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

H31E-02: Ground rupture due to aquifer overexploitation: numerical modeling of a large lab experiment (Invited)

Wednesday, 12 December 2018
08:15 - 08:30
Walter E Washington Convention Center - 146A

Ground rupture is one of the major environmental impacts associated to land subsidence due to groundwater pumping. This occurrence usually develops when a significant compaction of the sedimentary sequence is caused in aquifer systems with specific geological conditions (i.e., intercepted by faults basins, bounded by shallow uneven bedrock, characterized by heterogeneous distribution of compressible/uncompressible deposits). Southwestern USA, China, Mexico, and Iran are the countries where the majority of ground ruptures has been observed. Ground ruptures can be up to 15 km long, 1–2 m wide, and 15–20 m deep. With the aim of improving our understanding of the mechanisms responsible for rupture generation, a large laboratory test was carried out at the Key Laboratory of Earth Fissures Geological Disaster, Nanjing, China. A 0.8-m high concrete prism resembling a bedrock ridge was placed in a 4.0-m long, 1.8-m wide, and 1.5-m high box and buried by granular material consisting of (from top to bottom) silt, coarse sand, and clay layers. The physical model is representative of the geological setting typical of Wuxi, China, a large city in Jiangsu Province threatened by ground ruptures. The porous medium in the box was saturated and then drained, with the formation of cracks in correspondence of the prism-shaped ridge. The experiment evolution was properly monitored in terms of water level, vertical displacements, strains, crack initiation and growth. The lab outcomes have been analyzed through an advanced numerical 3D modelling approach, where a variably-saturated finite-element (FE) groundwater flow model is coupled with a FE interface-element (IE) geomechanical simulator. The evolution of the distributed pressure, displacement. and stress/strain fields are provided by the FEs. IEs prove especially effective in examining the relative displacements of adjacent elements, such as the opening and slippage of preexisting faults or the generation of new fractures, by using an elastoplastic constitutive law based on the Mohr-Coulomb failure criterion. The preliminary simulations of the lab experiment have allowed improving the interpretation of the observed geomechanical processes and, consequently, the comprehension of the mechanisms responsible for rupture generation in subsiding basins.

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