Response

We want to thank the anonymous reviewer for the review. Below you can find our detailed responses (bold) to the comments:

Reviewer 3

The manuscript is actually an extended case study of the previous one (Alewell et al. 2011 Biogeosciences. 8:1769.). However, the authors in this study appear to over-interpret the results. The author indeed can carefully read the previous paper and discuss the results in a more balanced manner.

Reply: We think there is a misunderstanding here. Our manuscript deals with biogeochemical indicators of peatland degradation along a land use gradient in temperate bogs. Temperate bogs and subarctic palsa peatlands are completely different ecosystems. Also we use a large number of indicators to detect human-induced changes in the peat profile. The current study is therefore not an extension of Alewell et al. 2011 but an application of the Alewell et al. approach to a complete new situation in a different ecosystem context.

(1) The title. The title is relatively vague. The authors claim that 'Biogeochemical indicators of peatland degradation – a case study of a temperate bog in Northern Germany'. One could not understand what are biogeochemical indicators and how precisely these indicators could represent environmental disturbances. The new title is apparently needed in a straightforward manner.

Reply: Our title already gives precise information about the set-up. The specific indicators are described in the abstract. Stable isotopes, C and N concentrations as well as ash content are well known biogeochemical soil parameters which have the potential to indicate disturbance of ecosystems and their biogeochemical cycles.

(2) The conclusion. The authors conclude that 'All investigated biogeochemical parameters together indicate degradation of peat due to conversion to grassland, (ii) historical drainage as well as recent development and land use intensification. These statements are pretty vague and could be imagined without experimentation.

Reply: Our aim was to test if these parameters, particularly stable isotopes of carbon and nitrogen, are suitable indicators for peatland degradation and hence human disturbance. We selected a peatland with known land-use history and clear differences between the study sites to investigate the soil parameters and to test our hypotheses. With this newly gained knowledge about the indicators these methods can be applied to other peatlands where only little information on previous or ongoing disturbance is available.

(3) Peatland degradation as the theme is not appropriate. It appears there is no solid evidence in support peat degradation in this study. As the authors mentioned, aerobic and/or decomposition can occur in peatland, leading to degradation. However, the indicators, rather than solid evidence of

peatland degradation were investigated. It remains uncertain whether these indicators could accurately reflect what is going on in peatland. In addition, it was said that the highest carbon loss was observed in the intensively managed grassland (GI). However, only the carbon in soils was concerned. It seems that a large amount of aboveground biomass will be removed by grazing. What will happen if this was taken into account?

Reply: We disagree with reviewer 3: Peatland degradation is the focus of our study. We could show (significant) differences of the biogeochemical indicators between the two managed (degraded) sites on the one hand and the near-natural site on the other. The managed sites are degraded due to drainage and land use activities. We calculated C loss using the combined method (described in Leifeld et al. 2014) which is a time-integrative profile approach that integrates soil parameters (bulk density, ash content and C concentration) to calculate carbon loss since the onset of drainage. These calculations clearly show that the profiles lost substantial amounts of carbon since onset of drainage, i.e., these soils are degraded. Our aim was to estimate the total C loss of the soil to the atmosphere, whether it comes from peat oxidation or indirectly via harvesting of the aboveground biomass. For this type of calculation, harvest does not need to be included in the equations of the combined method. We agree that the observed carbon losses may have been caused by both, oxidation and smaller plant-derived residue inputs, but this does not change the total carbon budget of the soil. The cuts and manuring for the years 2007/08 and 2008/09 are presented in table 3 in Beetz et al. 2013.

(4) The authors seem to draw no solid conclusion for the usefulness of isotope techniques as indictors of peatland degradation. One point that is interesting I guess is the slope of 13C with depth. This slope appears to be a better predictor, and the authors can relate it to previous studies (Alewell et al., 2011). In fact, the current manuscript needs to be presented in a manner similar to previous study by Alewell et al. 2011.

Reply: We could show that even the near-natural site is influenced by the surrounding drainage activity which is displayed in the δ13C profiles as well as in the C loss calculation by the combined method. Hence, also bogs considered as near-natural or even natural could potentially be impaired by anthropogenic activities, at least in the past. Furthermore, the δ15N profiles show significant differences between the three investigated sites with both, increasing peat decomposition and fertilizer application systematically changing the δ15N signature of the soil. With this we concluded the usefulness of stable isotopes in bulk samples to detect peatland degradation. We again emphasize that slopes of 13C vs. depth are included in our analysis. We put our results, at several places, into context with those of Alewell et al. (2011) but, at the same time, stress that we are dealing with a very different type of ecosystem in the present manuscript.