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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Impact of coastal forcing and groundwater recharge on the growth of fresh groundwater resources in a mega-scale beach nourishment" *by* Sebastian Huizer et al.

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"This manuscript shows the application of numerical models to simulate different scenarios for the quantification of the freshwater resources in a mega beach nourishment experience in the Dutch coast. This experiment, also called the Sand engine, has different challenges for the simulation of the groundwater flow since it is a highly dynamic environment that affects to the shape and boundary conditions, this is an interesting topic in the hydrogeological sciences and many readers can be interested on seeing the results."

We would like to thank the Referee for the comments, which are highly appreciated.

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Discussion paper

We will improve the raised issues.

General Comments

"It is well written and applies the correct methods. But I think that the manuscript can be improved by showing the results with a more global perspective and less as a case study description. Also the novelty of this study should be presented more clearly and the analysis of the results/discussion can be improved."

Thanks for the compliments. We believe that the particular conditions at a coastal site are very important, which makes it difficult to extrapolate the effects to a global perspective. Therefore we wrote the paper more from the perspective of the Sand Engine, to describe the issues at this site in detail, and highlighted briefly the potential issues for other sites.

"The aims are very broad and the particular effects of coastal forcing and the geomorphological changes can be better described. I think that introducing the challenges from the perspective of the development of the numerical model would be needed to have a more complete overview. A more extensive introduction would help to understand the tasks that are going to be solved later.'

We agree, and have rephrased the aims, and introduces the challenges from the perspective of the development of a numerical model.

"In general it seems to be repetitive and a bit ambiguous the description of coastal forcing with multiple mentions of how important is this instead of describing precisely to what aspects is refereeing."

We agree with the Referee, and have deleted some sentences regarding coastal forcing.

"The boundary conditions of the model are based on previous models, unless this model is just a modification of a previous model (in that case it should be said), the boundary conditions should be clearly established. For example: “Other specified

heads and concentration boundaries were determined with an additional simulation with the groundwater model as described in Huizer (2016)" Which are the other specified heads and concentrations? What model scenarios are referring here? (the scenarios are presented later in the manuscript but at this point is not clear) ": : : the former model underestimated the salinization: : :" which model? In general this paragraph can be rewritten under the consideration that the reader does not have to be necessarily familiar with the previous models in the area. Probably a full description of previous models and the novelties of this study would help to the reader to frame better this study."

We have rewritten some sections of the paragraph to clarify the methodology.

"It is not clear what are the areas presented as foredunes, dunes, beach and sand engine, they should be defined and presented in the map."

We have added definitions of the mentioned areas (e.g. foredunes) to Figure 2, and have added a dotted line to Figure 2 that signifies the initial salinity distribution (fresh/salt).

"The model calibration presents some very clear criteria combined with ambiguous and arbitrary i.e. "the variation in the simulated head should be close or (almost) identical to the observed fluctuation pattern." What is close or identical? This is a very arbitrary description that can be improved. Another element that is arbitrary in the calibration is: "the salinity should be small or otherwise explicable". What is small? What is explicable?"

We agree that these criteria could be interpreted in various ways, therefore we have made small modifications in the phrasing of the criteria. The intent was the couple the mentioned criteria: the transient error in groundwater head should be smaller than the observed standard deviation, but stay similar to the observed fluctuations. We chose to keep the criteria concerning the groundwater salinity more qualitative, because the number of measurements was limited and small variations in the depth of the interface

can lead to large errors in the simulated groundwater salinity.

"It is defined that six factors affect to fresh groundwater resources but only three are considered. It is not clear what is the criteria for this and if this would also affect to the results obtained. I think that a better introduction would help to understand this."

We have rephrased this paragraph and deleted the line on the six factors. Together with the improvement to the introduction we believe this is resolved.

"The discussion is too descriptive basically presenting the results of the different models and adding some elements that could affect to the models (and in most cases are minor). A probably more interesting discussion, that can be also included in the conclusions, would be a quantitative comparison between the different factors that have been presented in this work. This would generate a broader impact of the results."

We agree that some aspects of the paper are not presented clear enough, therefore we have made some modifications to the discussion. Together with the improved descriptions of the aim of the research in the introduction, we believe this improved the impact of the results. However, we chose to avoid a too quantitative approach in the discussion, because some of the differences between the factors could be related to the conditions at this particular site, and some differences between scenarios could be caused by the differences in nature of the scenarios (how to compare a constant sea-level, to a constant morphology).

Specific Comments

"Page 3. Lines 5-12. The description about the outline of the work is not needed."

Yes, we agree and have deleted these lines.

"Page 6. Lines 20-22. Which data were used for this calculation?"

We used offshore measurements at the “Euro platform” of the Ministry of Infrastructure and the Environment (Rijkswaterstaat). This was added to the lines.

"Page 8. Line 21. There are two dots in a row."

We have corrected this in the ms.

"Page 9. Line 32. Either mention as described in sect 2.2., or repeat the model discretization but both are repetitive."

We agree, and have moved these lines, together with lines 31-33 on P9, to the methods section.

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