Research Application Summary

Estimation of pollution loading into Lake Kivu Basin

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Abstract

This study aimed at estimating sediment and nutrient loading into Lake Kivu from River Lwiro micro-catchment in Eastern DR Congo. Total Suspended Sediment (TSS), Total Nitrogen (TN), and Total phosphorus (TP) concentration, and Biological Oxygen Demand (BOD) were measured weekly for one year. In addition, TSS, BOD, TP and TN loads were estimated from the water flow. The BOD peaks were observed in September, November, April and July, with a relative high value in November. TSS concentration was highest in August and lowest in October. Peak discharge was observed in May. TN concentration was highest in February and April, while TP concentration was highest in May and lowest between August and October. TSS and TP loads had their highest peak in May while TN load was highest in February. These findings suggest that high sediments and nutrient loading coincide with the state of the cultivated land at the start of the season.

Key words: Lake Kivu, loading, pollution

Résumé

Cette étude a pour objectif d'estimer la charge des sédiments et des nutriments dans le micro-bassin du Lac Kivu. La concentration de sédiment total en suspension (STS) et l'Azote total (AT) et le phosphore total (PT) ainsi que la Demande Biologique en Oxygène ont été mesurés par semaine durant une année. En plus de STS, DBO, AT et PT, la charge a été estimée par le débit de l'eau de la rivière. Les pics de la DBO ont été observés en Septembre, Novembre, Avril et Juillet avec des valeurs relativement élevées en Novembre. La concentration de STS a été très élevée en Août et trop basse en Octobre. Le pic du débit de la rivière Lwiro a été observé en May. La concentration de AT été élevée en Mais est basse en en Février et en Avril ; par contre la concentration de PT été basse entre Août et Octobre. La charge de STS et PT ont leur pic en Mai alors que la charge élevée de l'AT est en Février. Ces résultats suggèrent que le pic de décharge des sédiments

et des nutriments dans le Lac Kivu a travers la Rivière Lwiro coïncident avec les début des cultures dans le bassin.

Mots clés: Lac Kivu, chargés, pollution

Background

Lake Kivu is one of deepest lakes in Africa and the most fragile and highly sensitive ecosystems in the region. It is one of the three known exploding lakes due its content in carbon dioxide and methane and is characterised by millennial timescales violent vegetation turnovers. Since the measurements in the 1970s, $14CCH_4$ and $ä13CCH_4$ changes indicate that methane produced from organic material has increased (Pasche, *in press*), saturating 40% of the Lake. Its high concentration of carbon dioxide and methane makes it one of the deadly lakes around the world. More carbon and nutrients inputs through erosion and atmospheric deposition will certainly exacerbate its degradation and instability threatening the livelihood of millions of people's depending on the basin resources (Bootsma *et al*., 1996). Carbon and nutrients loading into Lake Kivu is mainly linked to the rapid growth of population, deforestation and severe soil erosion within the Lake Basin. In the last few decades, the lake has undergone large changes in chemistry and biology as a result of growing human interference and pollution from domestic, industrial and agricultural activities which lead to a deterioration of water quality (Johnes, 1996; Muvundja *et al.*, 2009). The increasing sediment and nutrients loading pose also a severe threat to biodiversity and the stability of the Lake basin (Cohen *et al.*, 1993; Irvine *et al*., 2003). This study aimed at determining sediment and nutrient loading into Lake Kivu.

Literature Summary

The Great lakes of Africa, including Lake Kivu are being affected by atmospheric pollution, sedimentary, anthropogenic and climate change threats (Bootsma *et al.*, 1999; Hecky *et al.*, 2006). The excessive growth of human populations in the Lake Kivu basin, land use, urbanisation, deforestation, intensive agriculture and climate warming prompt changes in the water quality of the lake. The major sources of nitrogen and phosphorus to these lakes appear to be rivers and the atmosphere. The increase in sediment and nutrients loading pose therefore a severe threat to biodiversity (Cohen *et al.*, 1993). In the southern part of Lake Kivu the demographic pressure and associated anthropogenic activities coupled with the micro-catchment topography are seriously contributing to increased degradation of land and water resources. Soil degradation due to poor management is reported to have reached catastrophic proportions on agricultural lands

in East and Central Africa and particularly in Eastern D.R. Congo and Rwanda (Majaliwa *et al.*, 2010; Tenywa *et al.*, 2011). Generally, a portion of runoff and sediment generated from different land uses including croplands always ends up in drainage networks (Johnes, 1996). Bootsma and Hecky (1993) observed that nutrient load increases were associated with increased burning and soil erosion in water ecosystem.

Study Description

This study is being conducted in the River Lwiro micro-catchment within Lake Kivu Basin. The river Lwiro is located on the eastern flank of Lake Kivu between latitudes 2°15' and 2°30' S and longitudes 28°45' and 28°85' E. Its headwaters are in the Kahuzi-Biega National Park mountain region, at an altitude of 2000 m (Fig. 1). The soil comprises of clay and rich volcanic soil, which is easily eroded. In-situ measurements of

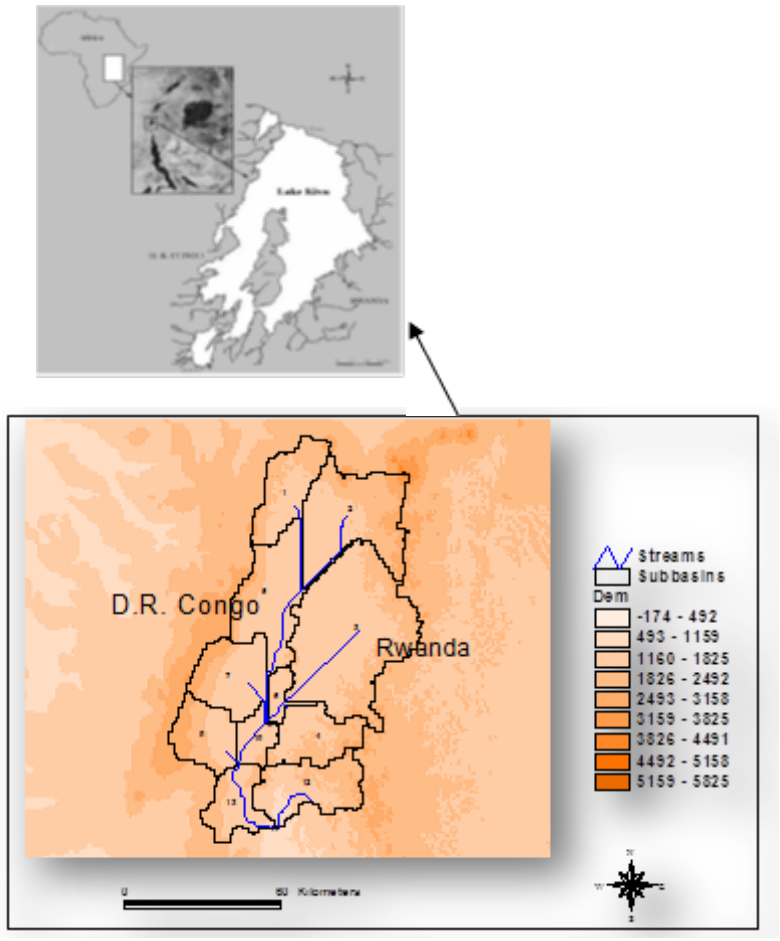

Figure 1. Lake Kivu. Basin

nutrients (P and N), pH, alkalinity, DO, BOD_5 and COD and water flows were carried out on weekly basis at the micro-catchment outlet following standard procedures (Golterman *et al*.,1978; Apha, 1981; Wetzel and Likens, 2001).

Figure 2 presents monthly variation of BOD and TSS in River Lwiro. Discharge is bimodal with a peak in May. The highest value of Biological Oxygen Demand (BOD) was observed in November and lowest in January. The Total Suspended Solid (TSS) concentration was highest in August and its load was highest in May.

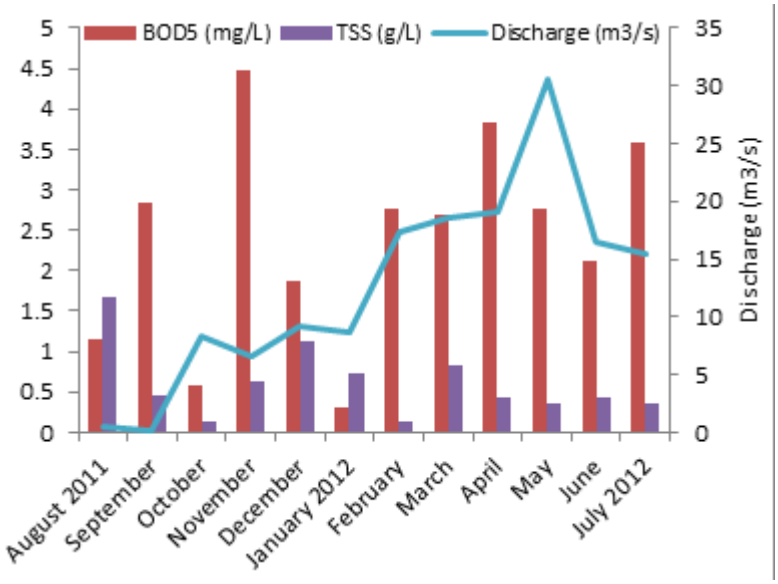

Figure 2. Monthly variation of BOD and TSS in River Lwiro.

Total Nitrogen (TN) concentration was highest in February followed by April and lowest between May and July (dry season) (Fig. 3). On the other hand Total Phosphorus (TP) concentration was highest in May (peak discharge). The load of TP during the sampling period was 5.49 t/Year and the TN was estimated at 51.37 t/year.

Recommendation

The study contributes to the development of effective methods for pollution assessment in the Lake Kivu basin and similar watershed areas. The results obtain suggest that there is only one discharge peak in the Lwiro-micro-catchment; while TSS load and BOD fluctuate across the year. Based on the preliminary results of this study, it is recommended that:

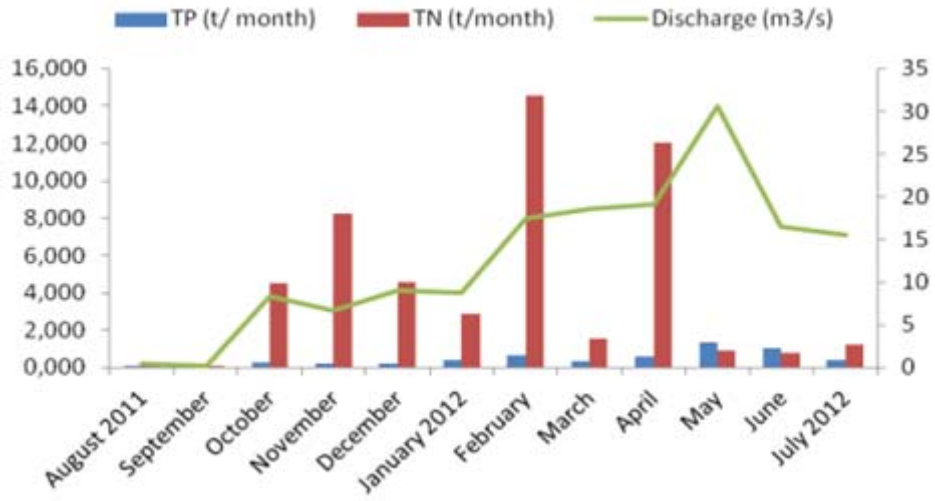

Figure 3. Monthly pollution load (TP and TN) in Lwiro river.

- Long-term studies are needed to cover the entire Lake Basin to enable accurate sediment and nutrient balance at Basin level.
- There is need to validate the SWAT model capabilities to simulate nutrient transport with additional field sampling.
- There is need for better ways of valuing the dynamic of land use/cover.
- And importantly, there is need for awareness creation among policy makers and communities within the Lake Basin as a pre- requisite to sustainable management the Lake Basin resources.

Acknowledgement

We thank RUFORUM for financing this study which forms the MSc. thesis research for the first author.

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