**Stabilization of carbon in mineral soils from mangroves of the Sinú river delta, Colombia**

**Reviewer comments**

**General comments –**

This paper aims to study source of carbon in a mangrove-wetland complex in Colombia, by exploring sediment characteristics. Although a potentially important and interesting study, it appears authors/researchers were not able to gather evidence that might be sufficient to draw the conclusions they presented. This reviewer believes that after critical revision, adding significant new information and providing additional analysis/interpretation their work could be a good addition to the literature, but in its present form, it is not fit for publication.

This MS could benefit immensely with a clear layout of sampling plan – sampling stations/plots, mangrove types, distribution and general habitat characteristics, elaborating the logic behind the selection of sampling plots. Attributes such as water depth, tidal range, salinity, proximity to the river mouth, fresh water discharge (rainfall patterns) and tidal mixing etc should be provided. Size of estuarine complex, and annual rainfall etc can be included in study area description. Also, Figure 1 (map of study location) indicates that river Sinu flows almost 10-12 km west of the sampling region. There is not clear suggestion in the figure or text that samples sites receive waters from River Sinu. This reviewer is somewhat perplexed and unable to understand the hypothesis and choice of the study design. Perhaps some clarification and effort in explaining this via text and figures would be beneficial for the readers.

Some important information is missing in the laboratory analysis section. For this entire section) there is no reference/no citation. This reviewer encourages authors to cite appropriate methods that were followed for analysis, and include all necessary and important details.

For calculating carbon storages in the sampled sites, bulk density of only one fringe site (P21) and one basin site (C4) was used for all plots. There is a large amount of spatial variability in soils even at small resolution and it is important to use site specific bulk density to calculate site specific storages. This reviewer has a serious reservation against this methodology.

This methods section does not include any description how data was analyzed. No statistical information is provided. What programs were used. Whether any tests for normalcy were performed? It is a standard practice to include such information in the MS.

This reviewer believes that the discussion section of this MS should be revised with more critical inputs, highlighting the new addition to this field. This reviewer commends authors for tedious field work and many hours of data entry and subsequent analysis, but it becomes difficult to see value of this research unless a more rigorous and through discussion is presented. The researchers could also report the broader implications of their research… i.e. How this understanding would be beneficial and for whom.

There are multiple incidences of discrepancies in sentence syntax and complex sentence formulation that diminishes readability and clarity of the text. This reviewer has suggested moving around text, and rewriting sentences to impart clarity. Such corrections will improve paper’s readability and should be relatively straight-forward to fix. I present my specific comments below with line numbers.

**Specific comments –**

Line 10: First use of Fe and Al – Expand

Line 13 Change *Than* -> to

Line 16: Statement – Most of the C was plant origin – Where else the C should have come? Please clarify – are you trying to differentiate between organic and inorganic C? It is not clear.

Line 26 – ‘various systems’ – What does author trying to refer to – various ecosystems? Or various compartments of C storage in mangrove ecosystems – trees, roots, soils etc. Please clarify.

Line 29-30. Please be specific. Right now it appears somewhat vague – identify ‘other sites’.

Line 31 – Suggest changing word – *diverse*. In its current usage it can be understood as the diversity of a mangrove stand, but this reviewer believes you meant different mangroves.

Line 32-34 – This reviewer suggests authors to include other factors that may be responsible for C storage. You currently note only two factors – productivity of mangrove vegetation and external factor – sediment transport. How about freshwater inputs, salinity, erosion, hydrodynamic energy experienced at a location, historical storms/flooding, anthropogenic influence etc.

Line 35-36: Authors are comparing global/regional variability in mangrove C storages with that find at a local scale within 10-15 km range. This reviewer would like authors to address this gap, and discuss factors affecting mangrove C storages at local and regional scales before looking into their study site observations.

Line 42: Expand ‘other systems’ to clearly state which regions, zones etc are you referring.

Line 44: Your statement ‘the high levels of soil carbon in Cispat´a bay’, contradicts your earlier statement (lines 40 -41) where you provide a range of C in soils and 95±9 Mg C ha−1 is not that high. Please rewrite to clarify that soil carbon in not high throughout Cispata bay.

Line 47-49 – Your deduction – ‘carbon stored in these systems may not have any external origin’, cannot be derived from the first part of your statement. If you are contend that – ‘carbon stored in these systems may not have any external origin’, then what are you trying to establish.

Line 47-53: Suggest rewriting this paragraph to clarify the message.

Line 55 – Change ‘these’ into what you are referring ->mangrove soils

Line 54-58 – This reviewer would encourage authors to revisit their main objective of this study, and try to clearly state that. Here, your objectives seems to be a corollary to the tasks you performed. (‘*…..using elemental and isotopic analyses of carbon as well as analyses of the soils’ mineralogy in concert with Al- and Fe-oxide measurements’*). State your objective, and then you can mention what was done to achieve that objective.

Line 65-66: What is the connection of deposition of river sediments and high C storage in mangrove soils. Authors did not mention a plausible reason for such hypothesis. Did they see heavy sediment load delivered by this river on an annual/periodic basis. Why does authors believe that the river brings high C sediments? No information to this observation provided in the text prior.

Line 68: Study site – You define your study area as study site where all sampling sites are located, and then later you refer- *‘… five fringe mangrove sites (plots P21, R1, R4, R5, R6) and at 5 basin mangrove sites (plots P16, C1, C2, C3, C4).*’ This reviewer suggest you use different terms to avoid confusion. May be ‘study area’ for the entire region, and then ‘location’ for fringe and basin mangroves, and then plots/sites for each individual sample collection point.

Line 72-73 – How so – provide details of exclusive wetlands and mangroves by either providing size, area of mangrove zone, or some other reference. What you say is very subjective and qualitative. This statement does not provide a good understanding of the area to the reader. Wetlands – does it include lakes.? Are these seasonal wetlands- fed by river or rainfall. What is the tidal range of mangroves, salinity range…flow/sediment load of river…all this information may be included in the study area description.

Line 78: Please define the two forest types as Fringe and basin earlier in the text, so you can use them

Line 87: Not clear what do you mean by ‘*We divided conspicuous layer changes at the boundary’*. Please clarify.

Line 89-91: What was the rationale behind using the entire 1m soil core of end members as one sample. Both riverbed cores of the Sin´u river and Nisperal coast are natural areas subject to soil depositional and erosional area, and 1m horizon can perhaps include variable conditions existing there over time. Mixing 1m depth profile of soil may result into different characteristics observed at those sites. You mention in Line 73-74 that River Sinu has changed directions in decades, so the river bed where end member was sampled may not be river bed few decades ago. Sampling 1 m deep core and mixing it as one sample may be erroneous.

Line 95: Why no explanation is provided for missing 80-100 cm depth sample at P21 (Fringe site)?

Line 97: If there were total 10 sites (Fringe and Basin) and 5 soil samples from each depth interval were collected, this should be 50 soil samples. How did authors collected 60 samples? Were there some replicates? Please provide this information.

Line 104: Was the sample sieved after grinding. If so please mention, and also include sieve size.

Line 105-106: This reviewer is not clear on the method for determination of IC? Elemental analyzer are known to provide total C and total N content in the sample. How was inorganic C determined?

Line 111-113: This reviewer has a serious reservation against using only one fringe site (P21) and one basin site (C4) bulk density values for calculating total Carbon storages at all plots. There is a large amount of spatial variability in soils even at small spatial resolution and it is important to use site specific bulk density to calculate site specific storages.

Line 118 – what do you mean by ‘in larger supply’? Please rewrite this whole sentence. Use expanded version first and abbreviated notation in parenthesis – example - Acetanilide-Jena3 (Ali-j3).

Line 121: Provide more details of the 12 representative samples. You have two end member sites so how do you have four end member representatives. What depths were chosen for the other samples from fringe and basin plots. Details missing.

Line 129-130 – Provide details of standard soils, and details of what samples were included to get the sample count of 46?

Line 128 to 133. Some important information is missing. How were these extractions performed? What was sample to solution ratio? How long were the samples treated, how were the solutions filtered? It is not clear if the solution was analyzed for crystalline or amorphous oxides. Using what protocols? For this entire section (Laboratory analysis) there is no reference/no citation. This reviewer encourages authors to cite appropriate methods that were followed for analysis.

Line 135: Consider rewriting/revising the entire results section. There are multiple issues that this reviewer cannot point out in its entirety, although I have highlighted some. This section needs more work.

Line 170-171: Differences at what depth?

Line 172-173: Table 2 does not provide information on the differences in mineral composition of two mangrove types. Revise Table 2 (see below specific comment for table 2).

Line 188-189: What do you mean by this statement – What is extracted clay mineral? Extracted by what solution. Confusing statement.

Line 193: Does oxalate extraction dissolved any crystalline iron oxide?

Line 196-197: What statistical test was performed? Was this statement for each sampled depth interval or only some? Was this test performed on the mean of all sampling plots or individual plots data was used as separate samples?

What is causing high variability in basin samples in comparison to fringe samples?

Line 211-13: Please revisit this sentence and rewrite to clarify what you mean. It’s confusing as it is now.

Line 225: What do you mean – *‘Because soil microorganisms utilize nitrogen and bacteria fix nitrogen….’* Please rewrite and clarify.

Lines 230-234: These sentences contradict what you said line 223-225. Consider revising and rewriting.

Line 235-244: Needs revision. Very confusing.

Line 247-249: That is a big bold statement. On what basis this claim is made. In previous paragraph you say that basin mangrove soils (Silty texture) can retain TOC for longer duration. Is it possible that the Carbon stored here was brought here from previous many years and have been accumulating? Whereas in sandy soils of Fringe mangroves do not offer sites for adhering C. There is no strong evidence or argument about differential in-situ production at either place.

Line 254-256: The authors need to spend more time on formulating these statements. Almost all organic C in mangrove ecosystem will be plant derived, so Isotopic ratio of C will show its plant derived, however it does not show if it was derived in-situ or transported from elsewhere. Also, there are multiple fractionation steps from C fixed by mangroves to its movement into the soil/sediments. The authors do not discuss or mention anything about that. Enrichment/or dilution in isotopic signature can happen at any of those fractionating steps. Please do not simplify it to a level that it loses its meaning.

Line 262 -263: What are you saying here? What grasses are you taking? Are you referring to sea grasses? As far as I know those are not C4 plants. What other grasses are you referring to in the basin area? Please revisit your theoretical understanding of differences in isotopic ratios and how it can be applied to mangrove ecosystems- particularly to elucidate C fixation, in-situ production and transport.

Line 267: How can you derive that basin areas are affected by Sinu river. There is no physical evidence, nor you mention that Sinu river flows influences this area. Your map indicated river bed almost 10-12 km away from your sampling sites. No information is provided regarding sediments loads, or flood plain influences…or any tributaries depositing sediments to this area.

Line 278-281: This reviewer is not convinced that appropriate information and evidence is provided to merit such conclusion.

Line 282-294: In this paragraph you say that both Basin and Fringe sediments originated in Sinu river and were transported by the river. But the main point of your paper seems to be that C in sediments were formed insitu and not brought by the river. Do you see the contradiction here? Are you suggesting that only mineral material was transported and not C. This observational study, unfortunately do not provide enough evidence to convincingly prove either way.

This reviewer liked how you used presence of halite to trace the history of your sampling plot to suggest that it had influence of hypersaline water and evaporation took place.

Line 303-314: This section can be rewritten to impart clarity. These is a lot of meaningful information, but it needed to be written in a manner that is clear to understand. Also, connect it to your findings clearly.

Lines 315-321: Again this reviewer has difficulty making sense of similarities and difference in basin and fringe mangrove soils. Authors tend to find similarities on one account and differences on other. This is confusing.

Line 323: What other studies are you referring to..?

Line 324-329: Different colorations and layers observed in the soil profile should have been reported in results, as physical properties of soils, and then discussed in this section.

Line 344-347: Try to provide a citation/reference for this statement.

Lines 315-356: This section can be rewritten, by moving a lot of textbook sort of information on soil mineralogy and forms moved to introduction. This will probably help you formulated your hypothesis, and once you have stated these theoretical underpinnings, it will allow you to better articulate your discussion of the observed facts in light of that.

Line 359: This study does not provide any information on the river water quality – amount of dissolved and particulate Carbon that river transports, and also physical sediment load that this river brings down. In absence of such critical information, an observation of mere sediment characteristics at a given point in time in river bed, and downstream locations may not yield a definitive answer.

Line 362: This reviewer is not sure whether the observations and research conducted /results obtained can be used to arrive at the conclusions that the authors have presented. Clearly, high C storages in basin mangrove is an artefact of high bulk density of the material. C density or C content (%) in mangrove soils were higher in fringe mangrove. Also, there is a possibility that coarser material gets deposited earlier in the in the mangrove delta (basin plots) while finer material brought by the river gets distributed further outwards where fringe plots are located. This distribution of sediments along the sampling area on the basis of hydro-dynamic energy could create differential signatures in the sediments. Role of tides and erosional processes could also redistribute fine sediments. There are not enough controls in this study design to rule out such possibilities. Also, age of sediments can be poorly estimated only on the basis of depth horizon, particularly in an area with a river that is known to be changing its course. Local stratigraphy may not be reliable unless paired with some other proxies (such as Lead 210 profiles).

Line 384: Figure 1 caption. What is the reason for mentioning end members in the caption. Are these locations highlighted in the map? Also, this reviewer recommends zoom into the section of map where all sites are located (mouth of Sinu river such that fringe and basin plots are clearing visible). Also suggested to use different colors to differentiate between basin and fringe plots. In this current version, the image is somewhat confusing, and is difficult to visualize spatial differences at local level.

Figure 2: Identify three plots as A, B and C (or as per journal recommendation for multiple plots in one image). And revise caption Something like – Inorganic carbon (IC; %) for a sampled plots (a) at \_? \_? \_ depth interval. Mean organic C (OC; %; b) and total nitrogen (TN; %) along the depth profile of sampled sites (c).

It will be useful to clarify the depth of soil horizon for IC%. Why end members are not showed in OC and TN plots? This reviewer recommends authors to clearly differentiate between fringe and basin sites in IC% plot.

Figure 3: Caption – change *both* to Basin and Fringe. Identify three plots as A, B and C (or as per journal recommendation for multiple plots in one image). Change – end member -> End member, basin -> Basin and fringe ->Fringe.

Figure 4. X axis notation missing ѳ. Also, what is ‘Sample 3’ mean?

Figure 5. Can authors format figures 4 and 5 similarly. Also, this reviewer was not clear why authors chose to only show two XRD patterns from two different sites, and two different depths?

Figure 6. Please expand caption to completely define the plots. Identify four plots as A, B, C and D (or as per journal recommendation for multiple plots in one image). It will be clear to indicate oxalate extracted and Dithionite extracted plots in the figure itself (in addition to subscript ‘o’ and ‘d’ on the y axis of plots.

Table 2. It will be useful if table 2 is expanded to include the mineral distribution across the sites. This reviewer would like to see additional columns added for Basin and Fringe sites, and information separated out for different depth horizons.