

Monitoring Groundwater Variations by Means of Precise Gravity Measurements



Photo 1: The relative gravimeter (left) and the absolute gravimeter (right).

Changes in the groundwater level cause changes in mass underground. These changes in mass are manifested as gravity changes above ground. Due to the improvements in gravity measurement technologies in recent years, it is now possible to detect these tiny gravity changes. Previously we measured the groundwater levels of observation wells to observe the groundwater variations. However, this time we made repeated measurements of precise gravity and attempted to detect quantitative changes in groundwater based on the observed gravity changes instead. There are two kinds of gravity measurements: absolute gravity measurements which directly measure the absolute value of gravity, and relative gravity measurements which measure the gravity differences relative to a reference point where the absolute gravity value is known (Photo 1).



Photo 2: Gravity measurement using the absolute gravimeter. The controller in the vehicle carries out the measuring operation.



Photo 3: Gravity measurement using the relative gravimeter. Above the gravimeter the researcher is measuring the amount of ground subsidence using a GPS.

In this study, we carried out high-precision gravity measurements combining absolute measurements and relative measurements in Jakarta, where a lot of ground subsidence is occurring due to excessive pumping of groundwater (Photos 2 and 3). However, ground subsidence also causes gravity changes in addition to groundwater level changes, so when making the gravity measurements we also measured the amount of ground subsidence using a GPS.