

Partitioning carbon sources between wetland and well-drained ecosystems to a tropical first-order stream - Implications to carbon cycling in the whole watershed (Nyong, Cameroon)
Moustapha et al.- Biogeosciences. Manuscript #BG-2021-69

Summary

The authors revised version of their study of C fluxes from the Nyong basin in Cameroon is greatly improved and addressed the concerns in the first submission. They have improved the narrative in the study and provided a clearer and data rich presentation of an important watershed type in the growing body of tropical carbon cycling. The paper is well cited and sets up follow up the next steps in studying this watershed well.

My comments are minor with one larger request. The units in the paper are still difficult to track and differ (slightly) from those in the literature. The authors present fluxes in t C yr-1, in contrast to Pg, Gg, or Tg C. For the sake of easier comparison to the wider literature, I recommend these be converted to a more commonly used unit. Similarly, for the estimates of degassing and respiration, they present in mmol or mol, in contrast to the rest of the paper in some form of g. I would again ask these to be converted to a more commonly used unit.

A final comment on the writing, which is inherently a personal preference. A fair number of sentences begin with ‘This...’, ‘These...’ etc., which asks the reader to do more work than should be. I ask the authors to make the readers job as easy as possible and be specific about the ‘this’ they are referring to from the previous sentence. By no means are the authors alone in this writing style and perhaps this is my own personal preference getting the better of me, but a stylistic change I would prefer to see.

General Comments

Title- Suggest changing ‘in the whole watershed’ to ‘at the watershed scale’

Abstract

The abstract is well written and well organized, though a few typos or words missing (see specific comments).

Introduction

The introduction is well written and cites recent literature. The only concern is the organization and structure of the 3rd paragraph, see specific comments for suggestions. Last, as the second objective focuses on temporal variation of C in rivers, maybe a sentence on this topic could be added to the 3rd paragraph, particularly as the seasonality of wetlands appears to play a large role.

Methods

No major concerns with the Methods section, only minor edits (see specific comments below).

Results, Discussion, References

No major issues.

Tables/Figures/Supplemental Files

Table captions generally go above the table (minor edit)

Table 4- can you provide 2 decimal points for these correlation coefficients? Non-significant p-values are also informative, one idea would be to put the significant correlations in bold text.

Table 6- I thought several of these measurements weren't made in the 2nd order site but were interpolated. If that is the case, please add that to the caption. The units for the columns are inconsistent (m⁻² for F and km² for area). I would suggest picking one and sticking to it. Again the conversion issue of mmol to t C appears here too.

Table 7- there is no Table 7! It goes from 6 to 8, please correct!

Figure 3, d- soil profiles are a little small on a full page, I imagine they will be even smaller when published. Can you make this bigger or separate out as a Supplemental Figure?

Figure 6- conductivity should be capitalized. I might add a note in the caption that the hashed boxplot is for GW and what the boxplots represent (median, quartiles, etc.).

Figure S1- personal preference against barplots for data that are not totals. Gas exchange coefficients should be shown as points or as a time series rather than boxes.

Specific Comments

L20- change 'great' to 'large'

L22-23- clarify to 'measured groundwater in a well-drained...'. I might also change the order of this sentence to list what was measured before listing the groundwater and streams.

L25- replace 'occasionally' with 'supplemented C measurements with measures of heterotrophic...'

L28- 'In larger streams (order > 1)...'

L33- is higher metabolism the only reason low oxygen was observed? If you make this statement, can you include the respiration rates?

L35- missing 'were' between exports and 1.6

L47- this first sentence contains a ton of information but is very long. I would suggest breaking into 2 sentences after 'cycle' on L48.

L52- ‘overlying’ is redundant, delete

L57- check the order of citations. They appear to be alphabetical but the years are not chronological. If this follows the journals format, ignore this comment.

L75- seems like this paragraph needs a concluding sentence. Perhaps something about empirically measuring C in all forms rather than relying on pH and total alkalinity estimates that are error prone are key to improving estimates from inland waters.

L77- Remove the i.e. Make this into a new sentence or integrate into the first half of the sentence. ‘In the aquatic system itself’ is strange wording, consider changing to ‘within the ecosystem’. You might consider widening the scope of this sentence to ecosystem respiration, as respiration by autotrophs is non-negligible and opens the discussion to a wider range of papers

L82- this paragraph starts by introducing respiration, but here shifts to degassing as a function of wetland area. Organization could be improved. Perhaps this paragraph could be about wetlands role in riverine processes, and include the various aspects of how they affect C export, evasion, and respiration.

L122- ‘flows west to the Atlantic…’. Same comment on L123 and L141.

L124- Is width an appropriate measure of wetlands? Is there an areal estimate that could supplement? Or does this refer to width laterally extending from the river?

L127- not sure what to make of ‘of unequal importance’. I would delete it

L208- ‘bubbles’. I would suggest starting a new paragraph after bubbles and merging the paragraph that starts on L215 with this paragraph that all describes the sampling and instrumentation. Further I would cut/paste the mention of respiration here and move to L246 where you detail the respiration methods.

L210- what is a one-off sample?

L211- delete ‘of the water’.

L255- ‘will be’ changed to ‘was’. Is there another study you can cite that combines estimates of water column respiration with a supplemental estimate of benthic respiration to get ecosystem respiration or total heterotrophic respiration? I might look in Reisinger et al. (2021) and references therein as a possible example.

L257- ‘catchment’. Singular.

L258- are these subcatchments in the Nyong basin? Please specify.

L372- were groundwater table measurements mentioned in the Methods section?

L386- wow, those are really high pCO₂! Well beyond the calibration ranges for the GC described in the methods. Were these values verified in another way?

L443- ‘goes to the wetland...’

L450- this doesn’t need to be added to the paper but you have a great dataset to explore how k₆₀₀ scales with discharge in 5 different stream orders (based on scaling equations, but still). Ecosystem metabolism estimates are greatly improved with a known k₆₀₀ ~ Q relationship, I would think deploying O₂ sensors (and pairing with CO₂ sensors) in these streams could be a great next step to begin estimating in-stream C fluxes, following the best practices in the literature (Grace et al. 2015, Hall and Hotchkiss 2017, Appling et al. 2018). Also a good note or addition to the Discussion starting in L656.

L530- take a look at some papers from different soil types in Central America to expand the discussion on respiration and seasonal soil moisture (Veldkamp et al. 2003, Schwendenmann and Veldkamp 2006)

References mentioned in the review

- Appling, A. P., R. O. Hall, C. B. Yackulic, and M. Arroita. 2018. Overcoming Equifinality: Leveraging Long Time Series for Stream Metabolism Estimation. *Journal of Geophysical Research: Biogeosciences* 123:624–645.
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- Hall, R. O., and E. R. Hotchkiss. 2017. Stream Metabolism. Pages 219–233 in G. A. Lamberti and F. R. Hauer, editors. *Methods in Stream Ecology, Vol 2: Ecosystem Function*, 3rd Edition. Academic Press Ltd-Elsevier Science Ltd.
- Reisinger, A. J., J. L. Tank, R. O. Hall, E. J. Rosi, M. A. Baker, and L. Genzoli. 2021. Water column contributions to the metabolism and nutrient dynamics of mid-sized rivers. *Biogeochemistry* 153:67–84.
- Schwendenmann, L., and E. Veldkamp. 2006. Long-term CO₂ production from deeply weathered soils of a tropical rain forest: evidence for a potential positive feedback to climate warming. *Global Change Biology* 12:1878–1893.
- Veldkamp, E., A. Becker, L. Schwendenmann, D. A. Clark, and H. Schulte-Bispinger. 2003. Substantial labile carbon stocks and microbial activity in deeply weathered soils below a tropical wet forest. *Global Change Biology* 9:1171–1184.