

| Reviewer Comment  | Author Response  |
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| <b>Referee #1</b>   |  |
| <b>General comment</b>  |  |
| <p>This study assessed the impact of mangrove dieback and recovery through assessing the changes in vegetation population and biogeochemical variables in the Gulf of Carpentaria. Findings from this study are important to understand the impact of mangrove disturbance on the biogeochemical processes, specifically their interaction between plant and sediment. This study will contribute to the current blue carbon literature while such coastal ecosystems are expected to undergo extreme disturbance in future. The manuscript is well structured and nicely written but can still be improved for some minor correction. Also, I would suggest providing further raw dataset obtained from this study in the supplementary information or via digital data repository platforms such as Mendeley Data and Figshare. Such of these data will provide a better understanding for the readers and also be useful for future meta-analysis based study on this topic. The publication of the ms can be recommended after revisions.</p> | <p>We thank the reviewer for the constructive feedback on the manuscript and will modify it to clarify the points raised. As suggested, we will also provide the entire raw dataset.</p> |
| <b>Minor comments</b>   |  |
| <p>Line 15: I would suggest defining the acronym for C, N, S when they first appeared. Sometimes acronyms can make confusion for non-specialist readers.</p>  | <p>We will define the acronym for C, N, S at the first appearance.</p>   |
| <p>Line 19: Were these samples or applicable for vegetation and sediments only?</p>   | <p>The samples include invertebrates, plants and sediments. We will rewrite the sentence to clarify this.</p>  |
| <p>Line 25: It would be great if data on vegetation population increase are presented in the abstract.</p>  | <p>We agree. We will provide vegetation data in the abstract.</p>  |
| <p>Lines 51-55: Most of the cases provided here highlight the impact of mangrove loss. If possible, authors can provide example or reference how mangrove recovery may restore biogeochemical processes. It is important when one of the study aims is to document the ecosystem recovery profile following dieback.</p>  | <p>Studies that show how mangrove recovery restores biogeochemical process are limited, but we will improve this section by providing references and/or examples.</p>                    |
| <p>Line 100: ‘Three field campaigns were carried out in August 2016, 2017 and 2018’. This sentence is redundant with lines 90-91.</p>   | <p>We will remove the sentence (Line 100).</p>   |
| <p>Line 115: Does this mean that leaves from the impacted site were obtained from seedling rather than survived mature trees?</p>   | <p>Leaves were from regrowth from survived trees. We will rewrite the sentence to clarify this.</p>  |
| <p>Line 116: I would suggest describing further steps on wood sampling approach, whether samples were done for sapwood only or with heartwood as well?</p>  | <p>Samples were from sapwood. We will add more information on wood sampling.</p>   |

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| Line 117: It is quite hard to see which stable isotope is applied for each sample. It would be great if the raw data are provided in Supplementary Information or online database.  | We will provide raw data.  |
| Line 120: In this section, maybe the readers want to know the reason for having a surface (<0.5 cm) and subsurface (0.5-20 cm) sediment samplings.  | The reason for having sediment samples from two depths is to compare surface sediments that represent the recent deposition and microphytobenthos, with the subsurface fraction which represents a long-term average. We will reword the sentence to clarify this. |
| Line 121: ‘each forest’ do you mean each zone? How many soil core per zone?   | Sediment cores were independent samples from the surface sediment. Samples (n=2 per transect) were collected from the mid intertidal zone. We will rewrite the sentence to clarify this.   |
| Line 133: Was number of the sample here denotes the number of photographs or number of quadrats? How many quadrats per forest zone at each transect?  | A photo was taken for each quadrat, so the number of photos and number of quadrats are the same. The quadrat sampling was carried out at the mid intertidal zone. We will clarify this in the method.  |
| Line 191: Was the variation similar to the impacted site? re: 34S depleted from higher to the lower tidal zone  | Yes, in both forests, leaf $\delta^{34}\text{S}$ values decreased from the higher to lower intertidal zones.   |
| Line 259: Double increased? Here may worth to discuss why both unimpacted and impacted sites show similar mangrove seedling increase, despite they have with different number and rates.  | We agree. We will discuss this.  |
| Line 271: In related to Kelleway et al 2018, was 13C between leaf and wood different significantly from this dieback study?   | It seems like the wood samples are more enriched than the leaves, but we do not have enough wood samples to make this comparison and also the wood samples were independently sampled from the leaves.   |
| Line 324: ‘lower mangrove C inputs’ change mangrove with autochthonous?   | We will change “mangrove” to “autochthonous”.  |
| Line 326: ‘The surface sediment (0 - 0.5 cm) differed relatively more than the deeper (0.5 to 20 cm) fraction’ Sorry, it is quite hard to follow this sentence.   | We will rewrite the sentence to make it easier to follow.  |
| Line 328: How about C/N ratio? It would be great to explore further roles of C/N ratio to support the findings in addition to elemental and isotope variation.  | Thank you. We agree. We will explore the C/N ratio data to see if it can support the findings.   |
| Table 1: Thanks. This table is really helpful to understand the scattered sampling time and what was sampled.<br><br>Table 2: it is quite unusual to have a comma between mean and SD. I would suggest replacing the comma with $\pm$ here and elsewhere. | We will use $\pm$ instead of comma between mean and SD.  |
| Figure 2: In the graph, I would suggest providing seedling per hectare instead of per quadrat.  | Thank you, we agree. Since the size of the quadrat is very small compared with a hectare, seedling per m <sup>2</sup> will be used in the figure.  |
| Figure 3: Were the authors collect the wood sample as well for SIA? Is there a possibility  | Wood samples were only collected from the mid intertidal zone, so we can not present the data in the same way.   |

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| of presenting $^{13}\text{C}$ and $^{15}\text{N}$ in the same way with $^{34}\text{S}$ , from landward to seaward?  |   |
| Figure 7: It is a nice conceptual figure. Please clarify if isotopes denote for both plant and sediment.  | We will indicate in the figure that the isotopes indicate animals, plants and sediment.   |
| <b>Referee #2 Martin Zimmer</b>   |   |
| <b>General comment</b>  |   |
| The authors provide data from element and stable isotope analyses in order to better understand post-die-off dynamics of a mangrove ecosystems. They interpret an observed enrichment in heavier isotopes as indicators of reduced C and N fixation and reduced S reduction in the impacted mangrove stand, while the increasing number of mangrove recruits over time suggests recovery of the vegetation. The lack of recovery of CNS cycling after 32 months, by contrast, is considered an indicator for the biogeochemical legacy of the mass mortality event.   | We thank Dr Martin Zimmer for the constructive feedback on the manuscript.  |
| Introduction: The praise of the stable isotope approach should certainly also include some mentioning of its flaws and weaknesses. Among these, the changes in the isotopic signature are not as globally "predictable" as the first paragraph of the Introduction suggests: many of these changes do not only depend on the species (both consumer and resource) involved but also on the specific environmental conditions: : : I suggest the first and second paragraph be merged (as they state essentially the same), following a first paragraph of extreme events (currently 2nd paragraph).   | We agree. The flaws and weaknesses of the stable isotope approach will be mentioned in the introduction and included in the interpretation of these results in the discussion. We will merge the first paragraph and the third paragraph to provide one paragraph of the stable isotope approach, following the paragraph of extreme events.  |
| Methods: Before learning about the die-back event (and hypotheses on its causes), I would like to get some information about the mangroves themselves, such as species composition, forest structure and so on! It seems <i>Avicennia marina</i> is/was the predominant species in the study area.  | We will provide some more information on the characteristics of the mangrove forest studied such as species composition and forest structure before we give information of the die-back event.  |
| It is interesting that hypersalinization (as a result of drought) is mentioned as major causative agent of the mass mortality. As <i>A. marina</i> is known to also occur under quite adverse conditions (e.g., at distribution limits of mangroves), wouldn't we assume that it is as tolerant to salinity stress as, e.g., <i>A. germinans</i> from the AEP? It would be nice to get at least an idea of the sediment salinity this hypersalinization resulted in. The reader might also be highly interested in understanding why the mangrove stand north of the river mouth was impacted, while the nearby(!) stand south-west of the river mouth was not. | The cause of this mangrove dieback was reported by Duke et al 2017 and Harris et al 2017 (cited in the present manuscript). It is thought that there were combined effects from drought conditions due to lower rainfalls, in combination with lower sea levels due to large scale climatic patterns (El Nino Southern Oscillation, and Indian Ocean Dipole). There is also a recent paper (Sippo et al. in press) which discusses the cause of the dieback, including: climate data, sediment geochemistry and groundwater availability. We will summarise those studies in more details to give a better idea of the causality. |

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|   | We can only hypothesize as to why the mangrove stand north of the river mouth was impacted while stand south-west of the river is not. We consider that this maybe due to river influence. It seems that the river outlet turns south-west (Fig 1), so it is likely that the south-west stand has more river influence. Other possibilities include localised groundwater flow paths. |
| It is obvious that 3 transects were monitored in each of the two stands – how many sampling plots were established in each transect? How were the data from these plots handled (pooled?, : : :?)? We need to better understand the (spatial) details of the sampling design!   | The number of sampling plots varied among samples. For example, 5 plots for mangrove leaves and 6 plots for sediment along the tidal zone. Data from these plots were pooled. To clarify the spatial details of the sampling design, we will add a table with number of plots for each analysis.  |
| Some more details about the "wood samples" would be helpful: how deep? where on the stem? Etc: : :  | Wood samples were collected at the mid tidal zone. Sapwood (diameter 5 cm to 15cm) were analysed. We will add more details about the wood sampling.   |
| According to the hydrodynamics of the area, do the offshore water samples reflect material that is likely to be washed into the mangroves or to be derived from the mangroves?  | The mangrove area is adjacent to an extensive area of mudflats. Material derived from the mangrove area is likely diluted and the offshore water samples mostly reflect material that is likely to be washed into the mangrove such as POM and phytoplankton. We will add a more detailed explanation for this.   |
| How were the photos taken to allow for relating the number of the seedlings on the photo to a given (unit of) area?   | For each photo, a 50cm x 50cm of quadrat was used to indicate a unit of area. These details will be added   |
| Even though the transects were chosen as to render the sites for comparison as similar as possible, there remains the fact that "unimpacted" and "impacted" are not replicated – strictly speaking, we are comparison two sites, one of which is by chance impacted, the other one is not. In this very particular case, I don't consider this a real issue, as the difference is very clear, but I would like to see that the authors take this non-replicated comparison of two sites that than results in generalized conclusions on "impacted" versus "unimpacted" into account and at least mention this restriction to their conclusions. | We agree. We will mention this restriction to the conclusion.   |
| Results: "had a 34S value of 16.6‰. . . compared to which value for the unimpacted site?"   | Wood samples for the unimpacted site did not have enough S to determine the isotope values, therefore we do not have sufficient data to make this comparison.   |
| l:225 - 230 : these values do not seem to be SIGNIFICNATLY different; though?   | Figure 5 shows the ANOVA results and which samples significantly differed, but we will rewrite the sentence to clarify this.  |
| l:230 ff(and throughout) : what is the "forest type" here? I think we are just comparing one impacted and one unimpacted stand (not two forest types); and I suggest to stick to this (like above)!   | We will use impacted and unimpacted throughout the ms.  |
| l:236 as above (and throughout) - - is "consistently" significant? It doesn't look as if it is(except for 2018). . . If the values are not  | We will indicate which means are significantly different in the text.   |

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| significantly different ; we cannot consider them "different"; - please clarify!  |   |
| Very minor linguistics:<br>1.181: "than at the unimpacted site"<br>1.183: "dominant mangroves species, <i>A. marina</i> , did not differ"<br>1.211: "than those from the unimpacted site" 1.218: "was similar to value of those collected in the mudflat"   | Thank you. We will correct the linguistic errors.   |
| Discussion: "mangrove degradation may be followed by fast colonisation of nonmangrove herbaceous species" – this is an important statement on a general and global problem: in the Caribbean, <i>Acrostichum aureum</i> , the Golden mangrove fern, builds up a dense canopy in disturbed/clear-felled mangrove areas. As this species, as well as congeners, also occur in the IWP: was the impacted forest (re-)colonized by the fern, or is there no propagule pool available in the vicinity?   | The impacted site was not colonized by the fern. There was fast colonisation by mangroves, so it is likely that a propagule pool is available in the vicinity.  |
| 1.265: why would the "stomatal conductance" be reduced in the impacted site? The environmental conditions were very similar (c.f. Methods), while one site showed mass mortality and the other one did not – what actually is/was the (environmental) difference between these two sites? Why did the mangroves die here but not there? Is the biogeochemical pattern observed a legacy of the die-back, or might it be related to the reason for the die-back (while a nearby mangrove did not exhibit mass mortality)? Several potential reasons for the observed $^{13}\text{C}$ pattern are listed – don't the authors want to discuss these? | There is less canopy cover at the impacted site, so there could be higher evaporation and lower water availability, which can reduce stomatal conductance.<br><br>Leaves were depleted in $^{13}\text{C}$ at the unimpacted site, suggesting that there could be higher water availability at the unimpacted site. Several potential reasons for the observed $^{13}\text{C}$ pattern will be discussed in more detail. |
| 1.275: what might these "chronic stresses" be? Are they a consequence of the die-back, or are they the reason (the drought that seems to have caused the mass mortality can probably not be considered a "chronic stress" but rather a massive disturbance)?  | Such environmental stresses may include hypersalinization of sediments and hydric, thermal and radiant stresses following mangrove losses (e.g. canopy loss). This is mentioned in 1.276-7  |
| 1.289: this is very interesting! I would have expected lower rather than higher variability in (sediment/microbial) processes upon such string disturbance – can you expand on this to explain how/why the drought and/or die-back would increase the variability of processes?   | We will expand on this. It is possible that the disturbance caused patchiness. The disturbed system may be at more unstable conditions and changing.  |
| 1.315: this interpretation of the findings suggests that at the impacted site it was dead wood that was sampled (from standing dead stems?), whereas wood from living trees was sampled at the unimpacted site – is that correct?   | Yes, we sampled dead wood from the impacted site and living wood from the unimpacted site. We will mention this in the ms.  |
| Fauna: before we can go into this discussion, the above issue of whether "consistent"/"substantial" is "significant" needs be clarified. Only IF the values   | We agree. We will use "significant" to indicate which samples statistically differed.   |

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| are significantly different, it will make sense to discuss or interpret such differences!   |   |
| 1.356: I don't follow this line of argument: Bui & Lee (2014) stress a potential enrichment by up to 5 – here we have a difference of 6-7 ‰ : : is this sufficient to indicate "some additional contributions"?   | Bui & Lee (2014) fed crabs with mangrove leaves. The crabs displayed an enrichment of about 5‰ from the leaves, so that the difference of 6-7‰ most likely indicates there was also a more enriched source. We will rewrite the line to clarify this.   |
| 1.363: does that mean that mangrove leaves did not play a role as food source in BOTH forests? If so, this cannot be an effect of the mass mortality, and – of course we would then not expect any change over time, as this observation would have nothing to do with mangrove recovery after disturbance: : : | We will add more information to clarify this. We consider that mangrove leaves played a minor role as food source, but other sources such as phytoplankton and MPB played a more important role in both forests. However, the presence or absence of mangroves can still change the isotope values of consumers, consistent with the finding for other studies, e.g., Bernardino et al. (2018).   |
| 1.395: I don't understand "can reflect consumer tissues with little isotope effect" – how do the patterns in producers reflect patterns in consumers; shouldn't it be the other way round?  | Isotopic compositions in essential amino acids can be reflected in the consumers with little trophic isotopic fractionation. We will rewrite the line.  |
| 1.403: what is it that mostly affect MPB? Besides the biotic changes, we would expect much more light, and thus, higher evaporation and less water at the impacted than at the unimpacted site. This already will change MPB drastically.   | We will discuss this in more details. Source of carbon and isotope fractionation can affect the isotope value of MPB. Changes to abiotic factors such as light, evaporation and water availability due to the canopy loss can change both C sources and fractionation. It is thought that lower respiratory input and lower dissolved inorganic C availability could change MPB drastically.  |
| 1.425: I do not understand how you derive these scenarios from the present study? I kind of agree with these potential scenarios (there might be other possibilities), but how does this relate to, how is this justified by, the present study?  | These are likely scenarios and there might be other possibilities. What we have learned from this study is that biochemical changes can be reflected in the isotopic values of organisms. Multi-annual sampling can be used to track their changes overtime and such isotopic information can be used to monitor biogeochemical changes in the future. It can be expected from this study that when the impacted forest is fully recovered, it would be isotopically similar to the unimpacted site. If the forest is unable to recover this may not be observed. |
| Minor: 1.410: omit "-"  | We will omit “-“  |