Study and Evaluation of Water Quality of River Ganga at Different Ghats of Varanasi City

Nusrat Ali1 Ugrasen Kumar2
1Assistant Professor 2M.Tech Student
1,2Department of Civil Engineering
1,2Integral University, Lucknow -226026, U.P., India

Abstract— This paper is attempt to analyze the water quality of river Ganga in Varanasi city. The present investigation reveals the seasonal changes in concentration of physico-chemical parameters in river Ganga at different Ghats of Varanasi city. Water samples were collected from the different sites viz: Santravidas Ghats, Assi Ghats, Harish Chandra Ghats, Dasawamedha Ghats, Lalita Ghats, Mannmandir Ghats, Manikarnika Ghats of Varanasi during Rainy & winter seasons in year 2016-2017. The physico-chemical parameter such as pH-value, Temperature, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total alkalinity (TA), Total Hardness (TH), Total Dissolve Solids (T.D.S), Turbidity, Chloride were used to analyses the pollution of river Ganga at selected sites. Comparison of estimated values with WHO and standard quality management revealed that water of study area is polluted which may be harmful for both aquatic bio-system as well as human beings. This results also revealed that the water quality was severely polluted in monsoon and moderately polluted in winter season.

Key words: Ganga River, Physico-chemical properties, water quality

I. INTRODUCTION

A. Ganga River

The Ganga is the most sacred river to Hindus and it is also a lifeline to millions of Indian who live along its bank and depend on it for their daily need. Ganga is a trans-boundary river of INDIA & BANGLADESH. The Ganga is longest river in INDIA. They are 2,525 km river rise in western Himalayas and flow south and east through the Gangatic plain of northern India into Bay of Bengal. The Ganges basin is the most heavily populated river basin in the world, with over 400 million people and a population density of about 1,000 inhabitants per square mile (390 /km²). The Ganga was ranked among the five most polluted rivers of the world in 2007. The Ganga Action Plan is an environmental initiative to clean up the river has been a major failure due to lack of good environmental planning, Indian traditions and beliefs and lack of support from religious authorities.

B. Qualities Of Ganga River

According to Hindu mythology a Ganga river have a great medicinal qualities. A Ganga river present an ideal biodiversity area. It have over then 140 fish species, 90 amphibian species and five area hitch support bird found nowhere else in the world. Ganga River producing fertile soil in the world. According to studies report by environmental engineers of IIT Roorkee, the Ganga decomposed the organic waste 15 to 25 times faster than other river. A Ganga river have a legenary medicinal qualities as compare to other HIMALAYA rivers'. According to NBRI (National Botanical Research Institute) Ganga water have an anti-bacterial quality.

C. Ganga River in Varanasi City

Ghats in Varanasi are river front steps leading to the banks of the River Ganges. The city has 87 ghats. Most of the ghats are bathing and puja ceremony Ghats, while a few are used exclusively as cremation sites. Most Varanasi Ghats were built after 1700 AD, when the city was part of Maratha. The patrons of current Ghats are Marathas, Shindes (Scindias), Holkars, Bhonsles, and Peshwes (Peshwas). Many Ghats are associated with legends or mythologies while many Ghats are privately owned. Morning boat ride on the Ganges across the Ghats is a popular visitor’s attraction.

II. OBJECTIVE OF WORK

Analysis the physico-chemical parameters of water of River Ganga in Varanasi city at different Ghats.

Study the change of physico-chemical properties of water with time

III. METHODOLOGY

The analysis of physico-chemical parameters started with sample collection. The sampling was collected in Rainy season and winter season in 2016-2017.

Before a sampling programme is undertaken, a detailed sampling protocol must be developed and as a minimum the following item must be specified.

1) Sampling plan
2) Sample labelling
3) Sample storage
4) Sample testing

Sampling will be collected from the different Ghats whose location is maintained below. The sample is collected in the closed bottle and store in environmental engineering lab refrigerator.

The water sample is subjected to analysis within 24 hrs. of collection for the physic-chemical parameter like PH, TEMPERATURE, BOD, COD, DO, TDS, TSS, ALKALINITY, TURBIDITY, CHLORIDE, TOTAL HARDNESS, etc. In this project the various parameter of water Location of sampling sites are following.

**IV. STUDY AREA**

The present study thus evaluates the effect of water quality of Ganga River in Varanasi city. Eleven necessary physiochemical parameters are estimated as per standard method. The sample was collected from the 7 most popular Ghats of Varanasi city (from Sant Ravidas ghat to Manikarnika ghat) the water sample to be collected through the study period i.e. after Rainy and winter season 2017 the the physico chemical parameter are analysed in the laboratory.

**Water sample collected from the following site**

- Sample 1 collected at Sant Ravidas Ghat
- Sample 2 collected at Assi Ghat
- Sample 3 collected at Harish Chandra Ghat
- Sample 4 collected at Dasawamedha Ghat
- Sample 5 collected at Lalita Ghat
- Sample 6 collected at Mannmandir Ghat
- Sample 7 collected at Manikarnika Ghat

**V. DRINKING WATER STANDARD: BIS 10500; 2012**

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>DESIRABLE LIMITS</th>
<th>MAX. PERMISSIBLE LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH-VALUE</td>
<td>6.5</td>
<td>8.5</td>
</tr>
<tr>
<td>D.O</td>
<td>2 mg/l</td>
<td>6 mg/l</td>
</tr>
<tr>
<td>BOD</td>
<td>6 mg/L</td>
<td></td>
</tr>
<tr>
<td>ALKALINITY</td>
<td>200 mg/l</td>
<td>600 mg/l</td>
</tr>
<tr>
<td>TURBIDITY</td>
<td>1 NTU</td>
<td>5 NTU</td>
</tr>
<tr>
<td>CALCIUM</td>
<td>75 mg/l</td>
<td>200 mg/l</td>
</tr>
<tr>
<td>FLUORIDE</td>
<td>1 mg/l</td>
<td>1.5 mg/l</td>
</tr>
</tbody>
</table>

**Table 2:**

<table>
<thead>
<tr>
<th></th>
<th>TDS</th>
<th>CHLORIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX. PERMISSIBLE LIMITS</td>
<td>500 mg/l</td>
<td>200 mg/l</td>
</tr>
<tr>
<td></td>
<td>2000 mg/l</td>
<td></td>
</tr>
</tbody>
</table>

**A. Source Of Pollution**

There are two types of pollution
1) Point source
2) Non-point source

1) Point Source

A point source is a single, identifiable source of pollution, such as a pipe or a drain. Industrial wastes are commonly discharged to rivers and the sea in this way.

1) Sewage effluent discharge
2) Domestic waste
3) Industrial effluents
4) Leather industries
5) Non-Point Source

Non-point sources of pollution are often termed ‘diffuse’ pollution and refer to those inputs and impacts which occur over a wide area and are not easily attributed to a single source. They are often associated with particular land uses, as opposed to individual point source discharges.

1) Solid waste
2) Bathing and washing on Ghats
3) Runoff from agricultural field
4) Human and cattle excreta & Fecal matter
5) Cremation

**VI. RESULTS & DISCUSSION**

Variation in physio-chemical properties of Ganga river in rainy and winter seasons at all the considering sites are presented in table1 and table2.
### Table 1: Physico-chemical data table of river Ganga in Varanasi city (During Rainy Season)

<table>
<thead>
<tr>
<th>S.N O</th>
<th>SAMPLING SITE LOCATION</th>
<th>pH</th>
<th>TEMPERATURE (°C)</th>
<th>TDS (mg/l)</th>
<th>TSS (mg/l)</th>
<th>DO (mg/l)</th>
<th>BOD (mg/l)</th>
<th>COD (mg/l)</th>
<th>HARDNESS (mg/l)</th>
<th>ALKALINITY (mg/l)</th>
<th>TURBIDITY (NTU)</th>
<th>CHLORIDE (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SANT RAVI DAS GHAT</td>
<td>7.3</td>
<td>29.2</td>
<td>52</td>
<td>225</td>
<td>5.32</td>
<td>5.21</td>
<td>6.43</td>
<td>245</td>
<td>182</td>
<td>11.32</td>
<td>135</td>
</tr>
<tr>
<td>2</td>
<td>ASSI GHAT</td>
<td>7.4</td>
<td>29.2</td>
<td>45</td>
<td>268</td>
<td>4.53</td>
<td>4.56</td>
<td>6.98</td>
<td>253</td>
<td>174</td>
<td>11.94</td>
<td>129</td>
</tr>
<tr>
<td>3</td>
<td>HARISCHAND GHAT</td>
<td>7.2</td>
<td>30.4</td>
<td>67</td>
<td>283</td>
<td>4.54</td>
<td>5.86</td>
<td>7.84</td>
<td>268</td>
<td>194</td>
<td>13.45</td>
<td>141</td>
</tr>
<tr>
<td>4</td>
<td>DASASWAM ADH GHAT</td>
<td>7.4</td>
<td>30.8</td>
<td>56</td>
<td>240</td>
<td>5.96</td>
<td>4.65</td>
<td>7.11</td>
<td>251</td>
<td>178</td>
<td>12.84</td>
<td>136</td>
</tr>
<tr>
<td>5</td>
<td>LALITA GHAT</td>
<td>7.1</td>
<td>31.2</td>
<td>42</td>
<td>268</td>
<td>5.46</td>
<td>3.89</td>
<td>6.76</td>
<td>273</td>
<td>175</td>
<td>12.24</td>
<td>142</td>
</tr>
<tr>
<td>6</td>
<td>MANN MANDIR GHAT</td>
<td>7.5</td>
<td>31.6</td>
<td>46</td>
<td>245</td>
<td>6.54</td>
<td>3.76</td>
<td>6.56</td>
<td>261</td>
<td>169</td>
<td>11.54</td>
<td>134</td>
</tr>
<tr>
<td>7</td>
<td>MANIKARNIKA GHAT</td>
<td>7.1</td>
<td>31.9</td>
<td>58</td>
<td>264</td>
<td>7.43</td>
<td>3.43</td>
<td>5.43</td>
<td>254</td>
<td>155</td>
<td>11.10</td>
<td>130</td>
</tr>
</tbody>
</table>

### Table 2: Physico-chemical data Table of river Ganga in Varanasi city (During Winter Season)

<table>
<thead>
<tr>
<th>S.N O</th>
<th>SAMPLING SITE LOCATION</th>
<th>pH</th>
<th>TEMPERATURE (°C)</th>
<th>TDS (mg/l)</th>
<th>TSS (mg/l)</th>
<th>DO (mg/l)</th>
<th>BOD (mg/l)</th>
<th>COD (mg/l)</th>
<th>HARDNESS (mg/l)</th>
<th>ALKALINITY (mg/l)</th>
<th>TURBIDITY (NTU)</th>
<th>CHLORIDE (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SANT RAVI DAS GHAT</td>
<td>7.6</td>
<td>11.5</td>
<td>48</td>
<td>218</td>
<td>5.98</td>
<td>4.21</td>
<td>5.56</td>
<td>265</td>
<td>145</td>
<td>9.54</td>
<td>121</td>
</tr>
<tr>
<td>2</td>
<td>ASSI GHAT</td>
<td>7.9</td>
<td>11.6</td>
<td>41</td>
<td>245</td>
<td>5.76</td>
<td>4.12</td>
<td>5.38</td>
<td>260</td>
<td>138</td>
<td>9.24</td>
<td>118</td>
</tr>
<tr>
<td>3</td>
<td>HARISCHAND GHAT</td>
<td>7.4</td>
<td>11.6</td>
<td>62</td>
<td>264</td>
<td>4.96</td>
<td>4.96</td>
<td>6.10</td>
<td>276</td>
<td>131</td>
<td>10.22</td>
<td>124</td>
</tr>
<tr>
<td>4</td>
<td>DASASWAM ADH GHAT</td>
<td>7.7</td>
<td>12.1</td>
<td>53</td>
<td>229</td>
<td>6.06</td>
<td>3.54</td>
<td>5.98</td>
<td>266</td>
<td>146</td>
<td>9.29</td>
<td>120</td>
</tr>
<tr>
<td>5</td>
<td>LALITA GHAT</td>
<td>7.8</td>
<td>14.4</td>
<td>38</td>
<td>248</td>
<td>5.65</td>
<td>3.23</td>
<td>5.19</td>
<td>279</td>
<td>128</td>
<td>9.54</td>
<td>130</td>
</tr>
<tr>
<td>6</td>
<td>MANN MANDIR GHAT</td>
<td>7.9</td>
<td>14.8</td>
<td>41</td>
<td>238</td>
<td>6.54</td>
<td>3.54</td>
<td>5.64</td>
<td>268</td>
<td>136</td>
<td>9.08</td>
<td>116</td>
</tr>
<tr>
<td>7</td>
<td>MANIKARNIKA GHAT</td>
<td>7.4</td>
<td>15.4</td>
<td>52</td>
<td>238</td>
<td>7.21</td>
<td>3.21</td>
<td>4.21</td>
<td>261</td>
<td>130</td>
<td>8.94</td>
<td>114</td>
</tr>
</tbody>
</table>
Fig. 5: Graph Showing Value of Ph at different sampling locations

Fig. 6: Graph Showing Value of Temperature at different sampling locations

Fig. 7: Graph Showing Value of Total dissolve solid at different sampling locations

Fig. 8: Graph Showing Value of Total suspended solid at different sampling locations

Fig. 9: Graph Showing Value of Dissolved oxygen at different sampling locations

Fig. 10: Graph Showing Value of B.O.D at different sampling locations

Fig. 11: Graph Showing Value of C.O.D at different sampling locations

Fig. 12: Graph Showing Value of Hardness at different sampling locations
VII. RESULT & CONCLUSION

A. pH-value
In rainy season the highest pH value 7.9 at Lalita Ghat and lowest value 7.6 at Manikarnika Ghat where as in winter season the highest pH-value 7.5 at Lalita Ghat and lowest pH-value 7.1 at Dasawamedh Ghat. If it is analysed by site wise the highest value 7.9 was found at Lalita ghat and lowest value 7.1 was found at Dasawamedh Ghat.

B. Temperature
In rainy season the highest Temp 31.9°C at Mankarnika Ghat and lowest 29.2°C at Sant ravidas Ghat & Assi ghat where as in winter season the highest Temp 15.4°C at Mankarnika Ghat and lowest Temp 11.5°C at Sant ravidas Ghat.

C. Total Dissolved Solids (TDS)
In rainy season the highest TDS value 283 mg/l at Harischandra Ghat and lowest value 225mg/l at Sant Ravidas Ghat where as in winter season the highest TDS value 264mg/l at Manikarnika Ghat and lowest TDS 218 mg/l at Santravidas Ghat. If it is analysed by site wise the highest value 283 mg/l was found at Harischandra Ghat and lowest value 218 mg/l was found at Santravidas Ghat.

D. Total Suspended Solids (TSS)
In rainy season the highest TSS value 67 mg/l at Harischandra Ghat and lowest value 42mg/l at Lalita Ghat where as in winter season the highest TSS value 62mg/l at Harischandra Ghat and lowest TSS 38mg/l at Lalita Ghat. If it is analysed by site wise the highest value 67 mg/l was found at Harischandra Ghat and lowest value 38 mg/l was found at Lalit Ghat.

E. Dissolved Oxygen (DO)
In rainy season the highest DO value 7.43 mg/l at Manikarnika ghat and lowest value 4.53 mg/l at Assi ghat where as in winter season the highest DO value 7.21mg/l at manikarnika ghat and lowest DO 4.96 at Harish Chandra ghat. If it is analysed by site wise the highest value 7.43 mg/l was found at Manikarnika ghat and lowest value 4.96 mg/l was found at Harischandra ghat.

F. Biochemical Oxygen Demand (BOD)
In rainy season the highest BOD value 5.86 mg/l at Harischand ghat and lowest value 3.43 mg/l at Mankarinka ghat where as in winter season the highest BOD value 4.96 mg/l at Harischand ghat and lowest BOD 3.21 mg/l at Mankarinka ghat. If it is analysed by site wise the highest value 5.86 mg/l was found at Harischand ghat and lowest value 3.21 mg/l was found at Mankarinka ghat.

G. Chemical Oxygen Demand (COD)
In rainy season the highest COD value 7.84 mg/l at Harischand ghat and lowest value 5.43 mg/l at Mankarinka ghat where as in winter season the highest COD value 6.10 mg/l at Harischand ghat and lowest COD 4.21 mg/l at Mankarinka ghat. If it is analysed by site wise the highest value 7.84 mg/l was found at Harischand ghat and lowest value 4.21 mg/l was found at Mankarinka ghat.

H. Hardness
In rainy season the highest hardness value 273 mg/l at Lalita Ghat and lowest value 245 mg/l at Sant ravidas ghat where as in winter season the highest hardness value 279mg/l at Lalita Ghat and lowest hardness 260 mg/l at AssI Ghat. If it is analyzed by site wise the highest value 273 mg/l was found at Lalita Ghat and lowest value 260 mg/l was found at Assi ghat.

I. Alkalinity
In rainy season the highest Alkalinity value 194 mg/l at Harishchandra ghat and lowest value 155 mg/l at Manikarnika ghat where as in winter season the highest alkalinity value 146 mg/l at Dasawamedh ghat and lowest alkalinity 128 at Lalita ghat. If it is analysed by site wise the
highest value 194 mg/l was found at Harishchandra ghat and lowest value 128 mg/l was found at Lalita ghat.

J. Turbidity

In rainy season the highest Turbidity value 13.45 NTU at Harishchandra ghat and lowest value 11.10 NTU at Manikarnika ghat where as in winter season the highest Turbidity value 8.94 NTU at Harishchandra ghat and lowest Turbidity 4.96 NTU at Manikarnika ghat. If it is analysed by site wise the highest value 13.45 NTU was found at Harishchandra ghat and lowest value 4.96 NTU was found at Manikarnika ghat.

K. Chloride

In rainy season the highest chloride value 142 mg/l at Lalita ghat and lowest value 129 mg/l at Assi ghat where as in winter season the highest chloride value 130 mg/l at Lalita ghat and lowest chloride 114 mg/l at Manikarnika ghat. If it is analysed by site wise the highest value 142 mg/l was found at Lalita ghat and lowest value 114 mg/l was found at Manikarnika ghat.

VIII. CONCLUSION

Thus we can conclude that the Ganga River gets seriously polluted due to discharge untreated sewage and industrial effluents and the residues of pesticides and insecticides used in the farms are washed in to it from the point and non-point sources. After the analysis of physico-chemical parameters of the water of river Ganga in my opinion the water is not fit for domestic use and it should be further treated. Due to the Establishment of a large number of hospitals, industries, textile mills, chemical plants, distilleries on the bank of river Ganga in Varanasi has led to increase in the pollution level in the River Ganga. After analysis of water samples from the different Ghats, it was found that the pollution levels of the river and the river body was more polluted at Harishchandra ghat due to large quantity of sewage discharge, industrial discharge and cremation activities

IX. SUGGESTION

Following suggestion are recommended for the betterment of river Ganga are:
1) Regular monitoring and strict law enforcement is needed to develop a strategy to manage the environmental hazards due to these elements and to improve environmental protection of this area. Our present data should serve as baseline for future reference.
2) Most of the city waste, industrial waste is dumped into the river without thinking twice about the consequences it would have on aquatic life as well as human health. So it has been prohibited to directly disposed sewage waste in river.
3) Make some law to punish those people who create pollution near Ganga and Increase the amount of water to improve water quality of river Ganga.
4) Sewage treatment plant are stabilised near river Ganga to protect the directly disposed of sewage waste and All the incoming waste water through drains should be diverted from the river.

ACKNOWLEDGEMENTS

The authors acknowledge the head, department of civil engg. Of Integral University Lucknow for providing facilities to this work.

REFERENCES

[1] Anil kumar (2015), Study and evaluation of water quality of river gomti in Lucknow city, uttar pradesh India',
[2] Ruby pandey, divya raghuvanshi & d.n Shukla (2014) assessment of physico-chemical parameters of river ganga at allahabad with respect to wqi uttar pradesh india',
[5] Sandeep arya and richa gupta (2013), ‘water quality evaluation of ganga river from up to downstream area at kanpur city’,


[18] Beg k.r. and Ali s. (2008), ‘chemical contaminants and toxicity of ganga river sediment from up and down stream area at kanpur’, American j of environ sci