Modelling land subsidence caused by groundwater exploitation and revealed by geodetic InSAR measurements in the Leuven area

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Synthetic Aperture Radar (SAR) is used since the late 1990s to measure slow-moving ground deformations. The SAR Interferometry (InSAR) technique provides high-density measurements of changes in land surface altitude over large-scale areas. In Belgium, most of the identified subsidence areas have been related to piezometric fluctuations in aquifers[1]. Using data acquired by satellite ERS and ENVISAT, from 1992 to 2001 and from 2003 to 2010 respectively, two areas of significant subsidence have been detected in the north of Leuven. In these specific locations, there are also many historical and currently active pumping wells. The problem of land subsidence induced by changes in the groundwater conditions is significant locally and a link between pumping or drainage and subsidence had been clearly shown in many locations[2]. For the area north of Leuven, data collection showed that the most important pumping wells are screened in the Brussels Formation and the Hannut Formation. Then, a 3D regional groundwater flow model of 5 layers have been developed. Transient simulations are performed starting in the 1990s for the next 30 years. This numerical groundwater flow simulation is coupled to a 1D geomechanical model for consolidation and rebound calculation. Even if the aquifer drawdowns are generally well reproduced by the model, it is less easy to obtain simulated subsidence in agreement with InSAR measurements during the corresponding periods. The subsidence observed by the InSAR measurements is the result of a delayed consolidation process as the pore pressure variations propagate slowly in the compressible low permeability aquitards[3] of the Ieperian. Results comparison to the InSAR measurements can also be used to constrain (calibrate) better the geomechanical model. The coupled models could probably then be used as predictive tools for future groundwater management in relation with local land subsidence risks.

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