

Interactive comment on “Fresh groundwater resources in a large sand replenishment” by S. Huizer et al.

S. Huizer et al.

s.huizer@uu.nl

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We would like to thank the Referee for the comments, which are highly appreciated. We will improve the raised issues.

General Comments

“The authors state that the volume of replenished sand in their case is “large”. Without a comparison to previous nourishments, the reader cannot judge if the volume 21.5 Mill. m³ is indeed large. Please give some figures for previous measures for comparison. “

We agree that the statement “large” is subjective and will remove this statement from P2L25. In the beginning of the paragraph (P2L14-16) we have mentioned the “traditional” nourishment volume of 12 million m³, which is (on average) applied yearly along

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the entire Dutch coast.

"The potential negative effects of a mega-nourishment should at least be mentioned briefly. Where does the sand come from? How does the extraction affect currents and wildlife there? What about sandbanks forming downstream which may obstruct shipping?"

We think that these issues are not relevant for the paper, and in addition, many of these issues are still under investigation within the large Nature Coast programme. Possible advantages were only mentioned as motivations for the creation of the Sand Engine. However, we will adapt the text to remove the impression that a mega-nourishment will predominantly have positive effect.

"Not sure whether your model cell size is appropriate for the initial steps of freshwater generation in the sand engine, when the freshwater body is still small. "

We agree with the Referee, and will perform additional simulations for the reference scenario to justify the spatial and temporal discretization. In order to justify the spatial discretization, additional simulations will be performed with horizontal resolutions of 25 m and 100 m and one simulation with an increased vertical resolution. The results of the additional simulations will be reported in a supplement; in the paper we will refer to the supplement.

"Why would a wetter winter lead to a lower volume of fresh groundwater (P10, L21-24). Should a wetter winter not lead to more recharge in NW European climate?"

Yes, a wetter winter would lead to a higher volume of fresh groundwater, however the text is comparing climate scenarios. The climate scenarios with a high response will lead to higher volume of fresh groundwater in comparison with the climate scenario's with a weak response. Overall the groundwater recharge increases more in the milder climate scenarios. We will adapt these sentences to clarify the intention.

"List references by year of publication, oldest go first (e.g. in Line 20) "

In the manuscript preparation guidelines for authors it is stated that ‘In terms of in-text citations, the order can be based on relevance, as well as chronological or alphabetical listing, depending on the author’s preference.’ We have chosen to list in-text citations by alphabetical order.

“The manuscript would be a better read after a liberal sprinkling of commas!”

We will check the manuscript for readability, and add commas where possible.

“Not sure about HESS C1-English sources in the references come with a translation? e.g. Buma (2013), P 14, L5 and others”

We will translate all Non-English titles to English; P14L5, P14L30, P15L1, P16L1-2, P17L12-13, P18L13-15, P18L16, P18L26-27, P19L17, P19L18-19, P19L26-27, P19L29, P20L15.

Specific Comments

“Page 1, Line 20: use spelling “deltas” not” delta’s” P. 1, Line 21: usual spelling in English is “Vietnam””

We will change this in the ms.

“P2, L6: not the whole of the Netherlands is a delta, right? People in Friesland and Limburg would probably not agree”

Yes, we will modify the text from ‘delta’ to ‘country’

“P2, L10-12: sand nourishment is not only done in the NL, the Germans do it, too, and probably other countries as well”

This is correct, and we have briefly addressed this in L4-5, however not specifically.

“P2, L11-12: how often is sand nourishment usually done? Every year, every five, ten, twenty years?”

We will change the line in the ms.

“P2, L15; replace “must rise” by “rises””

We will correct this in the ms as “is to rise”

“P2, L23: Weren’t their some presentations on the sand engine at the latest SWIM in Husum? Please cite references if appropriate”

Yes, the preliminary results that are described in this paper were presented at the SWIM in Husum.

“P2, L28: replace “determined” by “investigated””

We will correct this in the ms.

“P2, L31: please replace “shape” by a more appropriate term describing the geometry”

We will adapt the line with more appropriate terms; ‘retreat of outer perimeter’ and ‘increase alongshore extent’

“P3, L1: replace “in” by “into” (twice!) “

We will correct this in the ms.

“P3, L12: “displacements in seawater intrusion” sounds awkward please rephrase”

We will adapt this to “to dynamic changes in seawater . . .”

“P3, L13: no need to define SGD, delete text in parentheses”

We agree, and will delete definition.

“P3, L17/18: does variable density gw flow not include salt transport? (same for P5, L27)”

We agree, in the absence of other species there is no need to include salt transport here.

“P3, L23 and 24: replace “scenario’s” by “scenarios” P4, L5: probably “rainbowing” is

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the correct spelling?!”

We will correct this in the ms.

“P4, L10: delete “clean,” ”

We will change this and rephrase the sentence in the ms.

“P4, L13-15: how much groundwater is infiltrated, how much is extracted, how much is locally formed?”

We will add this information to the paragraph.

“P4, L24: replace “are” by “were” (same in Line 28) P4, L25-26: an aquifer made up of clay? are you sure? P5, L1: delete comma P5, L10: replace “observed” by “read off” ”

We will correct this in the ms.

“P5, L12-14: these were on-shore in the dunes, right?”

Yes, in the dunes and in some in the hinterland (urban area, polders). We will add ‘onshore’

“P5, L15-19: the purpose of these wells remains unclear, are they pumping saline/brackish water as interceptor wells? Are they running continuously? Please specify! “

Yes, these wells serve as interceptor wells; they control the groundwater level to avoid any possible negative impact of the nourishments. We will clarify this in the paragraph.

“P6; L15: add “the” after the second “and””

We will correct this in the ms.

“P6; L27/28: here you use m/d while above (L19) you use SI standards (m, s) ”

We have used the most common and appropriate unit for each model parameter.

“P6; L29-34: the values chosen for these data should be stated somewhere, maybe in a table”

We will transfer the values of the model parameter to a table.

“P7, L32-33: but HOW were they incorporated? and which ones? in what timescale? ”

The processes (coastal erosion, sea-level rise, and expansions of groundwater drainage and extractions) that are referred to in section P7L29-34 are visualized in Fig. 5. This figure illustrates how these processes are incorporated in the groundwater model. The historical coastal erosion is based on paleogeographic maps by Vos and de Vries (2013), the reference to this source was shown in Fig. 5. We will clarify this in the figure caption, and adapt the sentences in section P7L29-34 to clarify the methodology.

“P8, L25: why not use “every three months”? ”

We will change “quarter” to “every three months”, because this is more explicit.

“P9, L17: add “and” instead of comma P10, L12: add “the” before “situation” P11, L3: replace “with” by “by” ”

We will correct this in the ms.

“P11, L14-19: not sure whether a comparison to island lenses is appropriate here. This is also no conclusion but a introductory note. Maybe better deleted! ”

We will move this section toward the introduction (paragraph 1.3), and will delete the addition (L17-19) to reduce the focus on island lenses in this section.

“P11, L31: since you raise the issue: how many times was the sand engine flooded? “

Only certain areas of the Sand Engine have been flooded. Until now there have been two ‘major’ storms in 2011 and 2013 that lead to large inundations, and several ‘minor’ storms leading to less extensive inundations. We will this information to the paragraph.

“Fig. 1: add north arrow Fig. 1: legend for gray scales?”

We will add this to the figure.

“Fig. 3: explain formation names, maybe ages or so? “

We will add a legend to the figure with some information about the formations (age, lithology)

“Fig. 4: values for general head boundaries? give legend to identify aquitards and aquifers”

The values of the general head boundaries were taken from a previous model simulation of the southwest of the Netherlands (Oude Essink et al., 2010). We will add a legend to the figure, and to identify which layers are aquitards and aquifers.

“Fig. 5: modified after Vos 2013?”

We will correct this in the figure.

“Fig. 8: which year is shown?”

This is the year after calibration, before the construction of the Sand Engine (2010 – 2011). We will add this to the figure caption.

“Fig. 10: explain in caption that the labels refer to (climate) scenarios”

We will explain this in the figure caption.

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