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Using land subsidence observations for groundwater model calibration

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PS-InSAR derived subsidence and groundwater level time series are used to calibrate a groundwater model of Tazerbo well field, Libya, by estimating spatially varying elastic skeletal storage (S_{ske}) and hydraulic conductivity (H_k) of the model area. Tazerbo well field is a part of the Great Man-Made River Project (GMMRP) designed with 108 wells and total pumping rate of 1 million m^3/day. The water is pumped from the deep sandstone aquifer (Nubian sandstone), which is overlaid by a thick mudstone-siltstone aquitard. Pumping related deformation patterns around Tazerbo well field are obtained by processing 20 descending Envisat scenes for the period between 2004 and 2010, which yield a concentrated deformation around the well field with the maximum deformation rate around 4 mm/yr. The trends of time series of groundwater head and subsidence are in good agreement for observation wells located in the vicinity of the pumping wells and the pattern of subsidence correlates with the locations of active wells. At the beginning of calibration, different pairs of S_{ske} and H_k are assigned at observation well locations by trial and error so that the simulation results of the forward model would approximate heads and mean linear deformation velocity at these locations. Accordingly, the estimated initial parameters suggest relatively constant H_k(5 m/d) and increasing S_{ske} from south to north ($1x10^{-6}$ m^{-1} – $5x10^{-6}$ m^{-1}). In order to refine their spatial distribution, representative values of S_{ske} and H_k are assigned at 25 equidistant points over the area, which are restricted by the predetermined values. To calibrate the parameters at assigned locations UCODE is used along with MATLAB. Once the convergence is achieved the estimated parameter values at these locations are held constant and new "in between – equidistant" locations are determined to estimate S_{ske} and H_k in order to spatially refine their distribution. This approach is followed until the relation between observed and simulated results cannot be improved anymore. The final results, show good relation in the areas close to well sites, while difference between simulated and observed values increases towards the southeast boundary of PS-InSAR observations. This divergence can be explained by i) the uncertainty in the parameters at the southeast part of the model area, due to lack of deformation observations, ii) S_{ske} may have been underestimated at the locations with thin aquifer and thick aquitard material.