Geophysical Research Abstracts
Vol. 21, EGU2019-8954, 2019
EGU General Assembly 2019

Using natural tracers to assess the impact of surface water - groundwater interactions upon the vulnerability of a well field

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The Rhône's alluvial aquifer contributes to the drinking water demand of 180000 inhabitants in various agglomerations on the left bank of the Rhône near to Avignon, France. Two of the main pumping fields are on the island of Barthelasse which is the largest river island in Europe. Owing to its location close to the river and the presence of backwater directly connected with the river by drains, the aquifer is highly vulnerable to river pollution. The objectives of this study are to understand the water exchanges processes and to quantify the water transfer between river, backwater and groundwater in context of increase of water needs. In this way a large pumping test of 1000 m3/h during 24h was conducted in November 2018 in one of both pumping exploitation field, stopped for this occasion. An isotopic and physicochemical monitoring was performed, including time lapse isotopic monitoring using a laser spectrometer (O18, H2) and Rn content continuous measurements in one observation point located at 35 meters from the pumping wells, 60 meters from the backwater and 300 meters from the Rhône river . In addition, discrete samples were collected in several observation points on the field, in the pumping wells, in backwater and in Rhône river to analyses the major ions, 13C and 3H. To complete this study, groundwater levels, temperature, electrical conductivity and pH were also monitored with sensors already in place in the pumping field and in the Rhône river. The first results show that backwater and Rhône river have key roles in the hydrodynamic system. Indeed, the electric conductivity and Rn concentration in the observation well decreased with time according to the drop of the groundwater level showing that the contribution of surface waters increased steadily along the pumping test. The water chemistry in the pumping well indicated a participation of 10 % and 90 % of surface water and groundwater respectively, and the groundwater age estimation indicated a transit time of few days in the system. The backwater has a leakage effect to the groundwater but in none homogenous way due to the high heterogeneity of the alluvial aquifer. The backwater chemistry is strongly influenced by the river and to explain the groundwater dynamics, three hypothesis are investigated: firstly a direct connection between the river and pumping field, secondly a leakage effect of the backwater to the groundwater without direct connection between the river and pumping field and thirdly both river and backwater connection with the pumping field. This isotope geochemistry and multi-tracer approach is still in progress and gives the opportunity to have a better understanding of the groundwater and surface water interaction according to the pumping frequency in the different wells and the hydrological conditions (Rhône level variations).