Fusion of Time-Lapse Gravity Survey and Hydraulic Tomography for Estimating Spatially Varying Hydraulic Conductivity and Specific Yield Fields

*Jui-Pin Tsai[1], Liang-Chang Chang[1], Tian-Chyi Jim Yeh[2]

1. National Chiao-Tung University, Taiwan , 2. The University of Arizona, USA

Hydraulic conductivity (K) and specific yield (S_y) are important aquifer parameters, pertinent to groundwater resources management and protection. These parameters are commonly estimated through a traditional cross-well pumping test. Employing the traditional approach to obtain detailed spatial distributions of the parameters over a large area is generally formidable. For this reason, this study proposes a stochastic method that integrates hydraulic head and time-lapse gravity based on hydraulic tomography (HT) to efficiently derive the spatial distribution of K and S_y over a large area. This method is demonstrated using several synthetic experiments. Results of these experiments show that the K and S_y fields estimated by joint inversion of the gravity and head dataset from sequential injection tests in unconfined aquifers are superior to those from the HT based on head data alone. We attribute this advantage to the mass constraint imposed on HT by gravity measurements. Besides, we find that gravity measurement can detect the change of aquifer’s groundwater storage at kilometer scale, as such they can extend HT’s effectiveness over greater volumes of the aquifer. Furthermore, we find that the accuracy of the estimated fields is improved as the number of the gravity stations is increased. The gravity station’s location, however, has minor effects on the estimates if its effective gravity integration radius covers the well field.

Keywords: Hydrogeological parameters, Gravity, Hydraulic tomography, Joint interpretation

