

Comments on “Palaeo-modeling of coastal salt water intrusion during the Holocene: an application to the Netherlands” by J. R. Delsman et al.

General comment –

This paper discusses a very interesting topic of complicated salinity distribution in coastal aquifer and provides a unique approach of hydrological modelling combined with hydrochemical considerations. I, therefore, strongly recommend that it will be published in this journal provided some significant modifications will be made. The main problem is that the paper is quite difficult to follow and some parts can't be judged by the readers due to lack of explanations. Some of these modifications are relatively easy to make, such as showing some of the figure in colors so that it will be easier for the readers to notice the specific details. Other will require more work, such as providing more information about the different geochemical data so that the readers will not need to go to another previous paper in order to understand the current one. I am sure that some of the specific comments stem from my lack of understanding that can be dealt with by further explanations.

Specific comments

Abstract

- 1) The abstract is well written but a little too general. It will be nice to have more specific results of this study in the abstract, possibly relating to the use of the geochemical groups.
- 2) The first several lines are kind of introduction and can be shortened.
- 3) I am not sure that the term “perceptual tool” is the correct one here – why not “conceptual tool”?
- 4) Where is the information for “pre-Holocene” coming from? Is it from radiocarbon dating of this water? If yes, then you need to change the text where it is written that radiocarbon is not accurate and can't be used. If this time frame is obtained from the simulations, it should be specified as such.
- 5) The last sentence is too general – I suggest that you elaborate and be more specific or delete

Introduction

This chapter is well written but I missed some needed information with regards to the details of this studied area.

First, I suggest to have a chapter of “site description” as a second part of the introduction and move what you write in the “method” chapter to this chapter.

Second, you need to give a better summary about the concept of “hydrosome” and hydrochemical facies and characteristics of each of them from the published papers of Stuyfzand. The description in the “Hydrochemical facies analysis (HYFA)” chapter is not elaborated enough. The lack of such information make this paper difficult to read – the readers should be able to understand the paper as is and not to be forced to read the previous papers.

Methods

It will be better to give more specific details with regards to the recharge coefficients and not just to mention “precipitation surplus (precipitation minus evaporation)”. I suggest to give the actual estimations of precipitation and evaporation here and not only the surplus. Is the recharge the same in the whole studied area? Is there no different between the dune area and the other areas some of which seems of lower permeability? Is there no surface flow, which could effect the precipitation surplus?

Are the Tertiary clay layers the same as Maassluis Formation?

Is there separation between the different sub-aquifers? Are all parts connected to the sea in the same manner? The system seems to behave as one with only local effects of the less permeable layers. Is this something specific to the studied site or this is a good representation of the Dutch coastal aquifer?

It is not clear how you used the model of Goode for the age distribution. Moreover, there is no output of such simulation to show the readers what you mean in this part of your work and how do the simulated ages fit the tritium data. As you know, the tritium data give information only for ~50 years which is very small part of this study. Are the radiocarbon ages of Post not accurate or not good at all? If the problem is with accuracy, then you can still use them for this work since, as you state, is more conceptual than quantative.

Results

As written before, it is impossible for the readers to judge the comparison between the tritium ages and the results of the simulation. If this is important to be mentioned, then you need to give specific results (either as another figure or some specific data)

The explanation for the discrepancy between the results of the simulation and the measured heads at about elevation zero need to be better explained.

The term “model conservative tracers” is not clear in this work. It seems that in this work it means specific geochemical group, that you define as “hydrosomes”. But these need to be better defined. It is not clear how you dealt with them in the simulations. Are there a specific parameter that defines each group, either in the model or in the field or in both ? Is there mixing between the different groups? You also need to define better the other related terms such as “infiltrating transgression” and classic seawater intrusion – is it mostly about the time of the intrusion or there are other differences between these terms? Again, an elaboration in the second part of the “introduction” will be very helpful.

Discussion

The differences in the thickness of the mixing zones in the different parts of the section are interesting. Can you be more specific and mention what you mean by wide or narrow zone? Also, can you elaborate on the reasons for this difference? Could the flow velocity (of the fresh water) be an important factor?

I am not sure that this approach is so different from the others that start with steady state condition. It seems to me that the conditions that you use for 6500 BC could be defined as steady state condition and the results will not be very different. The interesting point in this work is that you also change the hydrogeological configuration with time. The actual way that this is done and its effect on the modeling is not elaborated enough. I understood that the end condition of each step is the initial condition for the next step – but, did such exercise create problems since these conditions do not fit the new configuration? In real life, the geological and hydrological condition are changed gradually and not in jumps, some of which are quite big.

Figures

Figure 1 – (a) – it is very difficult to see the details without colors – is there a reason for giving this figure in black and white?

Can you show the bathymetry? It is difficult to see the ridge in the sea, otherwise

(b) Again, it will be much better in colors. It is very difficult to see the details especially in the upper parts

What do you mean here by heterogeneous (in the legend)? Which parameters?

Figure 2 – again, please give in colors

I think that a small figure of sea level changes during the whole studied period will be very helpful

Figure 3 – I am not sure that averages are good in this case. If there are big variations with time, then it seems better to give data from specific times.

Figure 4 – The field data seem to fit the results of the simulation very well which is a great support for this work. Can you elaborate on the locations of disagreement and try to explain them? The effect of the clay layers seems surprisingly small given the fact that you run a transient simulation for not a very long period. Do you have specific data for the configuration and the permeability of these layers? I imagine that a change in these layers (e.g. significantly smaller permeability) will make a difference.

I do not see any evidence for SGD in the lower sub-aquifer. Is there no evidence for relatively fresh groundwater at depth of 100-150 meters near the shore, like there is in some coastal aquifers in other countries? It depends, of course, also on the continuity of the clay layer. Again, is this typical for the whole Dutch coast or specific for this area?

Figure 5 – this seems like a very interesting results and therefore it is a pity that it is not readable, even if I looked at it at 200%. You need to enlarge some of the writing from the work of Stuyfzand.

Again, although the comparison is very nice in many cases, it will be nice to elaborate also on the differences.

There are some areas that seem without data and still divided to groups – can you explain how this was done? Other data that are not given? Conceptual knowledge?

Some of the names are different in (a) and (b) – Is there a reason for that? Can you explain these differences?

How did you get the difference in ages?

Figure 6 – What is the salinity of the brown color ? I am not sure that I see it in the legend. Is the recharge the same in the whole section? If not, can you show that? It is difficult to see why there are the GH lenses since it is difficult to see the hydraulic heads. You may want to give few inserts of more detailed area in order to show what is missing in the large scale sections.

Figure 7 – are the SP units the same in the whole model? Why is there a change in SP in 1500? Is the rise in SP in the end a result of pumping?

Figure 8 –I do not see much changes in the last 100 years although there were big anthropogenic changes.

Did I miss something important? If there are changes, please refer the readers to them (possibly by a more detailed figure)