

Interactive comment on “Hydrochemical and isotopic evidences for deciphering conceptual model of groundwater salinization processes in a coastal plain, north China” by Dongmei Han

Anonymous Referee #1

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General comments

The specific aims of the study are reasonably clear. However, what is not clear is what new general information you hope to provide. There have been numerous studies of coastal groundwater in China (many of which are referenced). What new information will come out of this paper? There is the conceptual model, but is that different to what has been previously proposed (i.e. does this paper provide some new understanding and if so what are the current gaps in knowledge).

Additionally, how does the paper inform our understanding of coastal aquifers in general? Regional papers are useful, but to be published in International Journals they

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need to convey some new understanding that ideally is applicable to other study areas. The paper commences with a review of a range of topics and seawater intrusion in a number of settings. However, it is mainly a case study and while these are important, you need to revisit those topics and explain in the conclusions the relevance to research elsewhere.

Some aspects of the study are oddly placed. Notably, the changes to groundwater levels are discussed in Sections 2.2, 2.3 and 4.1, which makes it difficult to follow. Shortening it so that only the key information is presented and adding a diagram to illustrate the trends would help immeasurably. In a similar way, Section 5 has a lot of data presentation in it as well as interpretation and much of that should be moved to Section 4.

The description of the groundwater drawdown and the geochemistry is overly long and the reader gets lost in all the details. Both these aspects could be shortened considerably and presented in a more logical order. There is a tendency to introduce concepts (eg explaining the use of Cl/Br ratios) and new data (the radioisotopes, nitrate, Br) in the discussion; Figure 10 is explained in the discussion but used much earlier. The paper needs to be reorganised. Perhaps explain in more detail how we understand geochemical processes in the introduction (e.g., the general discussion of the use of Cl/Br ratios), describe all the data in one section, and restrict section 5 to interpretations.

I agree with most of the interpretations, although for reasons explained below, the interpretation of the radioisotopes of the thermal waters (which look to come from another study) cannot be correct. I may have missed it but I don't see a clear explanation of the seasonal variations in the stable isotope values of the shallow groundwater. It must be recording seasonal recharge (?) but is that consistent with the rest of the geochemistry?

Finally, the English is difficult to read although the message is generally understand-

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able. There are numerous places that the English needs to be corrected and I have not attempted to do this. It is not easy to write in a second language but careful proofreading of the final paper is required, which would increase its accessibility and impact.

Specific comments

Introduction

The introduction provides a comprehensive summary of the importance and threats to coastal groundwater. The threat to coastal groundwater due to sea level rise could be expanded a little as it is not just due to the interaction between seawater and the rivers, a rising sea level will induce saltwater intrusion away from the rivers and could wipe out perched freshwater bodies in some coastal aquifers.

Lines 63-70. This section does not convey much except that studies were done and the results were different. Either add a few more details about the results or just shorten it.

Lines 70-72. The definition of the hyporheic zone is older than that study, sentence needs rephrasing.

Lines 90-99. See the comments above on the aims of the study. This section needs to have a clearly articulated statement of how this review improves our general understanding.

Study Area

The geology and hydrogeology are reasonably well described needs some attention. Section 2.3 is a long and repeats some of the previous section (the drawdown and water use). It is also difficult to follow without illustrating on a Figure. Either add a map to show drawdowns or shorten this section to retain only the key facts. I am not sure that the localities (eg Zaoyuan) are on Fig. 1, which makes it difficult to follow.

Lines 122-124. Do you mean yield (abundance)

Lines 130-132. Not clear what a "complete" aquifer system is.

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Lines 140-143. More detail is needed here. By how much do the water levels vary? Is it across all the area? Critically, does depletion occur near the coast? Perhaps you could show a drawdown map or a few representative hydrographs.

Lines 184-188. I presume that these are depths? What depths do the production wells pump from?

Fig. 1 would be improved by adding some hydrogeological information such as: 1) groundwater flow paths and 2) indicating the zone where seawater intrusion is observed. Is there any reason that the explanation of the colours / symbols could not go on the key rather than in the caption?

Fig. 2 uses a different set of symbols to Fig 1. Make sure that these are the same. You could also merge Fig 2 into Fig. 1 as they are related and it would be easier to get the information from these two figures if they are together.

Methods

Lines 194-201. Some more detail on the wells are needed. The Table lists a single well depth, but both here and in the table information on the screen widths are needed as characterising the geochemistry from short-screened bores is much easier than from those with longer screens.

Lines 202-213. Quote the precision for all of the parameters and lower detection limits where important.

Lines 221-238. This is a standard technique and the description of it could be shortened.

Results

Section 4.1 repeats some of the historical information that is section 2 (the description of the cones of depression). Again, it is done without any illustration. As this is really background material, it probably is better to merge it into Section 2 which would avoid

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some of the long descriptions. It is difficult to understand the water level changes due to pumping as they are written. Given that the paper is long and is mainly focussed on geochemistry, it would be worth presenting the changes to groundwater levels in a single section (currently there is information in Sections 2.2, 2.3 and 4.1), shortening it so that only the key information is presented, and adding a diagram.

Section 4.2.

Lines 217-281. I am not sure that you have enough data to discern a seasonal variation. Is the variation the same as in the local rainfall (I presume that there are data)? If so you could just note that the rivers have stable isotope trends that follow those of the rainfall and shorten the detail in this section.

Lines 294-302. Suggest presenting the rainfall data first as it is part of the general background data against which you can compare your observations.

Line 302. Not clear what you mean by this.

Section 4.3 & Section 5.1

Section 4.3 does a good description of the major ion geochemistry. However, there is much basic description in section 5.1 (e.g., lines 386-420). Also there are data introduced in Section 5 (nitrate and Br) that do not appear in Section 4.

Overall splitting the data up in this way makes the paper long and convoluted. You need to decide where information goes and be consistent. Presenting all of the descriptive material (including water types) in section 4 and restricting interpretations of the data to Section 5 would make more sense. In which case the descriptive material on lines 386-420 could be merged into section 4.3.

The amount of description is also long. It is good to present the data in the text and I get very frustrated with papers that just refer to data in tables or figures without discussion, but there is a lot of detail presented in this study. Both for the stable isotope and the major ion data I would suggest cutting the detail down and presenting what you

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think is necessary. For example, do you need to describe the water types or would an explanation of the variations in salinity and general water chemistry be sufficient for this study? The Piper diagram does not show the types in any case but the separation of the waters is clear.

You also have a facies diagram (Fig. 8) and bivariate plots (Fig. 10). I am not convinced that you need both as surely the processes of freshening and intrusion could be shown on the bivariate plots?

Discussion

Lines 362-368. If the thermal water has measurable tritium then it has some component with a mean residence time of less than ~ 100 years. Given that it has old ^{14}C "ages" it looks to be a mix of old water (zero tritium, low ^{14}C) and young water (high tritium, high ^{14}C). In which case the ^{14}C ages are meaningless. The mixing will also affect the stable isotope ratios and the interpretation of palaeowaters (although the older component may still have a past climate signal). I am not convinced that the thermal waters are important to this story, but if they are going to be included, then they need to be interpreted correctly.

Lines 386-405. See above, this is description and belongs earlier.

Lines 406-409. Again, you are introducing new data. Collect all the descriptions of the data into Section 4.

Lines 441-458. This section describes some of the consequences of salinization, which would be better discussed towards the end of the paper after you have discussed the processes.

Lines 459-470. It is confusing to only introduce Fig. 10 here as most of its use is to describe water types, the presentation of which was much earlier in the paper. In any case, I am not convinced that the details on the water types adds much of substance to the paper. It lengthens the text and the salinization and freshening trends can be

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illustrated on the other diagrams.

Section 5.2.2. See comments above. The interpretation of the radioisotopes cannot be correct. In addition, the data is being re-presented here (lines 513-515).

Lines 530-544. There is a fair amount of introductory explanation in this section, which could have been presented earlier. More importantly, more new data (the Br and the Cl/Br ratios) is being introduced. It make the paper very difficult to follow when data is described piecemeal rather than in one section.

Section 5.3

The conceptual model is reasonable, but is it new? In this section or perhaps in Section 6, you should outline more clearly how your study has improved the understanding of seawater intrusion in this region (or how your model compares with conventional wisdom) and also how it fits in with current global understanding. The paper commenced by discussing a range of global issues and summarising a number of key studies, but it is not clear as to how the paper informs that global research and what relevance it may have to researchers working elsewhere.

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