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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 RC2 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: As a general comment, I have a concern that much of the literature data discussed here is (I believe) for POM suspended in rivers, and the data collected here is mainly from surface river sediments. As a result, there may be a little bit of a problem with these comparisons. Organic matter in sediments is processed differently than that which is suspended in the water column because of differences in the two settings in

their solid:solution ratios as well as their exposure to oxygen. Therefore, depending on how "stable" the bottom sediments are (i.e., how often they are resuspended into the river, how long they spend in the river before being re-deposited, and then how long they remain deposited as sediments) these differences in environmental settings may impact the conclusions drawn in the comparisons presented here. I will try and point out specific places in the text where I think this needs to be looked at a bit more carefully.

Reply: Many thanks for the good suggestion. Based on the limited available information, the Rajang Delta is still aggregation and the annual sediment rate of delta front is about 1 cm (Staub et al., 2000), which makes the seasonal comparison reasonable, but due to abnormal climate during two seasons, we could not make it. Resuspension and re-deposited process might be observed in the lower Rajang during dry season, where TMZ dominated, but it is related to the tide process, only one or two stations are covered. We add these information in the sampling section for the background information. For the comparison study in the manuscript e.g. Table 3, only the sediment samples were considered for the further comparison study. In Discussion 4.4 section, we deleted the comparison with suspended samples as suggested.

Revised: P6 L125- 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 is 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 is deposited in the delta front with preserved annual sediment layers at the order of one cm thick (Staub et al., 2000). P17L422- In this study, the OC content increases with decreasing grain size, implying that fine sediments, with larger specific surface areas and rich in clay, contain more OM than coarser sediments, as reported previously (Sun et al., 2017). Increasing (Ad/Al)V

values were observed in the Rajang with increasing grain size, which suggests that lignin associated with larger mineral particles is more strongly degraded.

Comments: 1. (26) – add “phenols” after “aldehyde”. Reply: Modified as suggested. Revised: P2L26- The selective sorption of acid relative to aldehyde phenols might explain the variations in the (Ad/Al)v ratio.

Comments: 2. (28-9) – Here and in the conclusions (line 428) and the text (line 395) they refer to “slower degradation”. I think they are really talking about material that shows less evidence of degradation since it’s not clear to me how rates of processes can be inferred from any of the results presented here. Reply: Sorry for the confusing, we modified it in the revised manuscript to make it clear. Revised: P2L30- In small rivers, a quick decline of C/N ratios responses to the slower modification of (Ad/Al)v ratio by the meant of better preservation of lignin phenols. P18L450- Quicker decline of C/N ratios related to slower lignin degradation in small rivers, this could be related to the expected impact of nitrogen on lignin degradation (Dignac et al., 2002; Thevenot et al., 2010). P20L486- A high N content will inhibit fungal lignin biodegradation, which might explain higher lignin phenols with moderate degraded process observed in the small river systems where a higher TN% was recorded.

3. (38) - Add “is” before “derived”. Reply: Modified as suggested. Revised: P2L40- It is reported that about 77% of the carbon stored in all tropical peatlands is derived from Southeast Asia.

4. (39) – I think “disturb” should be “disturbance”. Reply: Modified as suggested. Revised: P3L42- However, increasing anthropogenic disturbance in the form of land use change, drainage and biomass burning are converting this peat into a globally significant source of atmospheric carbon dioxide.

5. (59) – While the presence of lignin is an indication of the presence of OCterr, its absence is not necessarily an indication of the lack of terrestrial organic matter, since highly degraded soil organic matter may be devoid of any apparent lignin. Perhaps

this is a subtlety the authors don’t want to get into, but I wonder if this is worth at least mentioning? Reply: Yes, it is true, we modified the original sentence to avoid misleading. Revised: P3L62- Lignin, which constitutes up to 30% of vascular plant biomass, is a unique biomarker of OCterr although highly degraded soil organic matter, as another important contributor to OCterr, may be devoid of any apparent lignin.

6. (145) – A microwave “oven”? Reply: It should be microwave digestion system, Modified. Revised: P8L172- Briefly, the powdered samples were weighed and placed in O2 free Teflon-lined vessels, and digested in a microwave digestion system (CEM MARS5) at 150°C for 90 min (Goñi and Montgomery, 2000).

7. (154) – I found this whole paragraph very confusing.

Reply: We followed the suggestion, modify the paragraph, summarize variable parameters of lignin phenols, which will be applied in the following discussions.

Revised: P8L186- Ratios of syringyl-to-vanillyl phenols (S/V) and cinnamyl-to-vanillyl phenols (C/V) are often used to indicate the relative contribution of angiosperm and non-woody tissues versus gymnosperm wood, respectively (Hedges and Mann, 1979). 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): Lignin phenols vegetation index (LPVI) = [{S(S + 1)/(V + 1) + 1} $\times$ {C(C + 1)/(V + 1) + 1}] The ratio of P/(V+S) may reflect the diagenetic state of lignin when the other sources of P phenols (such as protein and tannin) are relatively constant (Dittmar and Lara 2001). The acid-to-aldehyde (Ad/Al) ratios of V and S phenols are often used to indicate lignin degradation and increases with increasing lignin oxidation (Otto and Simpson 2006).

8. (160) – A reference or two, and some additional discussion is needed about this index. For example, what kinds of values do you typically see among different end-member materials, fresh versus degraded materials, etc.

Reply: Add the reference 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) P14L346- This finding is further confirmed by the LPVI values (Gymnosperm woods: 1, non-woody Gymnosperm tissues, 3-27; Angiosperm woods: 67-415; non Angiosperm tissues: 176-2782),

9. (203) – Detritus samples are mentioned here for the first time. It's not clear to me from reading the methods section what they represent and how they were collected. This needs to be clarified. Reply: We add the information of detritus samples collection in sampling section as suggested. Revised: P7L146- Fresh, typical vegetations (listed in Table S2) were separately collected by leave, stem and roots, some detritus, which floating at the surface layer of the rivers were also collected for the comparison study.

10. (204-7) – By river "samples" do you mean river "sediments"? Also, I'm not sure I would be willing to say that there were differences between the 13C values in the peat-draining rivers versus the Rajang. Reply: Yes, river samples mean riverine sediments. After double checked our data of stable isotopes of sediments, we made the correction to make it better precise. Revised: P10L247- The isotope ratios of the peat-draining river's sediments (average ïĄđ'13C varied at -28.2 âĂŤ -27.4‰ were comparable with the Rajang's (average ïĄđ'13C = –28.6±0.6‰ (Tab. 3).

11. (209-) – I think Sum8 is defined as per 10 g dw (not 10 mg). Otherwise, many of the values presented here suggest you have more lignin carbon than total material. Reply: Sorry for the mistake, we modified as suggested. Revised: P11L253- except for the lignin yield (ïĄŞ8), which is the sum of C + S + V and is expressed as mg 10 g dw–1, and are presented in Fig. 2 as well as Tables 2 and S1-3. The highest yields were measured in the vegetation samples (300–900 mg 10 g dw–1). The lignin yield from the soil samples and the three small rivers (average of ∼30 mg 10 g dw–1) is also higher than that from the Rajang samples (average of <10 mg 10 g dw–1), with the

lowest value observed in the upper Rajang (0.16 mg 10 g dw–1; Table 2).

12. (257) - The discussion of results in Table 3 is a place where I have concerns about comparing literature data for suspended river POM and data here for bottom river sediments. Reply: All the information we summarized in Table 3 is about sediments samples no POM samples at all, we revised the sentence to make it clear. Revised: P13L302- Table 3 summarizes the distribution of bulk and lignin parameters of sediments from typical systems worldwide.

13. (270) – The transition here to discussing Arctic sediments is rather abrupt, and the point here is not clear to me. Reply: Thanks for the comments, we moved the Arctic sediments information as suggested. Revised: P13L314- The terrigenous OM has been affected by diagenesis, as (Ad/Al)V varies markedly among the different systems (Table 3). The (Ad/Al)V values of the sediments sampled here are comparable to fresh and only low to medium oxidized. Elevated (Ad/Al)V values observed from the Maludam's sediments (March, 2017) may be also attributed to source plant variations as observed in other study case (Zhu et al., 2019).

14. (272) – This sentence ("This study : : :") says very little and seems out of place here. Reply: Deleted as suggested.

15. (287) – The phrase ": : : sediment samples : : :phase" doesn't make sense to me. Reply: Thanks for the comment, we modified the sentences to be better presented. Revised: P14L327- Previous study reported that the sediment load from the basin to the delta was no seasonal pattern, combined with comparable precipitations during our two sampling seasons, our observations matched it (Martin et al., 2018; Staub et al., 2000).

16. (295-6) – I don't see how these relationships between 13C and Sum8 relate to Fig. 3. Reply: Sorry for the misleading, the plot of 13C and Sum8 was presented at Fig. 2. 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).

17. (303-4) – This is a place where additional information about the LPVI index would be useful. Reply: Modified as suggested. Revised: P14L346- This finding is further confirmed by the LPVI values (Gymnosperm woods: 1, non-woody Gymnosperm tissues, 3-27; Angiosperm woods: 67-415; non Angiosperm tissues: 176-2782),

18. (329) – The correlation in Fig. 4b is very weak at best, and in fact, if you include the sample collected from the Maludam in March 2017 you would probably get just as strong an inverse correlation. Reply: Yes, thanks for your comments, we redrew the figure and edited the sentences to make it more precise. Revised: P15L376- However, the ïĄŇ8 values with (Ad/Al)v ratios was not so significant in the small river systems as we expected, partially resulting from the variation of (Ad/Al)v also could be vegetation sources controlled (Fig. 4b).

19. (331-8) – Why is there no discussion of the positive relationship between (Ad/Al)v and grain size in the Rajang (Fig. 4c)? Reply: Added as suggested. Revised: P16L380- Of the sediments sampled here, the upper Rajang samples contain the largest coarse fraction and the finest sediments were collected from the Maludam in March 2017. The (Ad/Al)v ratios increase with increasing coarse fraction of the sediments in the Rajang, which is typically observed in other systems (Bianchi et al., 2002; Li eta l., 2015; Sun et al., 2017) (Fig. 4c).

20. (343) – I'm not entirely convinced there is a non-linear relationship in Fig. 5b. Fitting a straight line through the data might show a correlation just as good as some of the linear correlations in Fig. 4. Reply: We tested both linear and non-linear relationship for Fig 5b, the linear correlation has poor values for the fitting curve, r2=0.23ïijÑp=0.19ïijÑthat is the reason we chose nonlinear correlation to fit curve. Revised: No edited here.

21. (351) – What does "no clear trend" mean, especially in light of the linear correlation discussed on the next line.

Reply: Sorry for the confusion, it means good correlation among all samples, but no clear trend with small rivers samples, we corrected it as suggested.

Revised: P16 L401- However, in this study the ratio of P/(S+V) in most sediment samples did not vary greatly ($\sim$0.2). Although there was a linear correlation between the P/(S+V) and (Ad/Al)v ratios among all the sediments (r2 = 0.89), no clear trend was observed for the small rivers, which may suggest both parameter's more links to source instead of diagenetic process in these systems.

22. (359-362) – I think that it would be good to provide a little more detail to support this statement. The fact that the PC analysis says that lignin degradation is different in the Rajang versus the peat-draining rivers is interesting, but it's not clear to me what that means, and what new information it is giving us about how terrestrial organic matter is processed in these systems.

Reply: Thanks for the comments, as a starting paragraph of whole section, we add some general introduction of the differences of TOM in the Rajang and peat-draining rivers, more detailed information are presented in the following paragraphs.

Revised: P17L415- since it was recently shown that lignin could decompose as fast as litter bulk carbon in mineral soils (Duboc et al., 2014). In the delta region, most parameters were quite comparable, except ïĄŞ8 and OC% (Table S1). 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.

23. (363-) – This is another place where I have concerns about comparing literature data for suspended river POM and data here for bottom river sediments. Reply: The comparison with Sun et al., 2017, it refers to sediment samples only, but the comparison with Hedges (1986) was SPM samples, we revised it accordingly to make it more

precise. Revised: P17L423- In this study, the OC content increases with decreasing grain size, implying that fine sediments, with larger specific surface areas and rich in clay, contain more OM than coarser sediments, as reported previously (Sun et al., 2017). Increasing (Ad/Al)V values were observed in the Rajang with increasing grain size, which suggests that lignin associated with larger mineral particles is more strongly degraded.

24. (387) – The phrase ": : : when the conditions microbial preferred : : :" doesn't make sense to me. Reply: Modified as suggested to make it clear. Revised: P18L443- since nitrogen content tends to stimulates decomposition of low-lignin litter by decomposer microbes, but usually decrease the activity of lignolytic enzymes and inhibit decomposition of high-lignin litter (Knorr, et al., 2005; Thevenot et al., 2010).

25. (392) – "relative" should be "related". Reply: Modified as suggested. Revised: P18L452- Quicker decline of C/N ratios related to slower lignin degradation in small rivers, this could be related to the expected impact of nitrogen on lignin degradation (Dignac et al., 2002; Thevenot et al., 2010).

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2019-94/bg-2019-94-AC3-supplement.pdf

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