HEAVY METAL AND NUTRIENT LOADING OF RIVER RWIZI BY EFFLUENTS FROM MBARARA MUNICIPALITY, WESTERN UGANDA

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Abstract

The rapid expansion of Mbarara town in Western Uganda has significantly elevated its anthropogenic pollution over the recent past. It is feared that the increasing volume of untreated effluent discharge might find its way into the sources of domestic water. This study, carried out in the wet April annual seasons during the period 2010-2011, was geared towards the quantification of heavy metal and nutrient levels in the surface water of River Rwizi, the main Mbarara Municipal drainage system. These times were chosen primarily due to frequent torrential runoffs from the township area and increased total volumes of effluent and leachates. In this study, the effect of Mbarara municipal effluents on heavy metal and nutrient (phosphate, nitrite, nitrate and ammonium) loading of river Rwizi was investigated along with the changes in some basic water quality parameters, *i.e.*, pH, conductivity and hardness. Heavy metals, especially cadmium and lead, pose serious health risks to humans. The filtered water samples were digested with a perchloric acid/nitric acid/hydrochloric acid mixture. Total heavy metals Cu, Zn, Cd and Pb were determined by flame atomic absorption spectrophotometry. Results showed that there was a significant difference ($F = 4.369$, $DF = 11$, $p = 0.047$) in concentration of lead in 2010 and ($F = 7.105$, $DF = 11$, $p = 0.014$) in 2011 along River Rwizi around Mbarara Municipality, the concentration being higher downstream. Average concentration of 1.302 $\mu g\ ml^{-1}$ upstream, 0.807 $\mu g\ ml^{-1}$ in the town area and 1.608 $\mu g\ ml^{-1}$ downstream which showed an average increase in lead downstream. There was also a significant difference ($H = 8.00$, $DF = 2$, $p = 0.018$) in 2010 and 2011 ($F = 41.024$, $DF = 11$, $p= 0.000$), in concentration of zinc in River Rwizi water before and after Mbarara town, with average concentration being higher downstream. The higher metal concentration downstream more likely is a result of loading from the town. The concentrations of lead and cadmium were much higher than the WHO guideline values in drinking water (0.01 $\mu g\ ml^{-1}$ and 0.003

μg ml^{-1} respectively); indicating that ingestion of raw water from this river could expose one to the harmful effects of the two metals.

The concentration of Cu upstream, mid-town and downstream for 2010 and 2011 were compared using Kruskal-Wallis test, which showed a significant difference ($H = 9.33$, $DF = 2$, $p = 0.009$) in 2010 and ($H = 8.80$, $DF = 2$, $p = 0.012$) in 2011. There was a slight increase in concentration going downstream with average concentrations of 0.043 μg ml^{-1}, 0.069 μg ml^{-1} and 0.15 μg ml^{-1} going downstream. This is clearly a contribution from the town. There was no significant difference in concentration of Cadmium in 2010 along river Rwizi around Mbarara town ($H = 3.43$, $DF = 2$, $p = 0.180$). The average Cd concentration in most samples was 0.029 μg ml^{-1}. However, the concentration of Cd was higher than the WHO guideline value in drinking water (0.003 μg ml^{-1}), which poses a threat to living organisms using this water directly. Although the Zn and Cu levels were still below the maximum tolerable levels (MTL) of 3.0 Zn and 2.0 Cu laid down by the World Health Organisation (WHO), those of Cd and Pb are higher (0.029 μg ml^{-1} Cd and 1.608 μg ml^{-1} Pb against WHO MTL values of 0.003 Cd and 0.01 μg ml^{-1} Pb). Nutrient loading in the domestic water source is also on the increase. Results indicate a gradual annual increase in these levels and call for early pollution control measures by the relevant authorities.

Phosphate was the most predominant of the nutrients considered, followed by nitrates and fluctuating low amounts of ammonium and nitrite nutrients. Most nitrogen in River Rwizi water occurs as nitrates, whose concentration also increased downstream throughout the sampling period, giving no significant concentration difference in the sampling sites in 2010 ($F = 3.843$, $DF = 11$, $p = 0.062$) and a significant difference in 2011 ($H = 7.65$, $DF = 2$ $p = 0.022$). There was also a slight increase in nitrate levels in 2011 (0.233-0.577 μg ml^{-1}) as compared to 2010 (0.119-0.54μg ml^{-1}).