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Impact Assessment of Human Activities and Seasonal Variation on River Benue, within Makurdi Metropolis

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ABSTRACT

The physico-chemical properties of river Benue water were assessed during wet and dry seasons, to ascertain the impact of human activities on the water quality. Temperature, colour, turbidity, total suspended solids (TSS), total dissolved solid (TDS), electrical conductivity, pH, hardness, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrates, phosphates and total coliforms were determined. The result of temperature was found to range between 26-32 ^oC during the two seasons. Colour, turbidity, TDS, SS and pH were found to be between 106.10-147(PtCo colour), 18.18-24.29 (FTU), 17.19-38.78(mgL^{-1}), 12.55-49.57 (mgL^{-1}), and 6.76-6.81(mgL^{-1}), respectively, during the wet season. While during dry season, 4.0-402.20(PtCo colour), 1.60-319.20 (FTU),, 10.40, - 42.40(mgL^{-1}), 4.80, -347.60(mgL^{-1}) and 8.27- 8.68(mgL^{-1}) were observed for colour, turbidity, TDS, SS and pH respectively. The lowest value of hardness (40.20mgL^{-1} $CaCO_3$) was recorded during wet season and the highest was 47.20mgL^{-1} $CaCO_3$. Higher values of hardness 60.20-180.00 mgL^{-1} $CaCO_3$ were observed during dry season. DO, BOD and COD were found to range between 4.20-5.22(mgL^{-1}), 66.40-81.44(mgL^{-1}) and 91.60-128.93(mgL^{-1}) respectively during wet season, while 4.74-6.00(mgL^{-1}), 49.80-158.40(mgL^{-1}) and , 113.20-316.00(mgL^{-1}) was recorded during dry season. Similarly, 21.42-35.92(mgL^{-1}), 0.92-1.10(mgL^{-1}) and 57.60-1680 cfu/100mL was observed as the mean values for nitrates, phosphates and total coliforms during the wet season and 37.87-46.85(mgL^{-1}), 0.44-2.32(mgL^{-1}) and 26.00-1584.00 cfu/100mL recorded for nitrates, phosphates and total coliforms in the dry season. The result of the study revealed that although, the river was polluted at some points the human activities had not been sternly impacted on the river
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Keywords: *River, Pollution, season, runoff, Makurdi and water quality*

I. INTRODUCTION

Rivers are important sources of natural water apart from serving as a source of drinking water, irrigation and fishing; they are generally of immense importance in geology, biology, history and culture. Rivers represent about 0.0001% of the total amount of water in the world; they are vital carriers of water and nutrients to areas all around the earth. Rivers provide habitat, nourishment and means of transport to most organisms and travel routes for exploration, commerce and recreation. They are known to be an important source of valuable deposits of sand, gravels and even electrical energy.

Generally, rivers are known to have multiple uses in every sector of development like agriculture, industry, transportation, public water supply etc, conversely they are used as sites for waste disposal. Waste from industries, domestic sewage and agricultural practices find their way into rivers resulted in large scale deterioration of the water quality. Most often, the discharge of these wastes result into levels that are of health threat to the surrounding environment and even man. Kumar[1] reported that the pollution of a river could result to the spread of diseases like cholera, typhoid fever and diarrhoea. Studies have shown that the consumption of highly contaminated water can cause injury to the heart and kidneys. Toxins within water can harm or even kill aquatic organisms and other animals that may have accidently or ignorantly feed on the infected organisms.

The accumulation of wastes like urea, animal manure and vegetable peelings in water may lead to the growth of algae and other aquatic plants; the consequence is increase rate of microbial activities. This situation may result in depletion of dissolved oxygen causing the death of aquatic animals.

Furhan [2] reported that, the increase in anthropogenic activities as well as natural processes such as precipitation inputs, erosion, weathering of crustal materials, and degradation of surface waters have rendered most water bodies unsuitable for their multi-purpose usage.

The growing problem of degradation and human activities on river ecosystem has made it important for continuous monitoring of water quality of rivers to evaluate their state of pollution. Information obtained from such a study will help in preventing some common water borne diseases.

It is in the light of the above that the present study considered the assessment of river Benue within Makurdi metropolis imperative to ascertain the level of contamination of the river as a result of anthropogenic activities. The result of the study will reveal the inherent health risk if the contamination is beyond the regulatory standards.

II. MATERIALS AND METHODS

Sample collection

Water samples were collected from five locations along the river; Air Force Base (AFB), Benue Brewery Limited (BBL), New Bridge (NB), Saint Joseph's Technical College (SJC) and Rice mill (RM) all along the banks of river Benue (Figure 1.0). This was over a distance of 10 km starting from the Air force Base through the town to a distance away from the town. The first site, AFB located at the upstream is away from the town and was taken as the control site, since this place is less in commercial and agricultural activities. Samples were thereafter taken at interval of two kilometers away up to the RM located at the southern part of the town which represent the downstream. The samples were collected in August, 2009 and February, 2010 in the morning (between 7.30am-10.00am) using 120ml plastic containers.

Methods

Temperature was determined at site using mercury in glass thermometer. Colour, suspended solid, turbidity, dissolved oxygen, chemical oxygen demand, phosphate and nitrate were determined using direct reading spectrophotometer (DR/2000) made by the HACH Company. Total dissolved solid and conductivity were determined using TDS kit model 50150 made by HACH. pH of was determined using a pH meter. Water hardness was determined using Hardness EDTA titration. All the instruments were calibrated before used.

While biochemical oxygen demand was determine using the mathematical expression. While biochemical oxygen demand was determine using the mathematical expression.

BOD $mgL^{-1} = DO_i - DO_f$ /dilution factor
DO_i = dissolved oxygen before incubation
DO_f = dissolved oxygen after incubation for five days

Determination of Total Coliform Bacteria

10ml of MaCconkey broth was filled in 15 bottles using sterile syringe. The inverted Durham tubes were inserted in each of the bottles and the centrifuged for 15 minutes at 121°C. The bottles were then removed and placed in a sterile environment. 10ml of the water sample was inoculated in each of the first five bottles; 1ml of the water sample was inoculated in each of the second five bottles, while 0.1ml of water sample was inoculated in each of the last five bottles. The bottles were kept into an incubator and observed at the end of 24 and 48 hours for presumptive and confirmatory test respectively. The number of positive bottles indicated by colour change and gas formation in each of the rolls were recorded and compared with the bacteria load in the MaCcrady chart. This procedure was repeated for all the water samples

III. RESULTS AND DISCUSSIONS

From Table 1.0 the observed temperature during wet reason was highest (27.00 °C) at BBL and NB, whereas at AFB, SJC and RM, there was no variation in temperature, the value observed was 26.00 °C. From Table 2.0, the temperature observed during dry season was highest (32.00°C) at NB, this was followed by AFB 31.00 °C, BBL had 30.00 °C, while SJC and RM was found to be 29.80 °C and 29.00 °C respectively.

The temperature of any given water determines the rate of metabolism of aquatic organism and the concentration of dissolved gases. The high temperature recorded at BBL and NB during the wet season might be due to the type of effluent and wastewater discharged at these points from the Benue Brewery Limited and the abattoir respectively. The same reason could be responsible for the high temperatures of BBL (30.00°C) and NB (32.00°C) during the dry season. The high temperature at these points also indicate high rate of metabolic activities at these areas, which result to low levels of dissolved oxygen. The unexpected high temperature recorded during the dry season AFB could be due to the depth of the water. It was observed that the river dried at this point during the dry season such that the underneath sand was exposed. It implies that, light rays from the sun can penetrate through the water hence the depth was lower easily. As such, the water would be easily heated to high temperatures. The results of temperature for both dry and wet seasons agree with the results reported by [3].

The mean colour values recorded during wet season (Table 1.0) was 136.60, 140.40, 147.60, 106.00, 110.88 (PtCo, Colour) for AFB, BBL, NB, SJC and RM respectively. The mean colour levels (Table 2.0) observed during dry season at AFB, BBL, NB, SJC and RM were 4.00, 373.20, 402.20, 22.40 and 14.60 (PtCo, Colour) respectively. Statistical analysis of mean levels of colour at the control site using one-way anova indicate significant difference in seasonal variation at $p<0.05$. Also, significant difference exist at $p<0.05$, when the mean values of the samples were compared.

The results of the analysis point toward the colour impacts on the river at BBL and NB which could render the water not suitable for its intending uses. Water from these points may also cause foaming in boilers, hinder precipitation methods e.g., iron removal or water softening.

The mean values for turbidity during wet season was 18.18, 24.29, 23.80, 24.29 and 20.20 (FTU) for AFB, BBL, NB, SJC and RM respectively, while the mean values observed during dry season was 1.60, 319.20, 174.40, 11.00 and 8.40 FTU) for AFB, BBL,

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NB, SJC and RM. There was significant difference ($p<0.05$) in seasonal variation of turbidity.

Turbidity was generally higher during the wet season compared to dry season this may be due to heavy rainfall leading to increase surface runoff from adjacent streams and upper land which carriy a lot of suspended materials into the river leading to high turbidity values. Generally during wet season, suspended particles in the water are always in motion due to water high rate of circulation whereas in the dry season, the particles tend to settle on submerged logs as there is little turbulence.

The extremely high turbidity observed at BBL and NB during the dry season may be due to decrease in the rate of water circulation hence it takes a longer time for the highly concentrated effluents to be diluted during the dry season.

Phytoplankton biomass influences water transparency and therefore turbidity. The adverse effect of turbidity on freshwater include decrease penetration of light rays, hence reduced primary and secondary production, adsorptions of nutrient elements to suspended materials, oxygen deficiency, clogging of filtered feeding apparatus and digestive organs of phytoplankton organisms which may affect hatching of larvae[4].

The result of total dissolved solid (TDS) recorded during the wet season was 17.19, 21.73. 38.78, 20.60 and 18.41 (mgL^{-1}) for AFB, BBL, NB, SJC, RM respectively and 12.40, 42.40, 24.60, 11.60 and 10.40 (mgL^{-1}) was observed during the dry season. Statistics analysis indicates no significant difference at $p<0.05$ in seasons and location variation of TDS. Total dissolved solid is a measure of inorganic salts, organic matter and other dissolved materials in water. Changes in TDS levels in natural water often result from industrial effluent or salt- water intrusion.

Phyllis[5] reported that the concentration and composition of TDS in natural water is determine by the geology of the drainage, atmospheric precipitation and the water balance (evaporation-precipitation). Water with total dissolved solids greater than 1000 mgL^{-1} is considered to be blackish. TDS causes toxicity through increase in salinity, changes in the ionic compositions of the water and toxicity of individual ions. The lower TDS recorded in all season is in agrees with the lower values of turbidity the implication of which is increase penetration of light ray with consequent increase in photosynthetic rate by aquatic plants.

The mean values for total suspended solid (TSS) observed ranged between 12.55 mgL^{-1} - 49.57 mgL^{-1} (Table 1.0) during the wet season, a range of 4.80-347.60 (Table2.0) was recorded during dry season. There was significant difference among locations and seasons variation of TSS at ($p<0.05$). Generally TSS for the wet season was greater than that of dry season except for BBL and NB where it was found to be high (347.60mgL^{-1} and 156.40 mgL^{-1}) respectively during dry season. The higher TSS at these points may be due to the continuous discharge of effluents from the Benue Brewery Limited and the abattoir which carries many materials from the upper land into the river and since the rate of circulation is lower during dry season, this material concentrate at these points during dry season.

According to Bilotta [6], reported that these fine particles sometime act as food source for filter feeders which are part of the food chain, leading to biomagnification of chemical pollutants in fish and, ultimately, in man. Atobatele [4] stressed that in most river basins where erosion is a serious problem, suspended solids can blanket the river bed, thereby destroying fish habitat. TSS is partly a function of discharge because it increases with increase in discharge.

The result of conductivity (Table1.0) was found to be 59.40, 78.60, 91.00, 60.00 and 73.40(μScm^{-1}) for AFB, BBL, NB, STC and RM respectively during the wet season, during dry season, conductivity values (Table 2.0) the values obtained at AFB, BBL, NB, SJC and RM were: 43.40, 45.00, 45.00, 47.20 and 40.20 (μScm^{-1}) respectively. There was significant difference among locations and seasons variation in conductivity at $p<0.05$.

Electrical conductivity increase with increase in total dissolved solids. Results of the study indicate decrease in conductivity during the dry season. Reasons for the trend may be due to increase in concentration of salts, organic and inorganic materials as a result of discharges by the feeder streams, effluents from industries and runoff from domestic and other human activities into the river during wet season. The lower conductivity values during dry season may be due to the utilization of these substances by phytoplankton and other aquatic organism. High conductivity reflects the pollution loan as well as tropic levels of aquatic body. Conductivity values below 50(μScm^{-1}) are regarded as low, while those between 50 – 600(μScm^{-1}) are said to be medium and values above 600 (μScm^{-1}) are considered to be to be high [7].

For most Nigerian inland water bodies, conductivity values have been found to be below 500(μScm^{-1}) at the peak of dry season and less than 100(μScm^{-1}) during the wet season. High conductivity values have been reported to be indicative of pollution load of a river [3].

The pH of the sampled area was found to range between 6.76 – 6.78 during the wet season and 8.29 – 8.80 was observed during dry season. The results indicate slightly acidic during wet season and slightly alkaline during dry season. The result agrees with Atobatele [4] that pH decreases with increase rainfall. The decrease in pH during the wet season can be attributed to increase in organic matter brought about by rains which result in decrease in dissolved oxygen through the utilization of organic dehydration. Aquatic organisms are affected by change in pH because most of

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their metabolic activities are pH dependent. Adeyemo [8] opined that the optimal pH range for sustainable aquatic life is 6.5 – 8.2. According to Murdock [9], decrease in pH of water increases the solubilization of some metals, especially when the pH falls below 4.5. This will led to increase metal concentrations which may be toxic to fish and render the water unsuitable for other uses.

The result of hardness (Table1.0) observed during the wet season was 40.00, 60.60. 88.40, 60.00, 54.00 (mgL^{-1} $CaCO_3$) for AFB, BBL, NB, SJC and RM respectively, during the dry season, the following values were obtained for hardness (Table2.0), were; 60.00, 180.00, 160.00, 72.00, and 60.00 (mgL^{-1} $CaCO_3$) for AFB, BBL, NB, SJC and RM respectively. There was significant difference among locations and seasons variation at p>0.05 in hardness content of the sampled sites.

Total hardness is due to the presence of bicarbonate, sulphate, chlorides and nitrates of calcium and magnesium. Hard water requires more soap and synthetic detergents for home laundry and washing, and contributes to scaling in boilers and industrial equipment. The maximum permissible limit of total hardness for drinking water is 600mgL^{-1}[1]. The result of hardness indicate low hardness values during wet season and high values during dry season which may probably due to high dilution during wet season .

Dissolved oxygen was found to be (Table1.0) 5.08, 4.34, 4.20, 5.22, 5.10 (mgL^{-1}) for AFB, BBL, NB, SJC and RM respectively during the wet season and 5.20, 4.78, 4.74, 4.90 and 4.98 (mgL^{-1}) were obtained as mean values (Table2.0) for AFB, BBL, NB, SJC and RM respectively. There was significant difference among locations, but no significant difference was observed in seasons. The lower values of DO observed during wet season at BBL and NB could be due to phytoplankton bloom and decomposition of organic materials. The decrease in DO of water is due to its poor ability to hold oxygen at high temperature as a result of higher rate of microbial metabolism [10].

Biochemical oxygen demand (BOD) is a measure of the quantity of oxygen used by micro-organisms (e.g., aerobic bacteria) in the oxidation of organic matter. The result obtained from the study indicates BOD values (Table1.0) from AFB, BBL, NB, SJC and RM to be 66.40, 81.40, 81.44, 79.20 and 74.40 (mgL^{-1}) respectively during wet season, while 57.00, 158.40, 71.40, 62.60 and 56.60 (mgL^{-1}) were obtained (Table 2.0) from the same points respectively in dry season. The variation in BOD was observed to be similar to that of DO. The general high BOD values observed during wet season may be due to increase Urban runoff which carries pet wastes from streets and sidewalks; nutrients from lawn fertilizers; leaves, grass clippings, and paper from residential areas into the river. Oxygen consumed in the decomposition process robs other aquatic organisms of the oxygen needed to live. The relative high levels of BOD recorded at BBL and NB may be due the effluents discharged into the river at these points.

Rivers with low BOD have low nutrient levels and this implies high concentration of dissolved oxygen. Unpolluted, natural waters are expected to have BOD values of 5mgL^{-1} or less [11]. Statistical analysis indicates no significant difference at locations, although significant difference exists between seasons. Ezekiel [12] reported that BOD values are usually more during monsoon (heavy rain) than during dry season. Varunprasath [13] reported that algae and other producers in the water take up inorganic nutrients and use them in the process of building up their organic tissues.

The mean values of COD (Table 1.0) obtained from AFB, BBL, NB, SJC and RM during wet season was 98.70, 122.20, 128.93, 118.75 and 91.60 (mgL^{-1}) respectively. The mean values COD obtained (Table 2.0) during dry season was116.80, 316.00, 145.20, 125.20 and 113.20 (mgL^{-1}). Statistical analysis showed significant difference among locations and between wet and dry seasons, at p>0.05. Chemical oxygen demand is the oxygen required for chemical oxidation of organic matter with the help of strong chemical oxidant. Seasonal analysis reveals that maximum values of COD are recorded during wet season and minimum in dry. Chemical oxygen demand is an indicator of organic pollution, which is caused by the inflow of domestic, livestock and industrial waste that contains elevated levels of organic pollutants [14].

Nitrate values (Table 1.0) obtained ranged 21.42 to 35.92 (mgL^{-1}) during wet season while during dry season the mean values were found to range between 37.87 to 125.36 mgL^{-1} (Table 2.0). There was significant difference in nitrate content among locations and seasonal at p<0.05). Nitrate is a form of nitrogen and a vital nutrient for the growth, reproduction and survival of organisms. High nitrate levels of above 10mgL^{-1} are not good for aquatic life [15]. The high levels of nitrate obtained during dry season is in agreement with Adeyemo [8], who reported that nitrates are usually built up during dry seasons and that high levels of nitrates can only be observed during early rainy seasons. This is because the initial rains flushed out deposited nitrates from near surface soils into rivers but as the wet season progresses the levels reduces drastically. Nitrates stimulate the growth of plankton and water weeds that provide food for fish. This may increase the fish population. However, if algae grow too wildly, oxygen levels will be reduced and fish will die. Nitrates can be reduced to toxic nitrites in the human intestine, and many babies have been seriously poisoned by well water containing high levels of nitrate-nitrogen. The U.S. Public Health Service has established 10 mg/L of nitrate-nitrogen as the maximum contamination level allowed in public drinking water. Nitrate-nitrogen levels below 90 mg/L and nitrite levels below 0.5 mg/L seem to have no effect on warm-water fish, but salmon and other cold-water fish are more sensitive. The recommended nitrite minimum for salmon is 0.06 mg/L.

Phosphate is one of the most important nutrients responsible for eutrophication of rivers and lakes which increases algae growth and ultimately reduces dissolved oxygen levels in the water. Results of the study revealed the phosphate content (Table1.0) for AFB, BBL, NB, SJC and RM to be 0.91, 1.10, 1.15, 0.93 and 0.93(mgL^{-1}) respectively during wet season. The level of phosphate recorded during dry season (Table 2.0) was 0.44, 2.32, 1.10, 0.84 and 0.64 (mgL^{-1}). There was significant difference exist among locations and seasons variations at $p<0.05$. The high phosphate level during the wet season could be related to the high rate of decomposition of organic matter and from run-off, surface catchment and interaction between the water and sediments from dead plants and animals remains at the bottom of the river. The relatively high levels of phosphate observed at BBL and NB could be due to discharges and farming activities experience and these points. Also low water circulation during dry season could be implicated in the high content of phosphate. Phosphates content has less or no effects on humans and animals. The recommended maximum level of phosphate for rivers and streams had been reported as $0.1mgL^{-1}$, while 0.025 mg/L is found to accelerate eutrophication process in rivers and lakes [8, 16].

The result of coliforms (Table 1.0) was found to be 578.60, 1680.00, 1356.00, 1600.00 and 1680.00 (cfu/10mL) for AFB, BBL, NB, SJC and R<M respectively during wet season, result recorded during dry season (Table 2.0) was 426.00, 1584.00, 1152.00, 576.00 and 308.00 (cfu/10mL) for the same sites respectively during dry season. Coliforms are a broad class of bacteria found in our environment, including the faece of man and other warm-blooded animals. The presence of Coliform bacteria in water can lead to disease-causing organism such as Escherichia coli (E.coli) and fecal coliforms or parasites. The symptoms from these diseases may include; diarrhoea, nausea, vomiting, cramps or other gastro intestinal distress and in severe cases can be fatal [17]. The ingestion of E. coli may result to hemolytic uremic syndrome, a disease similar to dysentery, and potentially life-threatening. E.coli and klebselia bacteria may also caused urinary tract infections (UTIs). UTIs primarily affect women, and are especially common in pregnant women, due to hormonal changes and physical pressure on the urinary tract [18].

IV. CONCLUSION

The result of the study revealed, although, the river was polluted at some points the human activities had not been sternly impacted on the river. It is believed that continuous pollution of the water sources by these activities may lead to some health problems both to humans as it is some time experienced by the residents of living along the river. It may also have implications to some applications to which the river water is being put to.

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Table 1.0: Physio-chemical Characteristics of Water during Wet Season

Sites / Parameters	AFB	BBL	NB	SJC	RM
Temperature(°C)	26.00±0.00	27.00±0.80	27.40±0.80	26.00±0.00	26.00±0.00
Colour (PtCo colour	136.60±5.35	140.40±1.93	147.60±8.42	106.00±4.20	110.88±2.09
Turbidity (FTU)	18.18±0.06	24.29±1.16	23.80±11.21	24.29±1.20	20.20±0.98
TDS (mgL^{-1})	17.19±0.80	21.73±0.91	38.78±1.73	20.60±1.20	18.41±0.21
SS (mgL^{-1})	12.55±0.38	16.09±0.09	31.60±2.94	49.57±1.67	31.83±2.31
Conductivity (μScm^{-1})	59.40±5.42	78.60±0.68	91.00±4.90	60.00±3.03	73.40±2.42
pH	06.78±0.05	06.81±0.12	06.77±0.13	06.76±0.10	06.78±0.04
Hardness	40.00±0.00	60.60±0.80	88.40±2.49	60.00±0.00	54.40±3.77
DO (mgL^{-1})	05.08±0.19	04.34±0.61	04.20±0.62	05.22±0.12	05.10±0.22
BOD (mgL^{-1})	66.40±1.50	81.40±5.99	81.44±9.73	79.20±0.70	74.40±8.14

COD(mgL^{-1})	98.70±2.00	122.20±9.11	128.93±16.34	118.75±10.50	91.60±3.92
Nitrates (mgL^{-1})	21.42±0.80	37.40±11.79	35.92±3.81	35.28±3.69	29.72±4.78
Phosphate (mgL^{-1})	0.91±0.30	1.10±1.90	1.15±2.43	0.93±0.36	0.93±0.35
Coliform	578.60±0.49	1680.00±97.98	1356.00±5.93	1600±0.00	1680.00±00

Table 2.0: Physio-Chemical Characteristics of Water during Drying Season

Sites Parameters	AFB	BBL	NB	SJC	RM
Temperature(^{o}C)	31.00±0.00	30.40±0.49	32.00±0.00	29.80±0.40	29.00±0.00
Colour (PtCo colour)	04.00±0.49	372.20±21.77	402.20±1.21	22.40±8.45	14.60±3.61
Turbidity (FTU)	01.60±1.96	319.20±7.96	174.40±3.84	11.00±2.25	08.40±1.62
TDS (mgL^{-1})	12.40±0.80	42.40±1.71	24.60±2.94	11.60±1.50	10.40±1.50
SS (mgL^{-1})	04.80±5.88	347.60±5.71	156.40±2.50	14.00±1.55	13.40±0.49
Conductivity (μScm^{-1})	43.40±1.85	45.00±1.62	45.00±2.19	47.20±3.97	40.20±0.49
pH	08.34±0.13	08.29±0.34	08.80±0.03	08.68±0.10	08.57±0.12
Hardness	60.00±0.00	180.00±10.66	160.00±3.58	72.00±1.60	60.00±0.00
DO (mgL^{-1})	05.28±0.29	04.78±0.37	04.74±0.12	04.90±0.20	6.00±0.00
BOD (mgL^{-1})	57.00±2.83	158.40±5.76	71.40±0.12	62.60±3.98	56.60±0.21
COD(mgL^{-1})	116.80±6.01	316.00±11.71	145.20±8.35	125.20±7.96	113.20±0.80
Nitrates (mgL^{-1})	44.56±1.24	43.16±3.29	45.36±14.22	46.85±12.48	37.87±6.49
Phosphate (mgL^{-1})	0.44±2.94	2.32±7.96	1.10±2.15	0.84±2.33	0.64±2.33
Coliform	26.00±9.30	1584.00±34.09	1152.00±29.10	576.00±2.80	308.00±3.43