

## Water Quality Assessment of River Elemi and Ureje in Ado Ekiti, Nigeria

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### Abstract

Water treatment plant is collectively the industrial scale process that makes water more potable or useful by the use of some processes according to the tests and experiments carried out on the water. This project involves the use of surface water. Surface water could be regarded as all inland water permanently or intermittently occurring on the earth surface. The two sources of surface water used are 'Elemi' and 'Ureje' River. The objectives of this project is to find out the quality of water based on BOD, COD, DO, pH and other water quality parameters and to provide information for engineers to execute the project. The process involved in making these water sample potable are; pretreatment, coagulation, flocculation, sedimentation, filtration and disinfection. In comparing the quality of water from the Elemi River and Ureje River, it can be concluded that Elemi River is better to use for domestic purposes than Ureje River.

**Keywords:** Construction; Design; Elemi; Nigeria; River; Ureje; Water quality

### Introduction

According to M.G. Khublaryan, surface waters could be regarded as including all inland waters permanently or intermittently occurring on the Earth surface. Surface water includes water obtained from dams, streams and rivers. It can be contrasted with groundwater and atmospheric water. It is replenished by precipitation and by recruitment from ground-water. It is lost through evaporation, seepage into the ground where it becomes ground-water, used by plants for transpiration, extracted by mankind for agriculture, living, industry etc. or discharged to the sea where it becomes saline. These sources may be more easily contaminated by animal and human wastes, and chemicals from runoff. Surface water may also be at risk of algal blooms. Water Treatment is, collectively, the industrial scale process that makes water more acceptable for an end-use, which may be drinking, industry, or medicine. Water treatment is unlike small-scale water sterilization that campers and other people in wilderness areas practice. Water treatment should remove existing water contaminants or so reduce their concentration that their water becomes fit for its desired end-use, which may be safely returning used water to the environment. For most people, the term 'water treatment' refers to the treatment of polluted water, where the pollution could be from human waste or other sources of pollution. Only a small, but specialized sector in the field of water technology is the design, construction and operation of water treatment plants [1]. There are numerous papers and books where the various procedures of treatment steps, the different types of reactors, the process dynamics and reactions are described in detail. The purpose of treatment is the provision of safe drinking water. The following approach to the design, implementation and control of processes to effect or mediate quality transformations in water emphasizes physicochemical processes rather than operations. Safe drinking water is water with microbial chemical and physical characteristics that meet WHO guidelines or national standards on drinking water quality.

### Study area

AfeBabalola University, Ado-Ekiti (ABUAD), a Federal Government-licensed Private University is a model which is unique in many ways. It is located on 130 hectares of land at an altitude of over 1500 feet above sea level which ipso facto provides cool and ideal climate of learning and sports activities. It is located in Ado-Ekiti along Ijan road, opposite The Federal Polytechnics. The study areas, Ureje River lies at longitudes 005°18'25.87"E and latitudes 07°36' 23.82"N and longitudes and Elemi River lies at longitudes 005° 18.683'E and 07° 36.603'N. The area is underlain by Precambrian basement complex

rocks [2]. The continuous increase in population and the progressive infrastructural development within the campus daily emphasize the need for the development of a sustainable water supply. The University has spent fortunes in purchasing water to ensure that the daily demand for potable water on the campus is met. The rivers used for this research are the Elemi River and the Ureje River. The Elemi River comes from the town and flows through the school. The Ureje River comes from the mountainous sides which also flow through the school (Figure 1 and Table 1).

### Aim and Objective

The aim of this study is to determine water quality assessment of River Ureje and Elemi for ABUAD which will be safe and adequate. The specific objectives are;



Figure 1: Ariel Photo of the study location.(Source: Google map).

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**Received** August 07, 2015; **Accepted** August 24, 2015; **Published** September 10, 2015

**Citation:** Oluwafemi OK, Oluwadare O, Temidire D (2015) Water Quality Assessment of River Elemi and Ureje in Ado Ekiti, Nigeria. J Civil Environ Eng 5: 199. doi:10.4172/2165-784X.1000199

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Sampling Station	Elevation (ft)	Longitude and Latitude
Eleme River	357	07° 36.603", E005° 18.683"
Ureje River	451	07° 37.674", E005° 18.653"

**Table 1:** Elevation, longitude and latitude of the study areas.

1. To determine water quality based on BOD, COD, DO, TSS, pH and other water parameters
2. Provision of information for Engineers to execute this project

## Methodology

The methods involved in carrying out this research are discussed. The assessment of water quality based on its parameters will be conducted.

## Sampling

The purpose of sampling is to take samples in the study area and taken to the laboratory for further testing. Many factors have been considered to obtain accurate readings. Careful planning is a necessity in this study is the first sampling to the testing of samples in the laboratory. Among the factors to consider are time and duration of sampling, weather, equipment, methods to be used as well as testing materials that can be found in the laboratory recommendation by the American Public Health Association.

## Preservation

Preservation of samples was carried out to protect and ensure the sample to be tested in the laboratory has a quality of originality in any case very similar to the site for a period of time specified by the standard. Water sample has been treated with different materials according to the different experimental parameters. For the experimental COD, water sample was preserved with sulfuric acid ( $H_2SO_4$ ), while for the experimental parameters of BOD,  $NH_3$ -N and TSS, embalming is not required. All preserved water samples were stored in the refrigerator at a temperature below 4°C. During the experiment is run, samples of water withdrawn from the refrigerator should be left for a moment to allow the temperature of the water samples back to room temperature. This step is especially important for experiments involving chemical reaction between samples with reagent. This is because the rate of reaction with the reagent may not be done properly when the sample is at room temperature.

## Laboratory tests

Tests was conducted in laboratory and the following parameters were involved which are Hardness, Taste and Odor, Color, Turbidity, pH, BOD, COD and  $NH_3$ -N. BOD and COD were tested directly on arrival in the laboratory. However, curing must be done as soon as possible. If possible, to plan conservation strategies simultaneously tests conducted BOD. This is to avoid changes in the content, while accelerating the process of testing parameters. All steps are done with careful plan.

**Turbidity:** Turn on the turbidity meter. Standardize the meter using the 0.02 NTU Reference Standards. If possible, allow samples to come to room temperature before analysis. In cold weather, it may be necessary to move the turbidity meter indoors to measure sample turbidity. Mix sample to thoroughly disperse the solids. Wait until air bubbles disappear before dispensing sample into a cuvette. Gently agitate the sample to re-suspend any heavier particles without introducing air bubbles. Fill a clean, indexed sample cuvette to within approximately ½" (12 mm) of the top with a sample aliquot directly

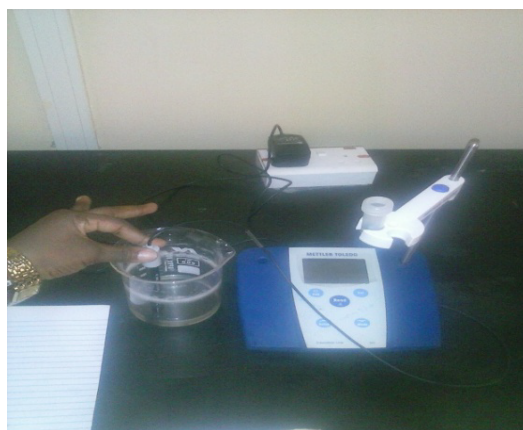
from the churn splitter or from a sample bottle. Place the cap on the cuvette and carefully clean any condensation from the outside of the cuvette with a lint free wiper such as Kim wipes. (Condensation may be prevented by coating the outside of the cuvette with a small amount of silicon oil). Place the sample cuvette into the well, align with the locator pin on the optical well, and take the NTU reading directly from the display. Select the appropriate display range for best resolution. Read the turbidity within 3-5 seconds (Figure 2).

**pH:** The pH was gotten using a probe and a meter. The probe and meter is calibrated according to the manufacturer's directions. Use of two buffers (pH 7 and 10) for calibration is recommended. The water sample can be collected in any glass or plastic container. Collect enough water samples so that you can submerge the tip of the probe. Rinse the probe with sample water before placing it in the sample. Place the probe in the sample and wait for the meter to equilibrate. If the meter needs to be manually adjusted to correct for temperature – you'll know it does if it has an extra temperature knob – adjust it to the temperature of the sample before allowing it to equilibrate. The meter will have come to equilibrium when the signal becomes steady. If it is taking a long time to equilibrate, you may try gently stirring the probe. However, do not agitate the sample since this may cause changes in the pH. Read the pH directly from the meter according to the manufacturer's directions (Figure 3).

**Taste and odor:** For getting the taste of the water sample, the water sample is poured into a beaker. The water sample is then warmed to 23°C. After this, use the front and back of your tongue to the sample and immediately spit out (Table 2). Using the threshold method, two



**Figure 2:** Turbidity Meter.



**Figure 3:** Ph metre and the probe.

CODE	DESCRIPTION/ OBSERVATION
A	Aromatic or spicy eg odor of camphor, lavender, cloves or lemon
AC	Cucumber or synura
B	Balsamic eg flowery

**Table 2:** Analysis of taste result.

water samples are poured into a conical flask. The first water sample is a clean source of water/odor free while the second water sample is the one we are trying to test or the water sample that has odor. The water is then warmed to a room temperature of 23°C. Dilute the odor free water sample with the water sample that has odor. After it has been diluted it is stirred and measured. The diluted water sample is then titrated with the suspected water sample. After this has been done, you will observe by using your nose to smell.

**Dissolved oxygen:** The test for determining the amount of oxygen present in a sample of water is to expose the water sample for 4 hours at a temperature of 27°C with 10% acid solution of potassium permanganate. The quantity of oxygen absorbed can be calculated.

**Hardness:** The water sample is poured into a conical flask and boiled. Next add 1.0 ml of ammonia buffer to the water sample. Then add 3 drops of eriochrome indicator. The water sample is titrated with a standard EDTA (Ethylene DiamineTra-acetic Acid) solution. The color of the indicator changes from wine red to blue.

**Biochemical oxygen demand:** BOD is tested in 5 days period and placed in incubator with a temperature of  $20 \pm 1^\circ\text{C}$  to determine rates of oxygen uptake. Dissolved oxygen is measured initially and after incubation, and the BOD is calculated from the difference between initial and final DO by using DO meter. Because the initial DO is determined shortly after the dilution is made, all oxygen uptake occurring after the measurement is included in the BOD measurement [3]. The apparatus used in this testing are air incubator or water bath and BOD bottle with 350 mL volume while BOD nutrient used as a reagent which consists of phosphate buffer solution, magnesium sulfate, calcium chloride, ferric chloride, sulphuric acid, sodium hyroxide and sodium sulphite solution.

**Chemical oxygen demand:** Before conducting COD testing, a blank samples need to be prepared as a control sample to ensure that no unneeded organic material added to the samole to be measured. COD reagent was added into the specified volume of distilled water to prepare a blank sample while distilled water can be replaced with water sample in order to prepare the measuring sample. Both blank and water samples was heated by a temperature of  $150^\circ\text{C}$  with a period of 2 hours duration. After that, COD concentration was measured by DR5000 and the oxygen demand in the blank sample is subtracted from the COD for blank sample to ensure accurate measurement of organic matter.

**Ammoniacal nitrogen:**  $\text{NH}_3\text{-N}$  is created as one of the intermediate compounds during metabolism and when combined with organic nitrogen, they had been recognized as the pollution indicators [4]. Same as COD testing, a blank sample was prepared in order to control the concentration of  $\text{NH}_3\text{-N}$  value. Several reagents such as Polyvinyl Alcohol, Mineral Stabilizer and Nessler Reagent were added into distilled water and samples and the concentration was determined by data recorded from DR5000.

## Results and Discussion

Based on the methodology of the study described above, findings from the laboratory testing were plotted into graphical form in order to interpret the data for each sampling station at the certain period time.

This is to give exact description and to understand the parameters the water treatment processes will take care of, water samples from both Ureje River and Elemi River [5].

### pH

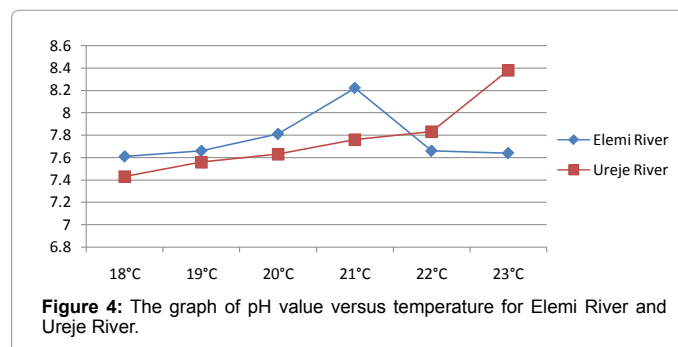
For the graph in Figure 4, pH values of Elemi River and Ureje River are represented. For Elemi River, the pH values steadily increased till it got to 20°C. At 21°C, the pH value increased much more. At 22°C, the pH value reduced to 7.66 and finally reduced to 7.64 at 23°C. For Ureje River, the pH values increased steadily till it got to 7.83 and increased much more at 23°C. The temperatures 18°C-23°C were used because they are room temperatures (Table 3 and Figure 4).

### Dissolved oxygen

For the graph in Figure 5, the DO values in percentage for Elemi River and Ureje River are represented. For Elemi River, the DO values are not really varying much at 25.5°C, 25.6°C and 25.7°C. For Ureje River, the DO values drastically reduced from 93% to 41% and increased to 50% at 25.7°C. Therefore, Elemi River has more DO than Ureje River (Table 4 and Figure 5).

### Biochemical oxygen demand

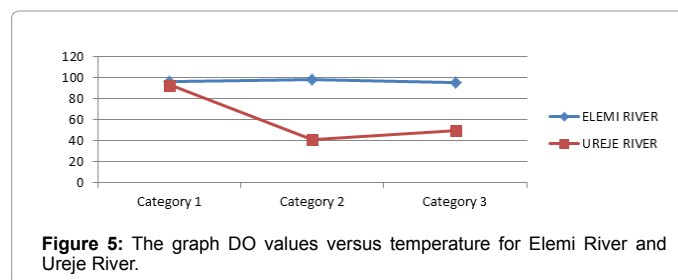
For the graph in Figure 6, the BOD values of Elemi River and Ureje River are plotted. For Elemi River, the BOD values are steady. For Ureje River, the BOD values are steady. Therefore, Ureje River has a higher BOD than Elemi River (Table 5 and Figure 6).



**Figure 4:** The graph of pH value versus temperature for Elemi River and Ureje River.

Temperature (°C)	18	19	20	21	22	23
pH value for Elemi River	7.61	7.66	7.81	8.22	7.66	7.64
pH value for Ureje River	7.43	7.56	7.63	7.76	7.83	8.38

**Table 3:** Laboratory data based on pH for Elemi River and Urejeriver.



**Figure 5:** The graph DO values versus temperature for Elemi River and Ureje River.

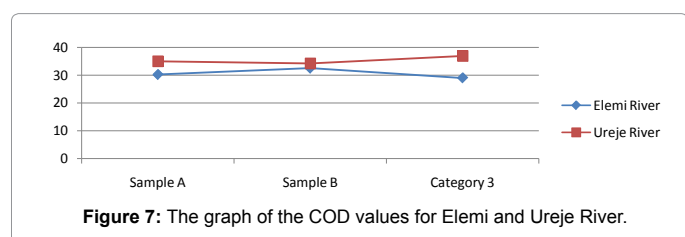
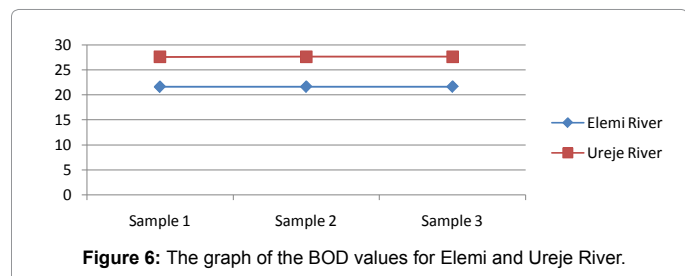
Temperature (°C)	25.5	25.6	25.7
DO for Elemi River (%)	96	98	95
DO for Ureje River (%)	93	41	50

**Table 4:** Laboratory data based on dissolved oxygen for Elemi River and Urejeriver.



Sample A(mg/l)	21.60	21.62	21.63
Sample B(mg/l)	27.60	27.62	27.61

**Table 5:** Laboratory data based on BOD for Elemi River (Sample A) and Ureje River (Sample B).

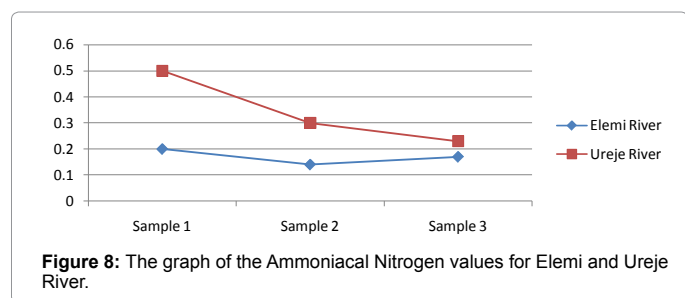


Sample A(mg/l)	30.2	32.5	29.0
Sample B(mg/l)	35.0	34.2	36.9

**Table 6:** Laboratory data based on BOD for Elemi River (Sample A) and Ureje River (Sample B).

Sample A(mg/l)	0.20	0.14	0.17
Sample B(mg/l)	0.50	0.30	0.23

**Table 7:** Laboratory data based on Ammoniacal Nitrogen for Elemi River (Sample A) and Ureje River.



## Chemical oxygen demand

The graph in Figure 7 shows the COD values plotted after the test for Elemi River and Ureje River. For Elemi River, the value increased a little from 30.2 mg/l to 32.5 mg/l and reduced again to 29.0 mg/l. For Ureje River, the value reduced from 35 mg/l to 34.2 mg/l and increased again to 36.9 mg/l. Therefore Ureje River has a higher COD value than Elemi River [6] (Table 6 and Figure 7).

## Ammoniacal nitrogen

Figure 8 above shows the graph of Ammoniacal values of Elemi River and Ureje River after testing. For Elemi River, the  $\text{NH}_3\text{-N}$  value reduced from 0.20 mg/l to 0.14 mg/l and increased again to 0.17 mg/l. For Ureje River,  $\text{NH}_3\text{-N}$  value reduced from 0.50 mg/l to 0.30 mg/l

to 0.23 mg/l. Therefore, Ureje River has higher Ammoniacal nitrogen than Elemi River (Table 7 and Figure 8).

## Total suspended solids

TSS is an indicator of water pollution. High TSS value causes the water to become turbid and polluted. After conducting the laboratory test on the water sample, the result gotten for the TSS is given in Table 8.

## Turbidity

The result gotten from testing the water sample using a turbidity meter is in Table 9 Using a standard solution of 664NTU. From the graph above in Figure 9, the turbidity for Elemi River and Ureje River were tested and the results were plotted on the graph. For Elemi River, the turbidity value for cell 1 is 2.54NTU but reduced to 1.18NTU to 1.08NTU and started increasing steadily till it reached cell 6. For Ureje River, the turbidity value for cell 1 is 2.40NTU but reduced to 1.01NTU and increased drastically to 2.60NTU and started decreasing gradually till it got to cell 5 and increased at cell 6. It does not meet the drinking water standard because the standard turbidity value for potable water is 0.1NTU. Therefore Ureje River has higher turbidity than Elemi River [7,8] (Tables 9-11 and Figure 9).

Water Sample	Volume of sample used (ml)	Initial weight of solid (g)	Final weight of solid (g)	Suspended solid (g)	Concentration of suspended solid (mg/l)
Sample A	50	3.49	1.13	2.36	4.72
Sample B	50	3.31	1.09	2.22	4.44

**Table 8:** Laboratory data based on total suspended solid for Elemi River and Ureje River.

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6
Elemi River	2.54	1.18	1.08	1.31	1.60	2.09
Ureje River	2.40	1.01	2.60	2.47	2.20	2.41

**Table 9:** Laboratory data based on turbidity for Elemi River (Sample A) and Ureje River (Sample B).

## Taste and odor

Water Sample	Code	Description
Sample A	AC	Cucumber or Synura
Sample B	B	Balsamic eg Flowery

**Table 10:** Laboratory data based on taste and odour for Elemi River (Sample A) and Ureje River (Sample B).

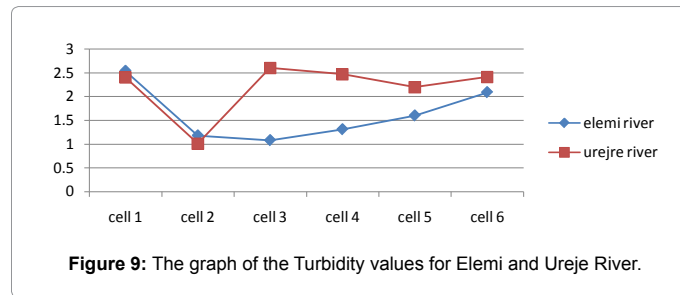
## Hardness

Water Sample	Type of Water
Sample A	Soft water
Sample B	Soft water

**Table 11:** Laboratory data based on hardness for Elemi River (Sample A) and Ureje River (Sample B).

## Conclusion and Recommendation

Samples were taken from the water sources, Elemi and Ureje River for the experiment to be carried out by the first objective. The results gotten from the experiment carried out were used to identify the water treatment process to use in treating the water. A few recommendations were made on the basis of experiments carried out and some of the results presented in the report. There is a need to put the surface water available into use, since the following treatment process has already been stated when the ground water source existing in ABUAD is not yielding enough.



The ultimate goal of designing a water treatment plant is to make it functional while avoiding factors that put them out of use. Such factors may include maintenance, foreign technology without appropriate adaptation and lack of resources (human, material and financial). The following water quality parameters should be routinely monitored;

- Turbidity
- Dissolved Oxygen
- pH
- Hardness

- Biochemical Oxygen Demand(BOD)
- Chemical Oxygen Demand(COD)

Total Suspended Solids(TSS)

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