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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Groundwater level changes on Jeju Island associated with the Kumamoto and Gyeongju earthquakes" *by* Soo-Hyoung Lee et al.

Soo-Hyoung Lee et al.

rbagio@kigam.re.kr

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Dear Reviewer 2,

Thank you for reviewing our manuscript and for providing useful comments. Below, we have outlined the replies to your comments. Also, we revised our manuscript based on your comments.

(1) The manuscript presents observation data of groundwater level changes by the Kumamoto and Gyeongju earthquakes. And authors proposed that the differences in groundwater level change are mainly due to the fault structures of MTL and Yangsan fault, respectively, presented in Figure 1. – this interpretation sounds perceptible, but

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needs more data to support the arguments.

1) Reply We agree with your comments. We added or modified manuscript. Based on tectonics, several fault fold zones including Tsushima-Goto fault of NNE-SSW direction lies between Jeju Island and Kumamoto and greatly attenuated the energy by the Kumamoto M 5.4 earthquake. By contrast, the energy by the Gyeongju earthquake was effectively transmitted due to the parallel extended Yangsan fault west Tsushima-Goto fault that elongates to the east of Jeju Island (Kim et al., 2016). We also agree with you about that the possibility of the different aquifer responses may affected the different water level changes by the Kmmamoto M5.4 and Gyeongju M5.4. Nevertheless, it is thought that the tectonics between the Korean peninsula, Jeju Island, and Kumamoto is a major factor of the groundwater level change by the Kumamoto and Gyeongju earthquakes. The above description is provided on the lines 18-23 of page 5 in the revised version.

(2) (p.5, line 1∼2) Authors stated that "higher hydraulic conductivity estimates yielded higher groundwater level changes". – higher hydraulic conductivities of aquifer matrix mean higher potentials of seismic energy to be reduced by groundwater along its pass ways. Then, how can the higher K cause higher water-level changes?

2) Reply We added or modified manuscript. Based on the geological columns of the seven monitoring wells (Fig. 2) and the groundwater level change vs. hydraulic conductivity (Fig. 9), we identified a positive proportionality between groundwater level change and hydraulic conductivity. When aquifer has a sufficiently high transmissivity, groundwater may easily flow into and out of the well, causing resonant motions in the hydraulic head (Cooper et al., 1965; Liu et al., 1989). Various transmissivity values may account for the different oscillation characteristics of the wells (Wang et al., 2009; Lee et al., 2013). In general, wells of higher transmissivity show more sensitive response to earthquakes even though the correlation is not great (Wang and Manga, 2009).

(3) Miscellaneous: - In Table 2, data need proper units. – In addition, in the ground-

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water level monitoring, the sensitivity should be given here to support less than 1cm of change being significant.

3) Reply According to your comments, we indicated the unit, cm, in Table 2. The specifications of the observation equipment are as follows: pressure range 10m, Accuracy ±1.0cm, Resolution 0.2cm, Temperature range: -20∼ +80âĎČ, ±1.0âĎČ, 0.01âĎČ (line 5-6 of page 3).

(4) [Conclusion] Groundwater level change is affected by numerous factors including tectonic settings, local geology of monitoring sites, monitoring well design and hydrogeologic properties of monitoring intervals. Thus, to make the argument of structural difference as the main cause of the difference of water-level changes, this manuscript should present some quantitative evidences. Otherwise, it could be just an observation report.

4) Reply We agree with your comments. We added or modified manuscript. Groundwater level change is affected not only tectonic settings but also local geology of monitoring sites, monitoring well design and hydrogeologic properties of monitoring intervals. Yet, in our study, four wells (SG1, PP1, JD2, and SS4) except two wells (SY1 and HD1) showed greater groundwater level changes to the Gyeongju M 5.4 earthquake than the foreshock and aftershock M 5.4 of the Kumamoto earthquake. This indicates that in the monitoring wells, tectonic setting is more dominant factor of groundwater level change to the Gyeongju and Kumamoto earthquakes, even if there exist local influences such as site geology around monitoring wells, monitoring well design, and hydrogeologic properties of the monitoring intervals. We revised our manuscript such description on the lines 11-14 and 33-35 of page 5.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2017-28/nhess-2017-28-AC2-supplement.pdf

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