

# ***Interactive comment on “Groundwater–surface water relations in regulated lowland catchments; hydrological and hydrochemical effects of a major change in surface water level management” by Joachim Rozemeijer et al.***

## **Anonymous Referee #3**

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The manuscript deals with the analysis of the effect of two water management options in low lying strongly regulated polder areas. The topic has very high concern under the view of climate change especially for coastal areas with similar conditions. They present a simple mass balance model for water balance and quality based on two years data collection extended by data from the local water boards in 10 artificial polder catchments. The study sites are located inland in the Netherlands between Amsterdam and Utrecht. The polders are characterised as low lying Marshland and were not connected. The models were calibrated based on the available data sets without

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validation. The procedure is quite ambitus because these low lying polders are dominated by slightly different hydrological processes and have a higher complexity than can be expected by the first view. The two management options are the actual praxis of a fixed water level in summer and winter period and flexible management. For the last case water stage is allowed to change between specified minima and maxima levels. The manuscript is relevant for the journal. It is a quite simple analysis of the different polders which have not only for their hydrological topic importance but as well for landscape management, nature conservation, ecology in the handling of climate change induced changes in low lying areas. But it needs some improvement, reorganisation and clarifications. In the abstract they explain the model in a way that it is the major part of the manuscript, but the water balance equation are part of the appendix. The description of the solute part is completely missing. Overland flow in low land area with very small gradients has to be clarified. Based on the equations it is possibly more a kind of ponding at the surface with the source from below the surface. The equations of the solute transport and a brief description which processes are taken into account or which are missing and to which part the reliability of the model is less good are very important for the manuscript and I would suggest that the equations should be moved from the appendix to the main part. Critical discussion of the effect of greenhouse gasses should be written. Areas with low lying groundwater levels have high CO<sub>2</sub> emission, which they have correctly mentioned. But increasing water levels can have the effect of higher methane emission with more negative effects on the environment. The introduction and method could be shortened. The ten different polders should be grouped based on the solutes of interest and possible by the dominating processes. Just based on the presented data most of the polders have Cl concentrations between 10 and 60 and then there are three with much higher ranges up to 1000 (the north western polders Botshol, Middelpolder, Ronde Hoep). Is in the mentioned three polders a different geology with faults or paleo channels / higher pressure gradients the reason as in the de Louw et al. (2010, 2013) studies? All three polders have a thick Holocene coverage. And instead the fresh water reservoir Loenderveen Oost which is

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more a lake than a polder has only a layering of 1 m without high values in CI. How can be the other solutes (nitrate, phosphorus, sulphate) categorised? Which polder systems were good represented by the mass balance equation and which less? How have they compensated the effect of the flow from polders which get additional input from the surrounding polders in case of the changing management without model validation? The models were calibrated based on their actual water management. Where there already polders under the flexible conditions? What is the error by applying a different water management to a polder under the actual conditions? How do they deal with possible changes in the hydrological processes, for example if the North-western polders with high CI are under the influence of boils (de Louw et al.; 2010, 2013) is that dominant process under flexible conditions irrelevant? In that case the calibrated parameter set up based on fixed levels would lead to a misleading prediction of CI by using that data set for the flexible water management conditions?

Specific comments:

P2, L15: I would be careful with the global, at a global scale these type of landscape have similar problems, but the presented model is limited to an area with comparable meteorological and geological boundaries.

P5, L16-29: shorten that paragraph and focus on a more precisely defined objective, move explaining parts to the methods

P8, L2-4: which study polder was in the two year observation period under which management option?

P9, L8: is the product information important? Would be a great benefit to add the spread sheet as supplementary material.

P9, L19-20: How was the minimum and maximum defined in case of a managed polder?

P10, L3-5: How legitimate is that procedure under the dominant geological conditions?

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Please add literature.

P10, L14: Add a list of the parameters and for which process they are used and the range. Which parameters are important for solute transport? A table with quality measures (Nash, RMSE, Bias, etc.) for water balance and the different solutes would be important to judge how the different models can represent the 10 polders.

P17, L2-3: that is contradictory to the conclusion, the main source of surface water is upconing groundwater. Here is the term overland runoff misleading. Is it more ponding water?

P18, L23-25: not clear, where is the source of Phosphorus? In the polder soils or in the groundwater?

Figure 3 and the hydrographs: add a marking at which period the flexible water management started.

Appendix: some of the catchments have a very poor Cl- performance, the dynamics are fine but the level is different, why? They do not present any other chemical solute hoof the performance is for the other solutes the performance? Present quality measures for the other polders (RMS, NSE, etc.).

References:

de Louw, P.G.B., Oude Essink, G.H.P., Stuyfzand, P.J., van der Zee, S.E.A.T.M. 2010. Upward groundwater flow in boils as the dominant mechanism of salinization in deep polders, The Netherlands. *Journal of Hydrology*, 394, 494–506, DOI: 10.1016/j.jhydrol.2010.10.009.

de Louw, P.G.B., Vandenbohede, A., Werner, A.D., Oude Essink, G.H.P. 2013. Natural saltwater upconing by preferential groundwater discharge through boils. *Journal of Hydrology*, 490, 74–87, DOI: 10.1016/j.jhydrol.2013.03.025.

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