Geophysical Research Abstracts
Vol. 14, EGU2012-301, 2012
EGU General Assembly 2012

Surface clogging process modeling of suspended solid during urban stormwater aquifer recharge

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Aquifer recharge (AR), which uses urban stormwater, is an effective technique to control the negative environmental effects of groundwater over-exploitation. While AR is widely used worldwide, clogging problems in infiltration systems remain the key restricting factor in broadening its practice. At present, quantitative understanding of the clogging process is still very poor. A laboratory study was conducted to understand surface physical clogging processes, with the primary aim of developing a model for predicting suspended solid clogging process before the AR projects start. The experiments investigated the clogging characteristics of different suspended solids size in recharge water by using a series of 1-D fine quartz sand columns. The results showed that the smaller the suspended particles in recharge water, the farther the distance of movement and the larger the scope of clogging in porous media. Clogging extents in fine sand were 1 cm, with suspended particle sizes ranging from 0.075 mm to 0.0385 mm, and 2 cm, with particles less than 0.0385 mm. In addition, clogging development occurred faster for smaller suspended solid particles. It took large-, medium-, and small-sized particles 48, 42, and 36 h, respectively, to reach pre-determined clogging standards. An empirical formula and its recursive model for the surface clogging evolution process were derived based on the series of experiments. The verification results obtained by stormwater recharge into the fine sand demonstrated that the model could reflect the real conditions of surface clogging processes. Parameter sensitivity of the model was determined, and results showed that the estimated parameters in model would not cause obvious errors for clogging prediction.