NH31B-0221: Numerical simulation of earth fissures caused by overly aquifer exploitation at Guangming Village, China

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Earth fissures accompanying anthropogenic land subsidence due to overly aquifer exploitation create significant geohazards in China. In the framework of an efficient and safe management of groundwater, numerical models represent a unique scientific approach to predict the generation and development of earth fissures. However, the common geomechanical simulators fail to reproduce fissure development because, due to compatibility conditions, they cannot be effectively applied in discontinuous mechanics. We present an innovative modelling approach for the simulation of fissure development. Firstly, a regional 3D groundwater model is calibrated on available piezometric records; secondly, the regional outcome is used to define the boundary conditions of a local 3D groundwater model developed at the fissure scale and implementing a refined discretization of the local hydrogeologic setting; finally, the pressure change are used as forcing factor in a local 3D geomechanical model, which combines Finite Elements and Interface Elements to simulate the deformation of the continuous aquifer system and the generation and sliding/opening of earth fissures The approach has been applied to simulate the earth fissure at Guangming Village in Wuxi, China with land subsidence of more than 1 m caused by the overexploitation of the second confined aquifer. The first earth fissure was observed in 1998. It developed fast from 1998 to 2007. The domain addressed by the local simulations is 2 km wide and 5 km long. The thickness of the aquifer system ranges from 0 m, in the proximity of a mountain ridge southward, to 210 m northward and includes a phreatic aquifer, the first and second confined aquifers, and four aquitards. The simulations spanned the period from 1980, i.e. before the inception of large groundwater withdrawals, to 2015. The modelling results highlight that the earth fissures at Guangming Village have been caused by tension and shear, which developed from the land surface downward. The main factors contributing to fissure generation include the shallow bedrock with a sharp ridge, the asymmetric shape of ridge, the uneven thickness of the sedimentary deposits at the west and east side of the buried ridge together with a different pressure change that have been responsible for differential land subsidence.

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