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Discussions

Interactive comment on "Seasonal and inter-annual variations in carbon fluxes in a tropical river system (Tana River, Kenya)" *by* Naomi Geeraert et al.

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We thank Anonymous Referee #2 for her/his comments on the paper that help us clarify the objectives of the paper and some points of the discussion.

GENERAL COMMENTS RC: I have several major concerns with this study. First, it seems that a lot of this data has already been published elsewhere. The authors fail to describe how the current manuscript is different from previous studies done on the Tana River by the same research group or a subset of this group.

REPLY: The dataset which is used for this analysis is indeed previously published (primarily in Geeraert et al. 2017, Biogeochemistry). In that article, we focussed on the de-

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tails of the C dynamics during three wet season campaigns. In the current manuscript, we want to use the detailed dataset to gain more insight in the long-term C fluxes in the river system and the potential effects of hydrological changes due to climate change or dam management. We acknowledge that this objective was not clearly explained in the manuscript and will rewrite it for clarification.

RC: Secondly, a majority of the conclusions were made using 2 years of high temporal resolution data that had different hydrological regimes. So, is it not surprising that the results indicate that the majority of the difference is associated with hydrological regimes?

REPLY: The identification of the different hydrological regimes was already presented in previous studies (Geeraert et al. 2015, Geeraert et al. 2017) and we used this knowledge here to further examine how that could affect the analysis and interpretation of annual C fluxes. The differences in seasonal variations in the two regimes were analysed in section 3.1 and 3.2, while in section 4.1, we presented what the error on the annual flux would be if we would fail to recognise the different hydrological regimes. Those insights are needed to consider future changes in fluxes due to changes in hydrology. It important to consider that the effects of different hydrological regimes can be mechanistically explained, i.e. we explain the observed differences between flooded and non-flooded high flows and the dry season by looking at the processes controlling carbon and sediment dynamics. Thus, we are not just using the difference between the various regimes in a statistical sense. Evidently, the quantification of the different effects is characterised by a large uncertainty: but this uncertainty is explicitly accounted for in our analysis.

RC: In my opinion, a lot more can be done with the data that is available. Why not look at concentration temperature relationships? It is not clear how large or small temperature fluctuations at the site were in terms of both seasonal and annual trends.

REPLY: The spatial and temporal variation of the physico-chemical parameters was examined in our Biogeochemistry paper (Geeraert et al. 2017) and no significant relationships with temperature were observed which could impact the C fluxes. Therefore, they were not further discussed in this manuscript. Temperature variations were very limited, 27.0+-1.5 °C and 28.5 +/- 1.7 °C in Garissa and Garsen respectively over all of our campaigns.

RC: The authors also simplify all the assumptions regarding retention or mobilization of carbon. There could be a strong impact of microbial reactions on POC, DOC and DIC fluxes. Note that microbially mediated breakdown of DOC can result in a pH decrease accompanied by an increase in bicarbonate alkalinity. Thus, DIC and DOC fluxes can be interlinked. How do the authors address this linkage in understanding patterns of DIC and DOC fluxes along the Tana river?

REPLY: The linkages and interactions between the different C species are discussed in depth in our Biogeochemistry (2017) paper. The fluxes from one C pool in the river to another were based on measurements of respiration rates and pCO2 and by closing the C budget of the river system. There are much more assumptions involved in these calculations and therefore, we didn't want to extrapolate the calculation of those fluxes outside of the observation time frame. The measurement of the concentrations are more robust and are suitable to expand in time.

RC: The publication is also missing recent references that are very much relevant to the current study. For example, Arora et al. (2016, Biogeochemistry); Raymond et al. (2013, Nature); and Van Cappellen and Maavara (2016, Ecohydrology & Hydrobiology).

REPLY: We included the references of Raymond et al. (2013) and Van Cappellen and Maavara (2016), but didn't include the one of Arora et al. (2016) because it was focussing on the C processes in soils, while our focus is on the magnitude of the different C fluxes, and how they would change when a change in discharge occurs in the river.

SPECIFIC COMMENTS RC: Page 5 Para 20 Slightly more detail can be added to the sentence stating the differences in sampling protocols, especially differences in DIC collection methods.

REPLY (option 1): We reformulated this sentence stating that an empirical relationship with TA was used for the calculation of the DIC.

RC: Page 5 Para 25 A reference should be provided for the maximum POC concentration chosen for this study.

REPLY: This value was chosen as an informed estimate (a reasonable value as the average of the three highest observations) to correct for values which were unrealistic as a result of the exponential shape of the regression equation. In addition, the number of days for which that correction was needed, was very limited; the correction was, depending on the regression line (figure 4), needed between 93 and 1128 times over the nearly 27 000 days in Garissa and between 135 and 1409 times in Garsen.

RC: Page 6 Para 25 “dry seasons still had a fair share” of what?

REPLY: They had a fair share in the total annual discharge (34-44%). For clarity, we rephrased the sentence to provide a better contrast with their proportion in time: The dry seasons still accounted for at least on third of the total annual discharge (34-44%), which is considerably smaller than their proportion in time ($\sim$58% of the year).

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