the acceptable limits. Total alkalinity of both the rivers was above the acceptable limits and pH was slightly alkaline. However, the values of total hardness in case of Bor river exceeded the acceptable limit during all the seasons as per BIS standards. This indicates the extent of pollution due to addition of effluents.*

### Introduction:-

Vidarbha (Idarba) and Bor rivers of Amravati district from Maharashtra are minor rivers which join together and flow into the Wardha River. Both rivers are under constant threat of pollution by floral wastes generated on account of pilgrimage, agricultural runoff, cattle grazing, faecal contamination and washing of cloths by ladies.

Water is great gift of nature "No life without water" is possible (Gupta and Gupta 1997). Rivers play an important role in the development of nation and sustenance of life which are being polluted due to speedy urbanization, industrialization and other developmental activities (Alam and Pathak 2010).

India is rich in water resources being endowed with crisscross network of rivers that can meet a variety of water requirements of the country. The Indian rivers are polluted due to discharge of untreated, sewage, industrial effluents and agricultural runoff (Jain et al.2011). In rural areas, people often use unprotected water drawn from rivers, lakes, and wells for drinking and domestic purposes (Indirabai and George 2002).

The quality of water is described according to their physicochemical and microbiological analysis. For effective maintenance of water quality through appropriate control measures, continuous monitoring of large number of quality parameters is essential (Mishra et al.2008).

Vidarbha (Idarba) river passing by Anjansingi and Durgwada and Bor river passing by Kurha of Amravati district from Maharashtra are minor rivers which join together and flow into Wardha River. Both rivers are under constant threat of pollution by floral wastes generated on account of pilgrimage, agricultural runoff, cattle grazing, fecal contamination, washing of cloths by ladies.

Supply of potable water is important to the development of any country. Clean water sustains a healthy population and it contributes to the quality of life to households through

the provisions of basic needs of water and sanitation. The present paper discusses account on seasonal variation in physicochemical analysis of Vidarbha (Idarba) and Bor Rivers of Amravati district from Maharashtra studied for one year during Oct. 2010 to Sept. 2011. The analyzed data were compared with standard values recommended by BIS (1998).

### Materials and Methods:-

All the representative water samples were collected in clean, phosphate free polyethylene bottles that have been pre washed with dilute acid followed by distilled water using standard procedures (NEERI Manual 1988) during winter, summer and rainy seasons from Oct.2010 to Sept.2011.

Various physicochemical parameters viz pH, Total dissolved solids, Alkalinity, Calcium hardness, Magnesium hardness, Total hardness, Sulphate, Nitrate, Dissolved oxygen, BOD and COD were determined using standard procedures (APHA (1995), ICMR Manual (1977), Trivedy and Goel (1986).

The pH of water sample was measured with a pH meter precisely calibrated with buffer solutions. Alkalinity was determined by titrating a known volume of water sample with 0.02 M HCl. Dissolved oxygen (DO) was determined by Winkler's titration. Total dissolved solids (TDS) was determined gravimetrically by evaporating known volume of water to dryness in a pre-weighed crucible on a steam bath. Total hardness was determined by titrating with EDTA using Eriochrome black T as indicator. Biological oxygen Demand (BOD) was determined by using the relationship  $BOD = DO - DO_5$  (APHA 1995). COD was determined by closed reflux titrimetric method.

Remaining physicochemical parameters were determined by using standard procedures (APHA (1995), ICMR Manual (1977), Trivedy and Goel (1986).

Sampling stations for Vidarbha (Idarba) River were as follows:-

| Sample code     | Site     | Location            |
|-----------------|----------|---------------------|
| S <sub>9</sub>  | Site I   | Dhareshwar Mandir   |
| S <sub>10</sub> | Site II  | Triveni Sangam      |
| S <sub>11</sub> | Site III | East side of River  |
| S <sub>12</sub> | Site IV  | West side of River  |
| S <sub>13</sub> | Site V   | North side of River |
| S <sub>14</sub> | Site VI  | Near bank of River  |
| S <sub>15</sub> | Site VII | Near bridge         |

Sampling locations for Bor River were as follows:-

| Sample code     | Site     | Location                                   |
|-----------------|----------|--|
| S <sub>16</sub> | Site I   | Below bridge on Kurha Road                 |
| S <sub>17</sub> | Site II  | Anjansingi-Kaundyanapur Road               |
| S <sub>18</sub> | Site III | Near bridge (Anjansingi Kaundyanapur Road) |
| S <sub>19</sub> | Site IV  | Near Durgawada                             |
| S <sub>20</sub> | Site IV  | Durgawada                                  |
| S <sub>21</sub> | Site VI  | Near kurha                                 |

Table 1:- Physicochemical parameters of Vidarbha (Idarba) River during Winter Season (Oct.2010-Jan.2011).

| S. No. | Sampling Stations | pH  | Calcium | Magnesium | TH  | TDS | Total Alkalinity | Sulphate | Nitrate | DO  | BOD | COD  |
|--------|-------------------|-----|---------|-----------|-----|-----|------------------|----------|---------|-----|-----|------|
| 01     | S <sub>9</sub>    | 8.6 | 33.7    | 16.7      | 188 | 318 | 274              | 7.5      | 4.70    | 7.6 | 2.8 | 11.4 |
| 02     | S <sub>10</sub>   | 8.5 | 31.8    | 16.2      | 182 | 312 | 272              | 7.7      | 4.92    | 7.4 | 2.7 | 11.1 |
| 03     | S <sub>11</sub>   | 8.5 | 32.1    | 15.7      | 184 | 317 | 274              | 7.6      | 5.01    | 7.5 | 2.9 | 11.3 |
| 04     | S <sub>12</sub>   | 8.6 | 32.6    | 16.1      | 183 | 313 | 275              | 7.8      | 4.94    | 7.3 | 2.6 | 11.2 |
| 05     | S <sub>13</sub>   | 8.7 | 33.2    | 15.9      | 186 | 316 | 273              | 7.4      | 4.96    | 7.2 | 2.9 | 11.5 |
| 06     | S <sub>14</sub>   | 8.6 | 33.9    | 14.8      | 187 | 314 | 276              | 7.7      | 5.03    | 7.4 | 3.1 | 11.7 |
| 07     | S <sub>15</sub>   | 8.5 | 34.1    | 13.7      | 189 | 319 | 271              | 7.9      | 5.05    | 7.3 | 3.0 | 11.6 |

Note:-All parameters are expressed in mg/ ml except pH.

Table 2:- Physicochemical parameters of Vidarbha (Idarba) River during Summer Season (Feb.2011-May.2011)

| S. No. | Sampling Stations | pH  | Calcium | Magnesium | TH  | TDS | Total Alkalinity | Sulphate | Nitrate | DO  | BOD | COD  |
|--------|-------------------|-----|---------|-----------|-----|-----|------------------|----------|---------|-----|-----|------|
| 01     | S <sub>9</sub>    | 8.5 | 31.1    | 13.8      | 181 | 312 | 271              | 7.4      | 4.82    | 7.1 | 2.9 | 11.8 |
| 02     | S <sub>10</sub>   | 8.6 | 32.4    | 14.2      | 184 | 310 | 273              | 7.7      | 4.68    | 7.2 | 2.7 | 11.6 |
| 03     | S <sub>11</sub>   | 8.6 | 31.8    | 14.7      | 183 | 313 | 277              | 8.1      | 4.93    | 7.0 | 2.8 | 11.7 |
| 04     | S <sub>12</sub>   | 8.6 | 33.2    | 13.2      | 182 | 316 | 274              | 7.8      | 5.10    | 7.3 | 3.1 | 11.4 |
| 05     | S <sub>13</sub>   | 8.5 | 32.7    | 13.6      | 185 | 315 | 276              | 7.9      | 5.23    | 7.4 | 2.9 | 11.5 |
| 06     | S <sub>14</sub>   | 8.4 | 33.2    | 14.4      | 187 | 314 | 275              | 7.6      | 4.99    | 7.6 | 3.0 | 11.3 |
| 07     | S <sub>15</sub>   | 8.5 | 33.9    | 15.3      | 188 | 317 | 272              | 7.5      | 5.07    | 7.5 | 3.2 | 11.1 |

Note:-All parameters are expressed in mg/ ml except pH .

Table 3 - Physicochemical parameters of Vidarbha (Idarba) River during Monsoon Season (June.2011-Sept.2011)

| S. No. | Sampling Stations | pH  | Calcium | Magnesium | TH  | TDS | Total Alkalinity | Sulphate | Nitrate | DO  | BOD | COD  |
|--------|-------------------|-----|---------|-----------|-----|-----|------------------|----------|---------|-----|-----|------|
| 01     | S <sub>9</sub>    | 8.4 | 32.1    | 14.3      | 184 | 312 | 271              | 7.9      | 5.14    | 7.3 | 3.0 | 11.7 |
| 02     | S <sub>10</sub>   | 8.5 | 32.8    | 14.9      | 181 | 311 | 273              | 7.6      | 5.72    | 7.1 | 3.1 | 11.4 |
| 03     | S <sub>11</sub>   | 8.5 | 33.9    | 13.8      | 183 | 314 | 272              | 7.7      | 6.17    | 7.2 | 2.8 | 11.6 |
| 04     | S <sub>12</sub>   | 8.4 | 32.7    | 14.2      | 186 | 313 | 275              | 7.4      | 6.84    | 7.5 | 2.6 | 11.9 |
| 05     | S <sub>13</sub>   | 8.6 | 33.3    | 13.7      | 185 | 316 | 274              | 7.5      | 7.19    | 7.4 | 2.7 | 11.5 |
| 06     | S <sub>14</sub>   | 8.5 | 32.8    | 13.3      | 188 | 318 | 277              | 8.1      | 7.89    | 7.3 | 2.9 | 11.8 |
| 07     | S <sub>15</sub>   | 8.4 | 32.3    | 14.1      | 187 | 317 | 276              | 7.8      | 7.74    | 7.0 | 2.4 | 12.0 |

Note:- All parameters are expressed in mg/ ml except pH .

**Table 4:- Physicochemical parameters of Bor River during Winter Season (Oct.2010-Jan.2011)**

| S. No. | Sampling Stations | pH  | Calcium | Magnesium | TH  | TDS | Total Alkalinity | Sulphate | Nitrate | DO  | BOD | COD  |
|--------|-------------------|-----|---------|-----------|-----|-----|------------------|----------|---------|-----|-----|------|
| 01     | S <sub>16</sub>   | 8.4 | 53.2    | 12.6      | 304 | 413 | 343              | 13.7     | 8.41    | 7.2 | 2.9 | 10.2 |
| 02     | S <sub>17</sub>   | 8.3 | 53.1    | 12.9      | 302 | 412 | 345              | 13.9     | 8.43    | 7.1 | 2.7 | 10.0 |
| 03     | S <sub>18</sub>   | 8.2 | 52.7    | 12.7      | 305 | 414 | 341              | 13.8     | 8.42    | 7.3 | 2.8 | 10.1 |
| 04     | S <sub>19</sub>   | 8.3 | 52.9    | 13.1      | 299 | 411 | 342              | 14.1     | 8.44    | 7.4 | 3.0 | 10.3 |
| 05     | S <sub>20</sub>   | 8.4 | 52.6    | 13.3      | 297 | 409 | 340              | 13.6     | 8.47    | 7.6 | 2.9 | 10.5 |
| 06     | S <sub>21</sub>   | 8.3 | 52.3    | 12.8      | 296 | 410 | 339              | 14.2     | 8.46    | 7.5 | 3.1 | 10.4 |

Note:-All parameters are expressed in mg/ ml except pH .

**Table 5:- Physicochemical parameters of Bor River during Summer Season (Feb.2011-May.2011)**

| S. No. | Sampling Stations | pH  | Calcium | Magnesium | TH  | TDS | Total Alkalinity | Sulphate | Nitrate | DO  | BOD | COD  |
|--------|-------------------|-----|---------|-----------|-----|-----|------------------|----------|---------|-----|-----|------|
| 01     | S <sub>16</sub>   | 8.3 | 52.2    | 13.3      | 297 | 411 | 338              | 13.9     | 8.47    | 7.6 | 3.1 | 11.4 |
| 02     | S <sub>17</sub>   | 8.4 | 52.5    | 13.1      | 293 | 413 | 341              | 13.6     | 8.44    | 7.4 | 2.8 | 11.1 |
| 03     | S <sub>18</sub>   | 8.2 | 52.3    | 13.2      | 296 | 410 | 339              | 13.7     | 8.45    | 7.5 | 2.7 | 11.3 |
| 04     | S <sub>19</sub>   | 8.3 | 52.4    | 12.9      | 301 | 409 | 342              | 13.4     | 8.46    | 7.3 | 2.9 | 11.2 |
| 05     | S <sub>20</sub>   | 8.2 | 53.1    | 12.8      | 295 | 414 | 344              | 13.3     | 8.43    | 7.2 | 2.6 | 11.5 |
| 06     | S <sub>21</sub>   | 8.1 | 52.9    | 12.6      | 298 | 415 | 344              | 13.8     | 8.40    | 7.1 | 2.4 | 11.7 |

Note:-All parameters are expressed in mg/ ml except pH.

**Table 6 :- Physicochemical parameters of Bor River during Monsoon Season (June.11-Sept.11)**

| S. No. | Sampling Stations | pH  | Calcium | Magnesium | TH  | TDS | Total Alkalinity | Sulphate | Nitrate | DO  | BOD | COD  |
|--------|-------------------|-----|---------|-----------|-----|-----|------------------|----------|---------|-----|-----|------|
| 01     | S <sub>16</sub>   | 8.2 | 52.6    | 13.1      | 298 | 409 | 346              | 14.0     | 8.43    | 7.4 | 2.7 | 10.6 |
| 02     | S <sub>17</sub>   | 8.3 | 52.1    | 12.7      | 295 | 412 | 343              | 13.7     | 8.41    | 7.2 | 2.9 | 10.2 |
| 03     | S <sub>18</sub>   | 8.4 | 52.3    | 12.9      | 297 | 410 | 345              | 13.8     | 8.44    | 7.3 | 2.8 | 10.3 |
| 04     | S <sub>19</sub>   | 8.2 | 52.4    | 12.8      | 301 | 414 | 344              | 13.9     | 8.42    | 7.6 | 2.6 | 10.6 |
| 05     | S <sub>20</sub>   | 8.1 | 52.7    | 12.9      | 299 | 413 | 340              | 13.5     | 8.40    | 7.5 | 2.4 | 10.4 |
| 06     | S <sub>21</sub>   | 8.5 | 52.9    | 12.6      | 296 | 416 | 341              | 13.6     | 8.45    | 7.1 | 2.5 | 10.7 |

Note:-All parameters are expressed in mg/ ml except pH.

### Results and Discussion:-

The physicochemical characteristics of both Bor and Vidarbha (Idarba) river water samples studied during different seasons from Oct.2010 to Sept. 2011 are presented in Table 1 to Table 6. All the values were compared with BIS standards.

#### pH:-

The pH of water body is very important in determination of water quality since it affects other chemical reactions such as solubility and metal toxicity (Agbarie 2009). From the available data, it appears that pH of Vidarbha River water ranged from 8.5-8.7 during winter, 8.4-8.6 during summer and Monsoon. Similarly, in case of, Bor River pH varied from 8.2-8.4 during winter, 8.1-8.4 during Summer and 8.1-8.5 during Winter. The pH shows slightly alkaline trend.

#### Calcium:-

Calcium forms the most abundant cation in fresh water which contributes hardness to waters (Arthi et al. 2011). In case of Vidarbha river, Calcium concentrations were found to vary from 31.8 -34.1 during Winter, 31.1-33.9 during Summer Season and 32.1-33.9 during Monsoon. In case of Bor River, it ranged from 52.3-53.2 during winter, 52.2-53.1 during

Summer and 52.1-52.9 during Monsoon. Calcium concentration is within the acceptable limit as per the BIS standards.

#### Magnesium:-

As per BIS standards acceptable limit of magnesium is up to 30 mg/ L. For Vidarbha (Idarba) river water, in winter season, Mg concentrations varied from 13.7 to 16.7. In summer season, this value was in the range of 13.2 to 15.3. In monsoon season, Mg proportion was noted from 13.3 to 14.9.

For Bor river water, in winter season, concentration of Mg noted was in the range of 12.6 to 13.3. In summer season, this value varied from 12.6 to 13.6 and Mg concentrations noted during monsoon season was from 12.7 to 13.1.

#### Total Hardness:-

Hard water causes incrustation in distribution systems and excessive soap consumption (Coleman 1976). In Vidarbha River, total hardness varied from 182-189 during winter, 181-188 during summer and 181-188 during Monsoon. In case of Bor River, the value of total hardness ranged from 296-305 during Winter 293-301 during Summer and 295-301 during Monsoon. It appears that the value of total hardness in case

of Vidarbha River was within the acceptable limit throughout all the seasons. However, the values of total hardness in case of Bor river exceeded the acceptable limit during all the seasons as per BIS standards.

#### Total Dissolved Solids:-

In water, total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles (Mahananda et al. 2010). In case of Vidarbha River, the values of TDS varied from 311-319 during winter, 310-316 during summer and 311-318 during monsoon. In case of Bor River, TDS ranged from 409-414 during winter, 409-415 during summer and 409-416 during monsoon. It indicates that the values of TDS in both rivers are within the acceptable limit as per BIS standards.

#### Total alkalinity:-

Total alkalinity of water is caused mainly due to OH, CO<sub>3</sub>, HCO<sub>3</sub> ions. Alkalinity is an estimate of the ability of water to resist change in pH upon addition of acid (Mahananda et al. 2010). In case of Vidarbha River, total alkalinity varied from 271-276 during winter, 271-276 during summer and 271-277 during Monsoon. In case of Bor river, total alkalinity values ranged from 339-345 during winter, 338-344 during summer and 340-346 during Monsoon. It appears that the values of total alkalinity in case of Vidarbha River as well as Bor River were beyond acceptable limit as per BIS standards. According to Nayak et al. (1982) Ghosh and George (1989) the higher alkalinity indicates pollution.

#### Sulphate:-

The sulphate ion is one of the important anions in natural waters and when present in higher quantity, it produces cathartic effect in human beings (Srinivas et al. 2002). The sulphate ion concentration, in case of Vidarbha River varied from 7.4-7.9 during winter, 7.4-8.1 during Summer and 7.4-8.1 during Monsoon. In case of Bor River, it ranged from 13.7-14.2 during winter, 13.3-13.9 during summer and 13.5-14.0 during Monsoon. It appears that sulphate ion concentration is within the acceptable limit in both the rivers throughout all the seasons.

#### Nitrate:-

The main source of the formation of nitrate is the decomposition and biodegradation of organic matters. High nitrates would indicate pollution level. Intrusion of sewage into the natural water increases level of nitrate (Manson 1991). In case of Vidarbha River, Nitrate concentration varied from 4.70-5.05 during winter, 4.68-5.23 during Summer and 5.14-7.89 during Monsoon. Nitrate concentration in case of Bor River, ranged from 8.41-8.47 during winter, 8.40-8.47 during Summer and 8.40-8.45 during Monsoon. It appears that nitrate concentration is within the acceptable limit during all

the seasons in both the rivers. Monitoring of nitrates in drinking water supply is very important because of health effects on human beings and animals (Mahananda et al. 2010).

#### Dissolved Oxygen (DO) :-

High level of DO is a sign of a healthy river. In case of Vidarbha River, it was fluctuating between 7.2-7.6 during Winter, 7.1-7.6 during Summer and 7.0-7.5 during Monsoon. In case of Bor River, DO varied from 7.1-7.6 during winter, 7.1-7.6 during summer and 7.1-7.6 during Monsoon. Decrease in DO can favor anaerobic decomposition of organic wastes (Sallae 1974).

#### Biochemical oxygen demand (BOD):-

The BOD value in case of Bor River ranged from 2.7-3.1 during winter, 2.4-3.1 during Summer and 2.4-3.9 during Monsoon. In Vidarbha River, the BOD value varied from 2.6-3.1 during winter, 2.7-3.1 during summer and 2.6-3.1 during Monsoon. As per BIS standards, the maximum permissible limit is 5 mg/L.

#### Chemical Oxygen Demand (COD):-

Chemical Oxygen demand determines the oxygen required for chemical oxidation of organic matter. COD values convey the amount of dissolved oxidizable organic matter including the non biodegradable matters present in it (Mahananda et al. 2010). COD estimates the carbonaceous fraction of organic matter (Arthi et al. 2011). In case of Vidarbha River, COD values varied from 11.1-11.7 during winter, 11.1-11.8 during Summer and 11.4-12.0 during Monsoon. In case of Bor River, COD value ranged from 10.1-10.5 during winter, 10.3-10.5 during summer and 10.2-10.7 during monsoon.

#### Conclusion:-

The study on analysis of the water quality parameters of Vidarbha (Idarba) and Bor Rivers of Amravati district from Maharashtra shows that the calcium, TDS, Sulphate, nitrate, dissolved oxygen, Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) values are well within the acceptable limits. Total alkalinity of both the rivers was above the acceptable limits and pH was slightly alkaline. However, the values of total hardness in case of Bor river exceeded the acceptable limit during all the seasons as per BIS standards.

In this present investigation, it was found that the maximum parameters were not at the level of pollution except few parameters like total alkalinity, pH for Vidarbha as well as Bor Rivers and total hardness in case of Bor river. The present investigation has led us to conclude that the quality of Vidarbha and Bor Rivers water samples subjected to study were acceptable from majority of physicochemical parameters while as per BIS standards, both the types of river waters need to be treated before their use for drinking and in domestic applications.

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