Water Quality Analysis of River Mahanadi in Sambalpur City

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Abstract- The study was conducted to assess and ascertain the physico-chemical properties of Mahanadi river water from five different locations of (Binakhandi, 500 m upstream of Binakhandi, 500 m downstream of Binakhandi, PC bridge and Dhanupali) Sambalpur city of Odisha during the month of March and August, 2014. The analysis was carried out by taking certain important parameters like pH, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), Chloride, total dissolved oxygen (TDS), Nitrate, Sulphates, total hardness (TH), electrical conductivity (EC) and Fluoride. Analyzed parameters like pH, DO, TH, Chloride, Sulphate, and TDS were found within permissible limit prescribed by IS 10500 except Nitrate and Fluoride content which exceeds at some sites. COD values were invariably higher than BOD indicating the presence of considerable amount of chemically oxidizable matter which were non-biodegradable. High COD values clearly indicates the status of the river water i.e polluted. EC also considerably recorded high particularly in site – 2 in summer season. These physicochemical parameters indicates the deterioration of water quality which is the result of various anthropogenic disturbances like industrialization, construction activities, utilization of agricultural and forest land for other developmental purposes. Other sources which contributes more or less in water quality depletion are disposal of untreated domestic and sewage effluents and different types of solid wastes directly to river.

Index Terms- Anthropogenic, Non-biodegradable, Oxidizable, Polluted.

I. INTRODUCTION

Rivers are the main inland water resources for domestic, industrial and irrigation purposes and often carry large municipal sewage, industrial waste water and seasonal run off from agricultural land to the coastal region. These are the main reasons for nutrient enrichment of river water as compared to other environments (Panda *et al*., 2006). Water recourses have critical importance to both natural and human development. It is essential for agriculture, industry and human existence. Water is one of the most abundant compounds of the ecosystem. The healthy aquatic ecosystem is depended on the physico-chemical and biological characteristics of water (Venkatesharaju *et al*., 2010) . As of now only earth is the planet having about 70 % of water but due to increased human population, industrialization, use of fertilizers in the agriculture and man made activity it is highly polluted with different harmful contaminants which can cause various water borne diseases.

Physico-chemical parameter of river water affects the biological characteristics and indicates the status of water quality. Different types of Physico-chemical parameters of water are pH, DO, BOD, COD, Chloride, TDS, Nitrate, Sulphates, TH, EC and Fluoride. These parameters are solely responsible for water quality. Quality of water generally refers to the component of water which is to be present at the optimum level for suitable growth of plant and animals. Aquatic organisms need a healthy environment to live and have adequate nutrients for their growth. The productivity depends on the physicochemical characteristics of the water body. The maximum productivity obtained when the physical and chemical parameters are at optimum level (Kamal , 2007).

Mahanadi is the largest river in Odisha. The assessment of water quality analysis of river Mahanadi in Sambalpur town becoming utmost importance because of various reasons like rapid urbanization, agricultural and industrial waste, sewage water comprises of domestic, medical and other wastes due to anthropogenic activities. Open defecation is another reason behind the pollution of river water. According to municipal report, more than 50 percent of latrine drains of the town are directly connects to the main drains which eventually fall on the river. About 40 percent population of the city defecates in open and about 30000 people take bath in the river bank (Jena, 2008).

II. MATERIALS AND METHODS

Study Site -:

Mahanadi emerges from Amarkant of Madhya Pradesh (MP) and runs across a number of districts of Odisha. It flows through a vast stage with numerous perennial and no perennial streams and forms a network of small and large tributes before joining the Bay of Bengal near Paradeep (Dash and Panda, 2010).

Location of Study Area -:

The river basin (80º30'E - 86º50'E and 19º20'N-23º35'N) extends over an area approximately 141,600 km², has a total length of 851 km and an annual run off of 50 x 109 m^3 with a peak discharge of 44,740 m^3s^{-} (Dixit *et al*., 2013).

Figure : 1 (Binakhandi)

Figure : 2 (500 m upstream of Binakhandi)

Figure :3 (500 m downstream of Binakhandi)

Figure : 4 (P.C.Bridge)

Figure : 5 (Dhanupali)

Climate of Study Area

The climate of the Mahanadi basin lying in Odisha is a tropical monsoon type and having maximum precipitation in July, August and first half of September. During winter season the minimum temperature is generally varies from 4 º C to 12 º C. The average annual rain fall is 1572 mm, of which 70% is precipitated during the southwest monsoon between mid June to mid October (Dixit *et al*., 2013).

Collection and Analysis of Water Samples

For the analysis of water, samples were collected at random basis from each site in plastic bottles previously rinsed with distilled water. Water samples were collected during summer and rainy season in the month of March and August of 2014 in the early hours of day. The samples were filled in plastic bottles of 2 lit capacities and were kept in refrigerator. The water samples were analyzed for various physic-chemical parameters i.e pH, DO, BOD, TH, COD, Sulphate, Nitrate, Chloride, Fluoride, TDS and EC.

pH of water sample were measured by using digital pH meter (Systronics 361). DO, BOD, Chloride and TH were measured by APHA (1992) methods. COD and Nitrate were expressed by EPA (1979) and APHA (2005) methods respectively. Sulphate, Fluoride and TDS were evaluated by UV visible spectrophotometer, digital fluoride meter (HI - 93729)

and TDS meter (Systronics 341) respectively. EC was determined by conductivity meter (Elico 361).

The results obtained were subjected to two way ANOVA using MS Excel 2007 data analysis tool.

III. RESULT AND DISCUSSION

Table – 1: Physicochemical parameters showing mean± SD in summer season

PARAMETERS	SAMPLING SITES (MEAN ± SD)				
	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5
PH	8 ± 0	8 ± 0	8 ± 0	7 ± 0	8 ± 0
EC(mho/cm)	276 ± 0	320 ± 0	275 ± 0	197 ± 0	205 ± 0
DO(mg/I)	3.13 ± 0.057	4.16 ± 0.115	3.46 ± 0.057	4.36 ±0.115	3.76 ± 0.057
BOD(mg/I)	3.56 ± 0.057	3.06 ± 0.057	3.43 ± 0.057	2.53 ± 0.057	3.4 ± 0.1
COD(mg/I)	66.251	61.66 ±0.577	76.33 ±0.577	56 ± 1	69.33 ±0.577
TH(mg/I)	48.33 ± 0.577	38.33 ± 0.577	46.66 ± 1.154	30.66 ± 0.577	41 ± 1
TDS(mg/I)	253.33±1.154	178.33±1.154	208.66±0.577	102.66±1.527	194.33±0.577
NITRATE (mg/I)	45±1	33±1	41±1	26±1	36±1
SULPHATE (mg/I)	24±1	18±1	22±1	13±1	21±1
FLUORIDE (mg/I)	0.24±0.01	0.18±0.01	0.22±0.01	0.14±0.01	0.21±0.01
CHLORIDE (mg/I)	45±1	31±1.732	41±1	28±1	34±1

Table – II: Physicochemical parameters showing mean± SD in monsoon season

PARAMETERS	SAMPLING SITES (MEAN ± SD)				
	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5
PH	6 ± 0	7 ± 0	7 ± 0	7 ± 0	8 ± 0
EC (mho/cm)	169 ± 0	157 ± 0	168 ± 0	73 ± 0	123 ± 0
DO(mg/I)	3.76 ± 0.057	4.76 ± 0.057	4.33 ± 0.057	5.53 ±0.047	4.53 ± 0.057
BOD(mg/I)	5.13 ± 0.057	4.16 ± 0.057	5.06 ± 0.057	3.63 ± 0.057	4.63 ± 0.115
COD(mg/I)	44±1	31.33 ±1.52	37.66 ±0.577	26.66 ± 1.15	31.66 ±0.577
TH(mg/I)	31.66± 1.527	25.66 ± 0.577	31 ± 1	20 ± 1	29 ± 1
TDS(mg/I)	199.66±0.577	127.33±0.577	160.33±0.577	90.66±0.577	155.66±0.577
NITRATE (mg/I)	55±1	37±1	48±1	28±1	46±1
SULPHATE (mg/I)	26±1	18±1	14±1	11±1	22±1
FLUORIDE (mg/I)	0.27±0.01	0.2±0.01	0.25±0.01	0.18±0.01	0.22±0.01
CHLORIDE (mg/I)	31±1	21±1	27.66±0.577	18.33±1.15	25±1

pH of water sample varied between 6 – 8 during summer and monsoon (which is lie within the tolerance limit of drinking water). In summer season pH recorded was 8 higher than in monsoon season. The high pH may due to higher algal growth and reduced microbial activity reported by Chetana and Somashekar (1997). The low pH in monsoon was 6 at site 1 may be due to high input of raw sewage into the river water and wastes effluents coming from the drains which directly join at this station. There was a significant difference in pH values both with respect to seasons as well as sites ($p < 0.001$) when two way ANOVA analyzed.

EC of water samples of all sites was high in summer season in comparison to monsoon season. In at site 2 the conductivity level was very high i.e 320 mg/L as compared to other locations. One of the reasons could be an inflow of urban waste as well as discharge of untreated municipal waste into the river containing heavy ionic concentrations (Alam *et al.*, 2007). Two way ANOVA revealed that there was significant difference in conductivity of different samples with respect to different sites ($p < 0.001$), however the season wise variation is not significant

In case of DO content of water samples, it was recorded maximum in rainy season than summer where it ranges varies 3.76 mg/L at site 1 to 5.53 mg/L at site 4. But the values of DO in both the seasons were well within the limits of drinking water standards of 6 mg/l (IS: 10500). Two way ANOVA results significant difference in DO of water samples both with respect

to seasons ($p < 0.05$) as well as with respect to sampling sites ($p < 0.001$).

BOD was more in monsoon than summer. During summer they show fluctuations between 2.53 mg/L at site 4 to 3.56 mg/L at site 1. The same situation was also found in rainy season with the highest value of 5.13 mg/L at site 1 and lowest at site 4 of 3.63 mg/L. The higher value of BOD during rainy was due to input of organic wastes and enhanced bacterial activity. Two way ANOVA analysis showed significant difference in BOD of water samples both with respect to seasons ($P < 0.001$) and sites ($p < 0.05$)

COD was recorded higher in summer than rainy. In summer COD were ranged from 56 mg/L at site 4 to 76.33 mg/L at site 1. During rainy season its value varies between 26.66 mg/L at site 4 to 44 mg/L at site 1. High COD at site 1 have been reported to be associated with high organic matter content and sewage disposal in rivers (Mishra and Ram, 2007). Khan *et al.*, (2003) observed similar trend in COD values in Huderia drain, Pakistan which was also polluted from industries and municipal waste. COD values were invariably higher than BOD indicating the presence of considerable quantity of chemically oxidizable matter most of which were non-biodegradable. High COD values clearly indicate that the river water is polluted. Two way ANOVA revealed that there was significant difference in the COD of water samples in both season wise ($p < 0.05$) and site wise ($p < 0.001$).

TH of water samples found to be higher in summer than monsoon. TH of water samples value ranged between 30.66 mg/L at site 4 to 48.33 at site 1 mg/l in summer season and in rainy season varies between 20 mg/l at site 4 to 31.66 mg/L at site 1. The permissible limit for total hardness is 300 mg/l (IS 10500). Hence all the water samples in the present study area were within the permissible limit. According to the results of two way ANOVA, there was significant difference in TH of water samples both with respect to seasons ($p < 0.001$) as well as with respect to sampling sites($p < 0.05$).

Chloride content of water samples was recorded higher in pre-monsoon than monsoon. Its value ranges between 28 mg/L at site 4 to 45 mg/L at site 1 in summer season. During monsoon season its value ranges between 18.33 mg/L at site 4 to 31 mg/L at site 1. In this investigation samples of river water were within the permissible limit. The results of this analysis agree with Abdel (2005). Two way ANOVA showed significant difference in chloride of water samples with respect season ($p < 0.001$). However the site wise difference was not significant

Nitrate content recorded higher in monsoon than summer. Nitrate was ranged from 28 mg/L at site 4 to 55 mg/L at site 1 in monsoon. While 26 mg/L at site 4 to 45 mg/L at site 1. The prescribed limit for nitrate is 45 mg/L. Hence all the water samples contains nitrate well within the permissible limit except site - 1, 3 and 5 in rainy season. The comparatively high value on site 1 could be attributed to anthropogenic sources like run off water, discharges of effluents from rotten waste containing nitrogen species and their subsequent oxidation by microbiological activity under aerobic conditions. Two way ANOVA revealed that there was significant difference in the COD of water samples in both season wise and site wise ($p < 0.001$).

TDS was maximum in summer than rainy. During summer its value ranged from 102.66 mg/L at site 4 to 253.33 at site 1 and in rainy season it varies from 90.66 mg/L at site 4 to 199.66 mg/L at site 1 and all the values are within the permissible limit for water i.e. 500 mg/L (IS 10500). Two way ANOVA revealed that there was no significant difference in TDS of water samples both with respect to seasons and different sampling sites.

Sulphate contents of all samples in rainy season were recorded higher than in summer. During summer its value ranged from 13 mg/L at site 4 to 24 mg/L at site 1.In rainy season it varies between 11 mg/L at site 4 to 26 mg/L at site 1 and all values are under the permissible limit i.e 150 mg/L as guided by IS 10500. Girija *et al.*, (2007) also reported higher values of sulphate during rainy season. The two way ANOVA revealed that there was no significant difference in sulphate content of water samples both with respect to seasons and different sampling sites.

Fluoride levels of water in monsoon season was higher than summer. During summer its value ranged from 0.14 mg/L at site 4 to 0.24 mg /L at site 1. In rainy season it varies from 0.18 mg/L at site 4 to 0.27 mg/L at site 1.The permissible level of fluoride in portable water is 1.5 mg/L as recommended by IS: 10500. Two way ANOVA revealed that there was significant difference in fluoride concentration with respect to seasons ($p < 0.001$) while the site wise difference was not significant.

IV. Conclusion

From the assessment of physico-chemical study it could be clearly concluded that the status and quality of Mahanadi River water in Sambalpur city be an eye opener which is very much prone towards alarmic condition for Sambalpur city and its population. Threatened rising of organic and inorganic waste levels which a consequence of human activity is definitely going to hammer on water quality and its ecosystem directly or indirectly. These anthropogenic consequences obviously hamper the aesthetic properties of aquatic systems and impose potential health hazards not only aquatic organisms but also other terrestrial life forms including human beings. So to sustain the river quality healthy, we should must concern about the waste and its disposal system. Particularly the diversion of local drains which carry effluents from various sources from the city area and their treatment has to be made.

References

[1] Abdel A.M. Water quality of Lake Bardawil Egypt. Journal of Egyptian Academy Society for Environmental Development, 61:79-83.

[2] Alam M.B. and Sattar M.A. (2007). Assessment of arsenic contaminant ion in soils and waters in some areas of Bangladesh. Water Science Technology, 42:185–192.

[3] APHA (1992). Standard Methods for Examination of Water and Waste Water, 18th edition. American Public Health Association, Washington, DC, US.

[4] APHA (2005). Standard Methods for Examination of Water and Waste Water, 21st edition. American Public Health Association, Washington, DC, US.

[5] Chetana S.A. and Somashekar R. K. (1997). Evaluation of water quality index of the river Cauvery and its tributaries. Current Science (Current Science Association and Indian Academy of Science, Bangalore), 72(9): 640–646.

[6] Dash M. and Panda T. (2010). Water quality and phytoplankton population in sewage fed river of Mahanadi, Orissa, India. Journal of Life Sciences, 2(2) : 81-85.

[7] Dixit P.R., Kar B., Chattopadhyay P. and Panda C.R. (2013). Seasonal variation of the physicochemical properties of water samples in Mahanadi estuary, East Coast of India , Journal of Environmental Protection, 4: 843-848.

[8] EPA (1979). Methods for chemical analysis of water and wastes, 353.3. Environmental Protection Agency, Washington, DC, US.

[9] Girija T.R., Mahanta C. and Chandramouli V.(2007). Water quality assessment of an untreated effluent impacted urban stream: the Bharalu Tributary of the Brahmaputra River, India. Environmental Monitoring and Assessment, 130: 221–236.

[10] Indian standard specifications for drinking water, IS: 10500, 1993.

[11] Jena V., Gupta S. and Matic N. (2013). Assessment of Kharoon river water quality at Raipur by physicochemical parameters analysis. Asian Journal of Experimental Biological Science, 4(1):79-83.

[12] Kamal D., Khan A.N., Rahaman M.A. and Ahamed F. (2007). Study on the physic-chemical properties of water of Mouri River, Khulna, Bangladesh. Pakistan Journal of Biological Sciences, 10 (5): 710-717.

[13] Khan F., Husain T. and Lumb A. (2003). Water quality evaluation and trend analysis in selected watersheds of the Atlantic region of Cannada. Journal of Environmental Monitoring Assessment,. 88:221-242.

[14] Mishra K.N. and Ram S. (2007). Comprehensive study of phytoplanktonic community growing in polluted ponds of Janupur City (U.P). Journal of Phytological Research, 20 (2): 317-320.

[15] Mishra S.R. (1996). Assessment of Water Pollution, New Delhi. Ashish Publishing House (APH) Corporation.

[16] Pagariya S. K.(2012). Analysis of water quality using physico-chemical parameters of Kolura pond in post- monsoon season. International Journal of Chemical and Physical Sciences, 1(2).

[17] Panda U. C., Rath S., Nayak P. and Bhatta D.(2006). Application of factor and cluster analysis for characterization of river and estuarine water systems - A case study: Mahanadi River (India). Journal of Hydrology, 331: 434-445.

[18] Samira A.B.M., Hawaa S.E.,Faiza A.H. and Fatma F.A. (2009). Determination of available nitrate ,phosphate and sulphate in soil sample. International Journal Of Pharmtech Research, 1(3):598 – 604.

[19] Smitha, Ajay D. and Shivashankar P. (2013). Physico chemical analysis of the freshwater at river Kapila, Nanjangudu industrial area, Mysore, India. International Research Journal of Environmental Sciences, 2(8): 59-65.

[20] Venkateshraju K., Ravikumar P., Somasekha R.K. and Prakash K.L.(2010). Physicochemical and bacteriological investigation on the river Cauveryo Kollegal stretch in Karnataka. Journal of Science Engineering and Technology, 6(1):50-59.

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