Fate of Fertilizers and Impact to the Ecosystem in the Chemelil Sugar zone, Kenya

Ongulu Roselyn Adhiambo, Kituyi, John Lusweti*,Mitei Yulita, and Maghanga, Justin

Dept. of Chemistry & Biochemistry, Moi University, P.O. BOX 1125-30100, ELDORET
E-mail: joluki@yahoo.com

*Author for correspondence and reprint requests

Evaluation of total phosphorus and total nitrogen in water and sediments of Chemilil Sugar belt, a catchment of Lake Victoria has been done to determine the fate and environmental impact of fertilizers that are used on farms in the catchment area.Extensive water and sediment sampling from various rivers within the area has been done. Total nitrogen and total phosphorus were determined by colorimetry. The nitrogen levels in sediments were 0.044%, 0.140%, and 0.262% in zones 1, 2 and 3 respectively, meaning that there was accumulation towards the lake. The levels of phosphorus in sediments were relatively lower, with levels of 0.071%, 0.213% and 0.78% in zones 1, 2 and 3 respectively. The total nitrogen in water was also low with levels of 0.078% and 0.066% in zone 1 and 2 respectively. Total phosphorus was particularly very low in water and most areas less than 0.001%. Both nitrogen and phosphorus were higher in sediments than in water. R. Morgut had the most polluted water samples while R. Ainamutua had the most polluted sediment samples in terms of total nitrogen. Total P was 0.001% throughout.

Key words: Impact, heavy metals, sediments, water quality, sustainability, urbanization

Introduction

Chemelil sugar belt is a catchment of Lake Victoria, agricultural activities in the region include; large scale sugarcane, tea, coffee, maize, tobacco and rice cultivation. Other farming activities include; horticulture, food crop farming and livestock rearing.
There is increasing awareness of the potential hazards that exist due to contamination of fresh water impoundments by toxic metals, phosphates and nitrates associated with agricultural activities, urbanization and the mining industry (Dupreez *et al*., 2003). To avoid this problem organic farming is practiced in some countries where crops are grown using environmentally friendly techniques, no synthetic chemicals are used instead natural compost such as dung ash, natural phosphate etc are used (Moellhausen , 2006).
Jaetzold and Schimdt (1977 part A) computed an estimation of the input of nitrogen and phosphorus based fertilizers in the area of each crop and on the recommended application rates. The most commonly used pesticides include; insecticides, herbicides, fungicides, rodenticides, acaricides and auxins.

In Kenya heavy dependency on these chemicals for food production has led to death of fish in the Lake, this in turn has led to the ban of exportation of fish to the European Union (Ntiba *et al.,* 2001). This affected fishing and the economy of the riparian countries. The total loss of income due to this ban was estimated to be more than US$300 million (Kengara, 2003).

Materials and Methods

Sampling

The area was divided into 3 zones with respect to sediments samples and two zones with respect to water samples. Sediment samples were collected from 14 points by a core sampler. All the samples were transported in cool boxes with freezer packs and stored at between -5 ^{o}C to -10 ^{o}C in the laboratory awaiting analysis.

Water samples were collected from 13 rivers by grab samples, in the morning, midday and late afternoon. The water was mixed in 1 litre plastic bottles which had been previously washed detergent, tap water, 10 % nitric acid and the thoroughly rinsed with double distilled water.

Zone one (S) had the rivers; Kedowa (9), Masaita (18), Murgut (19), Nyando at Muhoroni- Kericho road (15) and Nyando at IGD 7 (6).
Zone two(S) had the rivers, Ainaprigetuny (7), Great Oroba at Miwani -Chemelil bridge (23), Nyando at Ogilo (3), Ahero irrigation channel (20) and Nyando at Ahero (25).
Zone three (S) had the sampling sites; Parget (12), Ainabngetuny (4), Mbogo (13) and Ainamutua at Kibigori (1)
 Zone one (W) had the sampling sites; R. Masaita (4), R. Kedowa (9), R. Kimison at Kipkelion (10), R.Kipchorian at Kipkelion (7), R. Namting near Fort-Tenan (14), R. Murgut at Fort-Tenan (2), R. Nyando at Muhoroni-Kericho road (6), R. Nyando at IGD7 (15), R.Nyando at Ogilo (8) and R. Nyando at Ahero bridge (11)
Zone two (W) had the sampling sites; R. Parget (12), R. Mbogo (5), R. Ainamutua (13), R. Nyando at Ogilo (8) and R. Nyando at Ahero bridge (11).

Reagents

All reagents were of analytical grade quality and these were; hydrogen peroxide (30 %) lithium sulphate, selenium powder, sulphuric acid, ammonium molybdate, antimony potassium tartrate, ascorbic acid, sodium salycylate, sodium tartrate, sodium nitroprusside, sodium hydroxide, sodium hypochlorite and ammonium sulphate.

Sample digestion

The sediments were air-dried, crushed and sieved through 0.2 mm sieve as described by Okalebo and others (1998). Accurately weighed 0.3 g of the ground sediments was transferred to a digestion tube.

This digestion mixture was stable for 4 weeks-stored at 2 ^{0}C (Okalebo *et al*., 1998). About 0.3 +/- 0.001 g of the ground soil samples was weighed   and transferred into

digestion tubes. About 4.4 mL of the digestion mixture, which had been prepared by taking 0.42 g of lithium sulphate that had previously been added to 350 mL of 30 % hydrogen peroxide, mixed well and 420 mL of concentrated H_2SO_4 was added slowly and with care while cooling in an ice bath was added. Digestion was done at 360 ^0C for 2 hours in the block digester. The solution was allowed to cool and 50 mL of de-ionised water added and mixed well to dissolve sediments completely.

For colorimetric determination of total phosphorus a 12 g portion of ammonium molybdate was dissolved in 250 mL water, then 0.291 g of antimony potassium tartrate (KSb. $C_4H_4O_6$) was also dissolved in 100 mL of distilled water, the two solutions were added to the 2.5 M H_2SO_4 (1000 mL) previously prepared, mixed thoroughly and diluted to 2 litres and transferred to a reagent bottle. 2.108 g of ascorbic acid ($C_6H_8O_6$) was dissolved in 400 mL of ammonium molybdate/antimony tartrate/sulphuric acid solution (above) and thorough mixing done.

A 10 mL aliquot of the super-nant clear wet-ashed digest solution was pipetted into a 50 mL volumetric flask, about 20 mL of distilled was added to each flask, after which 10 mL of ascorbic acid mixture was added to each flask, it was made upto mark, shaking done and left for one hour for full colour development. The absorbance was measured at 880 nm in a spectrophotometer.

For total nitrogen determination, N_1 was prepared by dissolving 34 g sodium salicylate, 25 g sodium citrate and 25 g sodiuim tartrate in about 750 mL water. About 0.12 g sodium nitroprusside was added and when dissolved made upto 1000 mL with water and mixed.

N_2 was prepared by dissolving 30 g sodium hydroxide was dissolved in about 750 mL water, allowed to cool, then 10 mL sodium hypochlorite solution added and made upto 1000 mL with water and mixed well.

A micropipette was then used to transfer 0.100 mL of the standards and samples into marked test tubes, 5.00 mL of reagent N_1 was then added to each test-tube, mixed well and left for 15 minutes. 5.00 mL of reagent N_2 was then added to each test-tube, mixed well and left for one hour for full colour development. Each sample and standard absorbance was read at 655 nm using the spectrophotometer.

Results and Discussions

River Nyando at IGD 7 reported the highest levels of both total nitrogen (0.109%) and total phosphorus (0.074)in the zones the site was the closest to the lake in the zones. This shows that fertilizers used on the farms upstream are being washed to the rivers and that there is accumulation towards the lake. Sampling sites in the upper region had very low amounts of total nitrogen and phosphorus. R.Kedowa which is found furthest upstream had nitrogen levels of 0.009% and phosphorus levels of 0.007% implying that the elements are swept from farms in the area into water bodies.

Increase in nitrogen and phosphorus downstream in the zone could be an indicator that fertilizer components from farms are washed downstream towards the Lake. This could lead to over-enrichment and thereafter eutrophication could set in.

There was a general increase in total nitrogen in zone 2. It was noted that the level of nitrogen in this zone were on average higher than in zone 1. The lowest value in zone 2 was 0.064 % while the highest was 0.17 %. Since zone 2 is closer to Lake Victoria, it

implies that there is a possible accumulation of nitrogen with distance from the lake. This trend is dangerous because high levels of nitrogen can cause eutrophication with subsequent algal bloom and oxygen depletion.

Total phosphorus increased at first then decreased downstream, this could be due to dilution by incoming rivers, and it could also be due to uptake by plants. Surprisingly, highest value was recorded at Great Oroba (0.78 %), which is second from the upper region. This value was very high as compared to other areas in the zone. On average, values in this zone were higher than in zone 1 meaning that there was accumulation of phosphorus towards the lake. This is a bad signal meaning it can lead to eutrophication due to over-enrichment of the lake with phosphates.

There was a general increase in levels of nitrogen in zone 3 as well. Sediments sampled at R. Mbogo and at R. Ainamutua had very high nitrogen values of 0.365% and 0.333% respectively, which were the highest in the analysis. Phosphorus levels were much lower and were between 0.095 ppm at R. Parget and 0.064 at R. Ainabngetuny. Generally zone 3 had the highest levels of phosphorus and nitrogen. This shows that the elements are accumulating towards the lake which is a worrying phenomenon to the aquatic life.

The nitrogen levels in zone 1 were highest at R. Masaita (0.16) and lowest at R. Namting (0.02). The levels of phosphorus were constant and generally very low (0.001%). Since sediments had higher levels of both nitrogen and phosphorus, it implies that the compounds of these elements are precipitated and incorporated in sediments.

The average concentration of nitrogen in zone 2, which is closer to the lake, was low. . This could be due to dilution by rivers from the upper upper region or absorbance of the element by plants (aquatic).

Conclusion

Sediment samples collected from different areas of the CSB showed fairly elevated levels of nitrogen and phosphorus. Fertilizers applied on farms seemed to contribute significantly to increased levels of nitrogen and phosphorus in sediments.

Water samples showed very low levels of phosphorus and nitrogen. This could be due to precipitation of phosphorus compounds and therefore incorporation into sediments.

The levels of nitrogen and phosphorus were highest in zones closer to the lake in both water and sediments.

Acknowledgement

References

Dupreez, H., Health; G.M., Sandham, L. and Genthe, B. (2003), Methodology for the assessment of human health risks associated with the consumption of contaminated fresh water fish in South Africa. Water S.A. **29**: 69 -90.

Jaetzold, R. and Schimdt, H. (1977), Farm management handbook of Kenya, vol. II – Natural conditions and farm management, part A. Western Kenya (Nyanza and western Kenya provinces) Ministry of Agriculture in cooperation with the German Agricultural team. Published by Springer, Netherlands. **34**, 26-29.

Kengara, O.F. (2003), Pesticide residue analysis in Nyando catchment area of Lake Victoria (M.Sc thesis) Dept. of Chem., Maseno University.

Moellhausen (2006), Organic sugar can and molasses. Internet (www.moellhausen.com/products.aspx). 21/09/06.

Ntiba, M.J., Kudoja, W.M. and Mukasa, C.T. (2001), Management issues in the Lake Victoria watershed. Lake reservoirs; Res. Mgmt **6** 211 -216.

Okalebo, R.J., Gathua, K.W. and Woomer, P.L (1998), Laboratory methods of soil and plant analysis. A working manual 2nd edn. 29-54.

WHO and FAO (1998), Report of the 13th session of the codex committee on food and additives and contaminants. WHO and FAO: **270**