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Hydrogeophysical approach to estimate hydrogeological parameters

E. Rizzo (1), S. Straface (2), F. Chidichimo (2), V. Giampaolo (1), M. Votta (1), and V. Lapenna (1)

(1) CNR-IMAA, Hydrogeosite Laboratory, Marsico Nuovo-Tito, Italy (rizzo@imaa.cnr.it), (2) Università della Calabria, Dipartimento di Difesa del Suolo, Via P. Bucci, 42B, 87036, Rende - Italy (straface@unical.it)

The main problem of a real heterogeneous aquifer is its characterization which is usually obtained from the pumping tests and the relative measurements of the induced drawdown. Unfortunately, these methods are intrusive and expensive and the hydrological system is perturbed by the presence of perforations. Therefore, the use of a hydrogeophysical approach, with its low intrusive tools, is able to obtain a great deal of information of the aquifer at low cost.
The new controlled site “Hydrogeosite”, a large lab-pool (12x7x3m) situated in a steel shed in the research area of CNR-IMAA in Marsico Nuovo (Southern Italy), is a special large scale site where the laboratory experiments can be comparable at field scales ones. The large lab-scale system is completely filled with a homogeneous medium (quartz-rich sand with a medium-high hydraulic conductivity in the order of 10-5 m/s) to simulate the space and time dynamics of an artificial aquifer and to study the new relationships between geophysical and hydrogeological parameters. A pumping test realised in the Hydrogeosite Laboratory is shown. During this test, hydraulic head and self-potential variations generated by the pumping were recorded. The experiment was able to reach a quantitative correlation between the natural electrical field signals (Self Potential) measured at the ground surface and the produced groundwater flow (piezometric head). In particular the water table distribution, obtained using a KED approach, and the average hydraulic conductivity, obtained using a Boussinesque’s approximation, were both estimated by means of measured SP signals finding equivalent values of those calculated using hydraulic head measurements. Regarding the hydrogeophysical aspects of the experiment, it can be observed that the passive-type geophysical technique of the self-potential measured at the ground surface can be correlated with the groundwater flow produced both during the pumping and in the recovery phase.
The results of these experimentation open the possibility to deal with the problems regarding the monitoring of a real heterogeneous porous media, because of the actual necessity to have a lot of direct information to characterize the groundwater flow.