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Biogeosciences Discussions

Interactive comment on "Distribution and degradation of terrestrial organic matter in the sediments of peat-draining rivers, Sarawak, Malaysian Borneo" *by* Ying Wu et al.

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Revision notes to RC1 bg-2019-94 Distribution and degradation of terrestrial organic matter in the sediments of peat-draining rivers, Sarawak, Malaysian Borneo" by Ying Wu et al.

Comments: 1. Study region and sample collection: I suggest the authors add more background introduction and more sampling details. e.g., how the water discharge changes in those rivers monthly, and what were the discharges like during different sampling campaigns of each river? This may help to give the readers an overall impression of different hydrological conditions; soils: were they all surface samples or

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depth profiles? How were they collected? How representable were they?

Reply: Thanks for the comments, we have revised as suggested, add the information about sediment and water discharge in seasonal patterns. However, there is almost no information available about those small rivers and also no information about monthly discharge from the Rajang. The detailed sampling information about soil samples are also added as suggested.

Revised: P5-P6 The Rajang River drainage basin covers an area of about 50,000 km2. Elevations exceed 2000 m and hill slopes are steep, generally in excess of 258 m in the interior highlands and 208 m in lower areas (Martin et al., 2018). The three small rivers (the Maludam, Simunjan, and Sebuyau) are blackwater rivers that draining extensive peatlands (Fig. 1). The drainage basin of the Maludam is about 91.4 km2 and the majority of the river is located in the Maludam National Park with 10m thick peat (Muller et al., 2015). The other two rivers are highly human disturbed with intensive oil palm and sago plantations. For the Rajang, it is separated into two parts by Sibu Town, upper reaches mainly drains mineral soils, while down reaches develops multiple distributary channels (e.g., the lower Rajang, Serendeng, Igan; Fig. 1). These channels are also surrounded by broad peatlands. It is reported that peat greater than 1m thick covered 50% of the delta plain (Staub et al., 2000). However, Deforestation and changing in land use are accelerating the peatland degradation (Fig. 1). More than 50% peatland (11% of the catchment size) in Rajang watershed has been occupied by industry plantation (e.g. oil palm) (Miettinen et al., 2016). Fishery, logging and timber processing are the traditional supports for local citizens (Miettinen et al., 2016). The climate of the study area is classified as tropical ever-wet, with average rainfall in excess of 3700 mm/year. The average monthly water discharge of the Rajiang is about 3600 m3/s, with peak discharge (∼25,000 m3/s) observed during the northeastern monsoon season (December to March; Staub et al., 2000). However, the amount of suspended sediments delivered from the Rajang basin to the delta plain demonstrated slightly variation (2.0MT/s dry season versus 2.2 MT/s wet season) but changed substantially about the amount of sediment delivered from the delta plain to the South China Sea (Staub et al., 2000). It is estimated that the annual sediment discharge of the Rajang was 30 Mt. The turbidity maximum in the lower Rajang channels occurred during the low or reduced discharge period. It is reported that up to 24 Mt of sediment was deposited in the delta front with preserved annual sediment layers at the order of one cm thick (Staub et al., 2000). The water discharge of the Maludam is quite low, only 4.4±0.6 m3/s, from the 91.4 km2 catchment (Muller et al., 2015). The river length of Maludam is 33 km. For the Sebuyau and Simunjan, river length is 58 and 54 km, respectively (Martin et al., 2018). However, hydraulic information for these two rivers is largely unknown. The three sampling periods resembled the end of this northeastern monsoon (i.e., March, the end of the wettest season of the year) and were shortly before the beginning of the northeastern monsoon (i.e., August and September, the end of the drier season).

Comments: 2. Chemical analysis: what is the deviation of lignin analysis? This is important, as it can help to understand whether the variation of lignin indices were its natural variation or analytical error. Reply: Added as suggested. The deviation is less than 10%. Revised: P8 L183- Coefficients of analytical variation associated with phenols values were <10% based on replicate analysis of the same samples.

3. Line160: Please add reference for this equation. Reply: Added as suggested. Revised: P8L188- Since both ratios have been found to decrease with the preferential degradation of S and C relative to V phenols, lignin phenols vegetation index (LPVI) was developed to be an alternative approach to evaluate the original of various type of vegetations (Tareq et al., 2004; Thevenot et al., 2010):

4. Please add the information of what parameters were used in PCA and cluster analysis. Reply: Added as suggested Revised: P9L200- Multivariate statistical approaches such as principle component analysis (PCA) and cluster analysis (CA) are among the most widely used statistical methods in determining the significance of specific parameters (including OC%, TN%, mean grain size, clay% and silt%, total lignin phenols con-

centrations, DHBA and the ratios of vanillic acid to vanillin ((Ad/Al)V)) within a dataset (Pradhan et al., 2009).

5. Lines 194-195: The highest values of : (30%-49%), this sentence reads odd, please revise. Reply: Revised as suggested. Revised: P10L236: The highest values of OC were measured in plants samples and varied from 30%–49% (Table S2).

6. Line 200: delete which before exhibited Reply: Did as suggested. Revised: P10L241 Although nitrogen was enriched in the samples from the peat-draining rivers, they still had higher mean C/N values (15.8$\pm$3.7) compared with the lower Rajang (11.5$\pm$1.6) while vegetation samples, exhibited low N content and high C/N (C/N = 56$\pm$34).

7. Line 216: When describe correlations, the authors often use "good", however, it is not clear, what kind of relationship is "good", please define "good" (e.g., correlation coefficient R2 higher than 0.7), or use other words, e.g., significant or simply show R2 Reply: Yes, it is a good comment, revised as suggested through the whole manuscript. Revised: P11L259 There are correlations between ïĄŞ8 and OC% in each river (r2 > 0.5), with the slope decreasing in the order of Maludam > Simunjan > Sebuyau > Rajang (Fig. 2a). P14, L330- ; L350- The close correlation of factor 2 with OC% and ïĄŞ8 in the PCA suggests factor 2 relates to the source of the organic matter (Fig. 3), as also indicated by the strong correlation between OC% and ïĄŞ8 (r2: 0.53-0.85) (Fig. 2) For the Rajang, the LPVI values show a positive linear correlation with ïĄŇ8 concentrations (r2 = 0.56);

8. Line 238: do you mean which reflects the very low "P" value? Reply: Yes, it is. Revised: P12L280 The P/(V + S) ratio is low in the vegetation samples, except for the leaf samples (P/(V + S) = 0.22), which reflects the low P content in most vegetation (Table 2).

9. Line 254: I am a little confused here, do you mean that factor 2 showed close correlations with 8 and OC%, and factor 1 showed close correlations with (Ad/Al)v and grain size? Reply: Modified as suggested. Revised: P12 L294- Similar groupings

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are evident in the results of the PCA analysis, which was based on the distribution of factors 1 and 2 that represent total loadings of 45% and 32%, respectively (Fig. 3b). The PCA results implied that factor 1 showed close correlations with the (Ad/Al)v ratio and grain size while factor 2 showed a close correlation with ïĄŞ8 and OC%.

10. Lines 265-267: Could you please explain more how higher values of lig8 is caused by human activities?

Reply: The higher values of ïĄŇ8 found in our studied systems were linked to vegetation types (trees dominated) and partially caused by peat-draining and intense human activity near the watersheds (e.g. land use change and logging activities).

Revised: P13 L309- The higher values of ïĄŇ8 found in our studied systems were linked to vegetation types (trees dominated) (Zaccone et al., 2008) and partially caused by peat-draining and intense human activity near the watersheds (e.g. land use change and logging activities), as reported previously (Milliman and Farnsworth, 2011; Moore et al., 2013; Rieley et al., 2008). Much of the peatland neighboring the Simunjan and Sebuyau catchments has been changed to oil palm plantations (Martin et al., 2018). P17L417- The higher values of ïĄŞ8 and OC% were observed in Simunjan and Sebuyau, where land use and drainage observed. Usually land use and drainage of tropical peat will accelerate the loss of vegetation and OC degradation (Kononen, et al., 2016), here it may be explained by the high content of OC and lignin in oil palm, which is the major plantation in both regions.

11. Line 272-275: I think this sentence could go to the conclusion Reply: Modified as suggested. Revised: P20L488- Most of the OCterr discharged from the Rajang and small river systems was composed of woody angiosperm plants and the terrestrial organic matter undergoes limited diagenetic alteration before deposition, and could potentially become a significant regional carbon source to the atmosphere after extensive degradation. This study provides new insights into the amount of terrestrial OC preserved in the tropical delta region of southeastern Borneo, as well as into the bio-

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geochemical transformation of OM from terrestrial source to marine sink across this region.

12. Line 278: The average 13C of vegetation samples seems lower than -28.5‰ please double-check this value. Reply: Yes, we modified and made it clear. Revised: P13L321- The depleted average ïĄď13C values (-31.8 $\sim$ –28.1‰ of our vegetation samples indicate an insignificant contribution from C4 plants in the study area (Gandois et al., 2014; Sun et al., 2017).

13. Line 288-289: Do you mean close relationship between OC% and scores on factor 2, 8 and scores on factors 2? Reply: We modified the sentence to make it clear as suggested. Revised: P14L330- The close correlation of factor 2 with OC% and ïĄŞ8 in the PCA suggests factor 2 relates to the source of the organic matter (Fig. 3), as also indicated by the strong correlation between OC% and ïĄŞ8 (r2: 0.53-0.85) (Fig. 2).

14. Line 296: I suggest the authors add the loading of the main parameters on the two components (factors). Reply: The loading of two components is 45% and 32%, modified as suggested. Revised: P14L334- Furthermore, the differences between the upper and lower Rajang are highlighted by the PCA results (score 1 represents 45% of the total loading while score 2 is 32%) and bulk parameters; i.e., the upper Rajang drains a mineral soil whereas peat is dominant in the delta region.

15. Lines 315-318: Here the authors attributed the higher P/V ratio to the non-woody input for the additional lignin? Could you please explain more what is additional lignin?

Reply: We check the information of plant samples, add some information for the potential contributions for higher P/V ratios observed in small river systems.

Revised: P15L362- Considering this, non-woody angiosperms are the most likely source of additional lignin. Combined the composition of P and V in plants samples listed in Table S2, we find some dominant species, e.g. Dipterocarpaceae, Bruguierag ymnorrhiza(L.) Poir., Elaeis guineensis Jacq. have a relatively higher P/V ration in their non-woody parts.

16. Line 321: change “estimate” to “evaluate” Reply: Done. Revised: P15L368- (Ad/Al)v ratios are often used to evaluate the degradation status of terrestrial OM.

17. Lines 331-338: the (Ad/Al)v and lig8 relationship, in Rajang river, the authors used each single data point, but in the small rivers, the authors used average value? What if you do it the similar way, do you still see the correlation between (Ad/Al)v and lig8 or (Ad/Al)v and grain size in small rivers? The variation of (Ad/Al)v were much smaller in small rivers as compared to the Rajang river. In my opinion, grain size may not be the most important factor for (Ad/Al)v in small rivers as it also showed smaller variation.

Reply: We totally agree these opinions, actually we tried both ways to interpret the data we have got during preparation. Due to the size of the Rajang basin, the scattered dots could be more suitable to reflect the variation in general, while the small rivers, all data shown limited variation, if we still prefer single scattered data, there will be no clear trend observed at all. We used the average values to track their relations with variable parameters, just in order to provide the clear systematic pattern among those data.

Revised: No corrections for this point.

18. Lines 339-345: again for the correlation between S/V and (Ad/Al)v in small rivers, what if you use individual data point instead of average value? In Fig. 5b, it seems that the whole relation is because of Mal-2017.09, in other words, it seems that there was no significant relation between S/V and (Ad/Al)v in other two rivers.

Reply: If we use single dots for the small rivers, there is weak relation between S/V andïijĹAd/AlïijĽv in each system, but the reverse trend of S/V withïijĹAd/AlïijĽv still existed, based on this point, we decided to evaluate the relationship with average values.

Revised: No corrections for this point.

19. Fig. 6b: for Rajang, there were only three points, this kind of relationship is artificial, in my opinion. Why not using single data point instead of average value?

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Reply: ïijŽIf we use all the individual data of RajangïijŇwe could see there a reasonable relationship for the C/N and ïijĹAd/AlïijĽv ïijĹr2=0.34ïijĽïijŇbut since the small river systems use average data to present, we choose the same principle for the Rajang system to keep it comparable within one figure.

Revised: No corrections for this point.

20. Table 3: Please be careful with the effective number, e.g., C/N. Reply: Revised properly. Revised: Please refer to the Table 3.

21. Table 3: The font of last line is different to others, please revise. Reply: Did as suggested. Revised: Please refer to the Table 3.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2019-94/bg-2019-94-AC1-supplement.pdf

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