

Interactive comment on “Hydrogeological responses to the 2016 Gyeongju earthquakes, Korea” by Jaeyeon Kim et al.

Anonymous Referee #1

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1 General comments

The manuscript is a technical report which provides an interesting analysis of hydrological data and discusses the evolution of hydrological quantities before, during and after some earthquakes in South Korea.

The work is largely based on well-established methods and the scientific novelty is not very remarkable. The main goal is stated in the introduction at lines 105 to 107 and then later at lines 357 & 358. However, the neural network method applied in this paper (SOM - Self-Organizing Map) is not new and it is not apparent its advantage with respect to other clustering methods. See also the specific comment # 4.

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The manuscript is generally well organized and written, but it requires linguistic improvements, some of which are listed in the technical comments below.

From the scientific point of view, at some points, the manuscript is not sufficiently precise and rigorous, as described, e.g., in the specific comments # 1, 2 & 3 and in the technical comments # 9 & 10 below.

I am sorry, but I think that the innovative character of the work is not sufficient to publish the paper on HESS, whereas the manuscript is more adequate for a strictly hydrogeological journal.

2 Specific comments

1. Lines 37 to 41. The list of references shows that it is debatable to state that “few” studies are devoted to this research topic. A simple and fast search on google scholar shows a lot of papers related to the effects of earthquakes on hydrological processes and quantities. Perhaps, the Authors want to stress that most papers are devoted to earthquake precursors or to the study of co-seismic phenomena.
2. Throughout the paper, it would be necessary to consider in a more accurate and rigorous way the considered time scales. The following remarks provide some instances.
 - Lines 43 & 44. If the changes are related to seismic waves, they should disappear after the earthquake. Effects at different time-scales should be separated more clearly. The sentence “Seismic waves... geochemistry” should be better connected with the preceding one “Seismicity... groundwater systems”.
 - Line 187. The time scales should be considered in a more accurate and rigorous way. In fact, the sampling period of hydrological data is high with

respect to the duration of the earthquake wave train.

3. Line 93. Surface area is an extensive property: does radon concentration (which is an intensive property) depend on it? Should “surface area” be substituted with the intensive property “specific surface”?
4. In section 5 it is shown that several different processes might explain the behaviour of collected data. However, most (if not all) of such processes have been hypothesized in previously published papers: many of the papers cited in this section were published in the second half of the XX century. Such a discussion has a great value for local land management and natural risks mitigation, but a more limited interest for the international scientific community. Moreover, the declared goal of the paper is to show the relevance of the use of SOM, but the discussion of the relevance of this method – as compared with other possible approaches – is almost absent.
5. Carefully revise the number of significant digits used for several quantities. For instance, with reference to Table 3, is it physically significant to express concentrations with three or four significant digits, radon activity with up to five significant digits and Sr isotopic ratio with six significant digits?

3 Technical comments

1. Line 9. Specify M_L .
2. Lines 15 & 16. Rephrase “with bedrock characteristics”.
3. Lines 16 to 19. Erase “To analyze... from the earthquakes” and rephrase the remaining part of the sentence “annual monitoring data... during January 2017”.

4. Line 35. Substitute “underground” with “groundwater”.
5. Line 55. Rephrase “By using hydraulic properties”.
6. Line 61. Rephrase “was recorded as the largest”.
7. Line 64 to 69. The sentences “The occurrence... near the YSF (Lee and Jin, 1991; Lee and Na, 1983)” could be erased, since they do not give any scientific information relevant for the paper’s objectives.
8. Line 69. Substitute “interpreted” with “shown”.
9. Lines 72 to 75. The sentence “The occurrence... following the Gyeongju earthquakes” is quite self-evident and could be better rephrased.
10. Lines 81 & 82. Please explain how temperatures can be derived from measurements of groundwater level.
11. Lines 97 & 98. Add references.
12. Line 99. Specify “these”: strontium only or radon and strontium?
13. Line 101. Rephrase “according to the rock type in the bedrock of aquifers”
14. Line 129. Substitute “is approximately 21–35 km” with “varies between 21 km and 35 km”.
15. Lines 235 to 237. Rephrase, possibly as “The raw data were normalized in order to work with transformed quantities with zero mean and unit standard deviation”.
16. Line 238. Substitute “have” with “show”.
17. Line 287. Correct the exponent in $\text{Bq} \cdot \text{m}^{-3}$.

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18. Line 333 & 334. Rephrase the sentence “Groundwater level oscillation... of the aquifer”.
19. Line 355. Rephrase “were expected compared to those”.
20. Line 359. Rephrase “which was useful”.
21. Line 363. Rephrase “as one well binding the alluvial and bedrock aquifer wells”.
22. Line 382. Substitute “885–7851 ppb” with “from 885 ppb to 7851 ppb”.
23. Line 476. What about hydrogeochemical data?
24. Line 765. Use capital letters for “C.-Y.”.
25. Table 3. Rephrase the text of the footnote. Moreover, information is given for KW *-1 and KW *-2: what about KW 11-3? I am afraid that further details are missing: are the screened intervals located at different depths, or are these clusters of wells with different depths?
26. Figure 1. Sorry, but I do not understand this Figure. A more accurate and thorough description in the figure caption is necessary.
27. Figure 2. The colour scale of map (a) is a representation of ground surface level, isn't it? Maps (a) and (b) have the same extension, haven't they? Add this information in the figure caption and the colour scale bar in map (a).
28. Figures 3 & 4. These representations are not easily interpreted. More details in the text and in the figure captions could be useful.

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