Geophysical Research Abstracts,
Vol. 11, EGU2009-1414-1, 2009
EGU General Assembly 2009

Resolving the atmospheric pressure influence on watertable level fluctuations in the coastal aquifer south of Ravenna, Italy

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Knowledge of water table fluctuations in coastal zones is important to obtain information on the aquifers hydraulic properties. In order to uniquely interpret this information, it is important to quantify the contribution of each process causing the fluctuations. We recorded two long-period time series of watertable level variations in two piezometers of the coastal phreatic aquifer at Cervia (south of Ravenna), Italy. The piezometers were located on a transect normal to the shoreline, one at 40 m and the other at 70 m from the coast. The dataset has been cleaned for input from rain events, pressure loading and tide-induced fluctuations. The eliminations of fluctuations with frequency 12-24 hours has been particular difficult, because no analytical solution can simulate the observed real fluctuation behaviour. The best solution among those tested has been the one from Li et al., 2000 (c) for spring-neap tides.

Despite the fact that this solution predicts only groundwater waves generated by bichromatic signals, and that the boundary conditions require a steep beach slope (not always the case for this stretch of the adriatic sea), the results that we obtained are encouraging. As simplifying assumptions we used a beach slope set to the minimum acceptable value in the solution and no further interaction between the two bichromatic signals when added together. The Adriatic tide, in fact, is defined as “mixed” with dominant semidiurnal type, so that in order to model sea level variations properly we used four harmonic components as recommended from other authors (references). In enclosed or partially enclosed seas, seiches and tides could have similar frequencies, but they are caused by different processes. Seiches could, in fact, interfere with tide waves resulting in a change in amplitude and phase of sea level in response to wind and pressure. Seiches episodes have been extracted and filtered via power spectra and harmonic analysis in both dataset for sea level and watertable level variations. The interaction between seiches and tides has been identified and eliminated. At this point a last fluctuation was left in the datasets; the so-called ‘inverted barometric’ effect. This is well known for sea level variations and it has also been observed in groundwater level data. Surprisingly, the way this effect is transmitted through the aquifer is rather different from that described for tides: amplitude damping is smaller than expected (and appears to have a non-exponential trend) and also phase lag seems to have a non-linear relation with respect to distance from the shoreline.