The relationship between groundwater level and soil moisture for reduction of gravity disturbance.

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Tono Research Institute of Earthquake Science (TRIES) has been conducting continuous gravity observations in and around the Mizunami Underground Research Laboratory (MIU) aiming at the detection of earthquake-related gravity change. Quantification of gravity disturbances caused by groundwater level (or pore pressure) fluctuations has been refined by previous studies (Tanaka et al. 2006 G-cubed; 2013 EPS; under review). In particular, the primary factor of the gravity change in the order of a day or less, which is important in monitoring of crust activity, is precipitation (or unconfined groundwater level). By the way, in comparison with the groundwater level observation, soil moisture observation is incredibly easy and has much flexibility to install the instruments. Hence, we want to clarify these relationships based on observation data of gravity, groundwater level, and soil moisture, and then want to estimate gravity response caused by rainfall from soil moisture measurement. We have started parallel observations of an unconfined groundwater level (SBS16 borehole), a combined weather observation system including two soil moisture meters (made by Onset Computer Corp.), and a profile moisture meter (made by Delta-T Devices Corp.), at Syobasama Observation Point about 1.3 km away from the MIU site, since the fall of 2016. Meanwhile, continuous observation using gPhone gravimeters has been continuing inside and outside the MIU. At the time of this writing, because of the small amount of data and insufficient processing of collected data, we still have found no high precipitation or groundwater fluctuation events detectable by the gravimeter (approximately 10 mm on hourly precipitation, 30 mm on daily precipitation). However, when hourly precipitation exceeds about 5 mm, the SBS16 borehole is possible to respond on the order of meters in groundwater level. On 13-14 December 2016, there was a maximum 7 mm on hourly precipitation. At this time, in the soil moisture observations, the volume moisture content increased between 0 to 20%. The 0% was at the depth 30 and 40 cm channels of the profile moisture meter. On the other hand, the 20% was at the depth 10 cm channel of the same meter. The 20 cm depth channel of the profile moisture meter and the two soil moisture meters showed about 5% increase in water content volume. To adopt as a substitute observation for groundwater level observation, such the results indicate that the soil moisture meter should be installed and interpreted carefully because of its susceptibility to the setup situation. In future, we want to estimate these mutual conversion coefficients by comparing both groundwater level and gravity observation data after adequate data accumulation. Furthermore, we will aim to utilize soil moisture meter for correction of gravity observation of a place where groundwater level observation is unavailable.
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