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Organic and inorganic carbon fluxes in a tropical river system (Tana River, Kenya) during contrasting wet seasons

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Tropical river systems are often subjected to strong seasonality; in the Tana River (Kenya), for example, ∼60% of the annual discharge takes place during a 4-month period. As different carbon pools are transported by the river, seasonal differences in carbon fluxes will also occur. This can furthermore be enhanced or attenuated due to changes in the intensity of carbon transformation processes, such as microbial respiration and primary production, during the wet season. Besides that, seasonal flooding of flood plains or flooded forest is known to be a major driver of the biogeochemical and ecological functioning of tropical rivers ("flood pulse concept") and has been shown to be one of the major drivers of the CO_2 emissions from the Amazon River.

We monitored the fluxes of different carbon pools at two sites spaced 385 km apart along the lower Tana River (Kenya), which is characterized by a highly seasonal flow regime. Water samples were taken at daily resolution during three wet seasons. During one of those seasons (May-June 2013), considerable flooding took place between both stations, while the other two wet seasons (Oct-Nov 2012 and April-May 2014) were characterised by several distinct discharge peaks, without leading to substantial overbank flooding.

The flux of particulate organic carbon (POC) was observed to decrease in the downstream direction by 8 to 33% during all measurement periods. Fluxes of dissolved organic carbon (DOC) also decreased in the downstream direction during the wet seasons without flooding (by 10-38%) but increased drastically (increase of 231%) during the wet season with flooding. The dissolved inorganic carbon (DIC) flux increased downstream (by 6% to 62%) during all measurement periods. The total carbon flux (POC+DOC+DIC) increased by 33% in the wet season with flooding (2013), but decreased by 23% and 3%, respectively, during the 2012 and 2014 wet seasons.

Flooding thus affected the relative contribution of different C pools to the overall C flux: while POC dominated during wet seasons without flooding (60-70%), DIC was the dominant transported C pool (55-67%) when flooding took place. This is not only due to the loss of POC associated with overbank sediment deposition but also to the downstream increase of the DIC flux during flooding, which we attribute to the in-stream decomposition of organic carbon as well as to the decomposition of organic matter in flooded environments (oxbow lakes, backswamps, . . .). Similarly, the downstream increase of the DOC flux during flooding is likely to be caused by the release of DOC from flooded soils. We conclude that flooding events significantly altered both the magnitude and speciation of C fluxes in the lower Tana River, as they were found to lead to a general reduction of the POC flux, and simultaneously resulted in substantial lateral inputs of both DIC and DOC. The effect of flooding on carbon retention by rivers can only correctly be assessed if all three carbon fractions are accounted for.