AGU 100 FALL MEETING
Washington, D.C. | 10-14 Dec 2018

H31E-08: Statistical quantification of land subsidence due to groundwater withdrawal in the Chaobai alluvial fan, China, by coupling hydrofacies and geomechanical models

Wednesday, 12 December 2018
09:45 - 10:00
Walter E Washington Convention Center - 146A

Alluvial fans are characterized by large heterogeneity in soil distribution. Coarse and fine materials, the former being permeable and stiff and the latter less permeable and compressible, are alternatively distributed because of the complex depositional and diagenetic processes which occurred during long-term fan evolution. Alluvial fans are usually a main source of groundwater resource and have been significantly exploited in several countries worldwide with severe consequences in terms of piezometric decline and land subsidence. In this contribution we present a modelling framework to investigate the effects of sedimentary heterogeneity on land subsidence. Firstly, the heterogeneity of the sedimentary architecture of an alluvial fan is stochastically simulated through multi-zone transition probability models. Secondly, the facies model is translated into a 3D finite element grid and populated with facies-dependent hydraulic conductivity and compressibility field. The grid is then used to sequentially solve the groundwater flow and equilibrium geomechanical equations. The stochastic flow and geomechanical simulations are explicitly coupled. A Monte Carlo procedure is implemented to investigate the effects of the facies heterogeneity. The modeling approach is applied to the Chaobai plain, north of Beijing, China. Here, the alluvial aquifer system has been largely over-exploited since the 1970s to supply water to the Chinese capital, causing land subsidence up to 1 m in some portions of the plain over the last 50 years. Borehole Stratigraphic data from hundreds of boreholes, piezometric records, land subsidence measurements from levelling and SAR interferometry, deep compaction provided by extensometer stations are used to set-up the hydrofacies model and calibrate the 3D groundwater flow and geomechanical model. The simulation interval covers the time from 1965 to 2012. A number of 100 hydrofacies generations has been used. The statistical analysis of the model outcome has allowed characterizing the uncertainty of the 3D displacement field of the land surface associated to the Chaobai alluvial fan structure. The study casts a light on the possibility of simulating land subsidence due to groundwater pumping from highly heterogeneous sedimentary systems.

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