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Reply on RC2

Naima Iram et al.

Author comment on "Soil greenhouse gas fluxes from tropical coastal wetlands and alternative agricultural land uses" by Naima Iram et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-28-AC1, 2021

RC2

The study presents interesting findings of GHG measurement from wetlands, and their competing land uses expansion in Australia. I appreciate that the authors have incorporated my previous review comments, specifically by adding their raw data through SI. The current version is well improved. Please find below some specific recommendations which may be useful.

Author's response: We thank anonymous referee#1 for constructive feedback and for highlighting the improvement in the quality of the revised manuscript. The received recommendations were carefully considered and incorporated into the current version of the manuscript. A point-by-point response to comments was given below.

- Line 40: this opening sentence sounds awkward and unfinished.

Author's response:

We have rewritten the introduction, including the paragraph referred to by the reviewer:

L38: "The emissions of GHG in coastal wetlands mostly result from microbial processes in the soil-water-atmosphere interface (Bauza et al., 2002; Whalen, 2005)."

- Line 51: need reference.

Author's response:

- Lines 53-54: I suggest finding an alternative reference since (if I am correct) Boone's papers did not measure CO2 oxidation directly through gas sampling or analyser. They used stock changes instead, which is hard to find out the process underlying lowering soil carbon stocks.

Author's response:

Thanks for the correction; alternative references were included as following:

L48-L50. Firstly, when wetlands are converted to agricultural land, the oxidation of sequestered carbon in the organic-rich soils release significant amounts of CO_2 (Drexler, de Fontaine, & Deverel, 2009; Hooijer et L, 2012; Ciais et al., 2013).

- Line 57: how about CH4 emissions from the artificial ditch? I see lots of artificial ditch.

Author's response: Yes, drains can also be a source of CH4 in agricultural landscapes; we have added the following information:

L53-54: Artificial ditches and drains in agricultural landscapes are also sources of $CH_{4,}$ contributing ~ 0.2-3% of the total anthropogenic CH_4 emissions globally (Peacock et al., 2021)

- Line 60: …changing the balance between carbon and nitrogen…. Could you explain a bit more about this process? Any reference?

Author's response:

The sentence was removed from the revised introduction.

- Line 77: …reinstallation of tidal inundation…, tidal flow restoration?

Author's response:

We have chosen the term "reinstallation of tidal flow" as it implies that there was inundation that was interrupted. We have clarified as follows:

L55- 57: "Emissions of GHG from land-use change can be mitigated through various management activities in wetlands, for instance through reduction of fertiliser use, and the reinstallation of tidal flow on unused agricultural land (Kroeger et al. 2017)."

- Lines 79-80: Tidal coastal wetlands?

Author's response:

This section was removed from the revised introduction.

- Line 87: change information to data

Author's response:

This section was removed from the revised Introduction.

- Line 97-103: move the current last sentence to the second.

Author's response:

This section was fully revised as following:

L58-L63. In this study, we measured the annual GHG fluxes from different land-use types, including natural coastal wetlands (freshwater tidal forest, saltmarsh, and mangroves) and agricultural lands (a sugarcane plantation and a ponded pasture) in tropical Australia. The objective was to assess the difference within these land uses in GHG emissions throughout different seasons that characterise tropical climates (hot and wet vs cool and dry). This data will inform emission factors for the conversion of wetlands to agricultural land uses and vice versa, filling in a knowledge gap that has been identified in Australia (Baldock et al., 2021) and in tropical regions worldwide (IPCC 2013).

- L105: In the study site text, I haven't seen any description about the original land cover prior to sugarcane and pasture, were they mangrove, salt marsh or tidal forest? There is still missing information on the reason behind study sites/land cover selection.

Author's response:

The requested information was added for clarity as follows:

L70-72: Original land cover of this area before drainage was freshwater tidal wetlands, mainly Melaleuca forest and sedge swamps. When sugarcane farming started in 1943, ~70% of the freshwater tidal wetlands were cleared (Johnson, Ebert, & Murray, 1999).

- Lines 131-137: please describe how did you measure at two different tide conditions (low vs high tide). Did you use a floating collar? Also, currently how spatial replication was performed within site is unclear. You may want to add this information in table 1.

Author's response:

We measured five replicate chambers per site to account for small scale variability. The differences within chambers were not statistically significant ($p > 0.05$). For the measurements at different tidal inundation levels (which were always < 30 cm within at our sampling sites), we used the same static chambers but with the lateral holes opened to allow water movement and with vertical extension to avoid full submersion. We have clarified as follows:

L97-100. "We carried GHG measurements were conducted with static chambers, which had lateral holes that could be left covered with rubber bungs at low water levels, and left open at high water levels to allow water movement. During high tide measurements, vertical extensions of the PVC chambers were used to avoid submersion."

- Figure 1: I would suggest adding sampling location points in figure 1a.

Author's response:

Figure 1 has been modified to include sampling locations as suggested:

- Lines 161-172: did you cut any below ground roots during collar installation? Is one day sufficient to avoid the effect of soil disturbance during collar installation? I have a particular concern about the effect of disturbance from the installation. I understand that fieldwork is always tricky. Otherwise, you could describe this as a study limitation in the discussion or provide relevant reference if required.

Author's response:

The chambers were installed in areas that were mostly free of roots, but some of them had to be cut when setting them up. To avoid the effects of increased GHG emissions due to soil disturbance, we conducted three measurements at three days within a week of sampling. We did not detect any significant differences among days ($p > 0.05$), which gives us confidence that the initial disturbance by setting the chambers was not a major cause of data discrepancy. We have clarified as follows:

L127-129: The collars were installed to assure minimum soil disturbance. Furthermore, we did not find significant differences in GHG fluxes between different days ($p > 0.05$), which reflected negligible effects of collar installation on GHG fluxes.

- Line 168: did you collect 2 samples with 1-hour interval from each chamber? Was it sufficient to calculate flux?

Author's response:

To measure the linearity of the GHG fluxes over time, we collected four samples at 0, 20, 40 and 60 minutes. However, for GHG flux calculations, we collected two samples from all five chambers at 0 and 60 minutes. Our previous experience with this method has taught us that this is the most cost-effective way to measure GHG from wetlands (Kavehei et al., 2021) and agricultural lands (Rashti et al., 2015) which usually have relatively high emissions. This was described in the manuscript as following:

L152-155. For the sampling period during the hot and dry season (21 ☐ 29 October 2018), gas samples were collected at 0, 20, 40 and 60 minutes from all chambers to perform a linearity test for measuring increase or decrease in the concentration of the gas with time. For subsequent experiments, a linearity test was performed on subset chambers for each site (Rashti et al., 2016), and an R^2 value of > 0.7 was recorded for all tested samples with a linear trend for CO_2, CH_4 and N_2O over the experimental period (S2).

- Line 188: how about the other sampling periods?

Author's response:

The inaccessibility of these sites during most of the year due to permission for access into farms, adverse weather during most of the year (e.g. during very hot conditions or during flooding), safety risk due to crocodiles and the high cost of sample analysis (>$AUD 8,000 per experiment) limited our replication in time and space. However, we know from our previous studies (Rashti et al. 2015; Kavehei et al. 2021) and the results of present studies that GHG fluxes for CO_2, CH_4, N_2O show a linear trend over time (R^2 ≥ 0.7, therefore we measured linearity for one sampling season for all chambers and for one chamber per site for other sampling seasons. Furthermore, from our experience in other tropical locations, we know that temperature and rainfall are the main drivers of emissions. Thus we concentrated our efforts in account for these two factors by including three main periods: dry-cool, wet-hot and dry-hot. We described this in the manuscript as following:

L151-156. "For the sampling period during the hot and dry season (21 □ 29 October 2018), gas samples were collected at 0, 20, 40 and 60 minutes from all chambers to perform linearity test for measuring increase or decrease in the concentration of the gas with time. For subsequent experiments, a linearity test was performed on subset chambers for each site (Rashti et al., 2016: Kavehei et al. 2021), and an R^2 value of > 0.7 was recorded for all tested samples with a linear trend for CO_2, CH_4 and N_2O over the experimental period (S2).

- Lines 214-215: to me, the bulk density for mangrove and salt marsh are very high,

completely different than I observed in low tropics, especially for mangrove. This may also

reflect in very low C content, as provided in Table 2.

Author's response:

Yes, the Bulk density of mangroves is comparatively higher as compared to other tropical mangroves, which ranged between 0.1-.07 for the top 30 cm (Adame et al., 2013). In this region, the sediment is mostly composed of clay delivered through inundation in the floodplain, limiting the "accommodation space" to be filled by mangrove roots. As a result, the soil carbon content is not particularly high as shown in Serrano et al. 2019, C stocks and sequestration rates in Australian tropical mangroves ranged between 236±141 Mg C ha^{-1} $year^{-1}$ and 1.5±1.09 Mg C ha^{-1} $year^{-1}$ respectively.

- Lines 206-219: please provide your stats results in the text, at least p-value, particularly

when you compared measured variables between sites and depths.

Author's response: We included p values and added the analysis results file as a supplementary file (S4). We described this in the manuscript as following:

L174-179. For the top 20 cm soil, the natural wetlands had significantly higher EC (1418±104, 8049±276 and 8930±790 μS cm^{-1} for tidal freshwater wetland, saltmarsh and mangroves, respectively) compared to the agricultural land (190±39 μS cm^{-1}, 247±38 and 382±11 µS cm^{-1} for wet and dry ponded pasture and sugarcane, respectively; S4).

The mean bulk density of the top 30 cm soil of the saltmarsh (1.4±0.1 g cm^{-3}), sugarcane (1.5±0.1 g cm^{-3}) and mangroves (1.9±0.1 g cm^{-3}) was similar ($p>0.05$, S4),

- Figure 2: I would suggest enlarging x-axis labels and chart bars, as well as provide statistical differences note.

Thanks for the suggestion. The figure was improved.

- Table 3: please provide N sample size.

Author's response:

We measured 5 replicates from each site and reported in the manuscript as follows:

L 189 (n=5)

- Lines 274-276: I am surprised that all GHGs are not correlated with temperature. How about root contribution to CO2 effluxes?

Author's response:

We were also expecting a stronger effect; however, when we analysed the whole dataset, the effect of land use overridden any effect of temperature or rainfall. It is also true that in tropical regions, mean temperatures do not differ so much among seasons. For example, in our study sites, the lowest and highest monthly mean temperatures were 18-25°C and 23-30°C respectively (S3. Bureau of Meteorology, http://www.bom.gov.au/jsp/ncc/cdio/cvg/av)

- Line 285: how did you calculate total cumulative GHG emissions? Did you use GWP? This new paper may be useful and relevant: https://link.springer.com/article/10.1007/s10021-021-00631-x.

Author's response:

L145-151. Total cumulative GHG emissions were calculated by the equation described by Shaaban et al. (2015). Thanks for suggesting a recent paper on GWP; we cited this paper to clarify the difference between GWP matrix and $CO_{2\text{-equivalent}}$ calculations. We described this in the method section as following:

L145-151. Seasonal cumulative GHG fluxes were calculated by modifying the equation described by Shaaban et al. (2015) as following (Eq. 1);

where; Ri = Gas emission rate (mg m^{-2} $hr^{-1}$for CO_2 and µg m^{-2} hr^{-1} for CH_4 and N_2O, Di = number of the sampling days in a season and 17.38=number of weeks in each season assuming three seasons prevailed over an annual cycle (S3). Annual cumulative GHG fluxes were calculated by integrating seasonal cumulative GHG fluxes. Total cumulative GHG emissions reported in our research represent CH_4 + N_2O fluxes.

L156-158. For comparing GHG effects of CH_4 and N_2O fluxes, $CO_{2\text{-equivalent}}$ ($CO_{2\text{-eq}}$) were calculated by multiplying CH_4 and N_2O fluxes to global warming potentials of 25 and 298, respectively (IPCC 2007). It must be noted that GHG fluxes represented radiative balance in our study, as recently suggested by Neubauer S.C (2021)

Lines 330-336: I would suggest citing the organization name rather than website links

Author's response:

The suggestion was incorporated in manuscript L49-302.

Please also note the supplement to this comment:
https://bg.copernicus.org/preprints/bg-2021-28/bg-2021-28-AC1-supplement.pdf