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Impact of Industrial Effluents on Water Quality of Betwa, Mandedeep

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ABSTRACT *The impact of industrial effluent on water quality of Betwa, Rivers State of Madya Pradesh was investigated. Physico-chemical and organic parameters of water samples of the Betwa were examined to determine the quality and extent of pollution. Results indicated that TSS (Total Suspended Solid) ranged between 19.8 and 24.9mg/l; while THC (Total Hydrocarbon Concentration) was between 24.2 and 40.4. DO (Dissolved Oxygen) and BOD (Biochemical Oxygen Demand) varied between 38.2 and 41.5mg/l, and 38 and 59 mg/l respectively. The major sources of pollution were observed to be effluents from the industries and dump sites within and around the Betwa. These effluents were observed to impact seriously on the ecosystem. In order to maintain the ecological status of the Betwa, waste arrangement practice of effluent treatment through the use of retention pond was suggested.*

KEYWORDS : Physico-Chemical Parameters, Industrial Activities, Water Quality, Betwa

INTRODUCTION

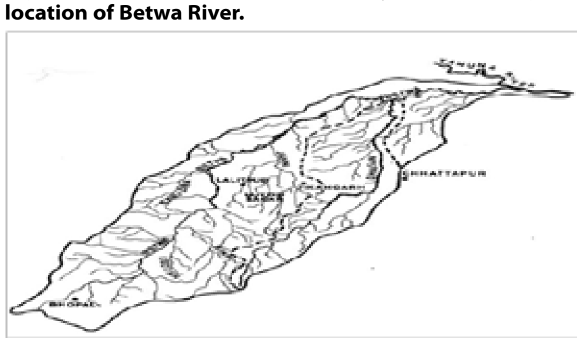
Worldwide, water bodies are the primary dump sites for disposal of waste, especially the effluents from industries that are near them. These effluents from industries have a great toxic influence on the pollution of the water body, as they can alter the physical, chemical and biological nature of the receiving water body (Murhekar GH 2011; Adekunle and Eniola, 2008). The initial effect of waste is to degrade the physical quality of the water. Later biological degradation becomes evident in terms of number ,and variety of the living organisms in the water (Gray, 1989). Often the water bodies readily assimilate waste materials they receive without significant deterioration of some quality criteria; the extent of this is referred to as its assimilative capacity (Adekunle and Eniola, 2008). Industrialization is considered the cornerstone of development strategies due to its significant contribution to the economic growth and human welfare. It has become a yardstick for placing countries in the League of Nations and an index of its political stature (FEPA, 1991). Industrialization, like other human activities that impact on the environment, often results in pollution and degradation. Industries turn out wastes which are peculiar in terms of type, volume and frequency depending on the type of industry and population that uses the product, Industrial waste is the most common source of water pollution in the present day (Ogedengbe and Akinbile, 2004) and it increases yearly due to the fact that industries are increasing because most countries are getting industrialized. The extent of discharge of domestic and industrial waste is such that rivers receiving untreated effluent cannot give dilution necessary for their survival as good quality water sources. The transfer of unfavorable releases from industries is detrimental to human and animal health and safety (Murhekar GH (2011).There is thus a challenge of providing water in adequate quantity and of the required quality to minimize hazards to human health and conserve the water bodies and the environment. Wastewater discharge from sewage and industries are major component of water pollution, contributing to oxygen demand and nutrient loading of the water bodies, promoting toxic algal blooms and leading to a destabilized aquatic ecosystem (Morrison et al, 2001). The effects of industrial activities on the quality status of streams/rivers have been carried out by scholars in the past. Environmentalists and scholars in other disciplines have attempted to examine the impact of industrial activities on the physico-chemical parameters and heavy metal concentration of rivers/streams, while others carried out a bacteriological assessment.(Adekunle and Eniola, 2008;) However, little or no information is available on the effect of industrial activities within Betwa ecosystem and its quality status. It is on this background that this study to examine the impact of industrial activities on the quality status of Betwa , River State by assessing its physico-chemical parameters with comparison to Federal Environmental Protection Agency (FEPA) Nigeria standards and the WHO standard.

The Betwa is a sink receiving wastes from industrial and other anthropogenic activities within environment. It is located between latitude 23"2" N and, and longitude77"43'E. The area experiences excess 1280 -1800 rainfall averaging mm/annum. It rains for about four months (June to October) during the year. It has an almost flat topography and is underlain by superficial soil that consists of salty clays mixed with silt sand (Fig. 1). Many human activities going on within and around the Betwa include, sand mining ,fishing, boating navigation, agricultural activities, receptor of wastes from industries like food processing, soap and detergent, agrochemical, paper mill, metal works and construction among others. This aquatic body also receives discharged effluents from residential buildings and adjoining abattoir along its bank.

Fig. 1 Map of the study area showing the location of Betwa River. NEW AREA -I

Fig. 2 Map of the study area showing the location of Betwa River. NEW AREA -II

Fig. 3 Geographical Map of the study area showing the location of Betwa River.



MATERIALS AND METHODS
The different procedures through which data used for this study were collected and analyzed are explained as follows:

Sample Collection and Analysis
Duplicate water samples were collected from three (3) sampling stations of 150 meter interval in the Betwa River New area I, New area II and one fifty meter away from adjoining, using plastic sampling bottles of 25cl by dipping the bottles 15cm below the water level at designated sampling stations. Prior to sample collection, all the plastic bottles were thoroughly washed and sun-dried; and before collection, the plastic battles were rinsed twice with the same water collected samples for biological oxygen demand (BOD) was collected into dark glass bottles for incubation. Samples for oil and grease were also collected with glass bottle with addition of nitric acid. After which, the sampling bottles were labeled with dates and collection stations. Until analysis, collected water samples were stored in a cool box at 40 C. PH, Temp, DO, TSS (Total Suspended Solid) and EC (Electrical Conductivity) were measured in-situ with the portable –parameter instrument during sampling.

SALINITY
Salinity as chloride content of the samples was determined argent metrically according to APHA -4500B, using the solution of silver nitrate with potassium chromate indicator. The chloride content was calculated from the volume of AgNO3used.

TURBIDITY
Turbidity of samples was analyzed using a HACH Ratio Turbidimeter as described in APHA-214A.

TDS
TDS were determined according to APHA 20gc using TDs meter after due calibration.

BIOCHEMICAL OXYGEN DEMAND (BODS)
The (BODS) was determined by measuring the DO of the samples contained in a BOD bottle before and after five days of incubation of 200C. According to APHA-51210B.

BOD = (S1-S2) – (B1-B2) x % dilution.

S1 = DO for the sample, S2 = DO after incubation of sample,

B1 = DO for the first day for blank, B2 = DO after incubation for blank

OIL/GREASE O/G
Oil/Grease O/G was determined using a spectrophotometer (AP1/RP-)Xylene and the absorbance of the combined extract determined in the spectrophotometer using xylen as blank.

Analytical Technique
Data obtained from the laboratory analysis of the water samples were analyzed using descriptive and inferential statistical techniques, notably tables, mean and one-way analysis of variance (ANOVA).

RESULT AND DISCUSSION
Physico-Chemical Parameters of Betwa Mandideep
The physico-chemical parameters obtained from the BETWA are shown in table. The table shows that the level of pH was high in the NEW AREA I and low at NEW AREA II and one this implies that the Betwa is acidic and this affects the metal solubility and the hardness of the water. However, aquatic organisms are heavily affected by pH because most of their metabolic activities are pH dependent. Nevertheless, the level of temperature was average at the new area I with 24^0 C, but increased steadily from the new area II to adjoining with temperature values of 29^0 C and 30^0 C respectively. These concentrations are normal for aquatic lives, and have minimal effects on acidity. The concentration of dissolved oxygen (DO) was high at the new area I with value of 41.3 mg/l and lower at the new area II with value of 38.2 mg/l. (Table 1). The level of DO New area I can adequately sustain aquatic lives, than the value recorded at Adjoining point. The Depletion of DO at the Adjoining could be attributed to the huge amount of organic load which require a high level of oxygen for chemical oxidation and breakdown. Likewise, the levels of biological oxygen demand (BOD) varied across the various stations, with the New area II recording the highest. The BOD obtained for this study compared with the highvalues obtained by Omole and Longe (2008) could be due to the concentration of industries that discharge liquid effluents into the Betwa, as regards to organic waste disposal in the latter study. It thus, reveals that Betwa has lower level of organic pollution, but high level of liquid pollution.

Also, turbidity was high in the New area II with a value of 31.8 NTU and lower on the ,New area I course with a value of 26.4 NTU. The level of total suspended solid (TSS) was higher in the New area II with 24.9 mg/l, but reduced substantially at the adjoining point with a value of 19.8mg/l. The deposition of solid particulates from the effluent through the river course could have led to the reduction in the volume of TSS the adjoining point. The total dissolved solid (TDS) content varied between 51 and 83 mg/l; the highest value was obtained at adjoining point followed by the New area I and New area II (Table 1). Furthermore, the content of electrical conductivity was high at the new area II and Adjoining, courses, but low at the New area I (Table 1). These values perhaps show the magnitude at which Betwa River is polluted; this indicates that the Betwa Water is not suitable for human consumption and can be harmful to aquatic survival. High concentration of conductivity and salinity in water has been reported to cause danger to both aquatic and human lives (Verla et al. 2007). The degree of oil pollution from nearby food industries , automobile water used as a coolant in industries may be responsible for the high proportions of oil and grease at the New area I(40.4 mg/l) and New area II (38.6 mg/l), but lower at the Adjoining point (24.2 mg/l). Oil and grease cause depletion of oxygen as well as suffocation of aquatic species. Hence, its highest concentration in Betwa River is detrimental to aquatic lives.

Table 1: Physico-chemical parameters of Betwa River

Parameters	New Area I	New Area II	Adjoining Point
PH	6.80	5.70	5.40
Temperture	31.50	29.80	30.10
Salinity (mg/l)	20.80	20.40	18.70
DO (mg/l)	41.50	40.00	38.20
BOD (mg/l)	38.00	50.00	59.00
Turbidity (NTU)	26.40	29.60	31.80
TSS (mg/l)	22.10	24.90	19.80
TDS (mg/l)	196.00	213.00	231.00
Conductivity (us/cm)	391.00	426.00	462.00
Oil and Grease	40.40	38.60	24.20

Comparative Analysis of Physico-Chemical Parameters with Fepa's permissible Limit

Table 2 presents the comparative analysis of the mean values of the obtained physical parameters of Betwa River with the limit outlined by FEPA, WHO for surface water; pH which is an indicator of acidic or alkaline conditions of water status was within FEPA's permissible limit (6-9),WHO permissible limit of 6.5 - 8.5 and also within the natural background level of 7.0 (Azumi DS, Bichi MH 2010). The temperature obtained (280 C) was slightly above the limit of 270 C tolerable by FEPA. Conductivity which is a method of obtaining an estimate of dissolved solids in water was far above WHO acceptable limit of 250 us/cm. The mean value obtained for this study was 426.3us/cm, while the range was 391- 462 us/cm. The mean turbidity value of 29.3 NTU exceeded the limit of 1.0 acceptable by FEPA and WHO. Turbidity is associated with suspended solid concentrations; the high turbidity content of this study was attributed to waste inputs from industries. This affects the general condition of the water and aquatic lives. The values of TSS and TDS were within FEPA acceptable limit of >10 mg/l and 500 mg/l respectively. In conclusion, the contents of physical parameters in Betwa River are within FEPA acceptable limit, except turbidity and temperature which are higher than FEPA standard of 5.0 and 270 C respectively. In addition, the value salinity (20 mg/l) fell below FEPA's acceptable limit of 2000mg/l. Also, the oil and grease content (34.4 mg/l) of Betwa far exceeded FEPA limit of 20 mg/l. The presence of oil and grease may be attributed to the activities of household consumption and automobile shops along the Betwa and around its environment such that an unavoidable amount of hydrocarbon was released into the Betwa causing inherent dangers to aquatic organisms. The content of oil and grease in Betwa may affect aquatic productivity, which in the long-run, will impact on the economic and social lives of local fishermen in the area. The ANOVA result indicates that the levels of Physico-chemical parameters in the three sampling points do not vary significantly with FEPA's and WHO's permissible limits for surface water ($F = 2.84$, $p<0.05$).

Table 2: Comparison of physico-chemical parameters ranges and means values with FEPA's, WHO's considerably limits

S/no	Parameter (s	Ranges	Mean values	FEPA limit	WHO
1	pH	5.4 – 6.8	6.0- 6-9	6.5-8.5	
2	Temperature	29.8 – 31.0	30	27	<35
3	Salinity (Mg/l)	18.7 – 20.8	20	2000	600
4	DO(Mg/l)	38.2 – 41.5	39	8-10	8-10
5	BODs (Mg/l)	38.0 – 59.0	49	10	10
6	Turbidity (NTU	26.4 – 31.8	29.3	1.0	1.0
7	TSS (Mg/l)	19.8 – 24.9	22.3	>1.0	>1.0
8	TDE (Mg/l)	196 – 231	213.3	450	500
9	Conductivity (us/cm)	391 – 462	426.3	200	200
10	Oil and Grease (Mg/l)	24.2 – 40.4	34.4	20	10

Comparative Analysis Of Organic Parameters With Fepa's Permissible Limit

The mean organic parameters of Betwa River in comparison with FEPA's standard for surface water are shown in table 3. Biological oxygen demand (BOD) is the commonest used index in water quality management; it represents the amount of oxygen required for the biological decomposition of organic matter under aerobic condition. It is perhaps an expression of how much oxygen is needed for microbes to oxidize a given quantity of organic matter (Chukwu, 2008). The mean value of Betwa River (49 mg/l) of BOD in was above FEPA's and WHO's acceptable limit of 10 mg/l. This implies that it is harmful to discharge untreated effluent into water bodies, as high BOD like that obtained for this study result in the depletion of dissolved oxygen, which perhaps is detrimental to aquatic lives. However, large amounts of organic matter could result in a near-absolute depletion of oxygen in the River (Fakayode, 2008; Chukwu, 2008).Dissolved oxygen (DO) is a measure of the degree of pollution by organic matter, the destruction of organic substances as well as the self purification capacity of the water body. The DO of Betwa River (39.8 mg/l) exceeded FEPA's acceptable limit of 10 mg/l (Table 3).

According to Chukwu (2008) most game fishes require at least 4-5 mg/l level of DO to thrive. High or low pH values in a river have been reported to affect aquatic life and alter the toxicity of other pollutant in one form or the other (Morrison et al. 2001). DO in liquid provides a source of oxygen needed for the oxidation of organic matter when the concentration is high and lack of it causes the water body to become dead or devoid of aquatic life (Chukwu, 2008).

Table 3: Comparison of organic parameters with FEPA's permissible limit

Parameters	Mean Values	FEPA'S Limit's	WHO's Limit
BOD(mg/l)	49	40	10
DO(mg/l)	39.8	30	8-10

CONCLUSION

Higher concentrations of most of the measured parameters are suggestive of input of effluents into the water from industries within and around the Betwa therefore by virtue of its present quality status is detrimental to aquatic lives; as the mean levels of parameters like turbidity, temperature, BOD and DO exceeded FEPA's permissible limits for surface water. High contents of BOD and DO often deplete the amounts of dissolved oxygen which is harmful to aquatic lives. The results reveal that the water quality status of Betwa is adversely impaired with the discharge of industrial effluents. Turbidity which relates to the amount of materials (effluents) present in the water is observed to be high as a result of input of wastes from the industries.

Likewise, the high content of TSS suggests that wastes are being added to the water from other sources apart from the industrial effluents. This is likely to be the dump sites within the resulting in the deposition of wastes into the Betwa during rainstorms. However,to sustain the ecological status of the Betwa. waste management practice of waste reduction, re-use and recycling should be encouraged; also simple physical treatment of effluents should be carried out through the use of retention ponds.

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