Observational & numerical evidence of storm-driven piezometric/conductivity dynamics in the Roussillon coastal aquifer (Mediterranean basin, France)

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IAHS2022-292
IAHS-AISH Scientific Assembly 2022

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For years, piezometric times series recorded in boreholes located nearby the shore clearly highlight multifarious interactions between the aquifer and the shoreface. Beyond the usual signature of earth tide observed almost everywhere, measurements show that piezometric cycles and trends, as well as particular groundwater flows in the coastal aquifer, may be driven by oceanic tide, infra-gravity/wave spectra, shoreline edge wave or wind-/wave-driven setup. At a given station, the groundwater dissipation of the marine signal should be proportional (i) to the frequency of the source and (ii) to the distance between the station and the shoreline. Assuming that those two effects can be distinguished, a full spectral analysis of piezometric time series at the station would reveal the nature of the marine processes at the source of the recorded perturbations.

Along the western French Mediterranean coast, a high-resolution hydro-geophysical observatory (several boreholes qualifying each layer of the Roussillon aquifer) was set up to quantify such interactions in terms of piezometric level and conductivity dynamics. We use data from this observatory to characterise how and how much coastal groundwaters are controlled by meteo-marine forces. We define a set of prospective meteo-marine conditions (mainly wave, wind and water level) ranging from fair to extreme weather. Then, a non-hydrostatic Darcy solver with free water table is designed by our team to question this specific problem. After a model calibration with data from the observatory, we massively calculate marine-controlled water table and groundwater flow dynamics. From such a comprehensive dataset, we delineate numerical-derived relationships between marine forcings and coastal groundwater behaviours. This exploratory work highlights the fact that marine influence on coastal aquifers may have been underestimated and could result in severe consequences on coastal water resources under certain conditions, which are discussed.