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## **Comment on hess-2022-326**

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Community comment on "The origin of hydrological responses following earthquakes in a confined aquifer: insight from water level, flow rate, and temperature observations" by Shouchuan Zhang et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-326-CC1>, 2022

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This review was prepared as part of graduate program Earth & Environment (course Integrated Topics in Earth & Environment) at Wageningen University, and has been produced under supervision of dr Ryan Teuling. The review has been posted because of its potential usefulness to the authors and editor. Although it has the format of a regular review as was requested by the course, this review was not solicited by the journal, and should be seen as a regular comment. We leave it up to the author's and editor which points will be addressed.

### **Summary:**

Zhang et al. investigate the hydrological responses following an earthquake in the Dazhai well China. They use the data in the well originating from 14 earthquakes from the period 2004 until 2015.

These hydrological responses utter in increased water-levels, temperatures, and flow rates. To unravel the origin of the water, they used a water mixing model, concluding that is comes from a deeper aquifer as it increases the water temperature. Moreover, using a tidal analysis they discussed that the aquifer hydraulic diffusivity and permeability changed following earthquakes.

### **Recommendation:**

It fits the scope of the journal because the manuscript is in the Hydrology and Earth System Science domain. The research is a well written and properly balanced in its arguing.

It is in a way an original research because it investigates the earthquake induced hydrological response based on quantitative research and does not stop at only qualitatively describing phenomena.

Moreover, the research has a good descriptive discussion and is well overthought. It contains a clear reasoning why for example proposed mechanisms by other papers should be accepted, adjusted, or rejected. In addition, it transparently reasons why two of the five dynamic strain mechanisms can explain the water-level and water flow changes in the aquifer. And why the static strain needs to be rejected.

Also, the abstract gives a proper overview of the performed research with a short introduction whereafter it describes the relevance followed by the methods and the obtained its results. As for the conclusion it also provides a solid and brief conclusion and contains the main findings of the research.

Moreover, the results are visualised in clear figures and tables, which are thereafter described in proper described paragraph on what it represents and how it links to the research.

I doubt whether the research is of immediate significance for other researchers in this discipline. In previous research it has already been indicated that earthquakes induce hydrological responses for example by Hosono et al. (2019) and Miyakoshi et al. (2020). However, the main novelty of this research is the description of the connection between the three aspects (water-level, water flow and water temperature changes) and the fact this specific research has not yet been performed in the Dazhai well.

In general, I find the work interesting and the analyses mostly sound. In my opinion the manuscript misses some statistical analysis of the data. Also, the regional aspect is lagging in the analysis, now it is only possible to do a local study.

I believe the manuscript can be accepted after some general issues have been addressed.

Underneath I provide several general comments followed by some minor remarks followed by several inline comments

## **General comments**

### *Single well*

To start with issue (1): in the research only one single well was used to retrieve the data from. The other deeper well is not used in the research as an input location for the main research results and data acquisition. Therefore, the obtained results may either only explain the local hydrological responses or the hydrological response is the result of an overlooked factor. Therefore, one could argue how significantly and plausible the results represent the area and the processes taking place in the aquifers. Using a larger number of wells will cover the possible local bias in the results. Therefore, the regional effect can be described better (Mohr et al. 2019, Cox et al. 2012, Hosono et al. 2019).

Another possibility could be to use discharge data coming from springs in the area, this was also used in the research of Manga and Rowland (2009). Although the discharge in a spring could be different from the increased discharge in a well, this extra data source could still enhance the significance of the dataset. Of course, temperature data could be a bit ambiguous, I would not advice to use this spring temperature.

### *Research focus and motivation*

Following with issue (2): in the section 'Geological setting and data sources', which could be acknowledged as the "Site description", the authors explain about the geological setting of the whole basin, to my opinion this also influences the resulting hydrological response in the aquifer of the well. However, in the conclusion and the other parts of the research, this broader perspective has not been touched upon.

Therefore, it would be recommended to either point out that only the Dazhai well and the aquifers it is directly connected to are of importance, or one should broaden the perspective to the whole (or part of the) basin. I would suggest to either make clear that this research only has investigated the Dazhai well (Most straight forward). Or discuss in the discussion section about the representability of this single well to the whole area/aquifer. This can be done with extra boreholes to gain extra lithostratigraphic knowledge of the area or by using the already provided information about the present aquifers.

### *Statistical analysis*

Following with issue (3): in the research the statistical analysis is not always consistent and is sometimes not present.

The authors make use of three models, the Hsieh model, Marquardt-Levenberg algorithm and the end-member mixing model.

They provided clear and good overview figures (figure 5: Hsieh's model, figure 7: Marquardt-Levenberg algorithm and figure 8: End-member mixing model) of the obtained results and the model outputs.

However, without any significance test or model and observation tests it doesn't make sense what the figures represent. For me it is hard to discuss whether the observations are well described by the model or not. The figures can give a wrong visualisation of the data. For the Marquardt-Levenberg algorithm this has already been provided in the supplements.

Suggested would be, to provide a more or less equal type of statistical analysis that already have been done for the Marquardt-Levenberg algorithm (in supplement S5). Provide in this test how well the model represents the observations.

### *Research question(s) and hypotheses*

Concluding with issue (4): The paper does not indicate what the research question is. In the introduction it stated what the investigation will be about, but it does not mention what question(s) will be answered. Based on the introduction and abstract it becomes clear what the aim of the research is. Due to the lack of this research question, it is hard to check whether the research question(s) are answered within the research and conclusion.

Advised is to provide one or more research questions. Preferably with hypothesis to strengthen the research. The goal of a hypothesis is that a provided research question is hypothetically answered and could be either rejected, adjusted, or approved based on the discussion of the results.

## Minor comments:

- Research paper structure: Paper misses a clear Methodology and results section. In the manuscript I can find where these sections are, but it is not clear at first sight. Moreover, it seems that in the result section and even the discussion new methods are introduced;
- Like the end-member mixing model (line 385). This model is an important model that is needed to find the answer to the research question. Consider moving this to a Methodology section.
- Site description: There should have been a site description instead of what is now mentioned as the geological setting of the area. In the section 5.2 line 390-391 there is also new site descriptive information which needs to be in the site description.
- Chapter 2, consider splitting these in a 'Site description' and a separate 'Methodology and data sources' section. Where in the second section the beforementioned methodology is included.
- One could decide to combine the result & discussion (chapter 3-5).
- Lack of analysis to the magnitude of the proposed mechanisms. There have been issued several mechanisms influencing the hydrological responses, however these only have been appointed to be present. The mechanisms have not been analysed on their magnitude, which may make a difference in the way the conclusions are drawn, it will probably change the emphasise on a certain mechanism. Though this may be out of scope for this research.
- The text is not always concise in the use of grammar and spelling, the conclusion for example first starts in the past tense and then switches to the present simple.

## In line comments

- 98, where is this 4 m coming from? Please provide elevation level of the well to check based on values in line 81 whether 4m is correctly calculated.
- Caption Figure 3 & 4, I suggest to change 'times' to 'events'
- Line 136 typo: Mk -> mK
- 196 there is for example mentioned something about a 95% confidence interval, however it is not clear to me which values are within this 95% interval. Do you mean that the errors are within a 95% interval or the changes in phase shift and tidal factor? This could either be a typo or an actual research failure.

I would recommend providing this statistical test as a supplement.

- 199 Incomplete data representation, only for EQ4, 6, 7, 11 the changes are discussed, what are the changes for the other earthquakes?
- 206 & 207, Typo? => there is stated that EQ11 and EQ12 have a phase shift smaller than -10 degree, however according to the table this value is larger than -10 degree.
- 210, typo in maybe it should be 'may be'.
- Figure 5: What do the red and blue dotted lines indicate? Please add this to the legend of the figure.
- 241, 321, 444 preexisting or pre-existing, please be constant in its spelling
- 244 word-choice, dilate -> dilation
- 245-247 & table 2, Here indicated that for the next analysis the values in table two will be used, however EQ1 and EQ8 are indicated not to be used but are still in the table. I suggest discarding them from the table
- 385-389 Consider moving this part to the methodology section
- 390-392 Info could be added the Site description, this is new information about the area
- Conclusion -> Inconsistent in the used tense, either use past tense or present tense

- 445 add "the" before hydrogeological setting
- 445 either it is: from 'the deeper' aquifer or from deep 'aquifers'

## References

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