Geophysical Research Abstracts
Vol. 21, EGU2019-15181, 2019
EGU General Assembly 2019

Hydraulic and mechanical characterisation of tide-induced head fluctuations in coastal aquifers

Tybaud Goyetche (1,2,3), Maria Pool (2,3), Jesus Carrera (2,3)

(1) Department of Civil and Environmental Engineering (DECA), Universitat Politécnica de Catalunya (UPC), (2) Associated Unit: Hydrogeology Group (UPC-CSIC), (3) Institute of Enviromental Assessment and Water Research (IDAEA), CSIC, c/ Jordi Girona 18, 08034 Barcelona, Spain

The tidal response test is a unique low-cost aquifer scale test to determine the hydraulic diffusivity ($D_h = k/S_s = T/S$), and thus the connectivity to the sea, from the analysis of the aquifer response to sea level oscillations. Yet, the method is hardly used in management practice possibly because it never behaves according to traditional theory (analytical solution of Jacob [1950] and Ferris [1951]). To illustrate the complexities of tidal response interpretation, we apply the tidal method to a series of well observations located in a Mediterranean coastal aquifer (Argentona experimental site, Barcelona, Spain). From a harmonic analysis over a two-month period, we identify the main tidal constituents and quantify their amplitude and phase shift (delay between the tidal fluctuation and the well response) at the reference open water and the observation wells. Two different effects are considered: (i) the hydraulic effect caused by the hydraulic connection between the aquifer units and the sea, and (ii) the mechanical effect generated by the compression of the undersea aquifer portion due to tidal fluctuations and its propagation landward. We perform several numerical simulations by considering different aquifer configurations to determine the aquifer geometry and calibrate its hydraulic parameters. We find that hydraulic diffusivity estimates derived from the amplitude attenuation are significantly different from those derived from the phase shift by more than one order of magnitude when the aquifer is assumed to be homogeneous and only the hydraulic effect is considered. A stratified configuration with different aquifer units and aquitards and including mechanical effects is required to reproduce properly the head response observed in the wells, particularly for the phase shift. Furthermore, calibrating the main constituents separately we observe that a decrease in the tidal period leads to higher diffusivity estimates, revealing a scale effect. Our numerical results demonstrate that mechanical effects play a very important role in the aquifer response to tidal oscillations, even in shallow thin aquifers, and must be accounted for proper characterisation and estimation of hydraulic parameters in coastal aquifers.

Acknowledgements

This work was funded by the projects CGL2013-48869-C2-1 y CGL2013-48869-C2-2-R of the Spanish Government. We would like to thank SIMMAR (Serveis Integrals de Manteniment del Maresme) and the Consell Comarcal del Maresme in the construction of the research site.

References

Ferris, J. G. (1951), Cyclic fluctuations of water level as a basis for determining aquifer transmissibility, Int. Assoc. Sci. Hydrol., 33, 148–155. Jacob, C. E. (1950), Flow of groundwater, in Engineering Hydraulics, edited by H. Rouse, p. 321–386, John Wiley, N. Y.