Distribution and Composition of Organic Carbon in the Tana River Basin, (Kenya).

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Introduction

- Rivers play an important role in the global carbon cycle, and process ~1.9 Pg C annually (Cole et al., 2007). Rivers do not merely transport carbon from the terrestrial to the oceanic environment, but also bury and process organic matter, typically acting as a source of CO_2 to the atmosphere (Devol et al., 1987, Cole and Caraco 2001, Mayorga et al. 2005).
- Due to increased carbon emissions, it is critical to understand carbon cycling both on a global and a watershed scale. However, there are few studies which quantify carbon fluxes in tropical rivers, and data for the African continent are particularly scarce.
- In this study, we report the altitudinal and seasonal patterns in carbon pools and their stable isotope compositions in Tana River Basin (Kenya)

Site and Methods

- The Tana River is the longest river system in Kenya (>1200 km), with a catchment area of ~120,000 km^2 (Kitheka et al., 2005).
- The main perennial source areas of the river are Mount Kenya (up to 5199 m), the Abardares ranges in the central Highlands of Kenya, and the Nyambene Hills in Eastern Kenya.
- The basin in general experiences two rainfall seasons: long rains between March and May and short rains between October and December.
- Data from field campaigns throughout the river basin are presented from a preliminary campaign in February 2008 (Bouillon et al., 2009; end of dry season) , September to November 2009 (short rains), and June-July 2010 (end of long rains).
- Furthermore, monthly sampling was initiated in January 2009 at several locations (ongoing), and data up to March 2010 are presented here for 2 of the downstream sites (Garissa and Tana River Primate Reserve upstream of Garsen). Extensive flood plains are located between these 2 locations, flooding is irregular due to regulation of river flows by reservoirs upstream
- The samples for total suspended matter (TSM) were filtered through pre-combusted and pre-weighed, 47-mm-diameter Whatman GF/F filters, dried and re-weighed, while samples for POC and δ^{13}C-POC were filtered on pre-combusted 25 mm Whatman GF/F filters, acidified, dried and measured with standard techniques (EA-IRMS).

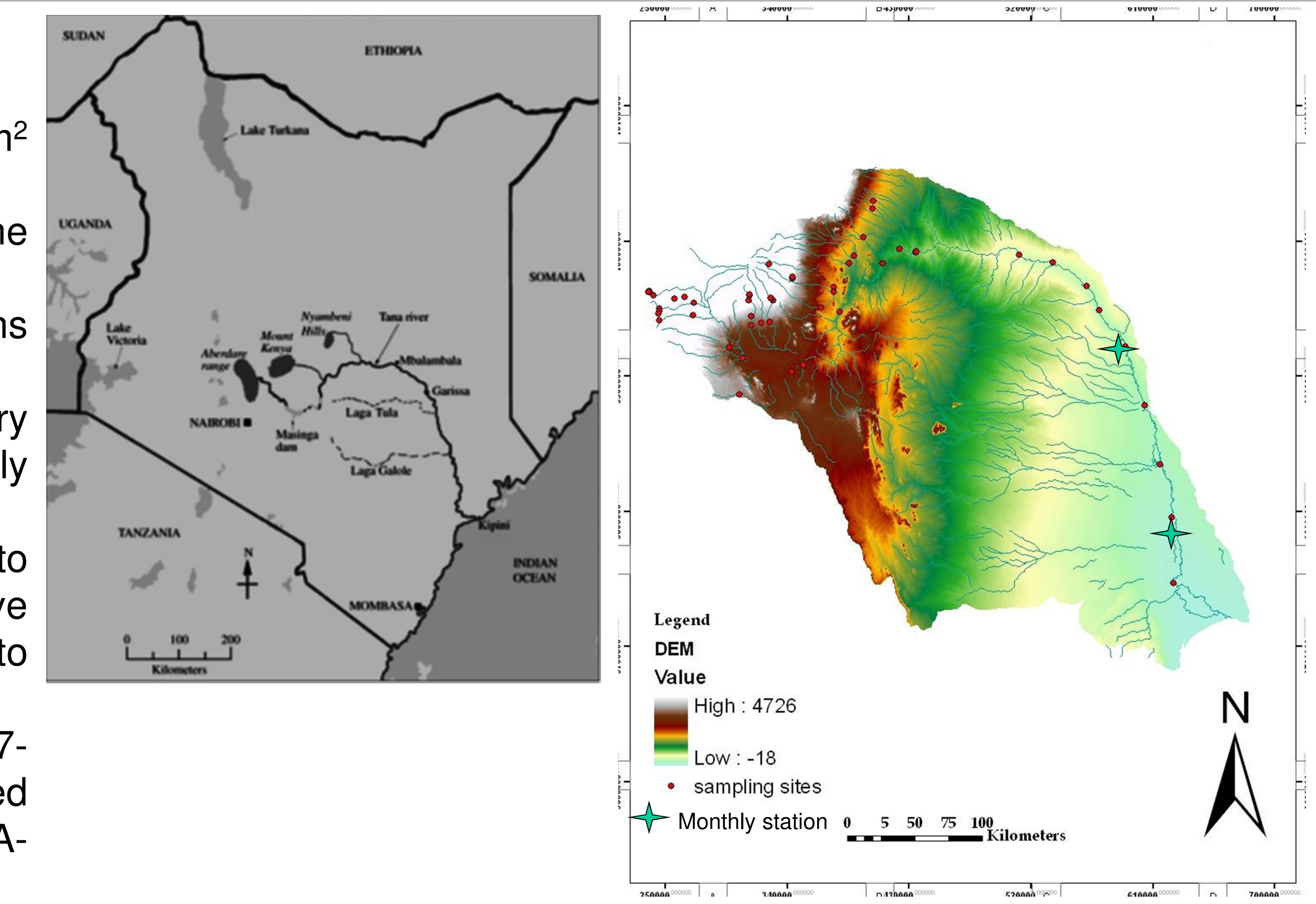

Figure 1:Location of the Tana River basin and sampling locations.

Results & Discussion

Total suspended matter and particulate organic Carbon

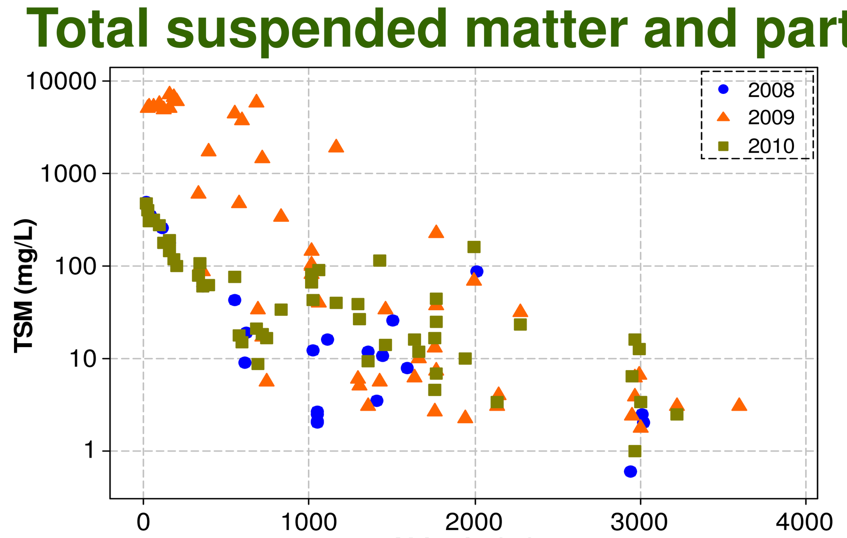

Figure 2: Altitudinal profile of TSM

- A consistent downstream increase in TSM was observed during all three sampling campaigns.
- TSM values were similar for the 2008 and 2010 datasets (p>0.05), but significantly higher during the short rains campaign in 2009.

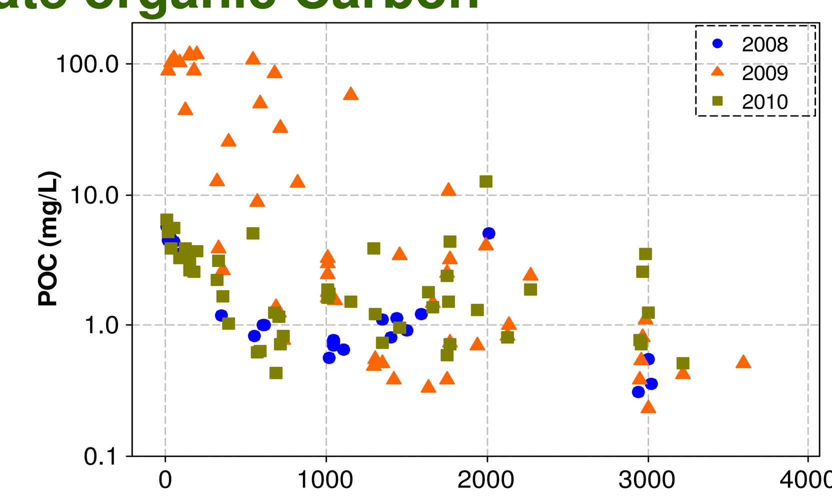

Figure 3: Altitudinal profile of POC

- The altitudinal distribution of POC concentrations shows similar trends as those in TSM, i.e. a consistent downstream increase during all sampling campaigns (p<0.01).
- POC for 2008, 2009 & 2010 differed significantly (p<0.05).

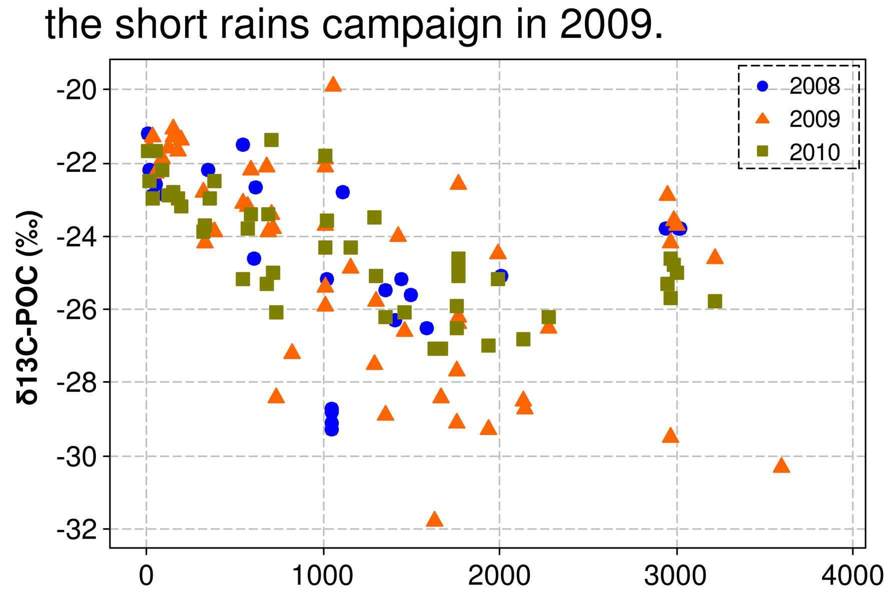

Figure 4: Altitudinal profile of δ^{13}C-POC

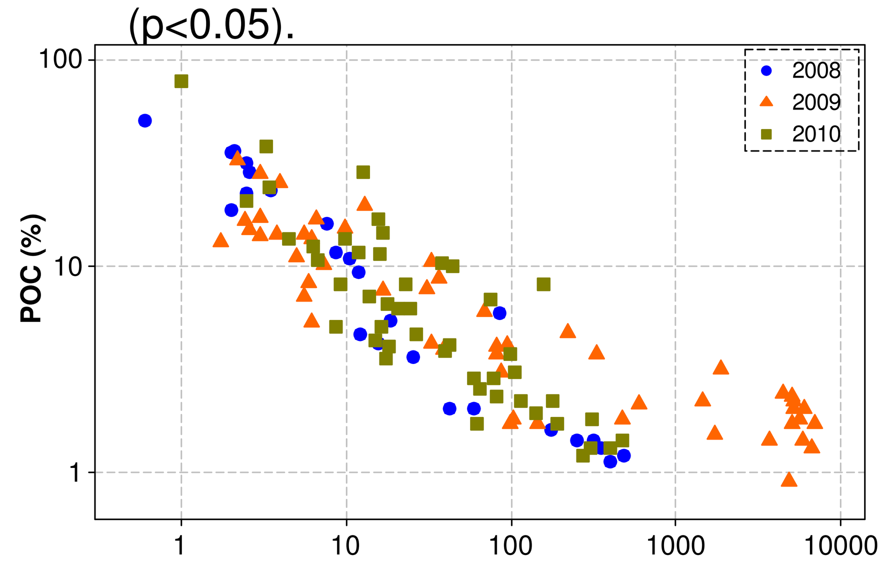

Figure 5: Relation Between POC % and TSM

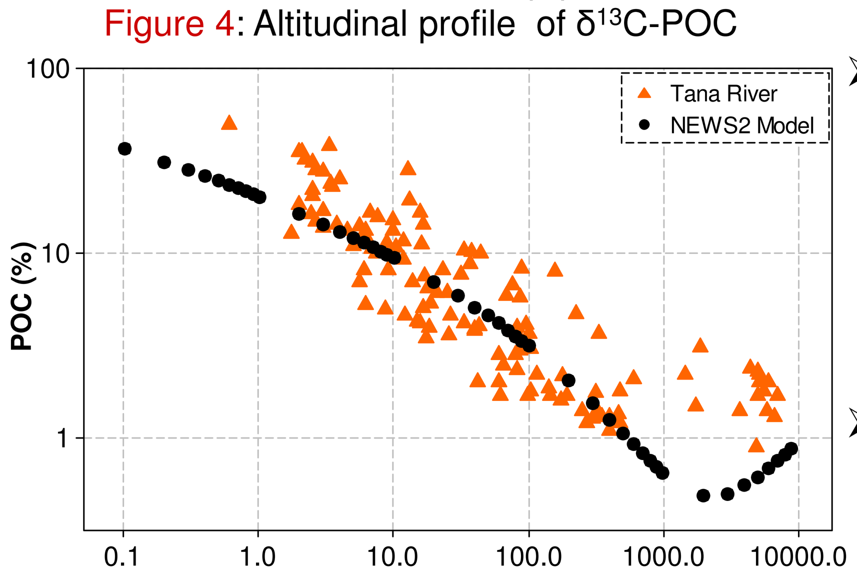

Figure 6: Comparison of Organic Carbon Export with NEWS2 Model

- δ^{13}C-POC increased downstream during all three sampling campaigns (p<0.01), and were predominantly of terrestrial origin as reflected by generally high POC/Chl a ratios. This trend thus reflects an increasing contribution of C4-derived carbon downstream. However, different years were not significantly different (p>0.05)
- TSM & % POC followed the classical inverse relationship (Bernardes et al., 2004) for all years sampled i.e. dilution of % POC with increase in TSM (p<0.01).
- The % POC/TSM relationship fits well with NEWS2 Model based on Ludwig et al. (1996) data.

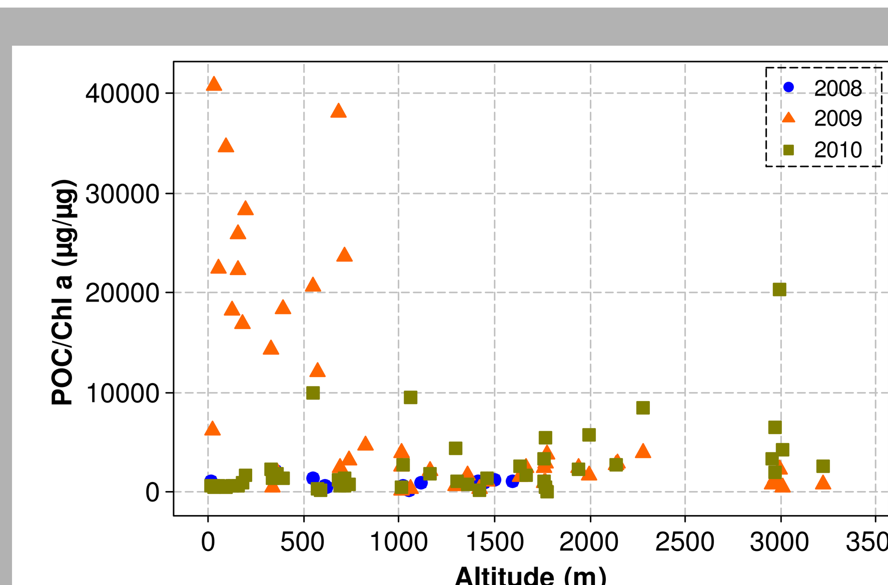

Figure 7: Altitudinal profile of POC/Chl a Ratio

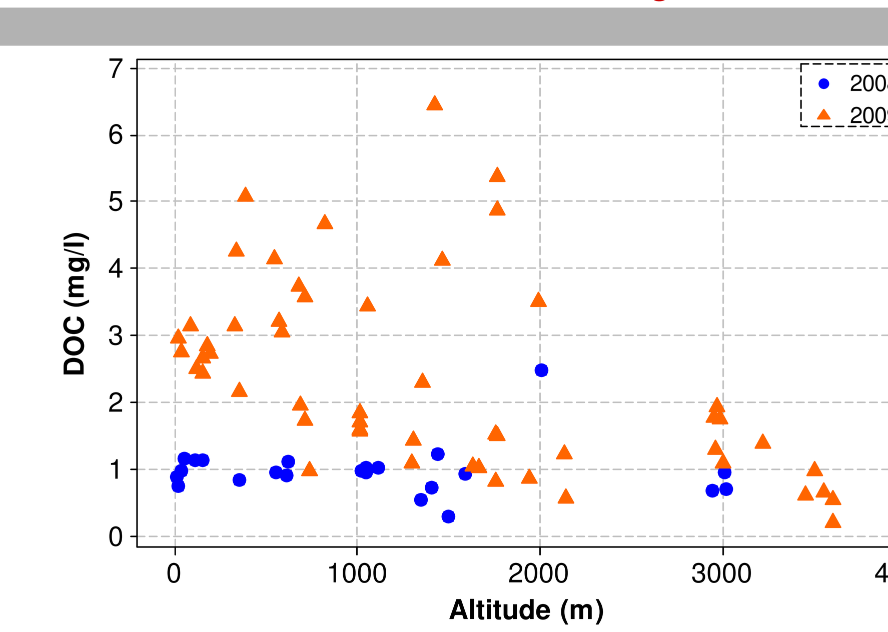

Figure 8: Altitudinal Profile of DOC

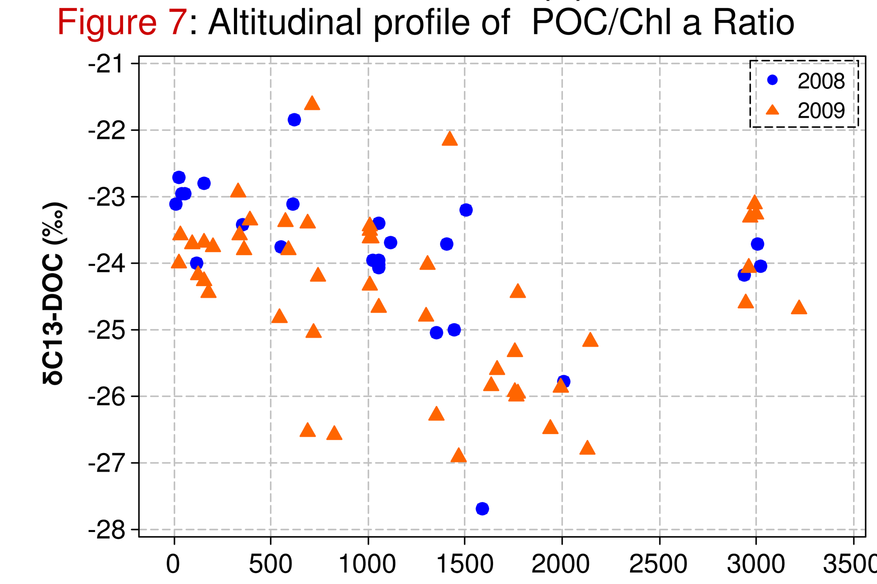

Figure 9: Altitudinal profile of δ^{13}C-DOC

- DOC concentration was higher in wet season (2009) & increased downstream.
- δ^{13}C-DOC increased downstream during the two sampling campaigns (p<0.01) suggesting C4 plant contribution, but were divergent in high altitudes

Seasonal variation in organic composition

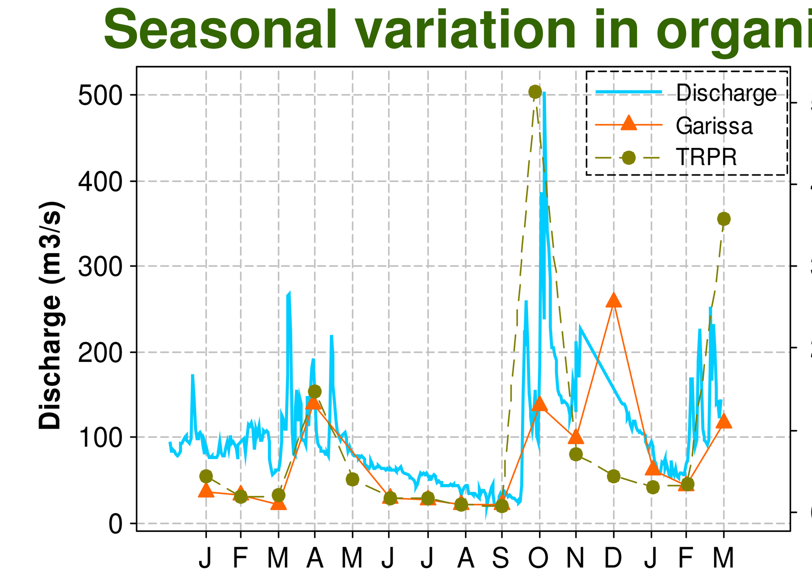

Figure 10: Discharge Superimposed with TSM

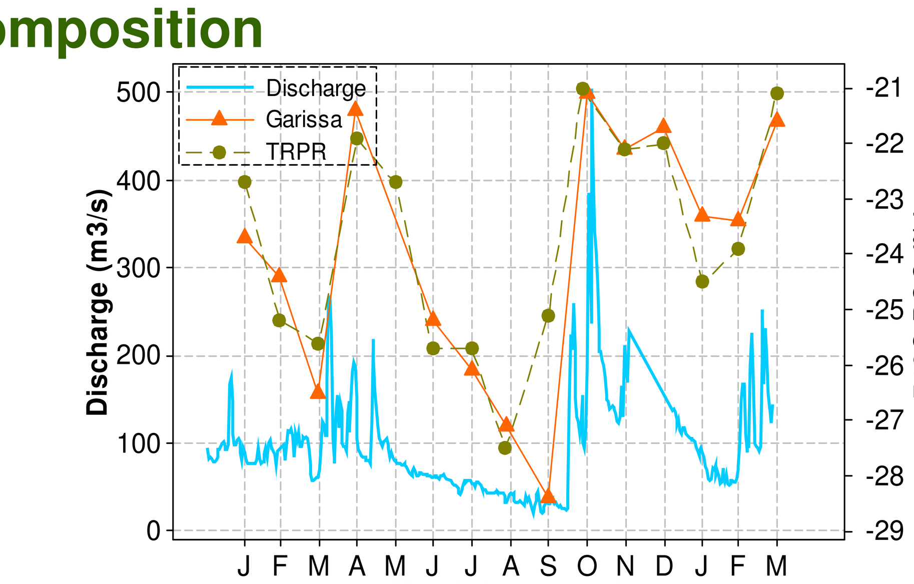

Figure 11: Discharge Superimposed with δ^{13}C-POC

- As expected, TSM & POC were highly episodic and highest in periods with high discharge
- Both TSM & POC maxima preceded peak discharge, particularly at TRPR station as observed previously by Kitheka et al. (2005). This suggests release of relatively mobile sediments during initial peak discharge.
- Seasonal patterns in δ^{13}C-POC signatures at both stations coincided closely, with δ^{13}C increasing markedly during periods of high discharge (-23 to -21 ‰), and decreasing towards predominantly C3 signatures toward the end of dry periods. This suggests that high sediment mobilization during rains occurs mostly in areas with significant grassland cover (C4).

References

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Acknowledgements

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Conclusions

- TSM and POC delivery is episodic during peak discharge, and mostly mobilized at intermediate altitudes
- In the lower section of the Tana River, POC mainly originates from areas with a significant contribution by C4 plant species during high discharge, while during low discharge POC is predominantly derived from C3 plant species.