Assessment Of Nutrient Load In Unwana River Flow Course

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Abstract

Three water samples were collected from different locations of Unwana River. The parameters analyzed were NH_3-N, NO_3^-, NO_2^- and PO_4^{-3} and these were done using UV-spectrophotometric method. The results of the samples showed that Location A has NH_3-N concentration of 1.63±0.17 mg/, B 0.95±0.73 mg/L, C 1.20±0.44 mg/L while NO_3^- in Location A was 0.73±0.39 mg/L, B was 0.73±0.19 mg/L, C 0.44±0.19 mg/L while NO_2^- concentration in Location A was 0.17±0.017 mg/L, B 0.17±0.017 mg/L, C 0.20±0.009 mg/L while PO_3^{-3} concentration in Location A was 12.1±0.39 mg/L, B 11.15±0.72 mg/L, C 11.43±0.092 mg/L. The results were compared with the World Health Organization (WHO) drinking water standard. The results showed that NH_3-N, NO_3^- and PO_4^{-3} were below the WHO drinking water standard and this did not pose any danger to the users. The results of the analysis indicated that the NO_2^- concentrations were above the WHO permissible limit of drinking water standard and this could pose threat to the persons using the water. High concentration of NO_2^- can cause methemoglobinemia (blue baby syndrome) in children. Due to high concentrations of NO_2^- the water should be treated before usage.

Keywords: *Nutrient, phosphate, UV-Spectrophotometric, danger, methemoglobinemia*

Introduction

Nutrient load also known as "Eutrophication" is an enrichment of water body by nutrient salts that cause structural changes to the aquatic environment. This leads to algal bloom and rapid plant growth, depletion of fish species and general deterioration of water quality and other effects that reduce and preclude use (Eni. 2016).

Nutrient load is a serious problem since it results in a deterioration of water quality and is one of the major impediments to achieving the quality objectives established by the water frame work directive at the European level. According to the survey of the state of the world's Lakes, a project promoted by International Lake Environment Committee, nutrient load affects 54% of Asian Lakes, 53% of those in Europe, 48% of those in North America. 41% of those in South America and 28% of those in Africa (www.lescienze). All water bodies are subject to a natural and slow nutrient load process, which in recent decades has undergone a very rapid progression due to the presence of man activities (so called cultural nutrient load). The cultural nutrient load process consists of continuous increase in the contribution of nutrients, mainly nitrogen and phosphorus (organic load) until it exceeds the capacity of the water body (i.e., the capacity of lake, river or sea to purify itself) triggering structural changes in waters.

Nutrient load most commonly arises from the oversupply of nutrients, most commonly as nitrogen and phosphorus, which lead to overgrowth of plant and algae in aquatic ecosystem. According to Ullman's Encyclopedia. "The primary limiting factors for nutrient load are phosphate". The availability of phosphorus generally promotes excessive plant growth and decay, favouring simple algae and plankton over other more complicated plants, and causes a severe reduction in water quality, phosphorus is a necessary nutrient for plant to live, and is the limiting factor for plant growth in many fresh water ecosystems. Phosphate adheres tightly to soil, so it is mainly transported by erosion. Once translocated to lakes, the extraction of phosphate into water is slow, hence the difficulty of reversing the effects of nutrient load (Khan and Mhamad, 2014). However, numerous literatures report that nitrogen is the primary limiting nutrient for accumulation of alga biomass (Khan and Ansari, 2005). The sources of this excess phosphate are phosphates in detergent, with the phasing out of phosphate – containing detergent, industrial domestic runoff and agriculture have emerged as the dominant contributors to nutrient load (Werner, 2002).

The aim of this study is to assess the nutrient load in Unwana River and this will help the general public to ascertain the level of nutrient load in the water body and it will avail the general public the knowledge of the concentration levels of the various parameters and whether the concentrations of the various parameters analyzed exceeded the WHO (2006) permissible water limit.

Materials and Methods

Determination of Nitrogen – Ammonia

The ammonia of the water sample was determined using UV-spectrophotometer model HACH DR 2400 (Phenate method) at a wavelength of 636nm according to the method described by (SAP, 1999). NH_4^+ solution 0, 2, 4, 6, 8 and 10cm^3 of the stock was pipette into 100cm^3 flask and this will be made up to mark.

A 5cm^3 of the filtrate from the sodium acetate extract was pipette into a flask and 2.5cm^3 of alkaline phenol, 1cm3 sodium potassium titrate and 2.5cm^3 of sodium hypochlorite was added into the flask. The maximum was shook well in each addition. The standard was treated similarly/ the absorbance was read off at the wavelength of 636nm on the UV – spectrophotometer. The

concentration of NH3 – N was estimate from the calibration plot.

Determination of Nitrogen – Nitrate

The nitrate of the water samples was determined using UV-Spectrophotometric method according to the method described by (SAP, 1999). Working NO_3 standard (10mg/L) solution: $10cm^3$ of the stock was pipetted into $100cm^3$ volumetric flask and was made up to the mark. From this solution 0, 1, 2, 3 ,4 and 5 each was pipetted into $50cm^3$ flask to have 0, 0.2, 0.4, 0.6, 0.8 and 1.0mg/L. This was made up to the mark after the colour developing reagent was added.

A $10cm^3$ of the sample was pipetted into a $50cm^3$ flask and $2cm^3$ of brucine sulphate was added together with $10cm^3$ of concentrated H_2SO_4 which was rapidly added. The solution was allowed to stand for 10minutes. The absorbance was read off at a wavelength of 470nm on the UV -Spectrophotometer. The concentration of NO_3 was estimated from the calibration plot.

Determination of Nitrogen – Nitrite

The nitrite of the water samples was determined using UV – Spectrophotometric method according to the method described by (SAP, 1999). Working NO_2 solution (10mg/L). A $10cm^3$ of the stock solution was pipetted into $100cm^3$ flask and was made up to mark. from this solution 0, 1, 2, 3 ,4 and 5 each was pipetted into $50cm^3$ flask to have 0, 0.2, 0.4, 0.6, 0.8 and 1.0mg/L. This was made up to mark after the colour developing reagent was added.

A $10cm^3$ of sample was pipetted into a $50cm^3$ flask and $2cm^3$ of 2M HCl was added onto the flask. Thereafter, $2cm^3$ of sulphanilic acid was added while stirring. It was allowed to stand for 5minutes. The standard was treated in a similar manner as the samples. The absorbance was read off at a wavelength of 520nm on the UV spectrophotometer after 20minutes. The concentration of NO_2 was estimated from the calibration plot.

Determination of Phosphorus

The phosphorus of the water samples was determined using UV spectrophotometric method (Ascorbic acid method) according to the method described by (Balance, 1996). Working P standard solution: A $5cm^3$ of the $100cm^3$ phosphorus stock solution was pipetted into a $100cm^3$ volumetric flask and was made up to the mark with distilled water.

A $5cm^3$ of the sample was pipetted into a $25cm^3$ flask and the pH of the solution was adjusted to 5. then $10cm^3$ of distilled water was added before the addition of $4cm^3$ of reagent B and was made up to the mark with distilled water. The blue color was treated in a similar manner as the samples. The absorbance was read off at the wavelength of 882nm on the UV spectrophotometer after 20 minutes. The concentration PO_4^{3-} was estimated from the calibration plot.

Results

Table 1 showed the summary of the statistical analysis of NH_3-N, NO_3^-, NO_2^- and PO_4^{3-} in the water samples of Unwana River, while Figure 1 is the bar chart conveying the levels of each parameter in the three locations in Unwana River. Figure 2 showed the mean concentration of nutrient load parameters.

Table 1: Summary of the Statistical Analysis of NH_3-N and NO3- in Unwana River

Sample	NH_3-N, mg/l	NO_3^-, mg/l	NO_2^-, mg/l	PO_4^{3-}, mg/l
A	1.63±0.17	0.73±0.039	0.17±0.017	12.10±0.39
B	0.95±0.73	0.73±0.19	0.17±0.017	11.15±0.72
C	1.20±0.44	0.44±0.19	0.20±0.009	11.43±0.092
D	1.12±0.02	0.67±0.001	0.30±0.002	13.26±0.08
E	1.04±.0.01	0.70±0.014	0.15±0.011	11.20±0.20
F	0.70±0.32	0.70±9.015	0.19±0.03	12.00±0.01
WHO (2012)	0.50	50	0.003	5

Discussion

The results in Table 1 showed that the mean concentration of NH_3-N in Location A was 1.63±0.17, B 0.95±0.73, C 1.20±0.44, D 1.12±0.02, E 1.04±0.01 and F 0.70±0.32. The results when compared with the WHO (2011) drinking water standard were higher than the findings. Figure 1 showed that the NH_3-N was lowest at Location F and was highest at Location A. The high concentration of NH_3-N leads to formation of harmful substances such as nitrosamine which is mutagenic in nature. When ammonia is present in water at high levels, it is difficult for aquatic organisms to sufficiently excrete toxicant, leading to toxic buildup in internal tissues and blood and potentially death (USEPA, 2013).

The results in Table 1 showed that the mean concentration of NO_3^- in Location A was 0.73±0.19 mg/L, B 0.73±0.19, C 0.44±0.19, D 0.67±0.001, E 0.70±0.014 mg/l and 0.70±0.015 mg/l. Figure 1 showed that the lowest concentration was obtained in Location C while the highest concentration was obtained in Location A. The results were higher than what were submitted by Afiaukwa and Eboatu (2013) which was 0.34±0.64 and was lower than what Kendre and Gawande (2015) submitted which was 45mg/l. The NO_3^- concentration in all the locations were lower than the WHO (2012) permissible limit of drinking water of 50mg/l. Nitrate is a very important nutrient for many plants and at times play roles such as growth-limiting nutrient. It is also used by algae and other water plants to form protein which subsequently be used by animals to form animal protein. Nitrate is a major ingredient of farm fertilizers and is necessary for plant uptake and is essential for plant growth (Neal *et al*, 2005). Nitrates are the indirect source of food for fish. This may increase the fish population. However, if algae grow too wildly, oxygen levels will be reduced and fish will die.

The mean concentration of NO_2^- in all the locations as shown in Table 1 ranged 0.15±0.011 - 0.30±0.002mg/l with Location E having the lowest concentration of 0.15±0.011 and Location D having the highest concentration of 0.30±0.002. The results obtained when compared with WHO (2012) were higher than the guideline set up for drinking water by WHO which is 0.003mg/l. The results were lower than the finding of Kendre and Gawande (2015) which was 3mg/l. Nitrite when found in high concentration in drinking water pose serious danger as it is the cause of methglobenemia otherwise known as blue baby syndrome in children.

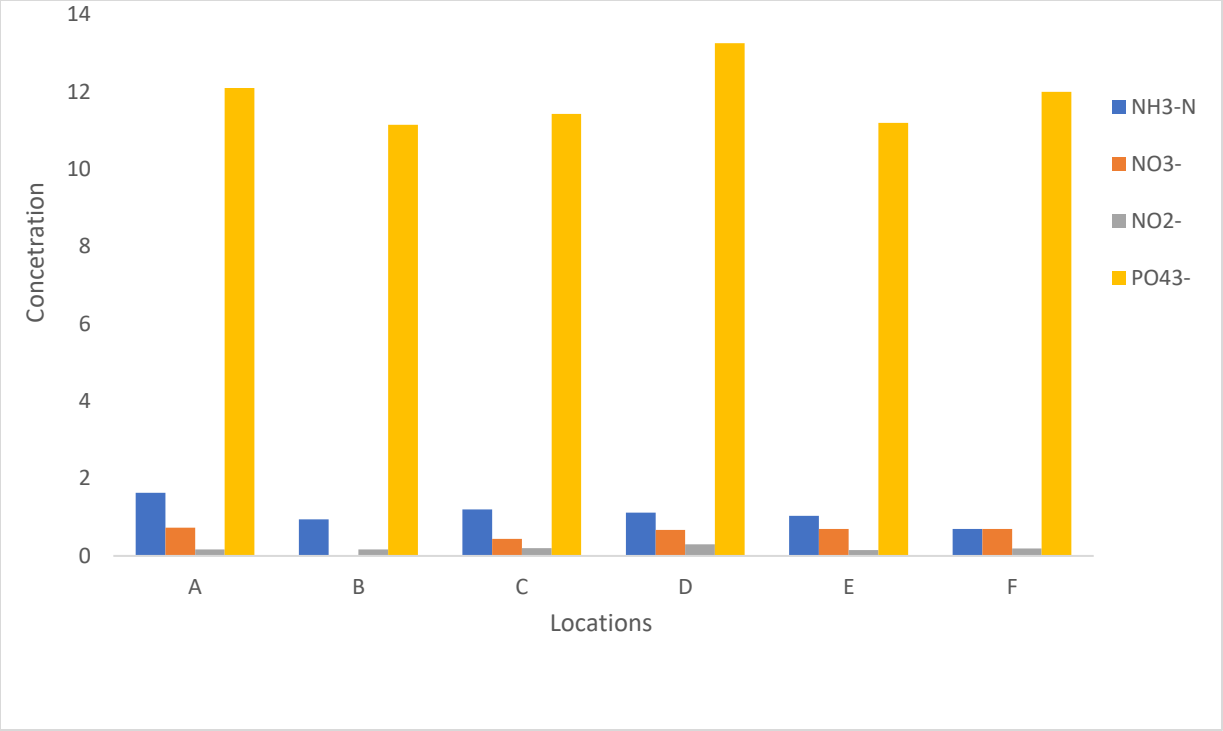

Figure 1Figure 1: Concentraton of the nutrient load in the water body

The results in Table 1 showed that the mean concentration of PO_4^{3-} in Location A was 12.10±0.39, B 11.15±0.72, C 11.43±0.092, D 13.26±0.08, E 11.20±0.20 and F 12.00±0.01 mg/l. The results as it is shown in Figure 1 has it that PO_4^{3-} in Location B recorded the lowest value while Location D has the highest value in the water samples. These results were higher than the WHO (2012) permissible limit for drinking water guideline of 5.00 mg/l. Our findings was extremely higher than the value of 0.002 mg/l submitted by (Dirican, 2015). High concentration of phosphate in water leads to eutrophication which in turn leads to algae bloom in water.

Conclusion

From the findings, the six locations contained different levels of ammonia, nitrate, nitrite and phosphate and it was found out that only nitrate was lower than the WHO (2012) drinking water standard. Therefore, water from those locations need proper and adequate treatment before use or consumption in order to avoid intake or intoxication of the element present in the water.

Recommendations

Due to high concentration of ammonia, nitrite and phosphate which were higher than the WHO drinking water standard and made the water unfit for domestic usage, proper and sufficient treatment should be given to the water.

Also, government should deploy effective techniques to researchers for proper treatment and purification of water before consumption in order to promote healthiness of the consumers and make water suitable for consumption and other industrial and biological uses.

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