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Biogeosciences Discussions

Interactive comment on "Effects of long-term flooding on biogeochemistry and vegetation development in floodplains – a mesocosm experiment to study interacting effects of land use and water quality" *by* A. M. Banach et al.

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Responses to the general comments of the Referee #1

The authors discuss the effects of long-term flooding on soil chemical processes and vegetation development. However, the introduction mostly focuses on the effects of summer floods, whose frequency will probably rise in the (near) future, and its consequences, while a 9 month flooding period is used in the article. Hence, in our opinion the introduction should be adapted to correspond more to the actual subject of this

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article. Furthermore, the authors should also state in the introduction why their work is unique, especially compared to Banach et al. (2009) and Antheunisse & Verhoeven (2008). Although the number of references (80) is too high for a normal research paper, some important papers in this field are not referred too.

We agree with the referee and changed a large part of the introduction accordingly, to explain the rationale of this work in comparison to other work and our earlier work. We have removed lines about summer flooding, including the first part of the abstract, and now stress the fact that we studied the effects of permanent shallow flooding (marshland creation) as a possible measure to reduce flooding risks, including the changes in the last paragraph of the introduction:

'The aim of this study was to investigate the possibility for the creation of permanently flooded wetlands (marshes) along rivers, in relation to flood water quality (NO3-, SO42-) and soil use (level of fertilization in the past). This measure is one of proposed strategies to counteract flooding risks; next to the creation of temporarily flooded areas for water storage during flood peaks which was investigated in our previous work (Banach et al., 2009b) and that of others (Antheunisse & Verhoeven, 2008). In order to study the effects of long-term flooding under controlled conditions, for which much less information is available in literature, a mesocosm design using intact sods was used. A period of 9 months was chosen as a minimum period necessary in order to cover both winter, spring, summer and autumn. The results with respect to biogeochemistry (especially C, Fe, P, N and S cycling) and vegetation development will be discussed in relation to water management and nature management. In addition, we will compare both management strategies.'

In addition, we reduced the number of references as suggested and included the references mentioned.

Responses to the specific comments of the Referee #1

Abstract 3265 line 15: Consider removing (including peat formation)

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We have removed this part of the text.

Introduction As said before, the introduction should be more in concordance with the experimental set-up. Furthermore they should explain why a 9 month period has been chosen in this experiment and discuss its ecological relevance.

We agree and changed the focus of the introduction from summer flooding to permanent flooding, as explained above and also for the Conclusions section (see below). In addition, we referred to the hydrological conditions in more pristine areas in the Discussion section.

We added (as indicated above): 'A period of 9 months was chosen as a minimum period necessary in order to cover both winter, spring, summer and autumn.'

3266 line 11: Will peat formation not cause a decrease in retention capacity?

We agree this is subject to discussion and added: ' , although this will decrease the hydrological retention capacity.'

3266 line 13: correct MCLEOD

This has been corrected as suggested by the referee.

3266 line 17: consider AND FLOODING TOLERANCE OF VEGETATION

We adopted this suggestion.

3267 line 3: this line suggests production of CO2 in submerged conditions. Consider rephrasing. We decided to remove the whole part about greenhouse gases, because it is less relevant and this makes the introduction much more concise.

3268 line 6: other references?

We decided not to add additional literature because of the high number of references, and changed the references to '(e.g. Rooth and Stevenson, 2000)'.

Material and Methods The description of the experimental design is too concise. Sev-

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eral aspects are missing, such as sampling date of sods, sod size, . . .Was the water-column refreshed or stirred during the experiment? This might influence the results considerably.

We have changed section 2.2 Experimental Design by adding all requested information: 'For studying the effects of long-term inundation with stagnating water, 40 sods (30x30x15 cm) were collected in total in autumn, with standing vegetation.'

3268 line 23: consider CULTIVATION HISTORIES

We changed 'histories of cultivation' into 'cultivation histories' as suggested.

3268 line 25: correct MOWN

The verb 'mowed' was changed into 'mown'.

3269 line 18: The authors opted for black foil to avoid light influence. Was temperature monitored during the experiment? Please clarify.

For clarification, we added the temperature range during the experiment: 'Each sod was fitted into a separate glass container (25x25x30 cm) at an air humidity of 40-90%, under natural light and temperature (5-41°C during the experiment) conditions following the outside diurnal and seasonal changes of light and temperature. . .'

3269 line 19: What are the floodwater mixtures levels based on?

We have now added: 'Four different floodwater mixtures were prepared based on field data (water quality of the Chodelka and Vistula River)' in the part on the Experimental Design.

3270 line 5: consider changing reference.

We added: 'Olsen P (as an estimate of plant available P, Olsen et al., 1954) in the Measurements and chemical analyses part. In addition the reference was added: 'Olsen, S. R., Cole, C. V., Watanabe, F. S., Dean, L. A.: Estimation of available phosphorous in

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soils by extraction with sodium bicarbonate. U.S. Dep. of Agric. Circ. 939, Washington, DC, 1954.'

3271 line 21-28: Why has vegetation been harvested in the middle of the experiment? Please clarify.

We answered this question by adding: 'Vegetation and algae were harvested 6 months after the onset of submergence and at the end of the study to be able to quantify biomass production rather than standing stock' in Vegetation description part.

Results

References to tables are not correct, please check. (e.g. table 4b does not exist).

We carefully checked all references to all tables and changed them accordingly.

Consider adding pH to figure 2.

To avoid too large figures, we decided to leave the information in the text part only. We feel that a figure of the pH would not add much to this text.

3272 line 12-13: Remove

We have removed this line as suggested by the referee.

3276: State better which Times are compared.

For the Repeated measures GLM, all dates were included as explained in the Materials & Methods. For the biomass data, it was indicated which date was meant.

3277 line 15: These N:P ratios seem very low. Furthermore, due to inundation SRP increases while the available N-fractions decrease. However, The N:P ratios increase after inundation. Please consider adding few lines in discussion.

We added: 'The increased availability of P due to flooding did not decrease these ratios in plant tissue, which further supports this idea.'

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Discussion The discussion should be expanded more. If one changes a meadow/pasture into a shallow lake, drastic changes in soil chemistry are to be expected. These changes should be discussed more in relation to the relevance of such long-time flooding (e.g. retention capacity, frequency of such events). Furthermore the results should be discussed more in relation to winter flooding and short-term summer flooding, e.g. what might be the possible differences on soil chemistry and vegetation development?

In our Conclusions, we added: 'The actual effects on biogeochemistry and vegetation will, in addition, strongly depend on the actual flooding duration and frequency, the flooding season and the water level. We tested the creation of a permanently, shallowly flooded situation throughout the year, as this is one of the possible measures to combine the reduction of flooding risks for the population and the restoration of marshes along rivers. These results differ from those of short-term summer flooding (Banach et al., 2009b) where flooding itself had the most striking effects on plant ecophysiology and soil biogeochemistry, regardless water quality. As the rate of the different biogeochemical processes and the growth of plants are both significantly influenced by temperature, winter flooding will have much less effects (e.g. Beumer et al., 2008; Loeb et al. 2008b).'

In addition, we pointed out more clearly throughout our Discussion that the aim of this study was to evaluate the effects of permanent, shallow flooding.

Tables & Figures General remark: Most legends could be more self-explanatory.

We carefully checked all captions and changed them if necessary.

Table 1: Correct AMORPHOUS.

We have corrected this mistake in Table 1.

Consider Decimal or Right Alignment.

We have applied right alignment in Tables 1 and 3, and decimal alignment in Tables 4,

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5, 6 and 7.

Table 2: The abundances seem to be pooled per treatment. Why? Please clarify. In which unit is abundance expressed? Capital letters are redundant since both grasses and sedges comprise only one family. Galium spp.: Correct 0;5.

The abundances were calculated for each aquarium and then pooled by treatment because the abundance varied strongly within and among treatments. As a result we got a range of abundances showing the variation, expressed in % - we added the units to the title of the Table 2. We have corrected the error about the abundance of Galium spp.

Table 4, 5 and 6: Re-consider the order of the effects (single, double interaction, triple interaction). Explain abbreviations in legend.

We re-arranged the order of the effects as suggested by the referee. In addition we added the legend to the tables explaining the effects.

Table 4, 5: Use same number of decimals for all F-values. Consistency in display of electrical values. Change TIME (T) in (T).

We have applied the requested changes in both Tables.

Table 5, 6: Make both subsections more distinct.

We now used italics for 'Sediment pore water' and 'Surface water' headings to make both subsections more distinct.

Table 6, 7: Remove reference to Table 4a. Tabulation of G _ L _ W

We have adopted both suggestions.

Table 7: Which time-periods are compared in this analysis? Please clarify. Make both subsections more distinct.

We added to the caption of the table: 'We compared data from both harvests.'

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Figures Figure 1: Consider removal.

We prefer to keep this figure to show the sampling location of our study.

Figure 2-5: Figure is too small. Increase size (e.g. move legends in figure to figure legend, use X-labels for lower two subfigures, use Y-labels for left column of subfigures, etc). Remove (SPW) from Y-labels.

We improved the figures by applying all requested suggestions of the referee.

Figure 3: Consider changing FIGURE 3 in FIGURE 2 (CONTINUATION).

We changed names of the figures accordingly.

Figure 5: Consider changing FIGURE 5 in FIGURE 4 (CONTINUATION)

We changed names of the figures accordingly.

Figure 6: Cover percentages for HAY start negatively. Please correct. Consider changing lay-out of Biomass subfigure (e.g. per treatment two colums, left =HAY, right = PAS)

We changed this figure as suggested.

Interactive comment on Biogeosciences Discuss., 6, 3263, 2009.