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Hydrology and Earth System Sciences Discussions

Interactive comment on "A combined field and modeling study of groundwater flow in a tidal marsh" *by* Yuqiang Xia and Hailong Li

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Summary The ms presents time-series of groundwater levels and groundwater modeling results of two transects (one covered with mangrove and one not covered with vegetation) to identify the geohydrological key-processes important to mangrove persistence. The results provide evidence that the aquifer under the mangrove transect was recharged with fresh groundwater from upstream regions, whereas the aquifer under the bold beach transect was not recharged with fresh groundwater. This confirms the hypothesis that fresh groundwater recharge of semi-confined aquifers drained by the sea is essential to the mangroves. I find the general methodological set up, consisting of a comparison of two transects using observations and model results, very

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Discussion Paper

convincing. However, I have some concerns from this respect as outlined below. Besides I think that the ms is not always precisely written and lacks a clear focus, leaving a whole lot of open questions to the reader. Therefore, I suggest that the authors consider rewriting the ms given the remarks mentioned below and take my methodological concerns stated below into account, in order to make the ms suitable for publication.

General comments

1. As mentioned above, the ms is not always precisely written and lacks a clear focus, at least concerning the introduction, discussion and conclusion sections. I suggest that the authors consider rewriting the ms given the remarks mentioned blow.

a) The authors test some speculations about the regional geohydrological functioning of mangroves, however, the ecohydrological relevance remains unclear in the introduction and discussion sections. From the current ms I conclude that fresh groundwater under the mangrove transect is discharged into the tidal creek during low tide; the high-resistance mud layer isolates the mangroves from the aquifer. So, how can then the mangroves benefit from the fresh groundwater at several meters depth? In my opinion, the ms would improve considerably if the underlying ecohydrological processes are well described in the introduction section and if they are confronted with the results of this study in the discussion section. Also, a figure which illustrates the conceptual hydrological models of both transects can be helpful for the reader.

b) The objectives stated in the introduction section are rather broad and could be specified more precisely. One of the reasons is that a clear hypothesis is missing in the introduction section. A hypothesis can be formulated given the literature mentioned, and may sound something like the speculations firstly mentioned in section 5.

c) Section 6 “Numerical verification” starts with resuming two “speculations” about the functioning of the geohydrological system of both transects. As these two speculations do not exclude each other, they should be seen as 1 “speculation” and described as such (see 1b).

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d) The discussion starts with a description of the similarity of the two transects. This section reads as a bunch of statements, without clearly explaining their mutual relations. Also, I would expect more emphasis on groundwater hydrology of both transects, and how the outcomes relate to situations described elsewhere (which are both only briefly given).

e) The conclusion section (page 5140) reads more like a discussion about mangrove conservation and should be focused more on the objectives of this ms. For instance, salt buildup under influence of evapotranspiration and the removal of salt by fresh groundwater seepage (r 21 and 23) is not considered in this study and typically should be part of the discussion. Some conclusions are given in the first paragraph (p 5140, r11-23). However, the conclusions are not explained very well, leaving many questions to the reader. What is the key-role mentioned at r14 exactly? How come that the lack of freshwater recharge results in aerated beach soil conditions (it seems to me that aeration can prevail under both freshwater and salt water recharge) at r 19? Why is fresh groundwater recharge a decisive factor for generating brackish groundwater?

2. I think that the general methodological setup can be described more clearly and convincingly if the sections 3 and 6 are merged into one section named “Methods”, starting with an methodological overview. Now, the method seems to consist of two separate parts, while the modeling exercise clearly has an added value to the field observations.

3. Conform the previous remark, I would prefer a results section consisting of two paragraphs, namely (1) Mangrove transect, (2) Bald beach transect. In each paragraph, the field data and the model results are subsequently outlined, including their consistency.

4. The authors use 2D groundwater flow modeling to corroborate a hypothesis obtained from observed trends and patterns in groundwater levels along two transects. Given this modeling aim, I have the following concerns about the suitability of the experimental set up:

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a) The boundary conditions that principally force the model (those assigned to the ground surface during submergence, the left boundary representing regional groundwater flow from upland and the tidal creek) are defined according to the observed groundwater levels. In other words, the results of the groundwater model are, strictly seen, not independent of the observed groundwater levels, which makes the model's corroborating evidence that supports the hypothesis under study less convincing. Hydrochemical monitoring results (e.g. Cl or EC) and/or measured fluxes are required to support the argumentation that the model captures the hydrological key-processes.

b) A no-flow boundary is assigned to the left boundary of the bald beach transect model. This boundary condition is only constrained by measured water levels in one observation well. Therefore, it seems to me that other boundary types might be suitable here as well. The author's argumentation would be much stronger if the authors could show that the observed patterns can not be reproduced using realistic parameter settings if other boundary conditions are assigned to the model.

c) The observations and models concern only a three day period, while long term dynamics (for instance due to monsoon precipitation and evapotranspiration) can also be important for fresh groundwater recharge of the mangrove's source aquifer. This should be discussed in the discussion section.

Specific comments 1. The abstract lacks a statement about the ecohydrological key-mechanism that justifies the presumption that fresh groundwater in semi-confined aquifers can be essential to the existence of mangroves.

2. Figure 4 can be improved by printing the time series for the mangrove transect in one column, and the time series for the bald beach transect in the other. Also, time series observed at a comparable location in each transect can be plotted next to each other (i.e., in 1 row), which would allow readers to analyse differences in hydrological behavior between the mangrove transect and the bald beach transect.

3. At page 5136, the authors mention that they estimated hydraulic conductivities

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through trial and error. More information should be provided about this process. Was a range of parameter settings defined prior to the calibration? When did the authors stop the trial and error process? Were the conductivities of each layer adjusted alternatively?

4. In many places, the authors resume the speculation that "the low-permeability marsh soil is underlain by a high permeability zone" in the mangrove transect (e.g. p 5136, r 10 and 23). This speculation, however, has by itself no relevance to the existence of mangroves. I think that should be added that seaward drainage of fresh groundwater from upland through this high permeability zone also is a critical factor. Only then mangroves can benefit from the presence of fresh groundwater conform the authors postulation.

5. I prefer a figure of simulated patterns of fresh and brackish groundwater (e.g. Cl-concentrations) in stead of Figs 7 and 9.

p. 5125, r 13: "surface and ground freshwater" → "fresh surface and groundwater"

p. 5125, r 20: "Effects on" and "nutrients". What is meant with "material"?

p. 5125, r 21 -24: this sentence misses a verb. Omit the long name of the research site

p. 5125, r 26-28: "advection prevents infiltration" . . . "removes solutes" . . . "the wetland".

p. 5125, r 27: "nutrient concentrations"

p.5126, r6-8: This sentence misses a statement: what was concluded?

p. 5126, r28: "mangroves are distributed along"

p5127, r2: Isn't it better to focus on the mangroves? I would state something like "critical to mangrove development".

P 5127, r10. I suppose that the modeling exercise has a higher goal then only simulat-

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ing water levels, namely to corroborate the observations for hypothesis testing.

P 5127, r27: what is meant with “Best mangrove”? the best preserved?

P5129, r15: “data are” Section 4: modify to present tense. E.g. p. 5130, r. 12 “transects are reported”

P5131, r 15: replace “possible” with “the”

P5131, r 16: replace “underlain” with “underneath”. . . . “and drainage by the sea”?

P 5132 r6-10. This sentence is too long, and the statements require more explanation. I suppose the authors attempt to argue why the seepage face is not permanently located at the creek bed.

P 5132 r 25: replace “but” with “, whereas”

P 5133, r11: this explanation is only reasonable if the high-permeability zone has a good hydraulic connection with the tidal creek, isn’t it? If so, add a statement like this.

p 5135, r 12-16: reallocate towards the end of this paragraph, so that all information about the boundary conditions is provided sequentially.

P 5136, r 1. The first sentence is part of the methods. Which hydraulic conductivities were estimated?

P 5138, r3 and 4: Add the unit of the mean gradient

P 5138, r11 “their outcrops” instead of “its outcrop”

P5139, r6. Here starts a very long sentence, which should be split in two or three sentences.

P5139, r15. replace “but” with “Whereas” . . .. “zones”

P5139, r18-19: “. . .below the ground surface at M7, but remained near ground surface at M1-M6”

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P5139, r20: “. . .filling of the soil pores with air, which improved. . .”

P5139, r26: replace “a scenario” with “a pattern”

P5140, r11: as mentioned above, I would focus on mangrove development, instead of on bald beaches.

P5140,r13: “water levels”

P5140, r15: Explain why the two-layer structure plays a key role (this is not straight forward when having read the current text).

P 5140, r20: “aerated”

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 5123, 2011.