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Biogeosciences Discussions



# *Interactive comment on* "Organic carbon and nitrogen export from a tropical dam-impacted floodplain system" *by* R. Zurbrügg et al.

**Anonymous Referee #1**

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Review of "Organic carbon and nitrogen export from a tropical dam-impacted floodplain system" by R. Zurbrügg, S. Suter, M.F. Lehmann, B. Wehrli, and D.B. Senn.

General comments

This paper addresses the role of tropical floodplains in the transport, storage and transformation of the organic matter along the aquatic continuum from land to the ocean. The manuscript analyzes fluxes and quality of organic matter flowing through the Kafue Flats, a tropical dam-impacted floodplain system in Zambia. This study presents relevant and important data of significant current interest, and is likely to attract a wide group of readers from the growing field of inland water carbon cycling.

The study is well designed, the sampling and analytical techniques are state-of-the art

and are clearly documented. The authors show convincingly that during the flooding season, more than 80% of the river water that passes through the floodplains remobilize and export to the river downstream large quantities of organic carbon and nitrogen (mainly in the dissolved form). They provide interesting correlations between elemental C:N ratio, isotopic signature, and spectroscopic proprieties, which help them to assess distinct source of dissolved and particulate matter and which will be a useful reference for further studies on this topic. Overall, dissolved organic matter has the same terrestrial origin in the upstream reservoir, river, and floodplain while particulate organic matter in all systems is dominantly of aquatic (phytoplankton) origin.

The paper is generally well-written although language can be further improved (see my suggestions below: Technical corrections/suggestions). The relevant scientific debate is cited and meets the standards of Biogeosciences. There are however a number of issues listed below that the authors should addressing prior to publication.

Specific comments

The abstract. This is just a suggestion but I think the reader expects to see a final conclusion of the abstract that relates more to the effect of the Kafue Flats on the OM dynamics (more related to the title and the main goal of the study) rather than a conclusion on the effect of the upstream reservoir which is mainly derived from the results of others (Kunz et al., 2011, Wamulume et al., 2011, etc). The authors may consider re-writing the last paragraph of the abstract or add another final conclusion to accommodate this remark.

Page 7945, line 25: States that particle trapping in dams together with hydrological alterations resulted from dam construction “may affect riverine OM loads and quality. . .”. While this is perfectly true, it is however not limited to “tropical systems” as suggested latter. Consider removing “in tropical systems”.

Chapter 3. Results Both subchapters 3.1 (describing the DOC, DON, DOC:DON and POC, PON and POC:POC) and 3.2. (describing 13C-DOC, 13C-POC, 15N-TDN and



BGD

9, C3247–C3254, 2012

15N-POC) are a bit difficult to follow since there is a downpour of mix information on temporal (2 flooding season + one dry season) and spatial variability of several parameters along the river stretch plus floodplain samples. I would suggest a bit of structure there. Moreover, why those results are not discussed and presented (Figure 3 and Figure 4) in chronological order as someone would expected from 2008, 2009 and 2010? Also, the variability of all parameters together with patterns along the river stretch during the three seasons that are illustrated in Figure 3 and Figure 4 and described in both subchapters (3.1 and 3.2) should be better documented (see points below).

Page 7953, line 24: The authors stated that during the dry season (October 2008), d13C-POC along the river was relatively constant at around -26‰Ẇhile this constancy is true for the first 250 km below the dam, a sharp and constant decreased pattern from about -24‰ to -30‰ (see Figure 4) emerge after 250 km. This is worth documenting as such decrease suggest an important shift in the origin of POC (from more terrestrial to aquatic sources) as water come out of the floodplain. Moreover, while relatively constant along the upstream river stretch, dry season 13C-POC seems to me significantly higher (around -26‰ than during both flooding seasons (average around -29‰. Those are important differences suggesting seasonal variability on the origin of OM and need to be pointed out and properly documented. Same apply to 15N-TDN and 15N-PON.

Page 7954, line 20: Related to the hydrological exchange between the river and the floodplain, it is stated that at around 200 km downstream of the dam, a large fraction of the river is forced into the flats while at around 300 km, the water returns from the floodplain. I was wandering if anyone has estimated the residence time of the water into the floodplain. This would be an important parameter explaining potential transformations of the OM in the floodplain.

Page 7955, line 16: Patterns of POC and PON loads needs more discussions. The mentioned increase in May 2010 and decrease in May 2009 and in October 2008 is relative to what? What factors are responsible for those increased/decreased trends? Increased discharge, increased concentration or both? I would also like to see a dis-



BGD

9, C3247–C3254, 2012





cussion of the relative contribution of DOC and POC as well as DON/PON/DIN to those increased/decreased load patterns. Based on Figure 7a and b, there seems to be a major change in the relative contribution of POC and DOC to the OC load (same for N load) suggesting a dilution effect due to increased discharge below 300 km but also a large retention of the particulate form in the floodplains.

Page 7956, line 6: Has anyone estimated the magnitude of OM burial in the Kafue Flats or other similar floodplain systems? It would be good to have an idea on the scale of this process.

Page 7956, line 11: How comparable are these estimated yields (representing either 1-3 or 30% of the annual primary production) relative to other similar studies? Citations are needed there if exists to validate and size the findings of this study.

Page 7958, line 2: States that "...terrestrial POM is efficiently retained in the ITT reservoir...as indicated by intense sediment accumulation...". While there is no doubt that the reservoirs can retain large fractions of the particulate inflowing load, sedimentation of 16,000 t C yr-1 as shown in Figure 9a (large fraction of which must be in-situ produced – otherwise the balance would not hold) represent only 16% of the inflowing load of 100,000 t C yr-1. This does not necessarily qualify for intense sedimentation, nor for efficient trapping. How much of the inflowing OC load of Figure 9a is in particulate form? If I would be to reconstruct the OC mass balance shown in Figure 9a, as it stands there, a surplus of +8 t C yr-1 (100,000 - 16,000 – 76,000) would be suggested. Is this due the not shown C produced by reservoir primary production? If yes, this seems awfully small giving an estimated annual average primary production rate of 280 g C m-2 yr-1 (according to Kunz et al., 2011) and a reservoir surface area of 364 km2. These should be shortly discussed together with potential uncertainties.

Page 7960, line 24: What is the difference between the two increased distances: a) from the river to the floodplain; and b) from the shore to floodplain? Give a better explanation.



BGD

9, C3247–C3254, 2012



Page 7961, line 12: This sentence need to be revised as it is not clear wheatear it refer to inflowing loads into the reservoir or out of the reservoir into the flats. Also, why plural ('loads") when latter on (line 14) there is only one value (7900t N yr-1) presented?

Page 7962, line 22: States that the exchange between the river and floodplain causes a net export of 35-75 kg C km-2 d-1 in the form of DOC? Is this true? I thought that only 80% of it is DOC.

Technical corrections/suggestions

Page 7944, line 14: delete "of" before "higher".

Page 7944, line 19: replace "than" with "like".

Page 7945, line 3: add "of' before "floodplains" and delete "play".

Page 7945, line 20: replace "cause" with "causing".

Page 7945, line 21: add "of" before "floodplain-derived".

Page 7945, line 24: add "to alter" after "thus".

Page 7945, line 26: replace "and both hydrological alterations and particle trapping" with "which together with hydrological alterations".

Page 7945, line 27: for better reading, consider deleting "OM" before "loads", add "the" before "quality" and add "of the OM" after "quality" so it become "may affect riverine loads and the quality of OM".

Page 7945, line 29: add "on" after "dam-impacts"

Page 7946, line 7: I believe that evidences of pronounced hypoxia were encountered over the "last" 150 km long stretch, after water comes out of the floodplains.

Page 7947, line 21: add "down" after "concentration".

Page 7947, line 23: "...water leaving the system...". What system? River system,



BGD

9, C3247–C3254, 2012





reservoir system? Please specify.

Page 7948, line 12: describe with full name here and everywhere else (especially throughout 2.2. Sampling campaign, and 2.3. Laboratory analyses) all abbreviations and initials used for the first time, for instance GF. EDTA, NH4, NO2, K2SO4, UV, NaOH, USGS, etc.

Page 7948, line 14: add “within” after “analyzed”.

Page 7949, line 18: delete either “of” or “and” before the last “standards”.

Page 7953, line 12: Move “values” after “d13-C-DOC” and delete “for”.

Page 7953, line 13: replace “for” with “during”.

Page 7953, line 21: “During the flooding season, d13C-POC increased by. . .”. Which flooding season? Which year? Figure 4 suggest an increased trend during both flooding seasons. If that’s the case, replace than accordingly with “During both flooding seasons,. . .”.

Page 7954, line 7: “3.5 $\pm$ 0.3 l mg-1 m-1“ - keep the same unit - see Figure 5a.

Page 7954, line 20: replace “was” with “is”. Otherwise mention the exact period of your observation when the “. . .stream flow was forced into. . .”. Same at page 7955, line 3.

Page 7955, line 16: Move “loads” after “PON” and delete “of”

Page 7955, line 29: add “at” before “3060 km2”.

Page 7956, line 8: there is a repeatedly use of “flooded area” in the same line. Consider using synonym words, for instance “flooded surface”.

Page 7956, line 11: consider re-writing this entire line after the comma. My suggestion: “suggesting that other processes (mentioned above) are dominantly responsible for the fate of the OM in the floodplain”.

Page 7956, line 18: delete “riverine” since you mention already that the floodplain is



BGD

9, C3247–C3254, 2012

an OM source to the Kafue and Zambezi rivers. Also, no need of capital letter from "Rivers"

Page 7956, line 19: replace "underestimates based on" with "underestimated by".

Page 7956, line 28: replace "be" with "originate".

Page 7957, line 6: first "and" must be "of"???

Page 7957, line 7: replace "suggest of"" with "suggest that".

Page 7957, line 11: POM cannot "consist of primary production. . .". You may consider re-writing this last part, for instance: ". . .originated from the primary production. . .".

Page 7957, line 18: This phrase, especially the last part need to be reformulated. As it stands, it reads: "In contrast to other systems. . .this is unlikely in the Kafue Flats".

Page 7957, line 22: Even spectroscopic results support chemical data, the fact that DOM is primarily terrestrial is a conclusion. The phrase should read something like: Spectroscopic results not only support the overall conclusion drawn from the chemical data that DOM was primarily of terrestrial origin, but. . . "

Page 7958, line 2: replace "of" with "between" and "with" with "and".

Page 7958, line 3: Move "FI" after "systems" and add capital letter to 'In".

Page 7958, line 8: Delete "of" before "terrestrial".

Page 7959, line 5: replace "but" with "and".

Page 7955, line 17: Delete "We found that,".

Page 7959, line 23: replace "Any" with "Even" and add comma after "more".

Page 7959, line 9, add "of" before "isotopically-light".

Page 7960, line 25: Delete comma after "production".



BGD

9, C3247–C3254, 2012





Page 7961, line 4: add “and” after “data” and replace “from” with “for”.

Page 7961, line 7: replace “as” with “than”.

Page 7961, line 25: move “completely” before “excluded”.

Page 7961, line 26: move “be” before “rapidly”.

Page 7962, line 9: replace “N-fixation rates that high” with “high N-fixation rates”

Page 7963, line 2: replace “based on” with “as indicated by”

Page 7963, line 9: I suggest starting a new paragraph with “Our study. . .”. Generally, this last paragraph needs a bit of “brush up” for better reading.

Caption Table 1, line 2: Loads do not have a minimum. Suggestion: “. . .loads were minimum at 230 km due to a channel. . .”.

Figure 1b, lower graph,: What does “Stage” stands for on the Y axis? Why not “water level”? Caption Figure 1, line 3: delete “to” after “and”.

Figure 3 and Figure 4: Why not displaying data in chronological order as one may expected from 2008 to 2010?

Caption Figure 5: comma after “circles)”, delete “and”, move “the” before “floodplain” and comma after “diamonds)”.

Caption Figure 7, line 2: add “For” before “The? Add comma after 2010. And replace “are” (line 3) with “were”.

Caption Figure 9. Be consistent putting a dot (or not) between (a) and (b) (see other figures). Same constancy for using capital letters (or not) when describing superscripts, i.e. “1)”

Caption Figure 10, line 1: delete comma after “components”

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