SOIL Discuss.,
https://doi.org/10.5194/soil-2020-73-AC2, 2021
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# *Interactive comment on* "Particulate macronutrient exports from tropical African montane catchments point to the impoverishment of agricultural soils" *by* Jaqueline Stenfert Kroese et al.

**Jaqueline Stenfert Kroese et al.**

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Received and published: 15 January 2021

We would like to thank Reviewer #2 for the feedback provided to our manuscript. We will take their comments into account when revising the manuscript.

Anonymous Referee #2 Received and published: 6 January 2021 The paper by Stenfert Kroese et al. addresses the impact of land use on particulate carbon and nutrient export from tropical montane catchments in the South-West Mau in Kenya and shows that soil fertility is lost with the conversion from natural forest to cultivated land. This study fills in an important knowledge gap on particulate nutrient export of tropical ecosystems in East Africa. The manuscript is mostly well written and clearly structured.



I recommend it for publication in SOIL after some revisions.

1) My main concern is the way the data is presented. In Figures 4 and 5 and Table 4, concentrations and ratios are presented for each sampling year separately. This might be prone to misinterpretation, as different seasons were sampled for each year. In Table 5 it is stated that the data are from wet period (2018) and drier period (2019). I think it's necessary to be consistent throughout the manuscript, thus, the same labelling is necessary for Figures 4 and 5 and Table 4. Related to this: While in the results differences between years/seasons are acknowledged, in the discussion the whole seasonality is neglected. Especially the C:N, C:P, and N:P ratios seem to differ during the different seasons. Might this indicate different sediment sources? I think this needs to be addressed shortly in the discussion.

Response: Thanks for this. We amended the labelling of Figure 4 and 5 and Table 4. Each sampling period is presented as '2018 wet period' and '2019 drier period' and the headings of Figures 4 and 5 and Table 4 were also amended to 'based on 13 22 sampling days for the sampling campaign from May October 2018 and 14 18 sampling days for the period April June 2019' to match with Table 5 and to clearly indicate the sampling periods.

We added a section in the discussion to address the differing ratios during the years 'The significant lower C:N ratio in the natural forest and tea tree plantations in 2019 compared to 2018 might indicate a reduction in organic matter content of the sediment sources during the drier period in 2019 compared to the wetter sampling period in 2018. The significantly higher C:P and N:P ratios in 2019 in the smallholder agriculture catchment suggest that the source of phosphorus originates from higher mineralization rates of organic matter and unused fertilizer from bare agricultural surfaces in the drier period of 2019 compared to the drier sampling period in 2018.'

2) Furthermore, the methods section lacks some more details: How where the data stored? Did you use an external datalogger or did the sensor log internally? The

stealing of power supply and subsequent data loss is mentioned, but it is not clear how the setup was powered. How long did you let the sediments settle before air drying the aluminum trays?

Response: We included a paragraph in the method section: 'The data is stored automatically on a data logger (con::cube, s::can Messtechnik GmbH, Vienna, Austria) and downloaded on a weekly to bi weekly basis. The data is additionally automatically uploaded to an online database, except for the site at the natural forest where there is no cellular network. The equipment is powered by solar panels and two batteries.' It is also mentioned that 'a more detailed description of sampling sites and instrumentation can be found in Jacobs et al. (2018)' (L. 149-152).

The sediment samples were allowed to settle up to 5 days before air drying. We amended the sentence accordingly: 'Sediment in suspension from all three sampling methods were allowed to stand for up to 5 days, then the supernatant was carefully removed, the remaining sediment water mixture was then placed in aluminium trays and air dried' (L. 198-199).

Specific comments: Introduction

3) p. 2 L52: What is the impact of an increased turbidity in streams?

Response: We included 'by increasing turbidity, which prevents light reaching aquatic plants'.

4) p. 3 L65ff: The presented results are from which ecosystems? All tropical?

Response: The results are from tropical and temperate regions. We included 'other studies in temperate and tropical regions' in the section to be more precise (L. 60-69).

5) p. 3 L69: "This is an important knowledge gap"

Response: We corrected to '. . . knowledge gap' (L. 72).

Methods



6) p. 9 L176: Integrating missing discharge data linearly does not seem right, if rainfall data is available discharge can be correlated to rainfall?

Response: We didn't integrate missing discharge data with the linear interpolation, only the sediment data was interpolated (L. 182).

7) p. 9 L179/180: Instead of calling it the "drier period of the start of the long rainy season" maybe use "onset of the rainy season"

Response: We corrected accordingly: 'the drier period of the onset of the long rainy season' (L. 185).

8) p. 11 L212: organic matter content

Response: corrected

9) p. 11 L219: I'm wondering how representative the yearly yields of sediment-associated TC, TN and TP are if you use only data from 3 sampling periods over two years. Or did you relate the C and nutrient yields to the turbidity data? If so, it is not clearly described.

Response: We did not relate TC, TN and TP concentrations to the long-term turbidity dataset. We acknowledge that the annual yields of sediment-associated TC, TN and TP are rather estimates due to the short sampling period. We included a paragraph to highlight the uncertainty of TC and nutrient yields; however, we believe it is important to keep the yield estimates in order to compare the different fluxes within the three catchments. 'Our sediment-associated TC, TN and TP yield estimations are uncertain. This is due to the sampling of the drier start of the long rainy season in 2019 and the short sampling period in both years. This might have resulted in missed sampling of storm events. Increasing the sampling frequency would improve our understanding of the particulate TC, TN and TP fluxes.'

10) p. 11 Data analysis: Which programs did you use for data analysis?

Response: We used R studio for data analysis. This was included in the manuscript as 'Data analysis was conducted with R software (R Development Core Team, 2017).'

Results

11) p. 12 L235: State somewhere in the text that the values between the brackets are the 95% CI.

Response: Included 95%-confidence interval in brackets.

12) p. 12 L236: Define the catchment runoff coefficient and how you calculated it in the text

Response: We included a sentence in section 2.2 'To relate the amount of runoff to the amount of precipitation received, the catchment runoff coefficient was calculated as defined as specific discharge as proportion of annual rainfall'.

13) Figure 3: This is a really nice figure, however, it is not discussed at all in the manuscript. For example, I'm wondering why SSY are a lot higher during the 2019 season compared to the 2018 season in the NF and TTP catchment, although the discharge seems lower. I see that this has been more the focus of recent work by the authors and is not the aim of the present manuscript, however, in my opinion if the data is presented like this in the manuscript it should be discussed accordingly.

Response: We inserted a paragraph in the discussion on the annual suspended sediment yields but also referred to a more detailed discussion to Stenfert Kroese et al. (2020b). 'The wetter 2019 might have resulted in higher annual suspended sediment yields for the natural forest and tea tree plantation catchments. In contrast, the smallholder agriculture catchment experienced higher suspended sediment yields during a drier 2019 compared to the previous year. The late onset of the rainy season resulted in a late start of the cropping season. As discussed in Stenfert Kroese et al. (2020b) this might have left bare agricultural land prone to erosion during stronger, but shorter rainfall events.'



14) p. 15 L286-288: are the reported OM contents mean values over both years? Maybe add these values to a table?

Response: The reported OM contents are mean values of a few sediment samples from both years. We added the values to Table 1.

15) p. 17 L324-326: add C and N to the units to avoid confusion: kg C day-1 and kg N day-1. Also for TP in line 328.

Response: Thanks for this, we amended the text accordingly.

16) Section 3.4: Does it make sense to calculate mean annual yields of the sampling periods? How representative are these values? I think this needs to be addressed in the discussion.

Response: We acknowledge that the anual yields of sediment-associated TC, TN and TP are rather estimates due to the short sampling period. We included a paragraph to highlight the uncertainty of TC and nutrient yields; however, we believe it is important to keep the yield estimates in order to compare the different fluxes within the three catchments. 'Our sediment-associated TC, TN and TP yield estimations are uncertain. This is due to the sampling of the drier start of the long rainy season in 2019 and the short sampling period in both years. This might have resulted in missed sampling of storm events. Increasing the sampling frequency would improve our understanding of the particulate TC, TN and TP fluxes.'

Discussion

17) p. 19 L359: Do you know how long ago the conversion from forest to agricultural land occurred in your study sites?

Response: The conversion of the forest to tea-tree plantations started in the beginning of the 20th century, however the conversion to smallholder agriculture was during the last four to five decades. We amended the following sentence: 'Similarly, a decline in soil organic carbon and nutrients was observed following conversion to agricultural

cultivation in the same catchments of the Mau Forest Complex which was converted during the last four to five decades (Arias-Navarro et al., 2017; Owuor et al., 2018; Wanyama et al., 2018)'.

18) p. 19 L362: For an easier reading: put the values in the bracket for TC and TN concentrations behind "natural forest catchment". Also add C and N to the units.

Response: We amended this in the revised manuscript.

19) p. 19 L375: Figure 6 shows no strong correlation between TC and TP for SHA. Be precise that only TTP shows a significant relationship.

Response: We amended the sentence to 'A significant relationship was observed between TC and TP for the tea-tree plantation catchment, . . .'.

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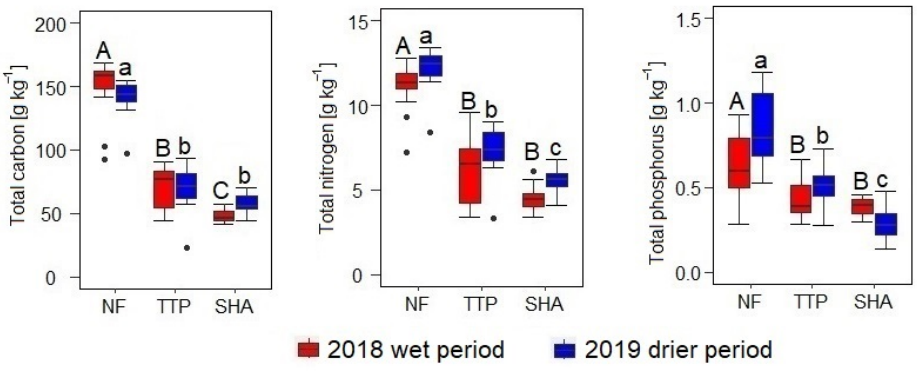


**Fig. 1.** Figure 4

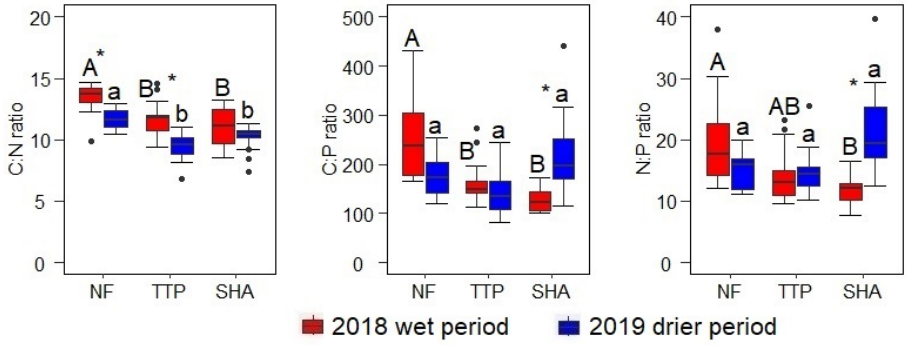


**Fig. 2.** Figure 5