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Hydrology and Earth System Sciences Discussions

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Interactive Comment

Interactive comment on "The effectiveness of polder systems on peak discharge capping of floods along the middle reaches of the Elbe River in Germany" *by* S. Huang et al.

S. Huang et al.

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Replies to Anonymous Referee #2 (Replies are imbedded in the original text of the referee)

The aim of the paper is not clear. The title points to a discussion of the effectiveness of polder systems along the Elbe River. However, the polders are not described in sufficient details to understand their function, not even their volumes in absolute terms or in relation to the flood volumes are given.

Authors' reply: Reviewer #1 did not have a problem with the aim of the paper and even states that " the aim of the paper is clearly set forth within the introduction and coincides with the title". However, I have now explicitly defined the aim of the paper in the last paragraph of the Introduction.

The quite complicated operation of the weirs is not discussed; obviously they are just designed for maximum effect during the 2002 flood with prior knowledge of the hydrograph. The effectiveness of the system for other hydrographs and no prior knowledge is not discussed at all.

Authors' reply: The reviewer is mistaken about never having prior knowledge of the upstream hydrograph. In operational flood management, the hydrographs of the upstream gages, in particular at Torgau and Dresden, are recorded. These hydrographs must enter as input into the model. If no prior knowledge of the upstream hydrographs is present, this would make the operation for any polder system during a flood most difficult. In addition, polder control is optimised to the characteristics of the flood wave. We have shown by example of a very extreme flood how effective the operation of the polders can be in capping the peak discharge. However, I have added an additional point to the conclusions stating that the effect of different hydrograph types and shapes on polder control is to be investigated in subsequent research.

The paper is mainly a description of an application of a 1-D model that was made quasi-2D by connecting many river sections in parallel. However, it does not give enough details to really understand the benefits of this approach, as compared to many others that already exist.

Authors' reply: The benefits of the quasi-2D approach have now been clearly defined in the Introduction. The text reads: "In this study, a quasi-2D approach is sought in which a 1D hydrodynamic model is used that allows the discretisation to be extended into the polder system to give a 2D representation of the inundation area. This would fulfill the following objectives: i) attain faster computations than using full 2D or 1D/2D combination models to better adapt polder control strategies to the flood wave characteristics during operational flood management; ii) allow future simulations of spatially distributed sediment and contaminant deposition during flood events; iii) provide faster computations to better suit uncertainty analyses using Monte Carlo techniques." In addition, simulations of sediment concentration during an extreme flood event have been included by an additional figure in order to bridge the developed methodology to the ultimate goal of the modelling approach, which is to obtain computationally inexpensive simulations of the spatial distribution of sediment and contaminant transport and fate.

I would therefore not print the paper in its present form.

Authors' reply: Substantial changes have been made to the manuscript including: i) the goals of the paper are stated very clearly now, ii) the benefits and objectives of the quasi-2D approach have been elaborated iii) all the comments have been considered and incorporated into the manuscript I believe the paper has now become very strong justifying publication.

Many models have already been proposed to simulate the effects of retention. The filling of the polders in the Elbe case is a slow process, taking a day or more. What is the benefit of using a hydrodynamic model as compared to much simpler models?

Authors' reply: We need the hydrodynamic model for an accurate simulation of the velocity and flow fields in the polder system. These are required for subsequent simulations of transport and fate of sediment and pollutants within the polders. An additional figure illustrates an example.

Fig. 1 should illustrate the 2-D spatial representation of the discretisation network. To me, the figure doesn't explain anything.

Authors' reply: Yes, OK. I have now replaced the figure with another figure showing other quasi-2D approaches cited in the literature. The figure is now referenced in the Introduction to give more background information on the approach and to make the methodology developed in the study more clear.

In table 1, some discharge values are given. In 2002, the upper station Torgau recorded a higher discharge than Wittenberg, although the Schwarze Elster joined in between.

This should be commented.

Authors' reply: This is due to the increased water retention of the floodplains in the lower section and three dyke breaches in the upper section, and has been noted in the caption of Table 1.

In Fig. 2, there are polders P1a, P1b, P1c etc. shown that are never mentioned the text. What is the effect of the indicated retention areas and how are they modelled?

Authors' reply: The figure has now been modified to alleviate the confusion by the additional polder notations.

In Fig. 3, the main polders are split up into many smaller ones. How has the discretisation been made? What is the advantage of considering inertia terms when water level changes are a few cm/h? The text mentions 4 control weirs, I count 5 (E, F2, G, H, I).

Authors' reply: In order to avoid cluttering the figure too much, the discretisation with junctions and channels is shown only for the polders. The junction-channel discretisation also was carried out for the river but is not shown. A note is included in the caption to clarify this. Since the model control volume does not consist of the polders alone but also includes the main river channel between Torgau and Wittenberg, the inertia terms needed to be included to capture the more dynamic water level changes in the river. In addition, including inertia terms has the advantage of better calculating the steep gradients at the polder inlets when they are first opened. "4 control weirs" was been changed to "5 control weirs".

What do the arrows at H and I mean? The lower one leads into the polder, the upper out. What is the function of weir f2?

Authors' reply: These are not arrows but symbols for weirs. This is indicated in the legend. Weir f2 connects polders P1 and P3 - this is explained in the text.

Fig. 4: What is meant with optimum control strategy? How was it found? How effective is it for other floods than the 2002 event? Why are gates H and I in the same graph?

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Authors' reply: We have now discussed our optimisation strategy for polder filling to achieve maximum capping of the discharge peak in Section 3.2, which is complimented with an additional figure (now Figure 4). The operation of the polder gates need to be changed depending on the upstream flood wave characteristics. H and I are not gates but locations along the river. They are given to show the effect polder P4 has on the river discharge. This is now clarified with additional information in the Figure 3.

Fig. 5 and 7: scale is too small to show anything reasonable. In addition, as I understand it, the Manning's n has been changed along the river to provide the best fit for the highest water levels.

Authors' reply: The scale is sufficient to show that the Manning's n showing good agreement between simulated values and measurements. The scale also allows the entire length of the studied reach to be displayed. The axes limits of the two figures are kept the same to allow for easier comparisons between the two simulations.

Fig. 6 and 8: The reason given for the deviations at the beginning of the hydrograph "Ě is due to the model being fitted to the peak discharge (pg.220, line14)" is not really an explanation.

Authors' reply: The phrasing has been changed to "Ě is due to the model being calibrated to better fit the peak discharge"

Improve Fig. 9 and 10. There are too many lines that give redundant information. Except at the beginning of the filling of the polders, water levels in the polders raise and fall simultaneously at both ends. Therefore hydrodynamic modelling seems not required. I think the weir length not the breath is 100 m.

Authors' reply: Perhaps there is some confusion because the letters E, F Ě K are locations along the river, not in the polders. This has been clarified in the figure caption and in the legend of Figure 3. Hence, the information is not redundant, because we wanted to show the recession of the capping as the flood wave progresses downstream. We

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kept the term “weir breadth” to comply with the definition of the term in the weir equation.

Fig. 11: confusing. I don’t see any water levels in the river. Nothing is visible in the lower figure. It is not polder P4. The figure doesn’t show the "efficacy of the quasi-2D approach in capturing the spatial differentiation in flow characteristics (pg. 221, line16)", but only that the water is flowing downhill.

Authors’ reply: The figure caption is wrong, sorry. The arrows are velocity vectors with the longest vector equalling 1.2 m/s. The caption now reads “Velocity vectors during filling (top) and emptying (bottom) of the P1+P4 polder system. The longest vector corresponds to a magnitude of 1.2 m/s”.

Fig. 12: see comment Fig. 9. Shown are only water levels in P4, not in P1 and P2. Where is point j?

Authors’ reply: Granted, point ‘j’ is very hard to see. It’s at the far right in polder P4 in Figure 3. The figure has been modified, so that the location points are easier to see. The caption of Figure 12 is now more concise and reads “Water levels in the river and P4, when only P4 is used for flood water diversion”.

Fig. 13: see comment Fig. 9. Nothing new

Authors’ reply: Perhaps there is some confusion because the letters E, F Ě K are locations along the river, not in the polders. This has been clarified in the figure caption and in the legend of Figure 3. Hence, the information is not redundant, because we wanted to show the recession of the capping as the flood wave progresses downstream. We kept the term “weir breadth” to comply with the definition of the term in the weir equation.

Fig. 14 and 15: I don’t understand why a reduction of the weir length by 50 % from 100 m to 50 m has no effect on the capping (pg.220, line 24), while a reduction of the weir coefficient by 10 % reduces capping by 10 %.

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Authors' reply: There is some reduction on capping, however the wider the weir, the less sensitive its parameters are on output. The sensitivity of the weir coefficient on capping was carried out on the model with weir breadths of 50 m. The weir parameters are more sensitive to model output for weirs with breadths of 50 m than for breadths of 100m.

Does percentage deviation in the boundary conditions mean reduction of the discharge (m3/s) or in the water level? Are the volume reduction and the capping reduction compared to the initial volume or relative to the reduced flood volume?

Authors' reply: The reduction relates to the water level. The volume and capping reduction are both compared to the reduced flood volume. These two points have been included in the figure caption.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 4, 211, 2007.

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