Geophysical Research Abstracts
Vol. 20, EGU2018-13968, 2018
EGU General Assembly 2018

Evolution of carbon fluxes along three East-African rivers

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Rivers are major drivers of the carbon cycle through transporting continental carbon to the ocean and also through the internal chemical processes. Riverine carbon dynamics depends greatly on the water cycle. Therefore, a greater comprehension of carbon dynamics in river systems, from upstream to downstream, is crucial to quantify carbon flow at global scale. Tropical basins, where the Inter-Tropical Convergence Zone balance is significant, presents a high variability of climatological and hydrological processes. Moreover the presence of the Est-African Rift and its tectonic and volcanic activities increase the complexity of carbon origin and transfer mechanisms determination.

The present study focuses on characterisation carbon fluxes in three East African rivers distributed along a latitudinal gradient. The Nyando River (0°S, Kenya) and the Lufirio River (9°S, Tanzania) discharge respectively in the Victoria and Nyassa Lakes, and the Tukela River (29°S, South Africa) spills into the Indian Ocean. Their surface areas are 3482, 842 and 29038 km^2, respectively, and the mean annual flow at the respective outlets are 22, 42 and 146 m3.s-1. The rivers were sampled at various locations from upstream to downstream in 2016. The water samples were analysed for total carbon, dissolved organic carbon, dissolved inorganic carbon, particulate organic carbon, and particulate inorganic carbon content. These results were combined with local hydrological parameters to better assess the origin and transfer processes of the riverine carbon. Our study finally indicates that the Nyando River exported 30790 tC.yr-1 to the Victoria Lake compared to 553 tC.yr-1 in the upstream zone. In this basin, particulate carbon represented 2.7%-14.7% of total carbon, while organic carbon represented 21.1%-48.2%. The Lufirio River exported 53415 tC.yr-1 into the Nyassa Lake against 35 tC.yr-1 at upstream. Particulate carbon represented 0.5-42.8% of total carbon in the Lufirio basin, while organic carbon constituted between 8.6% and 57.6% of total carbon. Finally, the Tukela River exported 222862 tC.yr-1 into the Indian Ocean against 503 tC.yr-1 in the upstream zone. In this basin, particulate carbon accounted for 1.0%-14.3% of total carbon, while organic carbon represented 28.2-91% of total carbon. Despite an increasing general trend in the downstream direction, each rivers presents its own specific pattern of spatial carbon fluxes variability. This increase in carbon fluxes along the river is discontinue and the dissolved carbon is always higher than the particulate fluxes. The mixing of different water source, the degassing of CO_2, the presence of preferential sedimentation area, the nearby land use could impact the quality and the quantity of carbon along these rivers. Thus, this study attempts to assess mechanisms regulating the carbon transfer for each of these East-African basins.