Geophysical Research Abstracts
Vol. 21, EGU2019-6272, 2019
EGU General Assembly 2019

Effects of Focused Groundwater Flow and Internal Erosion on Multiscale Land Deformation Risk in Urban Areas

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Urbanization often accompanies rapid developments both surface and subsurface of the cities and exerts hydrogeological impacts on the environment. Increasing impermeable covers and massive groundwater extraction result in pore pressure reduction and citywide land subsidence. There are also smaller and local scale land deformation and road collapse events that are associated with the internal soil erosion process with focused groundwater flow, induced by old sewer and water supply lines failure, water leakage from excavation sites and underground tunnels. The previous analysis shows that the location of road collapsing events in Seoul city is strongly correlated with urban hydrogeology change caused by the damaged underground infrastructure overlain by sandy riverine deposits.

We develop a fully coupled groundwater flow – land deformation model considering internal soil erosion process to understand the exact mechanism of land subsidence and road collapsing in the city area and investigate the effect of focused groundwater flow and internal soil erosion on enhancing risks in the subsurface. We also test the possible scenarios of collapsing events associated with the damaged tunnels and utility lines failure and quantify the displacements and porosity changes around the hazard sites. One of the main objectives of the research is to predict the potentially high-risk zone in the urban area under the dynamic changes of critical factors such as pore pressure, permeability, and a fine content fraction of the soil layer.