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# Prelimary investigation of various parameters of baraton dam water in response to drinking water use innovations

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## Abstract

Physico-chemical study of water is important to ascertain the effectiveness of the treatment system and make the necessary recommendations for further study and improvement of the water management system. Physico-chemical analysis of temperature, pH, Total Hardness, Total alkalinity, Biological Oxygen Demand, Dissolved Oxygen, Phosphates, Nitrates, and Sulphates of dam water, tap and water treatment effluent was carried out from fourteen sampling locations in September and November 2013 in order to assess the water quality index of water used by University of Eastern Africa, Baraton and her environs. From the study the level of phosphates and sulphates were found to be high in comparison with the provided WHO standards and therefore proper care should be taken to avoid the accumulation of these compounds in the water source.

Key-Words: Physico-chemical analysis, Dam, Baraton, Water quality index, Parameters

## Introduction

Water is essential to all living things. Despite it has been one of the most important compounds of the ecosystem has faced heavy pollution due to increased human population, industrialization, use of fertilizers in the agricultural sector and also due to man-made activities. This therefore has necessitated the need for a regular check of domestic water at regular intervals because this contamination in drinking water has caused the human population to suffer from varied water bone diseases. The availability is an indispensable feature for preventing diseases and improving quality of life (Adeyeye, 1994). According to Patil (2012), it is very important to test water before it is used for drinking, domestic, industrial or agricultural purpose. Ground water is an important source of freshwater having a balanced concentration of minerals. Human activities arising from overpopulation, urbanization, industrialization, agricultural activities, and mining have greatly affected this balance. Water quality is of vital concern to the humankind since it is directly linked with human welfare (Krishna et al., 2012).

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Studies have shown that uncontrolled disposal of industrial and urban wastes and the use of chemical substances in agriculture (herbicides, fertilizers and pesticides) are the primary cause of groundwater contamination (Ullah et al., 2009).The pH of a solution is measured as a negative logarithm of hydrogen ion concentration. At a given temperature, pH indicates the intensity of the acidic or basic character of a solution. pH values from 0 to 7 are diminishing acidic, 7 to 14 increasingly alkaline and 7 is neutral.

Measurement of pH is one of the most important and frequently used tests, as every phase of water and waste water treatment and waste quality management is pH dependent (American Water Works Association, 1964). The pH of natural water usually lies in the range of 4 to 9 and mostly it is slightly basic because of the presence of bicarbonates and carbonates of alkali and alkaline earth metals. pH value is largely governed by carbon dioxide/bicarbonate/carbonate equilibriums due to bioactivity of plants and in some case by hydrolysable salts. The effect of pH on the chemical and biological properties of liquid makes its determination very important (Standards Methods for the examination of water and wastewater, 2005).

Providing sufficient quantities of high quality water to satisfy our domestic, industrial and agricultural needs is an ongoing global problem (Jagessar et al., 2011). According to Eliot et al., (2008), 97% of the world water is saline, and is thus undrinkable, with 2% locked in glaciers and polar ice caps. This leaves only 1% to meet human demand. Nitrates in water exist due to pollution from point sources, agricultural runoff, industrial effluent, and other human activities. Relatively high concentrations of $NO_3^-$ usually have their origin in processes of organic pollution and excessive use of inorganic fertilizers (Magut et al., 2012). World Health Organization (WHO, 2006) has established a value of 50 $mgL^{-1}$ as the maximum allowed level as the basis for nitrate value for drinking water.

The objective of the study was to assess the physical and chemical properties of ground and tap water in the study area

## Material and Methods

### Study Area

The area under study is situated at the University of Eastern Africa, Baraton (U.E.A.B). U.E.A.B is located in Nandi County, Rift Valley, Nandi North District. It is a highland, exhibiting large forest cover of highland equatorial type. The altitude of the study area ranges from 1900 meter above sea level to the West and 1500 meter above sea level to the East. The rainfall patterns vary from a dry spell in June/July and high rainfall in August and September subsiding in October and November. The average annual rainfall received in this location is 1,124 mm per annum. Water for domestic use in UEAB and her environs are sourced from the dam and treated at the University water treatment plant.

### Sample Collection

Water samples from fourteen selected sites, namely; Dam Source, Dam Site A, Dam Site B, Dam Site C, VC's drive Effluent, VC's drive house no. 5 tap, graduation square effluent, community gate effluent, dean of women residence effluent, water treatment effluent, and water treatment inlet were collected using sample bottles acid washed and rinsed with distilled water. The samples were collected in September and November 2013, transported to the Chemistry laboratory at U.E.A.B using a cool box. Sample analysis was immediately done for parameters that need to be determined instantly and the rest of the samples were refrigerated at 4˚C to be analyzed later.

### Sample analysis

Laboratory grade distilled water for the preparation of reagents and samples was used for all the analysis.

### Phosphates

The samples were analyzed in triplicates and the average of the absorbance used to find the concentration using a standard graph. The analysis was performed using the Stannous Chloride method according to the Standard Methods for the Examination of Water and Waste Water (2000).

### Sulphate

Sulphate analysis was performed using Turbidimetric method. Determination of sulphate concentration was done according to Rossum et al., (1961) and Standard Methods for the Examination of Water and Waste Water (2005). According to this method, sulphate ion was precipitated in an acetic medium with Barium chloride so as to form Barium sulphate crystals of uniform size.

### Nitrate

### Nitrate Standard

Nitrate standard was prepared by dissolving 3.6107 g of potassium nitrate ($KNO_3$) that had been dried in an oven at 103-105˚C for 1 hour and diluting to 500 ml with distilled water. This is equivalent to 1000 ppm nitrate standard. A 50 ml solution was pipetted from the 1000 ppm standard and diluted to 500 ml with distilled water to make 100 ppm standard; 10 ml was then pipetted from the 100 ppm stock solution into 100 ml.

### Sample Preparation

A blank solution was prepared by pipetting 5 ml distilled in to 150 ml beaker. Samples were prepared by taking 5 ml of the sample into a 150 ml and taken to dryness on a hot plate. Two milliliter (2 ml) of phenol disulphonic acid was added and the sides were washed down lightly, warmed on hotplate, removed and allowed to cool. Ten milliliter (10 ml) of concentrated ammonium hydroxide was then added carefully in the fume hood. It was added carefully to a 50 ml volumetric flask, washed cleaned and made up to the mark with distilled water. The absorbance of the samples was measured with a UV-Vis spectrophotometer at 420 nm. The same procedure was used for the standards.

The following are the volumes of standards that were placed in a beaker: 1 ml 10 ppm was pipetted into 150 ml beaker(=10 ppm), 2 ml of 10 ppm was pipette into a beaker(=20ppm), 3 ml of 10 ppm was pipetted into 150 ml beaker(=30ppm). A standard graph was prepared then prepared.

### Alkalinity

The alkalinity of a sample was estimated by titrating against standardized sulphuric acid of 0.02 N at room temperature using phenolphthalein and methyl orange indicator. Titration to decolourization of phenolphthalein indicator will indicate complete neutralization of $OH^-$ and ½ of $CO_3^-$, while sharp change from yellow to orange of methyl orange indicator will indicate total alkalinity (complete neutralization of $OH^-$, $CO_3^-$, and $HCO_3^-$.

**pH**

The pH of the samples was analyzed using Jenway pH meter calibrated with pH buffer 4±0.1 and pH buffer 7±0.1. The samples were poured into labeled beakers and stirred to establish equilibrium between the electrodes and the samples to ensure homogeneity and the pH measured immediately.

## Results and Discussion

The total hardness was analyzed for at the VC drive No.5 and dam site A with a minimum of 3.86mg/L and a maximum of 4.16 mg/L respectively. Hardness is the property of water which prevents the lather formation with soap and increases the boiling point (Parihar et al., 2012). Hardness is a property that arises from the presence of calcium and magnesium salts (Radhakrishnan et al., 2007). The total hardness according to the WHO guidelines for drinking water, hardness has no prescribed guideline.

The DO values indicate the extent of pollution in water bodies (Bheshdadia et al., 2012).In the present study, a DO value of 14.2 mg/L at Dam site A was obtained and max. 18.3 mg/L at the VC drive No.5 Tap. Dissolved oxygen is an important parameter in water quality assessment and reflects the physical and biological processes occurring in water (Shaikh et al., 2009).

Electrical conductivity was analyzed from two samples, Dam site A and VC drive No.5 tap with a minimum value of 97.6µS/cm and a maximum value of 199 µS/cm respectively. According to Kalva (2012), high Electrical conductivity values indicates the presence of high amounts of total dissolved solids Electrical conductivity is a measure of water capacity to convey electrical current (Indian Council of Medical Research, 1975). The study found out that the EC level was within the permitted limits of 1500µS/cm, however, the value was high at the VC drive No.5 tap, which could be attributed to the use of metal pipes.

The pH of the samples ranged from a minimum 5.56 to a maximum 8.15. In the present investigation, a higher pH of 8.15 was observed at VC drive No.5 tap. This is an indication of the alkaline nature of the water (Baligar et al., 2004). Effluent sourced from the Graduation square had a low pH of 5.56. The reading was far below the accepted value established by the World Health Organization (WHO). The World Health Organization has established a minimum value 6.5 and a maximum value of 8.5 pH units as the international reference point for drinking water quality.

According to the current study, the level of phosphate from the sampled water ranged from 60 mg/L-187 mg/L in the month of September. During the month of November, phosphate levels were recorded to be 67 - 213 mg/L. The analysis confirmed the deviation of the samples from the maximum allowable standard of 5.0 mg/L.

The level of sulphates from the study ranged from a minimum 256 mg/L to a maximum 1056 mg/L in the month of September. No sulphates were detected from water samples from Dam site A, Dam source, Dam site C and water treatment inlet. In the month of November, the level of sulphates from the water samples ranged from a minimum 200 mg/L to a maximum 456 mg/L. In November, all the sampled water had sulphates present. World Health Organization has established a maximum allowable guide value of 400 mg/L. Four samples, two each from the two sampling months showed deviation from the maximum allowable limit.

The values of nitrates were a minimum 0.004 mg/L recorded from the sample obtained from Science building tap to a maximum of 0.027 mg/L recorded on the sample from Dean of Women residence effluent. These values are for the month of September analysis as recorded in table 1. During the analysis of water sampled during the month of November, nitrates values ranged from 0.004 mg/L registered at the sample from the water treatment effluent and graduation square effluent. A maximum value of 0.014 mg/L was recorded at the water treatment inlet.

Total alkalinity in the month of September ranged from 50-116mg/L recorded at the Community gate effluent, Science building tap with a maximum level at the community tap while during the month of November, the results ranged from a minimum value of 32 mg/L to a maximum value of 92 mg/L as recorded at the sample from the Dean of women residence.

## Conclusion

From the study, it can be concluded that the levels of phosphates, sulphates and conductivity was high. The results presented in table 1 and 2 indicate some levels of pollution which could arise from agricultural activities around the University. The high conductivity in tap water is due to the use of metallic pipes. Ground water pollution is becoming a challenge to the water systems. Proper protection of water sources by the university should be encouraged to prevent the deterioration of the scarce resource. Regular analysis should be performed to obtain relevant and up-to-date data on water quality monitoring and provide a basis for improving the quality of water and for further assessment.

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**Table 1: Sample analysis for the month of September**

| Sample Name | Temp ˚C | pH | Total Alkalinity | $[PO_4^{3-}]$ in mg/L | $[SO_4^{2-}]$ in mg/L | $[NO_3^-]$ in mg/L | DO in mg/L | $BOD_5$ in mg/L |
|---|---|---|---|---|---|---|---|---|
| **1. Dam Source** | 18.5 | 6.33 | 59 | ND | ND | 0.012 | | |
| **2. Dam Site A** | 18.0 | 7.52 | 66 | 153 | ND | 0.011 | 14.2 | 18.3 |
| **3. Dam Site B** | 18.0 | 7.68 | 64 | 187 | 156 | 0.018 | - | - |
| **4. Dam Site C** | 18.0 | 7.26 | 62 | 133 | ND | 0.012 | - | - |
| **5. VC's drive Effluent** | 18.0 | 6.29 | 84 | 80 | 400 | 0.006 | - | - |
| **6. VC's drive house no. 5 Tap** | 18.0 | 8.15 | 54 | 133 | 256 | 0.006 | ND | ND |
| **7. Graduation Square Effluent** | 18.5 | 5.56 | 80 | 93 | 381 | 0.020 | - | - |
| **8. Community Gate Effluent** | 17.9 | 6.33 | 50 | 60 | 344 | 0.005 | - | - |
| **9. Dean of women Residence Effluent** | 18.0 | 6.38 | 66 | 133 | 1056 | 0.027 | - | - |
| **10. Water Treatment Effluent** | 18.0 | 7.32 | 60 | 60 | 375 | 0.005 | - | - |
| **11. Water Treatment Inlet** | 18.0 | 7.69 | 52 | 107 | ND | 0.009 | - | - |
| **12. Community Centre Tap** | 17.9 | 7.49 | 116 | 67 | 375 | 0.012 | - | - |
| **13. Agriculture Tap** | 18.0 | 7.32 | 58 | 133 | 281 | 0.010 | - | - |
| **14. Science Building Tap** | 18.1 | 7.45 | 50 | 100 | 288 | 0.004 | - | - |

**Key (ND) -** The parameter being analyzed was not detected at the sample site.

**Table 2: Sample analysis for the month of November**

| Sample Name | Temp ˚C | pH | Total Alkalinity | $[PO_4^{3-}]$ in mg/L | $[SO_4^{2-}]$ in mg/L | $[NO_3^-]$ in mg/L | Conductivity in µS/cm | Total Hardness in mg/L |
|---|---|---|---|---|---|---|---|---|
| **1. Dam Source** | 18.4 | 7.19 | 40 | 313 | 200 | 0.013 | | |
| **2. Dam Site A** | 18.8 | 6.43 | - | 220 | 213 | 0.012 | 97.6 | 4.16 |
| **3. Dam Site B** | 18.9 | 6.61 | 80 | 127 | 200 | 0.010 | | |
| **4. Dam Site C** | 18.8 | 6.56 | 40 | 273 | 219 | 0.011 | | |
| **5. VC's drive Effluent** | 19.0 | 6.55 | 36 | 287 | 200 | 0.012 | | |
| **6. VC's drive house no.5 Tap** | | - | - | - | - | - | 199 | 3.86 |
| **7. Graduation Square Effluent** | 18.4 | 7.36 | 76 | 153 | 294 | 0.004 | | |
| **8. Community Gate Effluent** | 18.8 | 5.83 | 60 | 127 | 463 | | | |
| **9. Dean of women Residence Effluent** | 18.9 | 6.27 | 92 | 120 | 450 | 0.012 | | |
| **10. Water Treatment Effluent** | 18.4 | 5.83 | 32 | 67 | 294 | 0.004 | | |
| **11. Water Treatment Inlet** | 18.5 | 6.29 | 36 | 140 | 206 | 0.014 | | |
| **12. Community Centre Tap** | 18.9 | 6.32 | 86 | 140 | 269 | 0.012 | | |
| **13. Agriculture Tap** | 18.9 | 6.58 | 40 | 73 | 213 | 0.012 | | |
| **14. Science Building Tap** | 18.9 | 6.74 | 56 | 113 | 225 | 0.005 | | |

**Key (–): means the sample was missing or not analyzed for the parameter**

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