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Time-lapse seismic experiments to constrain hydrodynamic parameters at the stream-aquifer interface

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VP/VS or Poisson's ratio estimated from active seismic methods recently proved to be efficient in the imaging of the critical zone and associated hydrosystems. We suggest here a time-lapse application of this approach to provide both spatial and temporal constraints on the hydrodynamic model of the Avenelles experimental basin (Seine et Marne, France). The preliminary studies of this hydrosystem relied on typical combined interpretation of sparse geological and hydrological data. Geophysical surveys, performed throughout the watershed, helped delineating the different compartments and identifying their connectivity with the stream network. Once a basin-scale global hydrogeological model established, hotspots were targeted with local high frequency monitoring stations to investigate its stream-aquifer exchanges. At these stations, recorded data (bank piezometers, stream water temperature and level, temperature profiles in the hyporheic zone) clearly showed contrasts in the dynamic of the hydrosystem along the stream network. However, the nature of the compartments and their associated properties, observed at the basin-scale, would not explain the data observed at the local scale. It highlighted the need for detailed description of the hydrosystem, at the stream-aquifer interface. One specific hotspot was thus selected to perform soundings and geophysical measurements of higher resolutions. Thanks to electrical resistivity tomography, P-wave refraction and surface-wave seismic imaging, we provided a description of the local heterogeneities both in terms of lithology and water content. The seismic experiments were then repeated with a two-month time step. At each time step, pseudo-2D sections of Poisson's ratio clearly showed strong spatial and temporal variations in saturation of the vadose zone. These results then helped providing updated constraints and boundary conditions to the hydrodynamic model.