

Groundwater change by seismic ground motion of the 1999 Chi-Chi earthquake

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The water level change during and after earthquake has been reported. The volumetric strain change, vertical displacement, dynamic volumetric strain change, and seismic ground motion were proposed for the cause of the change. For example in the 1999 Chi-Chi earthquake (Mw7.6), Taiwan, decrease in water level was observed in the mountainous region around a fault, and water level increase of 10m was observed in the coastal plain away from the fault. Wang et al. (2001) showed that the decrease in water-pressure which was caused by increase in pore pressure at the basement induced the decrease in water level height, whereas the liquefaction caused the increase in water level in the coastal plain. According to the past study, positive correlation was observed between the amplitude of peak ground acceleration (the peak ground velocity amplitude) and groundwater level change of amount. However, there are many questions that this relation execute to which earthquake. Since dominant frequencies of seismic ground motion differ for each an earthquake, we must think the maximum amplitude of seismic ground motion as well as it for each frequency. However, the groundwater level change for seismic motion of various frequencies has not been reported. The sensitivity of the well against the volumetric strain (10-100 nanostrain) of Earth' tide differs for each well. The sensitive well against the Earth' tide would also be sensitive for strain change by seismic motion, but it has never been compared. I compared the spectral response of ground motion and groundwater level change, inspected whether in what frequency of seismic ground motion infect the groundwater level change.

Taiwan area is good for the investigation of coseismic water level change of well and degree of seismic ground motion because dense well network for water resource and the network of seismometers are distributed. We investigated the relation between coseismic water level change of well and seismic ground motion of the 1999 Chi-Chi earthquake(Mw7.7). I used the data that the wave form record of strong-motion seismograph is managed by Central Weather Bureau and water level in the well is managed by Water Resources Agency around the middle part of Taiwan (from January 1. 1994 to December 31. 2000).

I computed the tide components including in groundwater level data with Baytap-G (Tamura, 1995), and selected the observation wells which show the earth tide response. The wells with the earth tide response are 20, the wells without the earth tide response are 163 of them among 183. Second, I measured the degree of coseismic groundwater level change. The observation well in which the groundwater level change was observed is 162 of them among 183. Then we compared the water level change of amount with peak ground velocity of seismic ground motion every frequency and response sector. First, slightly high correlation was observed between the water level change and peak ground velocity or spectral response. For example correlation coefficient between it and vertical motion peak ground velocity in 0.1-0.2Hz is 0.68, correlation coefficient between it and vertical motion spectral velocity in 0.1Hz is 0.65. The sensitive wells for the Earth' tide can respond strongly to strain than the wells without response for Earth's tide. This suggests that the wells can record water pressure change since wellbore storage effect was so small. Second, the correlations are higher in a low frequency ground motions than a high frequency ones. Since the displacement response spectra is larger at low frequency (>1Hz) in Chi-Chi earthquake, water pressure in the aquifer would be increased by large amplitude of low frequency ground motion.

Keywords: the 1999 Chi-Chi earthquake, groundwater change, seismic ground motion, liquefaction