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Distributed temperature sensing to monitor the fresh/salt groundwater interface

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As pressure on coastal fresh groundwater resources increases, interest in coastal aquifers monitoring rises. The weakest point of coastal aquifers occurs at the underground fresh-salt water interface induced by seawater intrusion (SWI), highly sensitive to any change in the heads of the fresh and salt water bodies. SWI is, therefore, one of the main features of a coastal aquifer to be monitored and understood.
Traditionally, changes in electric conductivity have been used to identify and monitor the interface in coastal aquifers. Alternatively, natural differences in temperature between fresh and the saline groundwater bodies are also known to provide useful information. Optical Fibre Distributed Temperature Sensing (FO-DTS) is increasingly being used in field hydrogeology because of its high spatial and temporal resolution. To test the FO-DTS technology for the monitoring and quantification of the SWI dynamics, distributed temperature data were collected every 15 minutes in a Mediterranean granular aquifer during September-October 2017, matching with the occurrence of an extreme rainfall event.
Thermal response to the recharge event is compared with data collected independently in wells from electrical conductivity and temperature measurements. A 2D variable density heat and solute transport model is perform to simulate groundwater fluxes towards the sea and confirm the conceptual model defined from the interpretation of the FO-DTS data.
Distributed temperature data reflect thermal responses to the extreme recharge event. Detailed spatial and temporal characterization of fluxes towards the sea is then possible by combining these data with the numerical model. However, smaller displacement of the interface, like those produced by tides, were not detected by FO-DTS. Only hydraulic processes with thermal responses larger than 0.15 ºC could be observed with this technology. Therefore, the high spatial and temporal resolution provided by FO-DTS is limited by its temperature resolution, which depends on many factors, such as the DTS sensor, the number of connections, the calibration baths and the calibration process. In any case, it is a promising technology for monitoring of fast responses of the interface to large scale processes like recharge events.

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